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Archeological Investigations at the Santa Maria Creek Site (41CW104) Caldwell County, Texas

Robert Rogers

Linda W. Ellis

Brandy Harris

Candace Wallace

Haley Rush

See next page for additional authors

ATKINS

Atkins North America, Inc.
6504 Bridge Point Parkway, Suite 200
Austin, Texas 78730

Telephone: +1.512.327.6840
Fax: +1.512.327.2453

www.atkinsglobal.com/northamerica

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Environmental Affairs Division
118 East Riverside Drive
Austin, Texas 78704

Prepared by:

Atkins
6504 Bridge Point Parkway
Suite 200
Austin, Texas 78730

Principal Investigator:
Robert Rogers

Report Authors:
Robert Rogers
Linda W. Ellis
Brandy Harris
Candace Wallace
Haley Rush
Julie Shipp
Marilyn Shoberg
Charles Frederick
Michael Glascock
Jeffrey R. Ferguson
Mary Malainey
Chris Heiligenstein
Michael Nash
Boyd Dixon
J. Phil Dering
Leslie L. Bush

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Abstract

The excavations by Atkins at the Santa Maria Creek site (41CW104) described in the following report have succeeded in bringing together a myriad of information regarding aboriginal occupations in eastern Central Texas at the dawn of the Historic period. The analysis of the materials recovered from National Register of Historic Places testing and data recovery has demonstrated that even a site buried in sandy, bioturbated sediments can still significantly add to the archeological record. This becomes even more important for areas such as Caldwell County, Texas, which have witnessed few such investigations. The report utilized a wide array of analytical techniques to unravel the site, including extensive ethnohistorical research, artifact analysis, special studies, and experimental archeology.

Contents

Page

Page

Page

Page

Figures

Figures, cont'd.

Figures, cont'd.

Figures, cont'd.

Tables

Tables, cont'd.

Page

Acknowledgments

The successful completion of the archeological investigations at the Santa Maria Creek site has been the result of the work of many individuals. Atkins is especially grateful to Mr. Jon Budd of TxDOT ENV for his support of the project. Thanks are also extended to Dr. James Abbott and Dr. John Arn for visiting the site during the course of the excavations.

At Atkins, Robert Rogers served as Principal Investigator for the fieldwork and the preparation of this report. The field crew, led by Julie Shipp and Dr. Boyd Dixon (Project Archeologists), included Melanie Nichols, Shelley Fishbeck, Haley Rush, Andrea Stahman, Beth Sain, Matthew Cuba, and Lana Martin. Laboratory personnel were led by Candace Wallace and Linda Ellis. Figures were drafted by Candace Wallace and William Rackley. The report was edited by Linda Nance, and Clell Bond served as Quality Control Officer. Word processing was provided by Christine Vidrick.

1

INTRODUCTION

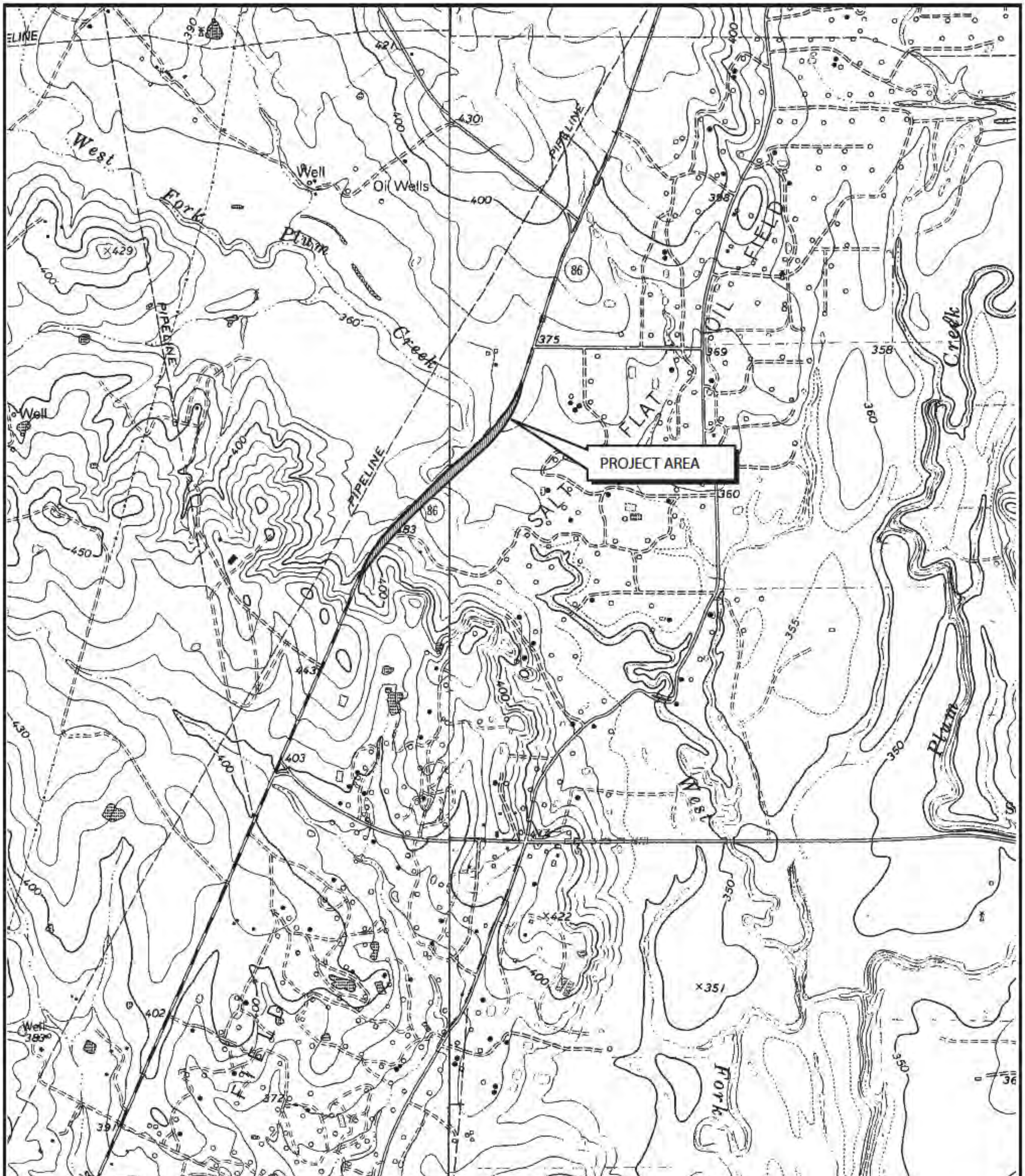
by Robert Rogers

During 2006 and 2007, Atkins conducted archeological investigations at the Santa Maria Creek site (41CW104), in Caldwell County, Texas. This work included National Register of Historic Places (NRHP) testing, carried out under Texas Antiquities Permit No. 4363/4636 between December 18, 2006, and January 9, 2007, and data recovery, performed from August 8, 2007, until October 31 of that year under Permit No. 4623. The site is located adjacent to Farm-to-Market Road (FM) 86, on the north side of an unnamed tributary of the West Fork of Plum Creek in Caldwell County, Texas (Figure 1). It was recorded by Atkins during a cultural resources survey for proposed improvements to FM 86 (Farabough 2006).

The area of potential effect (APE) consists of that portion of the newly proposed 50-foot (ft)-wide (15.2 meters [m]) highway right of way (ROW), which is situated north of an unnamed tributary of the West Fork of Plum Creek. The portion of the 2.8-acre new ROW found to contain prehistoric remains measures approximately 50 ft (15 m) in width east-west by 394 ft (120 m) in length north-south, covering 19,368 ft^2 (1,800 m^2) on the east side of the paved FM 86.

This report includes 15 chapters and five appendices. Following this introduction, Chapter 2 presents the regional and site-specific environmental settings. Chapter 3, entitled Settlement Patterns, contains a wide array of topics including defining the cultural area through intersite analysis and examining all similar-aged sites within a 50-kilometer (km) area, a review of historic Indian groups known to have been in the general site area, an overview of the numerous Spanish expeditions that traversed the area and a discussion of the numerous rivers and streams they crossed, an overview of the portrayal of the area on historic maps generated between the sixteenth and nineteenth centuries, and a description of the historic roads and trails that crisscrossed the area. Chapter 4 is a history of the investigations at 41CW104 that led up to the data recovery at the site. Chapter 5 describes the field methods, laboratory procedures, and special studies that were conducted for the site.

Chapter 6 contains the analysis of the numerous chipped and ground stone artifacts recovered from the NRHP testing and data recovery, and Chapter 7 looks more closely at some of these tools and the microwear seen on them. Chapter 8 describes the ceramics at the site, including a detailed description of the technological characteristics, ceramic petrography, and Instrumental Neutron



north

0 500 1000 meters

0 2000 4000 feet

Base Map: USGS 7.5' Quadrangles; Harwood and Luling, Texas

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Figure 1

Project Location Map

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Activation Analysis (INAA). The cultural features found at 41CW104 are described in Chapter 9, and Chapter 10 discusses the faunal remains. The analysis of the plant remains recovered from the site forms Chapter 11, while the fatty acid composition of selected feature rocks and artifacts is presented in Chapter 12. Chapter 13 presents the results of special geomorphological studies including soil micromorphology, particle size analysis, and magnetic susceptibility.

Chapter 14 contains the results of several experiments that were performed in assessing the nature of the thermally altered rocks (TAR) recovered from the excavations and their role in the subsistence practices of the site's inhabitants. Chapter 15 summarizes the investigations at the site and what conclusions were made. References cited follow Chapter 15.

The appendices include the radiocarbon dating forms, the specimen inventory, the lithic analysis tables, the ceramic analysis tables, and the INAA elemental data table. All of the appendices are provided on a CD.

2

PHYSICAL SETTING

by Robert Rogers

This chapter examines the regional and site-specific environmental setting of the Santa Maria Creek site. A regional overview is presented first, in part because the site is situated in close proximity to several regional ecotones, but more importantly because of the role the ecotones play in defining the settlement patterns that are presented in Chapter 3. The regional overview is followed by more-localized site-specific data including geology, hydrology, soils, and stratigraphy

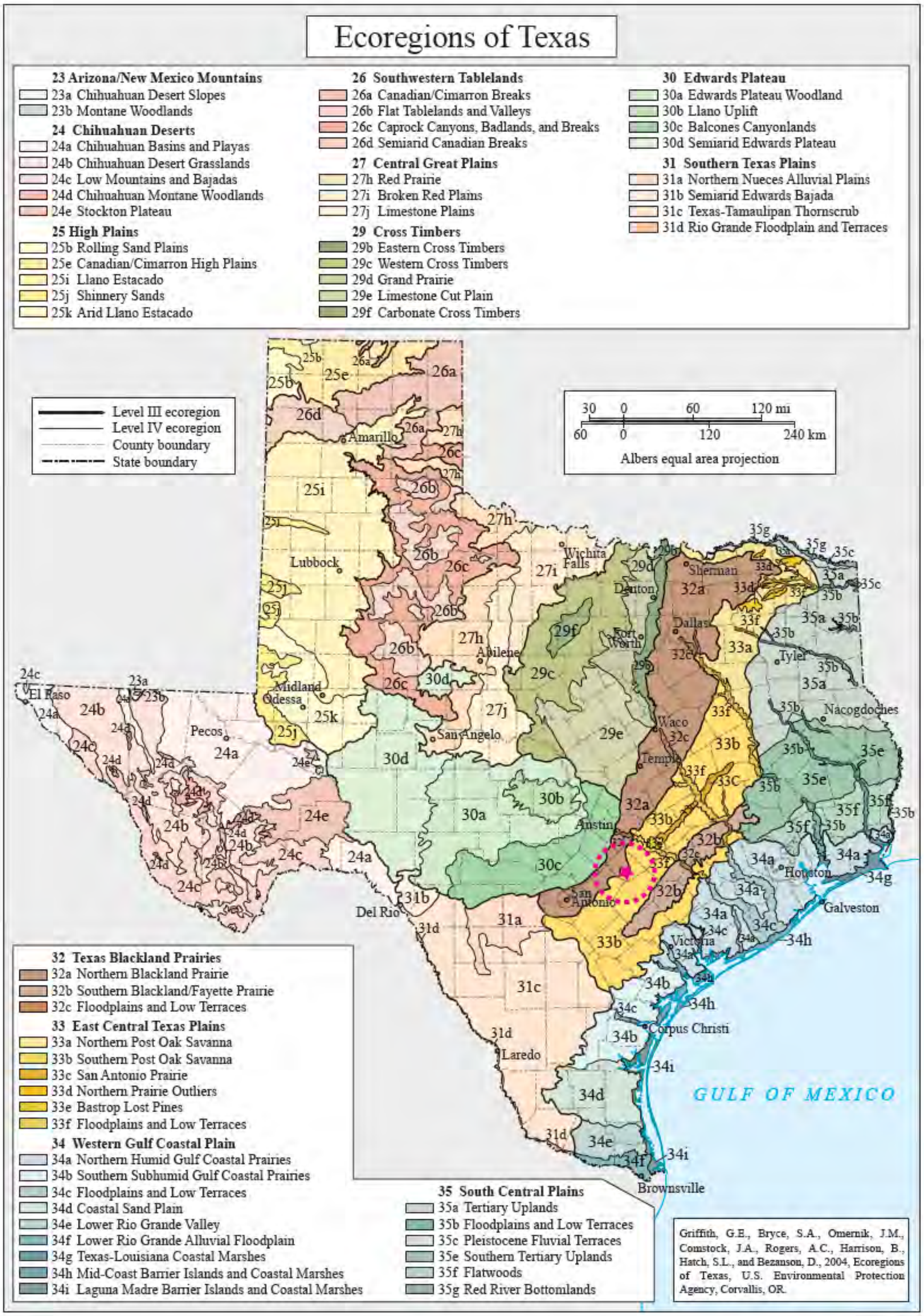
ECOREGIONS

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources (Griffith et al. 2004). Within approximately 50 km of 41CW104 (chosen for archeological review in Chapter 3), there are three ecoregions and eight subregions (Figure 2). These are Edwards Plateau (subregion Balcones Canyonlands), Texas Blackland Prairies (subregions Northern Blackland Prairie, Southern Blackland Prairie, and Floodplains and Low Terraces), and the East Central Texas Plains ecoregion (subregions Northern Post Oak Savannah, Southern Post Oak Savannah, Bastrop Lost Pines, and Floodplains and Terraces).

Edwards Plateau Ecoregion

This ecoregion is largely a dissected limestone plateau that is hillier to the south and east where it is easily distinguished from bordering ecological regions by a sharp fault line. The region contains a sparse network of perennial streams. Due to karst topography (related to dissolution of limestone substrate) and resulting underground drainage, streams are relatively clear and cool in temperature compared to those of surrounding areas. Soils in this region are mostly Mollisols with shallow and moderately deep soils on plateaus and hills, and deeper soils on plains and valley floors. Covered by juniper-oak savanna and mesquite-oak savanna, combined with topographic gradients, fire was once an important factor controlling vegetation patterns on the Edwards Plateau. It is a region of many endemic vascular plants. With its rapid seed dispersal, low palatability to browsers, and in the absence of fire, Ashe juniper has increased in some areas, reducing the extent of grassy savannas (Griffith et al. 2004).

The **Balcones Canyonlands** subregion forms the southeastern boundary of the Edwards Plateau. The Edwards Plateau was uplifted during the Miocene epoch at the Balcones Fault Zone, separating



41CW104

50 Mile Buffer

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Figure 2

41CW104 in Relation to the Ecoregions of Texas

Source: *Ecoregions of Texas*, Griffith et al. 2004

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Drafted by: C. Wallace

central Texas from the coastal plain. The Balcones Canyonlands are highly dissected through the erosion and solution of springs, streams, and rivers working both aboveground and belowground; percolation through the porous limestone contributes to the recharge of the Edwards Aquifer. High-gradient streams originating from springs in steep-sided canyons supply water for development on the Texas Blackland Prairies at the eastern base of the escarpment. The region supports a number of endemic plants and has a higher representation of deciduous woodland than elsewhere on the Edwards Plateau, with escarpment black cherry, Texas mountain laurel, madrone, Lacey oak, bigtooth maple, and Carolina basswood. Some relicts of eastern swamp communities, such as baldcypress, American sycamore, and black willow, occur along major stream courses. It is likely that these trees have persisted as relicts of moister, cooler climates following the Pleistocene glacial epoch. Toward the west, the vegetation changes gradually as the climate becomes more arid. Plateau live oak woodland is eventually restricted to north- and east-facing slopes and floodplains, and dry slopes are covered with open shrublands of juniper, sumac, sotol, acacia, honey mesquite, and cenizo (Griffith et al. 2004).

Texas Blackland Prairies Ecoregion

The Texas Blackland Prairies form a disjunct ecological region, distinguished from surrounding regions by fine-textured, clayey soils and predominantly prairie potential natural vegetation. The predominance of Vertisols in this area is related to soil formation in Cretaceous shale, chalk, and marl parent materials. Unlike tallgrass prairie soils that are mostly Mollisols in states to the north, this region contains Vertisols, Alfisols, and Mollisols. Dominant grasses included little bluestem, big bluestem, yellow Indiangrass, and switchgrass. Typical game species include mourning dove and northern bobwhite on uplands and eastern fox squirrel along stream bottomlands.

The rolling to nearly level plains of the **Northern Blackland Prairie** subregion are underlain by interbedded chalks, marls, limestones, and shales of Cretaceous age. Soils are mostly fine-textured, dark, calcareous, and productive Vertisols. Historical vegetation was dominated by little bluestem, big bluestem, yellow Indiangrass, and tall dropseed. In lowlands and more-mesic areas, such as on some of the clayey Vertisol soils in the higher precipitation areas to the northeast, dominant grasses were eastern gamagrass and switchgrass. Also in the northeast, over loamy Alfisols, were grass communities dominated by Silveanus dropseed, Mead's sedge, bluestems, and long-spike tridens. Common forbs included asters, prairie bluet, prairie clovers, and black-eyed Susan. Stream bottoms were often wooded with bur oak, Shumard oak, sugar hackberry, elm, ash, eastern cottonwood, and pecan. Most of the prairie has been converted to cropland, nonnative pasture, and expanding urban uses around Dallas, Waco, Austin, and San Antonio (Griffith et al. 2004).

The **Southern Blackland Prairie** subregion, also known as the Fayette Prairie, has similarities to the Northern Blackland Prairie although there are some geological, soil, vegetation, and land use differences. The Miocene-aged Fleming Formation and to the west the Oakville Sandstone have some calcareous clays and marls, but differ some from the Cretaceous-aged formations to the north.

Soils are mostly Vertisols (Calciusterts and Haplusterts), Mollisols (Calciustolls and Paleustolls), and Alfisols (Paleustalfs and Haplustalfs). The region appears dissected, and elevations are low. Historical grasslands were likely dominated by big bluestem and little bluestem-brownseed paspalum.

The **Floodplains and Low Terraces** subregion of the Texas Blackland Prairies includes only the broadest floodplains, i.e., those of the Trinity, Brazos, and Colorado Rivers. It covers primarily the Holocene deposits and not the older, high terraces. The bottomland forests contained bur oak, Shumard oak, sugar hackberry, elm, ash, eastern cottonwood, and pecan, but most have been converted to cropland and pasture. The alluvial soils include Vertisols, Mollisols, and Inceptisols (Griffith et al. 2004).

East Central Texas Plains Ecoregion

Also called the Post Oak Savanna or the Claypan Area, this region of irregular plains was originally covered by post oak savanna vegetation, in contrast to the more open prairie-type regions to the north, south, and west, and the pine forests to the east. Soils are variable among the parallel ridges and valleys, but tend to be acidic, with sands and sandy loams on the uplands and clay to clay loams in low-lying areas. Many areas have a dense, underlying clay pan affecting water movement and available moisture for plant growth. The bulk of this region is now used for pasture and range (Griffith et al. 2004).

The landscapes of the **Northern Post Oak Savanna** subregion are generally more level and gently rolling compared to the more dissected and irregular topography to the south. It is underlain by mostly Eocene- and Paleocene-aged formations with some Cretaceous rocks to the north. The soils have an udic soil moisture regime compared to ustic regimes to the south, and are generally finer-textured loams. Annual precipitation averages 40–48 inches. The deciduous forest or woodland is composed mostly of post oak, blackjack oak, eastern redcedar, and black hickory. Prairie openings contained little bluestem and other grasses and forbs. Typical wildlife species include white-tailed deer, eastern wild turkey, northern bobwhite, eastern fox squirrel, and eastern gray squirrel.

The **Southern Post Oak Savanna** subregion has more woods and forest than the adjacent prairie ecoregions, and consists of mostly hardwoods. Historically, a post oak savanna, a thick understory of yaupon, and eastern redcedar occurred in some parts. Many areas of this subregion have dissected and irregular topography. The soils generally have an ustic soil moisture regime, with sand and sandy loam surface textures. It is underlain by Miocene, Oligocene, Eocene, and Paleocene sediments. Sand exposures within these Tertiary deposits have a distinctive sandyland flora, and in a few areas unique bogs occur (Griffith et al. 2004).

The **Bastrop Lost Pines** subregion is an outlier of relict loblolly pine-post oak upland forest occurring on some dissected hills. It is the westernmost tract of southern pine in the United States. The pines mostly occur on gravelly soils that formed in Pleistocene high gravel, fluvial terrace deposits associated with the ancestral Colorado River, and sandy soils that formed in Eocene sandstones (Sparta Sand, Weches Formation, Queen City Sand, Recklaw Formation, and Carrizo Sand). The Lost Pines are about 100 miles west of the Texas pine belt and occur in a drier environment with 36 inches of average annual precipitation. In this area, the deep, acidic, sandy soils and the additional moisture provided by the Colorado River contribute to the occurrence of pines, which are thought to be a relict population predating the last glacial period (Griffith et al. 2004).

The **Floodplains and Low Terraces** subregion contains floodplain and low terrace deposits downstream on only the wider floodplains of major streams, such as the Colorado River. In addition, it covers primarily Holocene deposits and not Pleistocene deposits on older, high terraces. The bottomland forests contain water oak, post oak, elms, green ash, pecan, and willow oak to the east, and to the west some hackberry and eastern cottonwoods (Griffith et al. 2004).

Animals

The intergradation of habitat types and the activity patterns of wildlife species result in some overlapping of faunal communities. Forest-dwelling species may venture into open areas around forest stands, and species characteristic of nonforested habitats may occasionally be found in forested areas. Edges or ecotones between major habitats are preferred by many wildlife species. This is true to some extent for species such as the white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), and bobwhite (*Colinus virginianus*), as well as many songbirds. These transition areas are preferred, not only for the diversity of food materials available, but also for the usually dense cover provided through the characteristic overlap of vegetation communities.

Other fauna characteristic of the area include the fox squirrel (*Sciurus niger*), raccoon (*Procyon lotor*), gray fox (*Urocyon cinereoargenteus*), opossum (*Didelphis virginiana*), nine-banded armadillo (*Dasypus novemcinctus*), bobcat (*Felis rufus*), and swamp rabbit (*Sylvilagus aquaticus*).

Several mammals that formerly occurred in the site area are now extirpated. The following species may have been important to Native Americans and other early settlers of the region, either as food or competitors, or perhaps for cultural reasons: red wolf (*Canis rufus*), black bear (*Ursus americanus*), jaguar (*Felis onca*), ocelot (*F. pardalis*), collared peccary (*Tayassu tajacu*), and pronghorn (*Antilocapra americana*) (Schmidly 1983). Two birds that formerly occurred in the region but are now extinct include the passenger pigeon (*Ectopistes migratorius*) and the Carolina parakeet (*Conuropsis carolinensis ludoviciana*).

One important species of mammal to the prehistoric hunters in the area was the bison. This is particularly true for the latter part of the Late Prehistoric during initial contact with the Spanish. During the early contact period, when Spain was launching numerous expeditions northwards from Mexico, the locations of bison were noted. As early as 1691, during the expedition of Governor

Domingo Terán de los Ríos, a herd numbering about 4,000 was reported along the Navidad River in present-day Fayette County (Foster 1995:237). They were often encountered during subsequent expeditions (see Chapter 3).

Other mammals, such as the feral hog (*Sus scrofa*), did not occur in the region in prehistoric times, but were introduced by settlers of European ancestry. The nine-banded armadillo is likewise new in the area. This animal has expanded its range in eastern Texas since 1900, possibly due to progressive climatic changes, encroaching human civilization, overgrazing, and decimation of large carnivores (Schmidly 1983).

SITE-SPECIFIC ENVIRONMENT

Climate

The site is located at the periphery of the North Central and South Central climatic zones of Texas as defined by Blair (1950). The area is characterized by a relatively mild and uniform climate influenced by the warm and moist Gulf Stream air currents. The mean annual temperature for the area is 68.4 degrees Fahrenheit (°F), with a mean maximum temperature of 94 °F in July and a mean minimum of 38 °F in January (Radian Corporation 1976). An average year sees temperatures reach 90 °F or above on about 119 days, while freezing temperatures occur only on about 29 days. Annual precipitation averages 35.8 inches, and the heaviest accumulations usually occur in April and May.

Geology

The Santa Maria Creek site is situated on recent alluvium and Quaternary fluviatile terrace deposits. The recent alluvium includes floodplain and low terraces. These are subject to flooding and are composed of clay, silt, sand, gravel, and organic matter. The silts and clays are typically calcareous, dark gray to dark brown. Sands are composed primarily of quartz, and gravels are siliceous, containing chert, quartzite, and petrified wood, mostly reworked from Quaternary terrace deposits (Proctor et al. 1974).

The site extends onto Quaternary fluviatile terrace deposits of Pleistocene age that consist of gravel, sand, silt, and clay. Gravels are especially prevalent at the site location, and are siliceous, being composed of chert, quartzite, and petrified wood. Occasional metamorphic rocks from the Llano region are also present (Proctor et al. 1974).

Soils and Stratigraphy

The soils of two soil series have been mapped at 41CW104. The portion of the site extending for about 30 m north of the unnamed tributary of the West Fork of Plum Creek, where most of the hand excavations took place, contains soils belonging to the Gowen series (Lowther and Werchan 1978).

Gowen soils are in the fine-loamy, mixed thermic family of the subgroup Cumulic Hapludolls and order Mollisols. These soils occur in recently deposited alluvium. Typically, Gowen soils have a solum thickness greater than 2 m. Surface horizons having moist color values of less than 3.5 and evident structure range in thickness from about 60 to 150 centimeters (cm). Clay content of the 25- to 100-cm particle-size control section ranges from 20 to 35 percent, and more than 15 percent is coarser than very fine sand. Reaction ranges from neutral to moderately alkaline. The soil is noncalcareous above 130 cm. At the type locality in Erath County, Gowen soils have an A1-A2-Bw sequence.

At 41CW104 a typical profile of Gowen soils consisted of an A-2Ab-2Bw sequence. In some profiles, a second buried soil may have been present, though bioturbation (discussed below) made this recognition difficult. In others, an Ap horizon containing historic debris associated with highway construction was noted. The 2Bw horizon, was initially identified as a Bg or Bt horizon. However, particle-size analysis and soil micromorphology (see Chapter 13) reveal little textural difference between it and the sand-rich overlying horizons, and therefore the subhorizon designation Bw, which indicates a change in color, is probably more accurate. Figure 3 provides views of the soil horizons at the site. Table 1 represents a typical profile description for this part of the site, taken from Unit 29 in the primary excavation area.

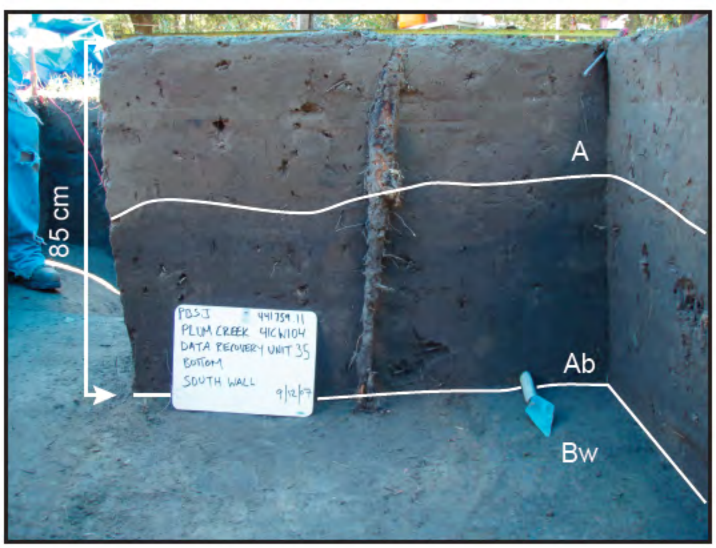
Table 1. Soil Profile Description, Unit 29, North Wall

Horizon	Average Depth	Description
A	0–30 cm	Thick bedded; clear, wavy boundary; dark yellowish brown (10YR 4/6) loamy fine sand; weak, fine, subangular blocky structure; very friable; few silicate pebbles; rootlets common; contains prehistoric artifacts and modern debris
2Ab	30–70 cm	Thick bedded; clear, wavy to undulating boundary; dark brown (10YR 3/3) loamy fine sand; weak, fine, subangular blocky structure; very friable; numerous prehistoric artifacts; charcoal; common silicate pebbles; primary artifact-bearing stratum
2Bw	70+ cm	Lower boundary not encountered; mottled 10YR 4/6 and 10YR 5/1 sandy clay; mottles are many, medium, and prominent; medium, moderate blocky structure; friable; upper surface is undulating, with depressions often containing light gray (10YR 6/1) sand

The light gray sand referred to as occurring in the undulating 2Bw horizon may be the remnants of the 2E horizon. Both the sand and the sediments comprising the 2Bw horizon were culturally or simply sediments from an ancient flood. An unconformity may exist between the 2Bw horizon and the artifact-bearing 2Ab horizon above it. Similar-appearing undulating B horizons are commonly encountered at excavations in east central Texas (Rogers 1993, 1995, 1997). At prehistoric site 41GM166, located in Grimes County, Texas, an Optically Stimulated Luminescent (OSL) date of at least 53,000 years B.P. was obtained from such a horizon (Stokes 1995).

Units 9 and 16, South Wall Profiles

Undulating Bw Horizon
Unit 1, South Wall Profile



Unit 35, South Wall Profile

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Figure 3

Soil Horizons

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Drafted by: C. Wallace

While the Ab or buried soil at 41CW104 contained abundant prehistoric materials, no cultural features were found in it. It does not contain an intact surface, but rather is an occupation zone, and though the number of occupations it witnessed cannot be ascertained, prehistoric artifacts and radiocarbon assays (see Appendix A) indicate they occurred during the Late Prehistoric and Early Historic periods. Earlier Archaic period visits to the site were evidenced by diagnostic dart points, though no Archaic-aged radiocarbon assays were obtained.

The buried prehistoric deposits at the site have been impacted by an array of postdepositional disturbances. It is probable that foremost among these is bioturbation. The presence of numerous infilled rodent burrows was commonly seen in the excavation units, and burrowing insects were also present. The effects of tree fall may have had the most pronounced impact on the deposits. It is estimated that in forested areas such as those that characterize the hardwood bottomlands and terraces around Plum Creek and its tributaries, significant inversion and mixing of soil horizons, and the artifacts in them, have very likely occurred (Wood and Johnson 1981:554).

The site also includes areas mapped as belonging to the Crockett soil series. These soils are in the fine, montmorillonitic, thermic family of the subgroup Udertic Paleustalfs and order Alfisols. The Crockett series consists of upland soils that are deep to weathered shale. They are moderately well drained and very slowly permeable. These nearly level to moderately sloping soils formed in alkaline residuum derived from Quaternary shales and clays. Slopes are dominantly 1 to 5 percent, but range from 0 to 10 percent. At their type locality in Kaufman County, Texas they have a horizon sequence of A-Bt1-Bt2-Bt3-BCtk-Ck1-Ck2.

At 41CW104 these soils are gravelly and shallow, with the A horizon averaging about 30 cm in thickness overlying the culturally sterile Bt horizon. It is best exemplified in the profile of the North Trench (Table 2).

Table 2. Profile Description, North Trench, West Wall

Horizon	Average Depth	Description
A	0–30 cm	Thick bedded; clear, wavy boundary; brown (10YR 5/3) gravelly loamy fine sand; weak, fine, subangular blocky structure; friable; prehistoric artifacts common
Bt	30–60+ cm	Lower boundary not encountered; mottled gray (10YR 5/1) and yellowish brown (10YR 5/8) sandy clay, mottles are many coarse and prominent; structure obscured by silicate gravels

These are the shallowest cultural-bearing soils at the site. As one proceeds downslope towards the intermittent tributary, the A horizon thickens. This portion of the site contains colluvially derived sediments, evidenced by the presence of silicate pebbles. The interface between the alluvial and colluvial deposits appears to be in the vicinity of Feature 4.

Useful Wild Plants

A multitude of useful wild plants would have been available to the occupants of 41CW104. While it is unlikely that a complete inventory of the taxa that were utilized will ever be assembled, it is possible to identify several potentially important plants by comparing modern botanical lists (Hatch et al. 1990) with the ethnobotanical, ethnohistorical, and archeological records. Table 3 lists some of the useful plants currently found in east Central Texas and includes information on the parts of the plants that were used by native groups, how they were prepared, and the season(s) in which they were harvested.

Table 3. Useful Wild Plants of East Central Texas

Taxa	Common Name	Part Utilized	Preparation/Uses	Season	Growth Form
ACERACEAE *Acer rubrum*	Red maple	Sap and bark	Sap for making sugar, and bark dried and pounded and made into bread.	Spring, February to April	Tree
ALISMATACEAE *Sagittaria graminea* *Sagittaria platyphylla*	 Grassy arrowhead Delta arrowhead	Tuberous roots	Boiled or roasted, eaten like a potato.	Spring to autumn	Water Plantain
ANACARDIACEAE *Rhus aromatica*	 Fragrant sumac	Roots, shoots, and berries	Berries were used fresh or dried and soaked in water to make a cool beverage "Indian Lemonade." Roots and shoots were peeled and eaten raw.	Summer	Shrub
AQUIFOLIACEAE *Ilex opaca* *Ilex vomitoria*	 American holly Yaupon	Leaves	Infusion of the leaves used to make a tea. The variety *vomitoria* made a stimulating and intoxicating drink.	Year-round	Shrub to small tree
ARACEAE *Arisaema triphyllum*	 Indian jack-in-the-pulpit	 Bulb or corn	Boiled, dried, ground into meal and baked into bread. The boiled spadix and berries were eaten as a luxury.	 Summer (May to July)	Stemless herb
Peltandra virginica	Virginia arrowarum	Bulbous root		Spring	
ASCLEPIADACEAE *Asclepias tuberosa*	 Butterfly milkweed	Roots, shoots, buds, and seeds	Boiled sometimes with buffalo meat and/or eaten like asparagus. Buds dried for winter use.	Summer	Perennial/ Herb
BERBERIDACEAE *Podophyllum peltatum*	 Common mayapple	Fruit	Fresh fruit eaten when the plant is dying and the fruit has fallen to the ground.	Summer (July to August)	Herb
BETULACEAE *Alnus serrulata*	 Hazel alder	 Timbers, bark, and roots	The wood is resistant to being water logged and is valued for its durability in construction. The bark and roots are used to dye cloth and wood objects to a red or black. The bark and roots also have medicinal properties.	Year-round	Tree
Betula nigra	River birch or black birch	Bark	Medicinal use for stomach pains.	Year-round	Tree
CACTACEAE *Opuntia compressa*	 Eastern prickly pear	Fruit	Eaten fresh or stewed.	Autumn	Shrub

Table 3 (Cont'd)

Taxa	Common Name	Part Utilized	Preparation/Uses	Season	Growth Form
CAPRIFOLIACEAE *Lonicera sempervirens*	Trumpet honeysuckle	Berries, leaves, and flowers	Eaten fresh and has medicinal properties (i.e., astringent, sore throat, and lungs).	Spring and summer (May and June)	Vine
Sambucus canadensis	American elderberry	Berries, blossoms, and bark	The berries are eaten fresh or cooked and the blossoms steeped in hot water make a beverage. Boiling the bark relieves toothaches.	Berries late summer and early autumn, blossoms come on in June and July	Shrub
CHENOPODIACEAE *Chenopodium* sp.	Wormseed	Leaves and seeds	Leaves eaten raw or cooked. Seeds eaten dried and ground.	Spring to early summer, seeds available in fall to early winter	Herb
COMPOSITAE					Herb
Aster sp.	Aster	Leaves	Boiled	Summer	
Erigeron philadelphicus *Erigeron strigosus*	Philadelphia fleabane Prairie fleabane	Leaves Leaves	Boiled, made into a tincture used medicinally to alleviate symptoms of common cold.		
Helianthus sp.	Common sunflower	Seeds, flowers	Seeds produce oil for protein, and flowers can be used as a dye.	Autumn and winter (September to December)	
CONVOLVULACEAE *Ipomoea pandurata*	Bigroot morningglory "Mecha-Meck"	Root	Roasted	Summer	Vine
CRUCIFERAE *Lepidium virginicum*	Virginia pepperweed	Leaves	Spice used as a garnish or salad.	Unknown	Herb
CYPERACEAE *Cyperus* sp. *Carex* sp.	Sedge family	Stems, tubers	Stems stripped of leaves used for food.	Unknown	Herb
EBENACEAE *Diospyros virginiana*	Common persimmon	Fruit	Raw and sometimes made into bread.	Autumn to winter (October to January)	Tree
FAGACEAE *Quercus alba* *Quercus nigra* *Quercus velutina*	White oak Water oak Black oak	Nuts	Some varieties are eaten raw, while others must have the tannin leached out. They are also roasted, ground, and made into bread.	Autumn and winter (October to December)	Tree
GRAMINEAE (Current name POACEAE)		Seeds, grass, and grain		Summer and fall	Herb
Echinochloa crusgalli *Zizaniopsis miliacea*	Barnyardgrass Marshmillet		Ground into flour for mush. Unknown.		

Table 3 (Cont'd)

Taxa	Common Name	Part Utilized	Preparation/Uses	Season	Growth Form
HAMAMELIDACEAE *Hamamelis* sp.	Common witchhazel	Seeds, bark, timber, and leaves	The seeds are edible. The timber was often used to make bows and arrows. The bark and leaves commonly were used medicinally for pain, to stop bleeding, and inflammation.	Seeds and leaves collected in the fall and dried	Shrub/ Tree
JUGLANDACEAE *Carya cordiformis* *Juglans nigra* *Carya illinoinensis*	 Bitternut hickory Black walnut Pecan	Nuts, hulls, and bark	The nuts of all varieties are edible. The hulls were used to make dye and the bark used medicinally for such things as snake bites.	Autumn	Tree
LAURACEAE *Sassafras albidum*	 Common sassafras	Bark of roots and leaves	Tea, beverage, spice, or flavoring added to medicine and cooking.	Year-round	Tree
LEGUMINOSAE *Apios americana*	 American potatobean	Seeds and roots	Eaten raw, roasted, or boiled. Taste of mushrooms or artichokes.	Summer	Vine
LILIACEAE *Allium canadense*	 Canada garlic	Bulb	Used as a spice in cooking.	Spring (April to July)	Herb
LILIACEAE *Polygonatum biflorum* *Smilax laurifolia* *Smilax rotundifolia*	 Great Solomon's seal Laurel greenbriar Common greenbriar	Stalk, shoots	The plant is boiled and eaten like asparagus.	Spring and summer (May and June)	 Herb Vine Vine
MORACEAE *Morus rubra* *Maclura pomifera*	 Red mulberry Osage-orange	 Berries Wood	 Eaten raw or stewed. Used to make bows.	 Summer (July) –	 Tree Tree
ONAGRACEAE *Oenothera laciniata*	 Cutleaf evening primrose	Roots and leaves	Boiled and eaten as well as used for medicinal properties.	Summer	Herb
OSMUNDACEAE *Osmunda cinnamomea*	 Cinnamon fern	Fronds	Boiled for soup.	Unknown	Herb
OXALIDACEAE *Oxalis violacea*	 Violet woodsorrel	Leaves	Fresh as in salads.	Summer (May to August)	Herb
PHYTOLACCACEAE *Phytolacca americana*	 Common pokeberry	Leaves and berries	Leaves are edible and prepared like spinach or asparagus. The berries are poisonous but may be used to make ink.	Spring (April to June)	Herb
PORTULACACEAE *Claytonia virginica*	 Spring beauty	Bulbs	The starchy bulbs were boiled and eaten.	Spring to summer (April to June)	Herb
RHAMNACEAE *Ceanothus americanus*	 Jersey tea	Leaves and roots	The leaves when dried were used as a tea or beverage and the red roots are an excellent dye.	Spring to autumn	Shrub

Table 3 (Cont'd)

Taxa	Common Name	Part Utilized	Preparation/Uses	Season	Growth Form
ROSACEAE		Berries and twig	Berries eaten dried or fresh and the twigs used to make a beverage. *Aronia arbutifolia* was used to make pemmican.	Late summer early fall (August to September)	
Prunus serotina	Black cherry				Tree
Aronia arbutifolia	Red chokeberry				Shrub
RUBIACEAE			Berries eaten raw, boiled, and made into jelly. Medicinal use of plant as astringent, diuretic, and parturient. *Galium* can be used as a poison and/or medicine.	Winter to early spring	Herb
Mitchella repens	Partridge-berry	Berries, leaves, and vine			
Galium tinctorium	Dye bedstraw	Seeds, leaves			
TYPHACEAE		Roots, shoots, bases of stems, flowering ends, and seeds	Root ground into meal, root and base of stem eaten raw, young stems also roasted and eaten like asparagus.	Spring and summer	Herb
Typha angustifolia	Narrowleaf cattail				
Typha latifolia	Common cattail				
UMBELLIFERAE		Roots	Raw roots given to an enemy could cause death as they are poisonous. If cooked and taken in small doses, served as a mild narcotic.	Year-round	Herb
Cicuta maculata	Spotted water hemlock				
Daucus pusillus	Southwestern carrot		Eaten raw or boiled.	Unknown	Herb
VITACEAE			Berries eaten raw, stalks boiled and peeled and eaten. It also was boiled down to a syrup and used as a sweet spice. Berries of the summer grape were probably eaten when in season and some dried for winter.	Unknown	Vine
Parthenocissus quinquefolia	Virginia creeper	Berries, and stalks			
Vitis aestivalis	Summer grape	Berries		Summer	

3

SETTLEMENT PATTERNS

by Robert Rogers and Brandy Harris

This chapter examines the variables that governed the patterns of behavior followed by the occupants of 41CW104. Initially, addressing this topic sought to place the site in a general cultural area and identify some of the early historic native groups who were recorded in the area. While the identification of native groups is discussed at length, it was found during the course of the research that the identification of a cultural area, at least one with firm geographic boundaries, remains elusive. This in large part, as will be seen, reflects the state of flux the native cultures were undergoing during much of the time that 41CW104 was occupied. Intense pressures from the Spanish in Mexico and New Mexico, and the movement of powerful native groups such as the Apache, were forcing new peoples into the area and displacing existing populations.

Spanish expeditions in Texas afford the primary evidence of the relevant historic Indian groups in east central Texas in the late seventeenth and early eighteenth centuries. These include the 1689 expedition of Governor Alonso De León, the 1691–1692 expedition of Governor Téran de los Ríos, the Espinosa-Olivares-Aguirre expedition of 1709, Ramón's expedition 1716, Alarcón's expedition of 1718, and Rivera's inspection tour of 1727. Among the inhabitants of the land to the east of the Edwards Plateau encountered by the Spanish were Sanan speakers such as the Emet, Sana, Sijame, and Toho. Others include the Apayxam, Caisquetebana, Cantona, Catqueza, Cava, and Mayeye (Campbell 1986). Displaced and migrating tribes from outside the area including the Jumano of West Texas, the Tonkawa and Wichita-speaking Yojuane of north central Oklahoma, and the Simaomo and Tusonbi of northeastern Mexico were also present.

The chapter includes a review of the archeological record for the cultural area made by using the State Archeological Atlas to plot the occurrence of recorded Late Prehistoric–Early Historic period sites by site type. These data, in addition to providing a framework for the settlement patterns analysis, allows observations to be made that may facilitate the creation of a predictive model for site location that will benefit future studies in the area.

Establishing a settlement pattern for the native peoples, as well as determining the nature and history of roads and trails in the area, included a review of historic maps, as the site was occupied quite close to the beginning of recorded history in the area. Atkins researchers examined a multitude of historic maps on file at the Texas General Land Office (GLO) Archives Division and the

Bexar County Archives, the Dolph Briscoe Center for American History at the University of Texas, and the Texas State Library, all in Austin, and the Old Spanish Missions Research Collection at Our Lady of the Lake University in San Antonio. Historians also reviewed digital map collections available online at the Bibliothèque National de France in Paris, the Biblioteca Digita Hispánica at the Biblioteca Nacional de España in Madrid, and the Biblioteca Nacional de México in Mexico City for sources not available in local archives and used digital collections available in-house through the Texas Historic Overlay (THO) (Foster et al. 2006) and in a broader database of map images collected during the research for the THO project.

The chapter is divided into eight sections. Following the Introduction are attempts at defining the cultural area through (1) a review of relevant archeological sites that have received extensive investigations, and (2) examination of all Late Prehistoric and Early Historic period archeological sites within a 50-km radius of 41CW104. The site types identified in this endeavor are then discussed in terms of their position within the environmental framework, thus providing important information relative to the Late Prehistoric and Early Historic cultures, and also supplying some basic data that may be of use in creating a model for general prediction of similar-aged archeological sites.

Following the discussion of known archeological sites is an overview of the Historic Native groups that are known to have been in the general area during the late seventeenth and early eighteenth centuries. These data served to reemphasize the fluidity within the patterns of behavior or settlement that characterized this time period. Further indications of this are provided in the subsequent presentation of the Spanish expeditions that crossed within a few miles of 41CW104. The various diaries and journals kept during those entradas provided a wealth of information regarding the native peoples, plants, animals, and geography of the area. An overview of the history of the naming of the area’s streams and rivers follows to help clarify a somewhat confusing topic.

The remaining sections deal with a thorough examination of the production of early maps reviewed at the above-mentioned repositories in an attempt to identify any documents that might portray historic trails and traces and/or provide information about native peoples associated with the general project vicinity. The sources reviewed dated from the 1520s through the 1840s and spanned three distinct periods of map production. As a result of this research, the project historian was able to identify when an extensive network of defined or charted roads emerged in the area and when the roads in the immediate vicinity of 41CW104 were constructed. The final section provides a summary of the settlement patterns analysis.

DEFINING A CULTURAL AREA

Intersite Analysis

One of the primary research topics put forward in the research design developed for the data recovery analysis and reporting for the Santa Maria Creek site concerned trying to place the site within a general cultural area. One obvious method proposed to help align the Santa Maria Creek site with a cultural area consists of comparing the site with similar-aged sites in the general region. Archeological sites chosen for comparison are Allens Creek (41AU31, 41AU36, 41AU37, and 41AU38), Sandbur (41FY135), Cedar Bridge (41FY74), Mustang Branch (41HY209), Toyah Bluff (41TV441), Barton (41HY202), Rowe Valley (41WM432), site 41GM281, and Penny Winkle (41BL23) (Figure 4).

Allens Creek Sites

Situated to the east in the Brazos River valley and the Coastal Plain, four sites near Allens Creek—41AU31, 41AU36, 41AU37, and 41AU38—yielded evidence of Late Prehistoric habitation (Hall 1981). At site 41AU37, two distinct Late Prehistoric stratigraphic components were noted. The earlier zone contained only points of the Scallorn type along with sandy paste ceramics of the Goose Creek type and yielded a radiocarbon date of A.D. 980 ± 70. The second zone, which temporally aligns with the occupations at the Santa Maria Creek site, produced both Scallorn and Perdiz points as well as sandy paste and grog-tempered ceramics, typed as Goose Creek and San Jacinto wares, respectively, and dated by analysis of associated carbon samples to A.D. 1480 ± 80. Bone-tempered and bone/grog-tempered sherds were found at site 41AU31 with Perdiz points only, and at 41AU38 with both Perdiz and Scallorn points.

The occupants of these sites exercised a number of subsistence methods, including plant processing and the exploitation of a wide variety of faunal resources, such as deer, antelope, mussels, and various small mammals, birds, amphibians, and fish. In her discussion of the Gulf Coastal Plain, Story associates these Late Prehistoric remains with the Mossy Grove tradition of the Texas coast, while noting the tentative nature of such an attribution due to the numerous similarities with the cultures of central and southern Texas (Story et al. 1990). Johnson also recognizes the strong resemblance of the Allens Creek assemblages to those of the Toyah tradition, with their Perdiz points and polyhedral cores, but distinguishes the Allens Creek peoples primarily by their lack of Classic Toyah pottery (Johnson 1994).

The strongest relationship between the Late Prehistoric components at Allens Creek and 41CW104 would appear to be in the ceramics and basic subsistence.

Sandbur (41FY135)

From 2001 through 2004, Atkins conducted analyses of material and data recovered by the Texas Department of Transportation (TxDOT) during archeological data recovery excavations at the Sandbur site in 1979 (Kalter et al. 2005). Those excavations resulted in the location and recordation of 15 cultural features and the recovery of 275,328 lithic artifacts, 81 ceramic sherds, 3,527 historic artifacts, 620 fragments of vertebrate faunal material, and 543 mussel shell fragments. This array of aboriginal artifacts spans the entire range of the prehistoric occupation of east central Texas. It is apparent from the large amount of finished stone tools and debris from tool construction and

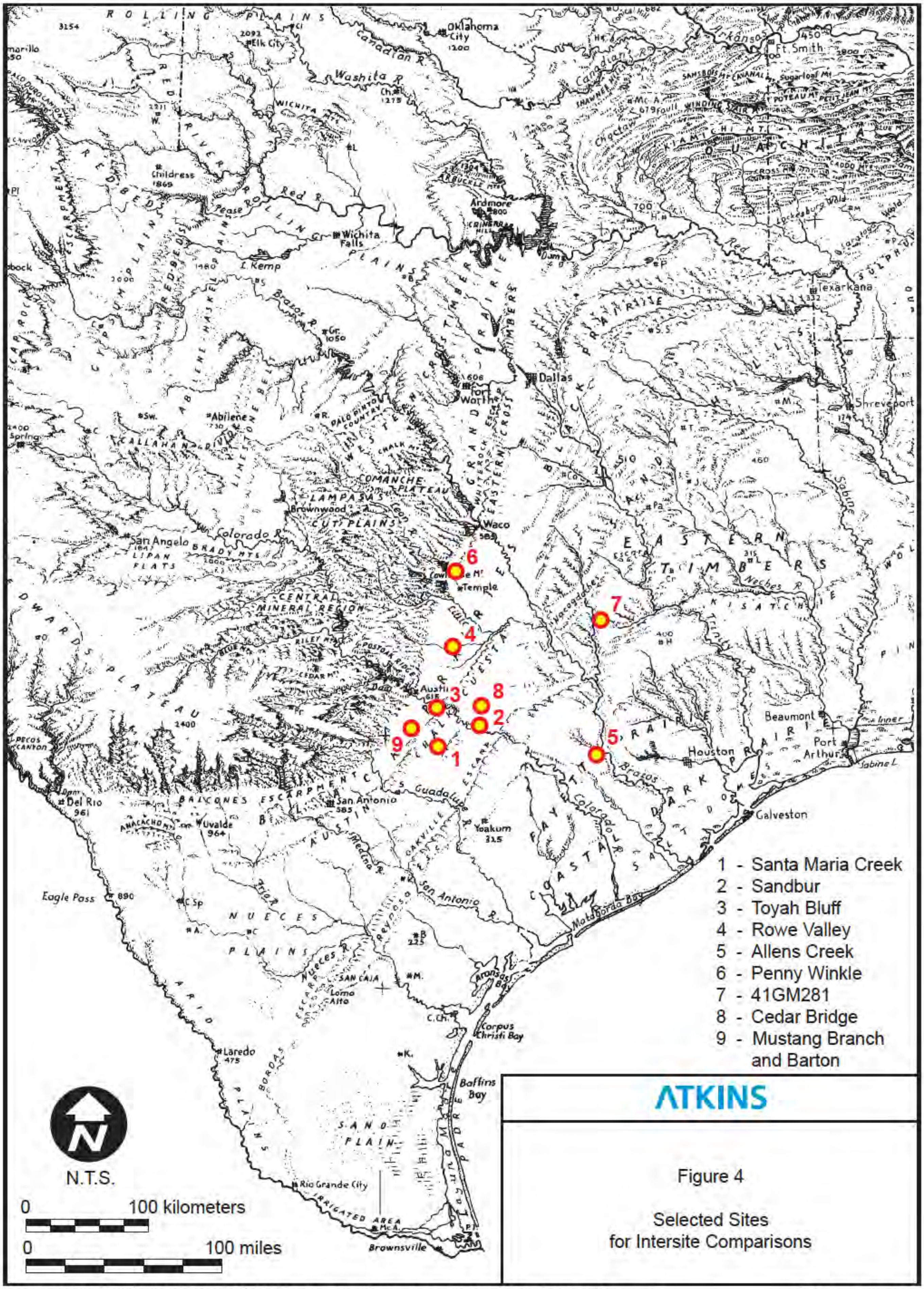

Figure 4

Selected Sites for Intersite Comparisons

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Drafted by: C. Wallace

maintenance that the site's location along a perennial stream overlooking the Colorado River floodplain, and adjacent to massive Quaternary-aged gravels suitable for stone tool production, made it attractive to native peoples for thousands of years. While most of the early cultural deposits at the site possessed only limited stratigraphic integrity, the latest component at the site contained in situ deposits that included subsistence remains, cooking features, stone tools, and ceramics, and it is this component that aligns with the occupations at the Santa Maria Creek site. Two radiocarbon dates were secured. The first of these, a bovid rib fragment from Feature 11 in the southern end of the site, from a depth of 30–50 centimeters below the surface (cmbs), produced a 2-sigma calibrated date of A.D. 1670 to 1780 and A.D. 1800 to 1950. The second sample consisted of carbonized plant matter recovered from the matrix inside a mussel shell from Feature 6 in the northern end of the site, at a depth of 57–69 cmbs, and yielded a 2-sigma calibrated date of A.D. 1400 to 1450.

The ceramic assemblage from the Sandbur site is small, containing only 81 sherds. Thirty-two of the sherds were too fragmentary for analysis. All of the remaining sherds were examined macroscopically, and 11 received petrographic analysis. Five sherds were submitted for neutron activation analysis. The sherds submitted for neutron activation analysis were among a total of 412 sherds and clays from archeological sites in central Texas and were part of a compositional study of central Texas ceramics that sought to shed light on mobility and interaction patterns of Late Prehistoric hunter-gatherers. The sherds from the Sandbur site were included in a group designated CT-2 and are made from Cretaceous or Tertiary clays found on the southeastern edge of central Texas.

Based on the macroscopic and petrographic comparison, it appears likely that the ceramics from the Sandbur site are the product of an indigenous population that had developed a tradition influenced by contacts with groups outside the area. It was speculated that the latest radiocarbon date from the site might be attributable to Sanan-speaking peoples who were known to reside in the general area. The eastern Sanan groups, such as the Emet, Sana, Sijame, and Toho, lived on the Blackland Prairie and adjacent savanna northeast of the San Antonio River, in an area about 130 miles in diameter.

The age of the Late Prehistoric/Protohistoric occupations at Sandbur compares favorably with those of 41CW104, as does the ceramic assemblage. It is also interesting to note that the records kept during the expeditions of Terán (1691), Espinosa-Olivares-Aguirre (1709), Aguayo (1722), and Rivera (1727) all recorded that Sanan speakers were in the general vicinity of 41CW104.

Cedar Bridge (41FY74)

The Cedar Bridge site (41FY74) occupies the west bank of Cedar Creek in Fayette County about 3 miles from the Sandbur site. A Late Prehistoric component, apparently a single zone preserved within the terrace deposits, extends 40 m along the terrace and comprises eight areas of activity, including one hearth and two bone concentrations. Faunal evidence from the site consists primarily of the partially articulated remains of a bison, with the presence of freshwater mollusk shells suggesting a supplement to the diet. Other faunal remains or evidence of exploitation of vegetal resources were lacking. Based on this and the lithic evidence, the site was interpreted as a single short-term occupation oriented around the processing of subsistence resources, primarily the bison kill. A secondary emphasis on the manufacture or maintenance of stone tools was suggested by 43 arrow points and fragments, mainly of the Perdiz and Cliffton types, in various stages of manufacture. The tool assemblage included beveled bifaces, perforators, gravers, and scrapers, all of which are common to the Toyah toolkit. Two Scallorn points were also present at the site, but were considered unassociated with the features and suggestive of an earlier occupation (Skelton 1977).

Five hundred fifty-two ceramic sherds were recovered from the Cedar Bridge site, representing at least five, and probably more, vessels; all were associated with the probable Toyah component, but none appear to fit well into any previously established types (Skelton 1977). The majority (n = 487), Group A, are similar to Leon Plain ceramics in their use of bone temper, but their paste is distinguished from that type by a high sand content. A burned lump of clay found at the site contained comparable amounts of sand as the Group A ceramics, and was interpreted as suggesting a possible local origin. In contrast, Group B, represented by 53 sherds, contained only small amounts of fine-grained sand with no visible temper. Through comparison of these with ceramics of established types and untyped specimens from other sites within the region, Skelton found that both groups were almost identical to sherds of two different varieties from the Erwin's Bridge site (41BU1) in Burleson County (Peterson 1965), approximately 25 miles to the north. Close similarities were also noted between Group B and certain sandy paste ceramics from site 41AU38, farther to the east in the Allens Creek project area (Hall 1981).

The ceramic assemblage from Cedar Bridge appears to compare favorably with that of 41CW104.

Toyah Bluff (41TV441), Barton (41HY202), and Mustang Branch (41HY209)

Excavations at the Toyah Bluff site (41TV441), located above Onion Creek in Travis County, revealed over 20 features, including burned rock hearths and earth ovens, some of which retained vegetal remains (Karbula et al. 2001). Faunal remains were also present, but in comparatively low numbers, representing bison, deer, dog, and turtle. Both the faunal and vegetal evidence suggest a significantly more diverse subsistence pattern for this period than often assumed, with bison probably supplementing rather than supplanting existing subsistence practices. Manos and metates, further signs of plant processing, were also found frequently in association with the burned rock features; in strong contrast, ground stone tools at the Santa Maria Creek site were scarce, particularly in the Late Prehistoric occupational zones. While the earliest of the features at Toyah Bluff date to approximately A.D. 1200, at least one of the earth ovens has been dated by radiocarbon analysis to within the normal range of Toyah activity, between A.D. 1310 and 1480.

Two Scallorn points, indicative of the Austin phase, were found near the earliest features. However, the majority of the diagnostic artifacts found at the site appear to belong to a typical Toyah assemblage, and include beveled knives, blades, drills, end scrapers, and nine arrow points of the Perdiz type. This blend of elements, combined with radiocarbon dates ranging from the early thirteenth to mid-fifteenth century, suggests that the site spanned the time traditionally considered as the transition between the Austin and Toyah phases. However, due in part to the continuity of hearth features throughout the site's Late Prehistoric occupation, it was postulated that the site's inhabitants may have been Austin phase peoples who gradually adopted the technological advances in lithic manufacture usually associated with the Toyah phase. Ceramics recovered from Toyah Bluff consisted of 39 small specimens (nearly the same amount as at 41CW104), the majority of which were bone-tempered with sandy paste; due to similarities with sherds from nearby sites, these may suggest a widely produced local type (Karbula et al. 2001). Other ceramics from the site were characterized by sand and bone temper or by a very sandy paste. This latter group may possibly reflect ties with eastern Texas or the Texas coast due to their similarities with the Goose Creek Plain type.

Two sites along the Onion Creek valley in Hays County, the Barton site (41HY202) and the Mustang Branch site (41HY209), were excavated first by TxDOT and then by the Texas Archeological Research Laboratory (TARL) in 1989 (Ricklis and Collins 1994). Evidence of occupation in this area dates to the Early Archaic and extends, except for a possible gap in the Middle Archaic, into the Late Prehistoric. The latter period is represented at the Barton site only by artifacts of the Toyah phase, while cultural materials from both the Austin and Toyah phases were encountered at the Mustang Branch site.

The Mustang Branch site consists of two distinct areas: one occupying the narrow alluvial terrace (41HY209-T) along the Mustang Branch of Onion Creek, and the other (41HY209-M) atop a steep bluff to the south (Ricklis and Collins 1994). The terrace component produced a discrete zone of lithic material, burned rocks, and bones within the alluvium between 60 and 80 cmbs. Within this zone were nine diagnostic projectile points: five arrow points of the Scallorn type and four Early to Late Archaic dart points of the types Nolan, Castroville, Ensor, and Darl. The dart points were interpreted as the results of curation by the Late Prehistoric occupants, rather than the mixing of strata. Subsistence data point to a fairly broad-based strategy, including deer, *Rabdotus* snails, freshwater mussels, and plants, as evidenced by the presence of a wild onion. Carbon samples from this zone yielded dates between the late thirteenth and the late fourteenth century A.D., suggesting an occupation at the very end of the Austin phase.

Above this stratum, separated by approximately 20 cm of almost sterile soil, was a culturally rich layer containing material indicative of the Toyah phase. This dense scatter of lithic and bone debris contained numerous examples of elements of the Toyah toolkit, including 36 end scrapers, 12 thin bifacial knives, 11 flake drills, and 41 arrow points and fragments, 23 of which were complete enough to be typed as Perdiz points. Numerous fragments of six ceramic vessels were also recovered. These include bone-tempered specimens, some with a fairly sandy paste, which are suggested to be similar to the Leon Plain type, and thus attesting to central Texas Toyah affiliations. Other sherds are attributed to the Poyner Engraved and, possibly, the Boothe Brushed or Bullard Brushed types, which could suggest northeast Texas Caddo origins. The site appears to have been centered around the hunting and processing of large mammals, as indicated by the remains of at least 19 deer, 8 antelopes, and 2 bison, which displayed signs of having been processed for marrow extraction. In addition to their use in the butchering of game, the associated components of the Toyah toolkit, such as scrapers, knives, and drills, also indicate the preparation and working of hides. Radiocarbon analysis provided dates ranging between the late fifteenth to early seventeenth century. The authors suggest a relatively short occupation due to the thinness of the deposit, the orientation around a central hearth, and the discrete concentrations of debris.

The bluff component of the Mustang Branch site (41HY209-M) features a large burned rock midden, formed primarily during the Late Archaic, which, along with the surrounding bluff, was occupied in the Late Prehistoric period (Ricklis and Collins 1994). This later occupation, combined with shallow soil deposits, has resulted in the site being highly compressed chronologically. A total of 31 Scallorn points were found within the upper levels of the midden area, along with 18 Perdiz points and other materials associated with the Toyah interval, including end scrapers, utilized blades, and ceramics attributed to the type Leon Plain. The Toyah interval was also represented by a burned rock hearth containing bison and deer bones. Radiocarbon analysis of eight bone samples yielded dates ranging from the late fifteenth to early seventeenth century A.D., with only one sample dating as early as the late fourteenth century. Due to the fractured condition of most of the Perdiz points, combined with the presence of preforms and unfinished points, the site appears to have been utilized for the production of arrow points, perhaps after a bison kill.

The northern section of the Barton site, located on an alluvial terrace of Onion Creek, produced over 33,000 pieces of lithic debitage and broken tools within a thin stratum between 10 to 20 cmbs (Ricklis and Collins 1994). A total of 168 arrow points were recovered, all adhering to the Perdiz type, and representing all stages of that type's manufacture. Also present were numerous thin bifaces, scrapers, and utilized blades. A single burned rock hearth provided charcoal dating to between the mid-A.D. 1600s to early 1700s, but the chief purpose of the site appears to have been the production of lithic tools. Also present were several fragments of a single ceramic vessel, containing grog temper within a silty clay paste; although an origin within the Caddo area may be possible, this conjecture could not be supported by visual or petrographic analysis (Ricklis and Collins 1994).

These sites are the closest distance to 41CW104 of any of the comparative sites. While they are much more extensive than what is known of the occupations at 41CW104, they have components of similar age, and there are similar characteristics in the material assemblages (i.e., Scallorn arrow points, scrapers, and bone-tempered sandy paste sherds) to suggest shared cultural traits.

Rowe Valley (41WM432)

Rowe Valley is located on the south bank of the San Gabriel River about 5 miles north of Taylor. The site is contained in a 10-m-thick Holocene-aged alluvial river terrace and was discovered after portions of the terrace had been mined for fill dirt. Texas Archeological Society field schools conducted excavations at the site in the 1980s and identified two isolable occupations dating to between about A.D. 1300 and 1700.

The ongoing analysis and interpretations of the site have focused on the latter of these occupations, which is believed to date to between about A.D. 1650 and 1700. These occupations may align favorably with some of the occupations at 41CW104. Cultural features unearthed during the excavations included resource-processing stations where bison, antelope, deer, and other animals killed during the late fall to early winter were butchered. Thermal features at the site include three types of hot-rock cooking features, one charcoal-and-ash-filled pit, and three small burned clay pits. Two of the burned clay pits are components of a meat-curing station. Tool-manufacturing features include chipping stations that vary from small flake concentrations to larger, complex concentrations interpreted as containing the refuse of many episodes of stone tool reduction. Stone tools include an assortment of arrow points, dominated by the Perdiz type but including others such as Cuney, Guerro, and Lott, which show ties to the Caddo region, the southern High Plains, and south Texas or Mexico. Butchering, skinning, and hide-processing tools such as beveled bifaces, end scrapers, side scrapers, and edge-trimmed flakes were also found.

Ceramics at Rowe Valley include bone-tempered sherds from a minimum of eight vessels. Whole vessels include a Patton Engraved jar and a Bullard Brushed jar, both of which are associated with southern Caddo groups, and a burnished orange jar more characteristic of Goliad Plain wares found on the Gulf Coastal Plain. Bone artifacts include a large spatulate bone made from a bison rib, and several bone beads. A freshwater mussel shell pendant in the shape of a serrated arrow point was also recovered.

Three discrete areas, designated Areas A–C, were identified at Rowe Valley. Most of the excavations occurred in Area A, which is described as having a single charcoal-and-ash-filled pit surrounded by a 5-m-wide culturally sterile band beyond which several thermal features occur in triplets. Each of these features has one or more chipping stations associated with it. This pattern is typical of Plains Indian villages, and the size of Area A suggests it could have supported about 84 individuals. Excavations in Areas B and C at Rowe Valley suggest similar patterns occur there, and the entire site may have supported as many as 150 to 300 persons. Prewitt (2004) speculates that given the nature of the artifacts recovered, the site represents a large multiethnic encampment that the three San Xavier Spanish missions were established to serve in 1748, known as Ranchería Grande. The ranchería was occupied by groups such as the Yojuane, Mayeye, Ervipiame, Asinai, Nabedache, Deadose, Cocos, and others. Admittedly, Rowe Valley could also simply represent a Toyah encampment with the variety of nonlocal materials reflecting the complexity of the sociocultural networks that may have characterized them.

The later occupations at Rowe Valley may have been contemporaneous with late occupations at 41CW104. Some of the Ranchería Grande Indians, such as the Mayeye, were reported in the general area of 41CW104. While some aspects of the material assemblages are shared, the sites differ in that Rowe Valley was a large settlement composed of a wide range of native groups assembled for defense, whereas 41CW104 appears to represent a more limited occupation by a smaller population.

Site 41GM281

Site 41GM281, located in the Post Oak Savanna approximately 100 miles northeast of 41CW104, produced over 100 Perdiz points, point fragments, and preforms (Rogers 1995). These differ visibly from specimens found in central and southern Texas, primarily due to their wide blades, outflaring barbs, and short stems. Scallorn and Catahoula points were also present, but represented by only 10 and 2 specimens, respectively. Radiocarbon samples provided dates ranging from A.D. 1150 to 1400, although the majority of occupations appear to have taken place in the latter years of that range, between A.D. 1300 to 1400. Ceramics from the site were primarily sandy paste or sandy paste and bone-tempered plainwares, some of which closely resembled upper Texas coastal and Caddo traditions.

The occupations at 41GM281 probably predate those of 41CW104. There are some similarities in the ceramic assemblages between the two sites, but 41CW104 lacks any indication of an alignment with Caddo ceramic traditions.

Penny Winkle (41BL23)

The Penny Winkle site (41BL23), located in the Blackland Prairie on the east side of the Leon River in northern Bell County, is approximately 75 miles (111 km) northwest of 41CW104. The site was recorded during an archeological survey of Belton Reservoir in 1962 (Shafer et al. 1964). Two sherds (TKP142 and TKP143) from the site were selected for geochemical, petrographic, and neutron activation analyses as part of the analysis of 27 sherds from 11 sites in central Texas containing Caddo ceramics mentioned above (Perttula et al. 2003). Both sherds are identified as Caddo trade ware.

Sample TKP143 from the Penny Winkle site is another example of a Caddo trade vessel found in central Texas. Compared petrographically with 41FY135 (Sandbur), the specimen has less amounts of quartz and pore space and a greater amount of matrix. It has about 9 percent bone temper, which is within the range for Sandbur. It also has a similar thickness. However, it is brushed, and no brushed pottery was found at the Sandbur site. Perttula et al. (2003:11) note that much of the brushed pottery at Caddo sites tends to be bone tempered, but the technological or stylistic implications are not well known.

Petrographic analysis of the Santa Maria Creek (41CW104) ceramic samples showed a much higher percentage of quartz and a greater amount of pore space than was observed in the Penny Winkle (41BL23) ceramic samples. However, one relatively distinct bone-and-grog-tempered sherd (Lot 222-1) recovered at the Santa Maria Creek site also appeared to be a possible Caddo trade ware.

Late Prehistoric and Early Historic Period Sites within 50 km of 41CW104

The purposes of this study were to (1) identify archeological sites of similar age to the Santa Maria Creek site within a distance of approximately 50 km, and (2) record selected characteristics of the physical environment at each site. It was hoped that these data could be used to identify trends in the archeological and environmental record that could be keyed to patterns of human behavior (settlement patterns), and facilitate the creation of a predictive model for the location of Late Prehistoric to Early Historic sites in the region useful for future studies. Sites were typically determined as Late Prehistoric by the presence of Scallorn or Perdiz arrow points. Fifteen of the sites contained ceramic sherds. A Caddo ceramic sherd was recorded by Dee Ann Story at the White Hole site (41HY231) in Hays County, and one metal arrow point was found at 41HY446, evidence of a Historic period aboriginal presence.

A systematic approach was used to examine the nature of Late Prehistoric–aged sites in the region of the Santa Maria Creek site. The State Archeological Atlas was searched by quad map for all Late Prehistoric to Early Historic period sites within 50 km of the Santa Maria Creek site. If any portion of a quad map fell within 50 km, the entire quad map was searched. A total of 46 quad maps were examined. The area searched included portions of 10 counties. All of Caldwell County was included, as were portions of Travis, Gonzales, Bastrop, Fayette, Lavaca, Guadalupe, Comal, Hays, and DeWitt Counties.

All site forms and maps located on each quad were first examined for time period. Data were then recorded for those sites dating to the Late Prehistoric and Early Historic periods. The recorded data were site type, ecoregion and subregion, geology, drainage basin, nearest stream (including distance and stream rank), soils, site size and depth, and recovered archeological materials. A data viewer was created by Atkins GIS personnel that contains general locational data, quad maps, site locations, Natural Resources Conservation Service soil data, and National Hydrography data.

The type and amount of archeological work in the study area is a contributing factor to the location and therefore patterning of archeological sites. Sites recorded during surveys for road and pipeline projects will exhibit a linear pattern, and those for parks, such as Lockhart State Park, would appear clustered in that area. The area around a project area may appear to be absent of sites, when possibly the area around it has simply not been surveyed.

The number of sites for each county is also likely a result of the relative amount of archeological survey completed for each county, as there are significant discrepancies in the number of sites recorded in neighboring counties. For example, Lavaca County has the fewest total archeological sites, 39, and no recorded Late Prehistoric sites, where Travis County has 2,399 recorded sites.

A total of 63 archeological sites (including 41CW104) containing Late Prehistoric components were identified within an approximate 50-km radius of 41CW104 (Table 4). This total includes 13 sites in Bastrop County, 11 in Gonzales County, 10 in Hays County, 8 in Guadalupe County, 8 in Travis County, 4 in Caldwell County, 4 in DeWitt County, 3 in Fayette County, and 1 each in Wilson and Comal Counties.

Site Type

Assigning site types to the 63 recorded archeological sites is based on data contained in the Texas Historical Commission's (THC) Texas Archeological Sites Atlas. It thus represents the work of a multitude of individuals during many field efforts under a variety of conditions, and reported on over a number of years. As can be expected, this information is variable. At times the data are meager and poorly recorded, while at others the recording effort was substantial and includes interpretive data.

Based on these data and with these limitations in mind, the sites found in the search are divided into four basic types: Encampments, Campsites, Campsites/Quarries, and Lithic Scatters. Encampments are large and often contain thick deposits containing a wide range or artifact types, features, and subsistence remains. These sites are indicative of intensive occupations. A total of 7 encampments were identified.

Campsites are generally smaller and contain evidence of short-term occupations where limited tasks were carried out. These are the most abundant of the site types, numbering 44, At times quarries also served as campsites, and five of these were recorded.

Lithic scatters are sites that contain few tools, no subsistence data, and likely served as short-term locations. While only six sites of this category are included, this is not reflective of the number of this type of site present on the landscape, but merely those scatters that contained Late Prehistoric diagnostic artifacts. Lithic scatters are probably the most common site type identified during field investigations.

Ecoregions

As discussed in Chapter 2, ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources (Griffith et al. 2004). Within the approximate 50-km area chosen for archeological review, there are three ecoregions and eight subregions. These are Edwards Plateau (subregion Balcones Canyonlands), Texas Blackland Prairies (subregions

Table 4. Sites Within a 50-kilometer Radius from 41CW104

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
Bastrop County							
41BP55/Campsite	East Central Texas Plains/Bastrop Lost Pines	Simsboro Formation (Eocene)	Colorado River	Sandy Creek (30 m/2)	Sayers	Unknown size/ Unknown depth	Leon Plain sherd, Perdiz, arrow point, side scraper, debitage
41BP62/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace		Colorado River (30 m/7)	Bastrop	392,532 m^2/ 1 m deep	Arrow point, FCR, mussel shell, cores
41BP66/Campsite/Quarry	East Central Texas Plains/Bastrop Lost Pines	Caddell Formation (Eocene)		Colorado River (10 m/7)	Jedd	Unknown size/ Unknown depth	Projectile points, scrapers, hearths
41BP74/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace		Colorado River (Unknown distance/7)	Unknown	149,728 m^2/ Unknown depth	Dart points, Scallorn, Perdiz arrow points, choppers, ground stone, FCR, mussel shell, bone
41BP279/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace		Colorado River (20 m/7)	Axtell	4,000 m^2 / 2 m deep	Dart and arrow points, Waco sinkers, scrapers, knives, spokeshaves, FCR, pits, subsistence remains
41BP291/Campsite	East Central Texas Plains/Bastrop Lost Pines	Caddell Formation (Eocene)		Tributary to Gills Branch (430 m/1)	Jedd	44,500 m^2/ Unknown depth	Arrow points, including obsidian, flake tools, debitage, FCR
41BP292/Campsite	East Central Texas Plains/Bastrop Lost Pines	Caddell Formation (Eocene)		Tributary to Piney Creek (200 m/1)	Crockett	18,600 m^2/ 20 cm deep	Dart and arrow points, metate, FCR, debitage
41BP298/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Queen City Sand (Eocene)		Mill Creek (300 m/2)	Rosanky	45,000 m^2/ 1 m deep	Arrow points, cores, debitage, FCR
41BP299/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace		Little Alum Creek (300 m/2)	Axtell/Jedd	17,400 m^2/ Unknown depth	Marcos dart point, Perdiz arrow point, FCR
41BP302/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace	Colorado River	Colorado River (100 m/7)	Shep	34,400 m^2/ 40 cm deep	Pottery, FCR, debitage, bifaces

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41BP303/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace	Colorado River	Colorado River (450 m/7)	Axtell	60,700 m^2/ Unknown depth	Dart and arrow points, bifaces
41BP304/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace	Colorado River	Unnamed tributary to Colorado River (80 m/1)	Axtell	17,000 m^2/ Unknown depth	Darl dart points; Scallorn, Fresno, Perdiz, Bonham, Alba arrow points; bifaces
41BP659/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Quaternary terrace	Colorado River	Colorado River (120 m/7)	Shep	30 x 130 m/ 130 cm deep	Scallorn arrow point, Leon Plain pottery, FCR, faunal remains including possible bison, mussel shell
Caldwell County							
41CW15/Campsite	East Central Texas Plains/Southern Post Oak Savannah	Quaternary alluvium	San Marcos River	West Fork Plum Creek (130 m/2)	Trinity	200 m/ Unknown depth	Bifaces, cleavers, plain potsherd
41CW100/Lithic scatter	East Central Texas Plains/Southern Post Oak Savannah	Wilcox Group (Eocene)		McNeil Creek (300 m/2)	Crocket	Unknown size/ Unknown depth	Scallorn arrow point, biface
41CW130/Campsite	Texas Blackland Prairies/Floodplains and Terraces	Quaternary terrace	San Marcos River	San Marcos River (100 m/4)	Lewisville	36.5 x 225 m/ 20–80 cm deep	1 sherd, debitage, FCR
Comal County							
41CM248/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Ridge summit and sideslope	Guadalupe River	Guadalupe River (5 m/4)	Purves	½ by ¼ km/ 75 cm deep	Burned rock midden, hearths, burial; stone tools, faunal remains; Scallorn, Perdiz arrow points; plain ceramics
DeWitt County							
41DW8/Campsite	East Central Texas Plains/Southern Post Oak Savannah	Quaternary terrace	Guadalupe River	Guadalupe River (30 m/4)	Tremona	½ by ¼ km/ 40 cm deep	Plain sherd, biface fragments, debitage, bone, mussel shell

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41DW9/Campsite	East Central Texas Plains/Southern Post Oak Savannah	Quaternary alluvium	Guadalupe River	Guadalupe River (200 m/4)	Meguin	2 acres/ 1 m deep	Clear Fork gouge; Guadalupe adz; bifaces; milling slab fragments; baked clay/daub; plain ceramics; Scallorn, Fresno, Perdiz arrow points; bone; mussel shell
41DW10/Campsite	East Central Texas Plains/Southern Post Oak Savannah	Quaternary terrace	Guadalupe River	Guadalupe River (50 m/4)	Tremona	3 acres/ Unknown depth	Dart points, adze, mussel shell, bone fragments, Scallorn point
41DW192/Campsite	East Central Texas Plains/Southern Post Oak Savannah	Oakville Sandstone (Miocene)		McCoy Creek (50 m/2)	Tremona	50 x 75 m/ Unknown depth	Scallorn point, cores, debitage
Fayette County							
41FY103/Campsite	East Central Texas Plains/Floodplains and Low Terraces	Oakville Sandstone (Miocene)	Colorado River	Tributary to Rocky Creek (175 m/1)	Carbengle	Unknown size/ Unknown depth	Lithics and ceramics
41FY172/Lithic scatter	East Central Texas Plains/Floodplains and Low Terraces	Caddell Formation (Eocene)	Colorado River	Buckners Creek (100 m/2)	Cadell	35 x 80 m/ Unknown depth	Perdiz point, FCR, debitage
41FY422/Campsite/Quarry	East Central Texas Plains/Southern Post Oak Savannah	Yegua Formation (Eocene)	Colorado River	Unnamed tributary to Colorado River (250 m/1)	Straber	8 acres/ 30–110 cm deep	Gouge, arrow points, FCR, debitage
Gonzales County							
41GZ3/Campsite/Quarry	East Central Texas Plains/Floodplains and Low Terraces	Quaternary alluvium	Guadalupe River	Guadalupe River (20 m/4)	Selvern	75 x 400 m/ 25 cm deep	Guadalupe biface, arrow point, hearths
41GZ11/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium		Guadalupe River (120 m/4)	Meguin	30 x 100 m/ 25 cm deep	Scallorn arrow point, debitage, bone, mussel shell
41GZ23/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium	Guadalupe River	Guadalupe River (5 m/4)	Gholson	75 x 400 m/ 25 cm deep	Scallorn arrow point, biface fragments, cores, debitage, point, mussel shell, FCR

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41GZ73/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary terrace		Gelhorn Creek (10 m/2)	Chazos	30 x 100 m/ 1 m deep	Ceramic, biface fragments, debitage, mussel shell
41GZ107/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Manning Formation (Eocene)		Tributary to Peach Creek (100 m/1)	Burlewash	200 x 800 m/ Unknown depth	Arrow point, cores, debitage, FCR
41GZ109/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium		Tributary to Peach Creek (50 m/1)	Chazos	150 x 200 m/ Unknown depth	Scallorn point, debitage
41GZ118/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium		Peach Creek (40 m/4)	Buchel	75 x 75 m/ Unknown depth	Flakes and chips, cores, arrow point fragments, burned lithic material
41GZ128/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium	Guadalupe River	Guadalupe River (200 m/4)	Meguin	75 x 100 m/ 1 m deep	Flakes and chips, cores, burned lithic debris, mussel shell, turtle shell, and 2 Scallorn arrow point fragments
41GZ147/Campsite/Quarry	Texas Blackland Prairies/Southern Blackland Prairie	Recklaw Formation (Eocene)	San Marcos River	San Marcos River (200 m/4)	Rosanky	10 m diameter/ Unknown depth	Pedernales dart point, Perdiz arrow point, cores, spokeshaves, 4 scrapers, FCR, debitage
41GZ180/Campsite	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium	Guadalupe River	Guadalupe River (20 m/4)	Jedd	150 x 250 m/ 25 cm deep	End scraper, debitage, cores, biface fragments, mussel shell
41GZ181/Campsite/Quarry	Texas Blackland Prairies/Southern Blackland Prairie	Quaternary alluvium	Guadalupe River	Guadalupe River (20 m/4)	Meguin	100 m/ Unknown depth	End scraper, mussel shell
Guadalupe County							
41GU12/Lithic scatter	Texas Blackland Prairies/Northern Blackland Prairie	Leona Formation (Quaternary)	Guadalupe River	Guadalupe River (300 m/4)	Lewisville	225 x 420 m/ Unknown depth	Pedernales dart point, Scallorn arrow point, end scrapers, cores, hammerstone, debitage
41GU13/Campsite	Texas Blackland Prairies/Northern Blackland Prairie	Leona Formation (Quaternary)	Guadalupe River	Guadalupe River (30 m/4)	Queeny	Unknown size/ Unknown depth	Perdiz, scrapers, cores, debitage, mussel shell, bone, FCR

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41GU17/Encampment	Texas Blackland Prairies/Northern Blackland Prairie	Quaternary terrace	Guadalupe River	Geronimo Creek (30 m/2)	Branyon	50 x 150 m/ 1 m+ deep	Manos, metates, Guadalupe adzes, Late Archaic dart points, Scallorn arrow points, corner-tang knives, utilized flakes, cores, spokeshaves, conch shell pendants, drills
41GU30/Campsite	Texas Blackland Prairies/Northern Blackland Prairie	Quaternary terrace	Guadalupe River	Guadalupe River (20 m/4)	Queeny	3 acres+/ 30 cm deep	Dart and arrow points, cores, flakes, burned rock
41GU67/Encampment	Texas Blackland Prairies/Northern Blackland Prairie	Neylandville Marl (Cretaceous)		Tributary to Youngs Creek (80 m/1)	Heiden	350 x 350 m/ Surface only	Dart points; scrapers; hammerstones; cores; Clear Fork gouge; turtleback end scrapers; Pedernales, Bulverde, Martindale, Marcos, Darl dart points; Scallorn arrow points
41GU92/Encampment	Texas Blackland Prairies/Northern Blackland Prairie	Quaternary terrace		Geronimo Creek (150 m/2)	Branyon	70 x 120 m/ Surface only	Pedernales, Marshall, Castroville, Marcos, Montell, Ensor, Fairland, Darl dart points; Scallorn arrow points; large knives; choppers; ulna flakers; bone awl; deer antler baton; manos; metate
41GU117/Encampment	East Central Texas Plains/Southern Post Oak Savannah	Quaternary terrace		Guadalupe River (5 m/4)	Barbarosa	1 acre/ 2 m deep	Andice, Frio, Pedernales, Ensor, Bell, Midland, Darl, Castroville, Montell, Tortugas dart points; Guerrero, Scallorn arrow points; drills; Guadalupe tools (40); scrapers

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41GU127/Campsite	East Central Texas Plains/Southern Post Oak Savannah	Quaternary alluvium	Guadalupe River	Guadalupe River (50 m/4)	Ferris	30 x 30 m/ 30 cm deep	Scallorn, biface fragments, small burned core, some flakes, mussel shell fragments
Hays County							
41HY9/Campsite	Edwards Plateau/ Balcones Canyonlands	Quaternary terrace	Blanco River	Blanco River (50 m/4)	Denton	Unknown size/ Surface only	2 possible arrow point fragments, dart points, blades, scrapers, knives, drill, FCR
41HY34/Campsite	Edwards Plateau/ Balcones Canyonlands	Quaternary terrace		Blanco River (130 m/4)	Lewisville	4 acres/ Unknown depth	Tortugas, Darl, Frio, Marshall dart points; Scallorn, Granbury arrow points; scrapers; knives
41HY37/Lithic scatter	Edwards Plateau/ Balcones Canyonlands	Del Rio Clay/ Georgetown Formation (Cretaceous)		Sink Creek (50 m/2)	Eckrant-Rock	Unknown size/ Surface only	Arrow point fragment, misc. bifacial tools
41HY160/Encampment	Edwards Plateau/ Balcones Canyonlands	Quaternary alluvium		Sink Creek (30 m/2)	Oakalla	150 x 250 m/ 2.8 m deep	Paleoindian, Archaic, and Late Prehistoric tools; bone tools; lithic debris; ground stone; bone debris; and ceramics
41HY188/Encampment (primarily Late Prehistoric)	Edwards Plateau/ Balcones Canyonlands	Del Rio Clay/ Georgetown Formation (Cretaceous)		Sink Creek (100 m/2)	Tinn	20 x 50 m/ 2 m deep	Perdiz, Scallorn, Ensor, Frio, Marcos, Marshall, Lange, Pedernales, Plainview, Barber projectile points; faunal remains; hearths; trash midden
41HY231/Campsite	Edwards Plateau/ Balcones Canyonlands	Quaternary terrace		Blanco River (5 m/4)	Eckrant-Rock	12 x 122 m/ 2 m deep	Milling slab, brushed Caddo sherd, dart points, Clear Fork tools
41HY233/Campsite	Edwards Plateau/ Balcones Canyonlands	Edwards Limestone (Cretaceous)		Blanco River (500 m/4)	Comfort-Rock	1 acre/ Surface only	Nolan, Pedernales dart points; Scallorn arrow point; Clear Fork gouge

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41HY234/Campsite	Edwards Plateau/ Balcones Canyonlands	Edwards Limestone (Cretaceous)		Sycamore Creek (500 m/2)	Eckrant-Rock	2 middens, 12–15 ft in diameter/ Up to 4 ft thick	Pedernales, Bulverde, Travis, Catan, Fairland dart points; Scallorn arrow points; bifaces; preform; some unifacial tools; burned rocks; and chipping debris
41HY446/Campsite	Edwards Plateau/ Balcones Canyonlands	Austin Formation (Cretaceous)		Purgatory Creek (100 m/2)	Rumple-Comfort	Unknown size/ 80 cm deep	Metal arrow point; chipped stone debitage; bifaces including discoidal core, elongated biface, and chopper; carbon; fauna
41HY476/Campsite	Edwards Plateau/ Balcones Canyonlands	Pecan Gap Chalk (Cretaceous)		Tributary to Plum Creek (30 m/1)	Houston, Gruene	15 x 30 m/ 30 cm deep	Scallorn projectile points, ground stone, burned bone, mussel shell, charcoal, abundant lithic tools, hearths
Travis County							
41TV16/Campsite	Edwards Plateau/ Balcones Canyonlands	Quaternary terrace		Onion Creek (130 m/2)	Austin and Patrick	50 x 70 cm/ 60 cm deep	Nolan, Bulverde, Travis, Pedernales, Darl, Ensor dart points; Scallorn arrow points
41TV142/Encampment	Texas Blackland Prairies/Floodplains and Terraces	Quaternary terrace		Colorado River (130 m/7)	Dougherty	100 m diameter/ 1 m deep	Ensor dart point; Perdiz arrow points; knives, cores, flakes, midden
41TV199/Campsite	Edwards Plateau/ Balcones Canyonlands	Austin Formation (Cretaceous)		Tributary to Bear Creek (2 m/1)	Patrick	Unknown size/ 18 inches deep	Darl dart points; Scallorn, Fresno arrow points; knives
41TV783/Campsite	Edwards Plateau/ Balcones Canyonlands	Glen Rose Formation (Cretaceous)		Tributary to Williamson Creek (20 m/1)	Bracket	70 x 150 cm/ Surface only	1 Perdiz arrow point fragment, grooved stone, bifaces, unifaces, cores
41TV1170/Lithic scatter	Edwards Plateau/ Balcones Canyonlands	Fredericksburg Group (Cretaceous)		Tributary to Barton Creek (200 m/1)	Speck	5 acres/ Surface only	Paleoindian point fragment, arrow point fragment, thinly scattered flakes, broken bifaces

Table 4 (Cont'd)

Trinomial/ Site Type	Ecoregion/ Subregion	Geology	Drainage Basin	Nearest Stream (distance/rank)	Soil Series/ Order	Site Size/Site Depth	Materials
41TV1391/Campsite	Texas Blackland Prairies/Northern Blackland Prairie	Navarro Group (Cretaceous)		Dry Creek (180 m/2)	Houston Black	80 x 200 m/ Unknown depth	Arrow point, biface fragments, mano and mano fragment
41TV1614/Campsite	Edwards Plateau/ Balcones Canyonlands	Quaternary high gravels		Boggy Creek (100 m/2)	Speck	75 x 200 m/ 2 m deep	Dalton, Pedernales, Lange, Montell, Castroville, Bell, Ensor, Frio dart points; Perdiz arrow point; obsidian flake
41TV2105/Campsite	Texas Blackland Prairies/Floodplains and Terraces	Quaternary terrace		Colorado River (230 m/7)	Bergstrom	50 x 95 m/ 1 m deep	Darl dart point, Scallorn arrow point fragment, bone-tempered potsherd, scrapers, 1 possible shell bead, debitage, burned rock
Wilson County							
41WN63/Lithic scatter	East Central Texas Plains/Southern Post Oak Savannah	Weches Formation (Eocene)		Tally Branch (400 m/2)	Crockett	70 x 130 m/ 3 cm deep	Archaic and Neo-American points, knives, and bifaces

Northern Blackland Prairie, Southern Blackland Prairie, and Floodplains and Low Terraces), and the East Central Texas Plains ecoregion (subregions Northern Post Oak Savannah, Southern Post Oak Savannah, Bastrop Lost Pines, and Floodplains and Terraces).

A total of 15 sites were recorded within the Balcones Canyonlands subregion of the Edwards Plateau Ecoregion. This includes 2 encampments, 11 campsites, and 2 lithic scatters.

Twenty-two sites were recorded in the Texas Blackland Prairies Ecoregion. The Northern Blackland Prairie had 3 encampments, 3 campsites, and 1 lithic scatter; the Southern Blackland Prairie had 1 encampment, 9 campsites, and 2 campsite/quarries; and 2 encampments and a campsite were identified within floodplains and low terraces of the Blackland Prairie.

Twenty-six sites were found within the East Central Texas Plains Ecoregion. The Southern Post Oak Savanna held 1 encampment, 5 campsites, 1 campsite/quarry, and 2 lithic scatters. The Bastrop Lost Pines contained 4 campsites and a campsite/quarry; and the floodplains and low terraces had 10 campsites, 1 campsite/quarry, and 1 lithic scatter.

Geology

The Bureau of Economic Geology's (BEG) *Geologic Atlas of Texas* (Austin and Seguin Sheets) was consulted for the geologic setting of each of the sites listed in Tables 4 and 5 (Proctor et al. 1974, 1981). From oldest to youngest, the geologic units are Cretaceous: Glen Rose Formation, Fredericksburg Group (including Edwards Limestone), Georgetown Formation, Del Rio Clay, Austin Formation, and the Navarro Group (including Pecan Gap Chalk and Neylandville Marl); Eocene: Simsboro Formation, Wilcox Group, Recklaw Formation, Queen City Sand, Weches Formation, Yegua Formation, Caddell Formation, and Manning Formation; Miocene: Oakville Sandstone; and Quaternary: Leona Formation, Quaternary High Gravels, Quaternary Terraces, and Quaternary Alluvium.

It is clear from the above data that the Quaternary-aged sediments deposited along the courses of the streams and rivers were the preferred site settlement areas. Looking at these units in closer perspective, the following can be discerned.

Both the lithic scatter and the campsite of the Leona Formation occurred in the Guadalupe River Basin in the Texas Blackland Prairie Ecoregion. The single campsite on the Quaternary High Gravels was found in the Colorado River Basin in the Balcones Canyonlands subregion of the Edwards Plateau Ecoregion.

Ten campsites on Quaternary Terraces occurred in the East Central Texas Plains Ecoregion. Eight of these were in the Colorado River Basin, and two were in the Guadalupe River Basin. Four Quaternary Terrace campsites were in the Texas Blackland Prairies Ecoregion. Two of these were in the Guadalupe River Basin, one was in the San Marcos River Basin, and one was in the Colorado

River Basin. Four Quaternary Terrace campsites were in the Edwards Plateau Ecoregion; all four were in the Blanco River Basin.

Table 5. Geologic Units and Site Occurrence

Geologic Unit	Encampments	Campsites	Campsites/ Quarries	Lithic Scatters
Cretaceous				
Glen Rose Formation		1		
Fredericksburg Group		2		1
Del Rio Clay/Georgetown Formation	1			1
Austin Formation		2		
Navarro Group	1	2		
Eocene				
Simsboro Formation		1		
Wilcox Group				1
Recklaw Formation			1	
Queen City Sand		1		
Weches Formation				1
Yegua Formation			1	
Caddell Formation		2	1	1
Manning Formation		1		
Miocene				
Oakville Sandstone		2		
Quaternary				
Leona Formation		1		1
Quaternary High Gravels		1		
Quaternary Terraces	4	18		
Quaternary Alluvium	1	9	2	
Totals	7	44	5	6

A total of four Quaternary Terrace encampments were recorded. The three found in the Texas Blackland Prairies Ecoregion include two in the Guadalupe River Basin and one in the Colorado River Basin. The encampment found in the East Central Plains Ecoregion occurred in the Guadalupe River Basin. The two found in the Edwards Plateau Ecoregion include one in the Colorado River Basin and one in the Blanco River Basin.

Nine campsites and two campsites/quarries were found in Quaternary Alluvium. One of the campsite/quarries was located in the East Central Plains Ecoregion in the Colorado River drainage basin, and the other is located in the Texas Blackland Prairies Ecoregion in the Guadalupe River Basin. Of the four campsites found in the East Central Texas Plains Ecoregion, three were in the Guadalupe River Basin and one was in the San Marcos River Basin. The remaining Quaternary Alluvium campsites were found in the Texas Blackland Prairies Ecoregion, within the Guadalupe River Basin. One encampment was located in Quaternary Alluvium in the Edwards Plateau Ecoregion near Sink Creek.

Both of the campsite/quarries found in Quaternary Alluvium occurred in the Guadalupe River Basin. One was in the East Central Texas Plains Ecoregion, the other in the Texas Blackland Prairies Ecoregion.

Soils

There are 28 soil series present at the 63 archeological sites within the 50-km study area. Five soil orders are represented: Alfisols (38 percent), Mollisols (40 percent), Vertisols (17 percent), Inceptisols (4 percent), and Entisols (1 percent).

Upland Soils

Twenty-four of the archeological sites are located on upland terrain. These are typically shallow sites that lack stratigraphic integrity. An exception is found at site 41BP298, which contains cultural deposits to depths of about a meter. However, there is not sufficient information on the nature of the vertical distribution of artifacts from that site to determine whether they were buried in windblown sediments or colluviums, or were vertically displaced by postdepositional forces. Upland soils are nearly equally divided between Mollisols and Alfisols. A few sites occur on Inceptisols.

Alluvial Soils and Buried Sites

It is in the alluvial deposits of Quaternary age that buried archeological deposits typically occur, though admittedly from most of the site data it is uncertain whether these buried deposits possess stratigraphic integrity and could be considered true *gisements*. Nevertheless, these alluvial soils at least possess the potential for this as well as the preservation of otherwise perishable organic remains of plant and animal origin.

Table 6 has been prepared to examine the relationship between site depth and soil type/taxonomy. All sites identified as having cultural deposits 1 m or more in depth are included in the table.

Three soil orders are represented in the table: Alfisols, Mollisols, and Vertisols. Alfisols include the suborders Paleustalfs and Haplustalfs. The order Mollisols includes Haplustolls, Paleustolls, and Argiustolls. Vertisols are represented by the suborders Haplusterts and Hapluderts.

Table 6. Recorded Archeological Sites in Deep Alluvial Soils

Trinomial	Depth of Cultural Deposits	Soil Series	Soil Taxonomy
41BP62	1 m	Bastrop	Paleustalfs (Alfisols)
41CW104	1 m	Gowen	Haplustolls (Mollisols)
41DW9	1 m	Meguin	Haplustolls (Mollisols)
41FY422	1.1 m	Straber	Paleustalfs (Alfisols)
41GZ73	1 m	Chazos	Paleustalfs (Alfisols)
41GZ128	1 m	Meguin	Haplustolls (Mollisols)
41GU17	1 m +	Branyon	Haplusterts (Vertisols)
41GU117	2 m	Barbarosa	Paleustolls (Mollisols)
41HY160	2.8 m	Oakalla	Haplustolls (Mollisols)
41HY188	2 m	Tinn	Hapluderts (Vertisols)
41TV142	1 m	Dougherty	Haplustalfs (Alfisols)
41TV1614	2 m	Speck	Argiustolls (Mollisols)
41TV2105	1 m	Bergstrom	Haplustolls (Mollisols)

It should be noted that these data represent the soils mapped at the location by the Soil Conservation Service, and it is unknown if the stratigraphy at any of the sites was compared to the soil series descriptions to verify confirmation with the mapped series. That said, the data may be useful in generally predicting the likelihood of a given locale for harboring buried archeological deposits. However, other factors besides soil taxonomy must be considered, particularly with regard to the presence of well-preserved organic remains. These factors include age of the cultural materials, the nature of how they were deposited, and perhaps most importantly, the adverse effects of postdepositional disturbances.

Drainage Basins and Streams

The sites identified within the 50-km radius fell within the following river basins: Colorado River, Blanco River, San Marcos River, and Guadalupe River.

The distance to the nearest stream and the rank of that stream were recorded for each site in the study area. The distance to the nearest stream varied from 5 to 500 m. Approximately 43 percent of the sites were located within 100 m of the nearest stream. The average distance to the nearest stream is 130 m.

The Strahler system was used to find stream orders. Algorithms were not employed, simply the principal that when two first-order streams come together, they form a second-order stream, and so on, up to an order of 10 (e.g., the Mississippi River). Streams of a lower order joining a stream of a higher order do not change the order of the higher stream. It is not until a stream joins another stream of the same order that the stream order becomes higher.

The data viewer was utilized to identify the order of the streams. The stream orders within the 50-km study area ranged from 1 to 7. Stream orders of 1 were the headwaters and tributaries to the named streams. Twelve sites occurred along these streams. Named creeks were generally a stream order of 2. Twenty sites were recorded along these streams. The smaller rivers (Blanco, San Marcos, and Guadalupe) have stream ranks up to 4, and 22 sites were found there. Finally, the Colorado River has a stream rank of 7, and 9 sites were found along it.

HISTORIC INDIANS

The list of native peoples that could have occupied the Santa Maria Creek site is quite lengthy, as several nonindigenous groups arrived in the general area in the late seventeenth century after being displaced northward by the Spanish or by the southeastward expansion of the Plains Apache. T.N. Campbell (1988a:73) lists 60 groups associated with the nearby Bastrop area during the seventeenth and eighteenth centuries. Of these, he notes that only the Apayxam, Caisquetebana, Cantona, Catqueza, Cava, Chaguantapam, Cumercai, Emet, Mayeye, Menanquen, Panasiu, Sana, Tohaha, and Toho may have been indigenous to the general area.

The following discussion focuses on what is known about most of these indigenous peoples, as well as the nonnative groups encountered or mentioned in the area during the Spanish expeditions of 1691–1727. Other groups, such as the Jumano and the Apache, are not included as they were latecomers or infrequent visitors to the area and are unlikely to have been the inhabitants of the Santa Maria Creek site.

Cantona

During the late seventeenth and early eighteenth centuries, the Cantona were known to the Spanish by several names, including Cantanual, Cantujuana, Cantauhaona, and Cantuna. At that time, they inhabited the prairies between the Guadalupe and Trinity Rivers, particularly east of the sites of the present cities of San Antonio, Austin, and Waco. They were most frequently reported along the Colorado and Brazos Rivers. Their success as bison hunters was noted by the Spanish. The Cantona were usually encountered sharing the settlements of other groups and appear to have been welcome at encampments of Jumanos and their associated tribes, with Coahuiltecan speakers (Mescales, Payayas, Xarames), near San Antonio, and to the east with the Cava, Emet, Sana, and Tohoho, and other Tonkawan speakers (Campbell 2011a). The linguistic affiliation of the Cantona has for years been uncertain, but recently it has been suggested that they were Caddoan speakers (Newcomb 1993:24). They may have been the same people as the Kanohatinos that La Salle encountered. A few Cantonas entered San Antonio de Valero Mission at San Antonio in the first half of the eighteenth century. They were last encountered living with the Caddoan-speaking Wichita, in the second half of the eighteenth century.

Catqueza

The Catqueza (Caquiza, Casqueza, Catcueza) were recorded briefly in Spanish documents of the late seventeenth and early eighteenth centuries. At that time, they were living northeast of San Antonio, in the Guadalupe valley between present-day San Marcos and Gonzales. This area includes the location of the Santa Maria Creek site. It is uncertain what linguistic group they belonged to as they were sometimes found in association with Cibolas and Jumanos. They may have arrived late in east Central Texas from Mexico or West Texas. One of their leaders was reported to have been brought up in Parras, Saltillo, and Parral, and later returned to New Mexico to join his people (Campbell 2011b).

Cava

The Cava (Caba, Cagua, Caouache, Lava) were located in the late seventeenth century north of Matagorda Bay and between the Guadalupe and Colorado Rivers, though typically they resided with other native groups such as the Sana, Emet, Cantona, Toho, and Tohaha. Between 1740 and 1750 some of the Cavas entered San Antonio de Valero Mission at San Antonio. Their linguistic and cultural affiliations are uncertain; they may have been Tonkawan, Karawanawan, or Coahuiltecan speakers (Campbell 2011c).

Chaguantapam

Campbell (2011d) notes that there is some confusion regarding the name Chaguantapam, which was recorded in 1690 by Fray Mazanet for one of the Indian groups living north of Matagorda Bay on the upper courses of the Lavaca and Navidad Rivers. Mazanet noted that other Indian groups lived in this same area, but he gave a name for only one of them, the Muruam. He said that these Indian groups all lived by hunting bison and collecting wild plant foods. In the San Antonio de Valero Mission registers, "the name Chaguantapam occurs only once, in a baptismal entry of 1737, and this was corrected by insertion of the name Mallei (Mayeye). If there were Chaguantapam individuals at Valero, they were never recorded as being baptized, married, or buried there" (Campbell 2011d).

Cibola

The name Cibola (Cibolo, Cíbula, Síbolo, Síbula, Zívolo) was given to a number of native groups who specialized in bison hunting. The linguistic affiliation of the Cibola Indians remains unknown. They lived in West Texas in close association with the Jumano, and both groups hunted and traded throughout Texas and northern Mexico from El Paso to the Hasinai in east Texas. They may have originally occupied the area between the Pecos and Colorado Rivers, but were displaced by the Apache until they disappeared as an ethnic group (Campbell 2011e). In 1691 Domingo Terán de los Ríos encountered Cibolo among the 2,000–3,000 mounted Indians near the Guadalupe River (Foik 1933).

Emet

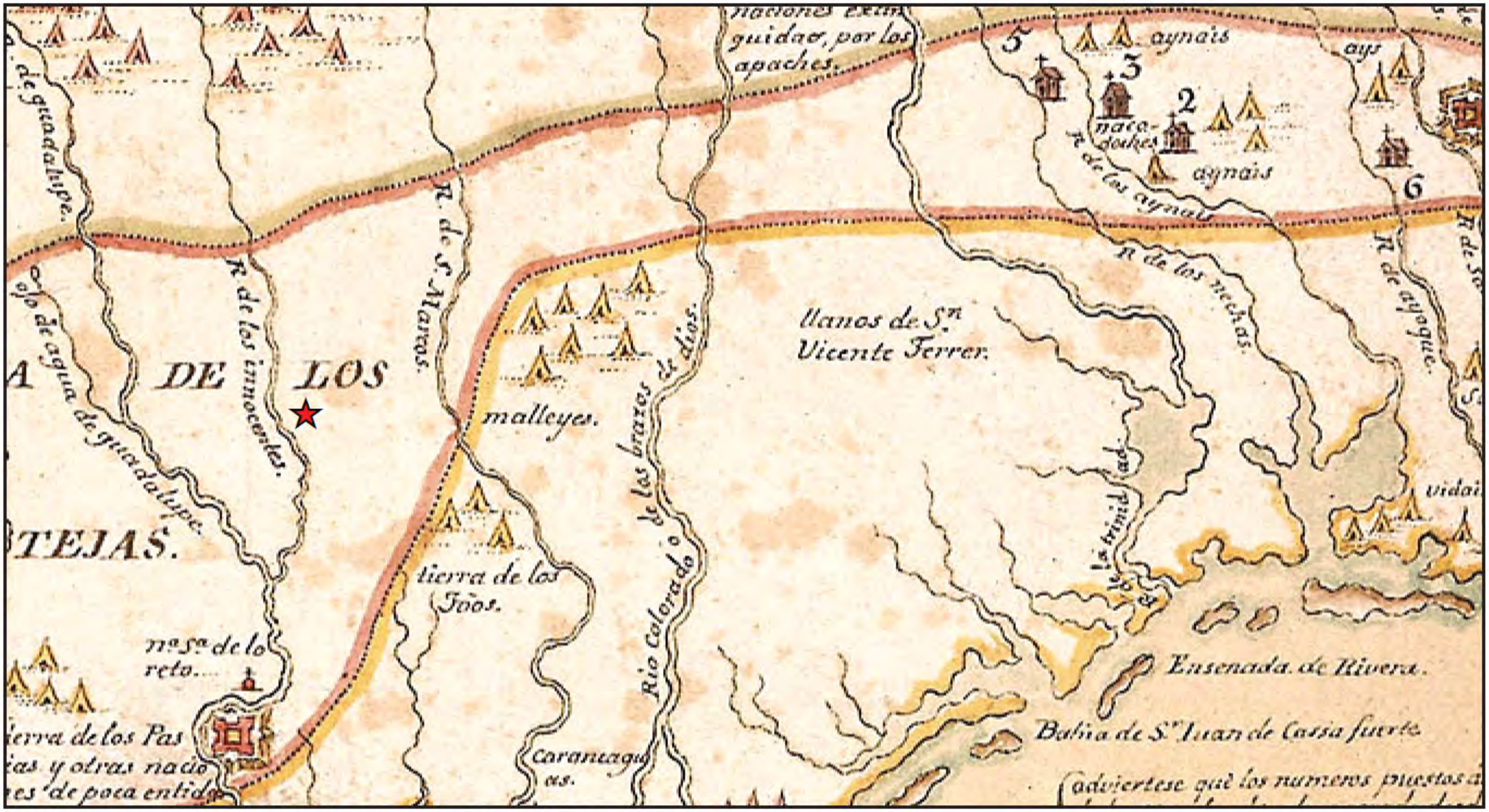
Between the late seventeenth and mid-eighteenth century, the Emet (Emat, Emiti, Ymette) occupied the coastal plain north of Matagorda Bay and between the Guadalupe and Colorado Rivers. They were often found in settlements with other groups, particularly Cantonas, Cavas, Sanas, Tohos, and Tohahas. Between 1740 and 1750, some of the Emets entered San Antonio de Valero Mission at San Antonio. The linguistic and cultural affiliations of the Emet Indians are uncertain, though they were probably Tonkawan or Karankawan speakers (Campbell 2011f).

Ervipiame

The Ervipiame (Chivipane, Cibipane, Hierbipiane, Huvipane, Hyerbipiame, Yerbipiame, Yrbipia) Indians were first known in 1673, at which time they lived in northeastern Coahuila and adjacent parts of Texas where they were in close association with bands that have been identified as Coahuiltecan in speech. In 1675 they were encountered in the southwestern part of the Edwards Plateau. By 1707 they had migrated into central Texas and became the dominant group in the Ranchería Grande de los Ervipiames, a series of settlements made up principally of Coahuiltecan refugees from northeastern Coahuila and the adjoining part of Texas, but later augmented by refugees from various Spanish missions in Texas and Coahuila. In 1722 the San Francisco Xavier de Náxara Mission was founded at San Antonio for the Ervipiames of Ranchería Grande, and their village near the mission was known as the Ervipiame suburb. After this, the Ervipiame Indians who remained at Ranchería Grande, or who retired to it from San Antonio after their mission was merged with San Antonio de Valero Mission, were associated mainly with groups identified as Tonkawans-Tonkawas, Yojuanes, and Mayeyes. They lost their identity among the various bands, which in the nineteenth century came to be called Tonkawa. They were with the Tonkawans at San Francisco Xavier de Horcasitas Mission, founded about 1748 on the San Gabriel River near present Rockdale (Campbell 2011g).

Mayeye

The Mayeye (Macheye, Maheye, Maiece, Maieye, Malleye, Maye, Muleye) are first mentioned by Henri Joutel of La Salle’s expedition in 1687 as one of the peoples encountered between Fort St. Louis and the Maligne River, southeast of present-day Waco (Newcomb 1993:24). They were encountered by Alarcón west of the Brazos River in 1718. Rivera came across a small band of Mayeye in the *Monte Grande* southeast of lower Brushy Creek (Animas de Abajo) in Williamson or Milam County in August of 1727 (Jackson 1995:32). The location of the Mayeye encampment is shown on Barreiro’s map (Figure 5). Later (about 1748), members of the tribe entered San Francisco Xavier de Horcasitas Mission on the San Gabriel River. A few years afterward, when the San Gabriel missions were abandoned, some of the Mayeyes entered San Antonio de Valero Mission at San Antonio, where they were recorded as late as the 1760s. Sometime in the 1770s, a group of



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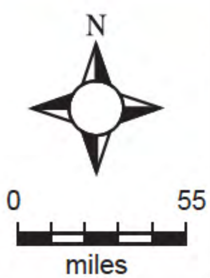

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Figure 5

Portion of Barreiro's 1728 Map Showing Toos and Malleyes (Mayeye)

Source: University of Texas at Austin, Texas Beyond History, http //www.texasbeyondhistory.net/adaes/images/barriero-1728.html

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Drafted by: C. Wallace

nonmissionized Mayeye Indians moved southward to the coast and joined the Coco Indians, a Karankawa group that lived along the lower Colorado River (Campbell 2011h).

Menanquen

Campbell (2011i) notes that a concise ethnic identity has never been established for the Menanquen because variants of the name have been regarded as names for separate Indian groups. The registers of San Antonio de Valero Mission of San Antonio indicate that at least 11 Menanquen individuals (4 adults, 7 children) lived at that mission during the period 1741–1755. Documents other than mission registers contain two names that appear to be variants of the name, including the Manam, which was recorded in 1690 by Fray Mazanet for one of eight groups he had encountered on the Guadalupe River, apparently in the area between the sites of modern Cuero and Seguin. The eight groups were listed in the following order: Tohaa (Tohaha), Toho, Emat (Emet), Cava, Sana, Panasiu, Apasxam (Apayxam), and Manam. Mazanet noted that all of these groups lived by hunting and gathering (he listed unspecified wild plant products, fish, and bison as foods). According to Mazanet, the Manam were associated with the Cava. In the registers of San Antonio de Valero Mission, eight native personal names of Menanquen individuals are recorded. Five are male names: Aujup, Aureian, Bobeon, Sicnereum or Sicnereun, and Sunaguqum; and three are female names: Caiara, Tequejan, and Ujuiagua. No meaning is given for these names, and they are not known to be associated with any known language (Campbell 2011i). The linguistic affiliation of the Menanquen is unknown.

Mescal

In the late seventeenth century, the Mescal (Mescate, Mexcal, Mezcal, Miscal, Mixcal) ranged over a large area, extending from northeastern Coahuila northward across the Rio Grande at least as far as the southern margin of the Edwards Plateau. They were among the Indians for whom the San Juan Bautista Mission was founded at its first location on the Rio Sabinas in 1699. Some Mescal families also entered San Francisco Solano Mission, for a few were reported there in 1706 when it was located near present Zaragoza, Coahuila. Other members of the tribe migrated northeastward to reside in Ranchería Grande in east Central Texas near the junction of the Little and Brazos Rivers. They were encountered there along with Ervipiame, Mesquite, Pamaya, Payaya, Sijame, Ticmamar, and Xarame by the Ramón expedition in 1716. The few Mescal Indians at San Francisco Solano Mission probably followed this mission when it was moved from Coahuila to San Antonio, Texas, in 1718 and became known as San Antonio de Valero. However, many of those reported in Valero records may have come from Ranchería Grande. The Mescals of San Juan Bautista seem to have remained with the mission when it was moved from the Rio Sabinas to present Guerrero, Coahuila, near the Rio Grande. Some were reported there as late as 1738. The Mescal Indians slowly lost their ethnic identity during the eighteenth century (Campbell 2011j)

Pamaya

The Pamaya (Panaa), who spoke a dialect of Coahuilteco, were first mentioned when Jean Jarry, a member of the La Salle expedition, was captured and interrogated by the Spanish in 1688. Jarry had deserted the expedition and was living among the natives. In 1691 Fray Mazanet recorded an encounter with the Pamayas and five other Indian groups between the Río Sabinas and the Rio Grande in what is now northeastern Coahuila. When next recorded, in 1716, some Pamaya were found by Ramón at Ranchería Grande west of the junction of the Little and Brazos Rivers. The next year, St. Denis found the Pamayas and Indians from five additional groups farther south, in the Blackland Prairie, east or northeast of modern Austin. The Mission San Antonio de Valero registers permit identification of approximately 45 Pamaya individuals for the years 1719–1753 (Campbell 2011k).

Panasiu

The Panasiu were recorded in 1690 by Mazanet as one of the groups he had encountered on the Guadalupe River east of what is now San Antonio. In the following year, he wrote that they did not speak the language now known as Coahuilteco, though their language is unknown. Campbell (2011l) notes the Panasius lost their ethnic identity before 1718, for they were not recorded as being represented at any of the Spanish missions of southern Texas.

Payaya

The Payaya (Paia, Paialla, Payai, Payagua, Payata, Piyai, and other variants) were a Coahuiltecan-speaking group that was first reported during the Terán expedition (Hatcher 1932:14). During that time, they ranged over an area that extended from that of San Antonio southwestward to the Frio River and beyond. However, it is with the San Antonio area that the Payayas were most consistently associated. A local stream was referred to as El Arroyo de los Payayas, and a pass through the hills northwest of San Antonio was known as Puerto de los Payayas. Shortly before 1709, a group of Payaya Indians joined other Coahuiltecans and moved to the vicinity of present Milam County in east central Texas, where they settled among Tonkawans at Ranchería Grande. Other Payayas entered missions in both Coahuila and Texas, and were one of the groups for whom San Antonio de Valero Mission was established at San Antonio in 1718 (Campbell 2011m).

Sana and other Sanan Speakers

The Sanan language has been identified as a distinct speech of a regional people by the analysis of over 100 personal aboriginal names and several group appellations in 1992 (Johnson and Campbell 1992). The names of these individuals were recorded at the Spanish missions at San Antonio and in eastern Coahuila, and indicate that around A.D. 1700 the speakers of the language were separated into two groups, referred to as eastern and western Sanan speakers. The western speakers resided in Coahuila and are not pertinent to the current study. The eastern Sanan speakers were residing on the inland coastal plain of Texas, east and southeast of the Edwards Plateau, and included the Sana, Caguas, Toho, Menanquen, Macocoma, Xana, Mesquites, Emate, and Sijame. These groups were first identified living on the Guadalupe and Colorado Rivers north of Matagorda Bay during the closing decades of the seventeenth century. Some of them appear to have ranged as far north as the San Gabriel and Brazos Rivers. In general, the eastern Sanan peoples occupied the prairie and *monte* areas to the east and southeast of the Edwards Plateau (Johnson and Campbell 1992).

The Sana were encountered by the Terán expedition in the vicinity of present-day Seguin, Texas, in 1691. In 1709 the Espinosa-Olivares-Aguirre expedition waited on the banks of the San Marcos River for the Sana to bring them news of the Tejas nation (Tous 1930a:6). The Alarcón expedition encountered members of the Xana tribe near Bellville in Austin County in 1718. When crossing Plum Creek (San Rafael) in 1722, the Aguayo expedition encountered a squad of mounted Sana Indians, armed with pikes and bows. The Indians were clothed in garments provided by Governor Aguayo while at San Antonio, and were waiting for the expedition to renew their allegiance to the Spanish King. Some Sana entered the mission of San Antonio de Valero from 1740–1749 (Hoffman 1935:35).

Simaomo

The Simaomo were originally a remnant population displaced northwards from northeastern Coahuila. They were encountered during the 1690 expeditions of Alonzo de León in his search for La Salle's Fort St. Louis. At that time they were living between Matagorda Bay and the Colorado River. They were known to encamp with Mescal, Sana, Tohaha, and Hasinai hunters. They were encountered along the Colorado River by the Espinosa-Olivares-Aguirre expedition of 1709. Nothing is known of the Simaomo after that time (Campbell 1988a:64–65).

Toho and Tohaha

While the Toho and Tohaha were distinct groups, they were often found closely associated. Both occupied the area of the lower Guadalupe and Colorado Rivers, and resided in villages with the Cantonas, Cavas, Emets, and Sanas. Campbell (2011n) noted that attempts to link the Toho with the Atayos mentioned by Cabeza de Vaca are not very convincing because over 150 years separate the initial records of the two groups. However, the identification of the Tohos with the Tohaus (Tohans, Tokaus) mentioned in the records of the La Salle expedition is generally accepted and is supported by the fact that both Tohau and Tohaha appear on the same list of localized groups.

Tusonibi

Campbell (1988a:66) notes that this group was only mentioned because they were found along the Colorado River by the Espinosa-Olivares-Aguirre expedition. The Tusonibi may have been the same people recorded in northeastern Mexico as Juzan, Tuisoni, Tusane, Tusonid, and Tuzan, who were later collectively known to the Spanish as the Carrizo.

Yojuane

The Yojuane were first encountered by Europeans in 1601 when Juan de Oñate led a Spanish expedition from New Mexico eastwards into the plains of west-central Oklahoma. They were Tonkawa speakers who were displaced southwards by the Apache and Osage around 1650. The Yojuane were recorded as living in Texas in 1691, and were encountered along the Colorado River by the Espinosa-Olivares-Aguirre expedition of 1709. Later, they were found living with the Coco, Mayeye, and Tonkawa near the junction of the Brazos and Little Rivers (Campbell 1988a:64).

SPANISH EXPEDITIONS, 1691–1727

The following descriptions are provided for the six Spanish expeditions that crossed lands in the general vicinity of the Santa Maria Creek site, beginning with the expedition of Domingo Terán de los Rios in 1691, and culminating with that of the Inspection Tour of Brigadier Pedro de Rivera in 1727. These accounts are intended to be general summaries; however, closer attention to detail is provided in the descriptions of the plants, animals, and native peoples in the general region, an area roughly corresponding to the junction of the eastern edge of the Edwards Plateau and the Post Oak Savannah, extending from Cibolo Creek to the Colorado River. Figure 6 shows the routes for four of the expeditions.

The earliest journey across the lands of Texas had been the well-known trek of that of Álvar Núñez Cabeza de Vaca between 1528 and 1535. While this was a unique and fascinating journey, Cabeza de Vaca's route did not cross central Texas and is thus not discussed in detail. Instead, the reader is referred to the work of Krieger (2002) for the story of the entire journey and that of Campbell and Campbell (1988) for a discussion of the Indians of coastal and south Texas. However, certain relevant details of the *Relación de los Naufragios y Comentarios* are included in the present study, such as Cabeza de Vaca's encounters with the "cow people" believed to have been a group of Jumanos.

All of the following expeditions stemmed from Spain's desire to thwart French efforts at gaining a foothold in what would soon become known as the Province of Texas, which France claimed by right of the explorations of La Salle in the 1680s. In 1686 the first land expedition seeking to expel the French from their colony at Fort St. Louis set out from Nuevo Leon under Alonzo de León, the first governor of Coahuila. This would be the first of five expeditions that De León would lead in this effort, but it did little more than explore the southern bank of the Rio Grande. His second expedition in 1688 succeeded in crossing the river, and his third later that year captured a Frenchman who was ruling a tribe of natives north of the river. Finally, in 1689, De León found the remains of La Salle's fort, which had been destroyed by Indians shortly before. Several Frenchmen were found living with the tribes in the area.

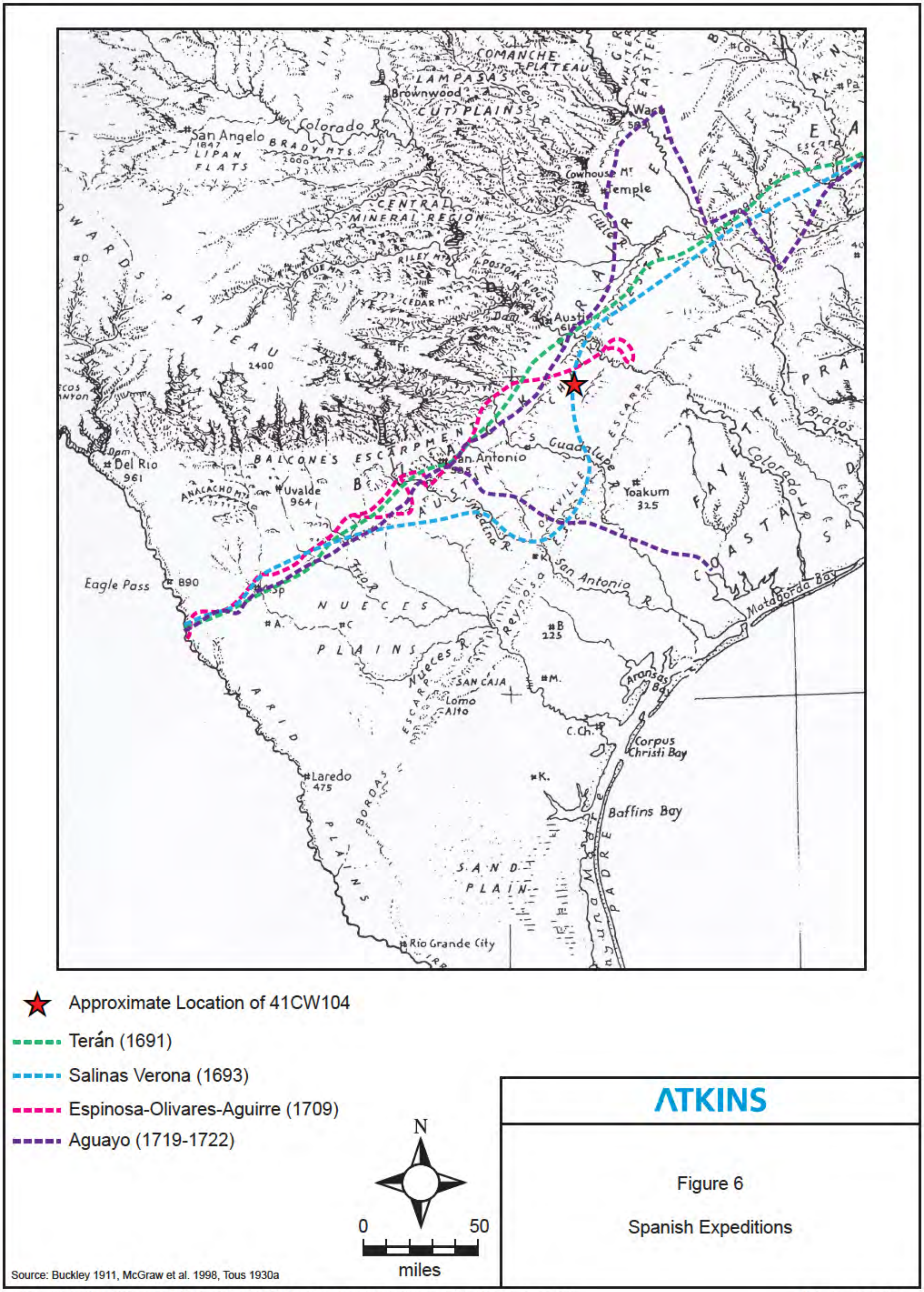

Figure 6

Spanish Expeditions

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Drafted by: C. Wallace

While on this expedition, a chief of the Tejas visited De León, and asked him to establish a mission among his people. De León's chaplain, Fray Damián Mazanet of the Franciscan College at Queretaro, was impressed with the Tejas chief and was interested in the tribe because of stories he had heard of the miraculous conversions of Mother Agreda (González 1982a; Hatcher 1932:48). The consent of the Spanish authorities for such a mission was granted, and in 1690 De León and Mazanet visited the Tejas Indians and founded two missions among the Nabedache, San Francisco de los Texas near the Neches River and Santísimo Nombre de María a few miles to the north. The land occupied by the Hasinai, or Texas Confederation, was raised to the status of a province, and Domingo Terán de los Ríos selected as its first governor (Hoffman 1935).

Domingo Terán de los Ríos, 1691–1692

The route taken by Governor Domingo Terán de los Ríos was the first of the Spanish *entradas* to cross in the vicinity of the Santa Maria Creek site. The expedition sought to establish seven missions among the Tejas Indians, investigate rumors of French settlements on the Texas coast, and to make a record of the geography, plants, animals, and native peoples that were encountered along the route. The leadership of the expedition was divided between the military mission under Governor Terán and the spiritual one under Fray Damián Mazanet, who were often at odds with one another. Both Terán and Mazanet kept diaries of the journey. These were translated into English by Mattie Hatcher (1932).

The expedition crossed the Rio Grande del Norte on May 27, 1691. On June 6 they reached the Nueces River, which Terán referred to as San Diego, and Mazanet named San Norberto. Mazanet noted there were large pecans trees in a valley near the river. Great quantities of buffalo were seen nearby, and the river was teeming with fish, including *vagres* (catfish) and perch (Hatcher 1932:13, 52). The next day the expedition reached the Frio River, which the natives called Guarapacavas (Cold Water).

When they reached the Hondo River on June 9, they were met by Indians of several nations: Sanpanal, Patchal, Papanaca, Parchiquis, Pacuachiam, Aguapalam, Samampac, Vanca, Payavan, and Patavo. Most if not all of these people were Coahuiltecan speakers (Campbell 1988b:47). On June 13 the expedition camped on the banks of an arroyo adorned by a great number of trees including cottonwoods, cedars, willows, oaks, and mulberries. In the arroyo were a great number of fish, while the surrounding uplands contained numerous wild chickens (prairie chickens). This place was named San Antonio de Padua. The Payaya Indians had *rancherías* at this location, which they called Yanaguana (Hatcher 1932:14). Terán noted that these people were docile and affectionate. The Spanish remained in camp at this location the following day, and Fray Mazanet ordered a large cross to be set up, and in front of it an arbor made of cottonwood trees, where an alter was set up. Mass was said there, attended by the governor, all of the soldiers, as well as the natives, to whom Mazanet distributed gifts.

From San Antonio de Padua, the party traveled east-northeastward over level lands without woods. After 5 leagues they camped near an arroyo where there were a great many buffalo, while in the lagoons were alligators and abundant fish. The Indian name for this area (Ymatiniguiapacomicen) referred to its being a place where colors could be found for painting shields (Hatcher 1932:55). As was typical, the two expedition leaders, who did not get along very well, each gave the stream a separate name—it was called San Ignacio by Terán and Santa Crecencia by Mazanet. Later, it became known as Cibolo Creek.

Continuing east-northeastward, the expedition reached the Guadalupe River on June 18. Here they encountered about 2,000 to 3,000 natives of many nations—Jumano, Cibolo, Casqueza, Choma, Cantona, and Mandones. Terán stated that they had formal patents from the governors of Viscaya and New Mexico, and spoke Spanish. He did not trust them, however, and concluded that they were fairly intelligent, brave, haughty, and numerous (Hatcher 1932:15). Mazanet records that these Indians had with them letters from the missionaries among the Tejas, who reported great illness among those people. The Spanish accompanied the natives to their *ranchería*. The Indians were mounted and used saddles, which they said they captured from the Apache, who were their mortal enemies.

Mazanet noted that every year the Jumanos (and accompanying tribes) came to the headwaters of the Guadalupe and sometimes as far as the Tejas, to hunt buffalo, as they said that there were none in their own country. He also states that the area around the Guadalupe River formed a boundary between native linguistic groups. South of the river, all spoke one common language, while from the Guadalupe to the Tejas many languages were spoken, as one encountered the following nations: Catqueza, Cantona, Emet, Cavas, Sana, Tojo, Toaa, and others (Hatcher 1932:56).

The expedition marched 2 leagues to the east on June 19, in order to place some distance between themselves and the Indians. From there they turned northward and a quarter eastward until they reached a branch of the Guadalupe (Blanco) on June 20. The stream was described as having water that was very hot when it first came from the ground, but cooled quickly. They remained in camp in this area for a few days as a large number of horses had stampeded, possibly intentionally run off by the Indians. Finally, on June 25 they continued, traveling 1 league east and 6 leagues northeast, traversing many arroyos during that time, possibly including Plum Creek and its tributaries. They camped on an arroyo that the Indians referred to as Techaconaesa, which means place where there are prickly pears and mesquites. There were a great many other trees as well, including mulberries, ash, and hackberry. Numerous grape vines were noted. There were also many buffalo.

On June 26 Mazanet noted that a large mountain was visible to the east the entire way. This may have been Pilot Knob. The expedition turned eastward for another 2 leagues to the Colorado River. They spent a few days finding a suitable crossing for the livestock they had with them, generally traveling east-southeastward. On July 3, probably in the vicinity of modern-day Smithville, a party of 20 soldiers under Captain Martinez left for Matagorda Bay. The governor and the other members of the expedition remained encamped at the river. Martinez was to meet with a contingent of Spanish marines who were supposed to have sailed up the coast. He had been on the earlier De Leon expedition to the coast and was familiar with the territory. Martinez reached the bay on July 8. While he failed to find any sign of the marines, he did come into contact with natives of the Karankawa tribe, who exchanged captive French children for horses and tobacco. On July 22 the entire *entrada* once again began the journey to the Tejas.

The Terán expedition reached the Trinity River in August. From there they continued eastward to the Tejas. Terán met with the chiefs of that nation and remained in the area for about 3 weeks. He then began his return to trip to Matagorda Bay. When they arrived at the Guadalupe River, Terán took a small force towards the coast. Along Garcitas Creek, they encountered Gregorio de Salinas Varona who was carrying orders from the viceroy for Terán to return to the Tejas. On September 27, Terán's force, augmented with that of Salinas, began the trek back to east Texas. The governor reached the mission on the Neches and remained there until early November, when he traveled north to the Red River to meet the leader, or Caddi, of the Cadodacho. From there he began his return trip to the east Texas missions on December 5, under bitterly cold conditions. He remained at the missions until February 1, when the march back to Matagorda Bay began (Hatcher 1932:43).

During this part of the journey, Terán was guided by a Tlaxcalan Indian he personally chose. This tribe of Uto-Aztecan speakers from Central Mexico had faithfully served the Spanish as guides since Antonio de Espejo's expedition into the Trans-Pecos and New Mexico in 1582–1583 (Campbell 2011o). Given that other native guides that served Terán had fled during the journey, it is not surprising that he chose a reliable ally to guide his army to the coast in these difficult conditions.

Terán and his exhausted men reached the campsite he had used the previous fall near the present Victoria-DeWitt county line in early March (Foster 1995:71). There he met with soldiers from the ship waiting in Matagorda Bay. He and Captain Salinas sailed from the bay on March 24. Captain Martinez returned overland to Mexico with the remainder of the expeditionary forces, though no record was kept of this journey.

Gregorio de Salinas Varona, 1693

Gregorio de Salinas Varona served as governor of Coahuila from 1693 to 1698. Earlier, in 1691, he had commanded the sea division of the Terán expedition. In 1693 he led an expedition to the east Texas missions in order to bring much needed supplies, as the missionaries had not been able to sustain themselves. The expedition left Santiago de la Monclova on May 3, 1693, crossing the Rio Grande on May 10. The expedition rapidly crossed southern Texas, following Terán's route, and by May 19 had reached the Medina River. By May 24 they had crossed the Guadalupe River. Between there and the San Marcos River, the expedition encountered native groups including Suana [Sana?], Simaomo, Mescales, Tohaha, Muruam, and Cacaxtle (Campbell 1988a:66; Robbins 1998:81).

Salinas crossed the Colorado River on June 2. From there to the Trinity River, he closely followed the route of Terán, arriving at Mission San Francisco on June 13, 1693. Once the provisions had been delivered, the expedition returned to Mexico (Robbins 1998:81).

Espinosa-Olivares-Aguirre Expedition, 1709

The missions among the Tejas were short lived, surviving only 2 years. The excitement that was caused by the intrusions into east Texas by the French subsided and with it the need for posts on the frontier. The Kingdom of Texas was proving to be a disappointment for the Spanish crown, and the native peoples were becoming more aggressive. Disease and several crop failures added to the problems faced by the missionaries, and on October 25, 1693, the missions were abandoned. Fray Mazanet himself plied the torch to the building that served as the first mission in Texas (Hoffman 1935:11).

The Espinosa-Olivares-Aguirre expedition of 1709 was organized in response to the growing concern of French encroachments into Spanish territory. Two years earlier, the viceroy of New Spain had received intelligence that the French in Louisiana were intent upon establishing trade within Spanish dominions. A war council in Mexico City recommended that in order to prevent this, contacts should be made with the Tejas nation of east Texas and that they be persuaded not to accept French goods. A second goal of the expedition was to reestablish contact with the Tejas with the intention of once again promoting missions among them. By 1708 the Spanish viceroy had decided that renewing contact with the Tejas might be the best way at preventing east Texas from completely coming under French influence. The expedition was composed of Fray Antonio de Olivares, Commissary of the Holy Cross of Queretaro, Fray Isidro Espinosa, missionary in charge of the Mission of San Juan Bautista on the Rio Grande del Norte, Captain Pedro de Aguirre, commander of the Presidio of Rio Grande del Norte, and 14 soldiers of his command. Fray Espinosa served as diarist for the expedition.

The expedition left San Juan Bautista on the Rio Grande on April 5, 1709. On April 11 they crossed the Medina River, where they encountered a *ranchería* of the Payayas tribe. Espinosa noted that walnuts (pecans) were abundant along the river and constituted a primary food source of the Payayas. Two days later, they discovered an irrigation ditch that had been terraced, which they named San Pedro Springs (Agua de San Pedro). A short distance from the springs was a luxuriant growth of trees that rose near a populous *ranchería* of the Siupan, Chaulaames, and Sijames tribes. The river that was formed by this spring they named the San Antonio de Padua. After distributing tobacco, the expedition to find the Guadalupe River was led by native guides, camping first at a briny stream (Salado Creek). The following day they crossed the Comal River and reached the Guadalupe, which Espinosa described as having abundant, clear, and good water and fertile banks supporting sabines (cypress), elms, poplars, willows, and other trees. The expedition waited at the river for the Sana Indians, who were to bring them news of the Tejas, who had been summoned but did not arrive. On April 15 the force arrived at the banks of the San Marcos River, which they crossed on the following day. The next stream crossed after the San Marcos was Plum Creek: "Directing our course eastward through a forest of mesquite clumps and some elms we came, after a distance of about two leagues, to an arroyo with little water which we named San Rafael, Sovereign Prince, in who we entrusted the success of our journey" (Tous 1930a:6).

Espinosa's reference to dense clumps of mesquite is interesting. Earlier, in 1691, Mazanet had noted that the native word for one of the streams (possibly Plum Creek) around present-day San Marcos was Techaconaesa, which means place where there are prickly pears and mesquites. The importance of prickly pears in the native diet is well referenced in the literature, beginning with Cabeza de Vaca's account of his travels between 1528 and 1535 (Campbell and Campbell 1988; Krieger 2002). The beans and pods of the mesquite tree, while known to have been a food source in Mexico and the American Southwest (Havard 1895:121; Krieger 1956:56–57), does not appear to have been recorded as such in this region. This has led some researchers to speculate that it was not common this far north (at least in Cabeza de Vaca's time), but spread later as a result of overgrazing by cattle (Campbell and Campbell 1988:37). It would seem, based on the records of Mazanet and later Espinosa that as early as 1691, long before the effects of cattle overgrazing would have been evident, mesquite was present and in some areas was quite abundant. If so, it may have been an important food source during the summer and early fall, when the beans are ripe.

Espinosa provides additional information regarding the vegetation between Plum Creek and Onion Creek:

> . . . I cannot fail to mention in passing, that in addition to the fertility of the country exhibited by the variety of flowers, trees, and wild fruits, an abundance of hemp was noticed in the depressions of the ravines. This was so flourishing that it seemed to be cultivated though it had received no other care than that of the liberal hand of nature that beautifies everything. The hemp found in the fields could supply all the wants of the Indian women. Besides this, the land seems to be suited to the cultivation of vines, a great variety of which are found growing wild on the hills. The vines are very large and resemble those of Castile. The bunches are larger and the grapes thicker, the skin being tougher, but the fruit is sweet and palatable. Mulberry trees are found everywhere along the arroyos and rivers. (Tous 1930a:10)

About pecans, he says the following:

> The nuts are so abundant that throughout the land the natives gather them, using them for food the greater part of the year. For this purpose they make holes in the ground where they bury them in large quantities. Not all the nuts are of the same quality, for there are different sizes and the shells of some are softer than others, but all of them are more tasty and palatable than those of Castile, though they are longer and thinner. The Indians are very skilled at shelling them, taking the kernels out whole. Sometimes they thread them on long strings, but ordinarily they keep a supply in small sacks made of leather. . . . (Tous 1930a:10–11)

Mammals, birds, and fish are also described, with deer being so numerous they resembled flocks of goats. Bison were well described and said to constitute the most common food of the nations that live in the neighborhood of the Tejas. Bears, lions, tigers, and foxes were also mentioned.

The expedition did not camp on the San Rafael, nor did they encounter any native peoples there. They continued toward the Colorado in the hopes of finding Indians who could give them information regarding the Tejas. They began to encounter bison around Onion Creek, which was named Garrapatas on account of the large number of ticks that infested the area. The Colorado was reached on April 18. Part of the expedition remained in camp at the river while the rest continued to explore. A large, recently abandoned *ranchería* was found:

> Just beyond this part of the river is a shady place, about half-a-league, surrounded by trees, where we found an abandoned rancheria, in the shape of a half-moon which had more than 150 huts, but large and well made. There, while on our way, we came upon four graves covered with sticks, two of which still gave out an offensive odor and appeared fresh. (Tous 1930a:7)

Large herds of bison were encountered on both sides of the Colorado, which provided the expedition with meat. Returning to camp, the party was joined by a group of 40 Indians led by Captain Cantona, who was well known by the Spaniards. These were members of the Yojuan, Simonos, and Tosonbi tribes, An additional 37 individuals arrived the following morning and led the expedition to their encampment some 4 leagues northeast of the river, possibly near the headwaters of Wilbarger Creek (González 1982b:6). When asked about the Tejas, the Spaniards were told that the Tejas or Asinai were in their own country where they had always lived and had not moved into the San Marcos-Colorado River region. The Asinai were led by one Bernardino, who spoke Spanish fluently, having escaped from a mission on the Rio Grande. He was described as being very adverse to all matters of faith, having never been made a Christian. The Spanish then decided to go no farther, and after distributing gifts, began their return to the Rio Grande del Norte, which they reached on April 28.

At the end of his diary, Espinosa comments on the lands the expedition traversed, the vegetation, and the native peoples. He affords us with a glimpse of the human inhabitants who occupied this part of Texas within about 50 years of the occupations at 41CW104. He mentions the importance of pecans to the natives and the abundance of medlars (plums) along the streams. Bison is described as being the principal food of all the nations. The different tribes or nations, which are said to total about 50, were generally at war with each other. They are described as having a pleasing appearance, being well proportioned. The majority paint themselves with a single stripe across the forehead down to their nose and round the mouth. Some carefully paint their arms and necks to resemble necklaces. There are sorcerers among the nations, and the men occasionally use peyote. The men engage in hunting, but little else. The women tan and paint deer and buffalo hides for trade with the Spanish.

Domingo Ramón, 1716

As mentioned above, the presence of the Spanish at the east Texas missions ended in 1693 when Fray Mazanet was forced to abandon them by the Tejas chief Bernardino. In early 1716 the Spanish decided to permanently reestablish the missions, the assignment being given to Captain Don Domingo Ramón. His force contained about 65 members, including 8 married soldiers who brought their families with them to settle in east Texas. A sizeable contingent of clergy accompanied them. Ramón was joined on the Rio Grande by Fray Isidro de Espinosa and Fray Antonio Margil de Jesús. Both Espinosa and Ramón kept diaries of the journey (Foik 1933; Tous 1930b). In addition, Espinosa brought along an astrolabe to record latitude.

Also on the expedition were three Frenchman, including Louis Juchereau de St. Denis. St. Denis played an important role in the early settlement of Louisiana and east Texas. In 1699, he arrived in Louisiana on the second expedition of Pierre Le Moyne, Sieur d'Iberville, his relative by marriage. Once in Louisiana, St. Denis was given the command of a fort on the Mississippi River and another at Biloxi Bay. He conducted explorations to the west of the bay and ascended the lower Red River. During this time, he learned wilderness survival from his contacts with native groups, particularly the Caddo. When Fray Francisco Hidalgo sent his letter to Governor Cadillac requesting aid to the east Texas missions in 1713, St. Denis was sent there with a small force. He traveled to lands of the Hasinai Indians and was guided by them to the Spanish outposts on the Rio Grande. While on that journey, his party was attacked by a force of some 200 Apaches near present-day San Marcos, but they successfully defended themselves. At San Juan Bautista, he was placed under house arrest. Ordered to Mexico City for interrogation, St. Denis defended himself ably and was appointed as commissary officer and guide of the Ramón expedition. In October 1716, he returned to San Juan Bautista with considerable merchandise, but was again taken to Mexico City. Fearing imprisonment, he fled the city. St. Denis later married the granddaughter of the commander of San Juan Bautista and spent the remainder of his life in Natchitoches.

The Ramón expedition crossed the Rio Grande on April 27, 1716. The Nueces River was reached on May 4 and the Frio on May 7. On May 14 they arrived at the San Antonio River. Espinosa was much more impressed with the river than when he had seen it in 1709, and commented on the clarity and sweetness of its water, as well as the abundant amount and variety of fish it held. He noted the presence of alligators. He found the luxuriance of the setting enticing for the founding of missions and villages (Tous 1930b:10). The expedition resumed its march on the 16th, stopping at Arroyo Salado. Ramón remarked that despite its name it was not salty, and found wild grape vine stocks that appeared to have been hand planted.

On May 17 St. Denis, Captain Luis de San Dionisio, and a Quia Indian went ahead of the expedition in search of the Tejas Indians who were supposed to be traveling to meet with Ramón. The Comal River was reached on the 18th, being said to be only an arrow shot in length. Both Espinosa and Ramón commented on the beauty of its surroundings. Groves of walnut (pecan) trees lined its banks, along with willow, poplars, grapevines, and mulberry. The Guadalupe River was reached on the 19th. In it fish and alligators were numerous. The expedition thought the stream they were on was separate from the main channel of the Guadalupe, and named it the San Ybon (Foik 1933:13).

The next day (May 20) the expedition reached the San Marcos River. The banks of the river were covered in dense vegetation. No camp was made on the San Marcos, but instead the expedition continued for 2 leagues to the San Rafael. They stayed camped at the creek until May 22. Espinosa describes what appears to have been a comet in the night skies (Tous 1930b:12). The next day the expedition continued northeastward for 8 leagues, passing the spring that Espinosa had named San Isidro in 1709, and reaching the Arroyo Garrapatas (Onion Creek) at the end of the day.

The Colorado River was encountered on May 23, and the group camped there. The next 2 days were spent fording the river. On the 26th Ramón sent three men to search for Indians. While no natives were encountered, the men killed a bison and brought some of the meat back to the camp. The march to east Texas was resumed on May 28, and after about 4 leagues, they came to a stream they named Arroyo de las Benditas Animas on account of having recommended to the Holy Souls our good guidance. This was Brushy Creek (Tous 1930b:13).

On May 30 two natives, a Yerbipiame and a Mescal, were met who told Ramón that they had a ranch nearby and would act as guides. The San Xavier (San Gabriel) River was reached on June 1. While encamped on this river, Ramón sent three Indians to look for bison. Two other members of the expedition also left in this search but became lost and were never heard from again.

After traveling several leagues, on June 10 some Yeripiano, Ticmameras, Mesquites, and Asinai came into camp. The village of these Indians, which totaled some 500 persons, was reached on June 12. Espinosa remarks that the Indians were very good natured and included members of the Pamayas, Payayas, Cantonaes, Mixcal, Xarame, and Sijames tribes. The expedition remained among these people for 3 days.

Resuming the march, the expedition reached the Brazos River on June 15 and the Trinity River on June 23. On June 25 the expedition was met by a Tejas Indian who brought word that St. Denis was engaged in assembling Asinai. St. Denis arrived with these Indians on June 27.

Ramón's diary ends on July 11, 1716, with the expedition fully arrived in east Texas.

Martín de Alarcón, 1718

Martín de Alarcón, who had been appointed the governor of Texas in 1716, was assigned to lead an expedition to Texas in order to establish a mission and presidio on the San Antonio River and to deliver supplies to the east Texas missions. Alarcón was instructed to utilize native guides and follow the routes established by previous expeditions.

The Alarcón expedition, totaling 72 persons, including soldiers, craftsmen, 3 priests and 7 families, crossed the Rio Grande on April 9, 1718. Two of the priests kept diaries of the journey. The Frio River was crossed on April 19, the Medina River was crossed on April 23, and the San Antonio River was reached on April 25. On the banks of that river he founded the mission of San Antonio de Valero and nearby established the Presidio de San Antonio and the Villa de Bejar (Bexar), which he took possession of on May 5 (Hoffman 1935:49).

Alarcón had also been instructed by the viceroy to reconnoiter the bay of Spirtu Santo (Matagorda Bay). He took 25 men and 2 of the missionaries on this trek, which began on May 6. The party traveled northeastward from the newly established villa, crossing the brackish waters of Salado Creek and Cibolo Creek that day. The junction of the Comal and Guadalupe Rivers was crossed the next day. From that point the group traveled eastward and southeastward for about 10 leagues, of which 4 were along a good road and the rest through thick woods. The camp that day was along a creek the governor named Salsipuedes ("get out if you can") because of the dense thick woods.

While encamped at Salsipuedes, the two natives serving as guides abandoned the group, in fear of coastal Indians (Hoffman 1935:50). While no coastal people were encountered, the fear of their presence demonstrates that they could be expected to be encountered. Their presence this far inland during the month of May could be related to the seasonal exploitation of prickly pear during the late spring and summer months. This food source was a staple between May and August (Hall 1998:4) and resulted in the movement of different ethnic groups from a wide region. The Mariame, for example, Coahuiltecan speakers who resided on the lower Guadalupe, were mentioned by Cabeza de Vaca as participating in the seasonal migration to the prickly pear fields located near the basins and tributaries of the Guadalupe and Colorado Rivers (Krieger 2002:195).

On May 10 the party reached the San Marcos River, which they believed to be the Colorado. Traveling south along the river for 4½ leagues, they encountered its confluence with the Guadalupe. Realizing that they were lost, they turned upstream in order to search for the stream's origin. On the following day, they reached a wide and deep creek that they could not ford. This may have been Plum Creek (Hoffman 1935:95). They had seen two Indians earlier in the day with packs on their backs and had left presents of tobacco for them. The ford of the San Marcos was reached on the 14th and the Guadalupe was crossed on the 15th, where Alarcón nearly drowned. The group entered San Antonio on the 17th.

Alarcón returned to the Rio Grande for supplies in June. After returning to San Antonio, the journey to the Bay of Espiritu Santo and the east Texas missions began in early September. The expedition was joined by Captain Domingo Ramón and Fray Espinosa, who had earlier established the more northerly route to the Colorado River that was referred to as the road to the Tejas. All told, 18 clergy participated in the journey, along with 29 of the governor's soldiers, 3 Tejas Indians, and 2 other Indians, a Moruame and a Payaya. Initially, the expedition utilized the established road to the Tejas, but after crossing the Cibolo, they left it, turning eastward to the Guadalupe River. Alarcón planned to follow the Guadalupe to its junction with the San Marcos, cross over below the San Marcos and follow the opposite bank of the Guadalupe to the coastal plain, where he would turn eastward to the Colorado. From that point, he would lead a small group downstream to the bay (Foster 1995:135). The camp on the Colorado was reached on September 8. Francisco de Céliz noted that the woods at that point were composed of mesquite, hackberries, and much nopal (Hoffman 1935:59). This reference to abundant prickly pear supports the presence of this valuable foodstuff.

Alarcón's group reached the Bay of Espiritu Santo on September 23. After taking possession of it for Spain, he returned to his camp on the Colorado. The expedition to the east Texas missions continued, crossing the Colorado near present-day Columbus on the 28th. Guided by Captain Ramón, Fray Espinosa, and the Tejas Indians, the expedition reached east Texas in October. Alarcón remained in east Texas and adjoining parts of Louisiana until the end of November, meeting with the local Indian leaders and visiting the missions. The return trip to San Antonio appears to have been largely uneventful and is only briefly described by noting the streams crossed. The Trinity was crossed (with a mishap when a raft carrying some of the governor's possessions was overturned) as was the Brazos, at which time the expedition unhappily traversed the woody thickets of the Monte Grande. Afterwards, they crossed in succession the Colorado River, Los Animas (Brushy Creek) and the Garrapatas River (Onion Creek), the San Rafael, the San Marcos, the Guadalupe, and the Comal. The Villa de Bejar on the San Antonio River was reached some time near the end of the year.

Marqués de San Miguel de Aguayo, 1719–1722

The Aguayo expedition had as its cause the crisis in the affairs between France and Spain regarding the frontier between Texas and Louisiana. France had consistently claimed Texas following La Salle's failed attempt at settlement at Fort St. Louis. Since 1712 France had sought to open trade via a land route with Mexico. This aroused Spanish suspicions and led to the establishment of the east Texas missions. After 1716 the Spanish made little effort to support the missions, which led a priest in Mexico (Fray Hidalgo) to correspond with the French governor of Louisiana (Cadillac) to come to the aid of the missions. Cadillac initially displayed a desire to assist the missions, but shortly afterwards formed an aggressive policy that resulted in an attack on the mission at Los Adaes, which in turn led to the abandonment of the east Texas missions. This movement on the part of the French triggered a Spanish response—an expedition to reoccupy east Texas (Buckley 1911).

In December 1719 the Spanish government appointed the Marqués de San Miguel de Aguayo as governor of Coahuila and Texas, and assigned him with the tasks of establishing a presidio at the Cadodachos in east Texas and occupying Espiritu Santo Bay. The expedition got under way at Monclova in November of 1720, crossing the Rio Grande in March 1721. The expedition consisted of about 500 soldiers and 6 clergy, including Fray Espinosa, who had made two previous trips to east Texas. The expedition was to follow the route Espinosa had helped establish from the Rio Grande to San Antonio and the Colorado River. From there the route would skirt the Monte Grande to the

Navasota River, and on to east Texas. One of the clergy, Fray Peña, kept a diary of the journey (Forrestal 1935).

While on the Rio Grande, Aguayo had received news from Captain Garcias at the presidio of San Antonio de Bejar that Sana Indians had reported the French under St. Denis and their Indian allies from Ranchería Grande were encamped with unknown intentions only 30 miles from San Antonio. Aguayo dispatched two companies of soldiers to protect San Antonio. Meanwhile, Garcias sent Juan Rodriguez, a chief of the Ranchería Grande Indians who was in San Antonio petitioning for a mission among his people, to determine the location of the French. Rodriguez went as far as the Brazos River but failed to find any sign of the French or their allies (Buckley 1911:31).

While at the Rio Grande, Aguayo had sent a detachment under Captain Domingo Ramón to occupy Espiritu Santo Bay. Ramón reached the bay and claimed it for Spain on April 4.

Aguayo reached San Antonio—also on April 4—and spent about a month there. During that time he sent out a small, exploratory expedition in search of salt sources said to be in the area, and led forays against troublesome local native groups. On May 10 his expedition left for the east Texas missions, guided by the Ranchería Grande Indian Juan Rodriguez. Rodriguez informed Aguayo that the established route to the missions would not be appropriate for so large an expedition, as there were numerous swollen rivers and dense brush to contend with. A different route would be followed that traversed more-open country and would skirt the dense brush of the Monte Grande.

Peña noted that at the end of the day on May 13 the expedition reached Salado Creek, probably at the ford over the creek at modern-day Rittiman Road near Fort Sam Houston (McGraw 2011). This creek had initially been crossed during the Espinosa-Olivares-Aguirre expedition of 1709, which mentioned an arroyo "salogre" but did not name it. It received its name during the Domingo Ramón expedition of 1716.

The expedition left Salado Creek on May 15, traveling over lands thick with live oaks and mesquite. Peña noted that the latter produces fruit, which was eaten by the natives. This is a reference to mesquite beans as a food source. While Peña did not elaborate, he may have been referring to the native use of the mesquite beans for producing flour. At the end of the day, camp was made at Cibolo Creek, where the expedition remained until May 17.

From the Cíbolo, the expedition's route lay towards the northeast. Within a short distance, a hill was encountered named La Loma de las Flores for all of the wildflowers that were in bloom. The view from this hill was inspiring. Continuing for about 2 leagues, they came to a stream that Aguayo named Saint Pascual Baylon, which may have been Blieders Creek in Comal County. While the stream was small, it carried water year-round and supported riparian vegetation including mulberry, walnuts (pecans), junipers, poplars, and many vines. The Comal, which Peña called the Guadalupe, was only about a ¼ league away. Peña noted again the great variety of plants and thought if irrigation ditches could be built downstream, the location would be suitable for settlement.

Traveling farther, again heading northeastward for ¾ league, the modern Guadalupe River was reached. This was given the name San Ybón, which was in flood stage from recent rains. Mosquitoes, ticks, and chiggers plagued the expedition in their camp on the Guadalupe. On May 17, they reached Peñuelas Creek, probably present-day York Creek, near the Comal-Hays county line. Peña noted that only 1 league to the north was Lomeria Grande, a very broken country occupied by the Apache (Forrestal 1935:21).

The next steam to be crossed was the San Marcos River, which Aguayo called Los Ynocentes. Like the Guadalupe, it too was swollen. From this point the expedition traveled in a generally northeastward direction about 2 leagues to the San Rafael, or the modern Clear Fork of Plum Creek. Deer and turkey were abundant, and the fish in the stream were plentiful. At the creek, the expedition was met by a squadron of mounted Sana Indians armed with spears and bows. They were dressed in clothes that Aguayo had provided for them while in San Antonio, and they had come to thank him again and renew their fealty to the Spanish king.

From their camp on the San Rafael, the expedition traveled northeastward for ¼ league to San Isidro Spring. The location of this spring remains uncertain. Buckley (1911:37) thought that it equated with modern-day Lytton Springs, but based on both Espinosa's original account of 1709 and Peña's journal, it was likely located farther to the west, possibly in or just north of the Plum Creek watershed, between State Highway (SH) 21 and Interstate Highway 35. The expedition continued for another 4 leagues, camping along a small stream Aguayo named San Bernardino, which may have been the headwaters of Brushy Creek in Hays County. The next day was rainy, and the expedition only traveled 1 league, crossing several steep gullies until reaching level land and camping on Las Garrapatas River (Onion Creek) near McKinney Falls.

On May 23 the expedition, after leaving Onion Creek, crossed the Colorado River (called by Aguayo the San Marcos), the entire day's journey being through open country dotted with small hills. The river was swollen and very wide, and took some time to cross. The expedition halted about ¾ league north of the river, at a creek covered with shade trees, mulberries, and blackberries. This likely was modern-day Walnut Creek, possibly near U.S. Highway (US) 183 in Austin. Bison tracks were observed, and hunters sent out in search of the herd killed a very large bull. Peña recorded the latitude of the camp as 30 degrees (Forrestal 1935:24).

The following day the expedition entered level country crossed at intervals by low hills. After crossing a tributary of Walnut Creek (Santa Quiteria), the expedition stopped after 4 leagues at a second stream Aguayo named San Francisco. This may have been modern-day Gilleland Creek in Travis County. Peña again mentions the Apache, saying that travel in this country was dangerous as it bordered on the Lomeria Grande, which was inhabited by this warlike tribe (Forrestal 1935:24).

On May 27 the expedition crossed Las Animas Creek (Brushy Creek), noting that both sides of the stream were wooded. Later that day, they reached the San Xavier River (San Gabriel River). Three bison were killed near the river, and an additional 12 were killed the next day.

The expedition reached the Little River on May 31 and remained encamped for several days as soldiers were sent in search of Ranchería Grande Indians. Failing to locate these people, the expedition continued on June 14, traveling north to avoid swampy lands until reaching the Brazos near present-day Waco, which they crossed on June 19 (Buckley 1911:40). Within a few days, the expedition turned southwards or south-southeast and continued on this heading until June 27, when it veered to the northeast, probably in search of higher ground (Buckley 1911:40). Finally, on July 2, scouts from the expedition returned saying they had found the old Royal Road. The expedition would reach it after building a bridge over the Navasota River, which they called the San Buenaventura. That morning Aguayo had dispatched soldiers and clerics, including Fray Espinosa, in search of Tejas, who were rumored to be nearby. Instead, the group came upon Ranchería Grande Indians of the Bidai and Deadose tribes. Juan Rodríguez, who was the leader of the *ranchería,* was traveling with the soldiers and clerics. Aguayo joined them and told the natives to retire peacefully north of the Brazos and he would later have a mission built for them (Forrestal 1935:36).

The Aguayo expedition reached the Trinity River on July 9. After much difficulty, the swollen river was crossed using a canoe the clerics had constructed and hidden some years earlier. Sixteen days were expended crossing the Trinity. Afterwards, members of the Hasinai tribe were encountered, including eight of the tribal leaders and an interpreter named Angelina, who had been brought up on the Rio Grande and in Coahuila (Forrestal 1935:38). This woman appears in other accounts, including that of St. Denis and François Simars de Bellisle, the latter being deserted on the Texas coast in 1720. It is thought the Angelina River in east Texas was named after her (Buckley 1911:42). On July 28 the expedition reached the mission of San Francisco de los Tejas, just west of the Neches River. On that day Aguayo received a message from St. Denis, who arrived a few days later. Both men agreed to maintain peaceful relations though Aguayo insisted the French leave the province of Texas.

The Aguayo expedition remained in east Texas until November 1722 and reestablished the missions there, including the Mission San Miguel de los Adaes. He returned to San Antonio, arriving on January 23, 1722. His expedition was the last of the *entradas* and also the largest. Its results were important in that it secured Spain's hold on Texas for 150 years by increasing the military presence there and recommending to the Spanish king that several hundred families be settled there. Most of these would be from the Canary Islands and would settle San Antonio.

Pedro de Rivera y Villalón, 1727

We have seen that the search for La Salle had led to the recognition by Spain that Texas must be settled and its native population brought under Spanish influence if control of the area was to be maintained. The two missions among the Caddo established in 1691 were abandoned in 1693. In 1716 Franciscan missionaries were able to convince the viceroy to reoccupy east Texas, and as a result, six missions and a presidio were established. These were resupplied in 1718 and again in 1722. However, the need to defend the area (Texas), as well as New Mexico, had become a serious drain on Spain's finances, as the frontier was greatly overextended. In addition, the necessity of maintaining the presidios was uncertain, and charges of corruption among presidio commanders had been voiced in Mexico City (Jackson 1995:5).

The strongest proponent of presidio reform was Juan Manuel de Oliván Rebolledo. It was Oliván who had interrogated Louis Juchereau de St. Denis in Mexico City. This had led to his recognition of the need for a cohesive frontier policy and led to the Ramón expedition of 1716. Oliván saw the need for a broader approach to keep out the French, and he saw east Texas as the best place to stem the French aggressive threat. If Texas fell under French control, the rich mining regions of Nuevo Leon and Nueva Vizcaya would be threatened. While the northern frontier was guarded by 15 presidios and about 650 men, the soldiers were scattered and often operated as flying companies without permanent bases. An inspection of these bases was viewed by Oliván as critical, and with the arrival of viceroy the Marqués de Casafuerte in 1722, he got his wish. The leadership of the expedition to the presidos was given to Pedro de Rivera y Villalón, and got under way in November of 1724. It would take 3 years to complete and would travel over 3,000 leagues. The portion dealing with Coahuila and Texas, described in the following paragraphs, occurred in 1727 (Foster 1995; Jackson 1995).

Accompanying Rivera was Francisco Álvarez Barreiro, who had been the chief engineer during the Alarcón expedition. He was a distinguished surveyor and mapmaker, and copies of his maps made during the Rivera *entrada* have survived.

The Rivera expedition crossed the Rio Grande near San Juan Bautista, about 35 miles below present-day Eagle Pass, on August 7, 1727. The course they would follow would take them northeastward, crossing the Nueces River (August 9), Hondo Creek (August 11), and the Medina River (August 14). The Medina River formed the boundary that divided the jurisdiction of Coahuila from the Province of Texas. The river was in flood stage, probably from the effects of a tropical storm or hurricane, and it took an entire day to cross it. By August 16 the party had reached San Antonio de "Vejar" (Jackson 1995:29).

Rivera noted that at a distance of ½ league from the presidio at San Antonio was a small pueblo of Indians, while to the south-southwest an even smaller pueblo existed, inhabited by the Mezquite, Payaya, and Aguastaya nations. Continuing heading east-northeastward en route to Presidio

Nuestra Señora del Pilar de los Adaes, they camped at Cibolo Creek on August 18. The next day the Comal River, then referred to as San Miguel Creek, and Guadalupe Springs were reached (Jackson 1995:29–30).

On August 21 the expedition crossed the San Marcos River, which Rivera referenced as the Río de Los Ynocentes, a name given it by Alarcón on his return trip from east Texas in December 1718. They would spend the night on San Rafael Creek, which Rivera said was called Blanco Creek by some. They killed two bison that day.

Traveling 9 leagues on August 22, Rivera crossed Onion Creek, or Arroyo de Garrapatas. He does not mention the many ticks that Espinosa found there in 1709 (Tous 1930a:6). The Colorado was reached somewhere near the Travis-Bastrop county line on August 23. The party had crossed "open land without any woods" between Onion Creek and the river. The encampment made on the Colorado was at a place known as Arroyo del Encadenado, referenced by Peña as a campsite during the Aguayo expedition (Forrestal 1935:59).

Rivera did not encounter any natives between Cibolo Creek and the Colorado River. The absence of native peoples could stem from the increased presence of the Apache, who, as Fray Mazanet remarked as early as 1691, "were at war with all other nations" (Hatcher 1932:58). The presence of Apaches in the general vicinity of the Santa Maria Creek site early in the eighteenth century is indicated by their unsuccessful assault against St Denis's force near the San Marcos River during his trip to the Rio Grande in 1713–1714.

After crossing the Colorado, the route taken by Rivera led to Brushy Creek, which was crossed at two locations. The upper crossing was known as Animas de Arriba, named by Espinosa in 1716 as Arroyo de las Benditas Animas. The second crossing, which occurred on lower Brushy Creek, was called Animas de Abajo. The expedition entered the Monte Grande on August 27. This name was applied by the Spanish to the heavily wooded post oak belt that runs from south of San Antonio to the Brazos and Trinity Rivers. It was nearly impenetrable, and Rivera mentions traversing it as "maddening." It did form a defensive barrier against mounted warriors such as the Apache (Jackson 1995:32).

While in the Monte Grande, Rivera's force came into contact with some Mayeyes, who were encamped near a small spring named Las Puentezitas. The Indians were given presents of food, cloth, and beads. This probably occurred in Burleson County (Jackson 1995:33).

The expedition crossed the Brazos River on August 30, the Navasota River on September 1, and the Trinity River on September 3. They made contact with the Caddo (Nechas) on September 5 and inspected the Presidio de Nuestra Señora de los Dolores on September 7. A week later, on September 15, they reached the Presidio Nuestra Señora del Pilar de los Adaes. The expedition began its return to the Rio Grande on September 26, arriving at the Presidio San Antonio de Bejar on October 11. On November 8 the inspection of the Presidio Nuestra Señora de Loreto y Bahía del

Espíritu Santo began and continued until November 27. During this time, Rivera sent a detachment under Francisco Alvarez Barreiro to reconnoiter the coasts, ports, coves, lagoons, and terrain between the presidio and the Neches River.

Rivera arrived at the Presidio San Juan Bautista on the Rio Grande del Norte on December 12. He stated in his diary entry of December 23 that between Presidio de los Adaes and Presidio San Antonio, many members of his escort became ill and several died.

RIVERS AND STREAMS: A HISTORICAL OVERVIEW

The identification of the rivers and streams that were crossed by the Spanish expeditions to east Texas between 1689 and 1727 present to the reader somewhat of a challenge, as the Spanish often renamed the streams or confused one with another. This is, of course, understandable given the vast distances that were traversed during these journeys through a largely uncharted wilderness. Later the confusion would be perpetuated in the maps made of the province. The following historical overview is thus provided for the more important streams that occur in an area considered to be relevant to the current study, extending from just northeast of San Antonio to a few miles southeast of Austin. The streams in this area that fell along the routes of nearly all of the *entradas* include Salado Creek, Cibola Creek, the Comal River, the Guadalupe River, the San Marcos River, the Blanco River, Plum Creek (and its tributaries), Onion Creek, and the Colorado River.

In addition to the names used by the Spanish, Mazanet's diary of the Terán expedition to east Texas in 1691 often recorded the native names of streams. In the first part of the journal, Mazanet records the names in the Coahuilteco language. This ends around Cibolo Creek, which was called Papulacsap. Most of the streams crossed in the second half of the journey were given Caddo names (Johnson and McGraw 1998:121).

Salado Creek

An arroyo referred to as salogre (salty), which occurs northeast of San Antonio, was first mentioned in the diary of Espinosa and Olivares on April 13, 1709. The name Salado was first used during the Ramón expedition of 1716, by both Espinosa and Ramón. Both men noted that it was in fact not salty (Buckley 1911:34–35). Peña described the terrain around Salado Creek in 1721 as hilly, very wooded, and beautiful (Forrestal 1935:19). He and the other members of the Aguayo expedition may have crossed the stream at a ford at modern-day Rittiman Road, near Fort Sam Houston (McGraw 2011). The terrain surrounding the creek in this area, now known as James Park, still conforms to Peña's description.

Cibola Creek

When Terán crossed this stream in 1691 he called it the San Ygnacio de Loyola, and Mazanet on that journey referred to it as Santa Crecencia. As mentioned above, Mazanet gave the Coahuilteco name as Paplucasa but did not define it (Hatcher 1932:56). He does mention a spring of cold water flowing within a creek of warm, brackish water. Johnson and McGraw (1998:126) note that the word may be related to the Coahuilteco *wan pupako* (spring of water).

Espinosa failed to refer to the stream by name in 1709, but he, like others, noted that it was a stagnant stream. Ramón referred to it as San Xavier. It was named Cibola for the numbers of bison encountered there, the name first used in Peñas *Derrotero* of the Aguayo expedition in 1720. It has been referred to by that name ever since.

Comal River

Espinosa, while on the Ramón expedition of 1716, described what he called the Guadalupe, but noted that it had its origin in three springs, thus identifying the Comal River. Peña did the same during the Aguayo expedition. Rivera, in 1727, referred to the Comal as the Guadalupe, but distinguished it from the modern river by naming the latter the River of Nuestra Señora de Guadalupe. From the time it was first crossed, the Comal was noted for its crystalline water and luxuriant growth of trees along its banks, and was considered a suitable place for settlement.

Guadalupe River

In 1689 De Leon gave the name Guadalupe to the lower course of the river. The name was used with more consistency thereafter than the other rivers and streams. In 1691 Mazanet and Terán recognized it when they crossed it about 10 or 12 miles above where it joins the San Marcos, though Terán (noted for changing river names) renamed it the San Agustine (Buckley 1911:36). Mazanet recorded crossing a branch of the Guadalupe, which he called San Juan, and noted the native name as Canocanoyestatetlo. Espinosa and Olivares called it the Guadalupe when they crossed it in 1709. Espinosa confused it with the Comal in 1716, though Ramón distinguished between the two by calling the Comal the Guadalupe and the Guadalupe San Ybón (Foik 1933:12–13). Peña, traveling with Aguayo in 1722, did the same (Forrestal 1935:21).

San Marcos River

De Leon applied the name San Marcos to a river in Texas in 1689, but it is likely that it was the Navidad he was referring to, as it was the first river encountered after crossing the Guadalupe, and De Leon’s route was far to the south of later *entradas*. When the main route to east Texas shifted northwards, the name was still applied to the river that was encountered after the Guadalupe. Espinosa and Olivares correctly named it in 1709 as did Espinosa and Ramón in 1716. Aguayo (1720) and Rivera (1727) called it Los Ynocentes.

Plum Creek, Santa Maria Creek, and the Blanco River

Plum (Ciruela) Creek and Santa Maria Creek appear on Stephen F. Austin's 1829 *Mapa Original de Texas* (see Figure 21). Santa Maria Creek is the only tributary of Plum Creek shown on Austin's 1829 map, and therefore could either represent the West Fork or the Clear Fork of Plum Creek. However, the length of the creek on Austin's map more closely matches that of the Clear Fork of Plum Creek. The origin of the name Santa Maria is unknown. No stream anywhere in the vicinity was recorded by that name during any of the Spanish expeditions.

Plum Creek has been interpreted by some historians to have been the stream referred to in several of the diaries kept during Spanish expeditions as the San Rafael (Buckley 1911; Casteñada 1936; Hackett 1931). Other researchers have equated the San Rafael with the Blanco River (Foster 1995; Hoffman 1935; Jackson 1995; McGraw, Clark, and Robbins 1998).

The San Rafael was named during the Espinosa-Olivares-Aguirre expedition of 1709 (Tous 1930a). The expedition crossed the stream on Tuesday, April 16, after leaving the San Marcos River very near its source. According to Espinosa:

> We crossed the San Marcos River very near its source, the crossing being two arquebus shots from where the river rises. Directing our course eastward through a forest of mesquite clumps and some elms we came, after a distance of about two leagues, to an arroyo with little water which we named San Rafael, Sovereign Prince, to whom we entrusted the success of our journey. This arroyo has many holm-oaks (live oaks) and some elms and is reached by leaving the crest of the hills. (Tous 1930a:6)

From the above description, the crossing of the San Marcos was probably about 200 to 300 m below modern-day Spring Lake. From this point, the Blanco River is about 1 mile to the east, or less than ½ league. The next nearest stream is the Clear Fork of Plum Creek, located about 3½ leagues from the San Marcos crossing. The comment that the stream was reached after leaving the crest of the hills could apply to either the Blanco River or the Clear Fork of Plum Creek.

Espinosa would again cross the San Rafael a few years later with the Ramón expedition of 1716. On this occasion, the expedition had reached the San Marcos River, but the dense vegetation had forced them higher up:

> By this riverside the foliage was so dense that the ground was never illuminated by the rays of the sun. The wood being so impenetrable we continued our course higher up, between east-northeast and northeast about two leagues, as far as the Arroyo San Rafael, which had only pools, but those in abundance. (Tous 1930b:12)

In this case, it is not as clear which stream is being referred to. The term "higher up" suggests that they continued toward the uplands of the Edwards Plateau, and 2 leagues east-northeast and northeast could have led to either stream, depending on where the San Marcos was encountered.

Aguayo appears also to have referred to the Clear Fork of Plum Creek as the San Rafael when he crossed it in May of 1722 (Forrestal 1935:22).

That the San Rafael was equated with the Blanco River is indicated by Brigadier Pedro de Rivera, who camped along it in 1727. In his *Derrotero* Rivera recorded: "I spent the night of that day [June 20] on the uninhabited Arroyo de San Rafael . . . which others call the Blanco" (Hackett 1931:486–487).

It seems possible, if not likely, given the number of expeditions that crossed the area over the nearly 40 years under examination in this study, that more than one stream was referred to as the San Rafael. Based on the distance and direction of travel given by Fray Espinosa, when the name was first used in 1709 it may have been in reference to the Clear Fork of Plum Creek. Later, it appears to be associated with the Blanco River.

Onion Creek

Onion Creek was first crossed during the Espinosa-Olivares-Agurrie expedition of 1709. It was given the name of Garrapatas on account of the unpleasant experience with ticks (*garrapatas*). In 1716 the Ramón expedition crossed the stream, and Espinosa referred to it as previously, noting that they met their "old friends" (ticks) again, but they were more merciful than before (Tous 1930a:12). Later, in 1722, the Aguayo expedition camped and crossed the creek at the location of McKinney Falls, the creek being impassable elsewhere owing to a recent storm. Peña, in his diary, noted "from here as far as the San Marcos River [Colorado River] both banks of which are covered with a great variety of shady trees and vines" (Forrestal 1935:23). The creek was still referred to as Garrapatas as late as 1836 when it was depicted on Stephen F. Austin's Map of Texas published by H.S. Tanner (see Figure 22). It became known as Onion Creek sometime afterwards and is shown by that name on John Arrowsmith's Map of Texas compiled from surveys in the Land Office of Texas and published in London in 1841.

Colorado River

The Colorado River suffered more than most of the rivers of Texas from misnaming by the various Spanish explorers. In large part this stems from De Leon's application of the names Colorado and Espíritu Santo to the present Brazos River in 1690. When Terán reached the Colorado in 1691, he noted that it had previously been called the San Marcos and Colorado, but gave it the new name of San Pedro y San Pablo Apostoles (Hatcher 1932:16). Mazanet, traveling with Terán, noted the native name for it as Beatsi, and stated the designation of the river as the Colorado was attributed to the French, because of the reddish color of the water (Hatcher 1932:16–17, 61). In 1709 it was again referred to as the Espíritu Santo or Colorado by Espinosa and Olivares, likely because they were following De Leon's diary and had a poor understanding of the geography of the area. Espinosa did the same in 1716, but Ramón referred to it as the Colorado. Aguayo, because he did not recognize the San Marcos when he crossed it in 1722, applied that name to the Colorado, as did Rivera a few years later. By 1767 it was referred to as the Colorado (Buckley 1911:38).

HISTORICAL OVERVIEW OF TEXAS CARTOGRAPHY DURING THE SPANISH COLONIAL AND MEXICAN AND TEXAS REPUBLIC ERAS (BEFORE 1567–1829)

Though a comprehensive examination of all relevant maps depicting the project area during the Spanish, Mexican, and Texas Republic eras was beyond the scope of this project, historians sought to identify important map resources that might portray historic trails and traces and/or provide information about native peoples occupying or using the area during the period of contact. This research involved review of maps dating from the 1520s through the 1840s at a number of repositories including the GLO, the Dolph Briscoe Center for American History at The University of Texas, and the Texas State Library, all in Austin, and the Old Spanish Missions Research Collection at Our Lady of the Lake University (OLLU) in San Antonio. Historians also reviewed digital map collections available online at the Bibliothèque National de France in Paris, the Biblioteca Digita Hispánica at the Biblioteca Nacional de España, and the Biblioteca Nacional de México for sources not available in local archives and used digital collections available in-house through the THO and in a broader database of map images collected during the research for the THO project. The project historian also made repeated inquiries with the archivist for the Spanish Archives at the Bexar County courthouse, but was unable to gather information from the repository or to confirm whether additional relevant materials may be housed there.

This chapter also includes a summary of the map research results supplemented with data tables containing the titles, age, and cultural value statements for each map. Examples of maps from each period are included as figures (see Figures 7–36), specifically those showing important information, and though new information regarding historic settlement patterns in the project area based on archival sources was limited, historians were able to glean some clues. Specifically, historic map data support archival information indicating the project vicinity was in a region traversed regularly during the period of exploration by both Native American and European groups.

Cartographic and Texas history scholars have evaluated the history of Texas mapmaking in a variety of ways including by nationality or "school" of the producer (e.g., Spanish, French, etc.), by method of production (e.g., woodcut, engraving, lithography), by time period, or by some combination of the three. Robert Sidney Martin and James C. Martin divided the cartographic history of Texas into five distinct periods based on "the sources of the information contained in the map[s] and the methods utilized for compiling [them]" (Martin and Martin 1982:8). They derived this concept from the work of William P. Cumming, with updates based on their own research. In many ways, this method is the most useful as it takes into account technological advances in the fields of cartography, exploration, and navigation as well as historic events and trends that inspired and influenced mapmaking in general (Martin and Martin 1982:8). Of the five periods, only the first three cover the period of interest to this study. Understanding the character of and differences among the maps made in each of these periods is essential when evaluating the information they present.

The first, or primary, period extends from the "beginnings of European activity in the New World until the final decade of the seventeenth century." During this period, European cartographers created rudimentary maps based on the accounts of particular explorers, which were "often combined with preexisting mythology and fraudulent tales." The only tools available to early explorers included imprecise measurements of latitude using the unsophisticated instruments of the day and the notoriously inaccurate "dead reckoning" method of determining longitude (Martin and Martin 1982:8). The result was "incomplete often contradictory" accounts from different individuals who explored the same area, which cartographers tried to unite into "coherent depiction[s] of the unknown land." In their efforts, they often relied on their imaginations and on their often incorrect understanding of the natural world. As a result, "only with great care and difficulty can the resulting delineations be related to the actual features of the lands they depict" (Martin and Martin 1982:9). Another characteristic of maps from this early period is the reuse of a single base map that was often copied "by imitative mapmakers, frequently with degenerating accuracy and detail." Thus instead of improving with time, later maps were frequently based on new and erroneous interpretations of previous explorations rather than on fresh data (Martin and Martin 1982:9).

Besides rough sketches of the Texas coast dating as early as 1519, the earliest map representing features of Texas's interior was created sometime between 1544 and the death of renowned Spanish mapmaker Alonso de Santa Cruz in 1567 (Martin and Martin 1982:10). The map, titled "Mapa de Golfo y Costa de Nueva España desdé el Rio de Panuco hasta el Cabo de Santa Elena" (Martin and Martin 1982:13) has historically been referred to as "the de Soto map," though it depicts information from various other expeditions as well including those of "Juan Ponce de León and Lucas Vásquez de Ayllón, in the east, and Álvar Núñez Cabeza de Vaca and Francisco Vásquez de Coronado in the west" (Weddle 2011). Besides its portrayal of watercourses and improved documentation of the Texas coastline, the map also illustrates the location of over 60 Indian villages, some of which, including "Ays (Eyeish) and Guassa (Guasco)" can be directly linked to known Caddo villages in east Texas (Martin and Martin 1982:13; Weddle 2011).

This map, which in the Spanish tradition was not published or made available to other mapmakers or explorers of the time, became the basis for Abraham Ortelius's circa 1584 map of New Spain (Figure 7) widely viewed as "the best published depiction of the area prior to the eighteenth century." Ortelius somehow received a copy of the Santa Cruz map after years of silence from the

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Figure 7

Abraham Ortelius's
"Americae Sive Novi Orbis,
Nove Descripto," ca. 1584

Source: Copy on file at the Briscoe Center for American History, University of Texas at Austin

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Drafted by: C. Wallace

Spanish Royal Cosmographer, and his map "bears a striking resemblance to that of Santa Cruz" (Martin and Martin 1982:13). Despite their usefulness as the only depictions of the Texas interior from the sixteenth century, the maps were based on explorations of the area in the 1520s and were thus already decades out of date at the time of their original production. After the initial period of exploration in the early sixteenth century, Spain turned its attention to colonizing and exploring "areas with more settled populations and material wealth." As a result, the focus of mapmakers through the remainder of the sixteenth century shifted to the Gulf of Mexico, which remained a heavily traveled area, and to other parts of growing New Spain (Martin and Martin 1982:15).

The second, or transitional, period of Texas cartography (as defined by Martin and Martin 1982) extends from circa 1700 through 1820 and coincides with a period of increased exploration and settlement of the Texas interior and the subsequent establishment of missions and presidios in the province. Maps from this period can be characterized as "maps of experience" based on "actual observations made by Spanish officers and explorers using the crude instruments of the time" (Martin and Martin 1982:9). In addition to being more accurate, they include more detail and enable researchers to more easily correlate identified locations with what they are trying to represent. Other characteristics of maps from this period include the use of nomenclature to describe natural features borrowed from the native populations the Spanish encountered and more-representative rather than "precise" depictions of those same features. The lack of preciseness was even more marked in areas farther from established settlements (Martin and Martin 1982:9) such as the current project area.

The impetus for this period of mapmaking was the Spanish response to French encroachment into Texas, principally that of René Robert Cavelier, Sieur de La Salle in 1684 (Weddle 1991:343). Expeditions ensued to find and eject La Salle and his men from Spanish territory, and the information from these expeditions, including some place names still in use today, was transmitted to European mapmakers through a variety of channels. In many ways, the great "European interest in the fate of La Salle's colony, and the new information it revealed about the region, was reflected in the printed maps of the period" (Martin and Martin 1982:19; Weddle 1991:343).

The most famous maps of the secondary period were based on the expeditions of Alonso De León, the first governor of the province containing Texas. He led four expeditions in search of La Salle, found La Salle's abandoned fort in 1689, and was responsible for naming many of the region's inland features for the first time (Jackson and Weddle 1990:4; Martin and Martin 1982:19). Though their locations are depicted with "understandable inaccuracy" (Weddle 2011), the 1689 map of De León's route across Texas identified Coleto Creek (called De León) and the Guadalupe River (among others) (Castañeda 1936).

Other major maps of the period included those of Nicolás de Fer (1701), which was the first map to show the correct location of the mouth of the Mississippi River, Guillaume Delisle's maps of 1703 and 1718 (copied by almost every European mapmaker of the period), the latter of which has been called "one of the most important [maps] in the history of North America" (Martin and Martin 1982:19), maps from the Aguayo expedition of 1720, the 1727 map of Francisco Álvarez Barriero (military engineer on the Rivera expedition), and the 1768 map of José Alzate y Ramírez (based heavily on the Barreiro map) (Martin and Martin 1982:19–20).

These maps constituted a compendium of data gathered by both Spanish and French explorers and reported back to their respective governments. While the Spanish stuck to their policy of secrecy with regard to the geography of their New World holdings, the French published and revised a variety of maps during the period based on the firsthand accounts of explorers such as Pierre Le Moyne, Sieur d'Iberville, his brother Jean Baptiste, Sieur de Bienville, and their agent Louis Juchereau de St. Denis, the latter of whom travelled illegally from Mobile to Mexico twice during the early eighteenth century (Jackson and Weddle 1990:9). Spanish cartographers used these published data as well as the firsthand observations of trained mapmakers such as Francisco Álvarez Barriero, who the Spanish government sent to Texas specifically to map the province (Jackson and DeVille 1990:21; Martin and Martin 1982:19) (for detailed discussion of the individual maps that depict the project vicinity, see the map research results in the following section of this chapter).

The period of the great "Franco-Spanish rivalry" in Texas ended in 1762 with the French cession of Louisiana to Spain. This turn of events inspired a dramatic reduction in the Spanish presence in Texas facilitated through the inspection tours of the Marqués de Rubí. Rubí brought two "experienced engineers" on his tours of the province, Nicolás de Lafora and José de Urrutia. The men both produced important maps that were submitted with the inspection reports (see example on Figure 8). The recommendations in the reports in turn inspired a new Spanish policy towards the native inhabitants of Texas that involved developing alliances with various northern tribes against the Apaches. In this vein, "experienced French frontiersmen" such as Pedro Vial were enlisted to visit and treat with various tribes. Vial's expeditions "between Nacogdoches and Santa Fe [during the 1780s] are documented in several maps which added greatly to the knowledge of that area" (Martin and Martin 1982:20).

The final years of the second period in Texas's cartographic history were characterized by resurgence in concerns regarding French encroachment into Texas. After the Spanish were forced to return Louisiana to France in 1800, various French officials argued that the province's boundary extended as far west as La Salle's fort on Matagorda Bay or even all the way to the Rio Grande. In resistance, the Spanish government enlisted scholars, namely José Antonio Pichardo, to provide documentation of Spain's claim that the boundaries of Louisiana did not include the province of Texas. This conflict continued after the Louisiana Purchase of 1803, and both American and Spanish expeditions set out to map and explore the region. The results were some of the most accurate maps of the Texas interior to date, including those of Fray José María Puelles (1807), which "delineated the rivers of Texas accurately for the first time," and American maps by Zebulon Pike (1810) and John Melish (1816). These maps were used during the negotiation of the Adams-Onis

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Source: Copy on file at the OLLU Old Spanish Missions Research Collection, San Antonio, Texas

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Figure 8

Nicolás de Lafora
and Joseph de Urrutia's "Mapa de
la Frontera del Virreinato de Nueva
España por Nicolas de Lafora," 1771

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Drafted by: C. Wallace

Treaty of 1819, which established the modern eastern and northern boundaries of Texas, and during the subsequent influx of Anglo-American immigrants to the region during ensuing decades (J. Jackson 1988; Martin and Martin 1982:23).

The third period of Texas cartography corresponds to the Mexican and Texas Republic periods from 1820 to 1850. During this period, cartographers created maps based on actual surveys "made for the location of land claims by colonists and settlers, and performed by experienced professional surveyors utilizing the refined instruments and techniques of the period." Though "unsettled" areas still tended to be depicted erroneously, maps from this period represented a "marked contrast" to their predecessors, both in the quality and quantity of data represented (Martin and Martin 1982:9). Perhaps the first and best example of the new maps that appeared during this period was created by Stephen F. Austin in 1822. The map, which was later refined into the famous "comprehensive map . . . published in Philadelphia by H.S. Tanner" in 1830, was used in negotiations with the Mexican government regarding the location and boundaries of his proposed colony as well as those of other early *empresarios.* Austin based his map on actual surveys of the land supplemented in later versions with information from Manuel Mier y Terán gathered during his 1827 survey of Texas's eastern boundary (Martin and Martin 1982:24).

Austin's map continued to be the model for successive maps of Texas during the 1830s. Under the Texas Republic, a concerted effort to defend the fledgling nation from "Indian depredations and from Mexican intrusions alike" inspired a succession of maps of ever increasing quality and initiated a period of agency involvement in cartography. In particular, professional mapmakers in the employ of the GLO and the United States-Texas commission produced groundbreaking depictions of various parts of the territory (Martin and Martin 1982:27). "Texas fever" in the United States made publication of maps of the area widely popular, and numerous editions by a variety of publishers including John Arrowsmith, James Wyld, J.H. Young, H.S. Tanner, and S.A. Mitchell were released during the 1840s. This period culminated with the production of a map of Texas by the United States Army in 1844. This map, "published by order of the Senate . . . represents the best available information on the eve of annexation" (Martin and Martin 1982:28).

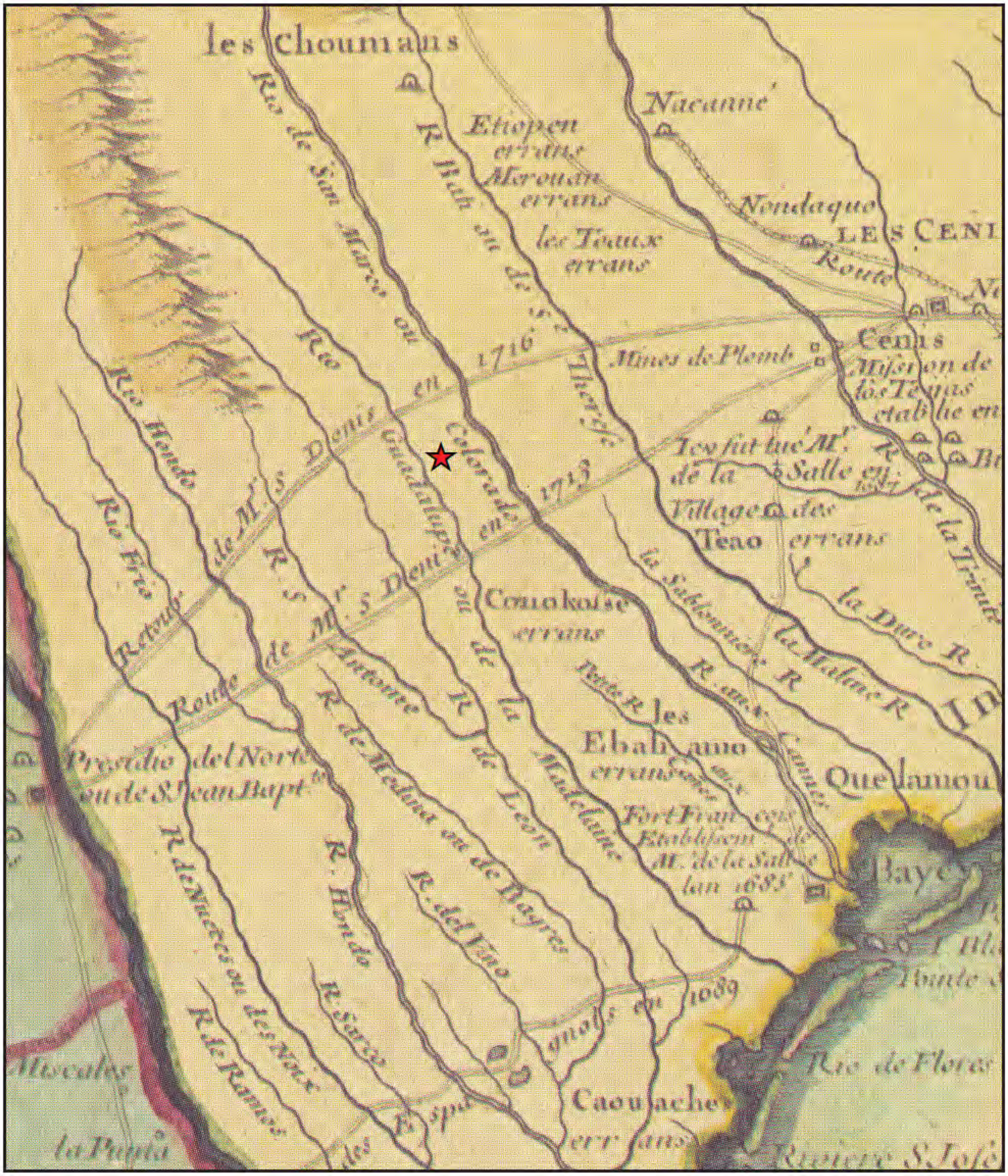
Subsequent expeditions and invasions associated with the Mexican American War "added significantly to the knowledge of the terrain." Improvements during this period and during the subsequent westward frenzy of the 1849 Gold Rush (Martin and Martin 1982:28) paved the way for the Modern period of Texas cartography that lasted through the 1930s when maps were "constructed by precise scientific data derived by modern methods like triangulation" and were typically produced by government agencies (e.g., the United States Geological Survey [USGS]) rather than by individuals (Martin and Martin 1982:9).

Overall, Texas has an extensive history of study and depiction by mapmakers beginning in the early sixteenth century. During the earliest period, little was known about the interior, and the most useful information involved representations of the Gulf of Mexico. Beginning in this period and extending through their association with the province, the Spanish were secretive about their geographic knowledge of the Texas interior and did not publish maps created by their explorers and/or by professional cartographers. Thus, the French produced most of the published documentation of the area from this period based on the experiences of their own explorers and on data they were able to gather from Spanish sources. The quality and accuracy of these maps was compromised as they were based on the interpretations of European mapmakers who had never seen the area and who relied on the incomplete and often inaccurate accounts of explorers and adventurers. As a result, maps from this period, which would have been contemporaneous with occupation at site 41CW104, provide little useful data regarding settlement and travel networks in the project vicinity (see Historic Map Research Results for more information).

After early expeditions into the interior, the Spanish shifted their interest to other portions of their new kingdom. No new expeditions or settlement attempts occurred for over a century until the 1680s, when feared encroachment by the French spurred a series of Spanish expeditions in search of La Salle's settlement and fort. These expeditions, beginning with that of Governor De Léon in 1689 and extending through the inspection tour of the Marqués de Rubí following the French cession of Louisiana to Spain, resulted in the creation of a large number of "experience maps" based on the actual observations of explorers and sometimes of professional mapmakers (Martin and Martin 1982:9). The French also conducted expeditions into Texas, and a map summarizing the results of their late-seventeenth- and early-eighteenth-century explorations by Guillaume Delisle was replicated for years by commercial mapmakers throughout Europe (Figure 9).

Maps from this second or transitional period in the history of Texas cartography, while still characterized by inaccuracies, illustrated newly identified and named watercourses, explorers' routes, which likely followed established trails used by their Native American guides, and other cultural features including Native American villages and *rancherías, parajes* or campsites used by explorers, and newly established settlements and presidios connected by the various iterations of the recently designated *camino real.* This "royal road," which was actually a series of routes, connected Los Adaes, the presidio of San Antonio de Bexár, various missions, and the provincial capital in Mexico*.* Thus, when reviewed with consideration for known discrepancies, maps from this period can offer more insight into settlement and occupation patterns than their predecessors through analysis of features identified and routes favored by explorers that likely developed from Indian trails and became designated roads during the colonial period.

Finally, the third, or Republic, period of Texas mapmaking was characterized by increased accuracy due to on-the-ground survey. Colonization began in earnest under the Mexican government, and *empresarios* such as Stephen F. Austin sought to delineate the limits of their colonies and to partition their holdings for sale to potential settlers. It was during this period that significant natural features in the project vicinity first identified by Spanish explorers a century earlier (such as Plum Creek) were depicted accurately in relation to manmade features such as portions of the *caminos reales* and other settlements. While they postdate the period of significance for



★ Approximate Location of 41CW104

0 110 miles

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Source: Copy on file at the Briscoe Center for American History, University of Texas at Austin

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Figure 9

Guillaume Delisle, "Carte de la Louisiane et du Cours du Mississipi...," 1718

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Drafted by: C. Wallace

protohistoric settlement in the area, review of the maps in comparison with earlier documents provides evidence of settlement patterns during the Republic era that could be connected to earlier patterns through more-in-depth analysis.

HISTORIC MAP RESEARCH RESULTS

Primary Period–Texas as the "Great Unknown"

Review of available maps from the primary period (extending from the initiation of European exploration in Texas through the last decade of the seventeenth century) from a variety of repositories revealed that though the project area is included on a number of maps, none present a detailed depiction of geographic or cultural features in the subject area during this period. Additionally, there is a gap in production of approximately 70 years between the expeditions and associated maps of the 1520s through the 1580s and the next production of detailed maps from the 1650s through the 1690s. As discussed in the historic background section, European powers, particularly the Spanish, turned their colonization and exploration efforts to other portions of the New World during this period, abandoning both Texas and its geography for almost a century.

The earliest maps that show cultural and geographic details of the Texas interior were made some time during the mid-sixteenth century. Early versions by cartographers such as Gastaldi (1548), Agnesse (1557), and Ruscelli (1561) "arbitrarily" placed rivers in what had previously been portrayed as an empty unknown expanse (J. Jackson 1998:3). Errors and omissions on early maps were due in part to the lack of reliable information available about the area and to the policy of "institutionalized censorship" (J. Jackson 1998:15) perpetuated by the Spanish government during the period. In their view, they were protecting the treasures of the Texas interior from "foreign intrusion," and thus common geographic errors, including a general lack of detail, tended to be repeated on maps throughout the sixteenth century (J. Jackson 1998:3).

Despite these difficulties, there were several important maps created during this era. The two most important, both for their increased level of detail, were by Alonso de Santa Cruz (before 1567) and Abraham Ortelius (circa 1584). The first, which was based on information from several early explorers and showed the locations of numerous Native American villages in east Texas and Louisiana, unfortunately does not extend far enough northward to include the area surrounding site 41CW104 (de Santa Cruz ca. 1544). The second, which may have been based on the map of de Santa Cruz and represents the entirety of North America and by default the current project area (see Figure 7), portrays the region's watercourses incorrectly and does not show any geographic or cultural features, including creeks, rivers, settlements, roads, or trails, near site 41CW104 (Ortelius ca. 1584).

Historians encountered one other map from the primary period that depicts the current project vicinity, though it does not provide insight into historic cultural features in the area. The map, created by French cartographer Nicolas Sanson d'Abbeville in 1650, signaled a reinvigoration of

European interest in the Texas interior and a "shift of cartographic domination . . . to France" (J. Jackson 1998:12). While the region encompassing the current project area is included, it is inaccurately represented, as Sanson d'Abbeville depicted only two rivers in the Texas interior, including the R. de Madalena (aka the Escondido River) (J. Jackson 1998:12) and the R. de Norte (or the Rio Grande), and the map contains no reference to other cultural features (e.g., Native American settlements, trails, etc.) (Figure 10) (Martin and Martin 1984:20; Sanson d'Abbeville 1650).

The remaining maps reviewed with information from this early period either do not include the project area or were created during the secondary, or transitional, period based on data from earlier explorations. Due to their lack of general usefulness in the study of the geography and history of the project area, the maps are not included in Table 7. Generally no new information on the Texas interior "reached the European mapmaking community during the first seven decades of the seventeenth century." As a result, none of the published maps from the period, which tended to be replicas of popular forms such as those popularized by Ortelius and Sanson d'Abbeville, provide any information that would help to elucidate settlement patterns in the vicinity of 41CW104 during the period of first contact. Additionally, no unpublished maps from the Spanish archives from this early period, such as the detailed map of Santa Cruz, contain any relevant data. In the minds of explorers and Europeans alike, Texas remained an unknown region inhabited by "chichimechi," the generic term used on contemporary maps for unnamed "hostile northern Indians" (J. Jackson 1998:3) and was excluded from further exploration and study until the end of the seventeenth century (Martin and Martin 1984:19).

Secondary Period—Colonization and Defense Inspire Cartographic Advances—The Project Vicinity Remains Undocumented in Contemporary Maps

The most prolific period of mapmaking involving the Texas interior began at the turn of the eighteenth century as both Spain and France attempted to stake claims in the area. Besides the sheer number of maps produced, they were also of higher quality and depicted more detail concerning geographic and cultural features. By the turn of the nineteenth century, technological advances and better methods of on-the-ground survey resulted in the creation of the most accurate maps to date, including those of Father José Maria Puelles and American Zebulon Pike. Despite the improvements, the current project area remained undocumented by cartographers. No maps from the eighteenth century showed Plum Creek or any other geographic or cultural features in the immediate project vicinity, and it was not until 1820, at the eve of Anglo migration into the region, that surveyors and cartographers began to depict the area in greater detail. Table 8 contains an inventory of all identified maps that include the project area during the period between 1700 and 1820 as well as assessment of their cultural value with regards to that region. Additionally, Figures 11–16, 23, and 24 represent sample maps from the period depicting the project vicinity in relation to significant cultural and geographic features.

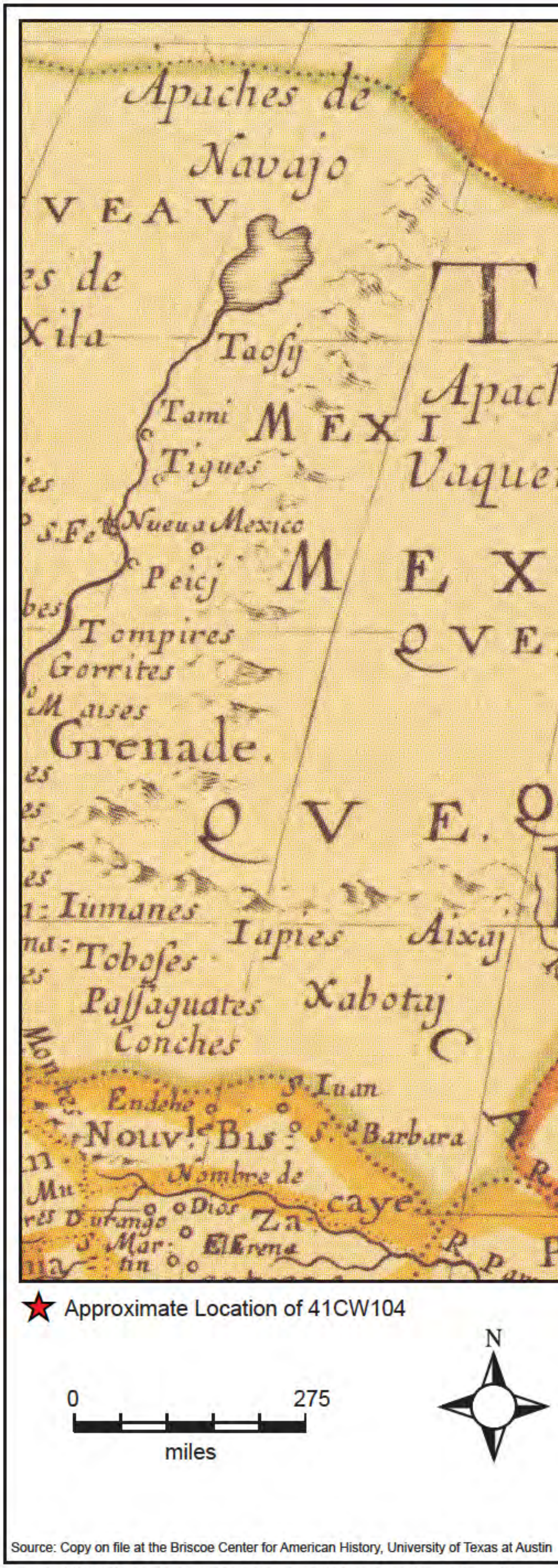

Figure 10

Nicolas Sanson d' Abbeville's
"Le Nouveau Mexique et la Floride," 1650

Source: Copy on file at the Briscoe Center for American History, University of Texas at Austin

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Drafted by: C. Wallace

Table 7. Primary Period

Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
Mapa de Golfo y Costa de Nueva España, desde el Rio de Panuco hasta el cabo de Santa Elena. . .	Alonso de Santa Cruz	between 1544 and 1567	None; focuses on area immediately adjacent to the Gulf of Mexico	Center for American History
Americae Sive Novi Orbis, Nova Descripto	Abraham Ortelius	ca. 1584	Earliest map to depict our area; based on earlier map of de Santa Cruz but includes more of the interior; watercourses are incorrect and no cultural features are depicted in our area	Center for American History
Le Nouveau Mexique et la Floride	Nicolas Sanson d'Abbeville	1650	First map signaling renewed European interest in the area; our area is included but inaccurately depicted; depicts R. de Madalena (aka Guadalupe River) but neither Plum Creek nor any cultural features (i.e., Indian tribes) are depicted	Center for American History
Insulae Americanne	Nicolaum Visscher	1652	Similar to Sanson d'Abbeville map but contains less cultural data; no detail in project vicinity or Texas interior	OLLU Old Spanish Mission Research Center, Original in Servicio Geografico Ejercito-Madrid

Table 8. Secondary Period

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
TSL 0003	Mexique or Nouvelle Espagne	Unknown	1700	Does not depict any detail in the Texas interior or the project vicinity; example of typical map from early transitional period	Texas State Library
TSL 1993	The Isle of California, New Mexico, Louisiane, the River Misisipi, and the Lakes of Canada	Herman Moll	ca. 1700–1710	Grossly distorted and at a large scale, depicts San Antonio and numerous Indian tribes but no geographic features with which to orient oneself, particularly in the Texas interior	Texas State Library
N/A	Carte du Mexique et de la Floride	Guillaume Delisle	1703	Depiction of watercourses is obviously incorrect; no geographic or cultural features depicted in the project vicinity (more accurate in a subsequent version from 1718)	Texas Beyond History
N/A	Les Costes aux Environs de la Riviere de Misisipi . . .	Nicolas de Fer	1705	Shows De León's route in search of La Salle; depiction is concentrated around coast and includes details in Louisiana; no details in Texas or the project vicinity	Center for American History
TSL 1067	Carte contenant de Royaume du Mexique et la Floride, dresfez fur les Meilleures observations et fur les Meimorres les plas Nouveaux	Unknown	ca. 1705–1720	Similar to other contemporaneous French maps of the period; shows only watercourses and no other cultural or geographic features	Texas State Library
BMP 1	Carte Nouvelle de la Louisiane presente a SM T.C. par F. Le Maire, Route de Espagnoles, 1689 et St. Denis, 1714	F. Le Maire	post-1714	Depicts the routes of De León and the first expedition of St. Denis across Texas. Labels the Guadalupe and Colorado Rivers (calls Colorado the San Marcos as well); may be early version of 1718 Delisle map	OLLU Old Spanish Mission Research Collection (Original in Bibliotheque de la Marine-Paris)
AGI 10	Mapa Geographico Noreste de Mexico	Juan Manuel de Oliván Rebolledo	1717	Depicts the Guadalupe and San Marcos Rivers as separate watercourses but does not depict Plum Creek; highly stylized and does not depict any cultural features in our area; only Native Americans referenced are *Nacion de los Tejas* to the east of the Trinity River	OLLU Old Spanish Missions Research Collection (Original in Archivo General de Indias, Seville, Spain)

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
TSL 0446	A Map of Mexico and New Spain, Florida, now called Louisiana, and Part of California & C.	H.R. Moll	1717	Depicts watercourses incorrectly, no geographic or cultural features in project vicinity; depicts the settlement of Abraham along the Robec River (alternately thought to represent the Colorado, Lavaca, or San Bernard River)	Texas State Library
N/A	Carte de la Louisiane et du cours du Mississipi Dressee sur un grand nombre de Memoires entrau	Guillaume Delisle	1718	Much more accurate depiction of watercourses and other geographic features based on observations of St. Denis and maps of François Le Maire. Shows both of St. Denis's routes across Texas (only cultural features in the project vicinity). Depicts the "Conokol'se errans," a tribe of wandering Indians, between the Guadalupe and Colorado Rivers. This map remained "the primary cartographic reference for the Mississippi Valley until the late 1700s"	Center for American History
TSL 0362	A Map of Louisiana and of the River Mississipi	John Senex	ca. 1720	Copy of Delisle map of 1718 by British cartographer; shows the same information	Texas State Library
BNP 9	La Louisiane et Vue de la Nouvell Orleans	Fr. Sieur Beauvillier	1719	Depicts watercourses in correct order though not correct geographically; depicts "Sauvages Barbares Apaches" east of the Colorado River and the route of St. Darbone [*sic*]	OLLU Old Spanish Missions Research Collection (Original in Bibliotheque Nacionale de Paris, Service Hyderographique)
TSL 0401	Ampilssima Regionis Mississipi Seu Provinciae Ludoviciane	Johann Baptiste Nurembergg	ca. 1720	Copy of 1718 Delisle map by German cartographer; shows the same information	Texas State Library
BNP 10	Carte Nouvelle de la Partie de l'ouest de la Province de la Louisiane sur les observations du Bénard de la Harpe	Fr. Sieur Beauvillier	ca. 1720	Depicts watercourses in correct order though not correct geographically; depicts "Roulle du Sieur d'Arbane" [*sic*]; no other cultural or geographic features in the project vicinity	OLLU Old Spanish Missions Research Collection (Original in Bibliotheque Nacionale de Paris)

Table 8 (Cont’d)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
TSL 0442	Mappa geographica regionem Mexicanam et Floridam, Terrasque adjacentes ut et Anteriores Americae Insulas, Curfas itedem et Reditus Navigantuim verfus flumen Missisipi et alias Colonies ob oculos ponens cura et fumptibus	Matthew Seutler	ca. 1725	Copy of 1703 Delisle map; depicts watercourses erroneously and with Latin names; identified the wandering tribes of the "Paoytes" and "Toho" north of the project area and the "Ebaham errante" between what could be the Colorado (Robec) and Guadalupe Rivers	Texas State Library
TSL 0385	Regni Mexicani seu Novae Hispaniae Ludovicinae N. Angllae, Carolinae, Virginae, et Pennsylvaniae, nec non Insularum Archipelagi Mexicani in America Septentrionali	Johann Baptist Homann	1725	Copy of 1703 Delisle map; no new information regarding project vicinity	Texas State Library
N/A	Plano Corografico e Hydrographico de las Provincias . . . de la Nueba Espana	Álvarez Barreiro (military engineer for the Pedro de Rivera inspections, 1724–1728)	1728	This map became the basis for subsequent copies in 1768 (when data was first published) and 1803. First map made by trained mapmaker from on-the-ground observations; shows province boundaries and is the first to show the locations of the Toos and Malleyes villages. The Toos are depicted adjacent to R. de S. Marcos (Colorado). No cultural or geographic features in project vicinity	*Mapping the Transmississippi West,* 1540–1861 by Carl I. Wheat (original in British Library)
TSL 6280	A Map of the British Empire in America, with the French and Spanish settlements adjacent	Henry Popple	1733	Very inaccurate with regard to Texas interior; no useful geographic or cultural information in project vicinity	Texas State Library
GLO 89222	Carta Geographica Della Florida Nell America Settentrionale	Giambattista Albrizzi	1740	Copy of 1718 Delisle Map by Italian cartographer; shows the same information	Texas General Land Office

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
TSL 1441	Mappa Geographica complectena Indiae Occentalis...Carte des Isles de L'Amerique et deplusieurs Pays de Terre Ferme situes au devant de ces Isles (&) autour de Golfe de Mexico	Jean Baptiste Bourguigon d'Anville	1740	Focuses on West Indies; shows Guadalupe and San Marcos Rivers but no other cultural or geographic features in the project vicinity	Texas State Library (copy from the Paul C. Ragsdale Collection)
N/A	Descripcion y Mapa de la Nueva Provincia Poblada de Barbaros Situada en la Costa de Seno Mexican, desde el puerto de Tampico hasta la Provincia de Texas	Miguel Custudio Duran	1744	First general map of province by Spanish since Barrerio; very stylized but depicts relationship of major watercourses in project vicinity correctly (i.e., San Marcos and Guadalupe Rivers), depicts no cultural or geographic details regarding the project vicinity	Mapoteca Mexico, Manuel Orozco y Berra Collection
AGI 17; TSL 2775	Iconismo hidroterreo ó Mapa Geographico de la America Septentrional	José Antonio Villaseñor y Sanchez	1746	Much more accurate depiction of watercourses; however, San Marcos is not labeled and no roads are shown; denotes Apaches to the northwest	OLLU Spanish Missions Research Collection (original in Archivo General de Indias, Seville, Spain); also copy at Texas State Library
TSL 2342	Amerique Septentrionale	Jean Baptiste Bourguigon d'Anville	1746	Depicts only watercourses, no other geographic or cultural features in project vicinity	Texas State Library
TSL 1525	An Accurate Map of North America Drawn from the beft. of Modern Maps and Charts and Regulated by Astronomical Observations	Eman Bowen	1747	Of such a scale that there is no detail in Texas interior or project vicinity	Texas State Library
TSL 0008	Parte du Mexique ou de La Nouvle Espagne ou se trouve L'Audce de Guadalajara Nouveau Mexique, Nouvelle Navarre California &c.	Robert Gilles de Vaugondy	1749	Depicts watercourses incorrectly; no other geographic or cultural features in the project vicinity	Texas State Library
TSL 0045	Carte de Mexique ou de la Nouvelle Espana	Unknown	ca. 1750–1760	Missing several rivers, intended to show location of La Salle's fort; no useful information regarding project vicinity	Texas State Library

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
TSL 0071	Carte de la Floride, de la Louisiane, et Pays Voifins: Pour servir a l'histoure Generale des Voyages	Unknown	1757	Depicts "R. de la Guadaloupe or de la Madelaine" and "R.S. Marc," and La Salle's fort; no other cultural or geographic features in project vicinity	Texas State Library
TSL 2039	Nouveau Mexique, Louisiane, Canada, et Nlle Angleterre	M. Brion	1766	No geographic or cultural features depicted; no detail in Texas interior	Texas State Library (copied from holdings of the Southwest Collection, Texas Tech University)
RAH 1	Toda la Frontera	Nicolas de Lafora and Joseph de Urrutia (under auspices of the Rubí expedition)	ca. 1768	Depicts Guadalupe (unnamed) and Colorado (or Rojo) Rivers with what appear to be two unnamed Indian villages between them (labeled *Rancherias de Gentiles* or Villages of Heathens in legend)	OLLU Old Spanish Missions Research Collection (original in Archivo General de Indias, Seville, Spain)
BNP 8 and SGE 3	Nuevo Mapa Geografico de la America Septentrional	José Antonio de Alzate y Ramirez	1768	Similar to 1803 map by unknown Spanish cartographer (was likely basis for that map); however, Ranchería Grande is depicted farther to the east; watercourse names are the same and Tierra del Toos is depicted to the SE of the San Marcos River (labeled R. de los Inocentes) while Malleyes are to the NE across the Colorado (labeled San Marcos); archival research indicates this map was based on Barriero Map of 1728 (first map made by trained mapmaker from on-the-ground observations)	OLLU Old Spanish Missions Research Collection (original copies in Bibliotheque Nacionale Paris and SGE Madrid); also at Center for American History
GLO 4667	Frontier of the King's Domain in North America	Joseph de Urrutia (copied by Luis de Serville)	1769	Shows Guadalupe and Colorado Rivers; roads are only cultural features depicted; no other cultural or geographic features in project vicinity	Texas General Land Office
SGE 15	Mapa de la Frontera del Virreinato de Nueva España	Nicolas de Lafora and Joseph de Urrutia (under auspices of the Rubí expedition)	1771	Does not depict San Marcos River; depicts Guadalupe, *camino real*, and several coastal Indian tribes	OLLU Old Spanish Missions Research Collection (original in SGE, Madrid)

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
SHM 1 and GLO 3031	Carta de las Provincias de Texas, Nuevo Santander, Nuevo Reino de Leon y Extremadura	Unknown	1773	Based on or an updated version of the de Lafora and Urrutia map of 1771; does not show any cultural or geographic features in the project area	OLLU Old Spanish Missions Research Collection (original in Servicio Historico Militar); also copy at Texas General Land Office
AGI 25	Mapa Nueva España por orden de Bucarely y Ursua	Miguel Constansó and Manuel Augustin Mascaró	ca. 1778	More-detailed depiction of watercourses; shows Camino Real; however, Plum Creek is not labeled, and there are no other cultural or geographic features in the project vicinity	OLLU Old Spanish Missions Research Collection (Original in Archivo General de Indias, Seville, Spain)
BNMP 3	Mapa de la Mission de la Espada hasta el Mississippi s.f.	Miguel Constansó and Manuel Augustin Mascaró	Unknown (ca. 1777)	Contains more-accurate depiction of watercourses and depicts crossings/fords of the San Marcos and Guadalupe Rivers and historic roadways; however, no specific cultural or geographic features in the project vicinity	OLLU Old Spanish Missions Research Collection (BNMP Paris)
TSL 6525	Le Nouveau Mexique Avec La Partie Septentrionale de L'Ancien ou de la Nouvelle Espagne	Rigobert Bonne	1780	Similar to other contemporaneous French maps of the period; shows only watercourses and no other cultural or geographic features in project vicinity; very out of date with regard to cultural and geographic knowledge of the period	Texas State Library
TSL 2069	A Map of Mexico or New Spain from the Latest Authorities	John Bew	1782	Copy of earlier French maps; does not depict watercourses correctly or any cultural or geographic features in the project vicinity	Texas State Library (copy from holdings of Roger Conger, Waco, Texas)
TSL 2113	Map of the European Settlements in Mexico or New Spain and the West Indies	Thos. Kitchin (Senr. Hydrographer to his Magesty)	1783	Copy of a historic map; very out of date with regard to the cultural and geographic knowledge of the period. Depicts no watercourses or other relevant geographic or cultural features in the project vicinity	Texas State Library
TSL 2025	Mapa . . . semanfiota la Prov. De Texas . . . con parte de la Colonia de Nuevo Santa Anna y Coahuila, etc.	Mariano Angel Anglino	1788	Original copied and updated by Pichardo at the turn of the 19th century; very detailed depiction of watercourses extending from Gulf as well as various settlements and a network of roads; no particular cultural or geographic features depicted in the project vicinity	Texas State Library

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
BNM 2	Mapa Geographico de las Provincias de la Nueva Espana	Unknown	1803	Later version of Barreiro (1728) and Alzate y Ramirez (1768) maps; contains some confusion with regard to river names; identifies the Ranchería Grande of 22 nations to the north of project vicinity between the San Marcos and Colorado Rivers; identifies settlement of the Toos to the southeast and the Malleyes to the northeast	OLLU Old Spanish Missions Research Collection (original in Biblioteca Nacional, Madrid, Spain)
TSL 7544	Spanish Dominions in North America	Aaron Arrowsmith	1803	Based on out-of-date information from several previous maps; depicts Guadalupe and Colorado Rivers, and locations of "Toos" and "Loretto" are identified along the Colorado and Guadalupe, respectively	Texas State Library
N/A	Mapa Geografica de las Provincias Septentrionales de Esta Nueva España	Father José Maria Puelles	ca. 1801–1807	Most accurate map of Texas interior of the period (unpublished); depicts watercourses accurately for first time; depicts *camino real* just north of confluence of San Marcos and Guadalupe Rivers; depicts no geographic or cultural features in project vicinity; used by Pichardo in creating his treatise and associated map	Center for American History
TSL 1456	[Mexico]	Engraved by J. Drayton	ca. 1805	Watercourses appear incorrect and only the Colorado is labeled; Bejar labeled; no other cultural or geographic features depicted in project vicinity	Texas State Library
N/A	A Map of New Spain…	Alexander von Humbolt	1804 (republished with updates in 1810)	Much more accurate than previous maps with regard to Mexico; however, mapping of Texas is very inaccurate; watercourses, roadways, and other cultural features incorrect; nothing depicted in project vicinity	Center for American History
TSL 0413	The Continent and Islands of the West Indies	Robert Wilkinson	1804	Focus is West Indies with only cursory attention given to the Texas interior; shows Guadalupe River but no other cultural or geographic features in the project vicinity	Texas State Library (also at Texas General Land Office)
TSL 1478	Louisiana	Samuel Lewis	1804	Only labels Colorado River in Texas interior; no other relevant geographic or cultural features in project vicinity	Texas State Library (copy from the Paul C. Ragsdale Collection)

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
N/A	Mapa Geographico…	Juan Pedro Walker	1805	Shows a much more accurate depiction of the major watercourses; however, Plum Creek is not depicted; does not include any cultural features in the project vicinity	Center for American History
AHN2	Plan Geographico de la Provincia de Texas por Disposicion del Ynspector Coronel Don Felyx Calleja	Unknown	1807	Part of Spanish attempt to define boundaries of its holdings after the Louisiana purchase; interesting for its depiction of the Camino Real but does not depict any additional cultural or geographic features in the project vicinity	OLLU Old Spanish Mission Research Collection (original in Archivo Historico Nacional, Madrid, Spain)
AHN1	Provincias Internas	Unknown	1808	Part of Spanish attempt to define boundaries of its holdings after the Louisiana purchase; depicts San Marcos and Guadalupe Rivers but no other useful cultural or geographic features in project vicinity	OLLU Old Spanish Mission Research Collection (original in Archivo Historico Nacional, Madrid, Spain)
TSL 1438	A Map of the Internal Provinces of New Spain	Zebulon M. Pike	1807–1810	Based on Pike's expedition and Spanish sources from the previous century; with Arrowsmith and Humbolt, defined how Texas would be viewed for the subsequent 2 decades; depicts the expedition's route, which generally followed the Old San Antonio Road; nothing new in project area;	Center for American History and Texas State Library
N/A	El Nuevo Mexico y Tierras Adyacentes Mapa Levantado para la demarcacion de los Limites de los Dominios Españoles y de los Estados Unidos por el P. D. Jose Pichardo quien lo dedica al Exmo. Sñr. D. Francisco Xavier Venegas Virrey de esta N.E. and Andoe	José Pichardo	1811	Depicts exploration routes of Rivera and Aguayo but watercourses are still incorrect; does not show any features in project vicinity; compendium of data from a variety of maps from the period attempting to depict justification for his understanding of the Louisiana-Texas border; accompanied his treatise	Center for American History
TSL 0361	Mexico or New Spain	Matthew Carey	1814	Watercourses are not labeled; depicts no geographic or cultural features in the project vicinity	Texas State Library

Table 8 (Cont'd)

Map #	Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
TSL 2201	Missouri Territory, formerly Louisiana	Matthew Carey	1814	Political map to show territory boundaries; no cultural features depicted; relatively accurate depiction of watercourses but no geographic or cultural features in project vicinity; draws boundary of the Missouri territory at the Colorado River	Texas State Library
TSL 1518	Spanish North America	Drawn and Engraved for Thompson's New General Atlas, 1814 by Unknown	1814	Based on data from numerous other maps dating all the way back to Barreiro (1728); no roads or other cultural features in project vicinity	Texas State Library
TSL 6524	Mexico	Aaron Arrowsmith	1817	Update from his 1803 version; watercourses incorrect; labels San Antonio and Colorado Rivers but no other cultural or geographic features depicted in project vicinity	Texas State Library
TSL 1520	Possessioni Spagnole Nell' America Settentrionale cio il Nuovo e Vecchio Messico e le Florida	N.B. Borghi	1818	Similar to other published maps from the period; labels Colorado River and shows Rancho on next river to the west (Guadalupe?); no roads or other cultural or geographic features depicted in the project vicinity	Texas State Library
TSL 2033	Spanish Dominions in North America, Northern Part	L. Hebert	ca. 1818	Copy of Humbolt map; inaccurate and no new information in the project vicinity	Texas State Library (originally appeared in Pinkerton's Modern Atlas, 1818)
TSL 1024	A Map of Louisiana and Mexico (Carte de Louisiane et du Mexique)	P.A.F. Tardieu	1820	First map to depict Plum Creek (not labeled); shows two roads; example of transitional map reflective of cartographic improvements of the Mexican and Texas Republic eras	Texas State Library (also at Texas General Land Office)

In total, historians identified and reviewed 57 maps from the secondary period that at least cover the area containing the current project vicinity. Of these, approximately 13 date from 1720 or before (see Table 8), and most are similar in their erroneous representation of significant geographic features and the general lack of detail in the Texas interior. The maps, most of them French in origin, as the Spanish did not publish any maps of the Texas interior during these early years, were based on actual observations as both the Spanish and the French engaged in a systematic reconnaissance of the area (J. Jackson 1998:42). Historians did not inventory maps that did not include the current project area.

During the 1680s, several Spanish maps were created in response to Alonzo De León's various expeditions in search of Sieur de La Salle (Martin and Martin 1984:21). Though Carlos de Sigüenza y Góngora's 1688 map based on one of the expeditions has been characterized as the "cornerstone document for Texas cartography" and was the first to exhibit evidence of an emerging understanding of the Texas interior, it does not approach or provide any information regarding the current project vicinity (J. Jackson 1998:23). Sigüenza also created a general map of New Spain during this period; however, no known copy of the map currently exists (J. Jackson 1998:37).

Throughout the ensuing decades, the bulk of cartographic efforts related to the Texas interior were undertaken by French mapmakers. These individuals relied on both Spanish and French sources regarding the region's character, and Nicolas de Fer and Guillaume Delisle (see Figure 9), among others, created seminal works in the rapidly evolving cartography of the area (Weddle 1991:326). Their early maps, characterized by "competing and evolving depictions of the interior" (J. Jackson 1998:40), were improved dramatically by information provided by French explorers during the early eighteenth century including Pierre Le Moyne, Sieur d'Iberville, Jean Baptiste, Sieur de Bienville, and Louis Juchereau de St. Denis. The information gathered by these men during their exploration of Texas resulted in the production of more-accurate accounts of the region's geography and cultural character than ever before. Though they obviously influenced maps published by the French, they also inspired improvements in Spanish mapping as Spanish officials grew increasingly concerned about the perceived threat posed by French encroachment (J. Jackson 1998:45; Jackson and DeVille 1990:21).

The primary example of the latter was the works of Juan Manuel de Oliván Rebolledo, who both ordered and closely monitored the expeditions of Ramón (1716), Alarcón (1718), the Marqúes de San Miguel de Aguayo (1721–1722), and Pedro de Rivera (1724–1728). He also created maps himself, and though still characterized by significant errors and omissions, his efforts represented a vast improvement over previous representations of the Texas interior (J. Jackson 1998:52) (Figure 11). It was during this period that major watercourses such as the Guadalupe, San Marcos, and Colorado Rivers were mapped for the first time, and the routes of explorers such as St. Denis became the first mapped trails represented in the Texas interior. Unfortunately, Spanish maps such as Oliván's "Mapa Geographico," which depicted major rivers emptying into the Gulf of Mexico for the first time, were never published and have only been available to scholars in recent decades

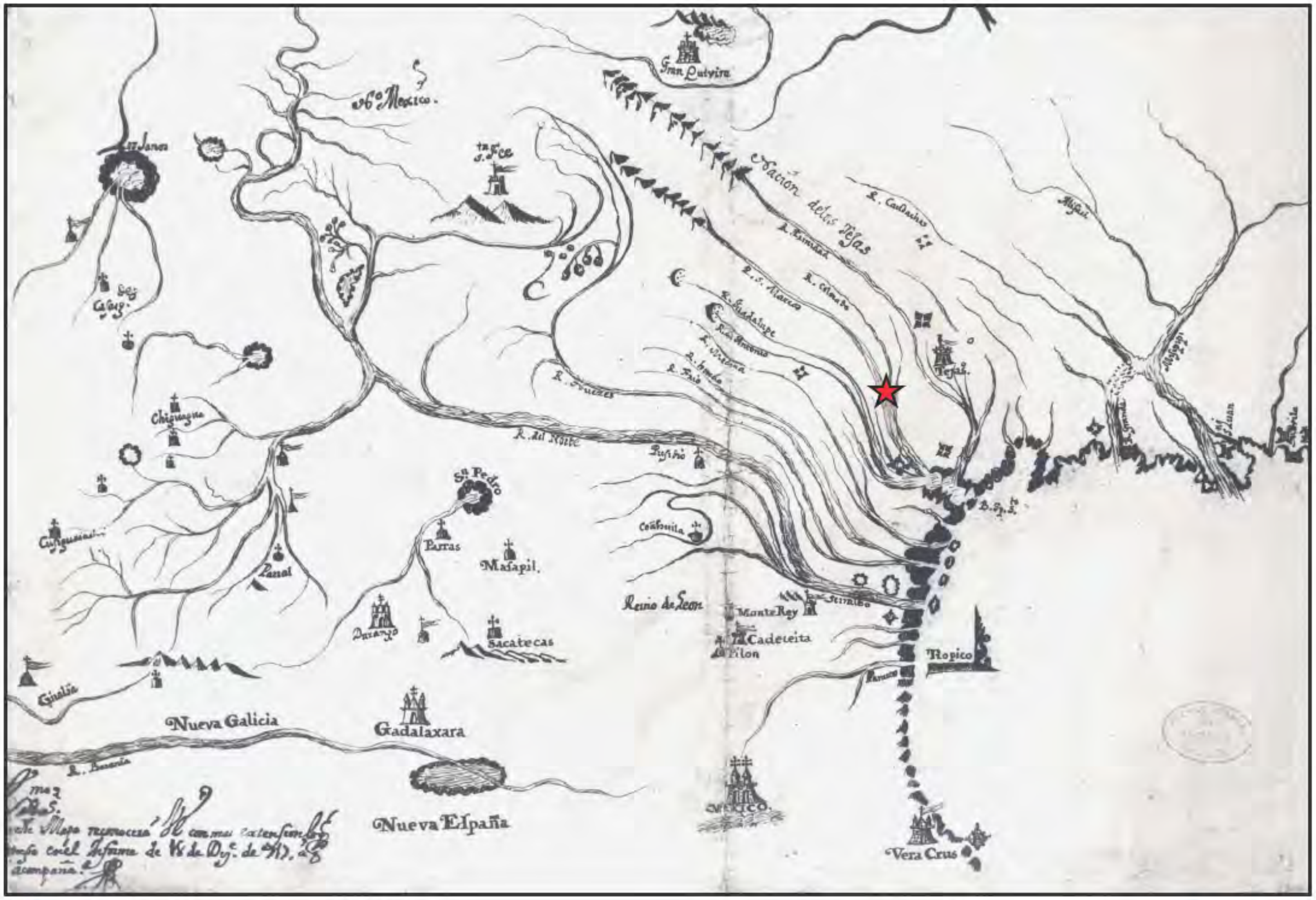

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Figure 11

"Mapa Geographica Noreste de Mexico"
by Juan Oliván Rebolledo (1717)

Source: Copy on file at the OLLU Old Spanish Missions Research Collection, San Antonio, Texas

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Drafted by: C. Wallace

(Jackson and Weddle 1990:14). As a result, the 1718 version of Delisle's map (*Carte de la Louisiane et du cours du Mississipi Dressee sur un grand nombre de Memoires entrau*) remained "the primary cartographic reference for the Mississippi Valley until the late 1700s" (Jackson and Weddle 1990:15; Texas Beyond History 2011). Cartographers throughout Europe copied the map, and it was even relied upon by Spanish mapmakers in the ensuing decades (see Figure 9).

With respect to the project vicinity, maps from the early eighteenth century (1700–1720) did not portray any specific geographic or cultural features in the area that provided significant clues about contemporary or previous settlement patterns. The earliest attempts dating to the turn of the century did not include any details on the interior, were grossly inaccurate with regard to the region's geography, and reflect the dearth of knowledge about the area prior to the French and Spanish expeditions of the following decade (i.e., maps 1 and 2 on Table 8). One of the best maps from the period, created in 1703 by Guillaume Delisle, was based on the unreliable accounts of the survivors of the La Salle expedition and depicted no settlements or other cultural or geographic features, such as trails or accurate watercourses, anywhere near the project vicinity. In fact, the only cultural information included for Texas was the identification of wandering Indians along the coast (Delisle 1703).

While dramatic improvements occurred overall following the dissemination of information from the expeditions of St. Denis and others, cartographic details about the project vicinity remained limited. Spanish mapmakers were more concerned about protecting the area from French invaders than with developing a thorough understanding of the geography or cultural groups of Texas. Similarly, the French focused detailed attention on east Texas, the area where they hoped to expand their holdings and influence in the immediate future. For example, the highly stylized 1717 maps of Oliván contain more-accurate representations of the region's watercourses as well as proposed presidio locations but contain little cultural information. In fact, the only Native Americans referenced are the "Nacion de los Tejas" to the east of the Trinity River (Oliván 1717a, 1717b).

Correspondingly, Delisle's much-improved map of 1718 contained more-accurate geographic data as well as additional cultural information for the entire Texas interior (see Figure 9); however, the map includes substantially more detail around settled areas such as Nacogdoches, Los Adaes, Natchitoches, and the various Caddo settlements in east Texas. In addition to the location of La Salle's doomed fort and the territory of the Ebahamo Indians encountered by La Salle's men (Cox 1905), Delisle's map depicts the purported routes of St. Denis's two expeditions across Texas in 1713 and 1716 as well as the route taken by De León during his search for La Salle. According to the map, the routes of St. Denis generally paralleled the *caminos reales*, and it denotes the "Conokol'se errans," a tribe of wandering Indians, between the Guadalupe and Colorado Rivers. This tribe, who otherwise remains unidentifiable, is the only group depicted anywhere near the subject area and the only group identified west of the Colorado River whose territory Delisle did not identify as along the coast (Delisle 1718). Various European cartographers copied both the form and content of Delisle's map in the ensuing decades (see Table 8).

The Delisle and other French maps from the period (see Table 8 for other examples) relied on information from the explorations of St. Denis, François Derbanne, and others that was transmitted via the French Court by Louisiana resident and priest François Le Maire (J. Jackson 1998:84). Le Maire has been described as the "liaison" that made the flurry of cartographic activity of the 1710s and 1720s possible (Higginbotham 1990:x). Other maps from the period are similar in content to the Delisle map, though many have much less detail, and none depict any additional cultural or geographic features in the project vicinity.

In 1728, Álvarez Barreiro, "surveyor, map maker, and experienced engineer" in the service of Pedro de Rivera during his series of inspection tours of Texas presidios and missions (1724–1728) (Chipman 2011; J. Jackson 1998:54), produced a map of New Spain, including Texas, based on his firsthand observations (Figure 12). Like other Spanish maps of the period, Barreiro's map, the first of its kind made by an individual with scientific training in cartography, was not made available to other cartographers or to the public until 1768 (J. Jackson 1998:66–67). Nevertheless, it had significant influence on subsequent Spanish mapmakers and initiated an emphasis on creating maps during rather than after expeditions.

Aside from continuing geographic errors resulting from Barreiro's reliance on information provided by residents for features he was not able to personally survey and from the rudimentary measurement tools in use during the period, the map presents a significant amount of cultural information not present on previous maps and offers a vast improvement in the representation of significant geographic features. For example, Barreiro depicted the Guadalupe and San Marcos Rivers (called R. de los Innocentes) correctly, including their relationship to each other and to their mouths in present-day Matagorda Bay (Barreiro 1728).

Though the map does not show any roads or trails, it does include numerous named and unnamed Indian villages. Though none are located in the immediate project vicinity, there are two unnamed Indian villages depicted between the Guadalupe and San Marcos and between the San Marcos and Colorado (called R. de San Marcos) Rivers. Farther south, the map shows two other villages. The first, identified as "tierra de los Toos," is depicted immediately east of the confluence of the Guadalupe and San Marcos Rivers on the west side of the Colorado (R. San Marcos). The second, called simply "Malleyes," is depicted to the northeast of the first extending between the Colorado and the Brazos (a.k.a. Colorado) Rivers. These were the Mayeyes encountered by Rivera in the Monte Grande west of the Colorado River in August 1727. Another notable cultural feature is the "*Rancheria grande compuesta de las Reliquas de 22 naciones extinguidor por los apaches*." Known as the Ranchería Grande, this mobile conglomeration of displaced tribes from various locations was then located between the Brazos and Trinity Rivers (Barreiro 1728). These cultural features, already out of date and of questionable accuracy when first published in a 1768 version of the map created by José Antonio de Alzate y Ramirez (Figure 13), were perpetuated in subsequent maps through the turn of the nineteenth century.

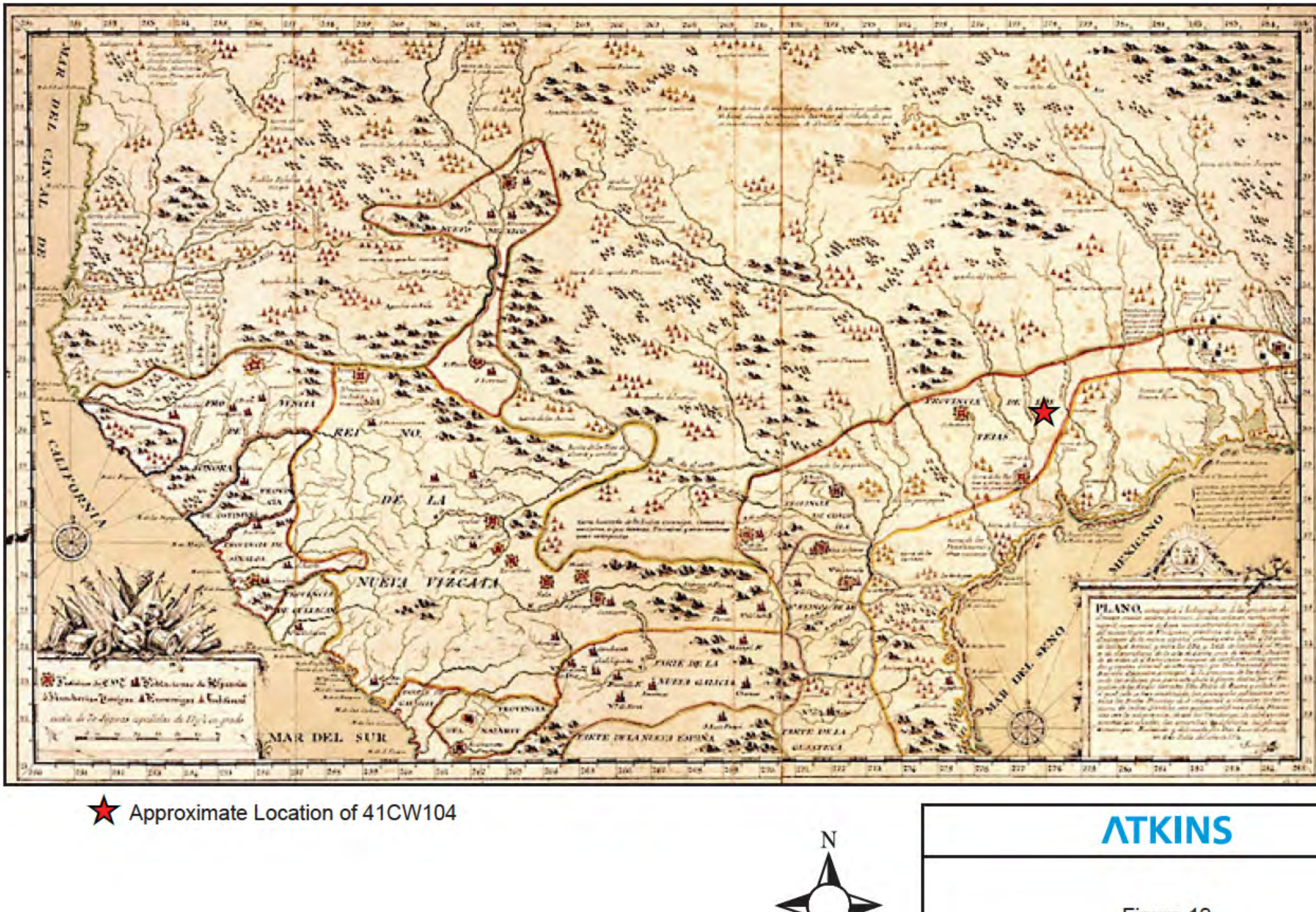

Figure 12

Plano Corographico e Hydrographico de las Provincia... de le Nueba España (Barreiro 1728)

Source: University of Texas at Austin, Texas Beyond History, http //www.texasbeyondhistory.net/adaes/images/barriero-1728.html

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Drafted by: C. Wallace

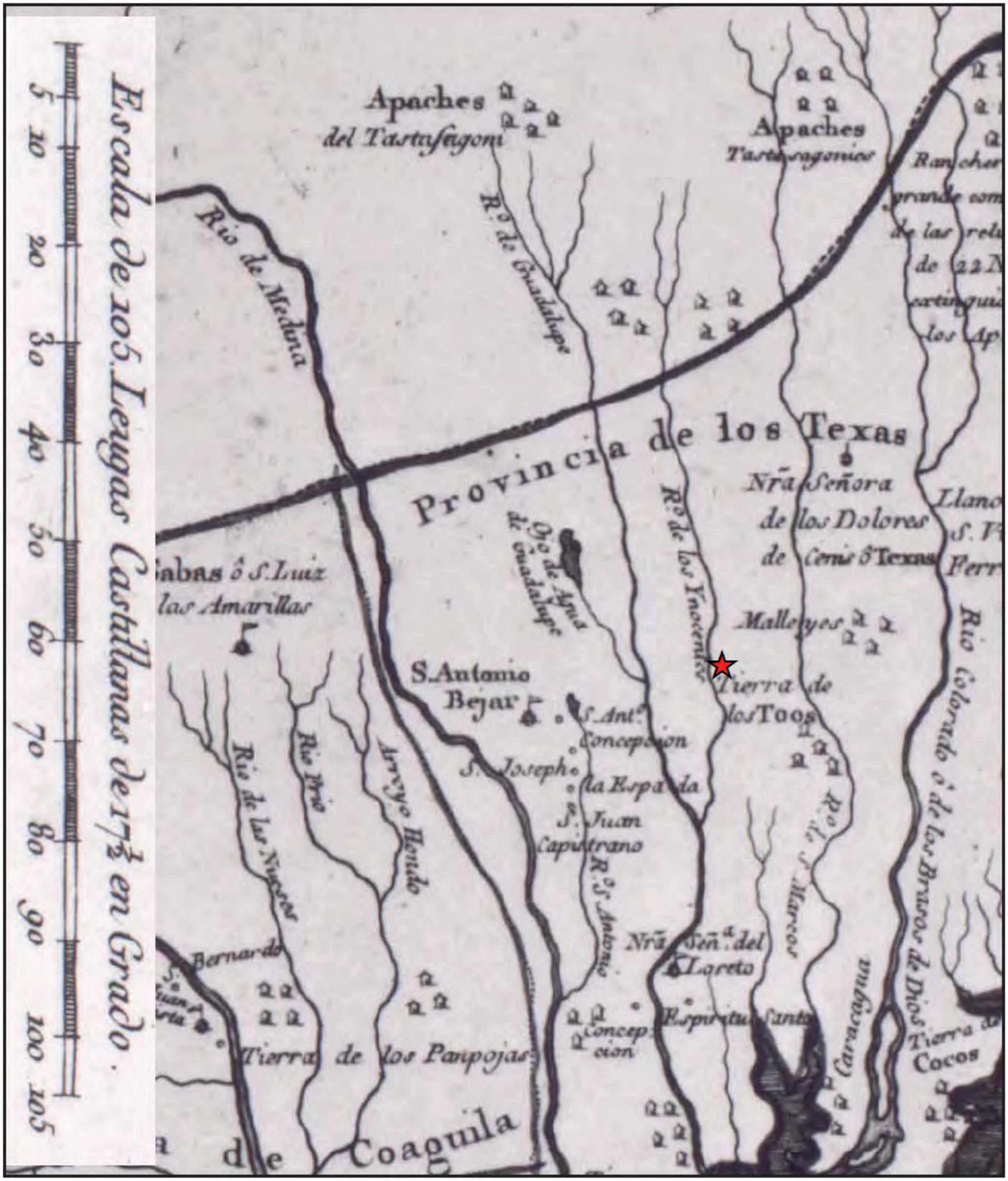

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Figure 13

Jose Antonio de Azalte y Ramirez's "Nuevo Mapa Geographico de la America Septentrional," 1768

Source: Copy on file at the OLLU Old Spanish Missions Research Collection, San Antonio, Texas

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Between Barreiro's map of 1728 and its first publication 40 years later, published mapping of the Texas interior was not characterized by any advances in the representation of either cultural or geographic features. In fact, most of the published maps of the period reverted back to outdated templates when representing the interior or did not depict any detail at all. A series of maps from various European cartographers including Popple (1733), Albrizzi (1740), d'Anville (1740 and 1746), Bowen (1747), and de Vaugondy (1749), among others, include out of date and inaccurate versions of Texas waterways (see Table 8), if they depict any at all, and none include any cultural detail in the Texas interior, such as Native American villages, roads, trails, or other settlements. This absence of published data can be linked to Spain's exclusionary policy concerning the sharing of geographic information about the Texas interior with other European powers (or even with their own citizens) and explains why the cartographic exceptions from this period (those maps that did show advancements) were all Spanish in origin.

The two primary examples of such exceptions include the maps of Miguel Custudio Duran (1744) and José Antonio Villaseñor y Sanchez (1746). Though both represented improvements in general understanding of the region's geography, neither map depicted any new information regarding the project area or the surrounding region. Duran and Villaseñor y Sanchez illustrated only major watercourses on both maps, though Duran was the first to present the San Antonio-Guadalupe River system and its tributaries correctly (J. Jackson 1998:99, 104), and neither depicted any cultural features in or near the project vicinity. Additionally, neither map was widely circulated (J. Jackson 1998:106). As a result, even their limited improvements in geographic representation of the region (Weddle 1991:332) were not generally adopted by contemporary cartographers.

In 1768, Mexican naturalist and scientist José Antonio de Alzate y Ramirez created one of the first maps of New Spain published by the Spanish government. In his representation of the Texas interior, Alzate y Ramirez "slavishly copied Barreiro" for most features, including "river courses, coastline, and even [used] the same legends" (J. Jackson 1998:133). As a result, while the map offered an improvement over popular published maps of the period in its geographic representation of the Texas interior, the cultural information, which Ramirez only adjusted in select cases, was tremendously out of date (see Figure 13). Therefore this "breakthrough" map, which was copied by numerous cartographers in the ensuing years (see Table 8), offered no new information regarding settlements, roads, or trails in the project vicinity (Alzate y Ramirez 1768).

After 1763, the Spanish had a new neighbor in the New World as the portion of French Louisiana east of the Mississippi River was ceded to the British. In response to the loss of the French threat, a period of Spanish "retrenchment" ensued during which many presidios and missions in east Texas were abandoned and the capital of Texas was relocated to San Antonio. To facilitate this action, the Spanish government initiated a series of inspections of Texas led by the Marqués de Rubí (Martin and Martin 1984:24). Rubí brought along engineers Nicolás de Lafora and Joseph de Urrutia who were charged with making maps of each presidio inspected and with making a general map of the frontier based on the inspection results (J. Jackson 1998:40–41).

Though the resulting maps were a vast improvement over anything in existence at the time, they also became obsolete more quickly than previous maps due to new information gathered during subsequent expeditions in the 1770s. Unfortunately, the general map (with versions dating to ca. 1768, 1769, and 1771) does not portray any significant geographic or cultural features in the project vicinity (Lafora and Urrutia ca. 1768, 1771; Urrutia 1769). There are two unnamed Native American villages (labeled as *Rancheria de Gentiles*, or “Village of Heathens,” in the legend) depicted between the Colorado (or Roja) and Guadalupe Rivers on the ca. 1768 map; however, it is difficult to associate the villages with precise geographic locations as the watercourses are not depicted correctly (J. Jackson 1998:154). The land surrounding the project area is represented as undeveloped on all of the maps; however, the 1771 version shows the *camino real* (see Figure 8). No other roads, trails, settlements, or tribal data are depicted in or around the current project vicinity.

Between 1776 and 1778, Miguel Constansó and Manuel Agustin Mascaró created a series of maps including the Texas interior. These maps, commissioned by Viceroy Bucareli, have been described as the “best synthesis of current geographical knowledge” (J. Jackson 1998:174) up to that date (see example on Figure 14) and far surpassed the Lafora/Urrutia map of the previous decade. Though they included a substantial amount of detail, including both cultural and geographic features, there is still no information regarding the character of the project vicinity. The maps include delineation of various stream crossings and fords along the San Antonio and Guadalupe Rivers, as well as the locations of missions, *ranchos*, and other settlements in the area based on a sketch map the men received from Governor Domingo Cabello ca. 1781 (J. Jackson 1998:182). Despite the additional detail, the region surrounding the project vicinity is still depicted as undeveloped. Additionally, they do not include any information regarding trails, roads, or tribes in the region (Constansó and Mascaró ca. 1777, ca. 1778.).

The Constansó/Mascaró maps remained the template for general maps of the region well into the nineteenth century as mapmakers concentrated on regional depictions of areas proposed for settlement rather than on comprehensive maps of the province. One exception during the late nineteenth century was the work of Mariano Angel Anglino (1788), which was later copied and used by Pichardo in his grand treatise on the boundary between Louisiana and Texas (Splawn 1928). This highly stylized map, which is “one of the rare manuscript maps of the entire region dating from the eighteenth century . . . drawn by someone working in the province itself,” includes detailed illustrations of watercourses, their tributaries, presidios, settlements, and “a complex road system shown as dotted lines” connecting the various places (J. Jackson 1998:288) (Figure 15).

Though no specific geographic or cultural features are shown in the project vicinity itself, the map is interesting because of its depiction of historic roadways. Historians were unable to acquire a copy of this map as only photographs exist in local archives. As a result, specific calculations regarding the approximate distances of these roadways from the project area were not possible. Figure 16 represents an adaptation of a photograph of a published copy of the map (J. Jackson 1998:292). The

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Figure 14

Miguel Constansó and Manuel Agustin Mascaró, "Mapa de la Mission de la Espada Hasta el Mississippi...," ca. 1778

Source: Copy on file at the OLLU Old Spanish Missions Research Collection, San Antonio, Texas

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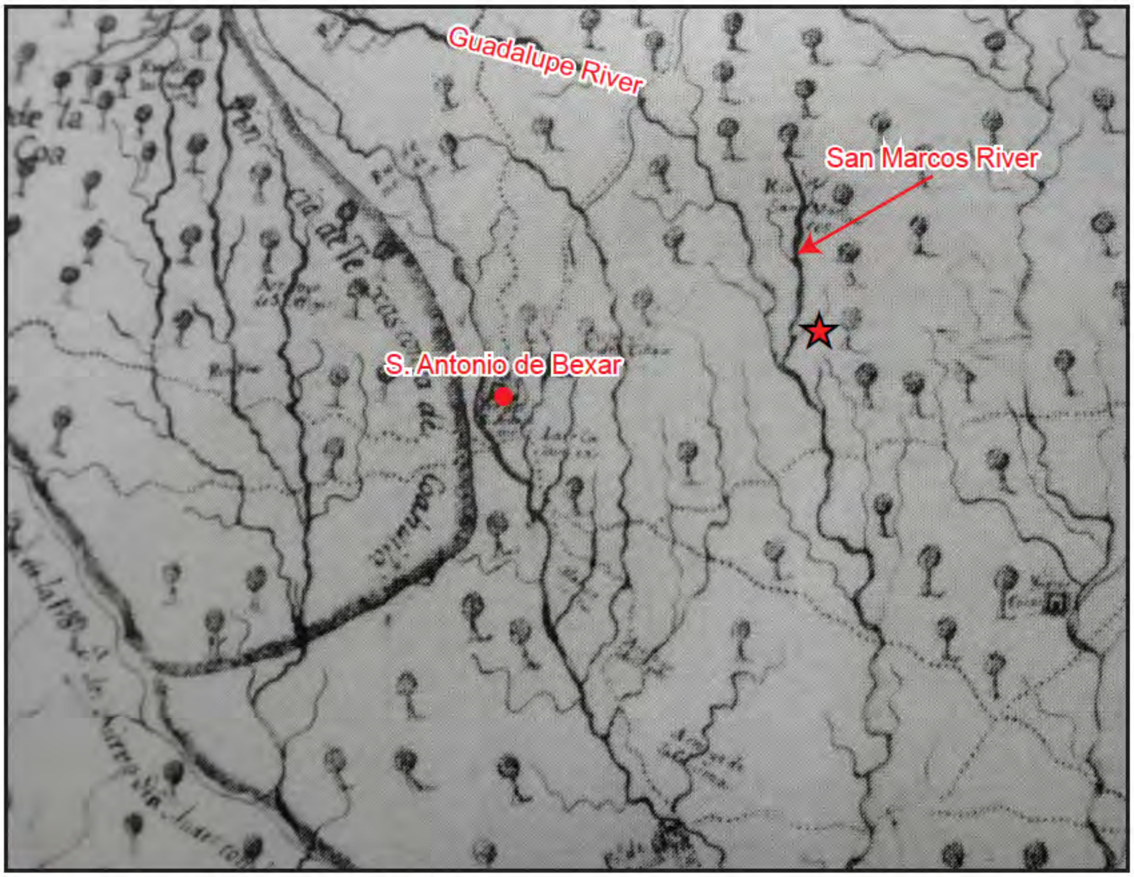
Drafted by: C. Wallace



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Historic Roadways

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Figure 15

Jose Antonio Pichardo's Adaptation of Mariano Angel Anglino's 1788 "Mapa... Semanfiota la Prov. de Texas..."

Source: Copy of original on file at Texas State Library, Austin, Texas

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Figure 16

"Mapa Geographica de las Provincias Septentronales de Esta Nueva España" by Father José María Puelles, ca. 1807

Source: Copy on file at the Briscoe Center for American History, University of Texas at Austin

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Texas State Library also has a photograph of the original taken from the C.E. Castañeda Collection in the 1940s.

Other published maps of the period, including examples from Bonne (1780), Bew (1782), and Kitchin (1783), among others, were significantly out of date with the cultural and geographic knowledge that existed about the Texas interior (see Table 8). All of these examples contained significant errors and omissions with regard to basic elements such as major rivers and included little or no cultural data for the province in general or for the project area in particular.

The next eruption of cartographic activity pertaining to the Texas interior occurred following the United States's purchase of the Louisiana territory in 1803. Both nations subsequently scrambled to determine the boundaries of their respective provinces, and international interest in the region peaked as exploration and settlement there increased. Despite the proliferation of map sources, details regarding the cultural and geographical character of the project vicinity remained scant during the first decades of the nineteenth century.

The unpublished maps of Father José María de Jesús Puelles, created between 1801 and 1807, were by far the most detailed, accurate, and influential of this period (J. Jackson 1988:347) (see example on Figure 16). The Puelles maps, which were ultimately part of Spain's effort to confirm the limits of their holdings in Texas and became the base maps for Stephen F. Austin's important cartographic achievements during the 1820s (J. Jackson 1988), were the first to depict all of the major rivers following accurate courses and in the proper location in relation to each other. The maps also included a significant amount of cultural data, depicting virtually "every river, creek, settlement, and Indian village in Texas" (J. Jackson 1998:318) as well as several historic roadways including the Camino de Tejas crossing immediately north of the confluence of the Guadalupe and San Marcos Rivers. Unfortunately, the maps do not show any new or relevant cultural or geographic information in the project vicinity. Neither Plum Creek nor any of its tributaries are depicted, and the only Native American group identified between the Guadalupe and Colorado Rivers is the "Tancaques" (Tonkawa). The map shows their village, or *ranchería*, a significant distance southeast of the project vicinity along the western bank of the Colorado River (see Figure 16).

Other published maps from this period either relied on outdated information and/or contained little detail regarding the Texas interior. Prominent examples include those produced by Arrowsmith (1803/updated in 1817), von Humbolt (1804/updated in 1810), Wilkinson (1804), Lewis (1804), and Drayton (ca. 1805) (see Table 8), and though some contained valuable improvements in their geographic representation of other parts of the Spanish empire, none contained accurate or groundbreaking information regarding the Texas interior or the project vicinity. Another unpublished map by Juan Pedro Walker (1805), which was also created via order of the Spanish crown and demonstrated marked improvement in the geographic depiction of the interior, was not of the caliber of the Puelles maps (J. Jackson 1998:322–323), nor did it show any new cultural or geographic features in the project vicinity. Several other unpublished maps from this period were commissioned by the Spanish government; however, none of those reviewed (dating to 1807 and 1808) provided any additional data about the region surrounding the project area (see Table 8).

In the following decade, three maps were published that "defined the way Texas was viewed by the world for the next two decades" (J. Jackson 1998:352). Of the three, which included improved maps by von Humbolt and Arrowsmith, as well as a new map including information gathered during the Zebulon Pike expedition, only the Pike map (ca. 1807) depicted any new cultural information relevant to the project vicinity (Figure 17). Many of the map's geographic features were based on Spanish sources from the previous century supplemented with on-the-ground observations. His expedition generally followed the Old San Antonio Road (Cutrer 2011) as it approached the project vicinity, and the associated map shows a *rancho* along the route near its intersection with the "Sn. Marco" River. Though relatively late in age compared to the subject site, the map confirms that settlement occurred along established travel routes and adjacent to watercourses.

Both exploration and cartography experienced a marked downturn during the period between 1810 and 1821. The Mexican revolution virtually halted the development of new maps, and those published during the period were typically copied from earlier templates and contained outdated geographic and cultural information. Examples including maps by Borghi (1818) and Hebert (ca. 1818) perpetuated incorrect geographical data and contained no new information relevant to the subject area (see Table 8).

The final map analyzed from the secondary period provides a fitting transition into the next era of mapmaking. The map, by French cartographer P.A.F. Tardieu (1820), delineates several historic roads and was the first to depict Plum Creek as an unlabeled watercourse (Figure 18). Though no other cultural or geographic features are denoted in the vicinity of the project area, it serves as a good example of the type of detailed mapping created after 1820. As discussed in the historic background section, the third period in the history of Texas cartography was characterized by the creation of maps based on actual surveys conducted by professional surveyors "made for the location of land claims by colonists and settlers" (Martin and Martin 1984:9). As a result, landforms, ponds, creeks, and other cultural features were documented carefully and specifically as part of property surveys.

Overall, the project area's isolation from the direct routes of historic expeditions, from the historic roadways that often but not always followed their paths, and from designated presidio and mission locations meant that it received little attention by Spanish or other European or American cartographers during the eighteenth and early nineteenth centuries. Though evidence from the accounts of Spanish explorers suggests that Plum Creek (and thus the site vicinity) was first encountered and identified by Europeans as early as 1709, it did not appear on any maps until 1820, upon the eve of Mexican independence from Spain. In general, Spain's "progress in exploring and occupying the region was slow." As a result, knowledge of the province and by default the

★ Site 41CW104 (Approximate Location)

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1. The historic map image(s) were digitally enhanced as part of the Texas Historic Overlay (THO) project, Texas Dept. of Transportation, Environmental Affairs Division, November 2006.

2. The source map image was obtained from the Texas State Library & Archives Commission, Austin, Texas.

3. A MAP OF THE INTERNAL PROVINCES OF NEW SPAIN Map. Zebulon Pike, 1807.

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Figure 17
Zebulon M. Pike, A Map of the Internal Provinces of New Spain, 1807

Prepared By 19910	Scale 1" 45 Miles
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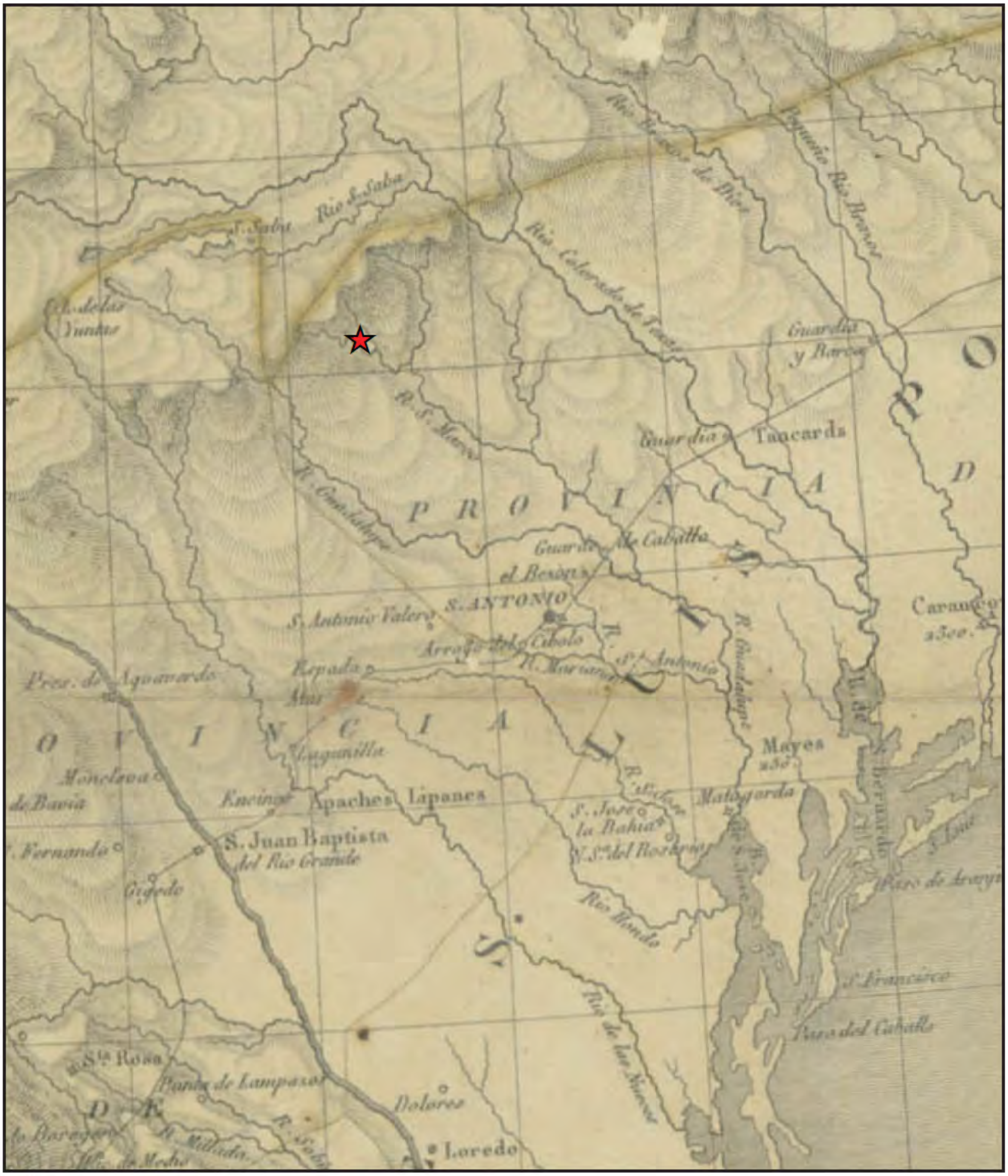

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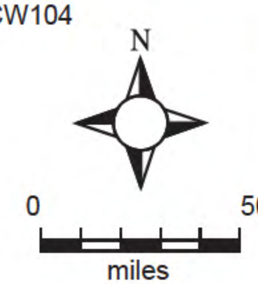

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Figure 18

Adapted from P.A.F. Tardieu's
"A Map of Louisiana and Mexico
(Carte de Louisiane et du Mexique)," 1820

Source: Copy on file at Texas State Library and Archives Commission, Austin, Texas

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Drafted by: C. Wallace

project area "remained vague and imprecise, apparently restricted to a general notion of the major rivers, coupled with more detailed conceptions of the vicinities of Béxar, La Bahía, and Nacogdoches and the well-traveled routes between them" (Martin and Martin 1982:371). Nevertheless, select maps suggest that the area between the Guadalupe, San Marcos, and Colorado Rivers was traversed by various tribal groups during the period of exploration and colonial expansion, including the Toos, Malleyes, and "Conokol'se." In addition to cultural data, the map research also helped to locate site 41CW104 in relation to known/designated historic roadways. Although none immediately approached the subject site, its general proximity to the *caminos reales* suggests that it was located relatively close to a regularly traversed area during the protohistoric period.

Initiation of the Third Period—Anglo Settlement Prompts Better Geographic Documentation of the Texas Interior

Historians only reviewed maps from the beginning of the third period of Texas cartography principally to determine when Plum Creek was first illustrated on historic maps and to trace the history of road development in the region. This period (post-1820) represented the first time the project area was mapped in detail, principally due to its location within one of Texas's original *empresario* colonies. The colony of Green DeWitt, founded in 1825, was located immediately west of Stephen F. Austin's original colony and bounded on the north by the Bexar-Nacogdoches road (a.k.a the Old San Antonio Road). By the time DeWitt received his grant, much of the area had already been mapped by fellow *empresario* and supporter Stephen F. Austin, who purposely located DeWitt's colony adjacent to his own to offer his settlers additional security (Lukes 1976:55).

The current site is located within the original headright of Gerron Hinds (GLO Records, Caldwell County Abstract 13) along Plum Creek. Hinds, one of the colony's original settlers, arrived in the region with other early settlers in 1825. His grant, surveyed and issued in 1831, was located approximately 1.5 miles above "Whiteman's camp" (GLO Records, Caldwell County Abstract 13). This description may refer to the original location of Gonzales, which was raided by Indians a year after its establishment. Whiteman, one of the outpost's original settlers, was killed in the attack, and many of the other residents fled to Austin's colony for protection (Roell 2011).

The original metes-and-bounds description for the league and labor (4,428.4 acres) survey containing 41CW104 describes the property as a mix of level prairie along the creek bottoms with the rest of the grant populated by timber, particularly post oak and blackjack. Three labors were denoted as "rich and good for farming," while the rest represented rangeland. The document, which includes a sketch map (Figure 19), does not reference any existing trails, roadways, or other camps or settlements in the area, though secondary sources indicate that numerous tribal groups, including the Karankawa, the Tonkawa, and several Plains tribes, still occupied and/or traversed the region during the period (Lukes 1976:114, 120, 122).

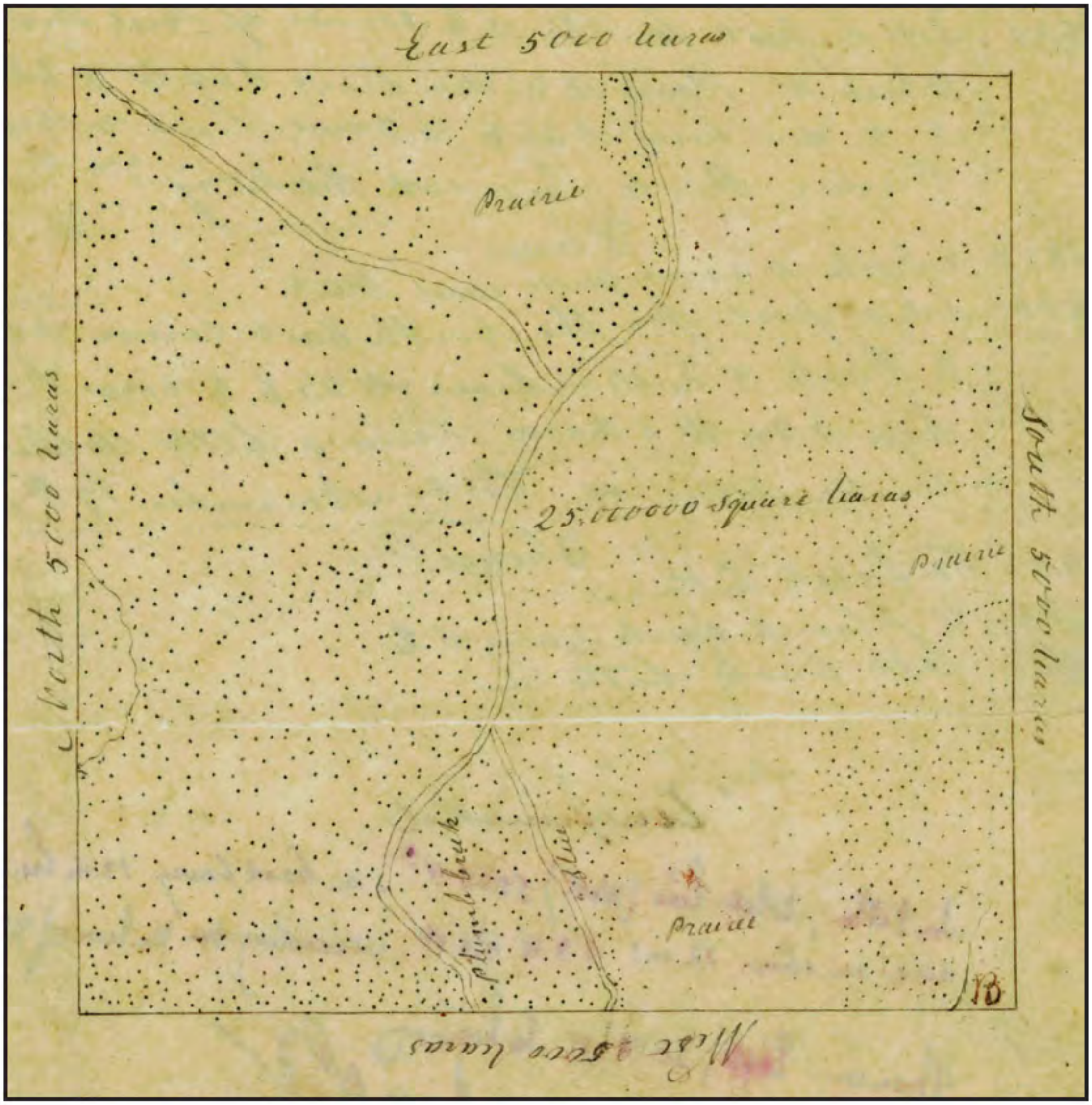

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Figure 19

Gerren (Gerron) Hinds Grant,
Caldwell County Abstract 13 (1828)

Source: Original Survey on file at the Texas General Land Office, Austin, Texas

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Drafted by: C. Wallace

Due to the region's settlement by Anglo-American immigrants in the years immediately following the Mexican Revolution, all of the relevant maps from this period relate to efforts to survey and partition the region into land grants (see examples from before 1828 in Table 9). This pattern continued during the Texas Republic and statehood eras as settlement increased necessitating the creation of maps to depict new networks of roadways and the communities, farms, and regions they connected. Stephen F. Austin created the most detailed maps of the vicinity and of the province in general during the 1820s.

Table 9. Third Period

Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
Mapa Geografico de la Provincia de Texas	Stephen Fuller Austin	1822	Nothing specific in project vicinity but useful for depiction of historic roads	Center for American History
[Colonization Grants, southern coastal Texas]	Unknown (traced by Elizabeth Howard West in 1912)	ca. 1822–1835	Part of a set of colonization maps traced by Elizabeth West in 1912; shows various roadways but no other cultural or geographic features in project vicinity	Texas State Library; copied from the Secretaria de Formento, Colonizacion, e Industria, Mexico City, Mexico, Colonizacion y Terrenos Baldios
[Colonization Grants, south central Texas]	Unknown (traced by Elizabeth Howard West in 1912)	ca. 1822–1835	Part of a set of colonization maps traced by Elizabeth West in 1912; shows various historic roadways in the Central Texas region but no other cultural or geographic features in the project vicinity	Texas State Library; copied from the Secretaria de Formento, Colonizacion, e Industria, Mexico City, Mexico, Colonizacion y Terrenos Baldios
[Colonization Grants in Texas]	Unknown (traced by Elizabeth Howard West in 1912)	ca. 1822–1835	Part of a set of colonization maps traced by Elizabeth West in 1912; shows various historic roadways in the Central Texas region but no other cultural or geographic features in the project vicinity	Texas State Library; copied from the Secretaria de Formento, Colonizacion, e Industria, Mexico City, Mexico, Colonizacion y Terrenos Baldios

Table 9 (Cont'd)

Map Title	Cartographer	Creation Year	Features Depicted in Vicinity of Site	Repository
[Texas]	Unknown (traced by Elizabeth Howard West in 1912)	ca. 1822–1835	Part of a set of colonization maps traced by Elizabeth West in 1912; shows roads in project vicinity; more-accurate depiction of watercourses, but no other relevant cultural or geographic features	Texas State Library; copied from the Secretaria de Formento, Colonizacion, e Industria, Mexico City, Mexico, Colonizacion y Terrenos Baldios
Mexico	A. Finely	1824	Labels Colorado and Guadalupe Rivers, but no other useful information in project area	Texas State Library
Texas	Fiorenzo Galli	1826	First printed map of Texas (made in Mexico); seems to be based on S.F. Austin's map of 1822; notes in margin are by Manuel Mier y Terán; does not specifically identify Plum Creek but shows roads and DeWitt's Colony	Center for American History
Unnamed [Texas]	Stephen Fuller Austin	1827	Does not depict Plum Creek but depicts several historic roads	Contours of Discovery/Center for American History
Mexico and Guatimala [*sic*]	Sidney Hall	1828	Only depicts watercourses in project vicinity; no other cultural or geographic details	Texas State Library
Map showing area between Nueces and Colorado Rivers	Stephen Fuller Austin	ca. 1828	Shows Santa Maria Creek and the Camino a Nacogdoches crossing in the immediate project vicinity; Camino a S. Felipe de Austin is also depicted relatively nearby	Center for American History

When Austin arrived in Texas in 1821, there was still little known about the majority of the region's interior despite its occupation and exploration by Spain over the preceding 3 centuries. Instead, only areas around designated settlements had been explored in detail, and aside from "the major rivers" and the coastline, little was known about the region's geography (Martin 1981:373). By 1822, Austin had incorporated information from his explorations of the area surrounding his colony, as well as "those of his colonists already on the scene in Texas," onto the base map of Father Puelles (see Figure 16) (Martin 1981:379). This map, entitled "Mapa Geografico de la Provincia de Texas," does not depict any specific cultural or geographic features in the project vicinity, but is interesting for its representation of historic roads in the area.

Austin continued mapping the state in the intervening years, relying on both personal and secondhand information from colonists, other *empresarios,* and explorers like Manuel de Mier y Terán (Martin 1981:385). Subsequent maps and sketches he completed in 1827 and 1828 provide additional information about the project vicinity not included on previous maps. For example, though Plum Creek is not specifically identified, an 1827 sketch shows the routes of both the upper and lower roads, labeled *Camino a Nacogdoches* and *Camino a Opelusas* [*sic*], respectively. An 1828 map includes more-specific geographic information, depicting both Santa Maria Creek and its tributaries, but only illustrates the *Camino a Nacogdoches* (Figure 20).

In the final published version of the map, dated 1829, Austin portrayed Santa Maria and Ciruela (Plum) Creeks as separate though converging watercourses. However, the West Fork of Plum Creek is not depicted. Another difference between the 1829 document and the previous version is the identification of the Nacogdoches Road as the *Camino de Arriba*. Several other roads are identified as well, and this map is the first to show the community of Gonzales to the south of the subject area. Austin also labeled the region to the south of the current project area as home of "Indios Tancanuacis ixibu errantes" (Tonkawa) (Figure 21).

Besides the Austin maps, historians also reviewed copies of unpublished maps commissioned by the Mexican government illustrating the location of existing and proposed colonization grants as well as the maps of Finely (1824), Galli (1826), and Hall (1828). While both the Finely and Hall maps were published using out of date and erroneous information regarding the character of the Texas interior (see Table 9), the Galli map, "which holds the distinction of being the first printed map of Texas" (Martin and Martin 1984), depicts rather accurate versions of the region's principal watercourses as well as the location of DeWitt's Colony and principal roadways of the period. The map was used by explorer Manuel de Mier y Terán during his expedition to Texas in 1828, and the only existing version of the map has his geographic and cultural notes in the margins. Unfortunately, the map does not include any updated information about the current project area, either regarding its geography or cultural history (Galli 1826).

Despite the increased accuracy of mapping from the third period, maps depicting the project area do not provide a significant amount of additional cultural information about the project vicinity.

★ Approximate Location of 41CW104

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Figure 20

Stephen F. Austin's
"Map Showing Area Between Nueces and Colorado Rivers," ca. 1828

Source: Original on file at the Briscoe Center for American History, Austin, TX

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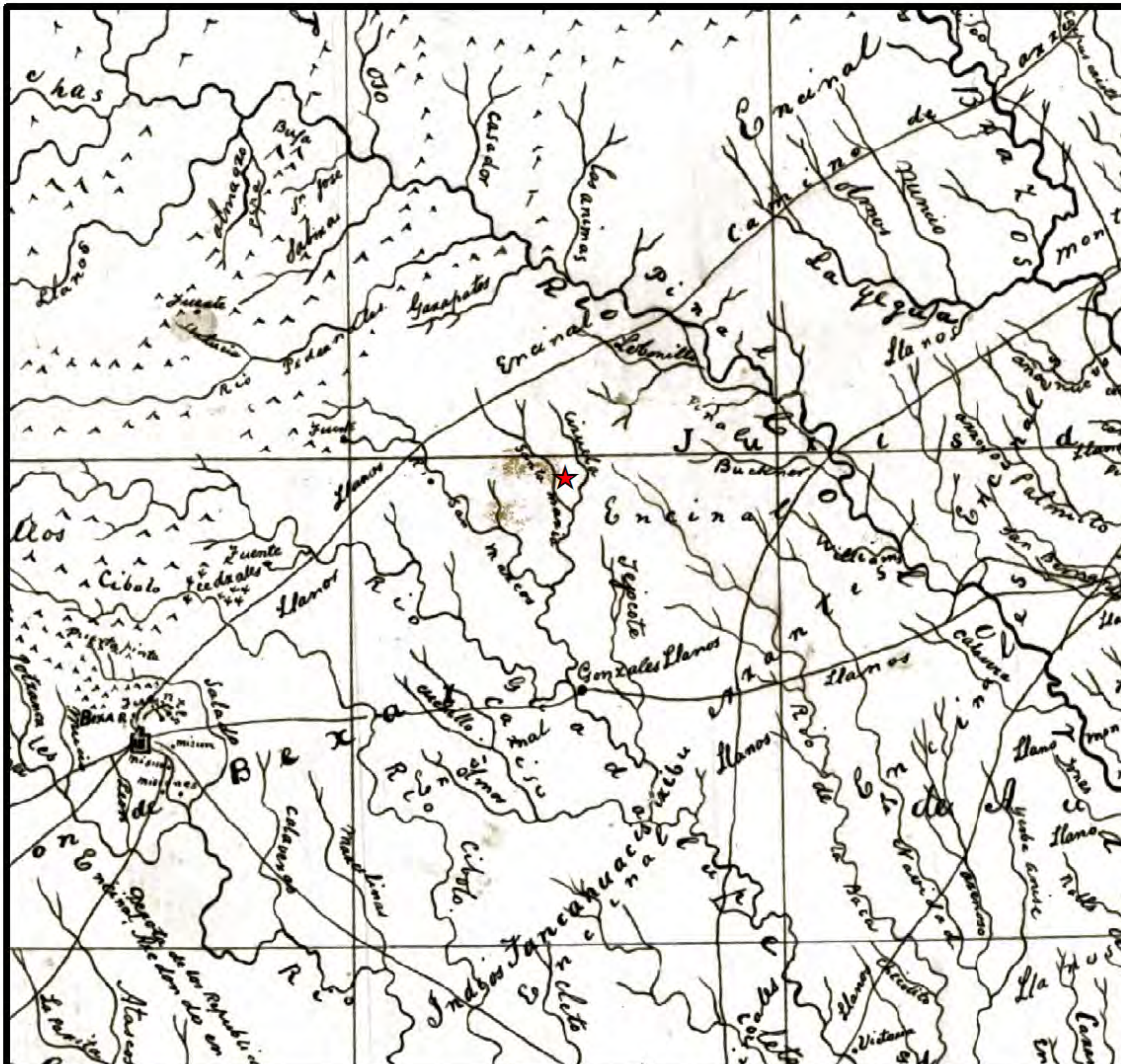
Drafted by: C. Wallace



★ Site 41CW104 (Approximate Location)

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1. The historic map images(s) were digitally enhanced as part of the Texas Historic Overlay (THO) project, Texas Dept. of Transportation, Environmental Affairs Division, November 2006.

2. The source map image was obtained from the Texas State Library & Archives Commission, Austin, Texas.

3. MAPA ORIGINAL DE TEXAS POR EL CIUDADANO ESTEVAN F. AUSTIN PRESENTADO AL EXMO SNR PRESIDENTE Map. Stephen F. Austin, 1829.

0 5 10 20 Miles

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Figure 21

Stephen F. Austin's Original Map of Texas, 1829

Prepared By 19910	Scale 1" 20 Miles
Job No. 100022694	Date 21 Jan 2013

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Instead, they include more-accurate representations of local watercourses and landforms but no evidence of previous occupations, historic trails, or other circulation routes.

HISTORIC ROADS AND TRAILS

The documented history of roadways and travel networks in Texas extends back to the period of initial European contact when Spanish and French explorers took advantage of existing Native American trails to traverse the region and to establish settlements and outposts. While there are limited archival and/or cartographic data regarding existing Indian trails used or encountered by early explorers, review of early exploration routes, official roads established during the Spanish Colonial period, known Native American occupation sites, and natural features that encouraged settlement offers some insight into historic settlement patterns and travel systems in the project vicinity. The following historic background briefly details the history of those portions of the *caminos reales* located nearest the project area. The *caminos reales* were an officially designated set of roadways with special status. The section also includes general information about roadway development and improvement after the Mexican Revolution as well as a brief narrative history of specific roadway development in the project vicinity. Comprehensive analysis of other aspects of historic settlement patterning is included in the summary section.

According to TxDOT's history of the *caminos reales,* there were several key factors that influenced the foundation and location of historic roadways. The roadways established during the Spanish Colonial period typically followed established Native American trails and often shifted in response to Native American settlement patterns, either to avoid or to connect existing or newly established settlements, and due to perceived threats from Native American groups. For example, historians theorize that the "gradual shift of the Presidio del Rio Grande road southeastward through the eighteenth and early nineteenth centuries may have been a direct result of the Apache and Comanche threat to Spanish travelers" (McGraw, Clark, and Kenmotsu 1998:35). Additionally, other social, economic, military, and environmental factors affected the locations of roadways. Such factors as established market systems, geography (i.e., the lack of navigable rivers, natural barriers to travel, etc.), communication requirements, and access to dependable water sources influenced both the establishment of Indian trails and of the official Spanish roads that followed (McGraw, Clark, and Kenmotsu 1998:36–38).

Los Caminos Reales and Other Historic Circulation Networks

Though traditionally considered a singular route across Texas, the *camino real* was actually a nonstationary "network of Indian trails, natural stream crossings, and exploration routes that made up northern Mexico's defense and communication system in the Spanish Colonial period" (de la Teja 1998:43). The trails, which lacked funding for construction or maintenance as well as amenities for travelers, were nonetheless well traveled due to the lack of other means of overland or nautical communication with Mexico (de la Teja 1998:43). The distance between settlers and settlements also necessitated the expansion of circulation networks as residents of far-flung outposts required both supplies and news from other locales (Canion 1936:14; Marshall 1934:4). The routes, which all "began at the Presidio del Rio Grande . . . and converged at San Antonio" before following a number of alignments "east towards the Sabine River" included various incarnations between the seventeenth and nineteenth centuries (McGraw 1998:4).

As the current project area is located to the northeast of San Antonio along routes between that settlement and the east Texas missions, this section only includes information about the portions of the *caminos reales* in that area. In particular, the "early upper trail known as the Camino de los Tejas," which "followed the springs of the Balcones Escarpment" was the preferred route between east Texas and San Antonio from initial exploration of the area in 1691 through about 1800. Circa 1795, another route, which Stephen F. Austin referred to as the "Camino Arriba," overtook the Camino de Tejas in popularity (McGraw 1998:4). Though it still connected San Antonio and east Texas and generally paralleled the previous trail, "the route looped southward through the dense southeast-central Texas Post Oak Savannah." This route passed immediately north of the Santa Maria Creek site. On some maps it is depicted as close as 20 to 25 miles (Figure 22).

As discussed in the section related to early exploration in the project vicinity, the projected route of the Domingo Terán de los Ríos and Fray Damián Mazanet expedition of 1691–1692 roughly parallels and bisects the area between the Camino de los Tejas and the subsequent Camino Arriba. This route, which became "the most-traveled upper road toward Nacogdoches until the establishment of the settlement of Bucareli on the Trinity River" in 1774, was followed by subsequent explorers and missionaries during the ensuing decades (Robbins 1998:70; Unknown 2011). The fact that this route was selected, continued to be used, and eventually received designation as a royal road suggests that it may have been well traveled before the Spanish Colonial era. As detailed in the various travel accounts from the period, the Native American guides who accompanied Spanish explorers often relied on established travel routes (Marshall 1934:2). Additionally, the expeditions often camped at established campsites, or *parajes*, along the routes, which were usually adjacent to springs or other dependable water sources.

Other groups of explorers and missionaries including those led by Salinas Verona (1693), Domingo Ramón and Fray Isidro Félix de Espinosa (1709 and 1716), and the Marqués de Aguayo (1719–1722) also passed through the vicinity using Terán and Mazanet's route, further establishing the prominence of this early road. The Camino de las Tejas, which was based partly on these routes and partly on geography (as natural barriers generally confined travel to a narrow corridor through South Texas during this early period), remained the most popular route through the province through the turn of the nineteenth century (McGraw, Clark, and Kenmotsu 1998:38).

During subsequent years, particularly during the Mexican Republic era, travelers used the route known as the Camino Arriba more frequently. Often referred to as the Old San Antonio Road, it followed the route of the Camino de las Tejas to the modern community of Comal where it turned

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★ Site 41CW104 (Approximate Location)

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1. The historic map images(s) were digitally enhanced as part of the Texas Historic Overlay (THO) project, Texas Dept. of Transportation, Environmental Affairs Division, November 2006.

2. The source map image was obtained from the Texas State Library & Archives Commission, Austin, Texas.

3. MAP OF TEXAS
Map. Stephen F. Austin, 1836.

0 6.25 12.5 25
Miles

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Figure 22

Stephen F. Austin's Map of Texas, 1836

Prepared By 19910	Scale 1" 25 Miles
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N:\Clients\S_T\TxDOT\100022694\geo\gis\22_map_Tex_1836_8x11.mxd southward and crossed the Clear Fork and Plum Creek itself at the current Hays/Caldwell county line approximately 25 miles from 41CW104 (McGraw 1998:4; McGraw, Clark, and Robbins 1998:221, 337). This road, which served as the principal Anglo migration route into Texas during the nineteenth century, remained in common use through the turn of the twentieth century and is currently paralleled by existing major highways. In fact, the road formed the northern boundary of DeWitt's Colony, an 1820s *empresario* grant that contained the current project area (Roell 2011).

As exemplified by the primitive nature of the royal roads, which remained little more than overgrown trails through the colonial era, the Spanish did not dedicate substantial resources to infrastructure development during their 3 centuries of association with Texas. As a result, all established trails or roadways, whether designated or secondary, were created and maintained without government support. An 1804 account of road conditions between Nacogdoches and Bexar reflects both their limited number and poor condition. In a report to the Spanish government, the governor indicated there were only two roads opened between Bexar and the presidio of La Bahía del Espíritu Santo and both had been created "by the continual traveling of people over them" rather than by government intervention. While this account omitted the numerous Indian trails that likely existed in the region due to the very specific definitions of civilization maintained by the Spanish, it confirmed that these main roads included no bridges, shops, inns, or public works of any kind (Marshall 1934:20–21).

This "hands-off" policy shifted somewhat around the turn of the nineteenth century as the advent of the cart trade between Mexico and Texas encouraged the development of wider, more-defined routes amenable to cart traffic. Infrastructure improvements at this time centered on road development and on the improvement of established fords and river crossings along designated routes (Canion 1936:27). As of 1807, a map by Father José María Puelles suggests there were four primary or designated routes traversing the province. These included the "upper" *camino real* or "San Antonio Road," the "lower" road that started in Laredo, crossed the "Nueces, the San Antonio and the Guadalupe to La Bahia . . . meeting the 'upper' road just before the Trinity," a route connecting Laredo and Bexar, and another "from Nacogdoches north through the Nadoca and Caddo villages to the Red River" (Marshall 1934:36).

Despite the extended period of Spanish hegemony in the province, at the inception of the Mexican Republic era there were only three permanent settlements remaining in Texas (San Antonio, Goliad, and Nacogdoches), and omitting Native Americans, there were less than 5,000 fulltime residents (Canion 1936:29). Settlement was necessarily limited to a narrow swath of the province below the c*aminos reales* for fear of hostile Native American groups such as the Apaches and Comanches who roamed the areas to the north (Canion 1936:20). Geography also limited both settlement and travel. As a result, cross-provincial trade and travel at this time was generally confined to three main series of roads including iterations of the San Antonio Road or Camino Arriba, the La Bahia Road, and the Atascosita Road. Both the La Bahia and Atascosita or Orcaquisa roads connected Goliad to Nacogdoches and other points east and crossed the *caminos reales* at different locations. A map from 1821 generally portrays the alignments of the main trails across Texas during this period (Unknown 1821) (Figure 23).

Regardless of the lack of active settlements, there is archival evidence that a rather complex system of secondary roads existed in support of the principal designated routes as late as the 1780s. Though many may have been abandoned (along with the former settlements they connected) by the Mexican Republic era, Mariano Angel Anglino's 1788 map, which was one of the rare general maps of the province made by an on-the-ground observer during the latter half of the eighteenth century, depicts numerous settlements and the system of road networks that connected them (see portion of adaptation, Figure 15). In Texas, he showed "Camargo, Laredo, Presidio Río Grande, Presidio San Sabá ('abandoned'), San Antonio, La Bahía, Presidio Orcoquisac ('abandoned'), Nacogdoches, an 'abandoned mission' (Los Ais), and Presidio Los Adaes ('abandoned')." He also depicted numerous settlements in Louisiana as well as others in Texas that are indecipherable. A number of roads connected these settlements. Anglino identified a "road on the right bank of the Rio Grande" that connected "Camargo to Laredo to San Juan Bautista." There were separate roads connecting both Laredo and San Juan Bautista to San Antonio. San Antonio, "which is a virtual hub," had four roads extending from it. The first led to New Mexico, while the second connected San Antonio to the upper Red River (with a fork at the Llano River). The third or higher road linked the community with "two Comanche villages" and forked "again below the Trinity." The final road went "to the 'Tanguayes,' via a 'Flecha' village on the Brazos and two villages ('Yscanje' and 'Guichas') on the Trinity" (J. Jackson 1998:288–290).

Numerous other roads connected San Antonio to Los Adaes and to La Bahía with branches to the abandoned settlement of Orcoquisac. The roads had forks extending from La Bahía past the Guadalupe and connecting with the San Antonio-Nacogdoches Road and the San Antonio-Orcoquisac Road. Other roads connected various abandoned presidios and missions and with other settlements in Louisiana (J. Jackson 1998:288–290). The map is not only illustrative of the region's decline, as reflected in the number of abandoned settlements that only increased by the time of the Mexican Revolution, but also demonstrates a level of infrastructure that emerged out of necessity, infrastructure that was both sponsored and maintained through use by Spanish citizens and by the Native American population. Unfortunately, the map shows no specific roadways or trails in the immediate project vicinity.

In the 1820s, during the flurry of Anglo settlement promoted under the Mexican Republic, existing trails became well-defined paths, and new trails connecting established colonies emerged. While most immigrants arrived in Texas via established Spanish roads, they created their own paths to the new municipalities and settlements they established (Canion 1936:31). Additionally, the immigrants transformed the existing Indian trails into wagon roads. The increased capacity of the former trails is exemplified by their representation on Stephen F. Austin's maps from the 1820s (Marshall 1934:26). Austin depicted five more roads than Puelles included on his map from the

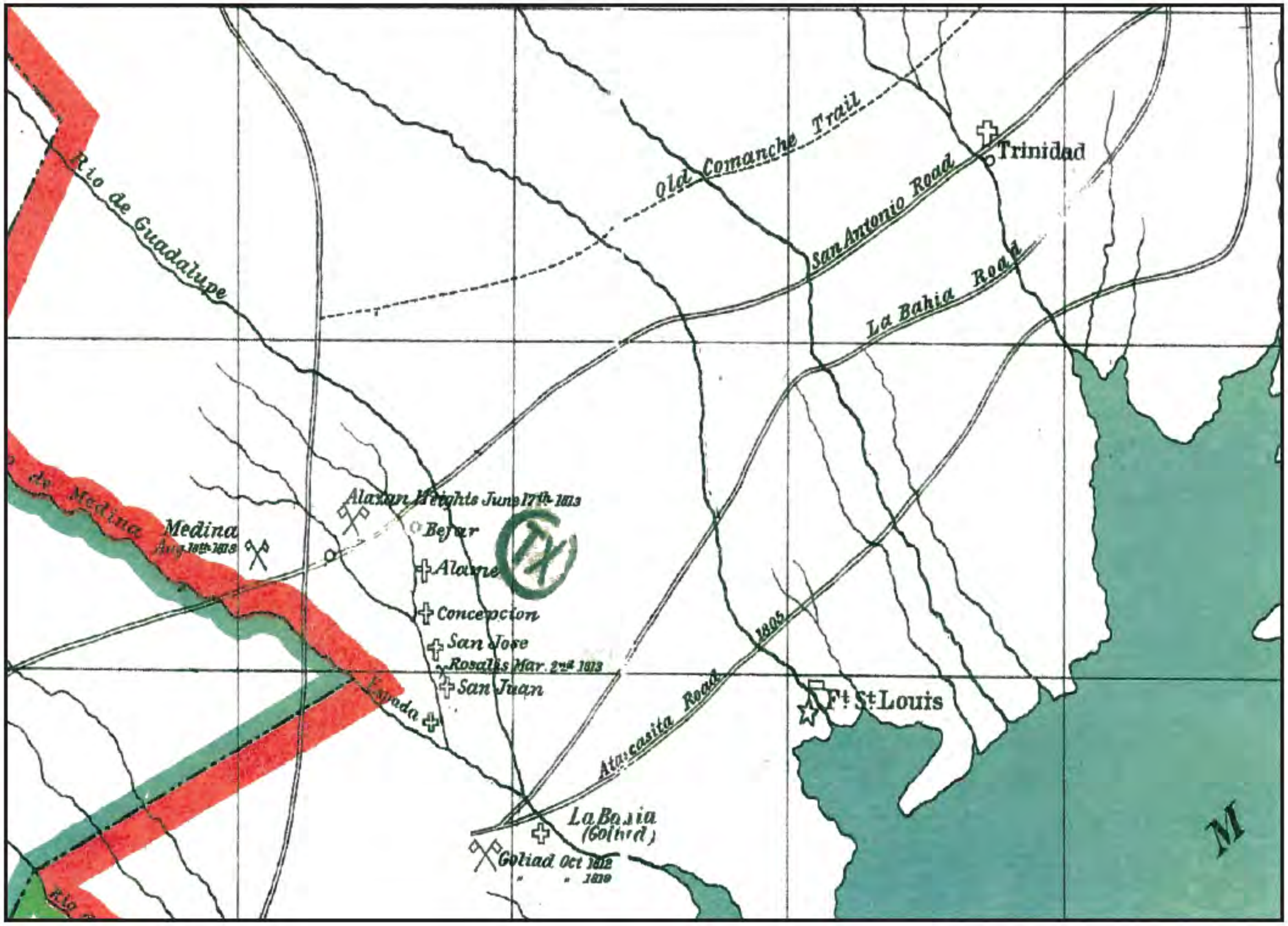

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Figure 23

From 1821
"Spanish Province of Texas..."
by Unknown Cartographer

Source: Adapted from copy or original on file in Saltillo Archives

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Drafted by: C. Wallace

previous decade, and their origins as Native American trails is supported by the fact that all led through or to established Indian villages (Marshall 1934:27–28). Though virtually impassable by today's standards, the importance of these roads during the period is exemplified by their use as the boundaries of all of the Anglo colonies approved by the Mexican government during the 1820s and early 1830s (Marshall 1934:54).

Despite the proliferation of new roads, established routes remained limited in both number and quality during the Republic era. In fact, sources suggest that the lack of viable circulation networks hindered economic development during this period. For example, early settlers in DeWitt's colony (which, as mentioned, contained site 41CW104) found that cultivation of cash crops (i.e., cotton) was not possible as there was no efficient means to get such crops to market. Even the main road (Camino Arriba) that bounded the colony to the north was no more than a path by today's standards and was impassable at times due to weather or threat of Native American attack. Additionally, they did not always offer the easiest route for travelers as they often contained extreme bends and turns to avoid "cane brakes and those parts of the forest where the timber was too thick to be easily cut through" (Marshall 1934:39). This lack of quality roads, which was lamented by colonists and Mexican officials alike, coupled with the lack of navigable rivers (Lukes 1976:105), discouraged concentrated settlement and economic diversity in the region throughout the antebellum period.

In 1830, the Mexican government passed what became the first "laws governing, or relating to the building or maintenance of roads in Texas." In general, officials sought to construct new wagon roads to facilitate increased trade and to connect new communities and settlements via an expanded road network (Canion 1936:34–35). Despite these positive intentions, another set of laws passed the same year effectively halted all government-sponsored infrastructure improvement projects in Texas. By 1830, Mexican officials had become wary of the new Anglo citizens (who numbered approximately 20,000 by that time) and of their intentions with regard to Texas sovereignty. As a result, they instituted laws restricting the development of infrastructure in the colonies (Canion 1936:35), among other prohibitions, and the development of new, designated roadways was generally put on hold until after the Texas Revolution.

During the Texas Republic era, a pattern of institutionalized roadway improvement and development began that continued generally unabated (with the exception of a brief decline during the Civil War) through the remainder of the nineteenth century. Officials sought to connect existing and new settlements, to facilitate trade, and to encourage settlement from outside of the province (Canion 1936:37). Roads and the implementation of mail routes followed settlements and forts as they expanded into previously "uninhabited" areas. Established roads often followed the paths of historic Indian trails or former Spanish roads, though many new roads emerged during this period as well. In 1844, Texas laid out the "Central National Highway" between San Antonio and Dallas, which continued to serve as a main travel artery after the region became part of the United States (Canion 1936:40, 46, 48–49).

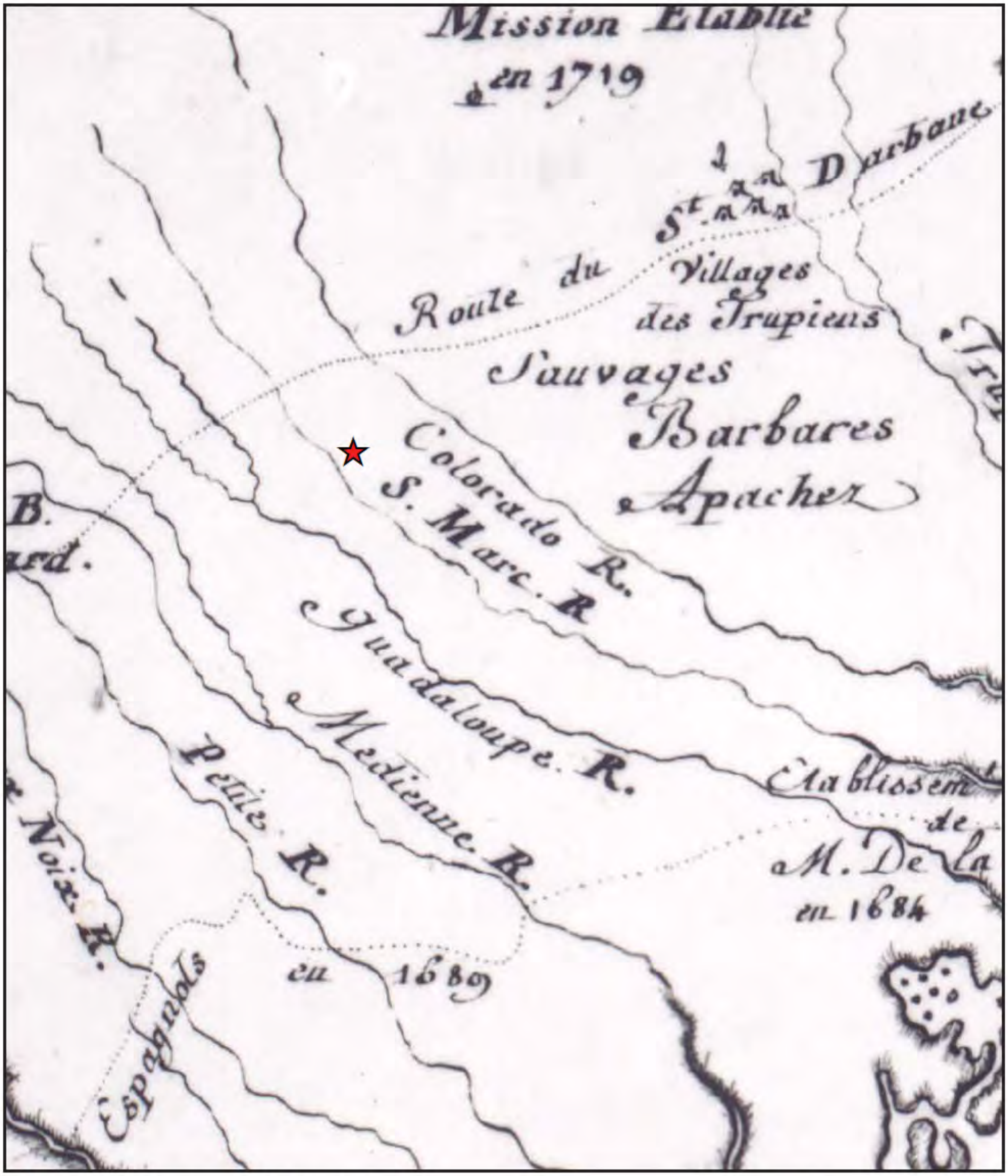
Developments during the postbellum period, including the foundation of major cattle trails through the region and the 1880 Travis County Commissioners Court authorization of the Austin-Lockhart Road (Canion 1936:71, 82), were particularly relevant to the project vicinity. Though development of an exhaustive narrative of roadway development in the region based on firsthand accounts and other primary sources is beyond the scope of this project, the following section includes information about specific developments and their effect on the landscape and character of the project area as discerned from historic maps and secondary sources. By the turn of the twentieth century, the project vicinity and much of the surrounding region was characterized by a complex network of roads linking individual residences and farmsteads to larger communities and markets. The advent of the railroad influenced the development of circulation networks in the project vicinity further as new communities like Luling developed and former settlements in the area, such as the historic farming community of Atlanta, disappeared (Smyrl 2011). Almost certainly some of the new roadways that appeared on contemporary maps from the period followed established or former trails and routes used by Native Americans or other early settlers.

Modern Roadways

Though various factors can impact the reliability of historic maps for tracing development patterns over time, particularly their age, the intentions of the cartographers, and the context of what they were trying to represent, reviewing maps of the project vicinity over time did provide some insight into the development of historic circulation networks in the area. In particular, historians identified when an extensive network of defined or charted roads emerged in the area and when the roads in the immediate vicinity of the site were constructed. For maps dating after the Texas Republic era, historians relied on images available in the THO (Foster et al. 2006).

As suggested by review of historic maps, established and charted roadways did not exist in the immediate project vicinity until the nineteenth century. Nevertheless, the first suggestion of trails or roads across the Texas interior appeared on published maps (reviewed by project historians) as early as 1718. In that year, Guillaume Delisle included the routes of French explorer and contraband trader St. Denis on his map entitled "*Carte de la Louisiane et du cours du Mississipi Dressee sur un grand nombre de Memoires entrau.*" The routes generally paralleled the *caminos reales,* as well as the paths of previous explorers across the region (see Figure 9). Similar maps depicting exploration routes followed in subsequent years (see examples from 1719 and 1720 on Figures 24 and 25). The 1728 map of Álvarez Barreiro was the first Spanish map to show charted roadways; however, like all Spanish cartographic achievements, it was not made available to other mapmakers or to the general public. Additionally, it only portrayed the designated or royal roads, which were located outside of the immediate project vicinity, and did not provide any insight into the development of secondary circulation networks in the area (Barreiro 1728).

The pattern of only including official roads and/or explorers' routes on maps of the Texas interior continued through the mid-eighteenth century when cartographers tended to copy or replicate old



★ Approximate Location of 41CW104

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Figure 24

From Fr. Sieur Beauvillier,
“La Louisiane et vue du
la Nouvell Orleans,” 1719

Source: Copy on file at the OLLU Old Spanish Missions Research Collection, San Antonio, Texas

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Drafted by: C. Wallace

★ Approximate Location of 41CW104

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Source: Copy on file at the OLLU Old Spanish Missions Research Collection, San Antonio, Texas

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Figure 25

Fr. Sieur Beauvillier, "Carte Nouvelle de la Partie de L'Ouest de la Province de la Louisiane sur las Observations du Bénard de la Harpe," 1720

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Drafted by: C. Wallace

map forms that included limited, erroneous, or out-of-date cultural information (i.e., the Alzate y Ramirez map of 1768). Even those maps that represented significant improvements in the cartographic depiction of the area did not include additional information about secondary travel networks in the region surrounding the project vicinity. For example, the maps Nicolás de Lafora and Joseph de Urrutia created during the Rivera inspections contained a significant amount of additional cultural and geographic information about the province as a whole (see Figure 8 for 1771 example). Nevertheless, vague suggestions of Native American presence in the region between the Guadalupe and Colorado Rivers are the only relevant cultural data related to the project vicinity (Lafora and Urrutia ca. 1768 and ca. 1771). Similarly the maps of Constansó and Mascaró from the 1770s (see example on Figure 14) provide a substantial amount of new information regarding stream crossings and fords in the Guadalupe/San Antonio river valleys but no additional data regarding roadways or other circulation networks in the project vicinity (Constansó and Mascaró ca. 1777 and ca. 1778) (see map research results summary for more-detailed information about these documents).

The unpublished map of Mariano Anglino (1788) represents an exception to this pattern. As discussed in the map research results section, this map includes a complex network of roads connecting various extant and abandoned settlements across the province (see portion of Pichardo's adaptation of the Anglino Map—Figure 15). Even so, the map does not depict any roadways or trails near the "unsettled" frontier of the project vicinity.

Around the turn of the nineteenth century, a flurry of mapping activity followed the United States's acquisition of the Louisiana territory in 1803. Though the Spanish and American responses to the resulting boundary question included increasingly accurate maps of the Texas interior, including those of Father José María Puelles (ca. 1801–1807) (see Figure 16 for example from ca. 1807), Juan Pedro Walker (1805), and Zebulon Pike (1810), none of those reviewed by historians provided any additional insight into existing trails or paths in use in the project vicinity during this period. This lack of detailed information regarding the region surrounding site 41CW104 changed dramatically after the Mexican Revolution as the Mexican government sought to secure its claims to Texas through promotion of settlement. The project area was included in one of the original Anglo-American colonies approved by the Mexican government during this period, and associated surveys of the area for land grant purposes resulted in production of numerous maps during the Mexican and Texas Republic periods that contained additional geographic and cultural details regarding the project vicinity.

Historians reviewed a variety of maps documenting transportation-related development during the period to determine the origins of the roads adjacent to and surrounding site 41CW104. Stephen F. Austin's published map of 1829 shows the Camino de Arriba, or Old San Antonio Road, located less than 20 miles north of Plum (Ciruela) Creek. There was also a road approximately 30 miles to the south connecting San Antonio, Gonzales, and Austin. Numerous other roads extended in various directions out of Austin and San Antonio, but there were no other roads in the immediate vicinity of the project area (Austin 1829).

By 1836, when an updated version of Austin's map was published in the United States, another road extended south of Gonsales [*sic*] and generally paralleled the Guadalupe River to the community of Victoria, but no other roadways had been constructed in the project vicinity (Austin 1836). A subsequent map, published in 1837, showed the same road network (Grovis 1837), but by 1839, another road north of the original road between San Antonio, Gonzales, and Austin had been designated connecting San Antonio, Seguin, and Columbus. This road was closer to but still outside of the immediate project vicinity (Hunt and Randel 1839). A series of maps from 1840 and 1841 depict additional settlement and community development in the Central Texas region, but no specific roadway development in the project vicinity (Arrowsmith 1841; Austin 1840; Valencia 1841).

Eight years later, in 1849, a German map created for use by German emigrants to the new American state of Texas portrayed numerous additional settlements along existing and newly constructed roadways. Of particular relevance to the project vicinity was the depiction of the location of the Battle of Plum Creek (identified as "Schlacht") and of a new road connecting Austin and Gonzales that crossed two branches of Plum Creek near the project vicinity (Figure 26) (Roemer 1849). By 1851, a published map identified the boundaries of Caldwell County as well as the new community of Lockhart. Lockhart was located along the Austin/Gonzales road, although the route itself is not illustrated on this particular map (Creuzbaur 1851). A subsequent Civil War–era map (1864) shows the Austin/Gonzales road as a trail extending through Lockhart and Austin (Figure 27). The map characterized the area as plentiful in supplies, particularly corn, cotton, and beef, and also showed a new trail extending east from Lockhart to LaGrange (Department of the Gulf 1864). In the years following the Civil War, a complex network of highways and farm-to-market roads emerged in the project vicinity.

A set of maps from 1867 demonstrates the rapid rate of road construction in the area during the immediate postbellum period (Figures 28 and 29). The first map, produced by the United States Engineers, depicts four roads radiating from Lockhart, leading northwest to Austin, northeast to Bastrop, generally east to La Grange, and southeast to Gonzales. This map, which is at better scale than those from previous decades, illustrates that none of the roads were located in the immediate project vicinity, though the road between Austin and Gonzales generally approached it (Holtz 1867). The second map, from the same year, shows two additional roads extending from Lockhart, one southwest through the project vicinity to the community of Prairie Lea, which was not depicted on the first map, and the second generally west to San Marcos (Pressler 1867). The Clear Fork and the West Fork of Plum Creek are identified on both maps.

A map from 1874 illustrates much the same road network as the Pressler map. The main difference is the appearance of the railroad crossing the southern end of the county (Mittendorfer 1874). After

★ Site 41CW104 (Approximate Location)

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1. The historic map images(s) were digitally enhanced as part of the Texas Historic Overlay (THO) project, Texas Dept. of Transportation, Environmental Affairs Division, November 2006.

2. The source map image was obtained from the Texas State Library & Archives Commission, Austin, Texas.

3. TOPOGRAPHISCH-GEOGNOSTISCHE KARTE VON TEXAS Map. Dr. Ferd Roemer, 1849.

0 6.25 12.5 25
Miles

ATKINS

Figure 26

Dr. Ferd Roemer, Topographisch-Geognostische Karte von Texas, 1849

Prepared By 19910	Scale 1" 25 Miles
Job No. 100022694	Date 21 Jan 2013

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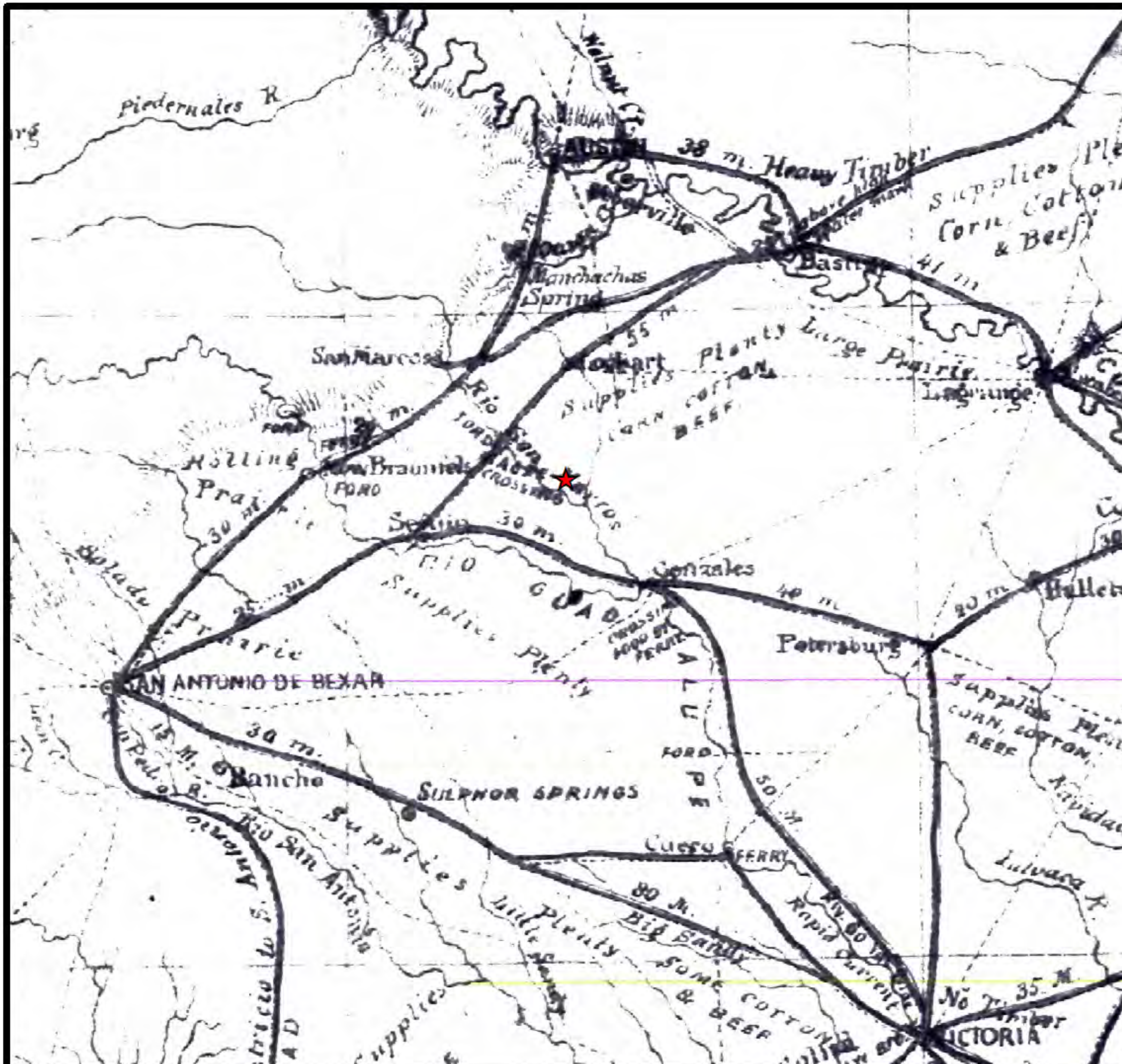

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2. The source map image was obtained from the Victoria College, Local History Collection, Victoria, Texas.

3. DEPARTMENT OF THE GULF MAP NO. 14 EASTERN AND CENTRAL TEXAS
Map. Unknown Author, 1864.

0 3.75 7.5 15
Miles

ATKINS

Figure 27

Department of the Gulf Map No. 14, Map of Eastern and Central Texas, 1864

Prepared By 19910	Scale 1" 15 Miles
Job No. 100022694	Date 21 Jan 2013

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★ Site 41CW104 (Approximate Location)

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2. The source map image was obtained from the Library of Congress Geography and Map Division, Washington, D.C.

3. MAP OF THE STATE OF TEXAS
Map. Helmuth Holtz, 1867.

0 2 4 8
Miles

ATKINS

Figure 28
Helmuth Holtz, Map of the State of Texas, 1867

Prepared By 19910	Scale 1" 8 Miles
Job No. 100022694	Date 21 Jan 2013

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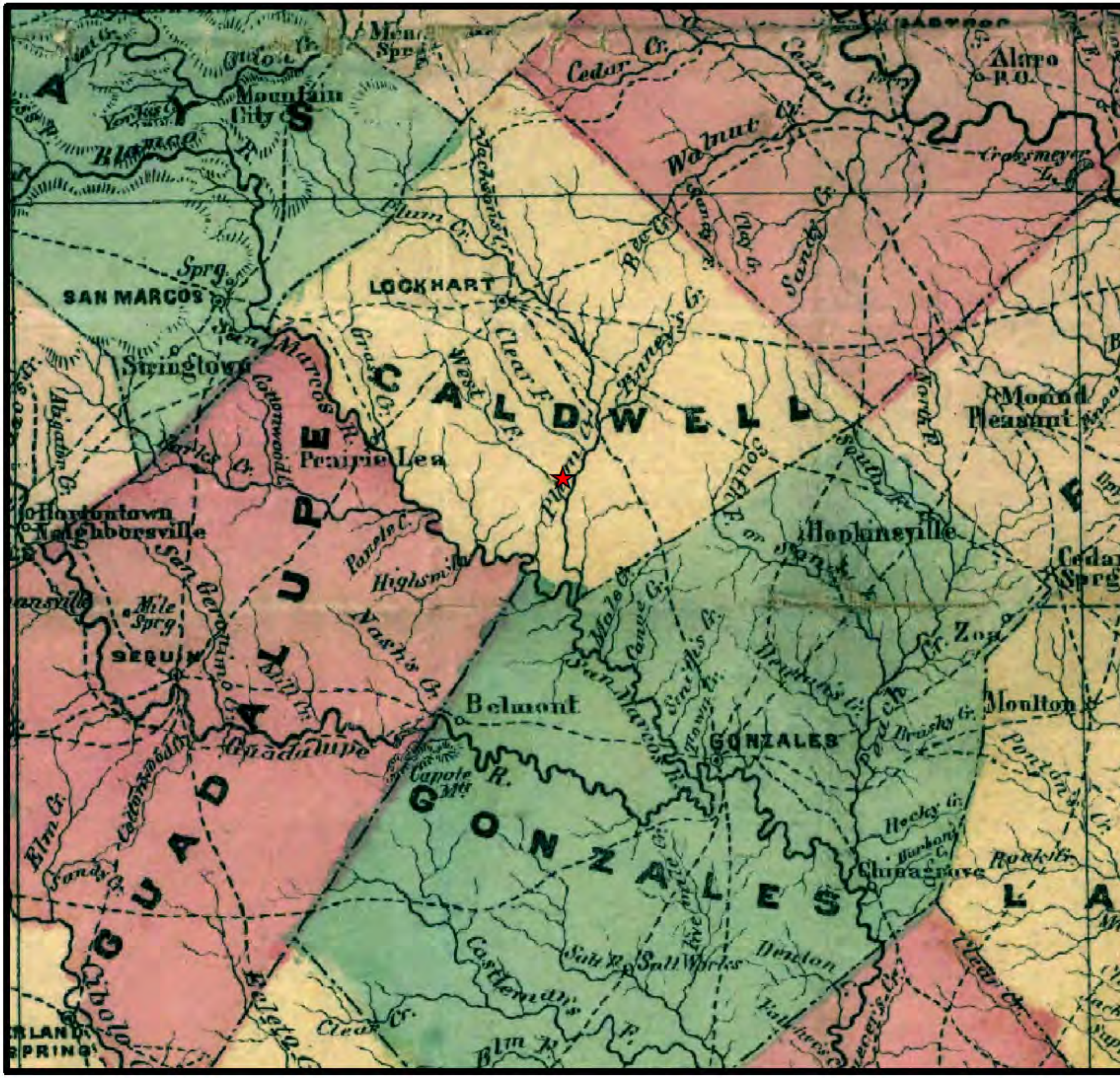

★ Site 41CW104 (Approximate Location)

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2. The source map image was obtained from the Texas State Library & Archives Commission, Austin, Texas.

3. TRAVELLER'S MAP OF THE STATE OF TEXAS Map. Chas. W. Pressler, 1867.

0 2 4 8 Miles

ATKINS

Figure 29

Chas. W. Pressler, Traveler's Map of the State of Texas, 1867

Prepared By 19910	Scale 1" 8 Miles
Job No. 100022694	Date 21 Jan 2013

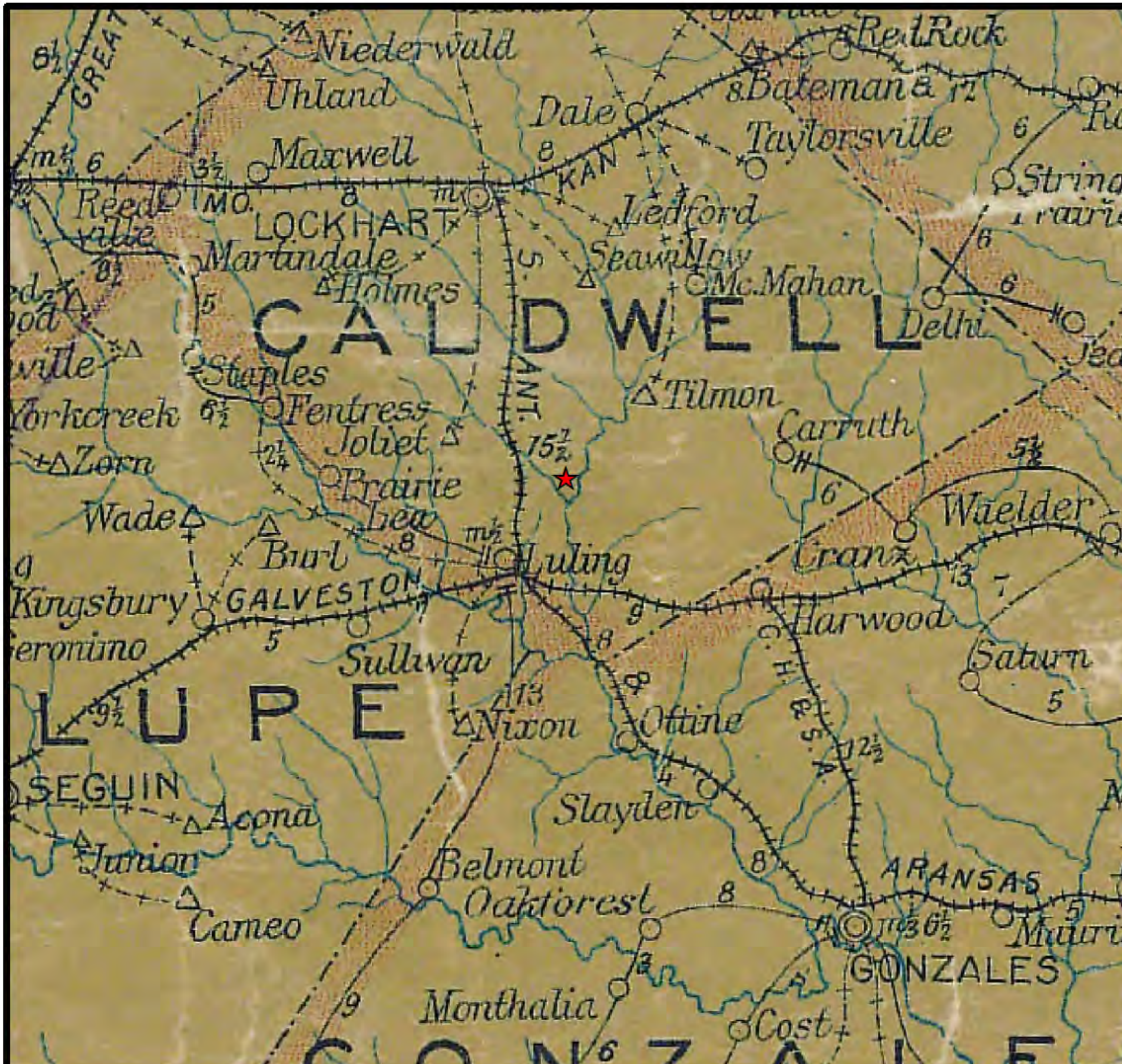
N:\Clients\S_T\TxDOT\10002269 \geo\figs\29_map_Tex_1867_pressler_8x11.mxd the mid to late nineteenth century, settlement in the project vicinity slowed down dramatically. As a result, maps of the area were made less frequently. The next map reviewed by project historians was a post route map from 1907. The map depicts a post road extending south from Lockhart to the nearby community of Joilet. A railroad track had also been constructed paralleling the route, which connected Lockhart and the relatively new community of Luling that developed as a rail stop in the postbellum period. Both the post road and the railroad crossed Plum Creek in the project vicinity (Figure 30; Haake 1907).

By 1911, the project vicinity was crossed by numerous private and farm-to-market roads (Figure 31). One in particular paralleled the West Fork of Plum Creek and connected to the road between Lockhart and Luling. This road paralleled the San Antonio and Aransas Pass Railroad. Road development at this time appeared haphazard as they avoided geographic barriers rather than taking the most direct route to destinations. Additionally, many were unpaved and were likely created by the individual residents who used them to access their property and to bring goods to market (USGS 1911).

By 1929, the local road network had been streamlined significantly. This was due in large part to the founding of the Texas Highway Department in 1917. From its inception, the agency worked to standardize road construction methods and to eliminate routes not conducive to automobile traffic (Canion 1936:101). At this time, the project area was surrounded predominantly by paved roads, several of which paralleled or approximated the routes of the highways and farm roads located in the area at present (USGS 1929).

By 1936, the discovery of oil in the region and the increased settlement it prompted served as the impetus for a series of significant highway improvements. The old Austin to Lockhart highway was extended and became part of SH 29. An unidentified farm-to-market road adjacent to SH 29 generally followed the route of US 183, which was constructed through the area in the 1950s. Additionally, what is now FM 86 located adjacent to site 41CW104 appears on the 1940 Caldwell County Highway map (updated from 1936) (Figure 32) (Texas State Highway Department 1940). According to TxDOT's highway designation files, this route was called SH 311 at the time and was replaced by FM 86 in 1943 (TxDOT Highway Designation Files, Farm to Market Road No. 86). The original highway had been constructed ca. 1939 (TxDOT Highway Designation Files, State Highway No. 311). A highway map from 1961 (updated from 1958) depicts the road network much as it is at present. Newly constructed US 183 had replaced the old farm to market road previously located in the area, and FM 86 was identified as a major thoroughfare with bridges existing at the current site location (Figure 33) (Texas State Highway Department 1961).

Overall, map research provided little evidence of specific road construction in the project vicinity until 1849, after Texas joined the United States. That is not to say that Native American groups and early settlers did not create or use existing trails in the area but rather that they were not considered significant enough to warrant cartographic documentation (i.e., those routes used by



★ Site 41CW104 (Approximate Location)

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1. The historic map images(s) were digitally enhanced as part of the Texas Historic Overlay (THO) project, Texas Dept. of Transportation, Environmental Affairs Division, November 2006.

2. The source map image was obtained from the Texas General Land Office, Austin, Texas.

3. POST ROUTE MAP OF THE STATE OF TEXAS Map. A. Von Haake, 1907.

0 1.25 2.5 5
Miles

ATKINS

Figure 30

A. Von Haake's Post Route Map of the State of Texas, 1907

Prepared By 19910	Scale 1" 5 Miles
Job No. 100022694	Date 21 Jan 2013

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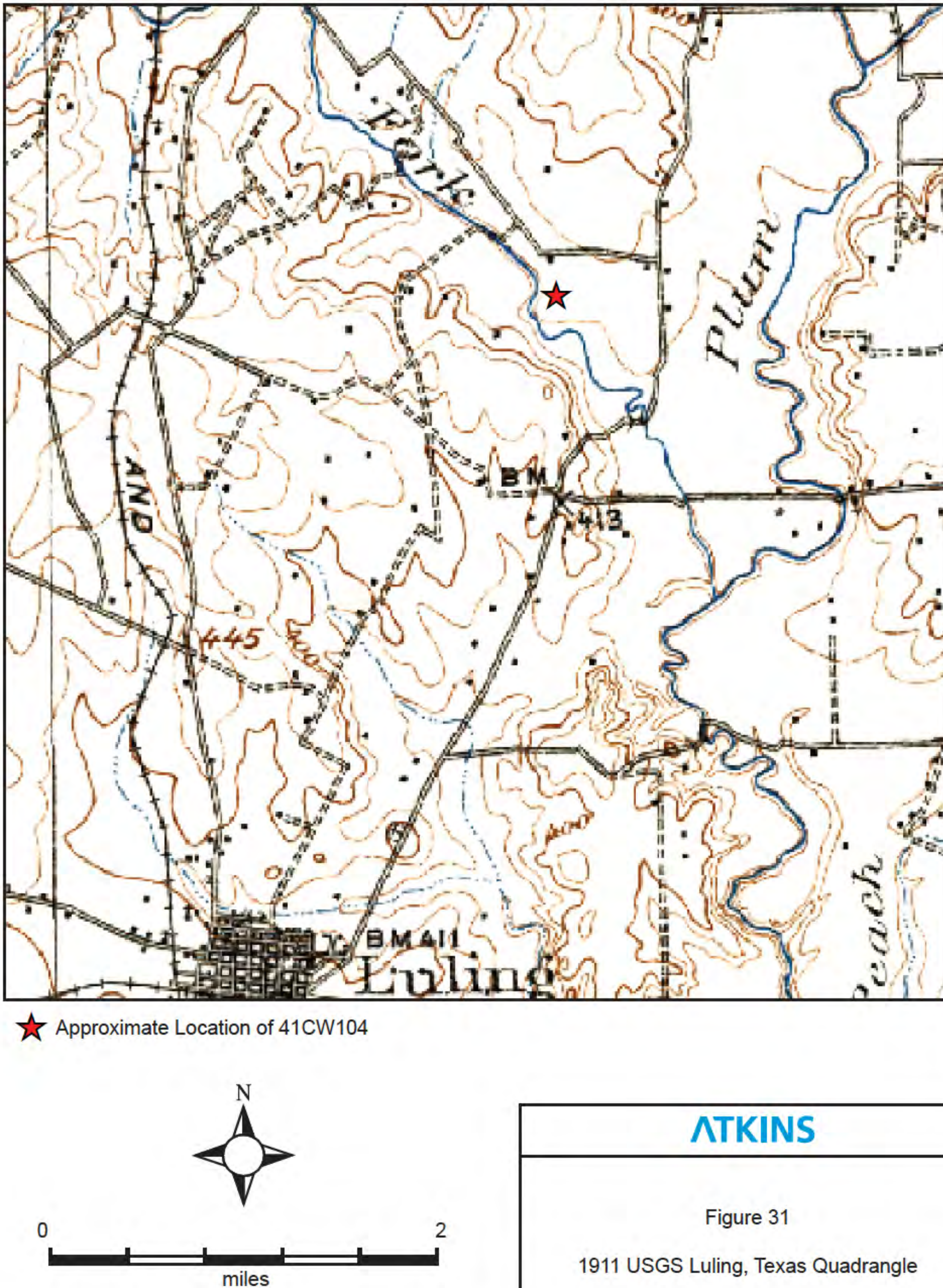

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Figure 31

1911 USGS Luling, Texas Quadrangle

Source: Texas Historic Overlay

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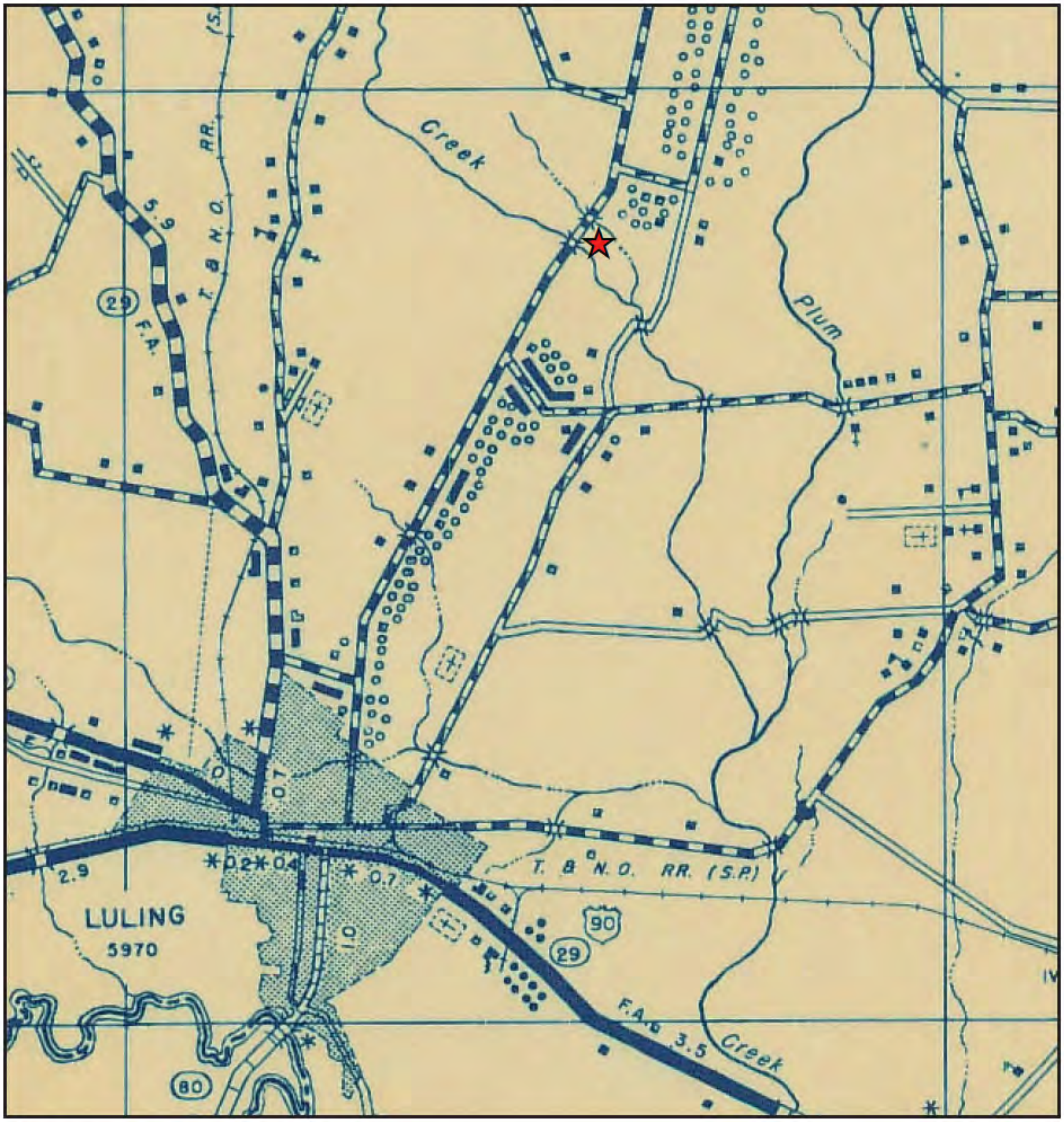
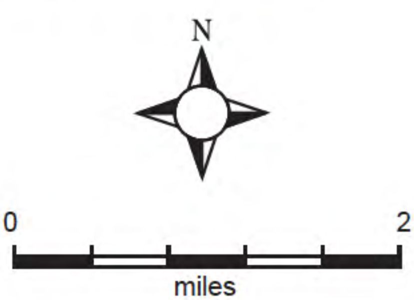
Drafted by: C. Wallace



★ Approximate Location of 41CW104



ATKINS

Figure 32

General Highway Map,
Caldwell County, Texas, 1940

Source: Map No. 4809, Texas State Library and Archives Commission

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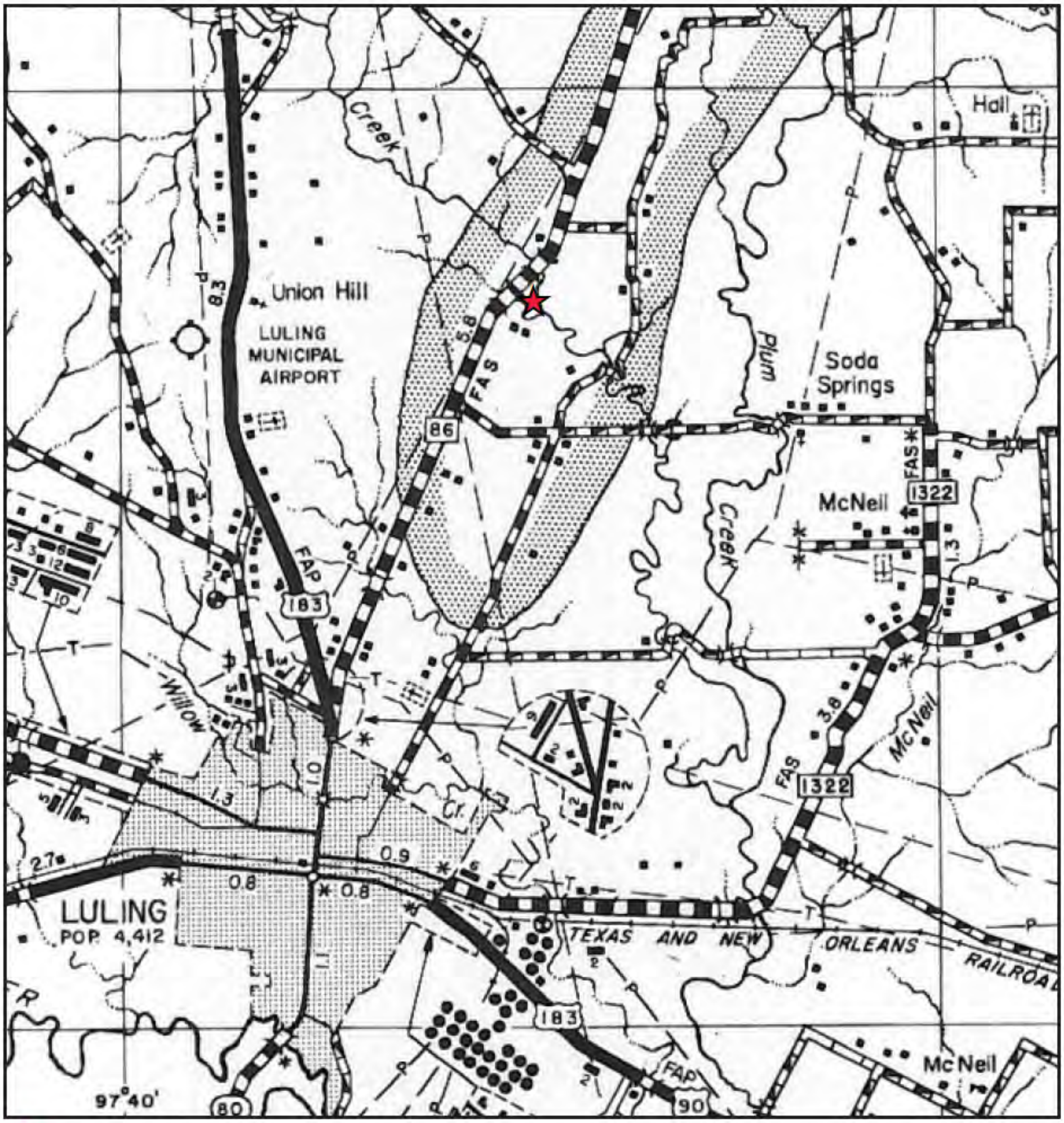
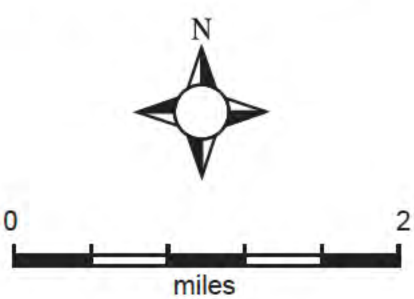
Drafted by: C. Wallace



Approximate Location of 41CW104



ATKINS

Figure 33

General Highway Map,
Caldwell County, Texas, 1961

Source: Map No. 5072, Texas State Library and Archives Commission

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Drafted by: C. Wallace

the influx of immigrants settling the area during the period). After 1849, concentrated community, agricultural, and transportation-related development continued in the region through the mid-twentieth century. New settlers and farmers would have taken advantage of the availability of existing trails, and the documented history of Native American groups in the region suggests they likely existed. Additionally, the existence of the Camino Arriba north of the project vicinity suggests travelers, settlers, or wandering tribal groups could have easily accessed the area by using or creating paths along watercourses such as Plum Creek that approached the main trail.

SUMMARY

Intrasite Analysis

Comparisons were made among the artifact assemblage at 41CW104 and a number of other Late Prehistoric and Early Historic period sites in the region, most of which have received extensive investigation. While in general these sites had substantially greater numbers of artifacts and represented intensive occupations, all of them appeared to have some characteristics in common with 41CW104. Most apparent among all of the sites is the similarity in the ceramic assemblages, which shows a general affinity to ceramic traditions of the Inland Coastal Plain of Texas.

Late Prehistoric and Early Historic Period Sites within 50 km of 41CW104

The purposes of this study were to (1) identify archeological sites of similar age to the Santa Maria Creek site within a distance of approximately 50 km, and (2) record selected characteristics of the physical environment at each site. The State Archeological Atlas was searched by quad map for all Late Prehistoric to Early Historic period sites within 50 km of the Santa Maria Creek site. A total of 63 archeological sites (including 41CW104) containing Late Prehistoric components were identified within an approximate 50-km radius of 41CW104. This total includes 13 sites in Bastrop County, 11 in Gonzales County, 10 in Hays County, 8 in Guadalupe County, 8 in Travis County, 4 in Caldwell County, 4 in DeWitt County, 3 in Fayette County, and 1 each in Wilson and Comal Counties. The site types found in the search are divided into four basic types: encampments (7), campsites (44), campsites/quarries (5), and lithic scatters (6).

Within the approximate 50-km area chosen for archeological review, there are three ecoregions. These are Edwards Plateau, Texas Blackland Prairies, and the East Central Texas Plains. A total of 15 sites were recorded within the Edwards Plateau Ecoregion, 21 sites were recorded in the Texas Blackland Prairies Ecoregion, and 26 sites were recorded within the East Central Texas Plains Ecoregion.

Geologic units include those of Cretaceous, Eocene, Miocene, and Quaternary ages. The majority (60 percent) of the recorded sites occurred in Quaternary deposits. It is in the alluvial deposits of Quaternary age that buried archeological deposits typically occur.

There are 28 soil series present at the archeological sites within the 50-km study area. Five soil orders are represented: Alfisols (38 percent), Mollisols (40 percent), Vertisols (17 percent), Inceptisols (4 percent), and Entisols (1 percent).

The stream orders within the 50-km study area ranged from 1 to 7. Stream orders of 1 were the headwaters and tributaries to the named streams. Twelve sites occurred along these streams. Named creeks were generally a stream order of 2. Twenty sites were recorded along these streams. The smaller rivers (Blanco, San Marcos, and Guadalupe) have stream ranks up to 4, and 22 sites were found there. Finally, the Colorado River has a stream rank of 7, and 9 sites were found along it.

Historic Indians

Research into addressing the relevant native groups in the region identified numerous peoples. This list includes indigenous groups, several groups of Coahuiltecan speakers displaced northward by the Spanish, as well as peoples displaced southward by the Apache. Much of these data was accrued during the Spanish expeditions between 1691 and 1727.

Spanish Expeditions, 1691–1727

The diaries and journals kept during the Spanish expeditions to east Texas during the late seventeenth and early eighteenth centuries provide valuable information on a host of topics relevant to the occupations at 41CW104. Particular attention was paid to these accounts as they passed the vicinity of the site. Identifications of native peoples, plants, animals, and the geography of the traversed lands afford an exceptional glimpse into an environment that has since been greatly altered by man.

One of the most telling revelations of the diaries is the scarcity of indigenous peoples residing in the area. When native groups were encountered, they were typically traversing the area for either trade, as exemplified by the 2,000–3,000 Jumano, Cibolo, Casqueza, Choma, Cantona, and Mandones encountered by Alarcón near the Guadalupe River in 1691, or the defensive villages of amalgamated bands of *ranchería* Indians found on the Colorado River by Espinosa-Olivares-Aguirre in 1709. Clearly, by the time of the expeditions, the effects of cultural displacement were well established in the area. Occasionally, small groups of peoples, such as the Mayeye recorded on Barriento’s map of the Rivera Expedition of 1727, were encountered.

Map Research

The project historian reviewed map resources at various repositories in an attempt to identify any documents that might portray historic trails and traces and/or provide information about native peoples associated with the general project vicinity. The sources reviewed dated from the 1520s through the 1840s and spanned three distinct periods of map production. Those from what has been termed the Primary period, which extended from the initiation of European exploration in

Texas through the last decade of the seventeenth century, are characterized by their lack of detail and general inaccuracy. They were based on the accounts of explorers who had only a limited knowledge of how to measure their geographic location and were often replicated by numerous cartographers "with degenerating accuracy and detail" (Martin and Martin 1982:9). Overall, none of the published maps from this period provided any new information regarding settlement patterns in the vicinity of 41CW104 during the period of first contact. In general, the Texas interior remained uncharted and unexplored between the early expeditions of the 1520s and subsequent explorations during the last decade of the seventeenth century.

Maps from the Secondary period (circa 1700–1820) constituted the most sizable portion of the archival record. In total, historians reviewed 57 maps from the secondary period that cover the area containing the current project vicinity. Despite the prolific cartographic production during this period and the increasing accuracy of the representations, the project vicinity's isolation from the direct routes of historic expeditions, from the historic roadways that often but not always followed their paths, and from designated presidio and mission locations meant that it received little attention from Spanish or other European or American cartographers during the eighteenth and early nineteenth centuries. Nevertheless, select maps suggest the area between the Guadalupe, San Marcos, and Colorado Rivers was traversed by various tribal groups during the period of exploration and colonial expansion. In addition to cultural data, the map research from this period also helped locate 41CW104 in relation to known/designated historic roadways. Although none immediately approached the subject site, its general proximity to the *caminos reales* suggests that it was located relatively close to a regularly traversed area during the protohistoric period.

Finally, historians reviewed maps from the early part of the Third period of Texas cartography (ca. 1820–1840s). This period represented the first time the project area was mapped in detail, principally due to its location within one of Texas's original *empresario* colonies. Despite the increased accuracy of mapping during this period, their purpose as tools of settlement rather than as records of exploration meant that they generally provided more-accurate representations of local watercourses and landforms rather than additional cultural information. As a result, they offered little insight into previous occupations, historic trails, or other circulation routes within the project vicinity.

Historic Roads

The project historian used historic maps and secondary sources to trace the development of historic trails and roadways in the project vicinity. As a result of this research, the project historian was able to identify when an extensive network of defined or charted roads emerged in the area and when the roads in the immediate vicinity of 41CW104 were constructed. In general, defined and charted roadways did not exist in the immediate project vicinity until the nineteenth century. During the eighteenth century, cartographers typically included only official roads and/or explorers' routes on maps of the Texas interior. Even those maps representing exceptions to this pattern, such as the unpublished map of Mariano Anglino from 1788, did not depict any roadways or trails near the project vicinity. In general, concentrated development of charted roads in the area began during the Republic and early Statehood periods. The turning point as represented in the cartographic record was post-1849 when concentrated community, agricultural, and transportation-related development began and continued unabated through the twentieth century. Nevertheless, mid-nineteenth-century settlers likely took advantage of existing trails, and the documented history of Native American groups in the region supports their existence. Additionally, the existence of the Camino Arriba north of the project vicinity suggests travelers, settlers, or wandering tribal groups could have easily accessed the area by using or creating paths along watercourses such as Plum Creek that approached the main trail.

4

SITE HISTORY

by Robert Rogers and Boyd Dixon, Ph.D.

INITIAL SITE RECORDING

Site 41CW104 was recorded by Atkins in 2006 during a cultural resources survey for proposed improvements to FM 86 (Farabough 2006). During the survey, 10 shovel tests and three backhoe trenches were excavated in the floodplain of the West Fork of Plum Creek. Trenching revealed that alluvial deposits occur within a portion of the site that appeared to contain intact prehistoric cultural materials. The lack of a concentration of artifacts, which were distributed throughout the vertical column from Level 1 to 6, suggested some cycling might have occurred as a result of flooding events, floral and faunal bioturbation, or historic to modern land clearing. Backhoe trenching was also conducted in the floodplain south of the site during the survey but produced negative results (Farabough 2006). This area contains frequently flooded alluvium.

The fairly consistent depth of sandy loam soils and cultural materials suggested that while the site had undergone significant cycling, it probably had not been heavily impacted by erosion. NRHP testing was therefore recommended by Atkins and TxDOT ENV since the site might harbor interpretable data regarding the horizontal distribution of prehistoric artifacts.

NRHP TESTING

Between December 18, 2006, and January 9, 2007, Atkins conducted NRHP eligibility testing at 41CW104 under contract to the TxDOT ENV. The APE consisted of a portion of the newly proposed 50-ft (15.2-m)-wide highway ROW situated near an intermittent tributary of the West Fork of Plum Creek. The portion of the ROW found to contain prehistoric remains consists of a strip measuring approximately 50 ft (15 m) in width east-west by 394 ft (120 m) in length north-south, covering 19,368 ft^2 (1,800 m^2) on the east side of SH 86.

The primary goals of the NRHP testing at 41CW104 were presented in a written scope of work submitted to TxDOT and concurred with by the THC, in reference to the fulfillment of Antiquities Permit No. 4363. These goals were related directly to evaluating NRHP eligibility under Criterion D in 36 CFR 60.4 and equivalent criteria under 13 TAC 26.8, including to (1) assess the age and extent of cultural deposits at the site; (2) assess the potential for the site to contain buried prehistoric features with intact faunal or floral remains; (3) assess the effect of proposed construction on the site, if it is found to be eligible for listing in the NRHP or designation as a State Archeological

Landmark (SAL); and (4) if eligible, to provide site-specific recommendations for mitigation of adverse impact to the site with the proposed ROW.

RESEARCH METHODS

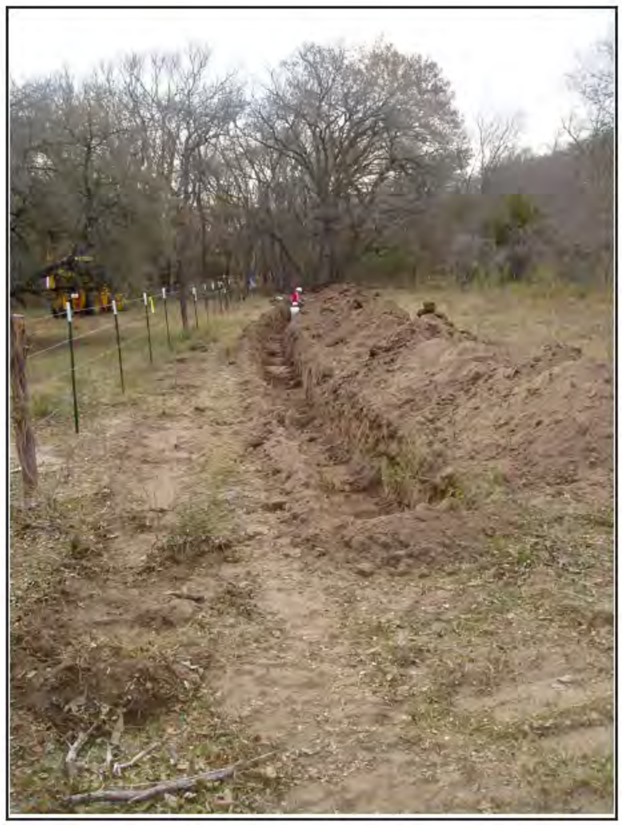
The research methods undertaken to accomplish the above goals were to be implemented in five phases: (1) detailed inspection and mapping of the site with the establishment of a metric grid system, (2) mechanical excavation of up to 100 linear meters of backhoe trench to delimit the horizontal and vertical extent of the site, (3) controlled excavation and geoarcheological characterization of at least four 1-x-1-m test units near intact cultural deposits encountered during trenching, (4) mechanical scraping of up to 100 m^2 in areas that yielded evidence of cultural deposits and increased artifact density, and (5) controlled excavation of features within areas exposed by mechanical scraping. Up to an additional 1.5 m^3 of hand excavation was also authorized by TxDOT ENV in the event that further testing might have the potential to contribute to the evaluation of the site for listing in the NRHP.

To initiate NRHP testing, the site surface was first inspected for cultural remains, after which a metric grid system was established and the site was mapped with pertinent details, including terrace edge, blocks of dense vegetation, and existing TxDOT highway datums. The site was then investigated by the mechanical excavation of two trenches totaling approximately 85 linear meters oriented roughly parallel to the long axis of the ROW (Figure 34). Soil was removed by backhoe with a flat-bladed bucket in shallow layers of approximately 10 cm or less until buried features, intact cultural deposits, or sterile subsoil were encountered. Trenching was terminated after encountering culturally sterile gravel deposits on top of clay subsoil.

Four 1-x-1-m test units (TUs) were then hand excavated in two areas found to contain relatively dense buried cultural deposits: TUs 1, 3, and 4 located approximately 40 m north of the relict channel west of Trench 1, and TU 2 located farther upslope west of Trench 2 (Figure 35). The units were excavated in 10-cm levels, and the soil was screened through ¼-inch wire mesh hardware cloth.

Preliminary examination of the cultural remains found in TU 1 through TU 4 indicated a large amount of fire-cracked rocks, which based on their size and fractures, were suggestive of stone boiling. Interestingly, the stone at 41CW104 is chert, and the use of this rock type for stone boiling is poorly represented in the archeological record (Black et al. 1998; Blackwelder 1926; Brink and Dawe 1996; Jones 1981; Lorrain 1972; Quigg 2003). To further explore these findings, three 4-x-5-m areas totaling approximately 60 m^2 located west of the backhoe trench were mechanically scraped. During the scraping, soil was carefully removed in thin layers of approximately 10 cm or less to expose buried features or intact cultural deposits. Profiles, plans, and soil samples from two burned rock features were found in Scraped Areas 2 and 3, and one mammal bone was found in Scraped Area 1.

a) Recording of Profile 1, facing south.



b) Gravel deposit on clay subsoil in north end of trench, facing north.

ATKINS

Figure 34

NRHP Testing Backhoe Trench

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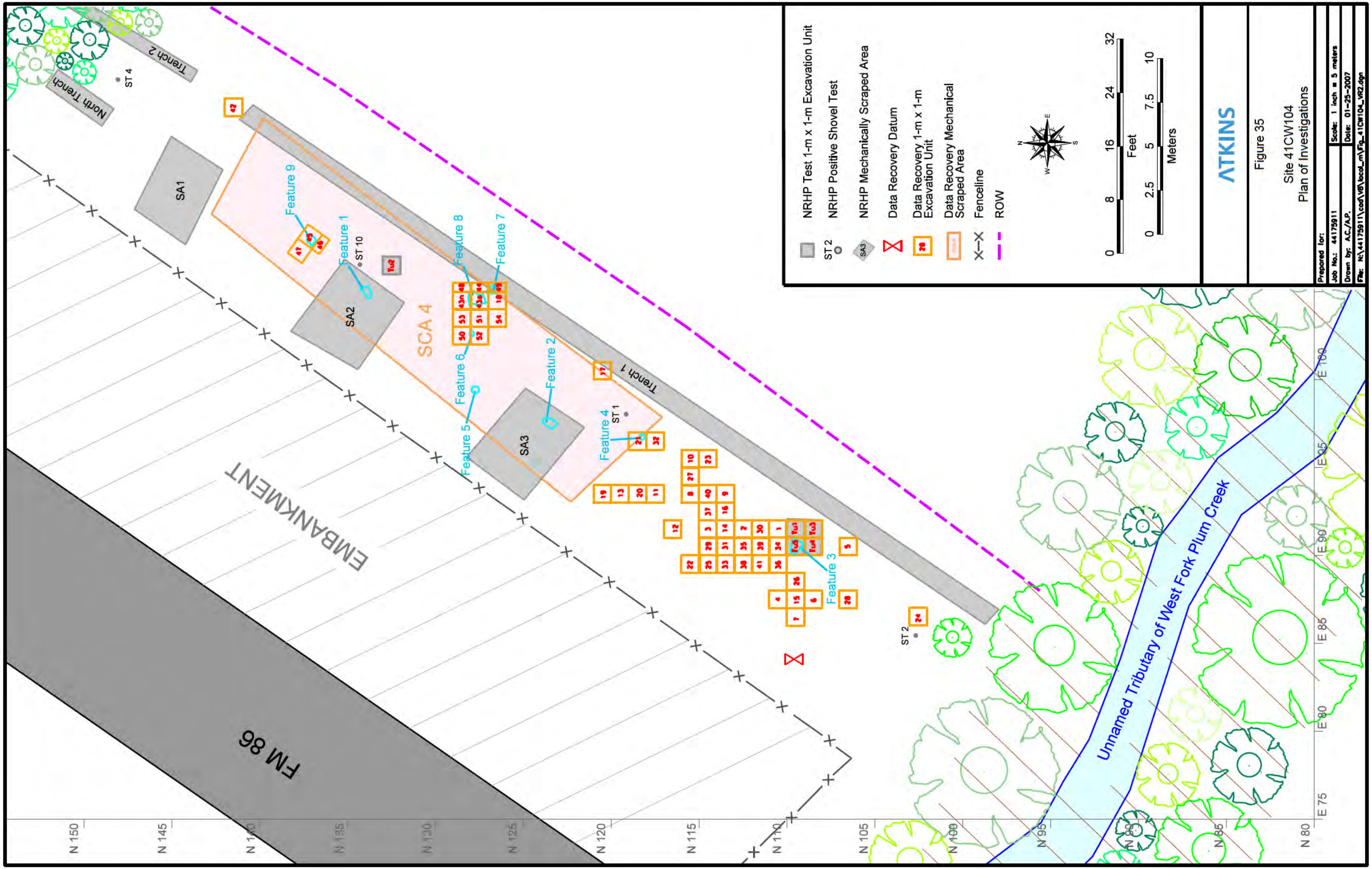
Drafted by: C. Wallace

Given the presence of intact features in the two mechanically scraped areas and the large amount of TAR believed to be associated with prehistoric subsistence practices, in particular stone boiling, observed in TUs 1, 3, and 4, an additional 1.5 m^3 of hand excavation was authorized by TxDOT to resolve outstanding issues affecting NRHP or SAL eligibility. This entailed the excavation of an additional test unit (TU 5) adjacent to TUs 1, 3, and 4, creating a 2-x-2-m block with the four units (see Figure 35). All test units and mechanically excavated areas were backfilled at the end of fieldwork.

Approximately 4,000 prehistoric artifacts were collected during testing at 41CW104 including 1,850 lithics (1,802 nontools and 48 tools), 2,058 pieces of fire-cracked rocks, 10 faunal bone fragments, and 1 undecorated bone-tempered ceramic sherd In addition, 38 pieces of glass, 11 metal fragments, and 27.8 grams (g) of botanical charcoal samples were recovered. Lithic tools include 1 Ensor dart point, 1 Clear Fork uniface, 2 scrapers, 1 planer, 4 indeterminate bifacial tools, and 38 flake tools. Identifiable faunal remains from the assemblage consist of one large mammal bone (TU 1, Level 5) and one metapodial fragment from an immature bovid (Scraped Area 1, 30 cmbs).

Eleven charcoal samples were collected during testing totaling 27.8 g; six of these were submitted for AMS radiocarbon dating. The six samples were recovered from TUs 1, 3, 4, and 5, from depths of 20 to 55 cmbs.

Site 41CW104 was recommended for listing in the NRHP under Criterion D. Further investigation was recommended at the site in order to mitigate the negative effects of proposed highway construction.



NRHP Test 1-m x 1-m Excavation Unit
NRHP Positive Shovel Test
NRHP Mechanically Scraped Area
Data Recovery Datum
Data Recovery 1-m x 1-m Excavation Unit
Data Recovery Mechanical Scraped Area
Fenceline
ROW
Feet
Meters
ATKINS
Figure 35
Site 41CW104
Plan of Investigations
Prepared for:
Job No.: 44175911
Drawn by: A.C./A.P.
Scale: 1 inch = 5 meters
Date: 01-25-2007
SCA 4
SA1
SA2
SA3
Trench 1
Trench 2
North Trench
Feature 1
Feature 2
Feature 3
Feature 4
Feature 5
Feature 6
Feature 7
Feature 8
Feature 9
ST 1
ST 2
ST 4
ST 10
EMBANKMENT
FM 86
Unnamed Tributary of West Fork Plum Creek

5

METHODS

by Julie Shipp

FIELD METHODS

Data recovery began with the reestablishment of a cruciform metric grid system at the site using a total data station (TDS). Datums were fixed to record all cultural deposits vertically and horizontally. The TDS was also used to collect data to compose a detailed map of the site showing current ground surface, location of excavation units and blocks, the depth of the buried anthropogenic zone, the clay surface at the bottom of excavation, location of mechanical scraping, and feature locations (see Figure 35).

Hand excavation units of 1 x 1 m were spaced along the cruciform in a checkerboard fashion and left open at the top of the Ab soil horizon in an attempt to locate artifact concentrations or features. Most of these data recovery units were later connected to form a block and excavated to sterile clay subsoil (see Figure 3). Excavation was conducted in 10-cm levels and screened through ¼-inch mesh. A total of 42 units, or 30 m^3, was excavated initially. Flotation samples were collected from the southeast corner of each level in every fifth excavation unit.

A number of samples were collected from the excavation units that were intended to help address research topics related to subsistence and site formation, and to assess chronology. These included radiocarbon dating, fatty acid analysis, magnetic susceptibility, particle-size analysis, and soil micromorphology.

In addition to the hand excavations, a 230-m^2 area was mechanically scraped in an attempt to locate cultural features in addition to the three features excavated during NRHP testing. Five burned rock features were located during the scraping (see Chapter 9). After consultation with TxDOT, 4 additional cubic meters were excavated around four of these features in Units 43–54.

Finally, metal detecting was also carried out across the site in an attempt to locate historic artifacts. While the detecting succeeded in locating some barbed wire, no historic artifacts were found that can be associated with the aboriginal occupations. A few additional modern metal items were also recovered from the upper 20–30 cm during the hand excavations.

ARTIFACT PROCESSING

Upon arrival at the Atkins Archeological Laboratory, all recovered cultural remains were sorted, labeled, and catalogued by provenience. During processing, inorganic remains were washed in distilled water. Lithic specimens larger than 2.5 cm were labeled. Organic remains were dry-brushed. Charcoal samples were brushed and weighed. All flotation and OSL samples were cataloged and processed.

All analyses of recovered artifacts were performed by qualified Atkins analysts according to the project treatment plan. Methods employed under each artifact category are detailed in each individual chapter. The specimen inventory appears in Appendix B.

Flotation samples were collected from both feature and nonfeature contexts at 41CW104. Samples were processed in the Atkins laboratory using a Flote-Tech flotation device in order to retrieve organic remains and artifacts smaller than 1/16 inch in size. Samples of both heavy and light fraction remains were bagged and submitted for macrobotanical analysis.

Charred botanical specimens recovered in the excavation screens were collected in foil pouches for potential radiocarbon dating and species identification. Samples were inventoried in the Atkins laboratory, and select samples were submitted to Dr. Leslie Bush at Macrobotanical Analysis of Austin, Texas, for species identification.

CURATION

The following materials will be curated at Texas State University in San Marcos, Texas: lithic materials, prehistoric ceramics, burned clay, faunal, botanical charcoal samples (excluding those specimens submitted for radiocarbon dating), ochre, and project documents, including original field forms. The following materials will not be curated: all TAR and all collected natural materials.

SPECIAL STUDIES

Macrobotanical Analysis

Identifying seeds, bulbs, and other plant parts that are extracted from the soil collected at 41CW104 can provide information as to what plants were available and likely exploited at the site. Carbonized plant remains are more-refined indicators of cooked foods and fuel resources. Samples recovered during testing were submitted for analysis to Phil Dering of Shumla Archeobotanical Services. Samples recovered during data recovery were sent to Dr. Leslie Bush at Macrobotanical Analysis of Austin, Texas, for analysis. The results of this analysis are presented in Chapter 11.

Fatty Acid Analysis

Fatty acids are basically lipids, or fats and oils that occur naturally in organisms. Evidence of foods such as large mammals, fish, and plants that may have been processed at archeological sites can often be extracted from lithic artifacts such as hearth rocks. Gas chromatography is used to analyze the fatty acid component of absorbed archeological residues. Analysis of plant and animal lipid residue is aided by the fact that the oils are relatively abundant and insoluble. An understanding of the decomposition patterns of various foods and food combinations has been ongoing, and experiments have included many natural foodstuffs of the Southern Plains. As a result, observed changes in the fatty acid composition of experimental cooking residues have enabled the development of a method of identifying archeological residues.

At 41CW104, TAR and grinding stones from the excavations, including from features, were selected for fatty acid analysis. This work was performed by Mary Malainey of the Department of Anthropology at Brandon University, Manitoba, Canada and can be found in Chapter 12 of this report.

Particle-size Analysis

Stratigraphy that may not be visually apparent may be deduced from particle-size analysis, particularly in sandy soils (Leigh 2001). Skewedness and modality of the grain sizes of archeological soils can indicate the modes and energy of the deposits at the site (Goldberg and MacPhail 2006). A study by Thoms (2007) at 24LN410 in the Northern Rocky Mountains utilizes particle-size analysis in a comprehensive approach to assess burned rock features and site integrity. Comparing particle-size and artifact distributions with regional sites in different depositional environments and with varying degrees of bioturbation suggests a rough correspondence in the sites. However, pedogenic effects on the site must be recognized by techniques such as particle-size analysis to evaluate individual site integrity. He concluded that burned rock features in sandy setting may be informative of cultural activities despite pedogenic effects (Thoms 2007).

A similar use of particle-size analysis was proposed for determining postdepositional processes at 41CW104. Radiocarbon dates from the site suggest a range of only about a few hundred years for the artifact-bearing deposits above the Bt horizon. Several column samples from excavation units were examined to investigate the depositional integrity of the site and postdepositional effects on artifact distribution. This work was performed by Charles Frederick (see Chapter 13).

Magnetic Susceptibility

Magnetic susceptibility is the capacity of a substance for magnetization (Rapp and Hill 1998). Variations in magnetic susceptibility at an archeological site may indicate zones of cultural activity. Soils that have been burned, such as those in hearths, and clay objects like pottery and bricks retain an elevated magnetic susceptibility (Kvamme 2001). An accumulation of these materials will occur on occupation surfaces, and these surfaces may be indentified in a stratigraphic profile by higher readings than the noncultural strata. At 41CW104, soil samples were taken in order to identify occupation zones.

Column samples from three excavation units were examined by Charles Frederick (see Chapter 13) for magnetic susceptibility measurement on a Bartington MS2 meter and MS2B sensor. Low frequency data (xlf) show an average reading of near 30, with a slight decline near the Bt horizon. The units tend to have a slightly higher reading within 20 cmbs, which is likely due to maghemite in the topsoil (Goldberg and MacPhail 2006).

Soil Micromorphology

Soil micromorphology has the unique feature of being a direct, undisturbed link between bulk field samples such as those taken for flotation and particle-size analysis (MacPhail and Cruise 2001). In this process, soils and sediments are observed microscopically, in thin sections, for a finer resolution of the chemical, organic, and mechanical effects of pedogenisis and thereby site formation at an archeological site. At 41CW104, soil micromorphological analysis was performed to provide a detailed characterization of the sediments across the site. This analysis was performed by Robert Rogers (see Chapter 13).

Ceramic Petrography

Ceramic petrography is a replicable, quantifiable approach for identifying ceramic paste composition, and involves the method of point counting and grain-size measurements from ceramic thin sections. The analysis is designed to count 200 points, a number determined to statistically represent all elements present in a sample (Stoltman 1989). Grain size is determined by measuring a number of nonplastic inclusions at their maximum width. General grain-size characteristics are identified based upon the range, mode, and mean of each sample in relationship to the Wentworth Size Scale. The general shape of the inclusions in the samples is based upon categories presented in Folk (1974). Ceramic petrography was performed by Robert Rogers (see Chapter 8).

Radiocarbon Dating

Radiocarbon dating remains the preferred dating technique for archeologists. A concern with this technique is to be able to secure material for analysis, which is limited to organic materials. At 41CW104, charcoal was present throughout the profile in most units, providing ample samples for analysis. In addition to the six radiocarbon dates obtained from the NRHP eligibility testing, 10 radiocarbon dates from data recovery were also sent to Beta Analytic of Miami, Florida. The samples were from loose wood charcoal found throughout the anthropogenic zone as well as near Features 6–8. All of the radiocarbon dates obtained from the investigations at the site are presented in Appendix A.

Instrumental Neutron Activation Analysis

INAA is an analytical technique useful for performing both qualitative and quantitative analysis of major, minor, and trace elements in archeological samples. Samples are irradiated with thermal neutrons in a nuclear reactor. Neutrons are absorbed in the nuclei of constituent atoms, and these atoms emit radiation with energy and quantity unique to each particular element. Analysis of the spectrum of gamma rays emitted by the sample allows a determination of the elemental composition of the sample.

INAA can be used to characterize the elemental composition of prehistoric ceramic pastes and draw conclusions regarding intensity and location of resource procurement and production loci and spheres of trade and regional exchange. Four ceramic sherds from 41CW104 were submitted to Dr. Michael Glascock of the Archaeometry Laboratory at the University of Missouri Research Reactor, Columbia, Missouri, for INAA. The results are contained in Chapter 8.

6

LITHIC ANALYSIS

by Candace Wallace, Linda W. Ellis, and Chris Heiligenstein

Analysis of the stone artifacts recovered from site 41CW104 followed a four-step process: (1) compilation of an initial inventory identifying basic artifact categories of lithic nontools and tools for the NRHP testing materials and of nontools, thermally altered nontools, and tools for the data recovery materials; (2) identification of a 10 percent sample of lithic nontool materials to undergo further analysis; (3) further classification and analysis of the 10 percent sample of lithic nontools and all lithic tools from both the testing and data recovery investigations, in accordance with the TxDOT Lithic Analysis Protocol; and (4) low-power microscopic examination of all tools to further identify any possible use-wear. Thermally altered rocks utilized for cooking are not included as part of the lithic analysis.

ANALYSIS METHODS

Raw Material Type

All analyzed lithic specimens were categorized by raw material type. A total of 1,755 artifacts, including debitage (n = 1,426), cores (n = 16), chipped stone tools (n = 287), and ground stone tools (n =26), were categorized by raw material. Raw materials recognized in the analyzed assemblage sample include chert (n = 1,691, 96.35 percent), metaquartzite (n = 30, 1.71 percent), quartz arenite (n = 28, 1.60 percent), and silicified wood (n = 6, 0.34 percent). Quite clearly, chert was the predominant choice for tool production at 41CW104. Metaquartzite was the predominant choice for ground stone tools. The properties of the individual material types are discussed in further detail below.

Chert is a siliceous microcrystalline aggregate of quartz, which consists of granular microcrystalline quartz formed as nodules or discontinuous beds in limestone. The chemical formula is SiO_2 and the specific gravity is 2.65. Chert has a hardness of 7, a colorless streak, a dull to waxy luster, and a conchoidal or splintery fracture. The color in hand sample is typically dark gray, light gray, gray-brown, brown, or red, although a range of colors is possible depending on the percentage of impurity inclusions (Nesse 2000).

Metaquartzite is sandstone composed of more than 90 percent SiO_2 and has been subjected to metamorphism under conditions of increased heat and pressure. The intergranular spaces of the metaquartzite have been filled as the intense tectonic conditions deformed the mineral grains and recrystallized the cementing agent forming a consolidated mass. Metaquartzite has a hardness of 7, a range of specific gravity of 2.65 to 2.7, a colorless streak, and a waxy luster. The fracturing of quartzites is unique in that the specimen will break smoothly through the grains in a subconchoidal to conchoidal manner. The color depends on the types of mineral inclusions and cementing agents. For example, a metaquartzite formed from the consolidation of quartz grains and quartz cement will be nearly white, while sandstone with quartz grains and hematitic cement will result in a brown to red or yellow color (Nesse 2000).

The distinction between metaquartzite and quartz arenite can become more complicated as the constituent grains become finer in size. Discerning the presence of impurities is the key to distinguishing between the two, as color is never a reliable physical property. For example, the presence of impurities such as sheet silicates (biotite, chlorite, or muscovite), hornblende, and hematite are diagnostic of metaquartzite.

Quartz arenite is composed of approximately 99 percent SiO_2 formed by the deposition of silica through solution, creating a homogenous mass. Unlike metaquartzite, the quartz grains of quartz arenite have not endured metamorphic deformation and are simply interlocked by a matrix of quartz (or carbonate) cement. Quartz arenite has a hardness of 7, a colorless streak, a waxy luster, and tends to fracture across the grains in a subconchoidal or conchoidal manner with respect to grain size. The color of a specimen in hand sample is typically pale gray to pale brown or white. Under a thin section, the quartz grains will appear subhedral or well rounded, while the cement matrix will exhibit the optical properties of quartz (Nesse 2000).

Silicified wood has the chemical formula SiO_2 and can include impurities such as hematite, copper, and manganese oxides. It has a hardness of 7, a colorless streak, a dull/earthy to vitreous luster, and a subconchoidal to conchoidal fracture. The color in hand sample is typically tan to brown, although a range of colors is possible depending on the presence of trace minerals (Nesse 2000). The key identifier for silicified wood is the preservation of the plant structure following the mineral replacement of the original material.

Thermal Alteration

All lithic specimens were examined for evidence of thermal alteration. This was identified based upon the attributes of color, luster, and fracturing. In particular, specimens exhibiting hues of red, increased luster, and/or fracture patterns consistent with exposure to heat were considered thermally altered.

It is difficult to say whether or not the thermal alteration of these materials was intentional. Heat-treated materials can be easier to work and may fracture more conchoidally than unheated specimens, as the point-tensile strength of the mineral is reduced upon heating caused by the fusing of impurities and microcrystals within the rock, thus allowing the material to fracture with less pressure and in a more even and conchoidal manner. This fusing also results in a surface that is more lustrous and even in appearance (Purdy and Brooks 1971). Studies have shown that introducing materials to controlled temperatures produces color change beginning at approximately 240 degrees Celsius (°C), with increased luster and reduction in tensile strength occurring generally between 350 °C and 400 °C (Purdy and Brooks 1971). Additional work by Frederick and Ringstaff (1994) in Bell and Coryell Counties, Texas, has shown an increase in workability of chert, predominantly between the temperatures of 330 °C and 460 °C. These temperature-range limits will vary somewhat depending on the chemical make-up of the particular raw materials.

Exposure of materials to much higher temperatures for longer periods of time results in abrupt fracturing and an increase in friability. All of the material types recovered from 41CW104 are composed of quartz crystals, which undergo disintegrative effects at temperatures in excess of about 575 ± 2 °C (Rogers 1928). These effects can be reached at lower temperatures if the impurities in the raw material have lower temperature limits than that of quartz. Any materials introduced directly to an open-air fire, such as those necessary for successful firing of pottery between 600 °C and 850 °C, would exhibit such a breakdown (Rice 1987).

Nontools

Nontool materials recovered from site 41CW104 consist of unmodified lithic debitage and cores. Nontool items were further categorized by raw material, presence or absence of thermal alteration, and mass in grams. Each nontool category is discussed in more detail below.

Debitage

Lithic debitage includes all unmodified, detached manufacturing debris. Debitage was further categorized by *morphology*, *size grade*, *percentage of cortex present*, and *platform type* (when applicable).

Following Sullivan and Rozen (1985), debitage was categorized by *morphology* into complete flake, broken flake, flake fragment, and debris. Complete flakes are debitage with a discernible single interior surface that retains a point of applied force and has intact margins. Broken flakes are distinguished from complete flakes only by their lack of intact margins. Flake fragments have a discernible single interior surface but do not retain a point of applied force or intact margins. Debris includes all debitage that lacks all of the above characteristics.

Size grade was determined using a series of nested sieves with the following sizes: 25.4 millimeter (mm), 19.05 mm, 12.7 mm, 6.35 mm, and <6.35 mm*. Percentage of cortex present* was recorded as being within one of the following ranges: 0 percent, 1 to 25 percent, 26 to 50 percent, 51 to 75 percent, and 76 to 100 percent. This percentage refers to the approximate amount of cortex present on the dorsal side of the flake.

Platform type was assessed following Andrefsky (1998), employing the following designations: indeterminate, cortical, flat, complex, abraded, faceted, multifaceted, rejuvenated, and missing. Indeterminate was recorded when the platform is not complete or cannot be easily viewed, such as when heavy patina is present. Cortical refers to any flake that retains cortex on the striking platform. Flat refers to all platforms that have a single facet, otherwise observed as a completely flat platform surface. Faceted refers to all platforms that have two facets only. Multifaceted identifies platforms that have three or more facets. Abraded refers to platforms that exhibit grinding on the marginal edges. Complex indicates platforms that show bifacial modification identified as an "angular surface created by the removal of several striking platform preparation flakes" (Andrefsky 1998:96–97). Rejuvenated identifies platforms that exhibit use-wear along the edges. Missing refers to all specimens that do not retain any portion of the platform, such as distal fragments.

Cores

A core includes any relatively large stone or cobble that shows negative flake scarring, resulting from intentional detachment. Cores were further categorized by *reduction*, *source material size*, *size grade*, and *percentage of cortex present*.

The *reduction* of cores refers to the direction from which flakes were removed and was recorded as either unidirectional or multidirectional. Unidirectional cores have flakes removed in the same direction from a single point or area, whereas multidirectional cores have flakes removed in varying directions and from multiple points of applied force. The *size of the source material*, when determinable, includes boulder (diameter greater than 256 mm), cobble (diameter greater than 64 mm but less than 256 mm), or pebble (diameter less than 64 mm). Those specimens for which the source material size could not be determined due to excessive flake removal are referred to as exhausted cores.

Size grade was determined using a series of nested sieves with the following sizes being recorded: 101.6 mm, 76.2 mm, 50.8 mm, 25.4 mm, and <25.4 mm. *Percentage of cortex present* refers to the approximate amount of cortex remaining on the entirety of the specimen. This was recorded using one of five ranges: 0 percent, 1 to 25 percent, 26 to 50 percent, 51 to 75 percent, and 76 to 100 percent.

Tools

All stone tools recovered from 41CW104 were initially categorized as either ground stone or chipped stone. All tool specimens were also categorized by raw material, presence or absence of thermal alteration, and mass in grams. Each tool category is discussed in detail below.

Chipped Stone Tools

Chipped stone tools were first categorized by their initial manufacturing technique and were recorded as being in one of the following categories: simple detachment-based, complex detachment-based, and core-based. Detachment-based tools are derived from pieces struck from larger cores. Simple detachment-based tools include flakes and blades that show minor modification and/or use-wear. Complex detachment-based tools undergo more intense modification and were categorized by production stage. Core-based tools are derived from the core itself, often pebbles or cobbles. It is sometimes difficult to distinguish between complex detachment-based tools and core-based tools. When distinctions can be made, they are often based upon evidence from the source material itself, such as ventral surfaces, bulbs of percussion, and/or striking platforms. Since these characteristics are often not present, complex detachment-based and core-based tools are evaluated and presented together utilizing the same analysis criteria.

Simple Detachment-based Tools

Simple detachment-based tools were initially separated by *class* into flake or blade. Blades refer to specimens specifically produced through blade technology. Such specimens were removed from blade cores. These items are typically long and often distinguished by being at least twice as long as they are wide, and they retain parallel lateral edges. Flakes include all other materials detached as a result of the reduction process.

Both flakes and blades in this assemblage were *subclassified* as bifacially modified, unifacially modified, or utilized. Bifacial modification refers to intentional modification from both sides along one or more opposing edges, often evidenced by patterned microchipping. Unifacial modification refers to intentional modification from only one side along one or more edges, also often evidenced by micro-chipping. These tools often show evidence of wear along the modified edge(s). Utilized specimens exhibit use-wear from one or both sides on one or more edges, but lack intentional modification. Wear patterns were used to further evaluate tool use and the material(s) the tool was used on.

Flakes and blades were further categorized by *morphology*. For modified blades, this information was recorded based upon the modification form, for example backed or stemmed. For unmodified (i.e., utilized) blades, this information was recorded based upon the morphology, such as dihedral or polyhedral. Morphology for both modified and utilized flakes was categorized following Sullivan and Rozen (1985) as complete flake, broken flake, flake fragment, and debris, as previously discussed in the debitage section above.

All specimens were further categorized by *size grade* and *percentage of cortex present*. *Size grade* was determined using a series of nested sieves with the following sizes being recorded: 101.6 mm, 76.2 mm, 50.8 mm, 25.4 mm, and <25.4 mm. *Percentage of cortex present* was recorded as being within one of five ranges: 0 percent, 1 to 25 percent, 26 to 50 percent, 51 to 75 percent, and 76 to 100 percent.

All simple detachment-based tools were then categorized by use-wear type(s). This assemblage expressed a maximum of four different wear locations/types. For each location the following information was recorded: *alteration type*, *alteration location*, *alteration shape*, *alteration length*, and *alteration utilization*.

Alteration type refers to the specific type of tool utilization. The following types of utilization were observed within this assemblage: adzing, cutting, perforating, planing, sawing, and scraping. Both cutting and sawing activities require the flake be held with the working edge parallel to the direction of use. The difference between the two is that sawing is generally used on harder materials such as bone or wood (Keeley 1980). Both planing and scraping activities involve the flake being held with the working edge approximately at a right angle to the direction of use; however, with planing the flake edge is pushed, while with scraping the flake edge is pulled (Keeley 1980). Adzing requires the flake to be held at a low angle towards the material surface and involves multiple, quick strikes against the material (Keeley 1980). Perforation activities require the flake to be held at an approximate 90-degree angle against the working surface, while the flake is utilized with a rotary action such as boring (Keeley 1980).

Alteration location refers to the portion of the flake where the wear occurred. Such locations include proximal edge, distal edge, and lateral edge. *Alteration shape* refers to the shape of the modified location and includes beaked, concave, convex, recurved, and straight. *Alteration length* refers to the length in millimeters of the entirety of the utilized edge. *Alteration utilization* refers to the material the flake was used against. Such materials are recorded as soft, medium soft, medium hard, and hard. Such broad terms for these materials was selected due to the microscopic limits.

Specimens deemed to be unique to the collection were submitted to a technical analyst for further use-wear identification. These specimens exhibited areas of high polish not seen on any other specimens in the collection.

Complex Detachment-based and Core-based Tools

Both complex detachment-based and core-based tools were initially separated by class into *biface* or *nonbiface*. Both bifaces and nonbifaces were then further subclassified as *formal* or *informal*. Formal specimens follow a clear trajectory of reduction towards a final tool form, represented in stages of production. Informal tool specimens are expedient in nature.

Tool *type* for complex detachment-based and core-based tools refers specifically to the function of the tool. Types recorded for this assemblage are adze, drill, chopper, knife, planer, projectile point, and scraper. Specimens for which functional type could not be discerned were simply listed as indeterminate.

All specimens were then categorized by *subtype/identity*, which refers to how they are generally identified typologically. The following specific morphological subtypes were identified within the assemblage: Clear Fork uniface, Cuney arrow point, Ensor dart point, Fresno arrow point, Pedernales dart point, and Scallorn arrow point. Additionally, specimens that could not be categorized by subtype but could be identified either as an arrow point or a dart point are listed as either indeterminate dart point or indeterminate arrow point. Specific qualifications for these types are listed below.

Clear Fork unifaces include all specimens that show the following characteristics: triangular to subtriangular in outline and a steeply beveled working edge with an angle between 60 and 75 degrees. Most of these specimens show use-wear consistent with adzing or scraping activities.

Ensor dart points include all specimens that show the following characteristics: triangular blades, broad stems, shallow side-notches, straight to slightly concave basal edges, low base/stem ratios, bifacial-bilateral edge construction, average edge angles ranging between 45 and 55 degrees, and straight to serrated lateral edges. This subtype has broad variations in metric measurements as well as flake scar patterning.

Fresno arrow points include all specimens that show the following characteristics: triangular in shape, straight to convex lateral edges, straight basal edges, collateral or random flake scar patterning, bifacial-bilateral edge construction, base angles ranging between 70 and 85 degrees, and average edge angles ranging between 35 and 45 degrees. Metric measurements for length and width vary slightly but have averages of approximately 3.5 and 2 cm, respectively.

Pedernales dart points include all specimens that show the following characteristics: lanceolate to triangular-shaped blade, parallel-edged bifurcated stem, and average edge angles ranging between 35 and 45 degrees. This subtype has broad variations in metric measurements, especially with rejuvenated specimens.

Scallorn arrow points include all specimens that show the following characteristics: triangular shaped blades, corner-notched straight to convex lateral edges, well-barbed shoulders, straight basal edges, low base/stem ratios, collateral flake scar patterning, bifacial-bilateral edge construction, and average edge angles ranging from 35 to 45 degrees.

Metric measurements for maximum *length*, *width*, and *thickness* were recorded for each specimen. In addition, the average angle of the working edge was recorded to the nearest 5 degrees using a goniometer.

Stage of Production was evaluated for all complex detachment-based and core-based tools utilizing the five-stage trajectory presented by Goode (2002). Stage 1 refers to initial package reduction, which is evidenced by specimens that are irregular in shape, retain large amounts of cortex, and exhibit minimal to no thinning along the edges. Stage 2, blank preparation, is evidenced by specimens that have more-regularized shapes, retain minimal to no cortex, and exhibit minimal thinning and some lateral refinement. Stage 3, shaping and thinning, is evidenced by specimens that have regularized shapes, retain no cortex, and exhibit secondary thinning. Stage 4, final edge trimming and sharpening, includes specimens that have reached their intended final form. Most tools at this stage represent specimens that were broken during use, cached, lost, or abandoned. Stage 5, rejuvenation, is evidenced by reworked edges, reduction in size, and other evidence of having been reworked. Some specimens were too fragmentary to have a stage assigned and are simply listed as indeterminate.

Portion refers to the extant amount of each individual tool still present, especially the large number of fragmented specimens. Portion was classified as either indeterminate, complete, distal, distal-medial, medial, proximal-medial, proximal, lateral edges missing, fragment, barb/shoulder, ear/tang, or stem. Fragment was used to describe specimens that were too fragmentary to determine portion. Indeterminate was used to describe specimens whose portion could not be distinguished from other known portion options, such as proximal and distal.

Failure/Discard was recorded for all specimens with the following categories: indeterminate, snap/end shock, impact/bending, perverse, hinge/step, overshot, material flaw, platform loss, excessive heating, exhausted, and cached.

Material *alterations* were also recorded for all specimens. Such alterations can include the following: none observed, indeterminate, thermal, white patina, black patina, oxide staining/yellowing, pigment staining, carbonate build-up, and other. The only alteration type observed within the assemblage from 41CW104 was thermal. The attributes representing thermal alteration are discussed above.

Edge morphology was recorded for all specimens, focusing only on the working edge of the tool. The following categories were recorded for this evaluation: indeterminate, straight (outward or inward edge projection less than 2 mm), concave (outward edge projection greater than or equal to 2 mm and less than or equal to 4.9 mm), convex (inward edge projection greater than or equal to 2 mm and less than or equal to 4.9 mm), recurved (outward and inward edge projection of greater than or equal to 2 mm), serrated, very concave (inward edge projection greater than or equal to 5 mm), very convex (outward edge projection greater than or equal to 5 mm), and not applicable.

A variety of *flake scar patterns* were recorded for each tool type, including indeterminate (pattern could not be discerned and often used for fragmented specimens), collateral (parallel flaking from each edge reaching the middle of the tool, forming a medial ridge), horizontal transverse (horizontal parallel flakes beginning on one lateral edge, traversing a single face of the tool, and terminating on the opposite lateral edge), oblique transverse (diagonal parallel flakes beginning on one lateral edge, traversing a single face of the tool, and terminating on the opposing lateral edge), and random (unpatterned flake removal).

Complex detachment-based and core-based tools can have edges prepared in many different fashions. The primary distinction is between unifacial and bifacial preparation. *Edge construction type* was categorized as indeterminate, bifacial-distal, bifacial-bilateral, bifacial-unilateral, bifacial-distal-bilateral, bifacial-distal-unilateral, bifacial-circumferential, unifacial-distal, unifacial-bilateral, unifacial-unilateral, unifacial-distal-unilateral, unifacial-circumferential, and other.

While many of these tool types were submitted to a technical analyst for more-intensive use-wear analysis, all specimens were examined under low-power microscopy for the following types of use-wear: *flaking attrition*, *crushing* and *smoothing*, *polish*, and *etching/pitting*.

Flaking attrition is evidenced by the removal of small flakes in a feathered or stepped manner, which results from tool use. These flakes are often more obtuse and have sharper facets than regular trimming flakes found on the preparatory edge of a tool. Flaking attrition is location dependent and classified as not present, bifacial-distal, bifacial-bilateral, bifacial-unilateral, bifacial-distal-bilateral, bifacial-distal-unilateral, bifacial-circumferential, unifacial-distal, unifacial-bilateral, unifacial-unilateral, unifacial-distal-bilateral, unifacial-distal-unilateral, unifacial-circumferential, unifacial-bilateral-oppositional, and other.

Crushing and *smoothing* are attributes most often associated with ground and battered stone tools but can occasionally occur on chipped stone tools. If identified, the following categories describing the location were recorded: not present, distal, distal-lateral, unilateral, bilateral, facial smoothing, facet smoothing, circumferential, primary proximal, and secondary proximal.

Polish is evidenced by luster/shine on a working edge of a tool. Polish does not include any wear attributed to hafting or thermal alteration. Polish is recorded by location and extent. Shallow refers to polish extending less than 5 mm from the tool edge, while deep refers to polish that extends beyond 5 mm from the tool edge. The following categories were employed for location and degree of polish: not present, shallow distal, deep distal, shallow lateral, deep lateral, unifacial-medial, bifacial-medial, bipolar, and proximal.

Etching/pitting refers to the striations and depressions that result from grinding and/or pecking. The location and extent of this attribute was recorded, with shallow referring to wear less than 5 mm from the tool edge and deep referring to extension beyond 5 mm from the edge. The following categories were used to describe the location and degree of etching/pitting: not present, shallow distal, deep distal, shallow lateral, deep lateral, unifacial-medial, distal-medial, circumferential, medial-bifacial, and bipolar.

All specimens were categorized by the presence or absence of a hafting element. Evidence suggesting hafting includes any of the following attributes observed on the proximal end of the tool: lateral edge dulling, lateral edge polish, facial facets, and presence of a masticate.

Projectile points were further categorized by *point class*. Recorded point class types are corner notched, side notched, stemmed, triangular, and lanceolate. Metric data recorded for all corner-notched and side-notched points included point length, point width, point ratio, left and right blade lengths, base/stem length or basal inflection, base/stem width, neck thickness, neck width, left and right notch depths, notch ratios, base to blade length ratio, base to blade width ratio, base/stem ratio, base form, left and right blade curvature, and left and right shoulder angles. Metric data recorded for all stemmed points included point length, point width, point ratio, left and right blade lengths, base/stem length or basal inflection, base/stem width, neck thickness, neck width, base to blade length ratio, base to blade width ratio, base/stem ratio, base form, stem form, left and right blade curvature, and left and right shoulder angles. Metric data recorded for triangular points consisted of point length, point width, point ratio, left and right blade lengths, base/stem length or basal inflection, base to blade length ratio, distal base form, left and right blade curvature, and left and right base angles. Metric data recorded for lanceolate points consisted of point length, point width, point ratio, left and right blade lengths, base/stem length or basal inflection, neck thickness, neck width, base to blade length ratio, distal base form, lateral base/stem form, and left and right blade curvature.

Ground Stone Tools

Ground and battered stone tools are generalized tools in the sense that a single tool may not be functionally specific with regard to the manner in which it is used or the things it is used to process or prepare. To systematically classify these tools, it is important to use well-defined criteria for recognizing their diverse nature and possible function. Since a variety of processes can produce distinctive wear, tools were assigned to specific analytical categories on the basis of several key variables: the mechanical processes involved, the outcome of those processes, and the material being processed. Microscopic examination of each tool aided in the identification of the key mechanical processes and the subsequent wear patterns still visible on the tool. Because any specific tool can be used in a range of activities, multifunctional tools were categorized on the basis of the predominant type of wear still visible on the tool.

The primary mechanical operations involved while using a ground stone tool are *rubbing* and *pounding*. *Rubbing* combines pressure and friction in order to reduce a mass through abrasive action, such as the grinding down of coarse particles into finer particles, by scouring or scraping away the surface or by sharpening, smoothing, or refining. The mechanical operation of rubbing can be used to reduce the mass of vegetal material (such as corn kernels, roots, or seeds) or nonplant material (such as clay or ochre). In this case, the material(s) to be ground are placed on the hard stationary surface or platform, and processing occurs when the upper handheld stone slides across the lower anvil stone (see Carter 1977; Kraybill 1977). However, the same mechanical operation is performed when ground stone tools are used to rub across a soft surface, such as hides or wood. Thus, the mechanical operation (rubbing) is the same, but surface to surface contacts vary depending on the type of material being processed, thereby resulting in wear patterns with different characteristics.

Pounding is a process of forceful impact. It is a pulverizing or crushing action that dehulls (as in the case of seeds and nuts) or reduces volume through the exertion of pressure (as in the case of roots and/or nutmeats). Pounding can also be used to reduce the mass of nonplant materials, such as the pulverizing of old potsherds for use as temper. Pounding can be employed to roughen the surface, as when the surface of a grinding slab is pecked; however, pounding can also be used as a means of softening, such as pounding the inner side of hide blankets (see Opler 1941:378).

Pounding and rubbing are processes that produce certain outcomes. Apart from the objective of the process (such as dehulling nuts or grinding grass seeds), the process itself (i.e., rubbing or pounding) results in certain types of wear on the tool. Depending on the surface to surface contacts (i.e., hard-object-to-hard-object or hard-object-to-soft-object), rubbing can produce at least five different types of wear: *grinding, polishing, striations, grooves, or notches*. *Grinding* is wear that results from surface fatigue associated with the pressure and friction generated when two objects are repeatedly rubbed together (see Adams 1996; Teer and Arnell 1975). *Polishing* is a form of tribochemical wear that occurs when surface fatigue and abrasive wear produce surfaces that are flat enough and smooth enough for the buildup of films and/or oxides. These smooth, shiny, glossy, or greasy surface(s) can result from actions such as rubbing a fine-grained piece of stone against a coarser-grained piece of stone, from friction against a softer material such as a hide, or from the residual buildup of the materials being ground (Adams 1996; Semenov 1964; Vaughan 1975). *Striations* are fine, thin lines that occur on the working edge and/or surface of the tool. They can occur as sets of lines that run parallel to one another in the same direction, as sets of crosscutting multidirectional lines, or circular swirls. This type of wear is often used to infer the direction of use. *Grooves*, by contrast, are broad furrows or channels characterized by linear, often parallel, troughs that have been cut into the surface of the tool. *Notches* are indentations that occur at or close to the edge of a tool. These indentations can be shallow or deep, but differ from striations and grooves in that they are generally wider and shorter and occur as V-shaped or U-shaped troughs close to the edge of the tool (see Vaughan 1975).

Pounding also results in distinctive wear patterns that differ from those produced by the mechanical operation of rubbing. These are *battering*, *pecking*, and *pitting. Battering* is wear that results from forceful impact. This type of wear is characterized by irregular indentations in the stone or crushed areas, usually on the ends or sides (see Bell and Cross 1980). *Pecking* is a special form of battering related to the refurbishing or roughening of a hand stone and/or the surface of an anvil stone. Wear associated with pecking is characterized by small random indentations or dimples across the ground or polished face or along the edges. *Pitting* occurs when large sections of a stone's surface are displaced during repeated pounding in the same area. These larger pitted areas are often characterized by jagged depressions or holes on the working surface.

LITHIC ANALYSIS RESULTS AT 41CW104

All analyzed lithic specimens were subjected to the aforementioned analysis. A total of 15,032 lithic materials were recovered from the site during NRHP testing (n = 1,850) and data recovery (n = 13,182) investigations. These lithic materials consist of 313 tools and 14,719 nontool specimens. Lithic tools include both chipped stone (n = 287) and ground stone (n = 26) specimens. Nontools consist of cores and debitage. The initial inventory for the data recovery investigations further subdivided the nontool materials by presence or absence of thermal alteration. Of the 12,917 nontool materials recovered during data recovery, a total of 5,948 specimens (n = 46 percent) exhibited signs of thermal alteration.

Due to the size of the lithic assemblage, it was determined that only a sample of the nontools would undergo further examination. Materials chosen for further analysis consisted of all tools from both the testing and data recovery assemblages (n = 313), all lithic nontool materials recovered in association with simple hearth features 7, 8, and 9 (n = 197), and all lithic nontool materials recovered from selected units 2, 4, and 25 (n = 1,245). Units 2, 4, and 25 were chosen because of the high volume of lithic materials and thermally altered rocks recovered from each unit, along with the presence of charcoal and/or prehistoric ceramics. Consequently, formal analysis was conducted on an assemblage sample of 1,755 lithic artifacts.

Nontools

The nontool collection from 41CW104 consists of 14,719 specimens, with 1,802 originating from the testing investigations and 12,917 originating from the data recovery investigations. The analyzed sample of the lithic nontool assemblage (n = 1,442) represents approximately 10 percent of the total assemblage. These materials were further subdivided into cores (n =16) and debitage (n =1,426). Raw material types encountered in the nontool assemblage sample include chert (n = 1,394, 96.7 percent), quartz arenite (n = 25, 1.7 percent), metaquartzite (n = 17, 1.2 percent), and silicified wood (n = 6, 0.4 percent). Chert was the predominant choice for chipped stone tool production, presumably because it was so readily available.

Cores

The 16 cores in the analyzed sample are all chert and all are of sizes further suggesting that the local river cobbles and pebbles were being utilized for core reduction at the site. All attributes recorded for the analyzed sample of cores are presented in Appendix C, Lithic Core Analysis. Thirteen of the cores exhibited multidirectional reduction, while the remaining three exhibited unidirectional reduction. Twelve of the specimens were too exhausted to determine the initial source size, and the remaining specimens were identified as three cobbles and one pebble. Size grades recorded for the cores are as follows: less than 25.4 mm (n = 4), 25.4 mm (n = 8), and 50.8 mm (n = 4). Only two of the specimens were completely decorticated, while the remainder had between 1 and 75 percent cortex remaining. Only three of the cores exhibited thermal alteration, suggesting that intentional heat treatment was not practiced frequently in core reduction at the site.

Debitage

Raw material types identified for the debitage sample are chert (n = 1,378; 96.6 percent), quartz arenite (n = 25; 1.8 percent), metaquartzite (n = 17; 1.9 percent), and silicified wood (n = 6; 0.4 percent). All attributes recorded for the analyzed debitage are also presented in Appendix C, Lithic Debitage Analysis. The 1,426 pieces of unmodified debitage were categorized by morphology into complete flakes, broken flakes, flake fragments, and debris. This assemblage includes 146 complete flakes (10.2 percent), 309 broken flakes (21.7 percent), 589 flake fragments (41.3 percent), and 382 pieces of debris (26.8 percent). The high proportion of broken flakes and flake fragments along with the low proportions of complete flakes and debris, suggests that this assemblage resulted more from tool production, use, and maintenance, rather than primary core reduction. The small number of cores recovered in the sample is consistent with this conclusion.

Size grade data can aid in the assigning of production stage. As lithic materials are progressively reduced in size, the materials being removed will reduce in size as well. Consequently, large quantities of large debitage would indicate activities related to primary core reduction, while large quantities of small debitage would indicate activities related to later-stage tool production, refinement, and/or maintenance. Size grades recorded for the 41CW104 assemblage are as follows: 25.4 mm (n = 20, 1.4 percent), 19.05 mm (n = 27, 1.9 percent), 12.7 mm (n = 120, 8.4 percent), 6.35 mm (n = 732, 51.3 percent), and <6.35 mm (n = 527, 37.0 percent). Based on the aforementioned principle, it appears that later-stage lithic tool production, refinement, and/or maintenance were the predominant activities in the areas of the site that were sampled.

The percentage of cortex present on the dorsal side of a flake can also be utilized as a good indicator for stage of reduction in the production of a lithic tool. Typically, the cortex on unworked raw material is removed first in the reduction process; therefore, debitage retaining a high amount of cortex would reflect earlier stages of tool production. Ranges recorded for the analyzed assemblage sample are as follows: 76 to 100 percent (n = 152, 10.7 percent), 51 to 75 percent (n = 48, 3.4 percent), 26 to 50 percent (n = 73, 5.1 percent), 1 to 25 percent (n = 192, 13.5 percent), and 0 percent (n = 961, 67.4 percent). The fact that the majority of the assemblage retains no cortex at all suggests that core reduction was not a major activity taking place in the sampled areas.

Platform data was recorded for 455 specimens in the collection, which was composed of 146 complete flakes and 309 broken flakes. Specific platform types generally identify various stages in the reduction process. Debitage with cortical, flat, and dihedral-faceted platforms indicate initial reduction stages. Multifaceted, abraded, and complex platforms generally indicate later stages of production, and rejuvenated platforms often indicate tool maintenance and recycling. The following categories were recorded for the analyzed collection: cortical (n = 89, 19.6 percent), flat (n = 134, 29.5 percent), faceted (n = 25, 5.5 percent), multifaceted (n = 59, 13.0 percent), abraded (n = 37, 8.1 percent), complex (n = 64, 14.1 percent), rejuvenated (n = 25, 5.5 percent), and indeterminate (n = 22, 4.8 percent). The platform data suggests both earlier stages and later stages of production occurring in equal amounts in the sampled areas. Combined with the already recorded data, it appears that the earlier-stage platform data may represent initial tool thinning as opposed to actual core reduction in these areas.

Finally, all debitage specimens were evaluated based upon the presence or absence of thermal alteration. Of the 1,426 analyzed pieces, a total of 634 (44.5 percent) exhibited signs of thermal alteration. This further confirms that while heat treatment was utilized in tool manufacture at the site, it was probably not an integral step in the reduction process.

Based upon the recorded data, it can be concluded that this analyzed assemblage sample of nontool materials probably represents later stages of lithic reduction and tool refinement and/or maintenance at the site. While the analyzed sample only constitutes 10 percent of the nontool assemblage, these materials were sampled from various portions of the site including the southern and northern extents as well as the central portion. This suggests the analyzed sample may actually represent the activities of the entire site and not just the analyzed portion.

Tools

A total of 313 lithic tools were recovered from the testing and data recovery investigations at 41CW104. This assemblage is composed of 287 chipped stone tools and 26 ground stone tools. Each technology was evaluated differently, and the data are presented in further detail below.

Chipped Stone Tools

Chipped stone tools were further categorized and evaluated separately as simple detachment-based (n = 235), core-based (n = 7), and complex detachment-based (n = 45). It was not always possible to confidently distinguish between core-based and complex detachment-based tools. Consequently, data for these categories are evaluated and presented together.

Simple Detachment-based Tools

Simple detachment-based tools are the predominant tool type recovered at the site, accounting for 75.1 percent of the tool assemblage (including both chipped stone and ground stone). The assemblage of simple detachment-based tools from 41CW104 totals 235 specimens. Subclasses recovered from the site include a bifacially modified flake (n = 1), a unifacially modified blade (n = 1), unifacially modified flakes (n = 142), utilized flakes (n = 90), and utilized fire-cracked rocks (n = 1). All of the tools included in this section of the lithic analysis are chert, and 88 of the 235 lithic tools (37.4 percent) exhibit signs of thermal alteration. All attribute data for the simple detachment-based tools can also be located in Appendix C, Lithic Simple Detachment-based Tool Analysis.

Expedient tools were the predominant tool type present at 41CW104. Patterned use-wear observed within this assemblage was consistent with scraping and planing activities, which presumably resulted from plant and animal processing. The expedient tool assemblage is set apart from other sites in the area occupied during the Late Prehistoric period in that blade technology was not a predominant activity, as it was at nearby sites such as the Sandbur site (41FY135) (Kalter et al. 2005). This inference is drawn from the fact that only one unifacially modified blade was recovered at 41CW104 out of a total of 235 expedient tools, as well as from the absence of blade cores and blades in the collection. An additional contrast to many Toyah phase sites is the use of these expedient tools for activities related primarily to plant processing, with very limited evidence for animal butchering or processing (Johnson 1994). The abundance of lithic source materials available at the site probably accounts for the large number of expedient tools on a site that is attributed to a more nomadic lifestyle, since large amounts of expedient tools generally suggest a more sedentary lifestyle (Andrefsky 1998).

Bifacially Modified Flake

The single bifacially modified flake (Lot 124) is a broken chert flake that has been bifacially modified along a convex lateral edge. The flake exhibits 10.51 mm of edge modification on the dorsal surface and 19.03 mm of edge modification on the ventral surface. The opposing lateral edge also demonstrates 8.32 mm of modification along a convex segment of the edge. Altogether, each site of edge modification on the flake is consistent with utilization for scraping medium-soft to medium-hard materials. Lot 124 has a mass of 15.70 g and is 32.80 mm long by 51.69 mm wide, with a maximum thickness of 10.25 mm.

Unifacially Modified Flakes

Unifacially modified flakes were the most common tool type recovered from the site, accounting for approximately 60.4 percent of the simple detachment-based tool assemblage. All attributes of the unifacially modified flakes are presented in Appendix C, Unifacially Modified Flake Attributes.

Based on wear patterns present in this assemblage, it is probable that these expedient tools were utilized for multiple activities including adzing, cutting, perforating, planing, sawing, and scraping. A total of 177 modified edges were identified in the tool assemblage, exhibiting patterned wear consistent with scraping (49 percent), planing (24.5 percent), and cutting (21 percent). Scraping and planing utilize the working edge of the flake at an approximately 90-degree angle to the direction of use; however, with planing the working edge is pushed, whilst the working edge is pulled during scraping activities (Keeley 1980). Cutting utilizes the flake edge in a manner that is parallel to the direction of use and is performed on soft to medium-soft materials (Keeley 1980). Similar to cutting, sawing involves the flake being held with the working edge parallel to the direction of use; however, this activity is generally used on harder materials such as wood or bone (Keeley 1980). Adzing activities require the flake to be held at an acute angle towards the material surface, and involves multiple, quick strikes against the material (Keeley 1980). Perforation activities require the flake to be held at an approximate 90-degree angle against the working surface, while the flake is utilized with a rotary action such as boring (Keeley 1980).

Unifacially Modified Blade

The single unifacially modified blade (Lot 374) from 41CW104 is a backed chert blade that has been modified along 22.91 mm of the straight lateral edge. The modified edge exhibits evidence of utilization for scraping medium-soft materials. Lot 124 has a mass of 5.02 g and is 58.22 mm long by 19.64 mm wide, with a maximum thickness of 4.37 mm.

Utilized Flakes

Utilized flakes account for approximately 38 percent of the simple detachment-based tool assemblage, further suggesting that expedient tools are the principal tool type used at the site. The basic attributes of the utilized flakes recovered from 41CW104 are recorded in Appendix C, Utilized Flake Attributes.

Based upon the wear patterns observed on the utilized flakes, it is evident that these expedient tools were utilized for activities related to adzing, cutting, planing, sawing, and scraping. A total of 105 utilized edges were identified in the tool assemblage, exhibiting wear patterns consistent with scraping (45.7 percent), cutting (28.6 percent), planing (12.4 percent), sawing (12.4 percent), and adzing (1.0 percent).

Utilized Fire-cracked Rock

The single utilized fragment of fire-cracked rock (Lot 20) recovered from the site is chert and was utilized along 6.96 mm of the straight lateral edge. The utilized edge exhibits evidence of wear consistent with sawing medium-soft materials. Lot 124 has a mass of 1.74 g and is 35.11 mm long by 10.21 mm wide, with a maximum thickness of 5.58 mm.

Core-based and Complex Detachment-based Tools

After being categorized as core-based or complex detachment-based, all 52 specimens were then classified either as biface or nonbiface. Bifaces include all bifacially constructed tools, and within this assemblage nonbiface refers to all unifaces. Biface tools were the predominant tools in the assemblage of core-based and complex detachment-based tools (n = 49, 94.2 percent). Both bifaces and nonbifaces were classified as formal (n = 49, 94.2 percent) or informal (n = 3, 5.8 percent) tools. All formal tools represent a stage in production and suggest a trajectory towards a recognizable tool type, while all informal specimens are expedient in nature and show very little reduction prior to use. All attribute data for the core-based and complex-detachment based tools is also presented in Appendix C, Lithic Core-based and Complex Detachment-based Tool Analysis.

Tool type was recorded based upon the actual utilization of the tool. Thirty-one specimens exhibit wear consistent with a specific use, 2 exhibit wear consistent with multiuse, and 19 exhibit indeterminate wear. In general, the indeterminate tools were too fragmentary to determine the nature of tool use since all indeterminate tools were incomplete specimens. Tool types recorded within the assemblage consist of the following: adze (n = 1), chopper (n = 1), knife (n = 3), planer (n = 2), projectile point (n = 13), scraper (n = 11), knife/drill (n = 1), and knife/scraper (n = 1). All specimens are further categorized and described within their respective types below. It is clear from the collection that the core-based and complex detachment-based tools follow a more formalized and clear reduction plan.

Adze

A single tool, Lot 49, was utilized for adzing and was further identified as a Clear Fork Uniface (Figure 36). This complete chert, complex detachment-based tool has a mass of 77.91 g and is 82.65 mm long by 54.05 mm wide, with a maximum thickness of 18.66 mm. This stage 4 uniface is made on a flake, and the working edge angle/bit angle measures 65 degrees. Lot 49 has relatively straight lateral and distal edges and a unifacial-circumferential edge construction. Unifacial flaking attribution, suggesting use as an adze, is located unilaterally along the distal edge with minor crushing along the same edge. As suggested by Dial (1998), it is believed that the unifacial Clear Fork tools, such as this one, often date a bit later than their bifacial counterparts, and often indicate an Early to Middle Archaic component.

Chopper

A single tool, Lot 51, was identified based upon form and utilization as a chopper (see Figure 36). This complete chert, core-based tool has a mass of 54.79 g and is 42.36 mm long by 41.12 mm wide, with a maximum thickness of 26.69 mm. This stage 1 uniface is made on a flake, and the recurved working edge angle measures 75 degrees. Lot 51 has relatively straight lateral edges and minimal reduction. Wear suggesting use as a chopper, in the form of unifacial flaking attrition, is located unilaterally along the distal edge.

Knives

Three specimens in the assemblage were identified as knives based upon observed use-wear and form (see Figure 36). Two specimens, Lots 81 and 120, were too fragmentary to assign a reduction stage, but Lot 374 belongs to stage 4. All three are fragmentary chert bifaces that are complex-detachment based with collateral flake scar patterning and bifacial-bilateral edge construction. Attributes of these three materials are shown in Table 10.

Planers

Two specimens in the collection were identified as planers based upon use-wear and form (see Figure 36). Both specimens are chert, core-based bifaces with no alterations and convex edge morphology. Attributes of these materials are shown in Table 11.

Projectile Points

Projectile points were the most common type of core-based and complex-detachment tools recovered from 41CW104, accounting for a total of 13 specimens (Figure 37). All of these specimens are chert and represent the following subtype categories: Ensor dart point (n = 4), Fresno arrow point (n = 4), Indeterminate arrow point (n = 1), Indeterminate dart point (n = 1), Pedernales dart point (n = 1), and Scallorn arrow point (n = 2). These materials are further described below within each subtype. All additional metric data for each of the projectile points not presented below can be located in Appendix C, Projectile Point Metric Data.

Ensor Dart Point: All four Ensor dart points recovered at the site are side notched and stage 4. As mentioned previously, there are a variety of attributes that these four dart points share, including triangular blades, broad stems, shallow side notches, low base/stem ratios, bifacial-bilateral edge construction, and average edge angles ranging between 45 and 55 degrees. Variations in the attributes are presented in Table 12.

Only one of these specimens, Lot 211, exhibited use-wear in the form of bifacial flaking attrition along a single lateral edge and etching/pitting along a shallow distal edge. Ensor dart points generally date to the Late to Transitional Archaic and are widespread across central and south Texas (Suhm et al. 1954; Turner and Hester 1999).

Fresno Arrow Point: All four Fresno arrow points recovered at the site are triangular. As mentioned previously, these points have the following attributes in common: straight basal edges, bifacial-bilateral edge construction, base angles ranging between 70 and 85 degrees, and average edge angles ranging between 35 and 45 degrees. Variations in this subtype's attributes are presented in Table 13.

Three of the four specimens, Lots 51, 144, and 353, exhibited wear in the form of unifacial flaking attrition unilaterally along the distal edge. This Late Prehistoric subtype is widespread across Central Texas, East Texas, and the Coastal Plain (Suhm et al. 1954; Turner and Hester 1999). This subtype is very similar to the Granbury arrow points recovered at the Sandbur site (Kalter et al. 2005), or the specimens Skelton (1977) identified as Granbury preforms. Points of this shape and style are often referred to as arrow point performs; however, three of the four specimens are very finely flaked and appear to represent final-stage arrow points rather than preforms for another subtype. The final specimen, Lot 353, does appear to be a preform for the Fresno subtype. This specimen is made from a flake and still retains ventral flake attributes.

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Figure 36

41CW104
Core-based and Complex
Detachment-based Tool Types

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Drafted by: C. Wallace

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Figure 37

41CW104 Projectile Points

Table 10. Bifacial Knife Attributes

Lot No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Edge Angle (degree)	Failure/ Discard	Alteration	Edge Morphology	Use-derived Flaking Attrition	Polish
81	2.61	18.93	31.32	4.52	35	Hinge/ Step	None Observed	Convex	Unifacial – distal – unilateral	Shallow Distal
120	8.51	43.62	32.96	5.44	35	Snap/ End Shock	Thermal	Straight	Unifacial – distal – unilateral	Shallow Distal
374	10.98	47.19	28.92	9.32	45	Hinge/ Step	None Observed	Convex	Unifacial – distal – unilateral	Shallow Lateral

Table 11. Bifacial Planer Attributes

Lot No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Edge Angle (°)	Stage	Portion	Failure / Discard	Flake Scar Pattern	Edge Construction	Use-derived Flaking Attrition	Polish	Etching / Pitting
24	24.63	52.08	42.37	13.85	50	2	Complete	Indeterminate	Random	Bifacial-bilateral	Unifacial – distal – unilateral	Not Present	Shallow Distal
144	9.97	34.57	25.62	12.97	35	1	Proximal-medial	Material Flaw	Indeterminate	Indeterminate	Unifacial – unilateral	Shallow Lateral	Shallow Lateral

Table Lithic 12. Ensor Dart Point Attribute Variations

Lot No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Portion	Failure/Discard	Edge Morphology	Flake Scar Pattern	Proximal Edge Grinding	Base Form
10	3.30	34.70	18.35	6.13	Complete	Indeterminate	Straight	Collateral	Not Observed	Straight
169	10.50	50.09	27.37	7.93	Proximal – medial	Excessive Heating	Straight	Random	Observed	Concave
211	5.27	34.24	23.42	6.68	Proximal – medial	Impact/Bending	Straight	Collateral	Observed	Straight
314	8.68	37.74	29.34	6.41	Proximal – medial	Impact/Bending	Serrated	Oblique Transverse	Not Observed	Concave

Table 13. Fresno Arrow Point Attribute Variations

Lot No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Stage	Portion	Failure/Discard	Alteration	Edge Morphology	Flake Scar Pattern
51	2.09	28.08	20.26	3.47	4	Proximal – medial	Impact/Bending	None Observed	Straight	Collateral
114	4.70	49.18	17.51	6.40	4	Complete	Indeterminate	Thermal	Convex	Collateral
144	2.80	34.80	21.33	3.44	4	Proximal – medial	Impact/Bending	Thermal	Straight	Collateral
353	4.04	32.65	24.37	4.97	3	Proximal – medial	Indeterminate	None Observed	Convex	Random

Indeterminate Arrow Point: A single arrow point, Lot 155, was too fragmentary to assign a specific subtype, but did retain sufficient attributes to be considered an arrow point. This point is a proximal-medial fragment of a stage 4 arrow point, which has an impact/bending failure. Lot 155 has a mass of 1.30 g and is 22.47 mm long by 15.24 mm wide with a maximum thickness of 4.07 mm. Additional morphological features consist of serrated lateral edges, random flake scar patterning, bifacial-bilateral edge construction, 40-degree working edge angle, a proportionate base/stem ratio, straight basal edge, and an expanding stem. This specimen exhibits use-wear in the form of unifacial flaking attrition along both lateral edges. Both basal corners are broken off, inhibiting the determination of subtype.

Indeterminate Dart Point: A single dart point preform, Lot 77, was too fragmentary and early in reduction stage to further determine subtype but retained enough attributes to be classified as a dart point. This proximal-medial fragment, attributed to an impact/bending failure, has a mass of 7.78 g and is 44.38 mm long by 22.33 mm wide, with a maximum thickness of 6.99 mm. Additional morphological characteristics consist of straight lateral edges, collateral flake scar patterning, bifacial-bilateral edge construction, 50-degree working edge angle, a proportionate base/stem ratio, convex basal edge, and a slightly contracting stem. This specimen exhibits use-wear in the form of unifacial flaking attrition on both lateral edges.

Pedernales Dart Point: A single specimen, Lot 277, is the proximal-medial fragment of a rejuvenated Pedernales dart point with an impact/bending failure. This specimen has a mass of 3.33 g and is 31.78 mm long by 22.11 mm wide, with a maximum thickness of 5.91 mm. Additional morphological characteristics consist of straight lateral edges, random flake scar patterning, bifacial-bilateral edge construction, 35-degree working edge angle, a proportionate base/stem ratio, notched basal edge, and a parallel edged stem. No evidence of use-wear was observed. This Middle Archaic subtype is found widely across central Texas (Suhm et al. 1954; Turner and Hester 1999).

Scallorn Arrow Point: Both Lot 69 and Lot 325 are proximal-medial fragments of stage 4 side-notched Scallorn arrow points with impact/bending failures. As mentioned previously, these points have the following attributes in common: triangular blades, corner-notched straight lateral edges, well-barbed shoulders, straight basal edges, low base/stem ratios, collateral flake scar patterning, bifacial-bilateral edge construction, and average edge angles ranging from 35 to 45 degrees. Variations in the in this subtype's attributes are presented in Table 14.

Table 14. Scallorn Arrow Point Attribute Variations

Lot No.	Weight (g)	Length (mm)	Width (mm)	Thickness (mm)	Alteration
69	1.78	32.75	16.33	3.28	Thermal
325	0.97	26.05	14.25	2.86	Not Observed

Both specimens exhibit wear in the form of unifacial flaking attrition, bilaterally on Lot 69 and unilaterally along the distal end on Lot 325. This Late Prehistoric subtype is one of the most widespread arrow point varieties, and occurs all over Texas (Suhm et al. 1954; Turner and Hester 1999).

Scrapers

Scrapers were one of the most abundant core-based/complex detachment-based tools recovered at 41CW104, accounting for 21.2 percent of this tool subgroup. A total of 11 specimens were recovered in a variety of shapes and sizes, but all exhibited use-wear indicative of utilization for scraping activities (see Figure 36).

Of these 11 specimens, a single tool, Lot 395, was further assigned to the subtype of Clear Fork uniface. Lot 395 is a distal-medial fragment of a complex detachment-based, stage 4 uniface that has a mass of 20.52 g and is 44.28 mm long by 37.21 mm wide, with a maximum thickness of 13.65 mm. This specimen is made on a flake, with a working edge angle/bit edge of 60 degrees. This tool has convex lateral and distal edges, collateral flake scar patterning, and unifacial-circumferential edge construction. Wear suggesting utilization as a scraper, in the form of unifacial flaking attrition, occurs unilaterally along the distal edge, with shallow polish along the same edge. As suggested by Dial (1998), it is believed that the unifacial Clear Fork tools, such as this one, date a bit later than their bifacial counterparts and often indicate an Early to Middle Archaic component.

The remaining 10 scrapers exhibit a variety of different attributes. Morphological attributes and use-wear for these specimens are presented in Appendix C, Scraper Attributes.

Knife/Drill

A single multipurpose tool, Lot 390, is classified as a knife/drill based on use-wear and form (see Figure 36). Lot 390 is only a fragment of a complex detachment-based, stage 2 biface, which has an overshot failure. It has a mass of 6.92 g and is 56.35 mm long by 14.43 mm wide, with a maximum thickness of 13.83 mm and a working edge angle of 65 degrees. This tool has relatively straight lateral edges and bifacial-bilateral edge construction. Wear suggesting utilization as a knife occurs in the form of unifacial flaking attrition along a single lateral edge, with polish along the proximal edge. Wear suggesting utilization as a drill, in the form of etching/pitting, occurs deep along the distal edge.

Knife/Scraper

A single multipurpose tool, Lot 198, is classified as a knife/scraper based upon use-wear and form (see Figure 36). This biface tool is a complete, stage 1, complex detachment-based, informal biface with a 45-degree working edge angle. Lot 198 has a mass of 42.98 g and is 59.68 mm long by 59.68 mm wide, with a maximum thickness of 14.01 mm. The reason for its discard is indeterminate. The specimen has convex lateral edges and random flake scar patterning. Wear suggesting utilization as a knife, in the form of unifacial flaking attrition and polish, occurs along a lateral edge. Wear suggesting utilization as a scraper, in the form of unifacial flaking attrition, occurs along a single lateral edge.

Indeterminate

A total of 19 biface tools could not be further categorized by type due to their fragmentary nature or lack of use-wear. A single specimen, Lot 314, exhibited use-wear in the form of unifacial-bilateral flaking attrition. A variety of morphological attributes are represented within the indeterminate category, and all such attributes are shown in Appendix C, Indeterminate Biface Attributes.

Summary

The chipped stone assemblage is composed primarily of expedient, simple detachment-based tools. All of the core-based and complex detachment-based tools follow a clear, formalized reduction plan, as very few informal tools were recovered. Use-wear observed in the chipped stone assemblage primarily suggests activities dominated by plant processing and, secondarily, activities associated with hide processing and woodworking.

The Archaic portion of the lithic assemblage, including the Clear Fork unifaces and various dart points, is comparable to those Archaic components at the Sandbur site (Kalter et al. 2005) and the Buckhollow Encampment (41KM16) (Johnson 1994). However, the Late Prehistoric component at the site differs from many other sites in central Texas dating to this time period. Many Late Prehistoric sites in the region belong to the Toyah phase, evidenced by Perdiz and other stemmed arrow points (which are absent in the 41CW104 lithic assemblage), along with blade reduction technology. The lithic assemblage recovered from 41CW104, however, presents something different. This assemblage is more akin to the lithic traditions of coastal groups, further distinguished by triangular and side-notched arrow points, an extensive amount of expedient flake tools, and even a large amount of rejuvenated tools. It is probable that the Late Prehistoric lithic materials recovered at the site represent traditions of a more nomadic coastal group.

Ground, Polished, and Battered Stone Tools

Twenty-six ground, polished, and battered stone tools were recovered from 41CW104. Many of the stones are weathered; however, based on microscopic examination, the 26 tools can be assigned to six morphological (i.e., functional) categories: pitted anvil stone (n = 1), pitted mano (n = 1), mano/mano fragments (n = 15), mano/hammerstone (n = 2), plant processing stone (n = 2), and hide/meat processing stone (n = 1). Four indeterminate grinding stones were also recovered.

Thirty-five percent (n = 9) of the ground stone tools found at the site were recovered in and around Features 6, 7, 8, and 9 (Table 15). Sixteen tools were recovered from excavated units, and one was found in Scrape Area 3. Fifty-eight percent (n = 15) of the tools were found between Levels 4 and 9.

Among the 26 ground, battered, and polished stone tools, three raw material types were observed: chert, metaquartzite, and quartz arenite (Table 16). Stones of metaquartzite are, by far, the most common, with 50 percent of the tools being made from this raw material. Interestingly, there is also a high proportion of chert tools (38 percent). The range of raw material types is fairly low given the size of the sample.

Recognizing the range of use-related activities associated with any particular tool can be difficult; however, certain key attributes help to identify the different actions (or processes) and the range of materials that produced the distinctive wear found on specific tools (see Ground Stone Methodology). Examination under 10–20x power binocular magnification revealed the presence of seven types of wear, with more than one type of wear usually occurring on the same tool. The observed wear types included grinding, pecking, polishing, pitting, battering, striations, and notches. All data recorded for the ground stones are presented in Appendix C: Ground Stone Attributes.

Among the tools that could be assigned a morphological (i.e., functional) category, the majority were upper handheld stones (n = 19), and the four indeterminate grinding stones also appear to be upper stones. These are the stones that are the most easily manipulated and supply pressure during the two primary mechanical operations of pounding and rubbing (see Carter 1977; Kraybill 1977). Only one stone was classified as a lower anvil stone, or the tool that absorbs the pressure of pounding and rubbing (see Carter 1977; Kraybill 1977).

Pitted Lower Anvil Stone

A pitted anvil stone is a platform stone that exhibits one or more cupped depressions indicating a distinctive grinding and/or pounding operation. Large flat stones, such as grinding basins, are those most easily recognizable, but smaller stones are also considered anvil stones if they functionally serve as stationary platforms that absorb the pressure of grinding or pounding. The one anvil stone from 41CW104 was found in Block 2, Unit 18 (Lot 142.1) in close proximity to Feature 7. It is a relatively small globular-shaped stone that exhibits wear on two surfaces and along two edges. On one surface, numerous shallow, pits are located slightly off-center, suggesting forceful areas of impact (Figure 38, View A). Subsequent grinding on this surface leveled the more jagged edges of the pits and produced a distinctive polish that coats the high-relief areas. On its opposite side, a shallow, smooth basin is located roughly in the center of the face (see Figure 38, View B). The relatively smooth edges of this pitted depression suggest rubbing or grinding in a circular motion rather than pounding. Distinctive areas of polish occur across the face of the stone and around the margins of the face. On this face, the wear is concentrated on the high-relief areas, suggesting that

Table 15. Distribution of Ground Stone Tools by Unit

Tool Category	1	2	3	4	11	16	18	24	25	26	29	30	35	42	43N	45	52/50	F8	Scrape Area 3	Grand Total
Hide-processing Stone					1															1
Mano								1	1		1				1	1		3		8
Mano Fragment	1	1		2						1			1	1						7
Mano/Hammerstone								1											1	2
Plant-processing Stone							1										1			2
Pitted Mano						1														1
Pitted Anvil Stone							1													1
Indeterminate Grinding Stone	1	1	1									1								4
Grand Total	2	2	1	2	1	1	2	2	1	1	1	1	1	1	1	1	1	3	1	26

Table 16. Ground Stone Raw Material by Tool Category

Tool Category	Chert	Metaquartzite	Quartz Arenite	Grand Total
Mano	2	6		8
Mano Fragment	3	2	2	7
Mano/Hammerstone		1	1	2
Pitted Anvil Stone	1			1
Pitted Mano		1		1
Hide/Meat-processing Stone	1			1
Plant-processing Stone	2			
Indeterminate Grinding Stone	1	3		4
Total	10	13	3	26

this surface was used primarily to grind softer vegetal material. At some point during its use life, several large chips were knocked off around one edge; however, the stone continued to be used as these large flaked areas also exhibit thick areas of polish.

Manos/Mano Fragments

Eight complete manos and seven mano fragments, representing 58 percent of the ground, battered, and polished stone tools, were recovered from 41CW104. As a group, the recovered manos are relatively small when compared to other sites in the region. For example, the eight complete manos from the site range from 46.27 mm to 84.32 mm long, with an average length of 71.351 ± 11.334 mm. By contrast, the five complete manos found at the Sandbur site range from 84.8 mm to 103.73 mm long, averaging 99.94 ± 13.827 mm. This hints at some functional difference in the use of manos at these two sites and suggests that whatever substance(s) were being processed at 41CW104 may not have required a heavy stone (i.e., less pressure to process).

Only two of the manos exhibit evidence of battering. This indicates that the manos used at this site were used primarily for reducing mass through the grinding down of coarse particles into finer particles (i.e., nutmeats or soft vegetal material) rather than for pulverizing or crushing (i.e., dehulling nuts or pounding roots). The overall shape of the stones is also interesting in that seven of the eight complete manos as well as four of the mano fragments have one convex surface and one flattened surface (Figure 39, Lots 174.1–425.3). This wear pattern suggests that whatever was being ground involved a similar process. On six of the complete manos, polish occurs on the high-relief areas. In general, the surface-to-surface wear patterns found on these 15 tools and tool fragments suggest they were used to grind both hard and soft substances.

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0 1 2 3 4 5

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Figure 38

Site 41CW104
Pitted Lower Anvil Stone
(Lot 142.1)

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Figure 39

41CW104
Manos

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Drafted by: C. Wallace

Pitted Mano

In addition to evidence for generalized grinding, this stone (Lot 290.1) also exhibits pitted areas on three of its irregular surfaces (see Figure 39). One edge of the stone is missing, but the pitted areas appear as small, shallow dimples or depressions with smoothly ground edges rather than deep, conical-shaped pits with jagged edges. This suggests that they were used in a circular motion to crush or grind down substance(s) rather than to pulverize them. Grinding occurs on the high-relief areas, indicating that relatively soft substance(s) were being ground.

Mano/Hammerstone

The two stones assigned to this category show evidence of both battering and grinding. On both stones, the area of battering is localized. On specimen 185.1 (see Figure 39), an extensive area of forceful impact occurs around the edge and extends onto one face. Ground areas interspersed with areas of polish occur on the opposite face and on the flattened end.

On specimen 44.1 (see Figure 39), battering occurs only on one end, but the remainder of the stone exhibits extensive grinding interspersed with areas of polish. Peck marks randomly distributed around the tool suggest rejuvenation of the surface. On both stones, the working surfaces show that the polish occurs on the high-relief grains, and the interstices between the grains are free of debris, smooth, and as shiny as the grains themselves. In other areas, there is micro-fracturing of the interstices between the grains, and grinding has obliterated the interstices between the grains, leaving distinctive patches of polish. This mixture of wear types suggests that this tool may have been a multipurpose food-processing tool used to pound then grind both relatively hard substance(s) and softer vegetal material.

Hide/Meat-processing Stones

Experimental work has demonstrated that there are distinctive differences in the wear patterns between stones used to process hides and those used to grind harder materials such as dried corn, nuts, or clay (see Adams 1988, 1996; Keeley 1980). These experiments have shown that the overall working surfaces of hide-processing stones appear smoother with a noticeably greasy luster or sheen, while the working surfaces of manos used for grinding harder materials appear rougher and the surfaces often have a frosted appearance. This pattern also occurs when processing meat products, in general.

On hide/meat-processing stones, the interstices between the grains are free of debris, smooth, and as shiny as the grains themselves. Although the surface appears fairly uniform when viewed with the naked eye, microscopic examination reveals that the individual grains are left in high relief and rarely is there micro-flaking. A distinctive sheen or polish also occurs on both the grains and in the interstices. Thus, wear is visible as a lustrous sheen produced by adhesive and tribochemical wear processes and is concentrated on the topographic lows as well as the high-relief grains (Adams 1988, 1996; Keeley 1980).

Given this criteria, one hide/meat-processing stone was identified in the 41CW104 ground stone assemblage. The stone is a small triangular chert fragment that is wedge-shaped in profile (Figure 40, Lot 92.1). Its concave base and one face of the tool exhibit a lustrous polish. At the juncture of this face and the base, two small, polished notches occur. Ethnographic evidence indicates that nonflaked stones, such as this one, were frequently used during hide processing. For example, the Apache used a sharp-edged stone to deflesh or remove remnant hair from the hide (Opler 1941). The Apache also used rough stones to rework or resoften prepared buckskin (Opler 1941), and the Comanche used nonflaked stones during the braining task (Wallace and Hoebel 1952).

Plant-processing Stones

Two plant-processing stones were recovered at the site (see Figure 40, Lots 415.1 and 145.1). Both stones are stream-rolled cobbles that were picked up and used with no apparent modification. Their shape and size seems to have been part of the selection process as each stone has multiple natural ridges and flat facets that exhibit wear. One stone (Lot 415.1) was recovered from Feature 6, and the other (Lot 145.1) was recovered in close proximity to Feature 7.

The largest stone (Lot 415.1) has patches of very bright smooth polish that occurs on the flattened edges and extends onto the surface in various places. One end of the tool also exhibits a utilized edge. Detailed use-wear analysis of this tool shows a series of subparallel grooves and fine striations, as well as a bright polish with sharply defined edges. The uniform orientation of the striations suggests motor actions that are consistent with scraping rather than cutting. The highly polished flattened areas point to plant processing, and is very similar to the polish found on experimental tools used to decorticate prickly pear pads (see Chapter 7).

The other stone (Lot 145.1) is also a chert cobble that is subtriangular in shape. It is wedge-shaped in profile and has one mounded surface that exhibits grinding and polish on the high-relief areas. Polish occurs on one flattened side of the tool and extends around its edges onto the surface of the tool. The bright polish suggests that it was also a plant-processing tool.

Indeterminate Grinding Stones

Four stones are broken fragments from larger tools. Although they exhibit remnant patches of wear, they are too fragmented to confidently assign them to any particular morphological category.

Summary

The ground stone assemblage found at 41CW104 provides a unique opportunity to link artifacts with actual resource utilization at the site. In general, the 26 tools recovered at the site include

Lot 92.1
Hide/Meat-processing Stone

Lot 415.1
Plant-processing Stone

Lot 145.1
Plant-processing Stone
View A

Lot 145.1
Plant-processing Stone
View B

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Figure 40

41CW104
Hide/Meat- and Plant-processing Stones

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Drafted by: C. Wallace

primarily upper handheld stones whose wear patterns are heavily weighted toward grinding or rubbing activities rather than pulverizing activities. This is reflected in the low number of tools that exhibit battering along their edges (n = 3). In addition, on the three stones that exhibit pitted areas, the shallow, smooth pits point to a process that involves the grinding down of mass rather than the jagged pits that are more indicative of heavy pounding. The small number of acorn and other nutshells recovered at the site also suggests some nut-processing activities.

While there is evidence of meat- or hide-processing activities, the majority of wear patterns are characteristic of contact with a hard plant material like wood or fibrous or gritty plant material. The shiny plant polish observed on several tools is especially interesting in that the use-wear noted on one of the plant-processing stones is similar to the polish found on experimental tools used to decorticate prickly pear pads (see Chapter 7).

7

MICROWEAR ANALYSIS OF FORMAL TOOLS AND UTILIZED FLAKES

by Marilyn Shoberg, Digital Microscopy Laboratory
The University of Texas at Austin

Artifacts classified as Formal Tools from the Santa Maria Creek site in Caldwell County, 41CW104, were delivered for microwear analysis by Robert Rogers, Principal Investigator of the project and Senior Scientist at Atkins. After initial examination of the group of 40 tools at a magnification of 10x, the sample was reduced to 15 tools by eliminating small arrow points, small fragments of tools, and artifacts considered poor candidates for analysis because of thermal damage or other surface condition issues. In addition, four utilized flakes were added to the sample to be analyzed (Table 17).

Table 17. Artifacts Examined for Microwear

Lot #	FS #	Category
77	42	Dart point
81	47	Biface fragment (larger fragment in this lot #)
91	58	Biface
120	102	Dart point
138	126	Biface
168	175	Biface fragment
198	219	Biface
211	241	Biface
214	246	Biface
225	266	Biface
247	304	Uniface
268	334	Biface
348	472	Biface
374	511	Dart point
395	553	Uniface
55	6	Utilized flake
165	170	Utilized flake
185	203	Utilized flake
188	201	Utilized flake

METHODS

The 19 artifacts were cleaned for microwear analysis by brief agitation in an ultrasonic cleaning tank, suspended individually in a plastic bag with water and a few drops of household ammonia in order to remove adhering sediments, then rinsed in distilled water. During analysis, artifacts are periodically cleaned with alcohol to remove finger grease. Freehand drawings in pencil were made of both faces of the artifacts for the recording of locations of microwear observations and photomicrographs.

The functional analysis of stone tools from the Santa Maria Creek site follows the traceological method pioneered by Semenov (1964), comparing a complex of wear traces including edge damage, polishes, and striations on archeological specimens to those on experimental tool analogs. Microwear attributes are recorded and photographed at magnifications from 50X to 500X using a reflected-light differential-interference Olympus BH-2 microscope with Nomarski optics. This system of specialized optics uses divisions of polarized light to enhance surface contours.

Table 18 provides a summary of use for the examined artifacts. Unless otherwise noted, the edge of the tool is at the lower edge of the photomicrographs in this report.

Table 18. Summary of Use for Artifacts Examined for Microwear

Lot No.	FS No.	Atkins Tool Type	Used/Not Used	Analysis Summary
77	42	dart point	used	planing hard plant/wood with fracture edge
81	47	biface	not used	
91	58	biface	not used	core fragment
120	102	dart point	not used	
138	126	biface	used	cutting soft animal tissue with projection and edge
168	175	biface	not used	broken in manufacture
198	219	biface	used	cutting soft animal tissue
211	241	biface	not used	discarded in manufacture
214	246	biface	not used	
225	266	biface	not used	unfinished projectile point
247	304	uniface	not used	core or cobble reduction flake
268	334	biface	used	cutting plant material (fibrous or gritty)
348	472	biface	used	cutting reed or grass with fracture edge
374	511	biface	used	projectile point use, and butchering
395	553	uniface	used	primary use hide scraping, secondary cutting hide with fractured edge
55	6	flake	used	scraping plant material, possible grass or reed
165	170	flake	used	scraping unknown material
185	203	flake	used	cutting soft animal tissue
188	201	flake	used	cutting soft and hard animal tissue, hafted

ANALYSIS

Dart Point 77-42: This is the proximal end of a dart point. The raw material is a fine-grained translucent brown chert. A snap fracture is perpendicular to the long axis, located approximately in the middle of the body of the artifact. The artifact may have broken during manufacture. Lateral edges are sharp and appear unused. There is no evidence of hafting on the stem of the point.

On one side of the artifact at the thickest area along the fractured edge, patches of smooth domed polish are present on two flat triangular facets, the remnants of two flake scars. The polish is on the high microtopography of the chert and wraps over the fractured edge. Undulations in the polish surface as well as smooth-bottomed grooves are oriented perpendicular to the fractured edge, reflecting the direction of motion during the use of this edge (Figures 41–43). The undulating smooth-textured polish is characteristic of contact with a hard plant material like wood. One surface at the fractured edge of this broken dart point appears to have been held at a low angle and used in a planing motion perpendicular to the edge on a hard plant material like wood.

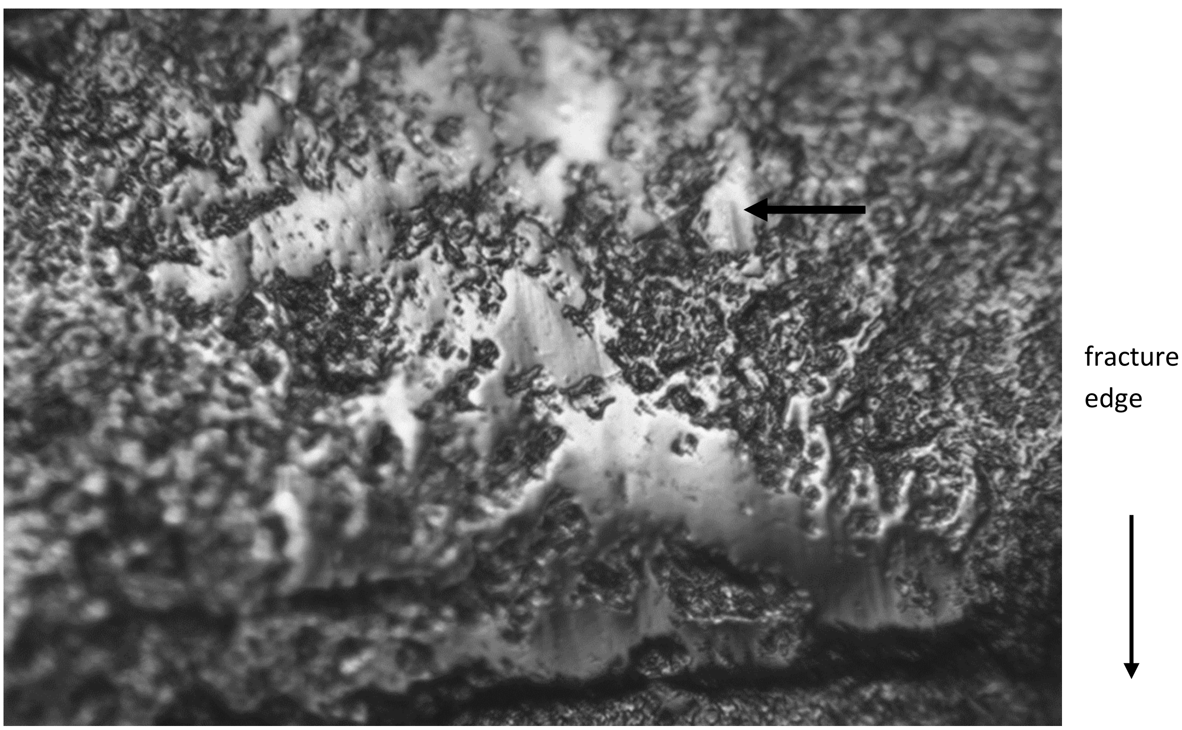

Figure 41: Dart Point 77-42, smooth-bottomed grooves in the polish surface, visible at 200x and 500x (arrows), are oriented perpendicular to the fractured edge, reflecting the direction of motion during the use of this edge (Image 77-42 side 1a @ 200x).

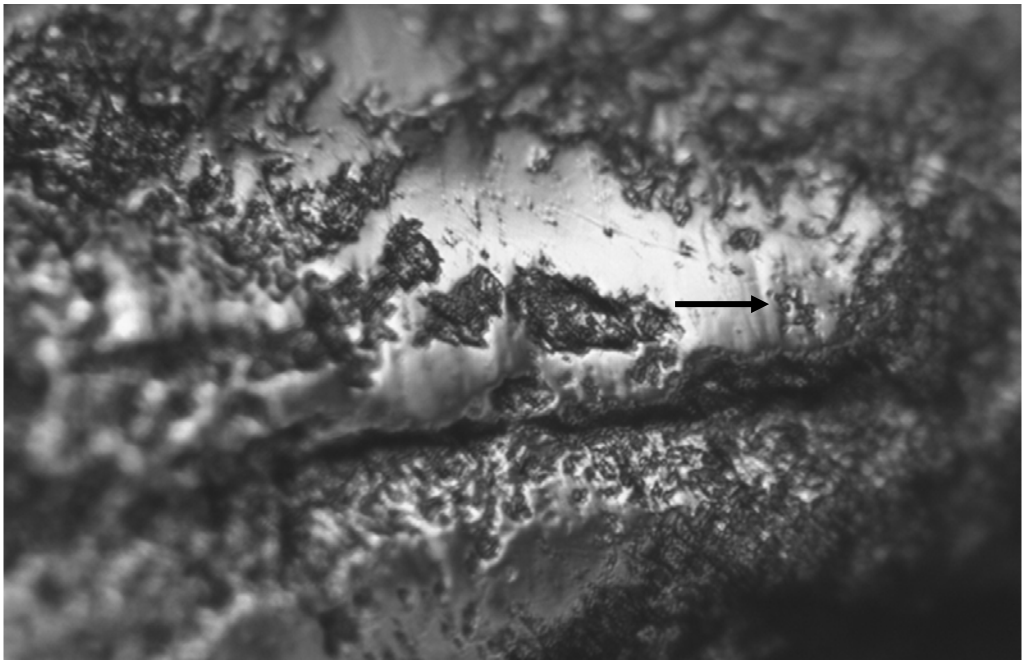

Figure 42: Dart Point 77-42, smooth trough (arrow) in polish is perpendicular to the edge (Image 77-42 side 1a [location 2] @ 200x).

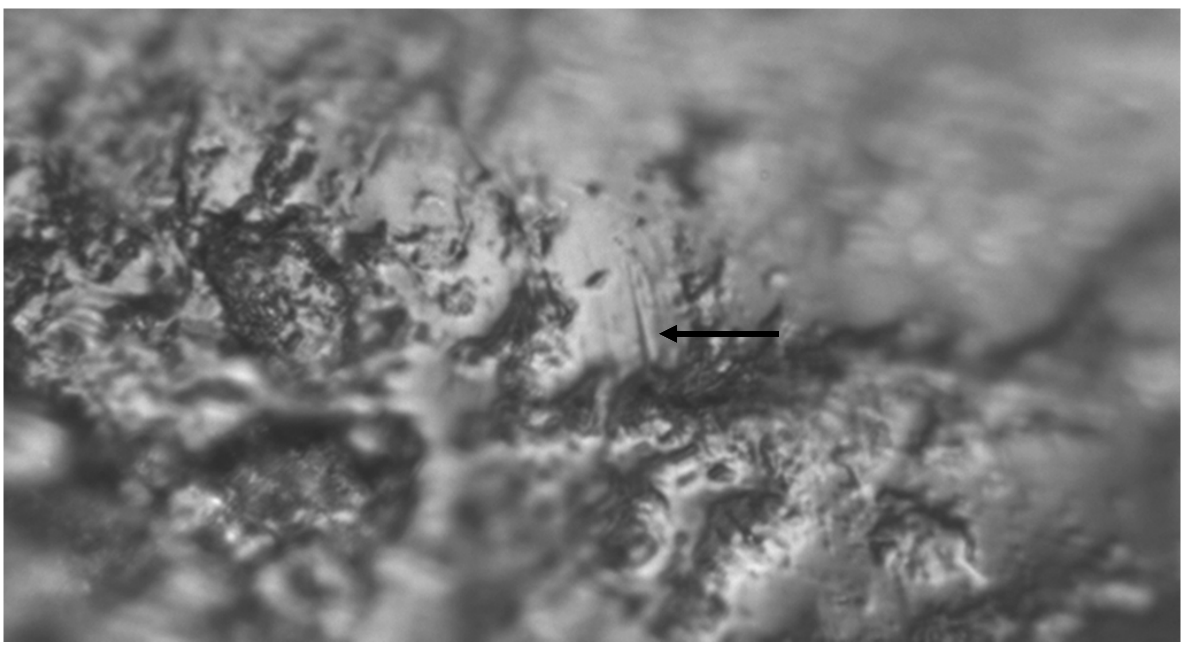

Figure 43: Dart Point 77-42, arrow indicates a trough in smooth domed hard plant polish; this linear feature oriented perpendicular to the tool edge reflects the direction of motion during use (Image 77-42 side 1a @ 500x).

Biface Fragment 81-47: The larger fragment in this lot and field specimen number was analyzed for evidence of microwear. This very thin biface fragment is manufactured of fine-grained brown chert. This may be the proximal fragment of a well-made thin biface. The break is a diagonal transverse fracture. The finished edges and the edges of the fracture were examined at both low and high magnification, and no evidence of use was found.

Biface 91-58: This biface of medium-grained brown chert has an irregular form and flake removal pattern. Multiple areas around the perimeter of the artifact have crushed impact fractures. This is a core fragment, and not an early manufacturing stage of biface manufacture. There are no good utilitarian edges or projections and no evidence that any edges were used. Overall diffuse abrasive polish is likely from handling.

Dart Point 120-102: The artifact is the basal fragment of a well-made very thin biface made of coarse-grained crystalline gray-brown raw material. The break is a diagonally oriented transverse fracture. Two areas of "nibbled" edge flaking along the fracture edge may or may not be from use. No visible polish developed on these flake scars or on adjacent surfaces. There is no microscopic evidence of use-wear on the finished edges of the biface.

Biface 138-126: The biface has an irregular outline and is made of gray and tan chert. It is relatively thick and has had thinning flakes removed from both faces; however, the intended finished form is not clear. Recent damage has removed a portion of the edge.

An isolated projection has the most evidence for having been used. The tip of the projection is worn from the removal of large and small, flat and step fracture flakes that extend from the tip along a 1-cm-long section of the edge. This area is smoothed and polished from wear. At high magnification, the polish on the tip and along the edge is invasive, developed on the high and low microtopography of the chert. Multidirectional fine striations formed in the polish during use (Figure 44). The wear patterns are characteristic of cutting soft animal tissue.

Biface Fragment 168-175: The raw material of this unfinished biface is fine-grained tan chert that has been heated. One face is relatively flat and has cortex remaining. The opposite face has a thick domed stack. Attempts to thin this area terminated in abrupt hinge fractures. The rounded end is bifacially thinned, while the opposite end terminates in a transverse fracture. The artifact appears to have been discarded in the manufacturing process. There is no microscopic evidence that the edges of the unfinished biface were used.

Biface 198-219: The bifacial tool is made on a cortical flake from a fine-grained brown chert cobble. The dorsal surface is approximately 70 percent cortex from the original cobble. The thicker "working" end of the tool has had a series of 8 flakes removed from the dorsal side to produce a cortex-free rounded edge outline. The ventral surface has had about 12 large thinning flakes removed, most originating at the distal “working” end; at least 2 thinning flakes originate from the lateral edges.

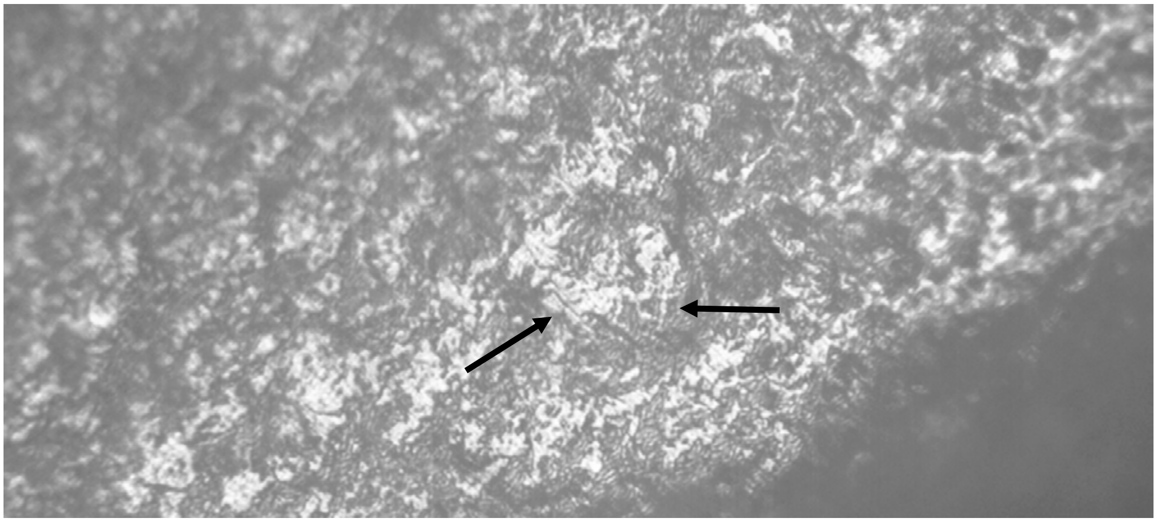

Figure 44: Biface 138-126 on the utilized tip; arrows indicate fine striations; the rounded edge is at lower right (Image 138-126 dd @ 200x).

Microwear evidence visible at a magnification of 10x consists of multiple series of smoothed, polished edge-damage flakes on both the ventral and dorsal sides of the thinned edge. When viewed from the dorsal or cortical side with the working edge up, the area with greatest wear is the upper left lateral edge. At low magnification, polish is well developed at the edges but also extends into the body of the tool and is down in old flake scars as well as on high ridges.

At magnifications of 50x and 200x, micro flakes have been detached from both the dorsal and ventral sides of the utilized edge (Figures 45 and 46), and bright invasive polish is well-developed from the edge and extends to surfaces interior to the edge (Figure 47). Multidirectional single striations in the polish are visible at 200x, oriented parallel, oblique, and perpendicular to the edge, reflecting multidirectional cutting motions (Figure 48). The invasive polish distributed over the working surfaces and microscopically developed on both high and low microtopography of the chert is characteristic of contact with soft animal tissue.

Summary: A working edge on this tool was created by bifacially thinning one end of a cortical flake from a chert cobble. This tool was used in multidirectional cutting motions on soft animal tissue. The tool appears to have been hand held and used long enough for areas of the edge to be rounded and smoothed.

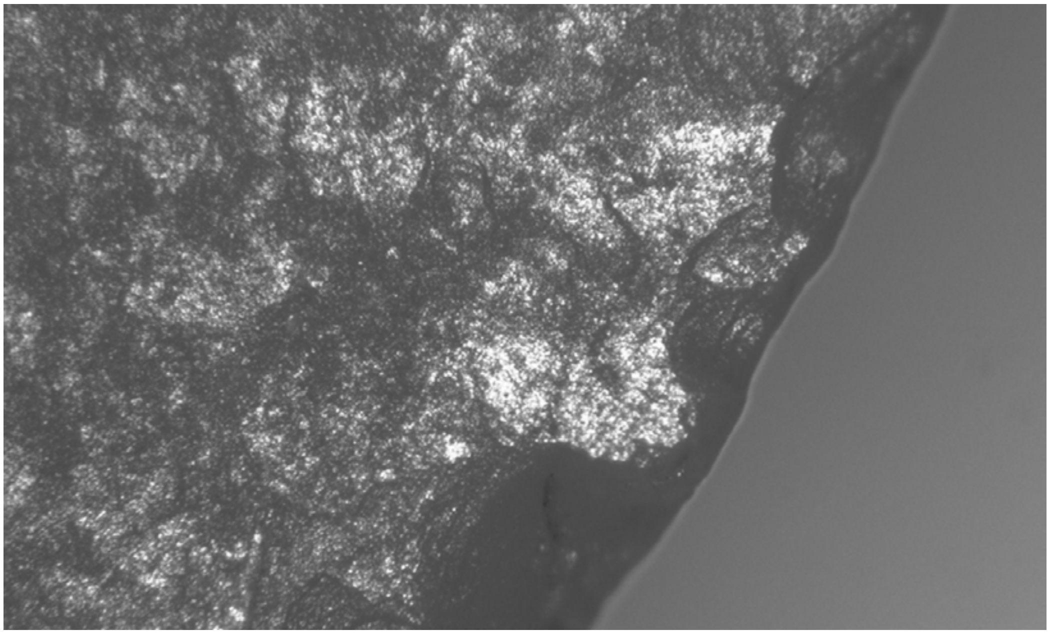

Figure 45: Biface 198-219, micro flakes have been detached from the dorsal face of this edge, polish is well developed on all surfaces, and the edge is rounded from use (Image 198-219 da @ 50x).

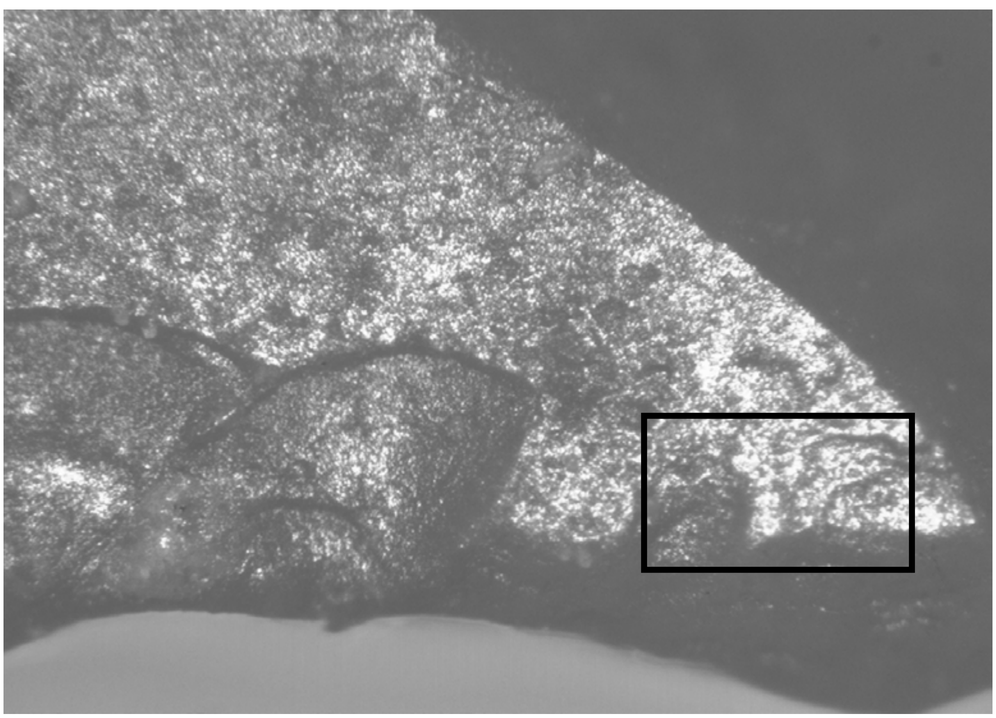

Figure 46: Biface 198-219, ventral face of utilized edge; area in rectangle is enlarged at 200x on Figure 47; polish extends from the edge into the interior of the tool (Image 198-219 vb @ 50x).

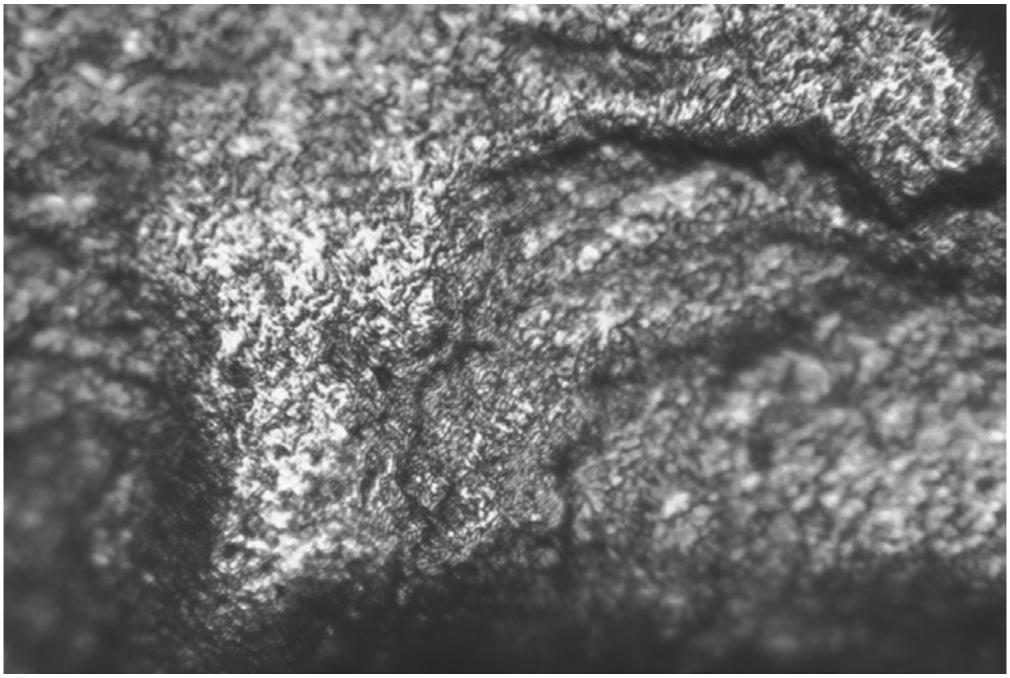

Figure 47: Biface 198-219 (Image 198-219 vb @ 200x)

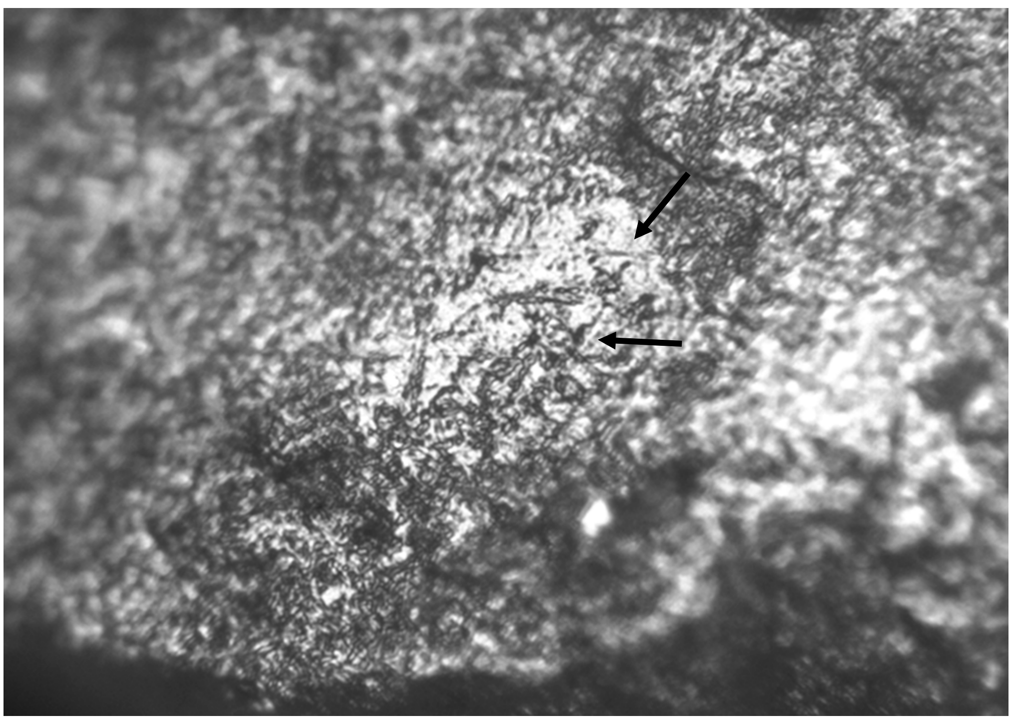

Figure 48: Biface 198-219, striations (at arrows) are oriented parallel, perpendicular, and oblique to the edge, just beyond the bottom of the photomicrograph (Image 198-219 dc @ 200x).

Biface 211-241: This roughly triangular artifact was manufactured from a cobble of gray-brown chert. Cortex remains on both faces. The artifact is unfinished, and there is no macroscopic or microscopic evidence that any of the edges were used.

Biface 214-246: This large bifacially flaked cobble is a coarse-grained brown material with numerous pockets of quartz inclusions. It vaguely resembles a chopper. One area of the edge is slightly smoothed, but there is no microscopic evidence that any of the edges were used.

Biface 225-266: The raw material of the biface is good-quality fine-grained brown chert. Side 1 of the biface has a relatively flat surface and the general shape of a projectile point. Side 2 is unfinished. The biface is very thick and domed at the distal tip, and the right lateral edge rises abruptly to a thick middle. The distal tip is crushed. The biface appears to be an unfinished projectile point. At high magnification, no areas of use were found on the edges or tip of the biface.

Uniface 247-304: The uniface is made on a cortical flake from a cobble of light gray chert. The striking platform, bulb of percussion, and eraillure flake scar are the only features on the ventral surface of the flake. Much of the raw material has the light chalky degraded texture of chert just interior to the cortical exterior of the cobble or nodule and is a poor surface for polish development or observations of microwear features. The dorsal or cortical side of the flake has had a series of flakes removed that terminated in hinge or step fractures. This artifact is more likely a byproduct of cobble reduction than an intentionally manufactured tool.

Microscopically, there is weak generic polish on the striking platform and one edge; however, there are no linear features in the polish, and no definitive use can be determined.

Biface 268-334: This artifact is made on a cortical flake from a heated fine-grained brown chert cobble. Strictly speaking, it has been unifacially modified, since no flakes have been intentionally removed from the ventral surface of the flake. On the dorsal or cortical surface, one edge is unmodified, the two opposite long edges have had one or two flakes removed each, and the remaining edge has had at least four flakes removed to achieve a thin functionally useful edge. A portion of this edge is gone, likely the result of excavation damage. A continuous series of flake scars on this edge appear fresh, with no patination or polish in comparison to other surfaces on the artifact.

Very bright polish is visible on both faces of the rounded corner of the utilized edge. At high magnification the polish is completely linked, a continuous blanket covering the chert surface and wrapping over the edge. The flat polished surface is densely crisscrossed by a web of multidirectional striations, oriented parallel and oblique to the edge of the flake. The striations are variable in width. As micropolish forms during the use of the edge, fibers, grit particles, or microchips from the tool itself are dragged over the surface with each stroke and leave tracks or striations in the polish that reflect the kinematics of use, the directional motion of individual use actions. The edge of this tool was well-used for multidirectional cutting of fibrous or gritty plant material (Figures 49–51).

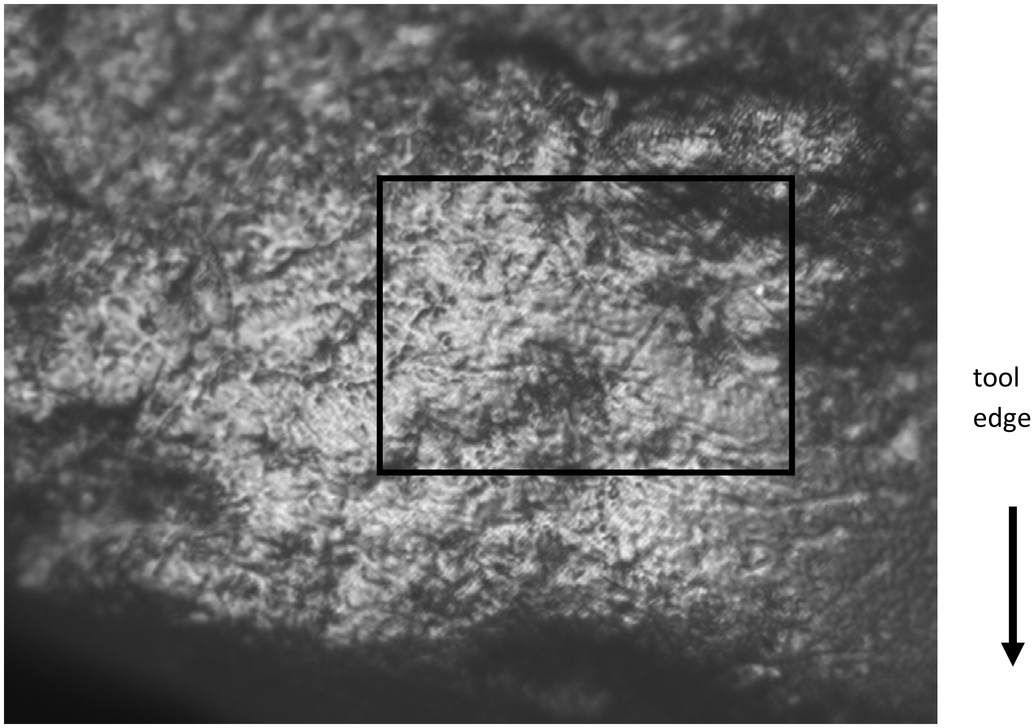

Figure 49: Biface 268-334, tool edge, area in rectangle is enlarged at 500x on Figure 50 (Image 268-334 side 1b @ 200x).

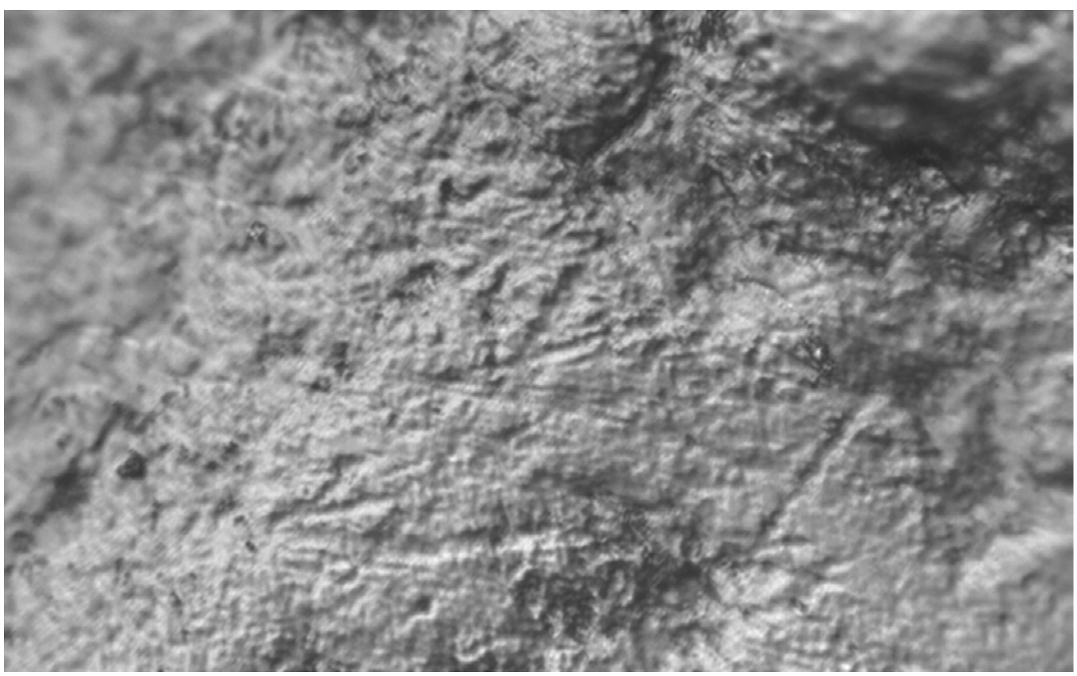

Figure 50: Biface 268-334, overlapping multidirectional striations reflect cutting motions with this edge (Image 268-334 side 1b @ 500x).

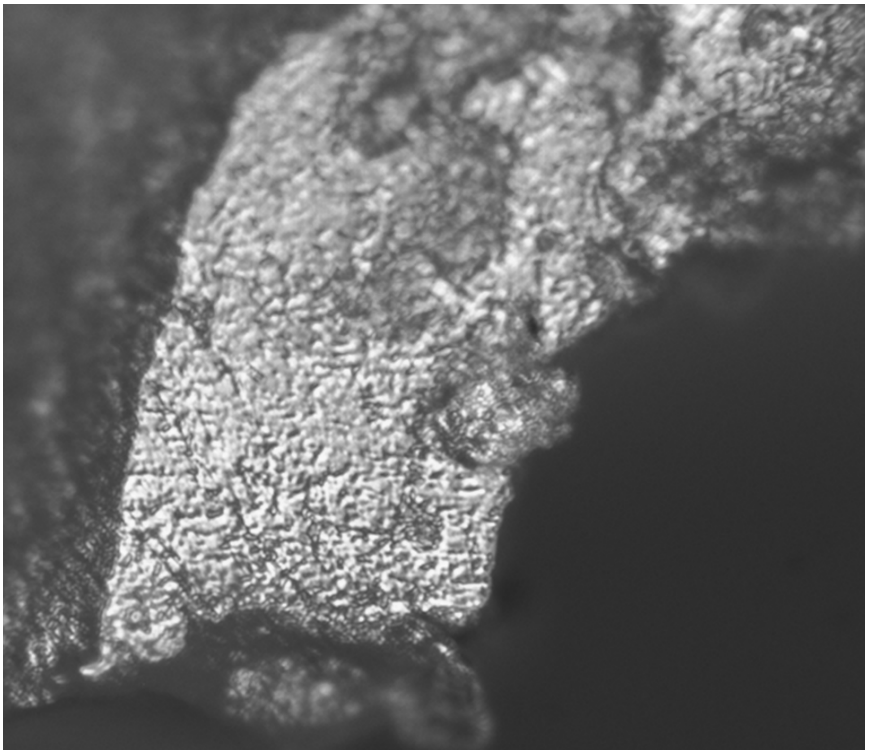

Figure 51: Biface 268-334, equally well-developed polish and striations on both faces of the utilized edge (Image 268-334 side 2b @ 200x).

Biface 348-472: The tool is a fragment of a large unfinished biface made of fine-grained brown chert. There are areas along both lateral edges with remnants of cortex that are insufficiently thinned for a finished biface. A twisting transverse fracture ended the biface manufacturing process. Patches of very bright polish are visible at low magnification on both faces of the artifact along the edge of the fracture.

At high magnification the polish is very smooth and has a domed appearance on the high microtopography of the chert surface. Very fine linear features in the polish are oriented parallel to the edge of the fracture and reflect a unidirectional cutting motion parallel to this long straight edge (Figures 52–54).

This smooth, domed polish that has developed on high points and wrapped over the edge (Figure 55) is characteristic of grass or reed polish. In experiments cutting native grass, polish develops very quickly into a solid bright continuous ribbon along the utilized edge. It is estimated that the degree of polish development on the edges of this tool represents a one-time use of perhaps one-half hour duration.

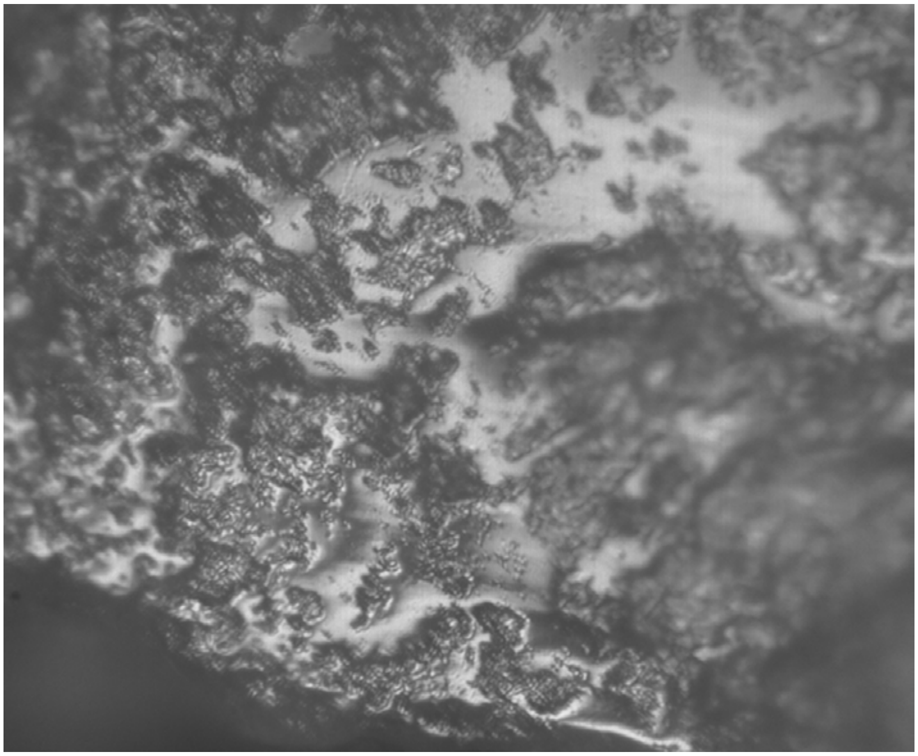

Figure 52: Biface fragment 348-472, individual components of very bright, smooth, domed polish are beginning to link up along the utilized edge of the tool (Image 348-472 side 1 b @ 200x).

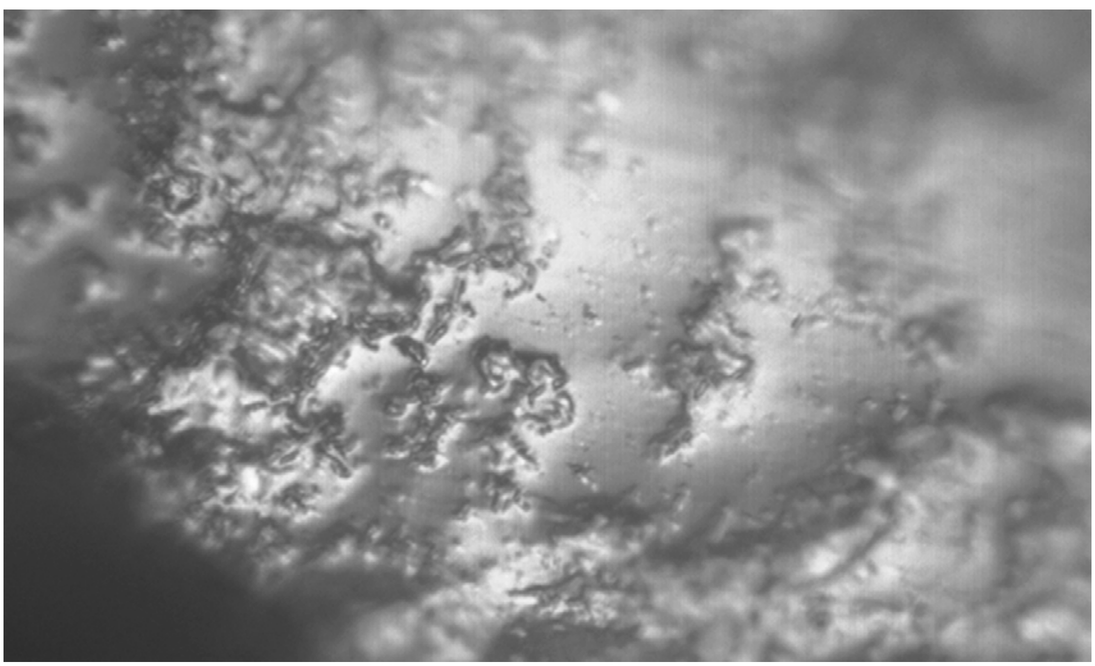

Figure 53: Biface fragment 348-472, very fine lines in smooth, domed polish are parallel to the fracture edge beyond the bottom of the photomicrograph. (Image 348-472 side 1b @ 500x).

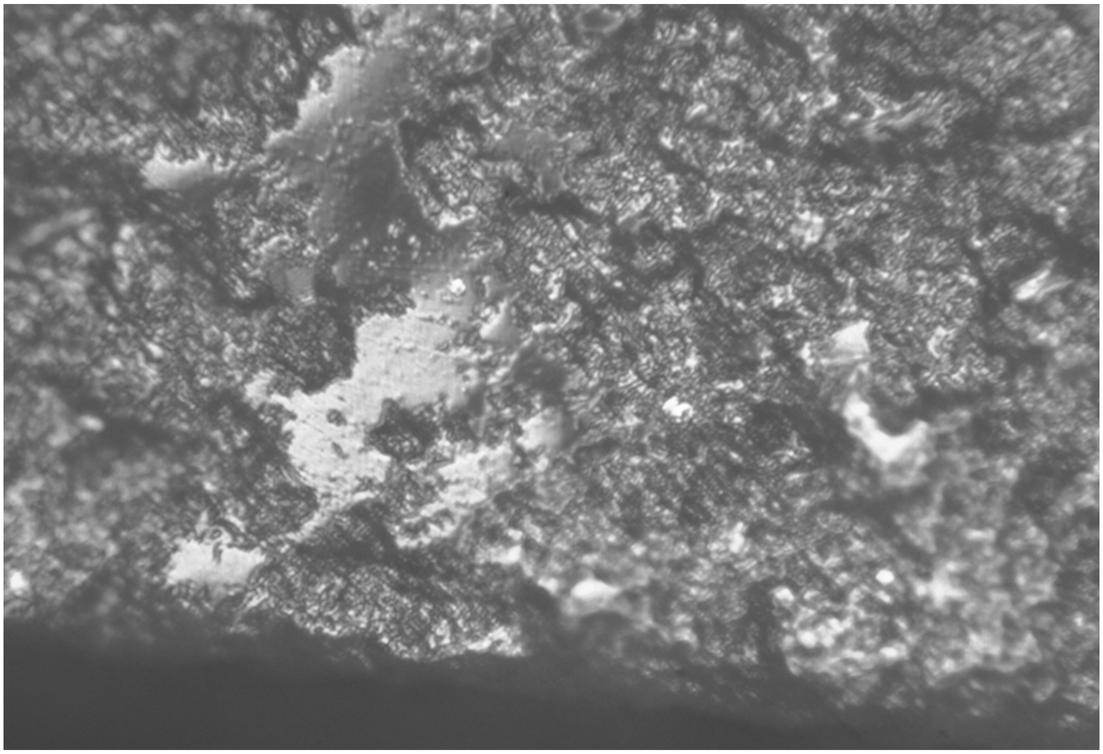

Figure 54: Biface fragment 348-472, domed polish components on the opposite side of the utilized edge (Image 348-472 side 2b @ 200x).

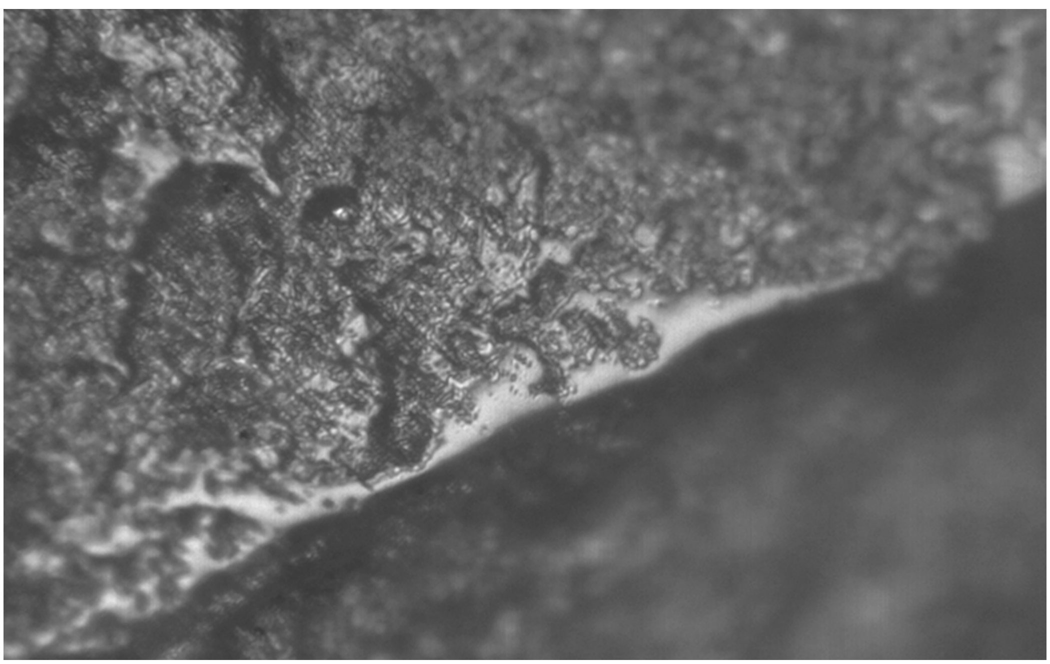

Figure 55: Biface fragment 348-472, continuous ribbon of smooth, domed polish wraps over the edge along the fracture (Image 348-472 fracture face a @ 200x).

Dart Point 374-511: This artifact is the distal fragment of a dart point made of fine-grained mottled brown chert. The proximal end terminates in a bending transverse fracture. The very fine distal tip is snapped off.

At a magnification of 50x, micro flaking is visible all around the snapped termination of the tip, and surfaces are covered with well-developed polish. Multidirectional single striations are in invasive polish all over the distal edges and tip (Figure 56). This reflects cutting actions in soft tissue. On Figure 57 smooth grooves in polish are parallel to the dart point axis and are from contact with hard material like bone or tendon. On Figure 57 there are fine striations perpendicular and oblique to the axis that are from fine grit and cutting motions. The large-diameter smooth grooves could be from impact, from use as a projectile point before the point broke, but the grooves are part of the greater body of evidence for this artifact having been used as a butchering tool.

There is evidence, however, for use as a projectile point on Figures 58 and 59. Very fine subparallel striations are aligned with the long axis of the point on a ridge at the thick midline of the point. These linear polish features have been observed on projectile points by many lithic analysts as summarized by Dockall (1997:322). At a magnification of 500x, it is clear that the long, straight subparallel striations are crosscut by more-randomly oriented fine and coarse striations. That means the striations that are perpendicular and oblique to the axis and cut across the impact striations occurred later in time and are from cutting motions that occurred in a subsequent use event. Multidirectional cutting striations in invasive polish were observed along the edges of the point as well. Contact with hard tissue like bone or tendon combined with soft animal tissue cutting indicates use as a butchering tool.

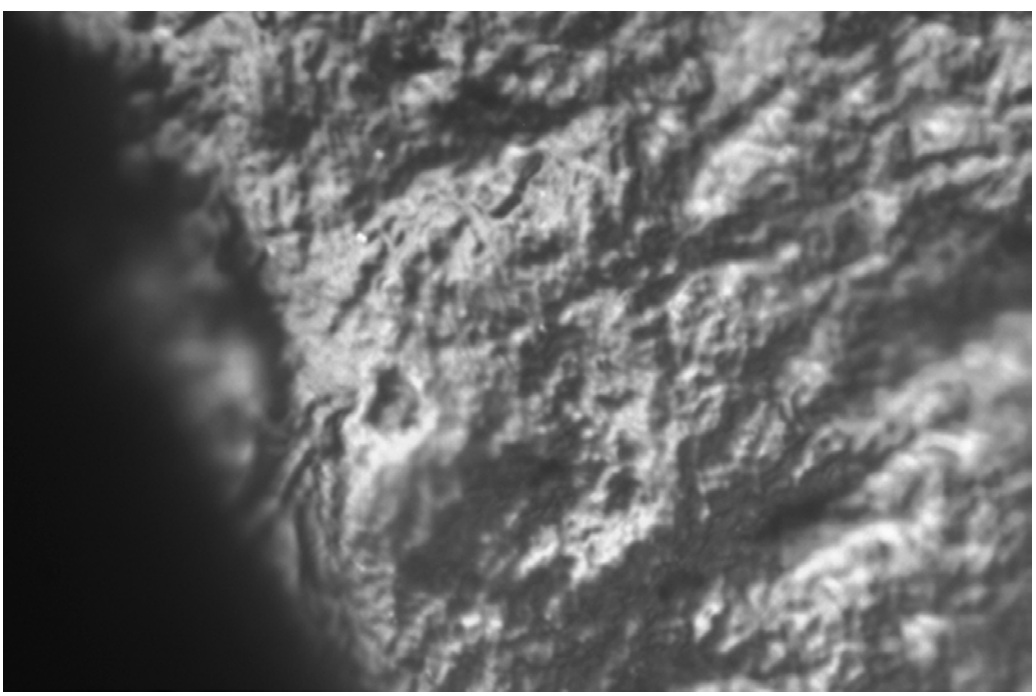

Figure 56: Biface fragment 374-511 (Image 374-511 side 1a @ 500x).

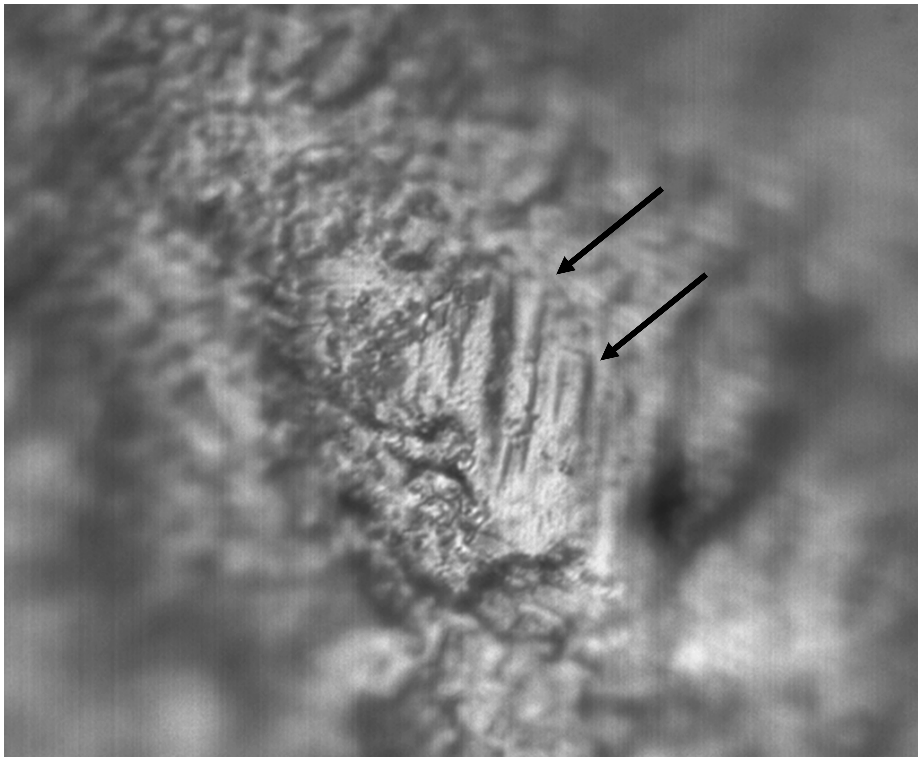

Figure 57: Biface fragment 374-511, smooth grooves are from contact with hard material like bone or tendon (Image 374-511 side 1b @ 500x).

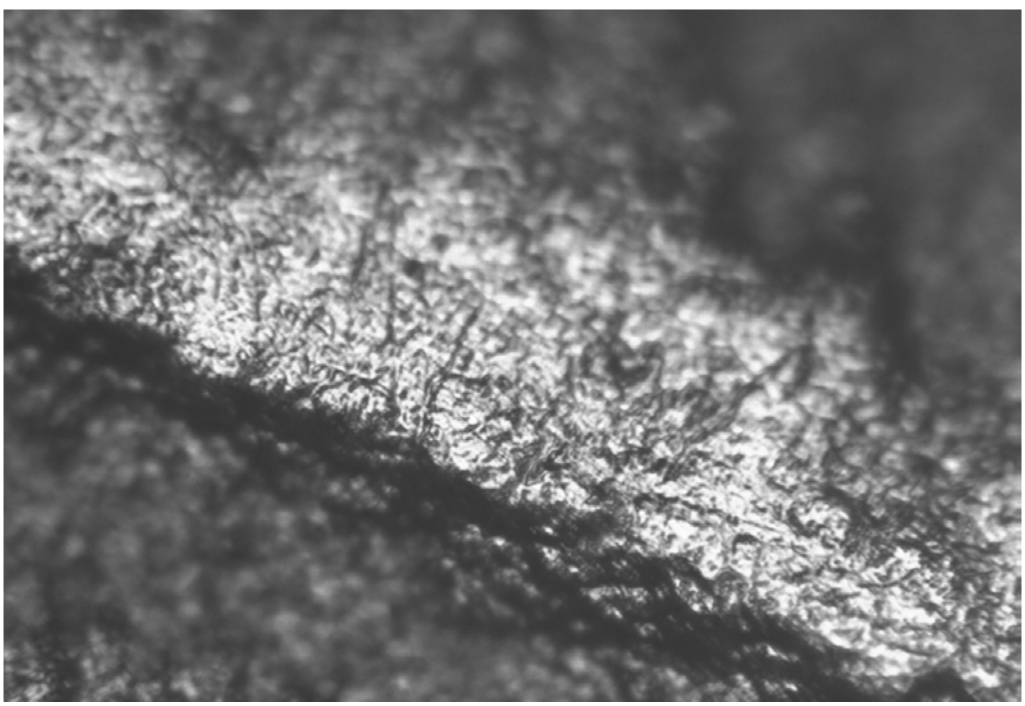

Figure 58: Biface fragment 374-511, multidirectional striations on the midline of the artifact (Image 374-511 side 2a @ 200x).

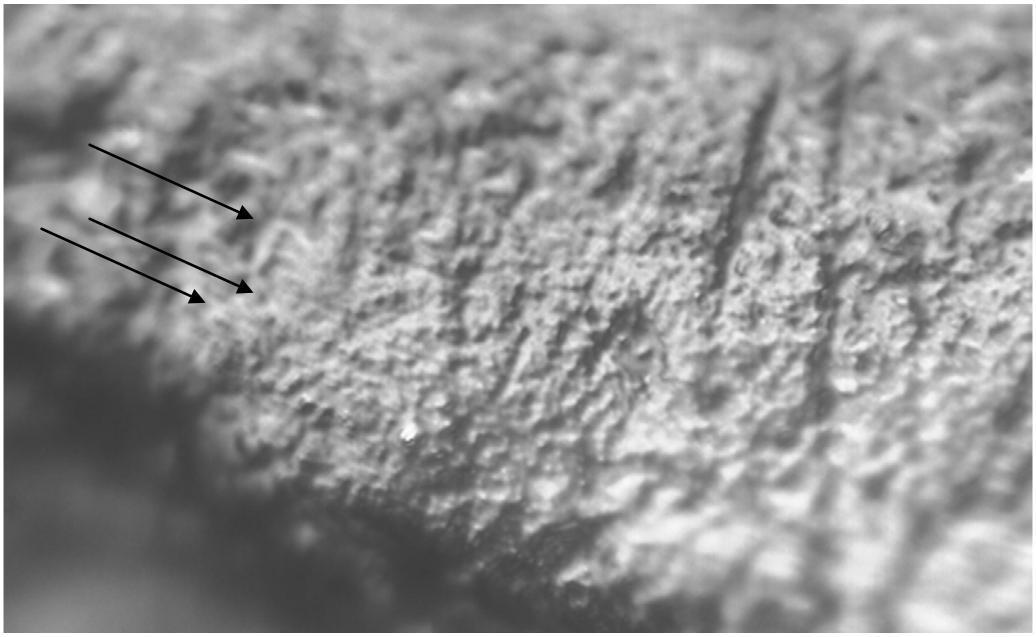

Figure 59: Biface fragment 374-511, arrows indicate the orientations of very fine subparallel striations that are aligned with the long axis of the point and are crosscut by later single striations of varying diameter (Image 374-511 side 2a @ 500x).

Unifacial Tool 395-553: This tool is the distal fragment of an end scraper made on a thick flake. The raw material is very fine-grained brown chert. The working end of the tool was skillfully shaped by the removal of thin flakes back from the end to a peak 2 cm from the end and equidistant from both lateral edges so that the thickest part of the tool is 1.36 cm thick. The tool fractured in a long diagonal fracture from one distal corner across the body to the opposite lateral edge. The edges and flake scars on the distal edge and the remaining lateral edge are rounded and smooth from wear (Figures 60 and 61), with polish down in old flake scars.

At high magnification, coarse-textured invasive polish completely covers the dorsal and ventral surfaces of the distal and lateral edge, covering both high and low microtopography of the chert (Figures 62 and 63). Striations of varying width are oriented parallel and oblique to the edge of the tool. Abrasive particles are embedded in the polish.

Both edges of the fracture are rounded and smooth. The same coarse-textured invasive polish is visible along both edges. Striations are parallel and oblique to these edges (Figures 64 and 65), reflecting cutting actions in a gritty animal contact material.

The microwear attributes of rounded edges and flake scars, coarse-textured invasive polish, and striations of variable width from grit particles are all characteristic of use in hide scraping.

Summary: This is a well-made tool, well used as a hide scraper, and had continued use after fracture as a hide-cutting tool.

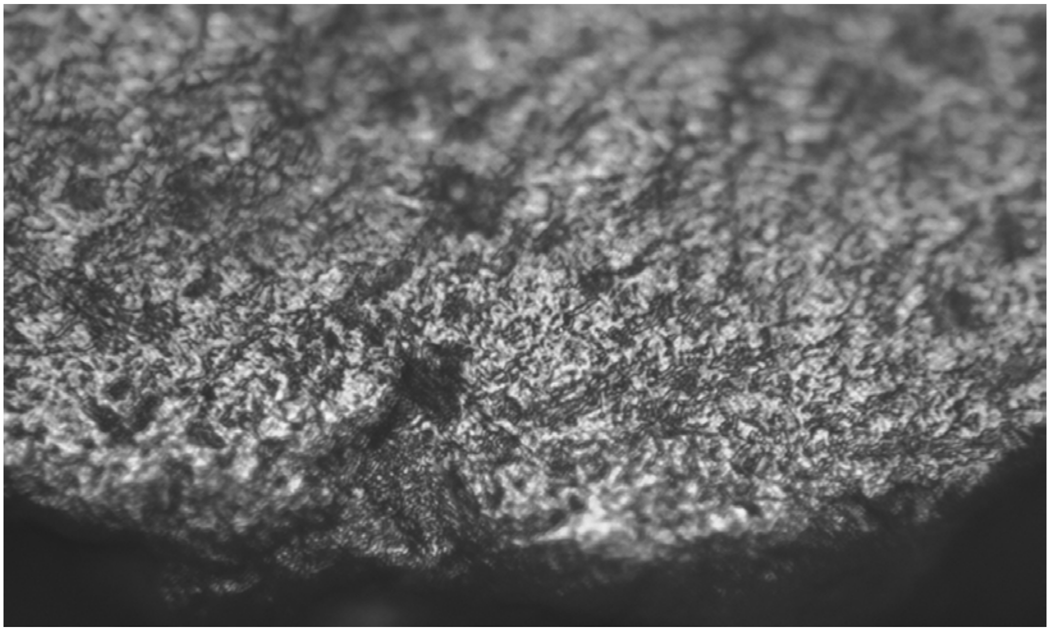

Figure 60: Unifacial tool 395-553, the lateral edge is rounded and polished. Multidirectional single striations are oriented oblique to the edge (Image 395-553 va @ 200x).

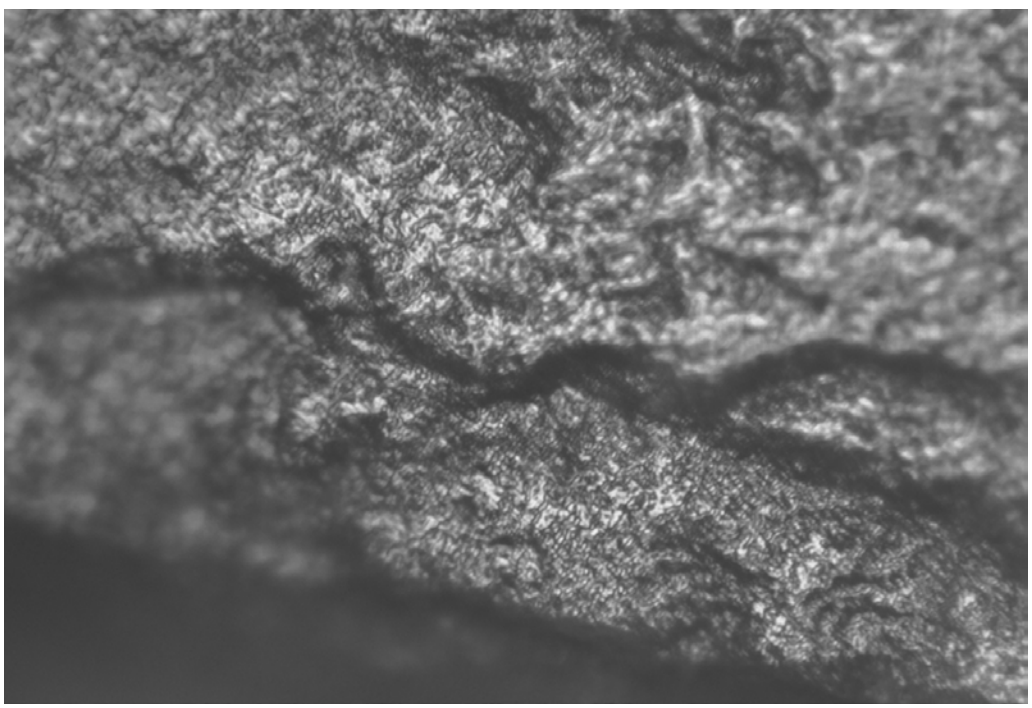

Figure 61: Unifacial tool 395-553, edges of step-termination flake scars back from the edge are rounded and smooth (Image 395-553 vc @ 200x).

Figure 62: Unifacial tool 395-553, striations in coarse-textured invasive polish are oriented parallel and oblique to the edge (beyond the bottom of the photomicrograph) (Image 395-553 vb @ 500x).

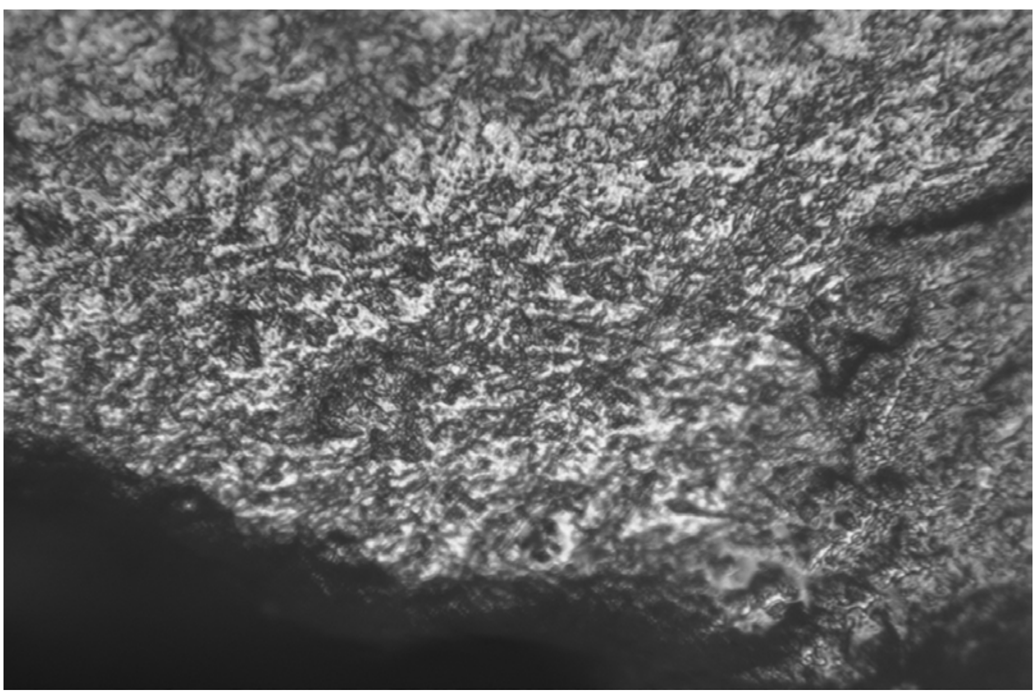

Figure 63: Unifacial tool 395-553, same as Figure 62, multidirectional striations in polish that extends from the edge to the interior, characteristic of soft tissue contact (Image 395-553 vb @ 200x).

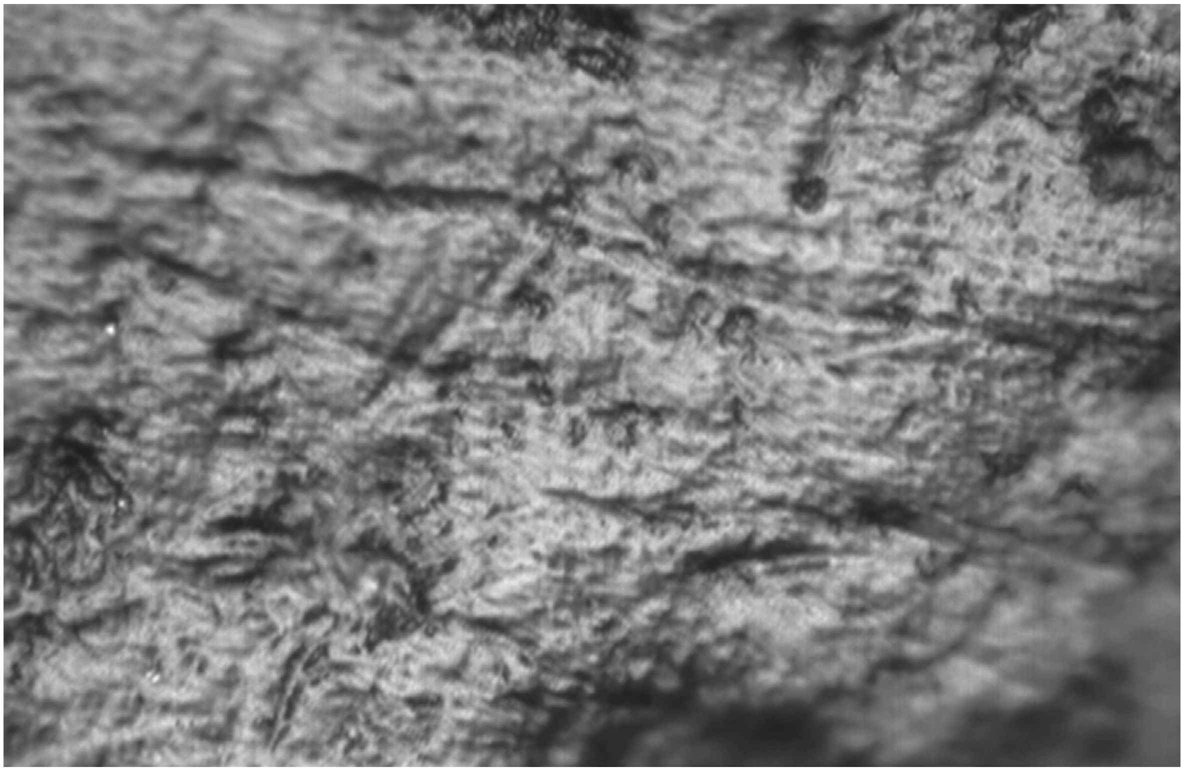

Figure 64: Unifacial tool 395-553, large-diameter, rough-edged striations are parallel to the fracture edge in this image (Image 395-553 vd @ 500x).

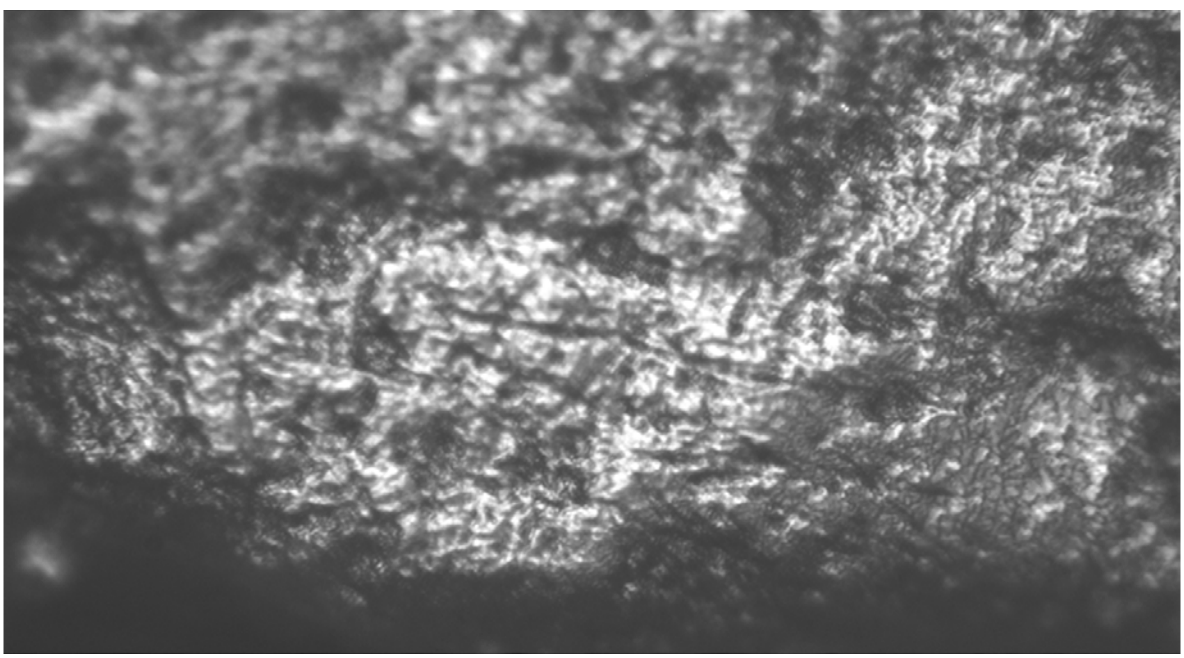

Figure 65: Unifacial tool 395-553, in a broader view, striations oblique to the edge are also seen (Image 395-553 vd @ 200x).

Utilized Flake 55-6: The small, thick, irregularly shaped flake is medium-grained caramel-brown chert with a remnant of cortex on the dorsal surface. A 5-mm-long section of an edge on the dorsal surface, opposite the cortex, is beveled, and has visible bright patches of polish along the edge on both dorsal and ventral surfaces (Figure 66).

At a magnification of 200x, patches of bright, smooth, domed polish are visible on both faces of the edge and down in the beveled scars (Figure 67). The polish wraps around the edge of the flake along this utilized edge (Figure 68), and the patches of polish have well-defined margins. The surface of the polish appears pitted, and scratched, possibly from grit particles at the interface between tool and contact material when the small flake was used (Figure 69).

The attributes of smooth-domed polish distributed in a continuous ribbon along and wrapped around the edge of the flake are characteristic of contact with a silica-rich plant material like grass or reed (Figure 70). The small utilized area of the beveled scar with polish in it, 5 mm long, suggests scraping something like small-diameter plant stem material.

Utilized Flake 165-170: This very thick flake is a medium-grained pinkish brown chert. The stone appears to have been heated. The ventral side of one edge has a 2-cm-long bevel from the removal of a continuous series of small flakes.

At magnifications from 50x to 200x, the artifact has an overall sheen on all surfaces, not more well developed at the apparently utilized edge. This sheen is frequently seen on heat-treated chert, and may mask any polish from use-wear. No definitive linear features were found at high magnification along the ventral or dorsal faces of the beveled edge.

It is postulated that the beveled edge of the flake was used, probably for scraping a hard material. No precise observations about contact material or direction of motion can be inferred since no polish related to the use of this edge could be found.

Utilized Flake 185-203: This complete flake is a very fine-grained gray-brown chert, has cortex on the striking platform, and a feather termination. Broad areas of very bright polish are visible on both dorsal and ventral surfaces, away from the flake edges. A general principal of microwear analysis of stone tools is that wear features such as polish that are not directly associated with an edge are not related to the use of that edge. Therefore, some other explanation must be considered as to the origin of the polish.

Microscopically, on the dorsal surface, large areas of smooth polish have striations both parallel and perpendicular to the long axis of the flake, and broad scratches that have removed polish (Figure 71). This combination of features is most likely the result of abrasion. Flake scar ridges in the midsection of the flake are worn smooth from handheld abrasion (Figures 72 and 73). Another area has mounded domes of very smooth “mystery” polish that lack directional features (Figure 74). On

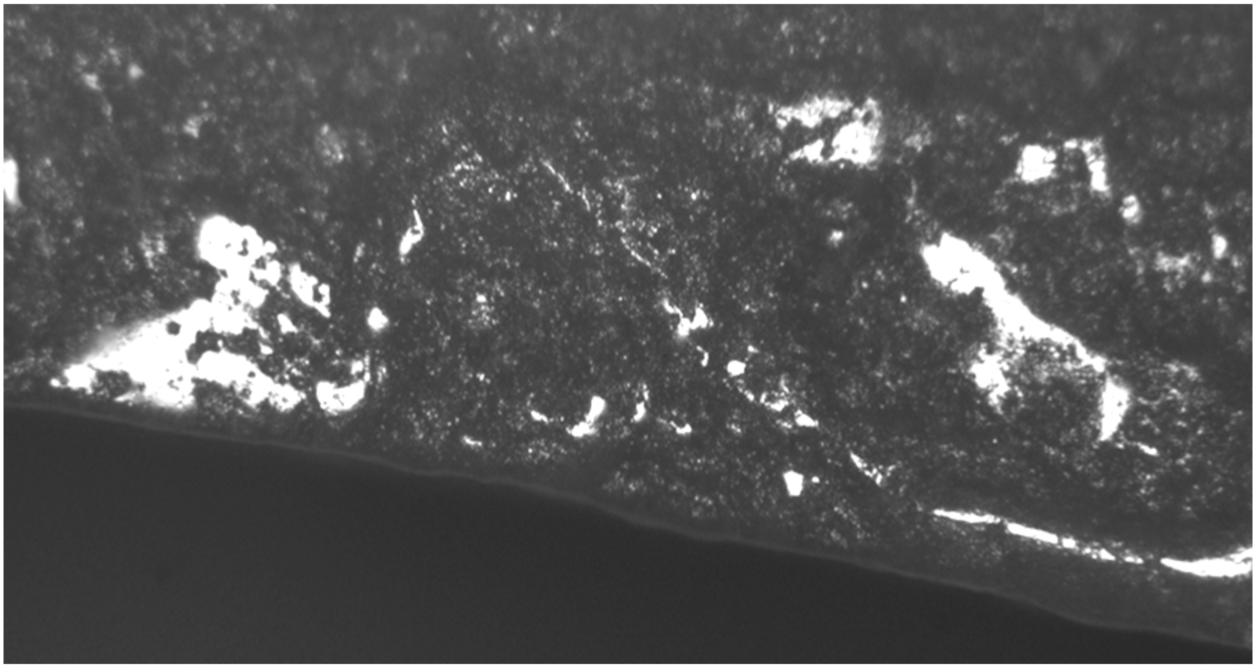

Figure 66: Utilized flake 55-6, patches of smooth, domed polish with well-defined edges are distributed along the beveled dorsal edge of the flake (Image 55-6 da @ 50x).

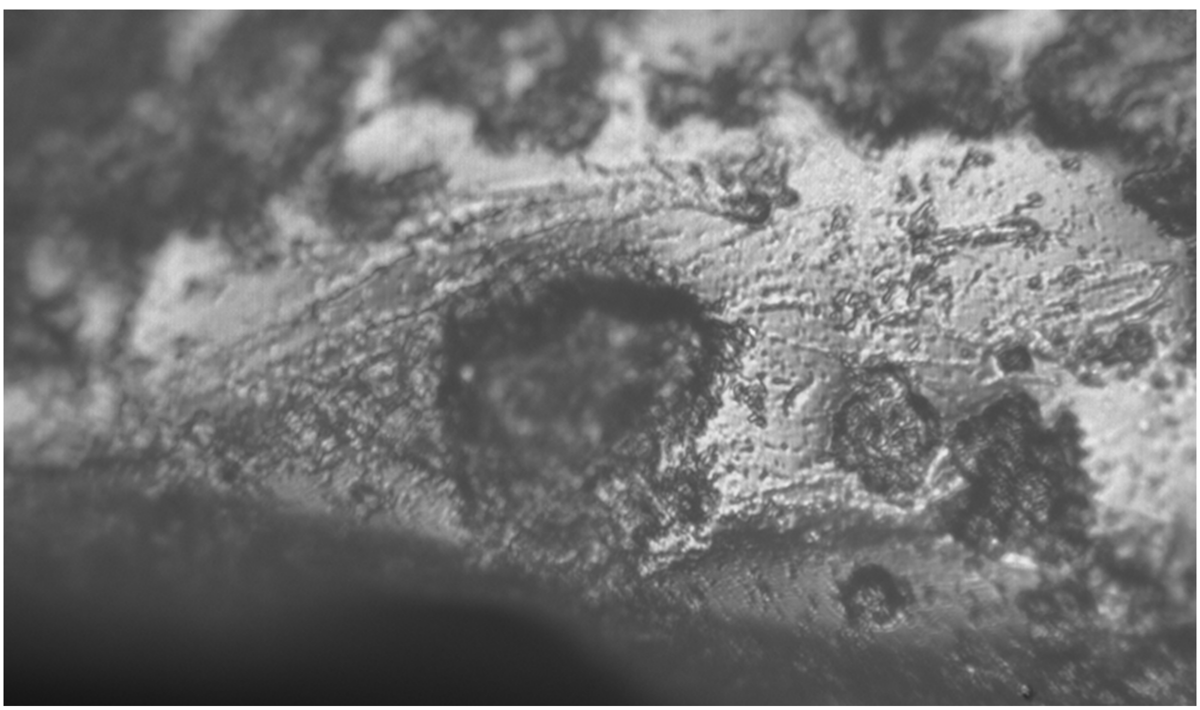

Figure 67: Utilized flake 55-6, smooth, domed polish appears pitted and scratched (Image 55-6 da @ 200x).

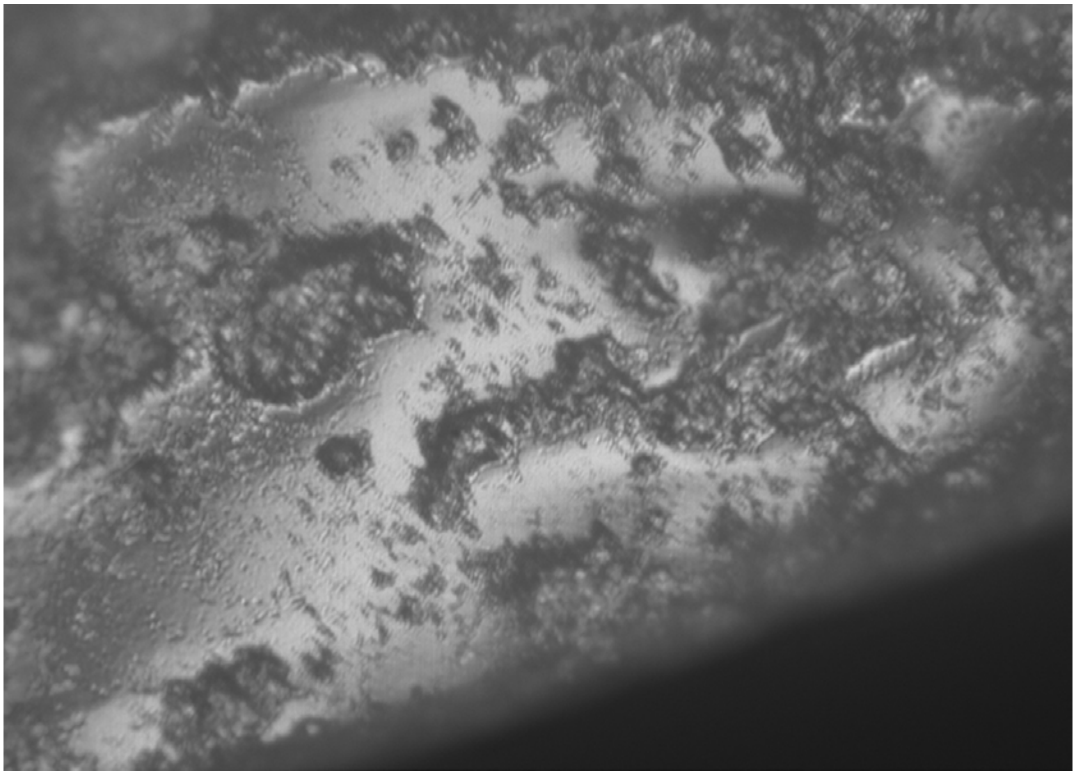

Figure 68: Utilized flake 55-6, smooth, domed polish with pitted surface wraps around the edge of the flake (Image 55-6 db @ 200x).

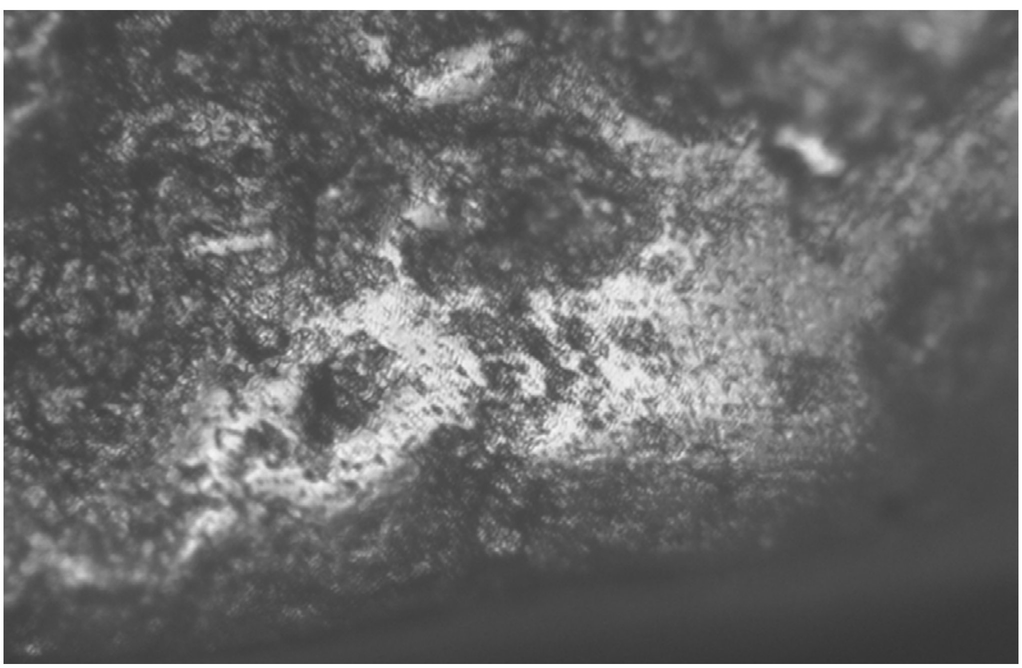

Figure 69: Utilized flake 55-6, polish with a pitted surface wraps around the edge (at bottom of photomicrograph) (Image 55-6 va @ 200x).

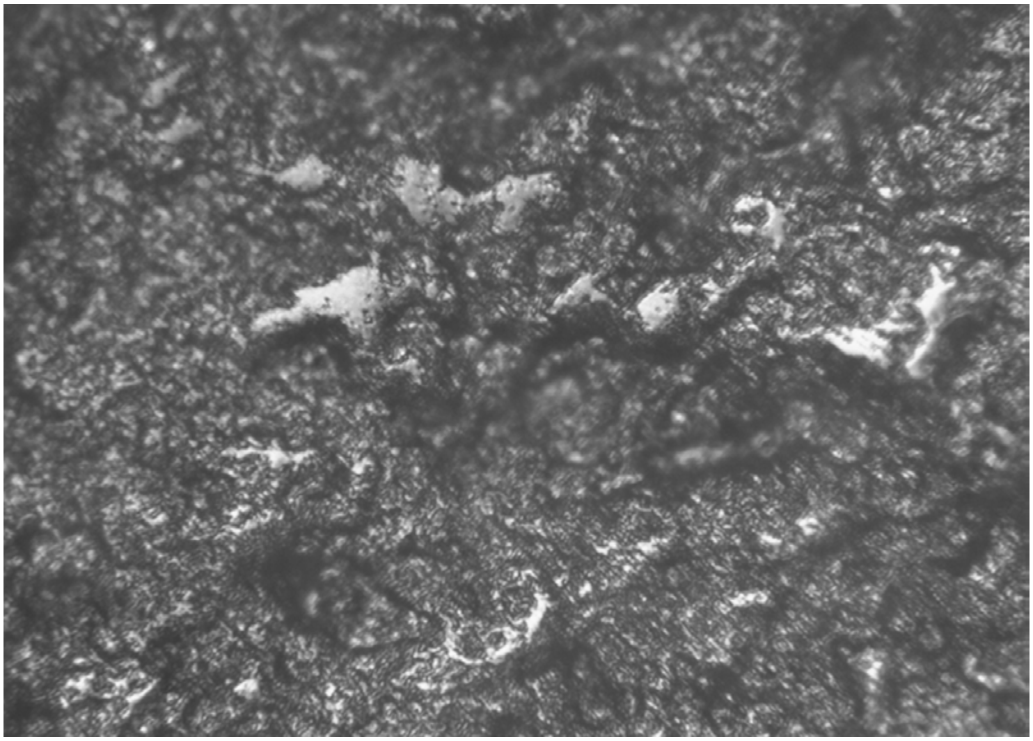

Figure 70: Utilized flake 55-6, patches of smooth, domed polish are on the high microtopography of the chert (Image 55-6 vb @ 200x).

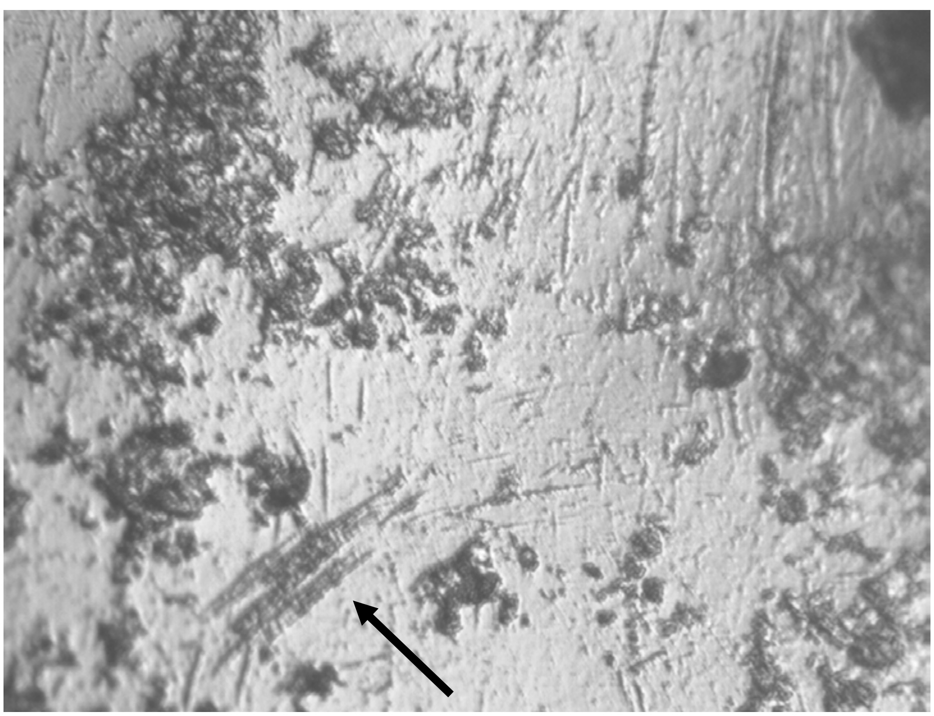

Figure 71: Utilized flake 185-203, striations of variable width are oriented parallel (vertical) and perpendicular (horizontal) to the long axis of the flake, and broad scratches at arrow have removed very smooth "abrasive" polish (Image 185-203 da @ 200x).

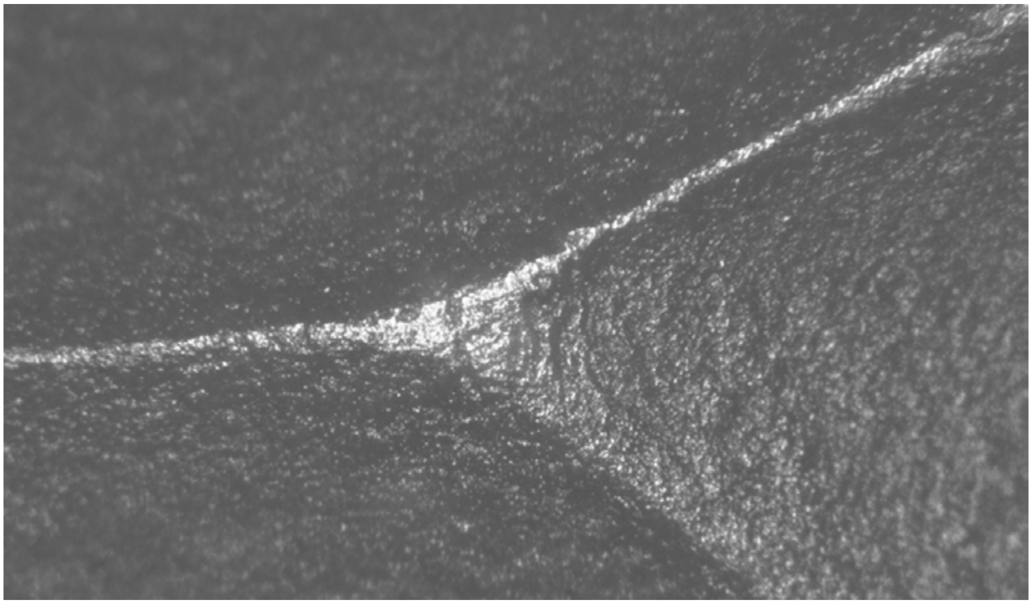

Figure 72: Utilized flake 185-203, flake ridges proximal to the utilized tip are worn smooth from handheld abrasion (Image 185-203 dd @ 50x).

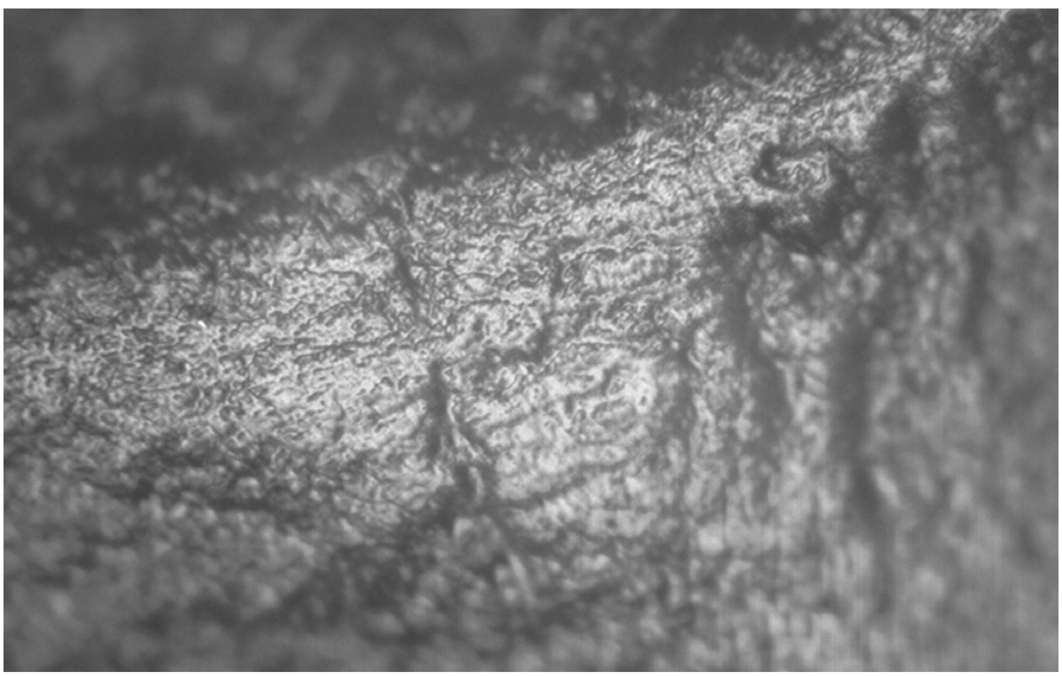

Figure 73: Utilized flake 185-203, invasive polish from handheld abrasion is on smoothed flake scar ridges (185-203 dd @ 200x).

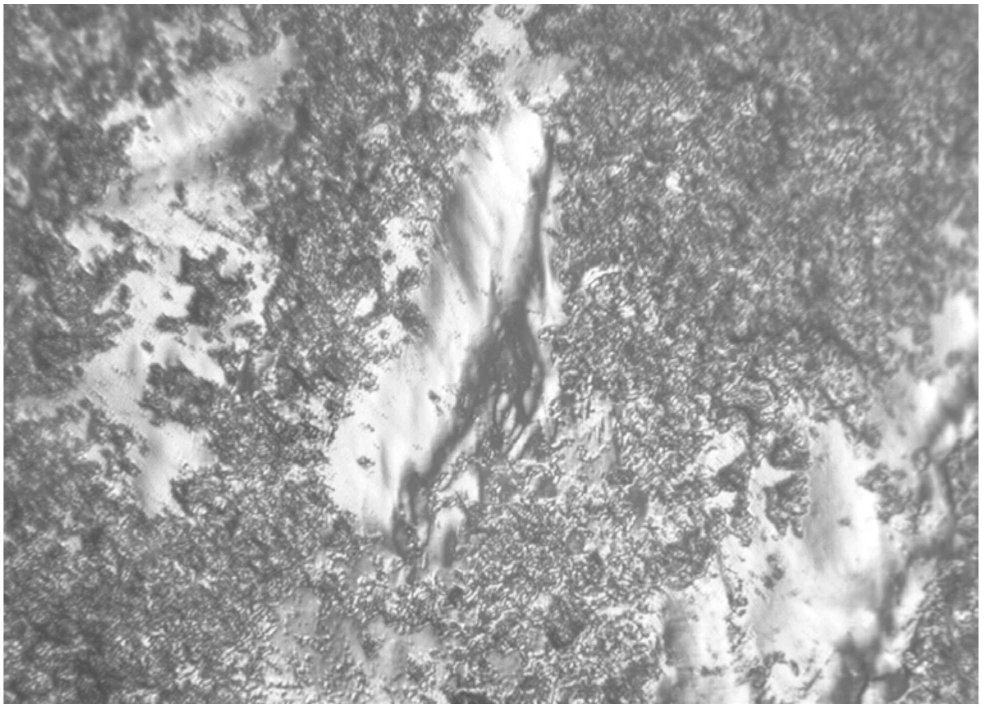

Figure 74: Utilized flake 185-203, on the dorsal surface, patches of very smooth "mystery" polish lack directional features, and are not associated with a utilized edge (Image 185-203 db @ 200x).

the ventral surface, patches of smooth polish have coarse striations parallel to the long axis of the flake. This also looks like abrasive polish, almost directly opposite the abrasive polish on the dorsal side of the flake (Figure 75).

At the sharp pointed distal tip of the flake, multidirectional single striations originate at the edge and are oriented oblique to the edge, and are in invasive soft tissue polish (Figure 76). This combination of wear pattern attributes all over the tip is characteristic of cutting soft animal tissue.

The patches of abrasive polish are difficult to interpret, but may be the result of the way the flake was held, perhaps with skin or some other protective material, while the tip was being used.

Flake 188-201: This very thick flake is from an early stage of reduction of a cobble of moderately fine-grained gray chert. Remnants of two previous flake scars are on the dorsal side.

At low magnification, a continuous series of flat and step fracture flakes is on the dorsal aspect of one edge, and a broad area of very bright, flat polish is in an indentation along the cortical edge of the ventral surface, and another area of very bright polish is on a small facet, at the thick end of the ventral side of the flake. No polish of any kind is found at high magnification associated with the edge flaking at the thick end of the artifact.

Figure 75: Utilized flake 185-203, on the ventral surface, patches of polish interior to the edge have coarse striations primarily parallel to the long axis of the flake (Image 185-203 va @ 200x).

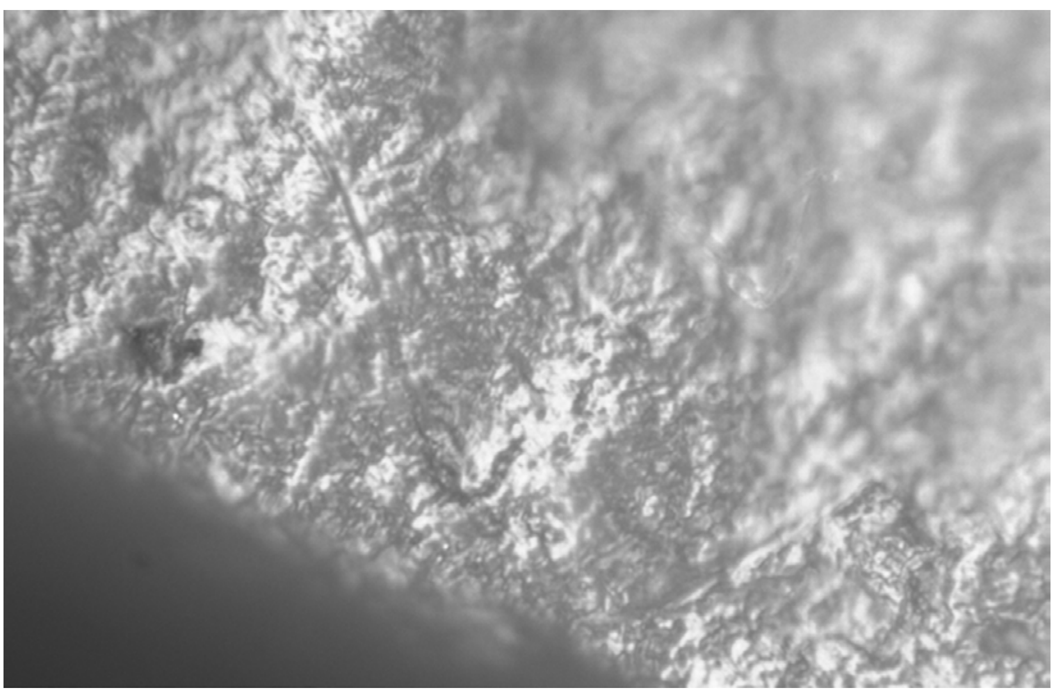

Figure 76: Utilized flake 185-203, multidirectional striations oblique to the edge (lower left) are in invasive soft tissue polish on the extreme distal tip of the flake and reflect cutting motions (Image 185-203 dc @ 500x).

The area of very bright polish in the indentation on the ventral aspect of the long cortical edge measures 5 x 2 mm and is seen at high magnification to be made up of patches of smooth, domed polish with clearly defined edges (Figure 77). At 200x, the polish surface is pitted and striated with a tightly packed pattern of very fine linear features oriented primarily parallel to the edge (Figures 78 and 79). This highly visible area of polish has all the attributes of frictional abrasive polish, caused by some kind of surface contact in this depression and is not associated with use of the adjacent edge.

Also on the ventral side, a small facet at the thick end of the flake has similar bright, smooth, pitted polish on a slight projection at the edge. Very fine linear features are oriented slightly oblique to the edge. This is also abrasive polish (Figure 80).

The thinner end of the flake has a slightly undulating ventral surface and cobble cortex on the dorsal surface. A continuous series of small flakes are detached from the rounded edge, primarily from the dorsal side, but a few from the ventral side. The flake scars are worn and rounded. A diffuse polish is visible all over the ventral tip.

At high magnification, the polish on this surface is pervasive, extending from the edge into the interior ventral surface, and is invasive on the high and low microtopography of the chert surface. Multidirectional striations are all through the polish, single and in groups, variable in width (Figures 81 and 82). The polish is considerably reworked with new striations crossing over old. This pattern of multidirectional striations in invasive polish is characteristic of cutting soft animal tissue. Small spots of contact with hard tissue are consistent with butchering.

The abrasive polish in the recessed midsection of the flake and on the extreme tip opposite the “working end” of the flake is most likely from some form of hafting. The very fine, short subparallel linear features in flat polish are from limited small movements against a surface.

The term ‘invasive polish’ as used here means polish that follows the contours of the crystalline chert surface as it develops, on low and high microtopography of that surface. It is generally associated with contact with soft animal tissue.

Summary: The flake was used as a butchering tool and was hafted.

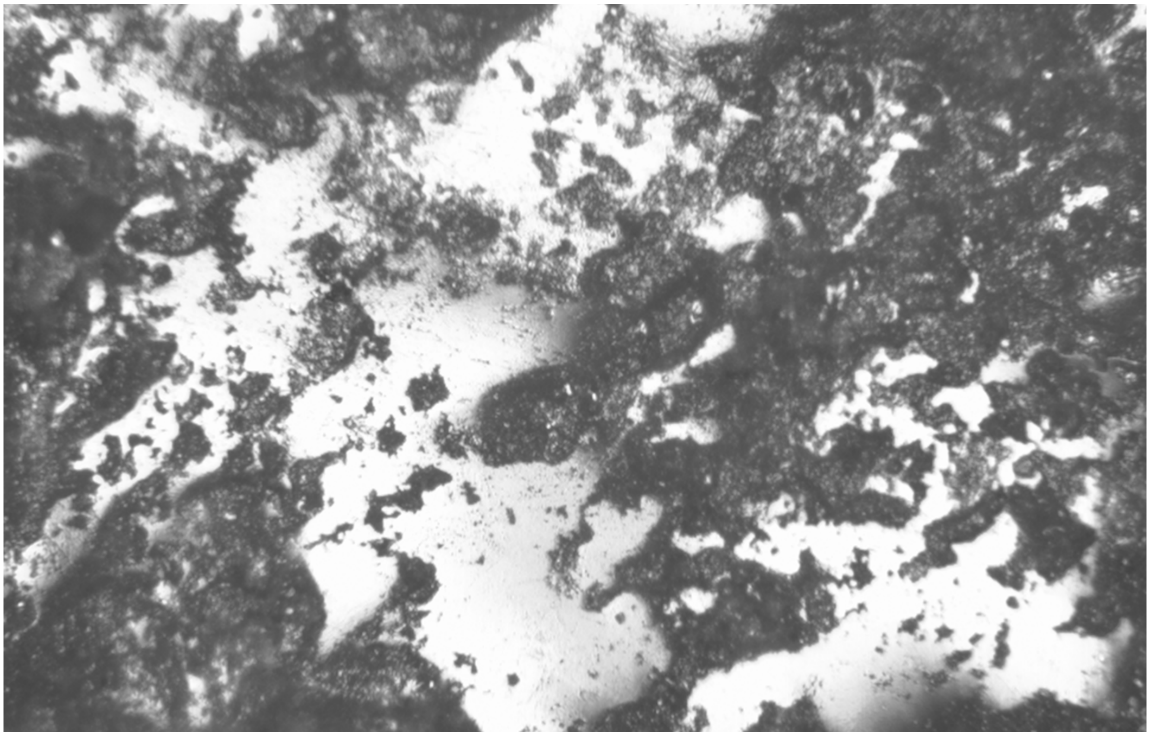

Figure 77: Utilized flake 188-201, patches of smooth, domed polish have clearly defined edges (Image 188-201 va @ 50x).

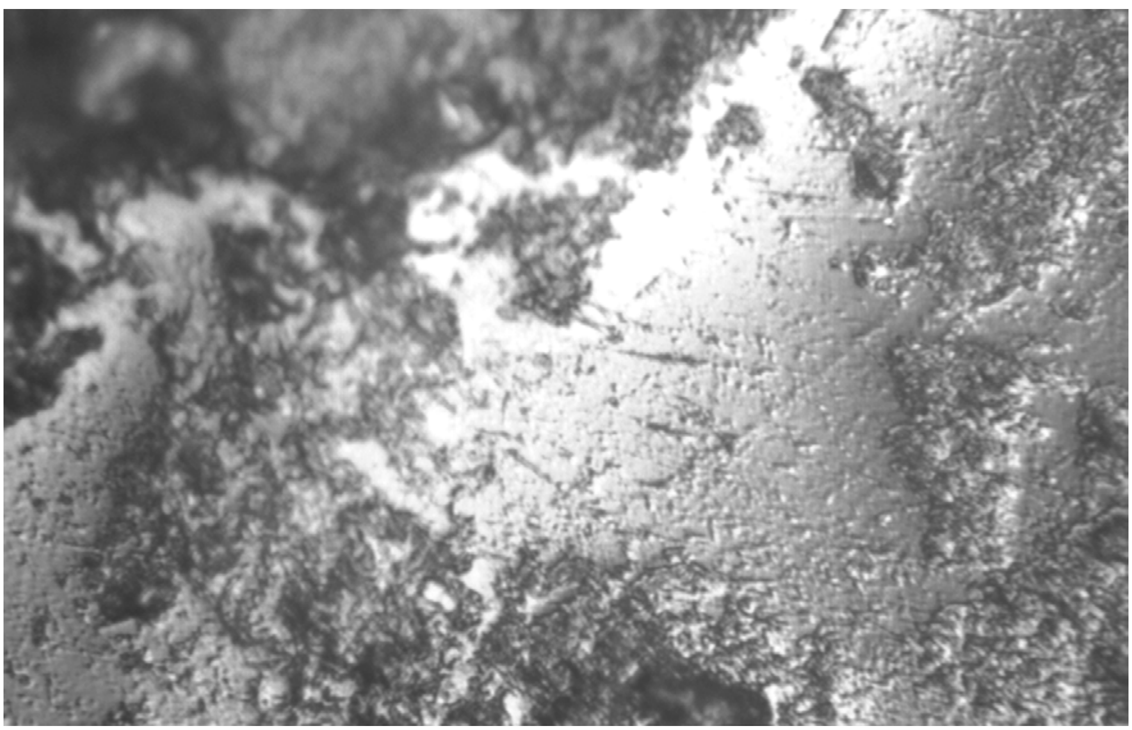

Figure 78: Utilized flake 188-201, the surface of smooth polish is pitted and reworked with very fine striations (Image 188-201 va @ 200x).

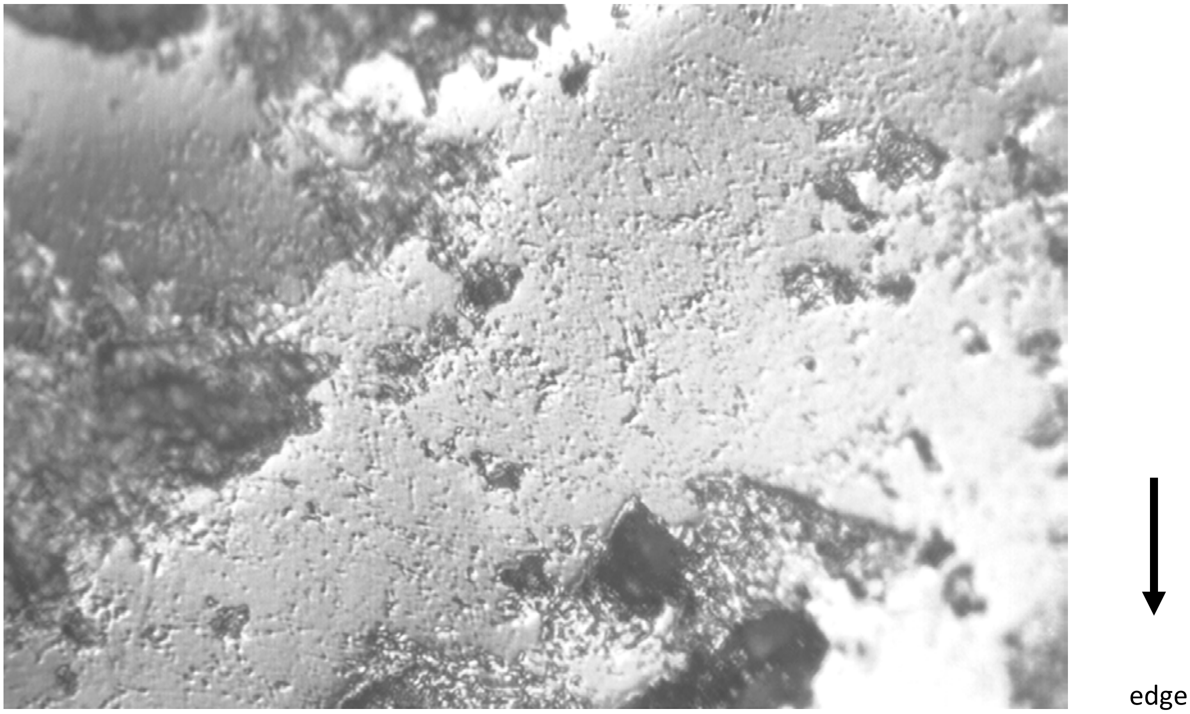

Figure 79: Utilized flake 188-201, very fine striations are primarily parallel to the edge (Image 188-201 ve @ 200x).

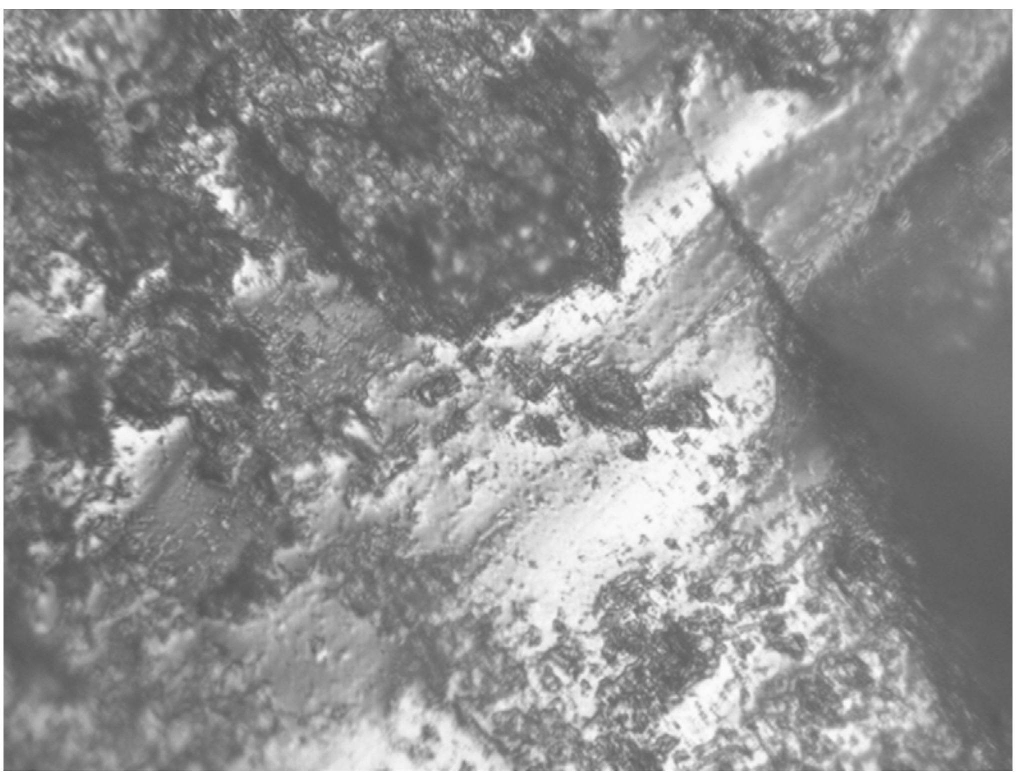

Figure 80: Utilized flake 188-201, pitted abrasive polish on the thick end of the artifact, ventral side (Image 188-201 vd @ 200x).

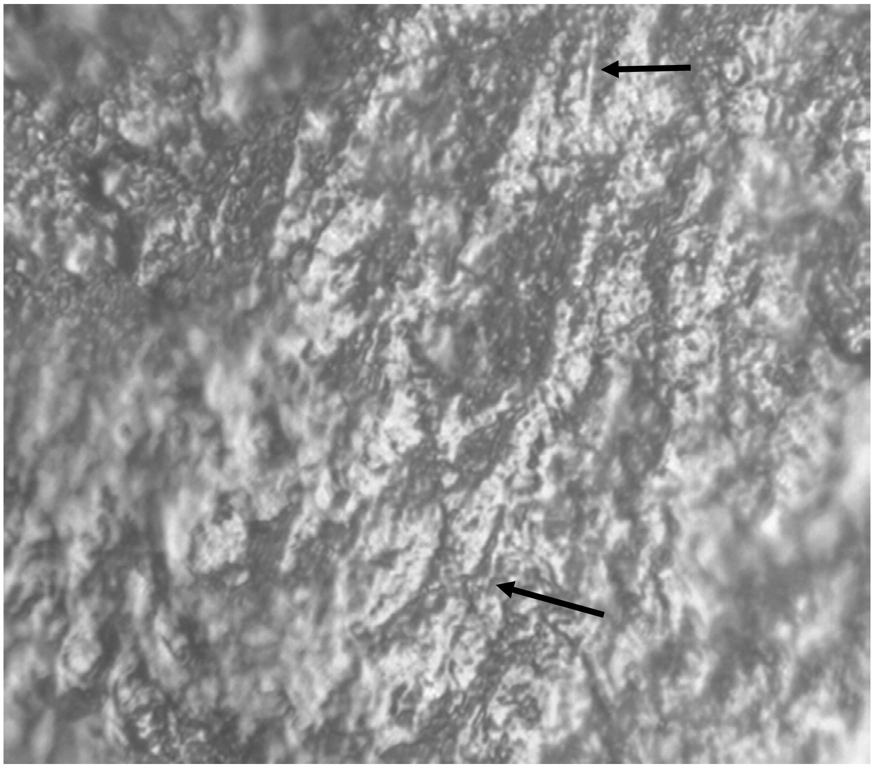

Figure 81: Utilized flake 188-201, single striations at arrows are oriented parallel to the long axis of the flake at the "thin" pointed end, in invasive polish (Image 188-201 vf @ 500x).

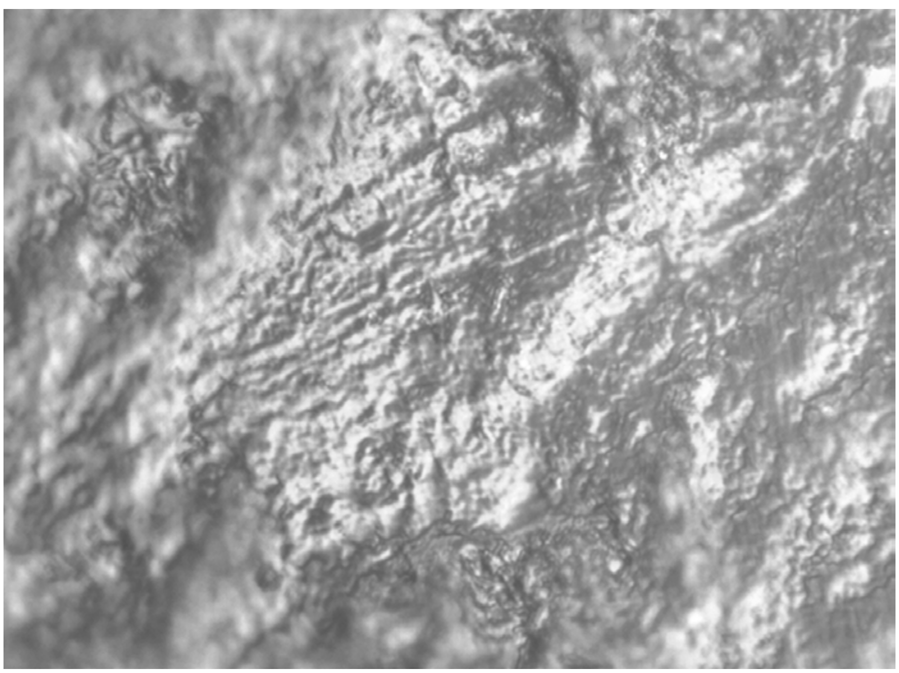

Figure 82: Utilized flake 188-201, single and grouped, striations are crisscrossed in invasive polish (Image 188-201 vg @ 500x).

8

CERAMIC ANALYSIS

by Linda W. Ellis, Robert Rogers, Jeffrey R. Ferguson, and Michael Glascock

ANALYSIS OF PREHISTORIC CERAMICS FROM 41CW104

by Linda W. Ellis

The Santa Maria Creek site lies at the interface between the Central Texas Archeological region and the Prairie Savanna Archeological Region, a geographic transition zone whose archeology reflects influences from adjacent archeological regions at different points in time (Perttula 2004; see also Bement et al. 1989; Fields et al. 2002; Kalter et al. 2005; Kenmotsu and Perttula 1993; Kotter et al. 1991; Skelton 1977). This is particularly true for the Late Prehistoric period, where sites often show marked inter- and intraregional differences in settlement patterns, chronology, and artifact assemblages. Ceramic assemblages, in particular, suggest a generalized fluidity of boundaries among the indigenous groups occupying and interacting in these two archeological regions.

The presence of pottery presents a challenge in terms of both its distribution and its affiliation. In east central Texas, ceramics are most commonly associated with Toyah phase assemblages. Ceramics have occasionally been found alongside Scallorn points, at sites such as Panther Springs (41BX228) on the southern edge of the Edwards Plateau (Black and McGraw 1985), the Baca site (41FY78) on Cedar Creek in Fayette County (Skelton 1977), and the Wheatley site (41BC114) on the Pedernales River 30 miles west of Austin (Greer 1976). Ricklis (1994) used radiocarbon dates to demonstrate that Toyah sites appear as early or nearly as early in the southern area of their distribution as they do in the north. He cites the difficulties of using radiocarbon dating, which statistically cannot be confidently pinpointed more precisely than about 100 years (Ricklis 1994:301). He espoused the idea that the diffusion of the Toyah toolkit or technocomplex is based on the assumption that the Toyah toolkit was highly useful in the hunting and processing of large game, particularly bison. Plain, bone-tempered pottery, which Johnson (1994) felt was a key trait, is not considered to demonstrate sociocultural unity. Rather, it was the Toyah lithic technocomplex that was adopted, with the people who adopted it keeping their own ceramic traditions. This pattern appears most pronounced at the margins of the Toyah cultural area, where pottery was influenced by the pottery traditions of adjacent areas of east Texas and the central and upper Texas coast (Ricklis 1994:305).

Toyah-era peoples made simple earthenware pottery to which they often added pulverized animal bone. Analysts most often group this **bone-tempered pottery** tradition under the typological category of Leon Plain; however, ceramic assemblages in both the Central Texas and Prairie Savanna archeological regions exhibit the presence of several different ceramic traditions that manufactured bone-tempered wares. Whether the plain bone-tempered pottery adopted by Toyah era peoples is a "Toyah" ware, as questioned by Johnson (1994), has yet to be determined. Likewise, lumping all bone-tempered wares recovered in these regions under the typological category of Leon Plain is problematic, largely because the criteria used to classify this type is still as ambiguous as it was when it was first defined by Suhm et al. (1954), and its spatial and temporal distribution as a cohesive type has yet to be fully understood. Associated with this issue are the ongoing questions regarding the technological and historical relationship between the protohistoric Goliad wares and the prehistoric Leon Plain type (Tomka 2010).

Archeological evidence from numerous sites along the east-southeast margins of the Prairie Savanna points to an area of shifting cultural boundaries. Ceramic assemblages are technologically diverse demonstrating the variety of cultural influences in this region during the Late Prehistoric and Protohistoric periods. Assemblages in this region often exhibit regionally distinct technological traditions that are closely related to the "Mossy Grove Culture/Traditions" (Story et al. 1990). In general, the Mossy Grove tradition defines the broad context of late prehistoric cultures located to the east-southeast, wherein sites represent both a general cultural pattern and a regional cultural tradition that partly parallels the Caddo tradition/culture to the northeast and encompasses the archeological remains of what were probably different ethnic and linguistic groups (Moore 1995; Perttula 1993; Story et al. 1990). Assemblages often exhibit commingled occupations with ties to both the Southeast Texas Mossy Grove cultures and the Caddo cultures (Moore and Moore 1996; Rogers 1993, 1995).

Along the southern margins of the Central Texas and the Prairie Savanna archeological regions, ceramic assemblages exhibit strong coastal influences (Hall 1981; Kalter et al. 2005; Rogers 1995, 1997; Skelton 1977). In particular, sandy paste ceramics with bone inclusions had low-frequency representation in Southeast Texas beginning with their first enigmatic appearance in the archeological record ca. A.D. 950 (Aten 1983); however, they did obtain a minor frequency in the early Round Lake period (ca. A.D. 1000–1350) through the Old River period (ca. A.D. 1350–1700), especially in the Brazos Delta-West Bay area and the Conroe-Livingston area. Characterized by the addition of "5–25 percent bone fragments" in a sandy paste, they are otherwise undistinguishable from the sandy pastes of Goose Creek wares and vary technologically from the later bone-tempered wares described as Leon Plain (Aten 1983).

In summary, ceramic assemblages in this transitional zone are technologically diverse, reflecting a number of distinct ceramic traditions. For example, Caddo ceramics with bone temper and distinctive design motifs are found in a number of assemblages in this transitional zone (see Ricklis and Collins 1994; Rogers 1995; Story et al. 1990). However, macroscopic and petrographic analyses of ceramics from other sites located in this zone suggest that many of the ceramics are the product of an indigenous population that developed a ceramic tradition(s) influenced by contacts with groups outside the area (see Kalter et al. 2005; Ricklis and Collins 1994). Thus, the question becomes, do the bone-tempered ceramics found at sites in this transitional zone represent a series of localized regional ceramic types? Further, are they simply varieties of the early defined type known as Leon Plain, or do these plain bone-tempered ceramics represent a distinctive "Toyah" ware? Addressing these questions will require a more comprehensive approach to the study of the ceramics found in this geographic transition zone that includes more-consistent and detailed analyses of ceramic technology. With this in mind, analysis of the ceramic assemblage recovered from the Santa Maria Creek site begins with a detailed technological analysis that was then compared to comparable ceramic assemblages from sites located within this zone.

Ceramic Methods

Like all human endeavors, pottery is the product of structured human behavior, and its qualities are determined by its raw materials and method of manufacture (Rice 1987; Shepard 1976). Presumably, the technological decisions made during pottery manufacture bear some relationship to the desired qualities of the finished pot. Therefore, understanding how a pot was made helps us understand how one pot varies from another, and by implication, it helps us to recognize the range of technological variability we might expect to see even on relatively similar pots.

Because no whole vessels were recovered at 41CW104 and all of the recovered ceramics are small, undecorated fragments, analysis of its ceramic assemblage focuses primarily on the technological aspects and observable modes that would aid in a more detailed classification of the ceramics. In the absence of whole vessels or vessel sections large enough to discern typologically distinct decorative motifs, one way to distinguish subtle differences between relatively similar ceramics is to look at the technological variations found on individual sherds (see Brown 1998; Ellis 1995; Lechtman 1977; Rice 1987; Rye 1981; van der Leeuw 1984). This approach has been advocated by many archeologists working in this region. Early on, they recognized the problem of blurred distinctions in Texas plainwares and advocated the usefulness of describing assemblages in terms of individual attributes since the typological approach offered so little information (Fox et al. 1979; Hester and Parker 1970; Skelton 1977; Story 1968). Thus, the sherds recovered at the Santa Maria site were characterized according to a suite of key technological attributes.

The technological attributes recorded for each sherd in the analyzed sample follow the current Council of Texas Archeologists/TxDOT Ceramic Protocols and include (1) two aspects of paste morphology (i.e., paste constituency and paste texture); (2) exterior and interior surface treatment; (3) exterior and interior decorative treatment; (4) morphological class (i.e., body, base, or rim), including rim characteristics; (5) average thickness; and (6) firing environment (i.e., oxidizing or nonoxidizing). Each of these attributes provides information about the technological variability observed on the recovered ceramics. This information enables finer-grained typological and technological distinctions, which in turn allow the analyst to more fully characterize the assemblage even in the absence of whole vessels and identifiable types, thereby providing a basis for placing the ceramics within a broader regional ceramic context.

Because many paste and surface treatment attributes can be ambiguous, petrographic analyses and/or INAA were performed on 13 of the sherds recovered during the data recovery excavations at 41CW104 (Table 19; Figure 83). These 13 sherds supplement the petrographic and/or INAA data performed on 6 sherds submitted during the testing phase (Figure 84). Together these 19 sherds represent 76 percent of the ceramics in the analyzed sample. Results of these studies provided finer-scale information about the intra- and intersite spatial patterning of the ceramics recovered at the Santa Maria Creek site relative to other ceramic assemblages in the region.

Table 19. 41CW104 Ceramics Submitted for Petrographic and/or INAA Analyses

Lot No.	Unit No.	Feature No.	North	East	Level	Elev (cmbd*)	INAA ANID	Petrographic Sample No.
2012 Submissions								
35.1	5		109	91	2	40–50	LWE104	CW104-1
56.1	2		112	92	3	64–74	–	CW104-2
84.1	9		113	94	2	54–64	LWE105	CW104-3
89.1	10		115	96	3	63–73	LWE106	–
126.1	17		120	101	2	40–50	LWE107	CW104-4
132.1	18		126	105	2	27–37	LWE108	CW104-5
149.1	21		118	97	1	36–46	LWE109	–
158.1**	23		114	96	1	47–57	LWE110	–
170.1	25	3	114	90	3	60–70	LWE111	–
231.1	31		113	89	3	60–70	LWE112	CW104-6
312.1	37		112	91	3	63–73	LWE113	–
327.1	37		112	91	7	103–113	–	CW104-7
412.1**	54		126	106	3	50–60	LWE114	–
2007 Submissions								
131.1	19		120	94	3	45–55	CWT-31	CW104-131
133.1	19		120	94	3	45–55	–	CW104-133
138.1	17		120	101	5	70–80	–	CW104-138
195.1	27		115	95	3	64–74	CWT-95	–
222.1	30		112	92	4	81–86	CWT-22	CW104-222
388.1	53		128	106	1	55–70	CWT-88	CW104-388

*cmbd = centimeters below datum

**Not illustrated

Lot 84.1
Rim Sherd
Bone in a Very Fine
Sandy Paste
INAA/PETRO

Lot 35.1
Body Sherd
Bone in a Fine
Sandy Paste
INAA/PETRO

Lot 89.1
Body Sherd
Bone in a Fine
Sandy Paste
INAA

Lot 231.1
Body Sherd
Bone in a Fine
Sandy Paste
INAA/PETRO

Lot 327.1
Body Sherd
Very Fine
Sandy Paste
PETRO

Lot 126.1
Body Sherd
Bone in a Very Fine
Sandy Paste
INAA/PETRO

Lot 132.1
Body Sherd
Bone in a Very Fine
Sandy Paste
INAA/PETRO

Lot 312.1
Body Sherd
Bone in a Very Fine
Sandy Paste
INAA

Lot 149.1
Body Sherd
Bone in a Very Fine
Sandy Paste
INAA

Lot 170.1
Body Sherd
Bone in a Very Fine
Sandy Paste
INAA

Lot 56.1
Body Sherd
Fine Sandy Paste
PETRO

CENTIMETER
0 1 2 3 4 5

ATKINS

Figure 83

41CW104 Data Recovery
Ceramics Sent for Petrographic
and/or INAA Analysis

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Drawn by: C. Wallace

a) Lot 195.1

b) Lot 222.1

c) Lot 131.1

d) Lot 133.1

e) Lot 388.1

f) 1Lot 38.1

CENTIMETER

0 1 2 3

ATKINS

Figure 84

41CW104 NRHP Testing
Ceramics Sent for Petrographic
and/or INAA Analysis

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Drafted by: C. Wallace

The Ceramic Sample

Thirty-two prehistoric ceramic sherds were recovered from site 41CW104. The analysis proceeded in two phases. The first phase involved an initial sort in which all the sherds in the assemblage were examined in order to identify those that could be conjoined or confidently be determined to be part of the same vessel (i.e., fitters). During the initial sort, seven sherds could be matched with at least one other sherd, leaving a total of 25 sherds in the analyzed sample. The data recorded on the analyzed ceramics are presented in Appendix D.

The second phase involved a detailed characterization of the ceramic sample according to the six key attributes listed above (for detailed discussions of the analytical methods and definitions of the individual attributes, see Ellis 1992, 1995, 1996, 2000, 2010; Ellis et al. 2010; Kalter et al. 2005). Toward that end, each sherd in the assemblage was examined under 10X power binocular magnification. Unfortunately, the majority of the sherds are all relatively small so assessing attributes was sometimes difficult.

Paste

Each sherd in the analyzed sample was assigned to a paste category according to the general character of its fired clay fabric. In particular, individual observations were made on two aspects of paste texture: (*1*) *Paste Constituency*—the type of nonplastic inclusions (i.e., identification of the type of nonplastic inclusions such as bone, grog, etc.) and the predominant size range of nonplastic inclusions [i.e., fine sand, very fine sand, silt, per Wentworth 1922, 1933]), and (2) *Paste Texture*—the general morphology and configuration of the crystalline components, amorphous material, and voids as observed in cross section (i.e., smooth, laminated, contorted). Paste categories established for this study are based on a consideration of those employed by Ambler (1970, 1973), Aten (1967, 1971, 1983), Ellis (1992, 1995), Ellis and Ensor (1998), Tunnell and Ambler (1967), and Winchell and Ellis (1991).

As Rice (1987:350) observes, "the microstructural characteristics of a ceramic underlie virtually all its use-related properties," and in low-fired pottery, the primary determinants of microstructure are the raw materials and the fabricating techniques used to produce the pot (see Rice 1987:348). For example, a vessel's porosity and permeability are directly related to the size, shape, and position of the pores, or voids, existing between the solid particles in the clay body, which, by implication, bear a direct relationship with the particular fabricating techniques used to shape the pot (Bronitsky 1986:223–224; Rice 1987:350–354; Saffer 1979; Vandiver 1988:142). Although the present study does not specifically address ceramic use-wear, it is presumed that paste choice was not random because potters knew from experience what physical characteristics and manufacturing techniques produced the most desirable pot given its intended use. This technological knowledge underlies the potters' selection of raw materials for paste preparation, vessel form, and the use of specific forming techniques (see Livingood 2007; Rice 1987; Rye 1981; van der Leeuw 1984).

Paste Constituency*:* The paste fabrics of the 25 sherds in the analyzed sample contain relatively poorly sorted sands. Microscopic examination of a freshly broken cross section of each sherd revealed three primary paste groups. The presence or absence of specific sets of tempering agents determined primary group designations. Within each primary paste group, subcategories were defined based on the size range of nonplastic inclusions noted in the paste fabric and the type of tempering agents noted (Table 20).

Table 20. Paste Groups Identified at 41CW104

Paste Group (PG)	Paste Subgroup	Paste Constituency	Paste Subgroup Totals
PG1 - Untempered Sandy Paste (n = 5)	1a	Untempered fine sandy paste	3
	1b	Untempered very fine sandy paste	2
PG2 - Bone and Grog Tempered (n = 1)	2	Bone, grog, crushed hematite, and coarse-sized sand embedded in a very fine sandy matrix	1
PG3 - Bone Tempered (n = 19)	3a	Bone and coarse-sized sand embedded in a fine sandy matrix	6
		Bone and crushed hematite embedded in a fine sandy matrix	1
	3b	Bone and coarse-sized sand embedded in a very fine sandy matrix	12
		Total	25

Paste Group 1 represents 20 percent of the sherds (n = 5) in the analyzed sample. The sherds assigned to PG1 consist of a relatively homogenous blend of untempered sand predominantly in the very fine to fine size range (Wentworth 1922, 1933). Those with paste matrices in the predominantly fine sand size range were assigned to PG1a, and the two sherds with paste matrices containing sands in the predominantly very fine size range were assigned to PG 1b.

The sherds assigned to Paste Groups 2 and 3 also contain large amounts of natural sand inclusions, but additional tempering agents had been added to the basic paste fabric. The one sherd assigned to PG2 had been tempered with grog, bone, and coarse to very coarse-sized sands, all of which were embedded in a sandy paste matrix containing sand in the predominantly very fine size range.

By far, the largest number of sherds recovered at the site fall into Paste Group 3. The 19 sherds in this group had been tempered with bone embedded in a sandy paste matrix containing predominantly very fine (PG3b) to fine (PG3a)-sized sands. In most cases, the sandy matrix also contained random coarse to very coarse-sized sand grains in addition to the bone fragments. The inclusion of these coarse-sized sands may simply be due to poor sorting of the clay prior to primary forming; however, the presence of discontinuously larger-sized coarse to very coarse sands embedded in a predominantly very fine or fine sandy matrix suggests the intentional blending of two different size grades of sand (see Aten 1983; Connaway 1980). In general, the bone fragments appear as crushed angular fragments that vary in color from white to gray to black and are relatively sparsely distributed throughout the paste matrix. In most cases, the bone fragments represent less than 5 percent of the overall paste fabric.

The spatial distribution of paste groups appears to be relatively randomly distributed across units (Figure 85). The bulk of the ceramics (88 percent) were recovered from the southernmost excavation units (see Figure 35); however, this area had the highest density of artifacts in general. The three sherds recovered to the north included one sandy paste sherd (PG1) and two bone-tempered sherds (PG3) recovered from a cluster of units surrounding Features 6, 7, and 8.

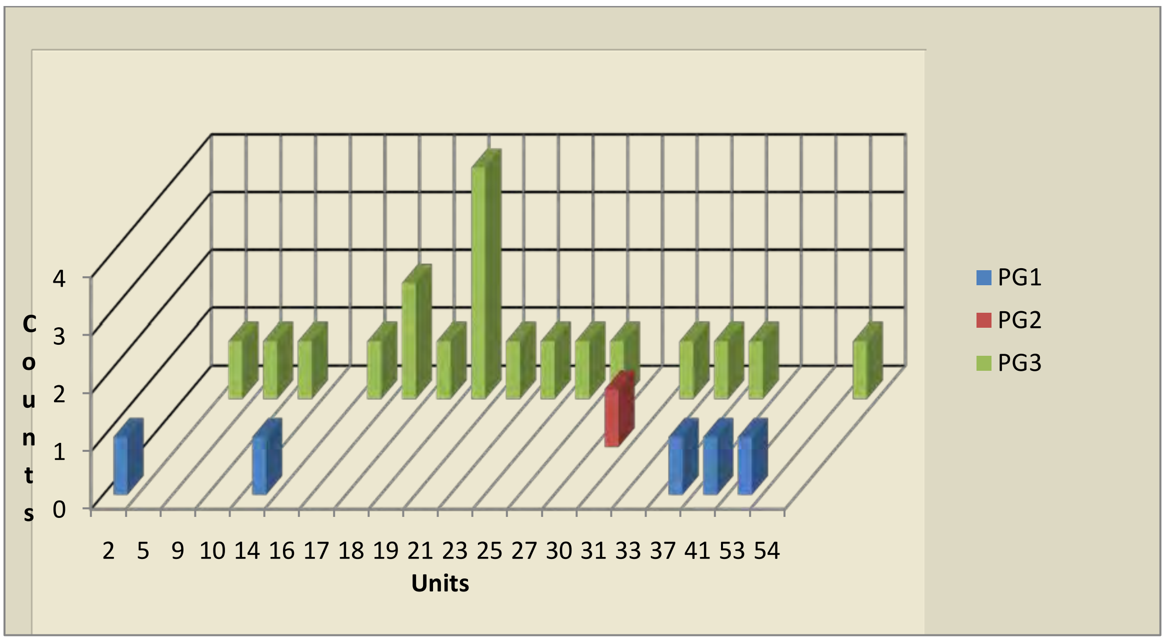


Figure 85: Paste Groups by Unit

Ceramics were recovered from as deep as Level 7; however, the majority (n = 22; 88 percent) were horizontally distributed across the upper four levels of the site (Table 21). Those recovered from Levels 5–7 included both bone-tempered (PG3) and sandy paste (PG1) ceramics. The fact that bone-tempered ceramics occur throughout the excavated levels suggests that earliest occupations at site 41CW104 date to the latter portion of the Late Prehistoric.

Table 21. Paste Groups by Unit and Level

Unit #	Level	PG1	PG2	PG3	Total
Unit 2	3	1			1
Unit 5	2			1	1
Unit 9	2			1	1
Unit 10	3			1	1
Unit 14	2	1			1
Unit 16	6			1	1
Unit 17	2			1	1
	5			1	1
Unit 18	2			1	1
Unit 19	2			2	2
	3			2	2
Unit 21	1			1	1
Unit 23	1			1	1
Unit 25	3			1	1
Unit 27	3			1	1
Unit 30	4		1		1
Unit 31	3			1	1
Unit 33	1			1	1
Unit 37	3			1	1
	7	1			1
Unit 41	4	1			1
Unit 53	1	1			1
Unit 54	3			1	1
Grand Total		5	1	19	25

Paste Texture: Texture categories were established on the basis of two criteria: (1) overall arrangement and orientation of the grains visible in the paste fabric, and (2) the presence or absence of any intervening pores or voids. Observations about the textural aspects of a sherd's general morphology and overall configuration provide information on the extent to which the clay was manipulated during paste preparation (e.g., wedging, kneading) and primary forming (e.g., the types of coil joints). This, of course, is influenced by the amount, size, and shape of the nonplastic inclusions in the paste, as well as the manufacturing techniques employed by the potter during primary forming (Shepard 1976:117–120). Some additives are used in their natural state (i.e., coarse sand) and others (i.e., potsherds, bone, shell) are ground, crushed or pulverized. Some materials break into relatively uniform grain size or natural planes (i.e., disintegrated sandstone or shell) while other materials have no natural planes or cleavage (i.e., potsherds or bone) to determine the size of the particles that will be formed. Thus, paste texture is directly related to (1) the type of added or naturally occurring inclusion found in the paste, and (2) the potter's method of paste preparation (see Shepard [1976:117–120] for a more detailed discussion of the issues related to paste texture).

To adequately assess this attribute, it is important that the freshly broken cross section show the vertical rather than horizontal orientation of the sherd. The textural aspects of two very small sherds could not be assessed. Among the remaining 23 sherds, paste texture was fairly evenly split between two categories.

1. Irregular – The largest number of sherds in the analyzed sample (n = 12; 48 percent) fall into this category. In cross section, the sherds with this paste texture have large, widely spaced irregularities such as hematite nodules, occasional coarse-sized sand grains, or burned-out chaffs of vegetal material. The paste fabric appears uneven, and the coil junctures are sometimes visible.
2. Laminated – Pastes assigned to this textural category have a stepped or platy look. In cross section, the relatively straight laminas are oriented at an oblique angle rather than being parallel or perpendicular to the sherd surface. Coil junctures usually appear beveled. The direction of the laminas, as well as the alignment of the coil junctures, provides information about forming techniques. For example, when laminas are angled toward the interior, this suggests that scraping was done in an upward motion on the exterior of the vessel and in a downward motion on the interior. Eleven sherds (44 percent) have pastes that appear laminated in cross section, and most of those have laminas oriented toward the interior portion of the sherd.

Thus, if we think of the various textural categories as representing locations on a continuum, then the ceramics recovered at the Santa Maria Creek site were fairly well worked, with any widely spaced irregularities being due to the presence of extraneous inclusions (e.g., bone, grog, hematite nodules, etc.) embedded in the paste fabric. However, a nearly equal number have pastes that appear laminated in cross section, indicating less-thorough manipulation of the clay prior to and during the forming process. These textural differences indicate that more than one paste preparation and/or fabricating technique was used to manufacture the vessels used at 41CW104, pointing to the variable use of different "paste recipes" (see Ellis and Ellis 1996a, 1996b; Ellis and Ensor 1998; Livingood 2007; Winchell and Ellis 1991). Different "recipes" require that different aplastic inclusions be added to the paste, which in turn affects the manipulation of the basic clay fabric during primary forming. In effect, the larger the inclusions, the more difficult it is to work the clay and achieve a more consistent paste fabric. Conversely, finely crushing the grog and/or bone inclusions allows for better working of the basic paste fabric, thereby enabling the potter to produce a finer-textured paste fabric.

If, as previously noted, paste texture is directly related to the type of added or naturally occurring inclusion found in the paste then we might expect to see proportional differences in the paste textures associated with different paste groups. However, as Table 22 indicates, paste textures are fairly evenly distributed across paste groups.

Table 22. Paste Textures Associated with each Paste Group

Paste Group	Irregular	Laminated	Total
PG1 – Untempered Sandy Paste	2	2	4
PG2 – Bone and Grog Tempered	0	1	1
PG3 – Bone Tempered	10	8	18
Total	12	11	23

If we take into account the fact that the bone found in 19 of the analyzed sherds occurs as relatively sparse, crushed angular fragments then something other than less-thorough manipulation of the clay may account for the textural differences noted in the assemblage. In terms of the size and variety of tempering agents, the 11 sherds with laminated pastes outwardly resemble the 12 sherds with irregular paste textures. Only their textures vary, suggesting that the textural differences between these sherds are probably related to something other than the mere size and type of inclusions present in the paste fabric. If a vessel's porosity and permeability are directly related to the size, shape, and position of the pores, or voids, existing between the solid particles in the clay body, then the high frequency of sherds with widely spaced irregularities in the paste texture may represent vessels manufactured for some specific function. Thus, different "paste recipes" can have functional implications. Alternatively, these differences could also have temporal implications. Or, they may represent changing ceramic manufacturing techniques among members of the same cultural group or the presence of different ceramic traditions from a different cultural group.

Vessel Form

In the absence of whole vessels, the general aspects of vessel form can be assessed through attributes such as thickness, diameter, and gross morphological category (i.e., body, base, and rim). The 25 sherds in the analyzed sample include 1 rim sherd, 1 base, and 23 body sherds.

The body sherds are small, with the majority of the sherds measuring between 4.5 and 30 mm along their maximum dimension, making it impossible to obtain diameter estimates for any of the body sherds. The body sherds range in thickness from 4.4 to 7.2 mm, with an average thickness of 5.622 ± 0.759 mm. The base (Lot 105.5) is a small center coil fragment measuring 8.7 mm in thickness. It is too small to determine the overall form of the base.

The undecorated rim sherd (see Figure 83, Lot 84.1) has a lip edge that had been rounded toward the exterior of the pot. It is a fragment from a relatively small vessel that had an outflaring rim and measured approximately 6.0 cm in diameter. The edge opposite the lip edge has an average thickness of 5.5 mm.

When the average thickness of the paste categories is compared (Table 23), there is considerable variation between the thicknesses of the untempered sandy paste wares (PG 1) and the bone-tempered wares (PG 3). Since the thickness of the vessel wall is directly related to the intended appearance and function of the vessel (see Rice 1987:227–228), it may be that the untempered sandy paste ceramics found at 41CW104 served a different function(s) than the bone-tempered wares. While this variation may simply result from the small sample size, the implications of the different "paste recipes" discussed above strengthens the argument that there are some functional differences between the vessels in each paste group.

Table 23. Thickness Attributes of the Sherds in Paste Groups 1 and 3

Untempered Sandy Paste (in mm)			
Average Thickness	Minimum Thickness	Maximum Thickness	Standard Deviation
4.975	4.4	6	0.732006375
Bone-tempered Paste (in mm)			
5.721	4.5	7.2	0.703624701

Exterior and Interior Surface Treatment

When the vessel reaches its final shape, modifications are made to its surface. These modifications are supplemental to the basic manufacture of the vessel and are performed after the vessel has attained its final shape. They affect only the outermost surface of the vessel and often effectively obliterate earlier primary-forming attributes. Techniques that affect the surface characteristics of a vessel can be carried out during all stages of pottery manufacturing; however, it is useful for analytical purposes to differentiate between surface modifications carried out on wet pliable clay (i.e., floating) from those that figure in the finishing of dry vessels (i.e., dry smoothing and burnishing), and those that add to the detail of the overall surface (i.e., decorative elements such as slips) (see Reina and Hill 1978:22–25; Rice 1987; Shepard 1976).

Among the 25 sherds in the analyzed sample, 11 sherds had exterior and/or interior surfaces that are too weathered to determine their original surface finish. Among the sherds with recognizable surface finishes, all had been floated but left unburnished. Floating is a process whereby the surface of the pot is repeatedly wet then lightly stroked to redistribute the finer particles. Sometimes referred to as a self-slip, this process levitates the fine clay particles to the surface leaving a fine coating of clay on the surface. This surface treatment technique has demonstrated spatial and temporal variability at a number of inland and coastal sites in the region (Ellis and Ellis 1996a, 1996b, 1999; Hamilton 1988; Wheat 1953; Winchell and Ellis 1991). On two sherds, red pigment had been added to the water used to wet the surface resulting in a distinctive red-floated surface. None of the sherds had been burnished and none had been decorated.

Firing Atmosphere

Firing atmosphere can be discerned from the variability in color. Although many variables affect color (such as clay composition and the atmosphere, temperature, and duration of firing), color generally provides an indication of whether or not pottery was fired in an oxidizing (lighter colors such as those in the tan, orange, light brown to red range), incompletely oxidized (shades of lighter and/or darker coloration), or a nonoxidized (dark colors such as dark brown, gray, or black) environment (see Rice 1987; Shepard 1976; Teltser 1993) for more-detailed discussions of firing attributes).

At 41CW104, the general variations in color development observed on surfaces and paste cores cluster at the darker end of the color spectrum (Table 24). This firing pattern indicates they were fired in atmospheres with insufficient (n = 17) or reduced (n = 8) amounts of oxygen. These patterns could result from several factors: (1) the firing temperature was too low, (2) the maximum temperature was not sustained long enough, (3) the firing atmosphere was only partially oxidizing, or (4) some combination of any or all of these variables.

Table 24. Firing Atmosphere of Sherds Recovered at 41CW104

Low fired and incompletely oxidized	17
Fired in a reducing atmosphere/cooled in a high-oxygen environment	1
Reduced	7
Total	25

There is one distinctive firing attribute, smudging, that occurs on two sherds in the analyzed sample. Smudging is a distinctive variant of open-air firing resulting from an extreme reducing atmosphere wherein carbon is deposited on the surface and in the pores of the vessel producing a dark gray to black finish (Rice 1987:158; Shepard 1976:88–90). These characteristic blackened surfaces result from specific firing techniques and differ from the blackened surfaces that result from using clays containing large amounts of organic material.

For clays with significant amounts of organic matter, heating of the organic materials moves the carbon to the surface of the clay where it is burned off in the form of CO_2 gas. However, under open-air firing conditions, temperatures and/or air flow may not be sufficient to completely oxidize the carbon. As a result, both the core and the surface of the sherd/vessel are characterized by a distinctive black color (Rice 1987:334). By contrast, smudged surfaces appear to result from the deposition rather than the elimination of carbonaceous material and are usually distinguishable in sherd cross section by their blackened color at or just below the surface that stands in contrast to their lighter-colored core. Because the presence of smudging documents a specific firing technique, consistent recording of this attribute may prove valuable in assessing regional firing practices. In fact, research suggests that there is some spatial patterning in this technique in that the percentage of sherds exhibiting smudged surfaces appear to increase as one moves southward toward the coast, pointing to a distributional disjunction between ceramic traditions located to the north/west and those located toward the east/coastal regions (Ellis 2010; Ellis and Ellis 1996a, 1996b; Hamilton 1988).

Intersite Comparative Analysis

The radiocarbon dates place the primary occupation at the Santa Maria Creek site between the Protohistoric period and the beginnings of the Colonial period. Minor occupations during the latter portion of the Late Prehistoric are also indicated (see Appendix A). One of the key ceramic questions to be addressed was whether or not the ceramics from the Santa Maria Creek site closely aligned with any of the known Late Prehistoric or Protohistoric types such as (1) the Rockport wares of the central coast, (2) the Mossy Grove ceramic traditions of the east-southeast, or (3) the central Texas Toyah wares (e.g., Leon Plain).

During the first phase of analysis, the ceramics recovered from the Santa Maria Creek site were characterized according to a suite of key technological attributes. The attributes observed during macroscopic examination, along with the results of petrographic and INAA, were then compared to the ceramic assemblages found at nine other similarly aged ceramic-bearing sites in the region. The goal was to determine any shared attributes and/or direct correspondences that might indicate cultural affiliations or similar ceramic cultural traditions. The archeological sites included in this comparative analysis were Allens Creek (41AU31 and 41AU38), Sandbur (41FY135), Cedar Bridge (41FY74), 41GM281, Mustang Branch (41HY209), Toyah Bluff (41TV441), Berclair (41GD4), and Panther Springs (41BX228) (Figure 86). Ceramic assemblages at these sites had been analyzed in enough detail to provide good comparative data, and in the case of three sites (Sandbur [41FY135], 41GM281, and Mustang Branch [41HY209]), special studies had also been performed on a sample of the ceramics.

It was also proposed in the Research Design that two sherds from the Santa Maria Creek site would be submitted for radiocarbon analysis in order to refine the age of the pottery at the site. According to Darden Hood at Beta Analytic (personal email correspondence 2011), carbon residue adhering to sherds would provide the most reliable date. In the absence of residue, the bulk organics in the sherd can also be dated; however, the sherd must be at least 1 square inch in size. Unfortunately, none of the 41CW104 sherds had carbon residue, and very few of the recovered sherds were of adequate size. Once sherds were submitted for petrographic and INAA, the only remaining sherds were small fragments. Thus, there were no viable candidates for bulk sherd dating.

Researching the ceramic assemblages from the nine comparative sites primarily involved a review of the published report of investigations for each site. Table 25 provides a breakdown of some of the key attributes discerned during this review. Since the collections from five of the comparative

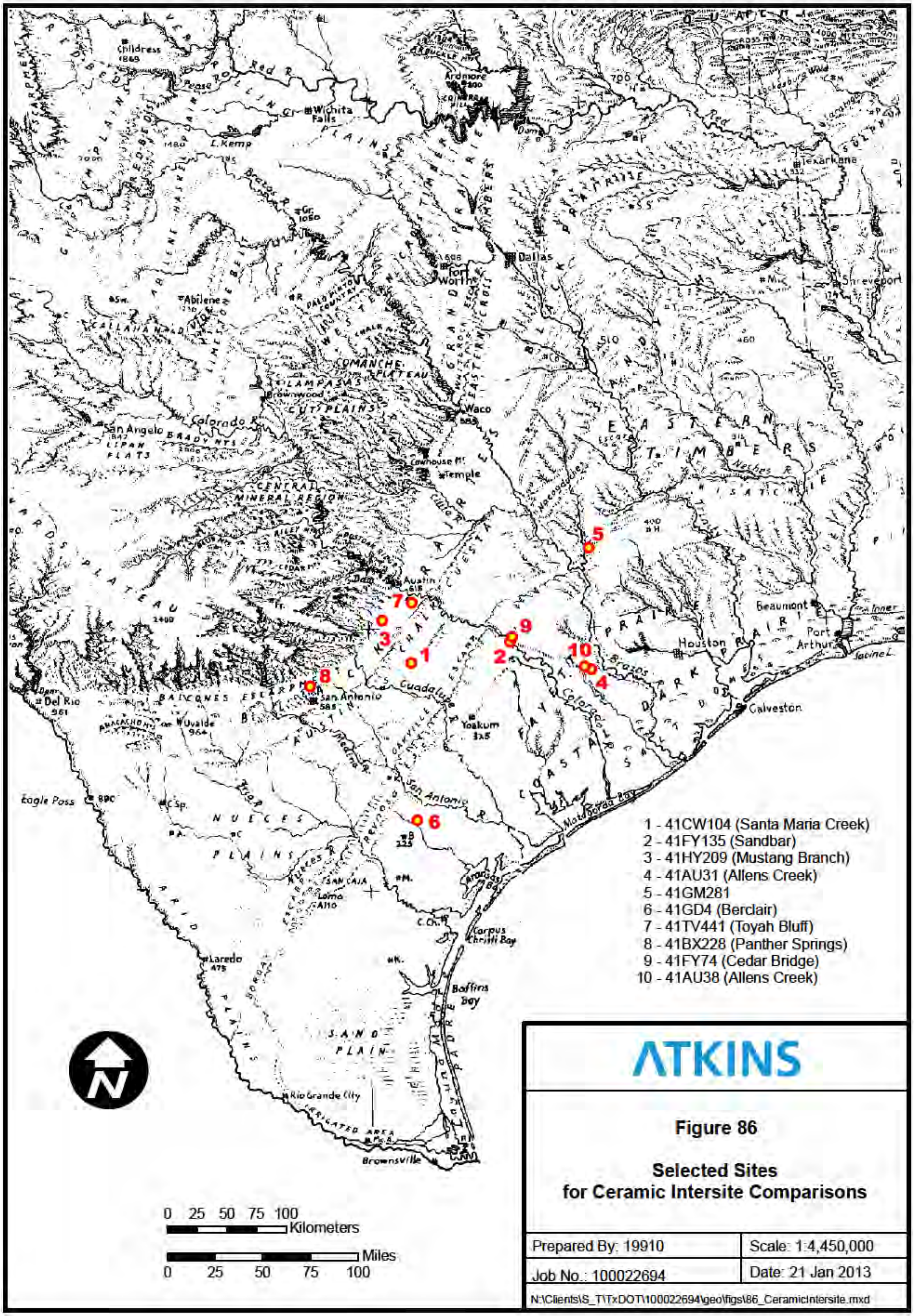


Figure 86

Selected Sites for Ceramic Intersite Comparisons

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
41TV441	Toyah Bluff (Karbula et al. 2001)	39 (included 2 unanalyzed sherdlets)	Group 1 (n = 18)	Bone temper in a sandy paste, but grog appears in 2 sherds and marl in 6 sherds.	Bone (5 to 25%), marl (5–25%), grog (<5%)	Closely relates to a Central Texas Ceramic Tradition as defined by Ricklis and Collins (1994)
			Group 2 (n = 4)	Crushed bone and larger-sized sand grains embedded in a silty paste.	Bone (<5%) and sand (5–25%)	May simply be highly eroded versions of either Group 1 or 3
			Group 3 (n = 15)	Hard, very fine sandy paste occasionally tempered with bone.	Bone (<5 %), sand (25%)	More closely resembles the Goose Creek types
41HY209T	Mustang Branch (Ricklis and Collins 1994)	480	Group 1 (n = 374)	Crushed bone temper in a sandy paste; 5–6 mm in thickness; interior surfaces well-smoothed and exterior surfaces vary, but most are burnished. Undecorated, ranging in color from dark gray to buff.	5–10% bone, 30% rounded sand grains	Sherds are within the range of variability of the Leon Plain type
			Group 2 (n = 69)	Crushed bone in a silty clay matrix; exterior and interior surfaces are well smoothed; interior surfaces and cores are dark gray, but exterior is mottled ranging from pale orange to buff to gray in color; thickness ranges from 3 to 6 mm. Decorated with vertical rows of fingernail punctations that split the bowl into quadrants.	20–30% crushed bone, extremely sparse quartz inclusions	Reconstructed portion of a small bowl (type unknown)
			Group 3 (n = 5)	Paste is a silty clay containing sparse amounts of grog; exterior and interior well smoothed; interior and core is dark gray, but exterior is mottled ranging from pale orange to buff to gray; thickness ranges from 5.5 to 6.5 mm with thickness on the shoulder measured as 7.5 mm; postfiring engraving on the exterior.	Sparse grog temper with 10% round sand grains	Shoulder fragments from a Poyner Engraved carinated bowl
			Group 4 (n = 9)	Paste is crushed bone with sparse sand inclusions; exterior surfaces are well smoothed or brushed; interior surfaces are well smoothed and burnished around the lip; thickness is 5–6 mm; horizontal row of punctations at the juncture of the vessel body and constricted neck; interior and exterior surfaces are buff-colored; paste core is dark gray.	Crushed bone (48%); carbonates (30%); with 12% subangular quartz	Rim, neck, and body sherds from a probable Boothe Brushed globular jar with a slightly constricted neck

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
			Group 5 (n = 2)	Paste is sparse grog and sand in a sandy paste; exterior surface is brushed and interior is smoothed; thickness ranges from 6 to 7 mm; and color dark buff on the exterior with a dark gray interior and core.	Sparse grog and poorly sorted sand (composes 30% of the nonplastic inclusions)	Brushed vessel fragments
			Group 6 (n = 21)	Sandy clay paste tempered with bone; burnished exterior surface and smoothed interior surface with carbon staining; undecorated; and thickness ranges from 3.5 to 4.5 mm.	Bone constitutes approximately 52% of the nonplastics; contains poorly sorted sand (27.8%)	Fragments of a smoking pipe with a vasiform shape; has a tapered round base with a rounded stem hole measuring 13 mm in diameter
41BX228	Panther Springs (Black and McGraw 1985)	227	Group 1 (n = 124)	Silty, very fine, and fine sandy paste tempered with finely ground bone (ranging in size from 0.4 to 2.5 mm) and carbonized material. Also includes very angular chert chips.	No paste constituency provided	One partially reconstructed vessel, multiple loose sherds that may be part of another vessel
			Group 2 (n = 74)	Silty paste tempered with finely ground burned and unburned bone. Also contains large silica grains.	Bone (ca. 3%), silica (ca. 1%)	Sherds are possibly from the same vessel, but the sherds in Group 2 appear to be from a different manufacturing tradition
			Group 3 (n = 12)	Moderately dense sandy pastes ranging from silty to fine sized on the Wentworth scale. All are tempered with finely crushed bone (ca. 0.125 mm). Several also contain large amount of carbonized material.	Bone (ca. 5%)	Fragments of several vessels recovered from BHT 11; sherds were widely distributed across the site
			Group 4 (n = 10)	Fine to very fine sandy paste tempered with bone (ranging in size from 0.60 to 0.125 mm)	Bone (ca. 5–7%)	Heavily eroded; all sherds possibly from the same vessel
			Group 5 (n = 6)	Silty to very fine sandy paste tempered with finely ground bone varying from 0.50 to 1.0 mm.	Bone (ca. 7%)	Possibly smudged
			Group 6 (n = 1)	Very fine to silty sandy paste tempered with bone ranging in size from 0.25 to 1.0 mm.	Bone (ca. 2–3%)	Floated surfaces with a slight luster; one sherd has two parallel incised lines on the exterior

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
41GD4	Berclair (Hester and Parker 1970)	868 and 1 partially restored vessel	Group 1 (n = 179)	Abundant bone that is often burned; exterior surfaces are smoothed but bone is visible and some are burnished, interiors are roughly smoothed, uneven, and some are scored, with visible bone; undecorated, thickness ranges from 3.5 to 7.5 mm, cores are generally gray to black but surfaces range from red to gray to brownish gray.	Bone, some fragments larger than 2–3 mm.	MNV estimated to be between 9 to 13; paste, as well as surface and core colors closely resemble the type Leon Plain as described by Suhm et al. (1954)
			Group 2 (n = 22)	Tiny fragments of bone in a somewhat sandy paste; very fine, compact, and small grained; exterior surfaces are smoothed, but uneven and sandy to the touch; interiors are similar; asphaltum traces occur on most sherds and a broad line occurs on the exterior of several sherds; thickness ranges from 5 to 6.5 mm; colors range from pale yellow to light gray to gray and cores are gray; fire-clouded and/or smudged.	Bone and sand (no percentages given)	Possibly represents 1 vessel
			Group 3 (n = 12)	Primarily sand and grit, with bone inclusions; exterior surfaces are rough with bone exposed on some sherds; interior surfaces are rough, uneven with smoothing marks evident; thicknesses vary from 6 to 11 mm; lip edges of the rim are slightly flattened; color varies from pale brown to light gray, with some partially fire-blackened; asphaltum from mending occurs on some.	Sand and grit, with bone inclusions ranging from sparse to considerable	MNV estimated to be between 2 and 3
			Group 4 (n = 3)	Bone temper with a coarse to somewhat laminated texture; exterior surfaces are well smoothed, interiors are rough and uneven; one sherd has asphaltum on the exterior; thicknesses range from 5 to 6 mm; colors range from reddish yellow to light red.	Heavily bone tempered, in one sherd most of the bone is burned	Possibly represent 2 vessels

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
			Group 5 (n = 16)	Some bone tempering in an overall sandy paste; exterior and interior surfaces are eroded, sandy and gritty to the touch; no decoration; thicknesses range from 5 to 11 mm; exteriors are pink to light gray and interiors are generally gray.	Some bone in a sandy paste that varies from very fine to coarse	Possibly represents 2 vessels
			Group 6 (n = 14)	Paste has crushed bone temper with a grainy, coarse texture; exterior slightly smoothed and pitted by leaching bone fragments; interior surfaces of most are similar to the exteriors, but some have tooling marks, one has asphaltum, and one is well burnished; undecorated; thicknesses range from 6.5 to 9.5 mm; lip edges are interior thinned and rounded; exterior and interior colors are similar, varying from pink to a mottled pinkish-gray to gray.	This group is distinguished by the very high content of crushed bone	Possibly represents 2 vessels
			Group 7 (n = 39)	Fine paste that is very compact tempered with finely crushed bone; exterior surfaces are smoothed, some with light burnishing; interiors are rougher with tool marks; thicknesses range from 4.5 to 8 mm; lip edges thinned from the interior, rounded and slightly outflaring; color ranges from brown to slightly reddish brown or grayish brown.	Finely crushed bone, sometimes burned	Most sherds from a single vessel and possibly 1 or 2 others
			Group 8 (n = 31)	Hard compact paste with bone tempering; have a sandy, gritty feel; exterior surfaces are well smoothed to lightly burnished; interior surfaces are rough with light tooling marks and scoring; two have lightly burnished surfaces; undecorated; thicknesses range from 5 to 9 mm; color is quite uniform on the exterior surface with the majority being brown and a few light gray; interior color is varied ranging from light red to pick gray to dark gray to brown; paste cores are dark gray.	Hard compact paste with bone tempering; two sherds have sandy pastes with little bone	Most sherds from a single vessel and possibly 2 others

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
			Group 9 (n = 104)	Burned bone temper; hard pastes that vary in texture from fine and laminated to granular and coarse; majority are well smoothed to lightly burnished (7 or 8 have a sandy gritty feel); interior surfaces are rough and uneven exhibiting tool marks and light scoring (a few are highly smoothed and well finished); undecorated; thicknesses range from 5 to 9 mm	Bone temper (most often burned) occurs in large quantities on most sherds; 2–3 sherds have rather sandy pastes and sparse bone	MNV estimated to be at least 3
			Group 10 (n = 110)	Bone tempered with very hard pastes that are generally fine and compact; exterior surfaces are well-smoothed and several are burnished; interior surfaces are much rougher, with tool marks very apparent; thicknesses range from 4.5 to 7 mm; lip edges flat to slightly rounded (not thinned as in previous group); exterior, interior, and core colors are dark gray to black, some of which are attributable to uneven firing, fire-clouds, or smudging.	Bone occurs in all although it is sparse in a few; a few sherds have coarse grainy pastes	Represents several vessels, but some may be fragments of other groups
			One partially reconstructable vessel	Paste is compact, though somewhat contorted; wall thickness ranges from 6 to 8 mm and base thickness is about 9 mm; paste core is gray, and exterior surface is gray to dark gray; appears to have been decorated with horizontal bands of asphaltum.	No paste constituency provided	A number of large thick sherds from a deep-sided jar with a rounded, convex base; maximum body diameter estimated at ca. 183 mm
			Misc. (n = 338)	Includes recognizable Rockport types (n = 2); decorated sherds with incised punctates (n = 1), fine line incision (n = 1), broad-line incisions (n = 1); brushed (n = 1), and asphalt-decorated design elements (n = 3). One worked sherd, 3 small bone-tempered sherds with sandy pastes; and 326 small eroded sherdlets.	No paste constituency provided	Includes fragments of a tubular stone pipe

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
41FY135	Sandbur (Kalter et al. 2005)	81 (included 28 unanalyzed sherdlets) (5 sherds submitted for INAA)	Group 1 (n = 1)	Bone temper/coarse sandy paste; fired in a reducing environment then cooled in the open air; 7.2 mm thick.	Sherds has less than 25% bone in the paste and a larger range of sand grain sizes	Plain body sherd from a jar
			Group 2 (n = 16)	Bone temper/sandy paste; fired in a reducing environment; somewhat thicker than the other bone-tempered sherds.	Sherds have less than 25% bone in the paste and lesser amounts of sand grains	All are body sherds
			Group 3 (n = 4)	Coarse bone temper/coarse sandy paste; body sherds had been fired in an oxidizing environment; rim sherd fired in a reducing environment; smoothed exteriors; rim is 6.6 mm thick and body sherds average 5.43 mm in thickness.	Sherds have profuse amounts of bone in the paste and larger range of sand grain sizes	One rim sherd decorated with a vertical row of cane punctations adjacent to a vertical incised line; and three plain body sherds
			Group 4 (n = 7)	Coarse bone temper/sandy paste; five sherds had been fired in a reducing atmosphere and two sherds from the same vessel had smoothed surfaces and had been fired in an oxidizing environment; body sherds average 5.80 mm in thickness and the rim sherd is 5.9 mm thick.	Sherds have profuse amounts of bone in the paste and lesser amounts of sand grains	One rim sherd and six plain body sherds; one body sherd has a scraped interior surface
			Group 5 (n = 1)	Bone temper/clay paste; fired in a reducing environment and cooled in the open air; 6.1 mm thick.	Sherd has less than 25% bone in the paste and a clay paste	Plain body sherd
			Group 6 (n = 8)	Sandy paste; some fired in an oxidizing environment (2 possible vessels) and some in a reducing environment (3 possible vessels); body sherds average 6.20 mm in thickness and rim is 5.0 mm thick.	Pastes containing lesser amounts of sand grains	One rim sherd with vertical incised lines and seven body sherds, including one decorated body with incised lines; resemble coastal ceramic sherds
			Group 7 (n = 11)	Coarse sandy paste; smoothed surfaces (one burnished); thickness averages 6.25 mm, oxidized or incompletely oxidized during firing.	Pastes containing a larger range of sand grain sizes	All are plain body sherds

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
41FY74	Cedar Bridge (Skelton 1977)	552	Group A1 (n = 252)	Bone-tempered, with profuse amounts of sand, loosely compacted and very friable.	Small proportion of pulverized bone (@ 2 mm)	Floated on both surfaces; sometimes polished (probably burnished); 30 smudged
			Group A2 (n = 118)	Bone-tempered, with profuse amounts of sand, loosely compacted and very friable.	Small proportion of pulverized bone (@ 2 mm)	Floated on both surfaces; sometimes polished (probably burnished); 20 smudged
			Group A3 (n = 67)	Bone-tempered, with profuse amounts of sand, loosely compacted and very friable.	Small proportion of pulverized bone (@ 2 mm)	Floated on both surfaces; sometimes polished (probably burnished); 29 smudged
			Group A4 (n = 50)	Bone-tempered, with profuse amounts of sand, loosely compacted and very friable.	Small proportion of pulverized bone (@ 2 mm)	Floated on both sides; 5 smudged
			Group B5 (n = 47)	Sandy paste; fine rounded sand, more-compacted clay body	Sand, no precise grain size given	Floated on both surfaces; 2 are smudged
			Group B6 (n = 6)	Sandy paste; fine rounded sand, more-compacted clay body	Sand, no precise grain size given	Floated on both surfaces; 1 is smudged
			Misc. 7 (n = 12)	Sherds are a mix of bone, grog, and sand; all are crumbs less than 1 cm in size.		Badly eroded sherdlets
41GM281	(Rogers 1995)	1,483/ @750 analyzed	38 percent of the assemblage	Bone-tempered		48 are decorated; 1 pipe stem fragment
			1 percent of the assemblage	Bone-and -grog-tempered		At least 1 was decorated
			4 percent of the assemblage.	Grog-tempered		Caddo decorative motifs; 11 are decorated
			57 percent of the assemblage	Sandy paste		46 sherds are decorated
41AU38	Allens Creek (Hall 1981)	509	Group 1 (n = 37)	Bone-tempered, colors range from light brown to light brownish gray to very dark gray; interiors are uniformly dark gray to very dark gray (smudged?).	Crushed bone in a silt to very fine sandy paste	Two rim sherds have incised lines parallel to the rim
			Group 2 (n = 66)	Bone and grog tempered	Fine sandy paste	
			Group 3 (n = 126)	Grog tempered	Fine sandy paste	One rim has lip notching
			Group 4 (n = 13)	Sandy paste; darker reduced colors	Fine to coarse sand	One is scored on the exterior; resemble central coast ceramics

Table 25. Comparative Ceramic-bearing Sites

Site	Site Name/ Reference	Total # of Sherds	Defined Ceramic Groups	Paste Matrix and Tempering Agents	% of Inclusions	Notes
			Group 5 (n = 6)	Sandy paste	Very fine to silty with coarse-sized inclusions; laminated	This group has a whipped and blended look; this, plus the differential distribution of grain sizes, suggests that they are sand tempered
			Group 6 (n = 259)	Sandy paste	Medium-coarse-sized sand	
			Group 7 (n = 2)	Sandy paste	Medium to coarse-sized sand	One is smudged
41AU31	Allens Creek (Hall 1981)	46	Group 1 (n = 3)	Bone tempered, primarily fired in a reducing environment.	Moderate amount of very fine sand with a high percentage of very finely crushed bone	The bone particles are smaller than those identified in the 41AU38 bone-tempered sherds, and they constitute a high percentage of the total
			Group 2 (n = 15)	Bone tempered, primarily fired in a reducing environment.	Primarily silt sized with some medium-sized sand grains	Floated surfaces
			Group 3 (n = 1)	Grog tempered		
			Group 4 (n = 27)	Sandy paste		

sites are housed at TARL, review of the published report was supplemented by a cursory reexamination of the ceramics from these five sites (Allens Creek, Sandbur, Toyah Bluff, 41HY209T, and Berclair).

Allens Creek (41AU31 and 41AU38): The Allens Creek project area is situated in the lower Brazos River Valley on the inland coastal plain approximately 100 miles (161 km) southeast of 41CW104 (Hall 1981). A total of 715 sherds were recovered from seven excavated sites, more than 98 percent of which were undecorated. Untempered sandy paste sherds composed 57 percent of the recovered pottery.

Among the seven sites excavated at Allens Creek, 41AU31 and 41AU38 contained substantial numbers of bone-tempered ceramics (see Table 25), which Hall (1981) believed represented occupations during the latter half of the Late Prehistoric and the early Protohistoric periods. Paste categories included primarily untempered, sandy paste sherds, but bone-and-grog-tempered ceramics were also found (Hall 1981). A cursory reexamination of the 41AU31 and 41AU38 ceramic collections housed at TARL largely confirmed Hall's (1981) original descriptions; however, some of the bone-and-grog-tempered sherds appear to have little or no grog, and the bone temper appears more finely crushed than that observed in sherds classified as having only bone temper. As noted by Hall (1981:261), the untempered sandy paste sherds resembled the Goose Creek Plain and Goose Creek Incised types found along the upper Texas coast, and the grog-tempered sherds resembled the San Jacinto Plain types (see Aten 1983). This author did, however, observe that at 41AU38 a small number of sandy paste sherds, assigned to Group 4, had distinctly darker reduced colorations. During reexamination of the collection, one of the sherds in this group also had a scored interior surface, an attribute that is more characteristic of central coast ceramics. Given their general coloration, their fine-to-coarse-sized sandy pastes, and the presence of scored surfaces, Hall's (1981) Group 4 sherds strongly resemble the ceramics found at sites in the Brazos Delta-West Bend Area (see Ellis 2000, 2003; Ellis and Ellis 1996a, 1996b). Thus, the ceramics present at 41AU38 and 41AU31 exhibit technological attributes that resemble those associated with at least two manufacturing traditions located to the south-southeast.

Sandbur Site (41FY135): The Sandbur site is located approximately 40 miles (64 km) northeast of the Santa Maria Creek site. The ceramic assemblage totaled 81 sherds. This total included 28 sherdlets that were too small and/or eroded to be analyzed. Five sherds were submitted for INAA and were not analyzed. During analysis, seven temper/paste groups were identified: (1) bone temper/coarse sandy paste; (2) bone temper/sandy paste; (3) sandy paste; (4) coarse sandy paste; (5) coarse bone temper/sandy paste; (6) coarse bone temper/coarse sandy paste; and (7) bone temper/clay paste (Kalter et al. 2005; see Table 25). Most are undecorated. Among the few sherds that are decorated, decorative elements include incised lines and punctations. One sherd with a drill hole was also found. Sherd thicknesses vary from 5 to 7 mm. Surfaces are largely smoothed with some evidence of burnishing. Several sherds exhibited scraping on their exterior and/or interior surfaces. The oxidization patterns noted on the sherds indicate the use of multiple firing environments that ranged from oxidized to reduced.

Eleven sherds from 41FY135 were submitted for petrographic analysis and five sherds were submitted for INAA. In general, the petrographic analysis confirmed the paste groups established during macroscopic examination, with any differences being primarily due to the relative abundance of sand in the paste matrix and the average size of the sand grains. Approximately 35 percent of the assemblage had been tempered with crushed bone that occurred in varying proportions, representing between 10 and 66 percent of the inclusions in the matrix. In general, the petrographic analysis of the 41FY135 ceramics showed marked similarities to many of the sandy paste and bone-tempered paste groups found at the Allens Creek sites, the Cedar Bridge site (41FY74), and 41GM281 (discussed below). In addition, INAA results indicate that the compositional variations of the five submitted samples are closely analogous to the compositional variation of ceramics from east-southeast Texas.

Cursory reexamination of the 41FY135 ceramics housed at TARL largely confirmed the categories discussed in the report, with the overall attributes noted on the ceramics from the Sandbur site showing a marked similarity to the ceramics found at the Santa Maria Creek site, the Cedar Bridge site (Kalter et al. 2005:213), and the Allens Creek sites (Hall 1981), particularly with regard to the recognized paste groups, sherd thickness, and oxidation patterns. Petrographic and INAA also show marked similarities to the ceramics from the Santa Maria Creek site (see below). In addition, the characteristic oxidation patterns and scored surfaces observed on several of the Sandbur site sherds are reminiscent of ceramics found in assemblages in the Brazos Delta-West Bend Area (see Ellis 2000, 2003; Ellis and Ellis 1996a, 1996b). Thus, the ceramic assemblage at the Sandbur site suggests the presence of multiple ceramic traditions that are closely tied to each other.

Cedar Bridge Site (41FY74): The Cedar Bridge site is located along Cedar Creek about 1 mile (4.6 km) upstream from the Sandbur site and approximately 41 miles northeast of the Santa Maria Creek site. The ceramic assemblage (n = 552) at 41FY74 was divided into three groups (Skelton 1977; see Table 25). Group A (n = 437) includes four subgroups that are presumed to be related. Only minor color changes separate the four subgroups. Pastes in this group have nonplastic inclusions consisting of large amounts of rounded sand grains, with small proportions of pulverized bone (0.2–2 m in diameter). All are undecorated. Surfaces are floated on the exterior and interior, but they are rarely polished; 19 percent are smudged.

Group B (n = 53) has two subgroups. Ceramics in this group have paste fabrics containing large amounts of fine rounded sand grains. All are undecorated, with floated exterior and interior surfaces that are rarely polished; 6 percent are smudged.

Misc. 7 (n = 12) includes sherds with variable pastes. All are “crumbs” less than 1 cm in size and/or badly eroded. The only decorated sherd in the assemblage (one exhibiting small linear punctations) is included in this group.

A cursory inspection of the 41FY74 ceramics housed at TARL confirmed the basic group designations assigned by Skelton (1977) in his published report. The assemblage is largely composed of small eroded fragments, but the variety of technological attributes (e.g., paste texture, surface treatments, oxidation patterns) exhibited on the sherds suggests the presence of numerous vessels. The bone-tempered ceramics included in Group A resemble those found at 41CW104, especially with regard to their sandy pastes tempered with small, sparse bone fragments. The 41FY74 Group B ceramics with their untempered sandy pastes and floated surfaces also resemble those found at 41CW104; however, interior smudging is much more prevalent at 41FY74 than it is at 41CW104. In general, the ceramics recovered at the Cedar Bridge site closely resemble those found in southeast Texas coast assemblages.

41HY209T (Mustang Branch site, Terrace, Toyah component): The Mustang Branch site is located along Onion Creek in eastern Hays County approximately 30 miles (48 km) northwest of 41CW104. Excavations at the site yielded a Toyah phase cultural component dating between about A.D. 1400 and 1600 (Ricklis and Collins 1994). Ceramics from the Toyah component yielded 480 sherds. Sherds were analyzed under 30X binocular microscopy, and the technological attributes recorded included paste characteristics, surface finish, decoration, thickness, and color. Selected samples were also subjected to petrographic and PIXE elemental analysis.

Six groups were recognized based on the presence of bone and/or grog temper (see Table 25). The sherds displayed an interesting heterogeneity, and each group was believed to represent a single vessel. The partially reconstructed vessel that comprises Group 2 has crushed bone temper and rather distinctive rows of fingernail punctations (Ricklis and Collins 1994:Figure 141). Interestingly, PIXE elemental analysis of a sherd from this vessel clustered this vessel with the bone-tempered Boothe Brushed sherd assigned to Group 4 (Ricklis and Collins 1994:Figure 142c). The presence of the Poyner Engraved sherd that comprises Group 3 indicates a nonlocal import of Caddo origin (Ricklis and Collins 1994:Figure 142a), and the PIXE elemental analysis of this sherd placed it in a cluster by itself.

A cursory reexamination of the 41HY209T ceramic groups housed at TARL was conducted. Overall, the Group 1 ceramics are relatively thin, with well-finished surfaces that frequently exhibit burnishing. Their bone- and/or grog-tempered pastes consist of silty clay to very fine sand, and their general coloration suggests they were fired in a reducing atmosphere. Although the ceramics from Group 1 are characterized as being within the range of the Leon Plain type (Ricklis 1994), this group contains both bone- and bone-and-grog-tempered ceramics whose overall attributes are more similar to Caddo ceramics. Elemental analyses of two sherds from this group indicate close elemental composition to the pipe fragment assigned to Group 6. This suggests that several ceramic traditions were present at the Mustang Branch site, with several of the groups exhibiting attributes similar to Caddo ceramics.

41GM281: Site 41GM281 is located along Peach Creek in the lower Navasota River basin in Grimes County, approximately 110 miles (177 km) northeast of 41CW104. Over 120 m^3 of fill was removed from the site, yielding more than 25,000 artifacts dating to the Late Prehistoric (A.D. 1250–1400) (Rogers 1995). The ceramic assemblage included 1,483 sherds, 750 of which were analyzed in detail. Untempered sandy paste sherds comprised the major paste group (57 percent), although relatively large numbers of bone-tempered sherds (38 percent) were also found (see Table 25). The identified ceramic types point to southeastern and eastern affiliations, and include upper coast types such as Goose Creek Plain, San Jacinto Incised, and Caddo types such as Holly Fine Engraved. Petrographic analysis performed on 14 samples showed definite similarities between the 41GM281 sherds and those recovered at the 41FY135, particularly with regard to the percentage of matrix, the ratio of matrix to pore space, and the average grain size. Their overall descriptions indicate similarities to the Santa Maria Creek ceramics.

Toyah Bluff site (41TV441): The Toyah Bluff site is located above Onion Creek in Travis County, approximately 40 miles (65 km) north of the Santa Maria Creek site. Ceramics recovered from Toyah Bluff consisted of 39 small specimens, the majority of which had bone temper embedded in a sandy paste. Three paste groups were identified (Karbula et al. 2001; see Table 25).

Group 1 includes ceramics (n = 18) with sparse to moderate amounts of bone temper (5–25 percent) embedded in a loosely worked sandy paste. Marl (i.e., crushed pieces of calcareous rock) was present in the paste of at least one-third of the specimens, and grog was found in two sherds. Colors ranged from tan to orange-brown to brown, indicating firing atmospheres that were oxidizing. The sherds were small and weathered so surface treatment could not be identified. Group 1 has a strong affiliation with those from the Middle Onion Creek site (41HY209); however, there are some definite differences, as well. The Middle Onion Creek ceramics were more highly fired, and their basic paste fabrics do have the high sand content found in the Toyah Bluff Group 1 sherds. In addition, the presence of the marl in a large percentage of the Group 1 sherds suggests a distinctive manufacturing tradition.

The four small sherds included in Group 2 have a silty paste with small amounts of very finely ground bone and large amounts of sand temper. Their surfaces were weathered and none were decorated. The coloration of the sherds indicates they were fired in an oxidizing environment.

Group 3 (n = 15) is characterized by hard, very sandy paste, occasionally tempered with sparse amounts of bone (less than 5 percent of the matrix). Sherds in this group resemble ceramics from the Texas coast. Colors range from dark gray to dark brown to dark black, indicating a reducing environment. The sherds are extremely weathered, but the remaining surfaces on several sherds appear smoothed and/or burnished. This latter group may possibly reflect ties with eastern Texas or the Texas coast due to their similarities with the Goose Creek Plain type. The presence of one sherd with a scored surface may indicate ties to the central coast ceramic traditions. Thus, the technological attributes observed on the Toyah Bluff ceramics point to the presence of several ceramic traditions at site. Finally, although many of the Group 3 sherds from the Toyah Bluff site resemble the bone-tempered sherds found at the Santa Maria Creek site, there are also differences, particularly with regard to the Group 1 sherds tempered with marl.

Panther Springs (41BX228): Located approximately 60 miles (96 km) west of 41CW104, the Panther Springs site (41BX228) is situated in north-central Bexar County (Black and McGraw 1985:184–199). Excavations at the site yielded 227 ceramics that were analytically grouped into six groups (see Table 25). All the groups included bone temper, and group assignments were made on the basis the presence or absence of additional tempering agents. The sherds assigned to Group 1 (n = 124) had finely ground bone fragments and carbonized material embedded in a silty to very sandy paste. The paste matrix of this group was also described as having very angular chert inclusions. By contrast, the sherds assigned to Group 2 contained finely ground bone embedded in a silty paste matrix that also included sparsely distributed large silica grains. The differing paste recipes suggest that the sherds in Groups 1 and 2 were the product of two different manufacturing traditions.

Given the presence of sherds with floated surfaces and smudging, the sherds in Groups 5 and 6 suggest possible affiliation with the ceramic traditions found among coastal groups to the south-southeast. The small crushed bone and the sandy texture of the Panther Springs ceramics in these two paste groups also appear similar to the ceramics found at the Santa Maria Creek site.

Berclair Site (41GD4): The Berclair site is located 85 miles (136 km) south of the Santa Maria Creek site in Goliad County. One partially restored vessel and 868 sherds were recovered at the site (Hester and Parker 1971). The sherds were primarily bone tempered. For purposes of analysis, the undecorated ceramics were divided into 10 analytical groups (n = 529), with group membership based on exterior surface color as defined by Munsell color standards (see Table 25).

A cursory reexamination of the Berclair ceramic assemblage housed at TARL was done. In general, the Berclair assemblage appeared to be very different from the 41CW104 assemblage. In particular, the majority of the sherds appear to have been made with clays containing a high organic content and fired in a reducing environment. Paste matrices were much more variable in terms of the size and density of bone, the texture, and amount of sand present in the sherds.

The Berclair ceramics included a broad range of attributes. For example, smudged surfaces were observed on several sherds. Decorative elements were also much more varied, including fine line incisions and punctated elements, broad-line incisions, brushing, and asphalt-decorated design elements. Asphalt-decorated wares are quite common to Rockport ceramics found along the central coast, while the brushing is reminiscent of Caddo wares. In general, the attributes observed on the sherds at the Berclair assemblage point to the presence of multiple ceramic traditions.

Conclusions

The primary research objective of this study has been to expand our knowledge of the bone-tempered ceramics found at sites in south Central Texas and to assess how the ceramics from the Santa Maria Creek site compare to other known sites in this transitional zone. The study began with a detailed technological analysis of the ceramics recovered at the Santa Maria Creek site (41CW104). This was followed by an intersite comparison with ceramic assemblages from nine similarly aged ceramic-bearing sites in the region. This study provided an excellent opportunity to compare ceramic assemblages from known sites and expand our database of technological and decorative attributes associated with the occurrence of bone-tempered ceramics during the latter Late Prehistoric and Protohistoric periods.

Several questions were proposed at the beginning of this chapter. (1) Do the bone-tempered ceramics found at sites in this transitional zone represent a series of localized regional ceramic types? (2) Are they simply varieties of the early defined type known as Leon Plain? Or (3) do these plain bone-tempered ceramics represent a distinctive "Toyah" ware? Over the course of the analysis, several key technological attributes were identified that provide data for addressing these questions.

First, analyses of paste attributes at 41CW104 identified three paste groups; however, the majority of the ceramics (76 percent) are bone-tempered wares. The bone used to temper the 41CW104 ceramics occurs as small, crushed, angular fragments that are relatively sparsely distributed throughout a sandy paste matrix containing fine-to-coarse-sized sand grains. A small percentage (20 percent) of the ceramics contains natural sands with no additional tempering agents. Only one bone-and-grog tempered sherd was found. The textural differences between the 25 sherds suggest that different "paste recipes" were used to manufacture the ceramics found at the site. Given their overall sandy matrix and general textural differences, the Santa Maria Creek ceramics closely resemble those found in assemblages located to the south-southeast (Aten 1983; Ellis and Ellis 1996a, 1996b; Hall 1981; Winchell and Ellis 1991).

Second, all exterior and interior surfaces on the Santa Maria Creek ceramics had been floated. This surface treatment mode also has a high-frequency occurrence in Mossy Grove assemblages located to the east/southeast. In fact, ceramics with floated surfaces have demonstrated spatial and temporal variability at a number of inland and coastal sites in the region (Ellis and Ellis 1996a, 1996b, 1999; Hamilton 1988; Wheat 1953; Winchell and Ellis 1991). It should, however, be noted that this surface treatment mode has been inconsistently recorded, partly due to its tendency to weather away. Thus, it may be more widespread than presently known.

Third, the presence of sherds with smudged interior surfaces suggests a specific firing technique that may prove valuable in assessing regional firing practices. The low percentage of sherds (8 percent) at 41CW104 that exhibit smudged interior surfaces is consistent with research that shows a distributional disjunction between ceramic traditions located to the northwest and those located toward the east-coastal regions (Ellis 2010; Ellis and Ellis 1996a, 1996b; Hamilton 1988). Again, this attribute has been inconsistently recorded or mentioned, but not quantified.

All of these attributes speak to the presence of different manufacturing traditions and/or broad-scale interactions with neighboring groups with different ceramic traditions. In particular, when the Santa Maria Creek ceramic assemblage is compared with other sites in the region, the 41CW104 ceramics seem to align more closely with the ceramic traditions to the east-southeast.

Finally, this assessment is further supported by the INAA results. The distribution of paste composition (i.e., paste constituency and paste texture) among the 41CW104 ceramics indicates that more than one paste preparation and fabricating technique was used to manufacture the vessels. This could indicate changing ceramic manufacturing techniques among members of the same cultural group or it could also indicate the presence of different ceramic traditions associated with different cultural groups. The results of the INAA show some patterned variability among the 15 samples, largely due to 5 samples whose compositional variability differs from the other 10 samples (see below). For example, sample CW222 shows elevated concentrations of many elements such as chromium and scandium. Interestingly, this sherd was the only bone-and-grog-tempered sherd recovered at the site.

The remaining 10 samples show greater similarity and likely represent local production. This is suggested by the comparison of the 41CW104 samples to the 15 compositional groups thus far identified in the Central Texas Database. Most of these 15 compositional groups represent localized production. While the 41CW104 samples do not match any of the current small groups, there is a match with one of the larger reference groups that points to the regionally local production of most of the samples. When comparisons were made between the ceramics from the 41CW104 and the Sandbur site, there is evidence of small-scale production and localized exchange between the two sites. This suggests that the bone-tempered ceramics found at sites in this transitional zone may indeed represent a series of localized regional ceramic types. Whether or not these localized regional ceramics could be considered varieties of Leon Plain or a distinctive "Toyah" ware remains to be demonstrated.

PETROGRAPHIC ANALYSIS OF CERAMIC THIN SECTIONS

by Robert Rogers

Introduction

Twelve sherds collected during data recovery at 41CW104 were submitted for thin sectioning and petrographic analysis. The methods employed in this study closely follow those developed by

Atkins analysts to evaluate ceramics at other sites in the Texas (Reese-Taylor 1993; Skokan and Perttula 1998; Rogers 2010). The methods were designed to produce descriptions that are detailed, quantified, and replicable. The analysis followed the definitions found in Shepard (1976:25) and Rice (1987:411). Nonplastics in the paste refer to tempering and naturally occurring inclusions.

Thin sections were prepared by Spectrum Petrographics. Each thin section consisted of a prepared slide containing a single ceramic sherd oriented perpendicular to the vessel wall. The samples were impregnated with blue-dyed epoxy and ground to a standard thickness of 0.03 mm. An Olympus BH-2 polarizing microscope was used in the thin section analysis. Initially, each slide was scanned and evaluated for general composition and porosity characteristics and using a 4x objective. A point count, intended to statistically quantify the composition of each sample was then made using a 10x objective. Ideally a 200-grain count was made, though some of the specimens were too small for this total to be obtained. During the point count, the thin section was advanced 0.5 to 1 mm, and the points along a line were counted. Following the point count, the long axis of 40 randomly selected grains was measured.

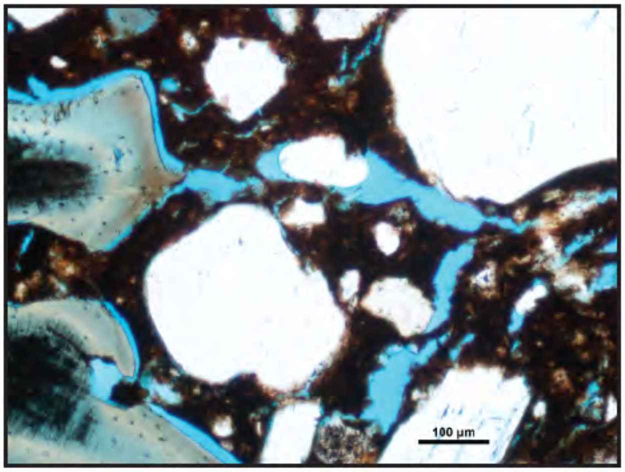
Descriptive Petrography

Lot 35.1, Unit 5, Level 2 (Figure 87): Lot 35.1 is composed of 42 percent monocrystalline quartz, 39 percent matrix, 14 percent pore space, and 5 percent bone. There are traces of chert, feldspar, and polycrystalline quartz. Matrix is dark reddish brown in plane polarized light (ppl). Pore space appears as short, multidirectional channels and chambers. Measurable quartz is moderately sorted and ranges from 0.10 to 1.10 mm. Mean grain size is 0.33 mm (medium sand), median grain size is 0.26 mm, and the standard deviation is 0.2452 mm.

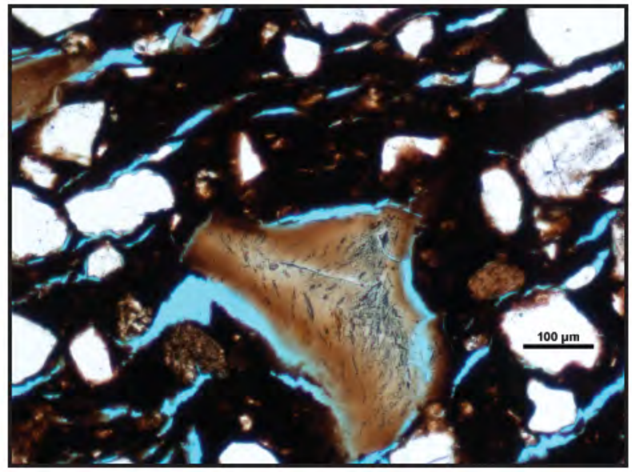
Lot 56.1, Unit 2, Level 3: Lot 56.1 is composed of 36 percent microcrystalline quartz, 40 percent matrix, 18 percent pore space, and 6 percent chert. There is a trace of polycrystalline quartz. Matrix is dark reddish brown in ppl. Pore space appears as short, narrow unidirectional channels and chambers. Measurable quartz is moderately sorted and ranges from 0.10 to 0.81 mm. Mean grain size is 0.30 mm (medium sand), median is 0.24 mm, and the standard deviation is 0.1743 mm.

Lot 84.1, Unit 9, Level 2 (see Figure 87): Lot 84.1 contains 24 percent monocrystalline quartz, 46 percent matrix, 16 percent pore space, 10 percent bone, and 4 percent chert. There is a trace of feldspar. Matrix is dark reddish brown. Pore space appears as narrow, elongated multidirectional channels and chambers. Measurable quartz is moderately sorted and ranges from 0.08 to 0.62 mm. Mean grain size is 0.22 mm (fine sand), median is 0.21 mm, and the standard deviation is 0.1376 mm.

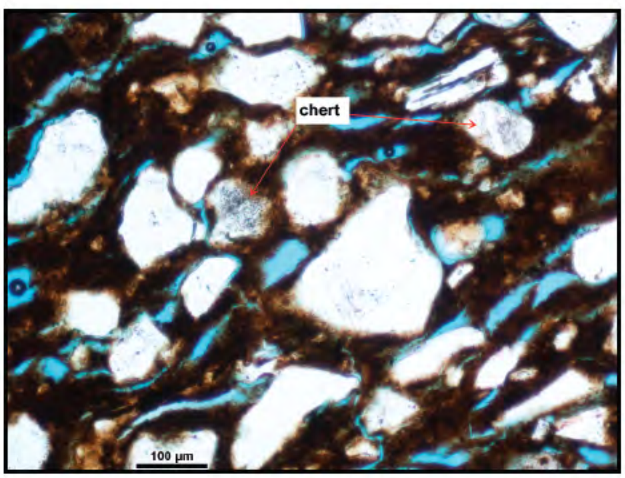
Lot 126.1, Unit 17, Level 2: Lot 126.1 contains 29 percent monocrystalline quartz, 50 percent matrix, 16 percent pore space, 3 percent bone, and 2 percent chert. There is a trace of feldspar. Matrix is dark reddish brown. Pore space appears as elongated, narrow unidirectional channels and



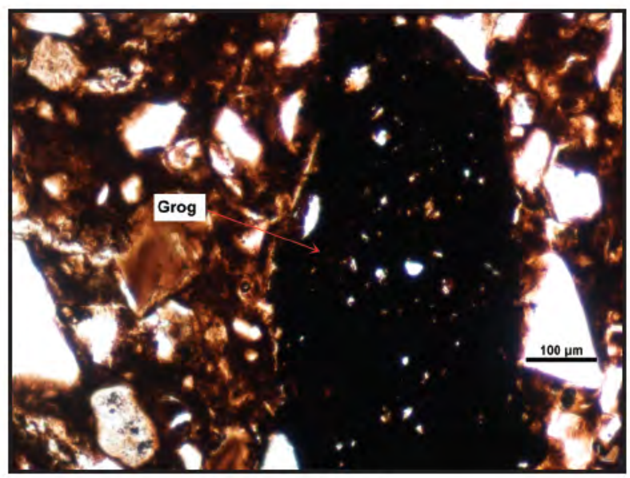
Sample 1
Lot 35.1



Sample 3
Lot 84.1



Sample 7
Lot 327.1



Sample 222
Lot 222.1

ATKINS

Figure 87

41CW104
Selected Thin Section Samples

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Drafted by: C. Wallace

chambers. Measurable quartz is moderately sorted and ranges from 0.08 to 0.82 mm. Mean grain size is 0.21 mm (fine sand), median is 0.16 mm, and the standard deviation is 0.1540 mm.

Lot 132.1, Unit 18, Level 2: Lot 132.1 is composed of 27 percent monocrystalline quartz, 48 percent matrix, 13 percent pore space, 6 percent bone, and 5 percent chert. There are traces of polycrystalline quartz and feldspar. Matrix is dark reddish brown. Pore space appears as short multidirectional channels and chambers. Measurable quartz is moderately sorted and ranges from 0.08 to 0.65 mm. Mean grain size is 0.24 mm (fine sand), median is 0.20 mm, and the standard deviation is 0.1380 mm.

Lot 231.1, Unit 31, Level 3: Lot 231.1 contains 37 percent monocrystalline quartz, 37 percent matrix, 16 percent pore space, 7 percent bone, and 3 percent chert. There are traces of polycrystalline quartz and feldspar. Matrix is dark reddish brown. Pore space appears as elongate unidirectional channels and chambers. Measurable quartz is moderately sorted and ranges from 0.08 to 0.87 mm. Mean grain size is 0.26 mm (medium sand), median is 0.225 mm, and the standard deviation is 0.1725 mm.

Lot 327.1, Unit 37, Level 7 (see Figure 87): Lot 327.1 contains 31 percent monocrystalline quartz, 82 percent matrix, 12 percent pore space, and 4 percent chert. There are traces of feldspar and polycrystalline quartz. Matrix is dark reddish brown. Pore space appears as unidirectional elongated channels and chambers. Measurable quartz is moderately sorted and ranges from 0.09 to 0.53 mm. Mean grain size is 0.22 mm (fine sand), median is 0.17 mm, and the standard deviation is 0.1176 mm.

Lot 131.1, Unit 19, Level 3: Lot 131.1 contains 28 percent monocrystalline quartz, 48 percent matrix, 14 percent pore space, 7 percent bone, and 3 percent chert. There is a trace of feldspar. Matrix is dark reddish brown. Pore space appears as short, narrow, curved multidirectional channels. Measurable quartz is moderately sorted and ranges from 0.1 to 0.77 mm. Mean grain size is 0.21 mm (fine sand), median is 0.19 mm, and the standard deviation is 0.1293 mm.

Lot 133.1, Unit 19, Level 3: Lot 133.1 contains 38 percent monocrystalline quartz, 44 percent matrix, 6 percent pore space, 8 percent bone, and 4 percent chert. There are traces of feldspar and unidentified opaque organic material. Matrix is dark reddish brown. Pore space appears as short, narrow unidirectional channels. Measurable quartz is moderately sorted and ranges from 0.09 to 0.45 mm. Mean grain size is 0.24 mm (fine sand), median is 0.225 mm, and the standard deviation is 0.1150 mm.

Lot 138.1, Unit 17, Level 5: Lot 138.1 contains 37 percent monocrystalline quartz, 48 percent matrix, 10 percent pore space, 5 percent bone, and 3 percent chert. There is a trace of feldspar. Matrix is dark reddish brown. Pore space appears as short, narrow, unidirectional channels. Measurable quartz is moderately sorted and ranges from 0.1 to 0.5 mm. Mean grain size is 0.23 mm (fine sand), median is 0.200 mm, and the standard deviation is 0.1129 mm.

Lot 222.1, Unit 30, Level 4 (see Figure 87): Lot 222.1 contains 17 percent monocrystalline quartz, 52 percent matrix, 13 percent pore space, 13 percent bone, 2 percent grog, and 3 percent chert. There is a trace of polycrystalline quartz. Matrix is dark reddish brown. Pore space appears as short to long, curved multidirectional channels. Chambers are associated with degraded bone fragments. Measurable quartz is low in frequency, moderately sorted, and ranges from 0.08 to 0.76 mm. Mean grain size is 0.22 mm (fine sand), median is 0.18 mm, and the standard deviation is 0.1442 mm.

Lot 388.1, Unit 53, Level 1: Lot 388.1 contains 45 percent monocrystalline quartz, 42 percent matrix, 11 percent pore space, and 2 percent chert. There is a trace of feldspar. Matrix is dark reddish brown. Pore space appears as short, narrow, curved multidirectional channels. There are a few wide chambers. Measurable quartz is moderately sorted and ranges from 0.09 to 0.42 mm. Mean grain size is 0.18 mm (fine sand), median is 0.15 mm, and the standard deviation is 0.0794 mm.

Observations

The preceding petrographic descriptions demonstrate that overall the sampled specimens from 41CW104 are quite similar in appearance and composition. The following observations are offered:

Matrix or Paste: All of the samples contain a dark reddish brown paste or matrix, composed of clay, silt, and fine sand. Lesser amounts of medium and coarse sand-sized particles are also present. Sorting is moderate in all samples.

Pore Space: Pore space varies in frequency from 6 to 18 percent (average = 13 percent). Typically, pore space appears as short, curved, narrow unidirectional or multidirectional channels. Chambers are much less frequent and are sometimes associated with degraded bone fragments.

Temper: Bone is the most common intentional temper, being found in nine of the samples. It sometimes appears badly degraded. One sherd is grog tempered. The remaining two samples contain no intentional temper.

Mineral Suite: Monocrystalline quartz was the predominant mineral in every sample, ranging in frequency from 17 to 45 percent (average = 32.3 percent) Mean grain size for the measurable quartz (i.e., greater than 0.07 mm) is typically within the fine sand size range, averaging about 0.23 mm. Lesser amounts of chert are present in all of the samples. Traces of feldspar and less frequently polycrystalline quartz were also observed.

NEUTRON ACTIVATION ANALYSIS OF CERAMICS FROM THE SANTA MARIA CREEK SITE (41CW104)

by Jeffrey R. Ferguson and Michael Glascock

Introduction

This section details the analysis and interpretation of four ceramic samples from 41CW104 (the Santa Maria Creek site) in central Texas analyzed by neutron activation analysis (NAA) at the University of Missouri Research Reactor Center (MURR). It describes sample preparation and analytical techniques used at MURR and uniformity of these samples as well as their relation to the seven samples from the Sandbur Site (41FY135) and general match with the larger Central Texas Database. The samples show a general affiliation with a large compositional group established for the region, and there is some suggestion of localized production and exchange.

Sample Preparation

Pottery samples were prepared for NAA using procedures standard at MURR. Fragments of about 1 cm^2 were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research.

Two analytical samples were prepared from each source specimen. Portions of approximately 150 milligrams (mg) of powder were weighed into clean high-density polyethylene vials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into clean high-purity quartz vials used for long irradiations. Individual sample weights were recorded to the nearest 0.01 mg using an analytical balance. Both vials were sealed prior to irradiation. Along with the unknown samples, standards made from National Institute of Standards and Technology (NIST) certified standard reference materials of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (a standard developed for in-house applications).

Irradiation and Gamma-Ray Spectroscopy

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). As discussed in detail by Glascock (1992), a short irradiation is carried out through the pneumatic tube irradiation system. Samples in the polyvials are sequentially irradiated, two at a time, for five seconds by a neutron flux of 8×10^{13} n cm^{-2} s^{-1} The 720-second count yields gamma spectra containing peaks for nine short-lived elements aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples are encapsulated in quartz vials and are subjected to a 24–hour irradiation at a neutron flux of 5 x 10^{13} n cm^{-2} s^{-1}. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 1,800 seconds (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 8,500 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

The element concentration data from the three measurements are tabulated in parts per million using the EXCEL spreadsheet program. Descriptive data for the archeological samples were appended to the concentration spreadsheet. The data are also stored in a dBASE/FOXPRO database file useful for organizing, sorting, and extracting sample information. The data file enclosed with this report contains the sample database in EXCEL format.

Interpreting Chemical Data

The analyses at MURR described previously produced elemental concentration values for 32 elements in most of the analyzed samples. Data for nickel in most samples was below detection limits (as is the norm for most New World ceramic analyses) and was removed from consideration during the statistical analysis. Because calcium (high in these samples most likely from the bone temper) has the potential to affect (dilute) the concentrations of other elements in the analysis, all samples were mathematically corrected to compensate for any possible calcium-included effects (the data were examined with and without calcium correction and the results were similar). The following mathematical correction was used as it has been proven to be effective in other calcium-rich datasets (Cogswell et al. 1998:64; Steponaitis et al. 1996):

$$e' = \frac{10^6 e}{10^6 - 2.5c}$$

where e' is the corrected concentration of a given element in ppm, e is the measured concentration of that element in ppm, and c is the concentration of elemental calcium in ppm. After the calcium correction, statistical analysis was subsequently carried out on base-10 logarithms of concentrations on the remaining 31 elements. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as calcium, on one hand, and trace elements such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and is only summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. Based on the provenance postulate of Weigand et al. (1977), different chemical groups may be assumed to represent geographically restricted sources. For lithic materials such as obsidian, basalt, and cryptocrystalline silicates (e.g., chert, flint, or jasper), raw material samples are frequently collected from known outcrops or secondary deposits and the compositional data obtained on the samples is used to define the source localities or boundaries. The locations of sources can also be inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples) or by indirect methods such as the "criterion of abundance" (Bishop et al. 1982) or by arguments based on geological and sedimentological characteristics (e.g., Steponaitis et al. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential "sources" intensively enough to create groups of knowns to which unknowns can be compared. Lithic sources tend to be more localized and compositionally homogeneous in the case of obsidian or compositionally heterogeneous as is the case for most cherts.

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Initial hypotheses about source-related subgroups in the compositional data can be derived from noncompositional information (e.g., archeological context, decorative attributes, etc.) or from application of various pattern-recognition techniques to the multivariate chemical data. Some of the pattern-recognition techniques that have been used to investigate archeological data sets are cluster analysis (CA), principal components analysis (PCA), and discriminant analysis (DA). Each of the techniques has its own advantages and disadvantages which may depend upon the types and quantity of data available for interpretation.

The variables (measured elements) in archeological and geological data sets are often correlated and frequently large in number. This makes handling and interpreting patterns within the data difficult. Therefore, it is often useful to transform the original variables into a smaller set of uncorrelated variables in order to make data interpretation easier. Of the above-mentioned pattern-recognition techniques, PCA is a technique that transforms the data from the original correlated variables into uncorrelated variables most easily.

PCA creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode, i.e., to search for subgroups in an undifferentiated data set, or in a more evaluative mode, i.e., to assess the coherence of hypothetical groups suggested by other criteria. Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

It is well known that PCA of chemical data is scale dependent (Mardia et al. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are common to most statistical packages. A common approach is to transform the data into logarithms (e.g., base 10). As an initial step in the PCA of most chemical data at MURR, the data are transformed into log concentrations to equalize the differences in variance between the major elements such as Al, Ca, and Fe, on one hand and trace elements, such as the rare-earth elements (REEs), on the other hand. An additional advantage of the transformation is that it appears to produce more nearly normal distributions for the trace elements.

One frequently exploited strength of PCA, discussed by Baxter (1992), Baxter and Buck (2002), and Neff (1994, 2002), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. A plot using the first two principal components as axes is usually the best possible two-dimensional representation of the correlation or variance-covariance structure within the data set. Small angles between the vectors from the origin to variable coordinates indicate strong positive correlation; angles at 90 degrees indicate no correlation; and angles close to 180 degrees indicate strong negative correlation. Likewise, a plot of sample coordinates on these same axes will be the best two-dimensional representation of Euclidean relations among the samples in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space (if the PCA was based on the correlation matrix). Displaying both objects and variables on the same plot makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups. Such a plot is commonly referred to as a “biplot” in reference to the simultaneous plotting of objects and variables. The variable interrelationships inferred from a biplot can be verified directly by inspecting bivariate elemental concentration plots. (Note that a bivariate plot of elemental concentrations is not a biplot.)

Whether a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber et al. 1976; Bishop and Neff 1989) is defined by:

$$D^2_{y,X} = [y - \overline{X}]^t I_x [y - \overline{X}]$$

where *y* is the 1 x m array of logged elemental concentrations for the specimen of interest, *X* is the n x m data matrix of logged concentrations for the group to which the point is being compared with $\overline{X}$ being its 1 x m centroid, and I_x is the inverse of the m x m variance-covariance matrix of group *X*. Because Mahalanobis distance takes into account variances and covariances in the multivariate group, it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's T^2, which is the multivariate extension of the univariate Student's t.

When group sizes are small, Mahalanobis distance-based probabilities can fluctuate dramatically depending upon whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon "stretchability" in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that may sometimes exclude true group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distance: with more elements than samples, the group variance-covariance matrix is singular, thus rendering calculation of I_x (and D^2 itself) impossible. Therefore, the dimensionality of the groups must somehow be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this approach is that the investigator's preconceptions about which elements should be discriminate may not be valid. It also squanders the main advantage of multielement analysis, namely the capability to measure a large number of elements. An alternative approach is to calculate Mahalanobis distances with the scores on principal components extracted from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using enough components to subsume at least 90 percent of the total variance in the data can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

Lastly, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens that are missing a single concentration value can still be used in group calculations.

Results and Conclusions

For the purposes of this interpretation, the 11 new samples (LWE104–114) have been combined with the four samples previously analyzed from the site for Robert Rogers (CWT131, 195, 222, and 388). The earlier report (Ferguson and Glascock 2008) detailing the first four samples generally compared the samples to previous Central Texas data, particularly the samples from 41FY135, but in the meantime we have conducted a major reinterpretation of the Central Texas data. In collaboration with Doug Boyd and Darrell Creel, 15 compositional groups were identified. Most of the groups are relatively small clusters of samples from a single site or very small area, but there are three large groups with large numbers of samples and large spatial distributions. The comparison of the 41CW104 samples (new and old) to the new Central Texas reference groups is explained in detail below.

Master Database Comparison

The interpretation of these data was begun with a Euclidian distance comparison to the MURR master database. While there were no close matches found (except to other samples from this site previously entered into the database), there was some consistent similarity to other samples from Central Texas, particularly the southeastern portion of the region.

Internal Compositional Variability

With a total of only 15 samples, it is not worthwhile establishing formal internal compositional groups; however, there is some patterned variability. Figure 88 is a good example of the variability observed in many other bivariate plots. Sample CWT222 shows elevated concentration of many elements, particularly chromium and scandium. Four additional samples show increased variability, including LWE114, CWT388, LWE108, and LWE110. The remaining 10 samples show great similarity and likely represent local production, although this is still a small sample to allow great confidence in assessing production patterns.

Comparison with Samples from the Sandbur Site

The letter accompanying the samples requested that these samples be compared to the seven previous samples from the Sandbur site (41FY135) as part of a larger project submitted by D. Creel. Bivariate plots revealed some interesting patterns. As noted in the previous report (Ferguson and Glascock 2008), there appear to be slight differences between the main pottery signatures from the two sites despite general similarity. Figure 89 shows the separation of the two possible production signatures. One sample from the Sandbur sites (UT401) seems to match the main signature from the Plum Creek site, while two samples from the Plum Creek site (LEW114 and CW388) seem to

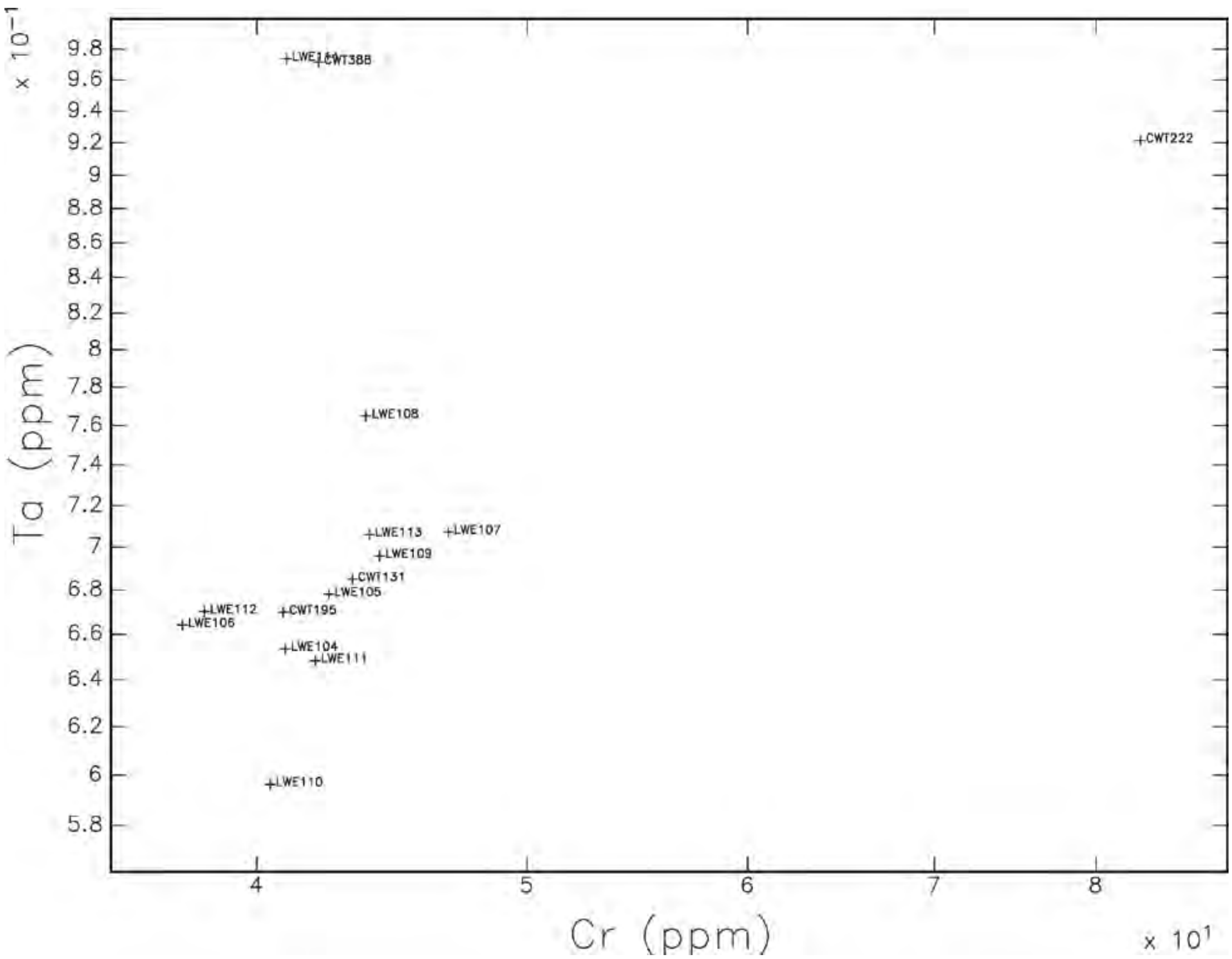


Figure 88: Bivariate plot of chromium and tantalum base-10 logged concentrations showing the variability of the Plum Creek samples.

match the main group from the Sandbur site. These samples are too small to confidently say this represents a clear pattern of exchange, but there is a good possibility of this pattern holding up with an increased sample size. This pattern holds up for concentrations of Ta, Zr, and Yb.

Comparison to the Central Texas Database Groups

The recent reinterpretation of the Central Texas database has identified 15 compositional groups. This work is still in its final stages, and thus the comparison should be considered preliminary. Permission to use these comparative reference groups was provided by Darrell Creel and Doug Boyd. Most of the groups are quite small and represent localized production. The Plum Creek samples do not match any of the current small groups based on the examination of numerous bivariate plots. There is a match with one of the large groups apparent in both bivariate plots and Mahalanobis distance projections. Figure 90 shows a plot of the Plum Creek samples along with the

three major Central Texas groups (Groups 10, 11, and 12). Table 26 lists the membership probabilities of the Plum Creek samples in the large groups.

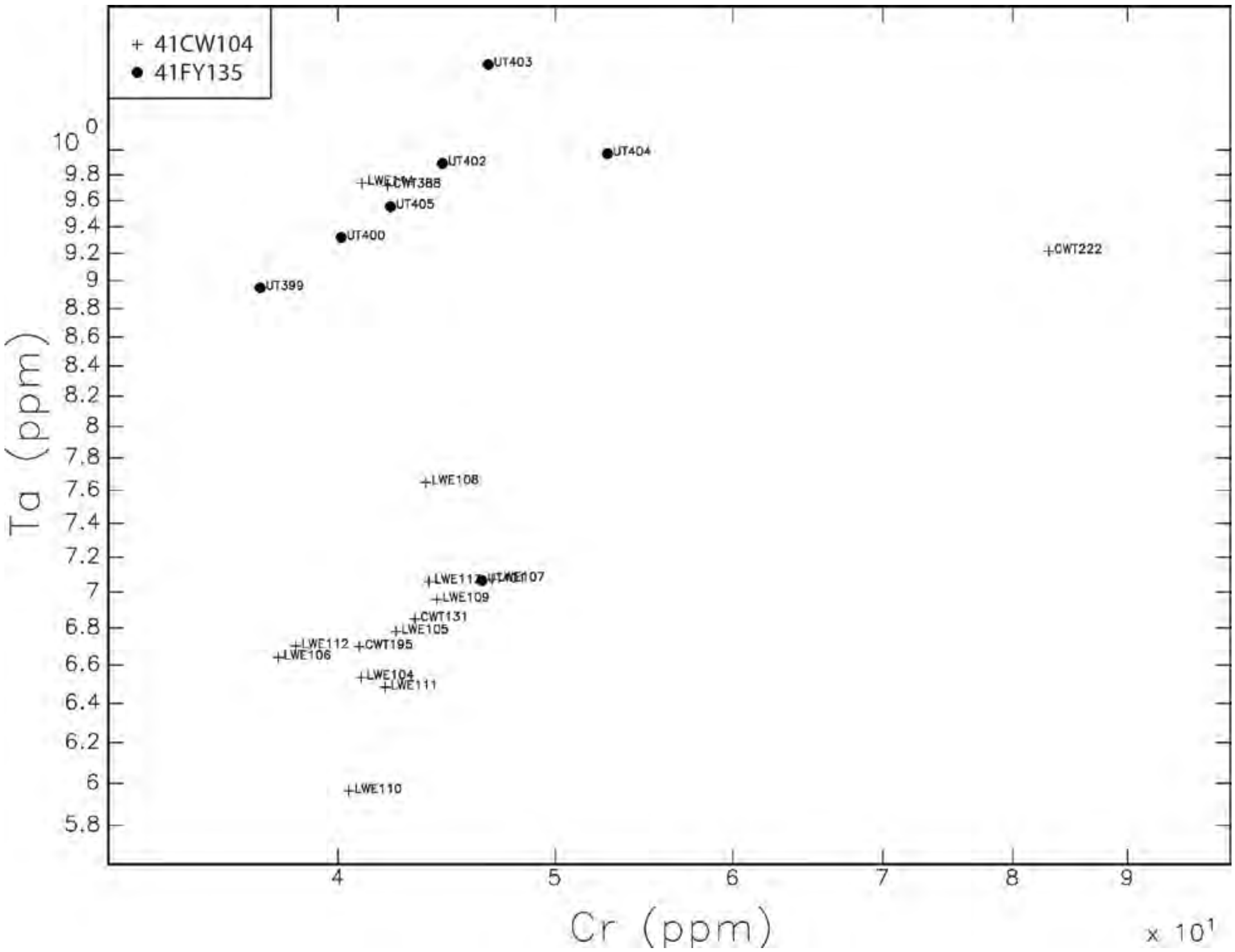


Figure 89: Bivariate plot of chromium and tantalum base-10 logged concentrations showing the similarity between the Plum Creek and the Sandbur samples.

Comparison to the Central Texas Database Groups

The recent reinterpretation of the Central Texas database has identified 15 compositional groups. This work is still in its final stages, and thus the comparison should be considered preliminary. Permission to use these comparative reference groups was provided by Darrell Creel and Doug Boyd. Most of the groups are quite small and represent localized production. The Plum Creek samples do not match any of the current small groups based on the examination of numerous bivariate plots. There is a match with one of the large groups apparent in both bivariate plots and Mahalanobis distance projections. Figure 90 shows a plot of the Plum Creek samples along with the three major Central Texas groups (Groups 10, 11, and 12). Table 26 lists the membership probabilities of the Plum Creek samples in the large groups.

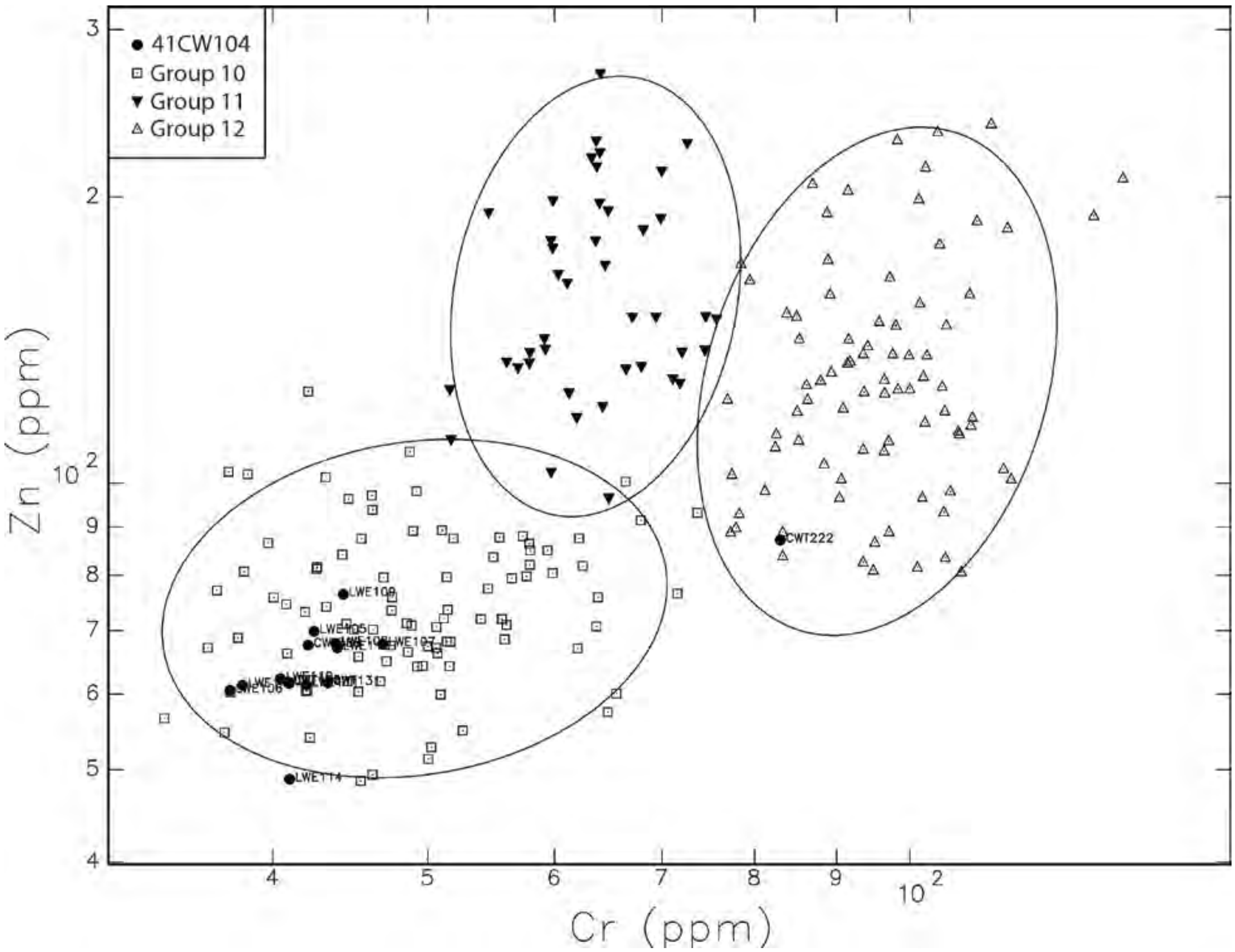


Figure 90: Bivariate plot of chromium and zinc base-10 logged concentrations
showing the similarity between the Plum Creek and the large Central Texas Reference Groups.
Ellipses represent 90 percent confidence intervals for membership in the groups.
The Plum Creek samples are individually labeled.

The majority of the samples have at least some probability of membership in Group 10 with little probability of membership in Groups 11 or 12. Sample CWT222 appears in the ellipse for Group 12 on Figure 90, but this is not upheld in other plots, and the membership probabilities shown in Table 26 suggest a greater affiliation with Group 10.

When these reference groups were initially developed, they were based on relatively subtle compositional differences, but recent work to map the distribution of these samples (with the help of Matthew Boulanger) has shown strong regional differences among these groups (Figure 91). Group 10 has the broadest distribution, but is concentrated in the southeast. Group 11 is restricted to the southeast, and Group 12 is concentrated in the northwest.

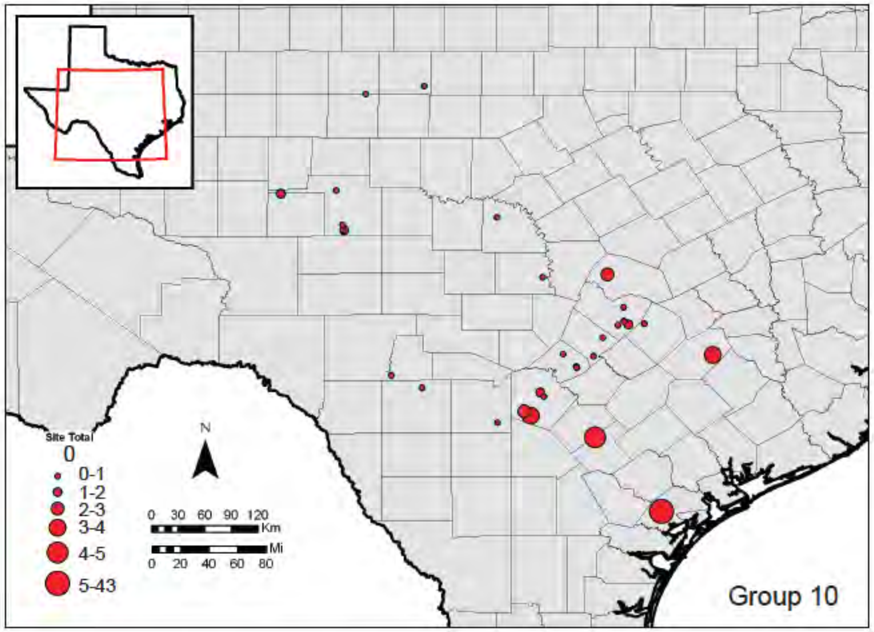
Table 26. Probabilities of Membership in the Three Large Central Texas Reference Groups Based on a Mahalanobis Distance Projection
Group Classification Using Mahalanobis Distance
Results are based on the following variables:
Sc V Cr Fe Zn As Rb Zr Sb Cs La Ce Nd Sm Eu Tb Dy Yb Lu Hf Ta Th
Best Group is based on highest membership probability > 0.001%
Membership probabilities (%) for samples from the group: CUTCOMB
Probability for each sample calculated after removal from original group.

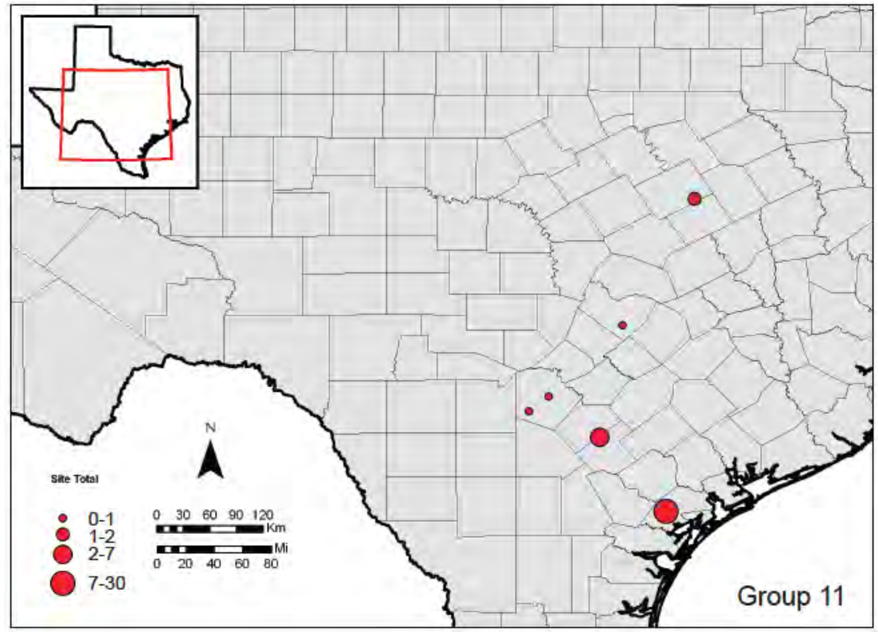
ANID	g10	g11	g12	Best Group
CWT131	6.319	0.004	0.000	g10
CWT195	0.008	0.000	0.000	g10
CWT222	4.481	0.000	0.000	g10
CWT388	0.000	0.000	0.000	
LWE104	0.000	0.000	0.000	
LWE105	24.008	0.039	0.000	g10
LWE106	3.972	0.000	0.000	g10
LWE107	56.525	0.001	0.000	g10
LWE108	22.657	0.010	0.000	g10
LWE109	8.498	0.003	0.000	g10
LWE110	0.000	0.000	0.000	
LWE111	11.097	0.001	0.000	g10
LWE112	0.063	0.000	0.000	g10
LWE113	16.681	0.000	0.000	g10
LWE114	0.010	0.002	0.000	g10

The general match with Group 10 is not surprising, although there is some slight difference from the large group, primarily in the reduced concentrations of tantalum.

Summary

The results presented here are necessarily tentative given the extremely small number of samples analyzed; however, there are similarities with one of the large reference groups identified in the recent reinterpretation of the Central Texas Database suggesting regionally local production of most, if not all, samples. At a smaller scale, there is evidence of small-scale production and exchange between the assemblages from the Plum Creek and Sandbur sites. A larger sample from both of these sites might strengthen the pattern of localized exchange, something generally not possible to document in the typically compositionally uniform ceramics from Central Texas.





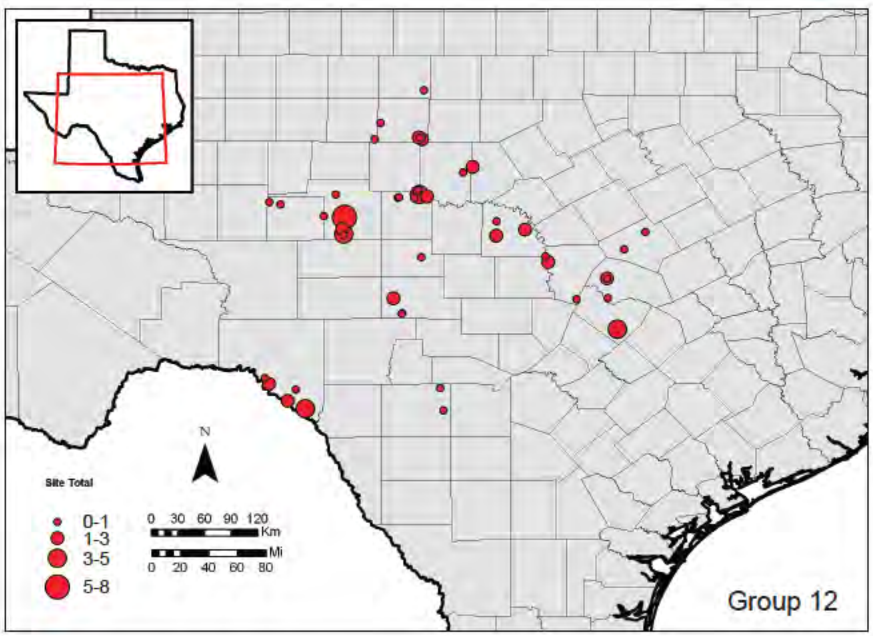


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Figure 91

Distribution Maps for the Three Main Central Texas Reference Groups

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Drafted by: C. Wallace

We acknowledge Tim Ferguson for his role in preparing the samples for irradiation, Matt Boulanger for his help with the distribution maps, and Darrell Creel and Doug Boyd for their permission to use the preliminary Central Texas reference groups. The Central Texas Ceramic Study reanalysis is a project sponsored by TxDOT. The CTCS data were used for comparative purposes courtesy of the Archeological Studies Program, Environmental Affairs Division, Texas Department of Transportation, Austin, Texas.

9

FEATURE ANALYSIS

by Julie Shipp and Robert Rogers

This chapter contains the results of the analysis of the prehistoric features uncovered at the Santa Maria Creek site during NRHP testing and data recovery. Features 1–3 were uncovered during the NRHP testing (Dixon et al. 2007), while Features 4–9 were recorded during data recovery. Most of the features appeared as clusters or scatters of TAR. However, Feature 3 consisted of a soil stain, which was determined to be noncultural, and Feature 4 was a large piece of carbonized wood that yielded a modern radiocarbon date. The location of all of the features at the site is shown on Figure 35.

NRHP TESTING FEATURES

Feature 1

Feature 1 was located during the mechanical excavation of Scraped Area 2. Once located, mechanical excavation ceased and the feature was excavated by hand. Feature 1 consisted of a scatter of 17 thermally discolored chert and quartzite cobbles, occupying an area of about 40 x 60 cm, long axis north-south (Figure 92). The feature occurred at the base of the Anthropic Zone at a depth of 45 centimeters below datum (cmbd). The rocks appeared to be lying flat in a single layer. No additional artifacts were found during the excavation of the feature, and none of the rocks were collected. The rock type, maximum dimension, and weight of each of the rocks were recorded in the field and are presented in Table 27.

Feature 2

Feature 2 was located during the mechanical excavation of Scraped Area 3. Once uncovered, mechanical excavation was stopped and the feature was excavated by hand. Feature 2 consisted of nine TAR, and was approximately 40 cm in diameter (Figure 93). The rocks were scattered in no discernible pattern. The feature was buried at a depth of approximately 55 cmbd, at the base of the Anthropic Zone. The rocks appeared to be lying flat. The rock type, maximum dimension, and weight of each of the feature rocks were recorded in the field and are presented in Table 28.

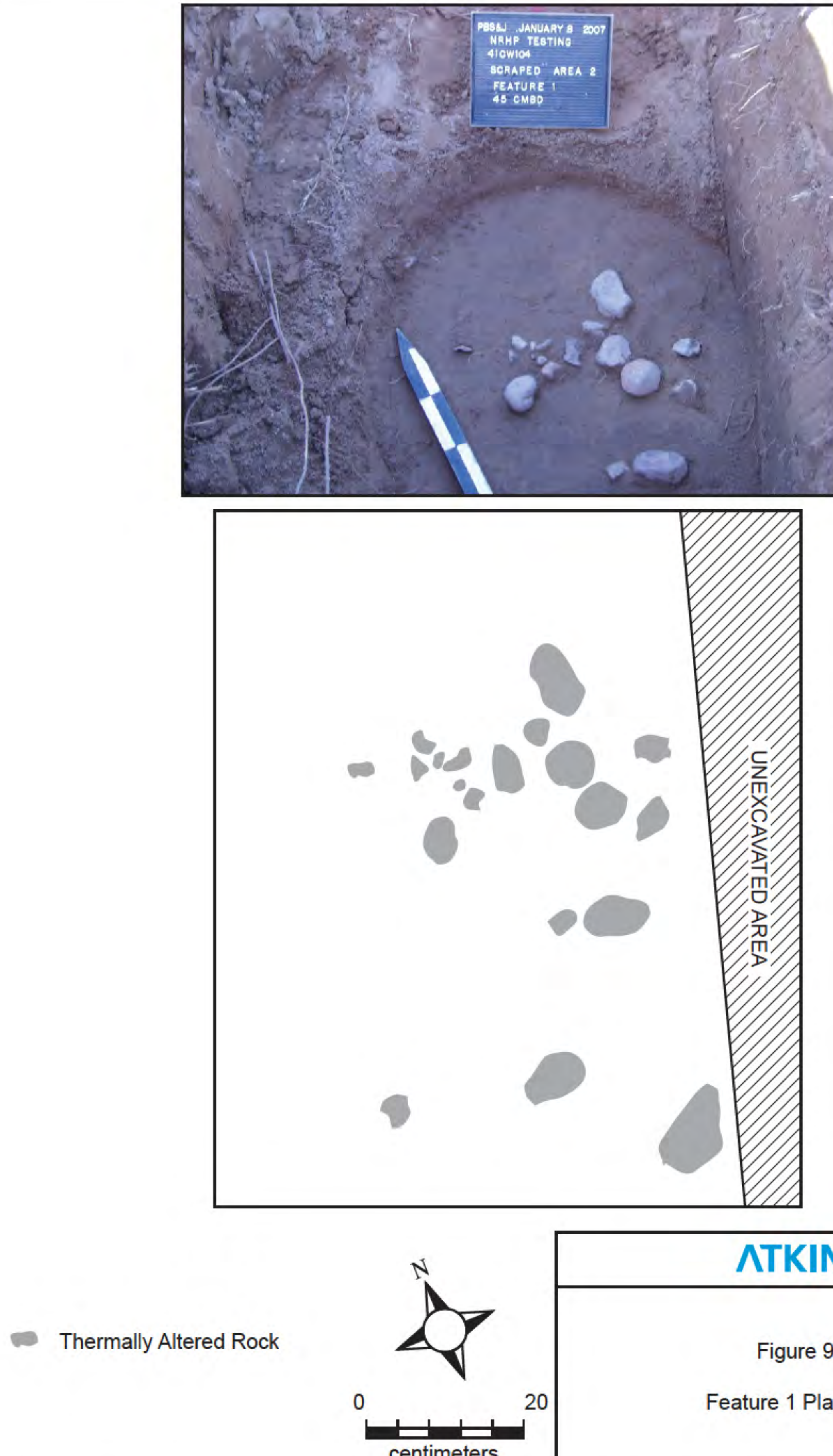

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Figure 92

Feature 1 Plan View

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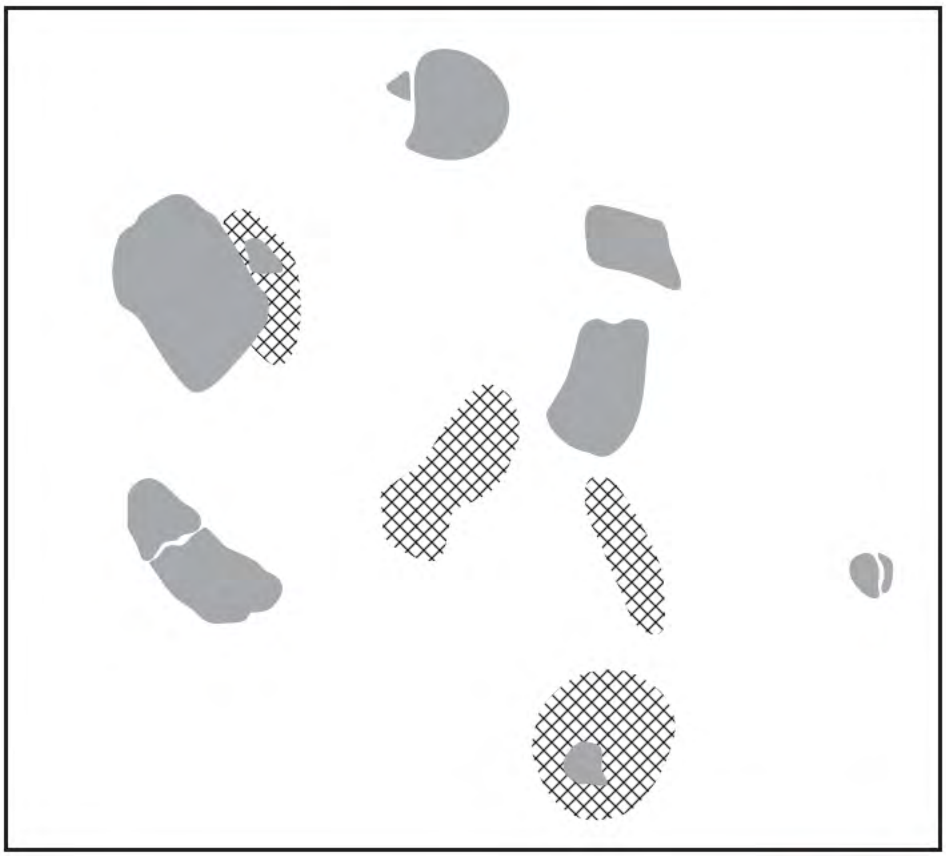
Drafted by: C. Wallace

Table 27. Feature 1 Rock Characteristics

Rock No	Material	Max Dimension (cm)	Weight (g)
1	Chert	6.7	247
2	Quartzite	8.3	369
3	Chert	10.2	399
4	Chert	7.4	212
5	Quartzite	4.3	79
6	Quartzite	6.4	212
7	Quartzite	6.8	214
8	Chert	4.4	36
9	Chert	8.3	290
10	Quartzite	4.6	25
11	Quartzite	5.8	93
12	Chert	3.6	20
13	Chert	6.7	201
14	Chert	4.6	40
15	Chert	3.9	29
16	Quartzite	3.2	10
17	Chert	3.1	37

Table 28. Feature 2 Rock Characteristics

Rock No.	Material	Size (cm)	Weight (g)
1	Quartzite (fragmented)	9.7	208
2	Sandstone	7.7	91
3	Sandstone	7.7	105
4	Sandstone	8.0	142
5	Sandstone	13.7	676
6	Quartzite	4.7	15
7	Quartzite	4.1	18
8	Chert	4.4	37
9	Quartzite (fragmented)	4.0	11



Thermally Altered Rock

10YR 4/3 brown, slightly mottled appearance

N

0 10

centimeters

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Figure 93

Feature 2 Plan View

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Drafted by: C. Wallace

Feature 3

Feature 3 was located during the excavation of Unit 5. The feature consisted of a dark stain measuring about 20 cm in diameter, which occurred in the floor of the unit at a depth of 62 cmbd (Figure 94). When excavated, Feature 3 was found to be only about 5 cm in thickness. Rather than cultural, the feature is interpreted as being the remains of a rodent burrow or den.

Figure 94: Feature 3 (noncultural)

DATA RECOVERY FEATURES

Feature 4

Feature 4 consisted of a 20-cm-long piece of carbonized wood, uncovered in excavation Unit 32 at 40 cmbd (30 cmbs), at the bottom of the Anthropic Zone (Figure 95). It was identified as oak (*Quercus* sp.), and submitted for radiocarbon assay. It proved to be of modern age (Beta-237669) (see Appendix A).

Feature 5

Feature 5 was located during mechanical scraping. It consisted of three thermally discolored cobbles (Figure 96). TxDOT archeologists inspected the feature when on a field visit during October 2007 and determined it to be too ephemeral for further investigation.

Figure 95: Feature 4 (noncultural), facing southeast

Figure 96: Feature 5, view facing west

Features 6–9

Features 6, 7, 8, and 9 were located during mechanical scraping. Excavation Blocks 2 and 3 were opened to investigate these features. All units within these blocks were excavated in 10-cm levels and screened through ⅛-inch hardware cloth. Feature fill was collected. Feature forms were completed, plan views of the features were drawn, and photographs were taken.

Excavation Block 2 consisted of 11 excavation units placed around features 6, 7, and 8 (Figure 97). These units included seven 1-x-1-m units (Units 18, 44, 50, 51, 52, 53, and 54), one 1-x-2-m unit (Unit 43), and two 1-x-0.5-m units (Units 48 and 49).

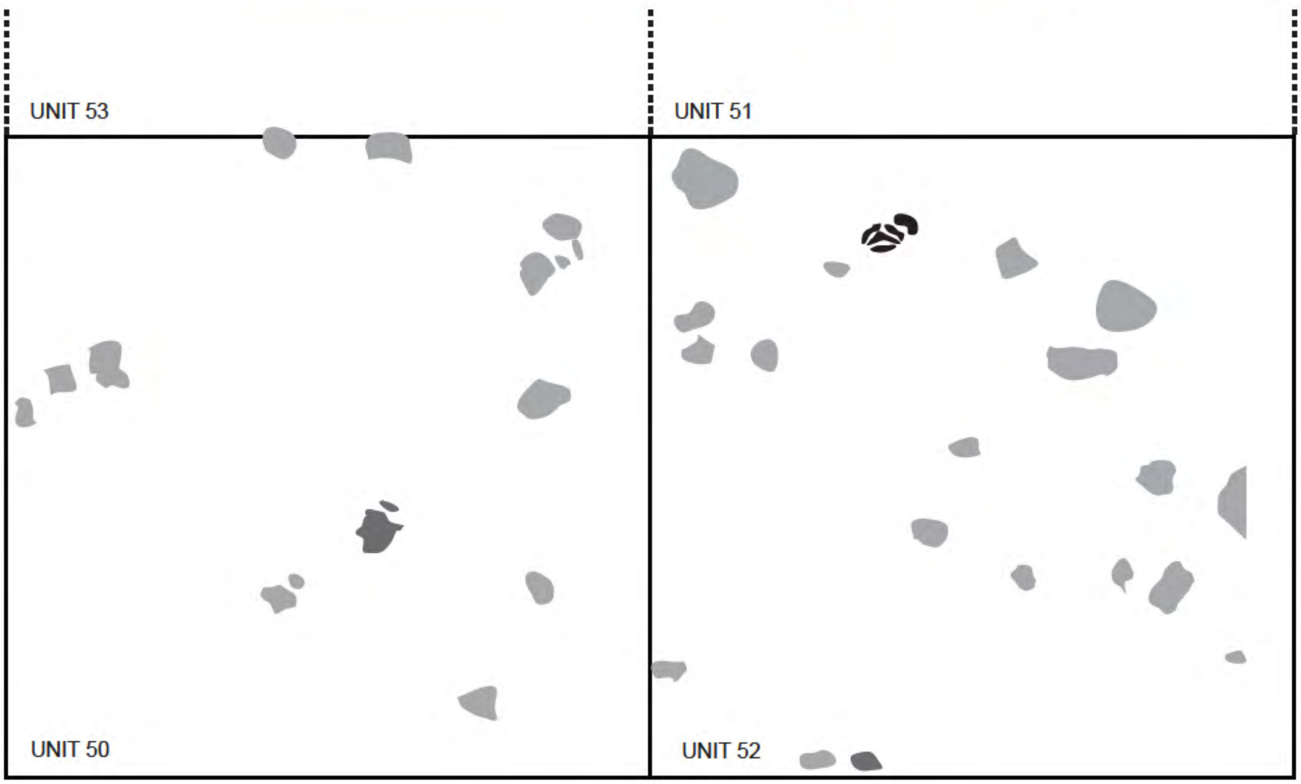
Figure 97: Features 6, 7, and 8, facing southeast

Block 3 was composed of three excavation units (Units 45, 46, and 47) placed to investigate Feature 9, the northernmost feature at the site. Units 45 and 47 were 1 x 1 m, and Unit 46 measured 1 m x 50 cm. Feature 9 was isolated from Features 6–8.

The analysis of artifacts believed to be associated with these features and the results of special studies performed on feature components are presented following the feature descriptions.

Feature 6

Feature 6 consisted of a scatter of 26 TAR. The feature was located approximately 2 m west of the center of Feature 8 (see Figure 97). The rocks from Feature 6 were resting near the boundary between the Anthropic Zone and the underlying E soil horizon, from approximately 55–75 cmbd (Figure 98). Because of the scattered nature of this feature, it did not receive the level of



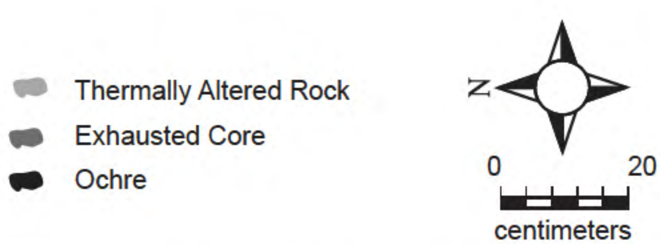


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Figure 98

Feature 6 Plan View

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Drafted by: C. Wallace

investigation afforded to the other burned rock features. However, the artifacts from the surrounding excavation units (50–53) provided supplemental subsistence data for Features 7 and 8.

Feature 7

Feature 7 was composed of 26 TAR (13 chert, 11 quartzite, and 2 sandstone); 2 chert specimens displayed no evidence of alteration (Table 29). The feature was located about 50 cm south of the center of Feature 8 (Figure 99). Most of the feature rocks were complete cobbles, though some exhibited angular fracture patterns. The rocks were resting upon an undulating Bt horizon at approximately 70–110 cmbd, in an area measuring 80 x 50 cm, long axis north-south (Figure 100). There was a depression in the Bt horizon that may have been formed by postdepositional groundwater runoff. The feature rocks were lying clustered along the sides of this small channel, suggesting that the feature is not in a primary context. Table 29 lists some of the characteristics of each of the feature rocks, as well as observations on the degree of thermal alteration.

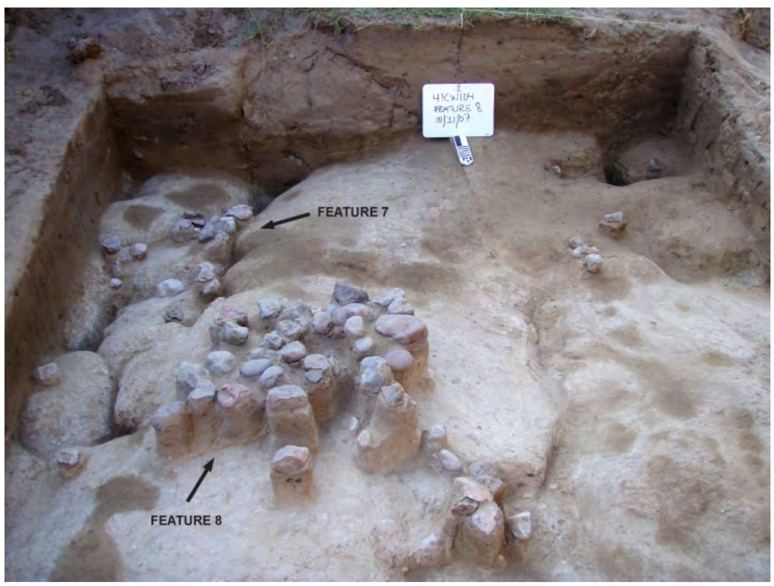


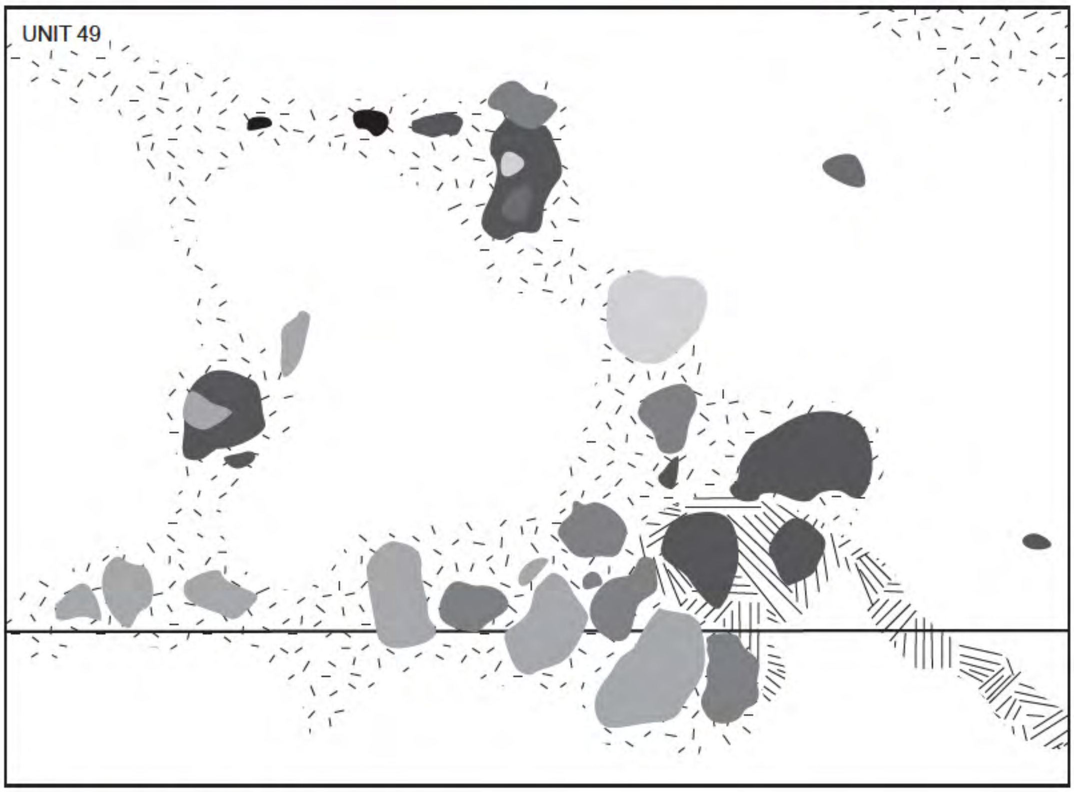
Figure 99: Features 7 and 8, view facing south

Feature 8

Feature 8 is interpreted to be a simple hearth consisting of 30 quartzite and 9 chert thermally altered cobbles. Two quartzite and 1 chert cobble showed no visible signs of thermal alteration. Most rocks were greater than 10 cm in size. There were two layers of rocks comprising the feature. The bottom layer was flat and consisted of a ring of rounded cobbles with a few angular rock fragments (see Figure 99). The upper layer consisted mostly of fragmented rocks and created a convex top to the feature. The feature was located at the base of the Anthropic Zone, approximately 55–75 cmbd (Figure 101). Feature 8 was contained within an area measuring approximately

Table 29. Feature 7 Rock Characteristics

Rock No.	Material	Maximum dimension (cm)	Weight (g)	Observations
1	Chert	6.5	207	Very red, angular
2	Quartzite	6.9	319	Pink
3	Quartzite	8.0	359	Pink
4	Chert	8.0	259	Very red, angular
5	Quartzite	10.6	506	Red
6	Chert	9.6	302	Red at cortex
7	Sandstone	7.5	175	Extremely red, crumbly
8	Chert	12.4	377	Pink, red exterior
9	Quartzite	5.7	212	Pink
10	Chert	7.8	217	Pink, red around cortex
11	Quartzite	7.6	153	Pink, red around cortex
12	Chert	7.9	346	Pink, red around cortex
13	Quartzite	8.8	122	Pink cortex, exterior very potlidded
14	Quartzite	8.7	201	Red around cortex
15	Chert	7.1	131	Pink, angular
16	Chert	6.1	200	Cortex potlid, pink
17	Chert	10.9	307	Red/pink, potlid interior
18	Quartzite	9.9	559	Pink, angular
19	Quartzite	6.7	219	Pink, angular
20	Quartzite	5.8	114	Lightly pink, angular
21	Chert	6.4	420	No visible alteration
22	Chert	5.6	38	Pink, angular
23	Chert	8.9	228	No visible alteration
24	Chert	6.2	109	Angular, red at cortex
25	Chert	6.7	83	Angular, red at cortex
26	Sandstone	5.7	33	Very red
27	Chert	4.7	24	Red at cortex
28	Quartzite	4.0	37	Angular, pink near cortex



Thermally Altered Rock (71-75 cmbd)
Thermally Altered Rock (76-80 cmbd)
Thermally Altered Rock (81-85 cmbd)
Thermally Altered Rock (86-90 cmbd)
Thermally Altered Rock (91+ cmbd)
Shallow Clay Depression
Deep Clay Depression

N

0 10
centimeters

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Figure 100

Feature 7 Plan View

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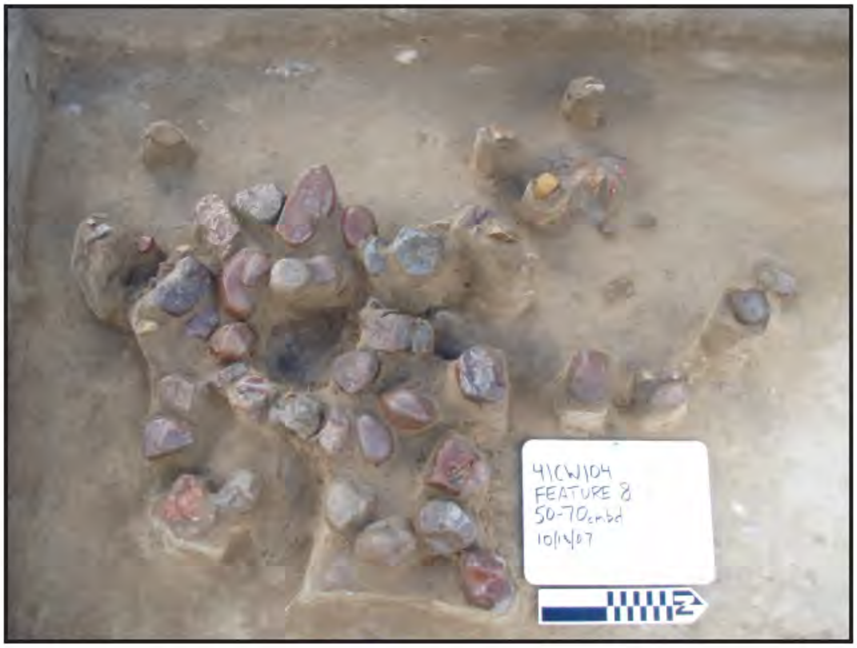
Drafted by: C. Wallace



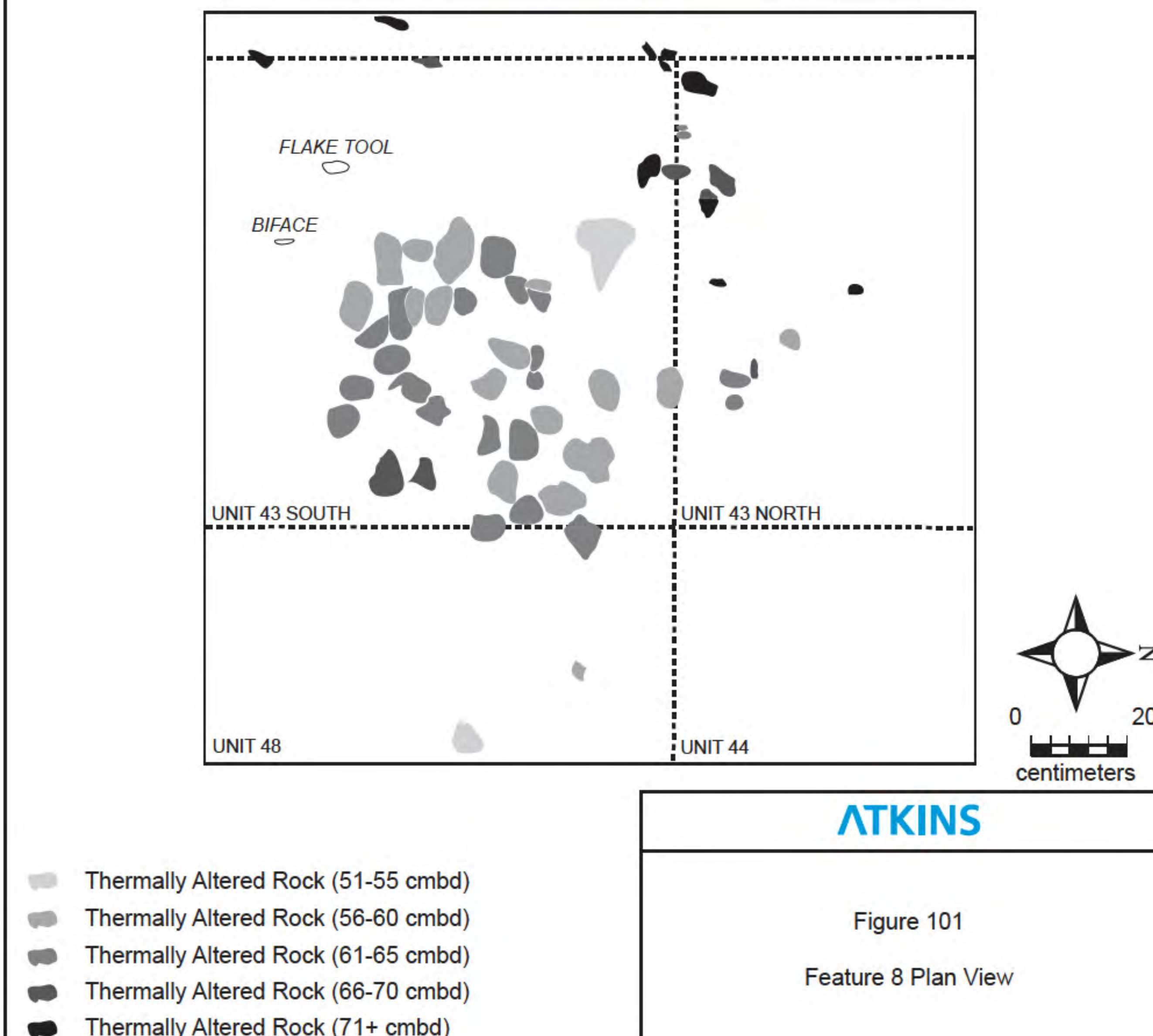


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Figure 101

Feature 8 Plan View

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Drafted by: C. Wallace

80 x 70 cm, long axis north-south. A few flecks of charcoal and a few pieces of burned earth were recovered from the feature matrix. While the soil around the feature did not appear burned, a thin (2 cm) layer of very dark grayish brown (10YR 3/2) sediment below the feature, did appear burned, suggesting the feature rocks were placed in a fire rather than having a fire built over them (see Figure 101). Table 30 lists some of the characteristics of each of the feature rocks, as well as observations on the degree of thermal alteration.

Block 2 Excavation Results

Artifacts recovered from excavation units in Block 2 include 700 pieces of chipped stone, 341 pieces of thermally altered chipped stone, 24 lithic tools (4 utilized flakes, 9 unifacially modified flakes, 3 bifaces, 1 Clear Fork uniface, and 7 ground stones), 3 ceramic sherds, and 35,164.12 g of TAR. Eleven flake tools and three ceramic sherds were analyzed utilizing TxDOT protocols. Seven ground stones were analyzed for use-wear. Two of the lithic tools were analyzed for micro use-wear. Five feature rocks from Feature 8 were analyzed for lipids.

Flotation samples from Features 7 and 8, 60–80 cmbd, yielded 34 carbonized macrobotanical remains (Table 31). Twenty-three pieces of carbonized wood, 10 nutshells, and 1 grass seed were identified. The carbonized wood likely represents the use of the wood for fuel. The nutshells were recovered from Features 7 and 8. The grass seed was recovered from Feature 8. One of the walnut (Juglandaceae) nutshell fragments from 70–80 cmbd was submitted for AMS radiocarbon dating and yielded a calibrated 2-sigma date of A.D. 1450–1610 (Beta-237674) (see Appendix A).

Eleven flake tools from Feature 8 and the surrounding excavation units were recovered from 60–80 cmbd. The flake tools appear to have been used for scraping, planing, perforating, and cutting.

Two of the ceramic sherds from Block 2 (Units 53 and 54) were composed of burned bone embedded within a sandy paste. The sherd from Unit 18 contained only sandy paste. It was submitted for INAA and petrographic analysis and is shown on Figure 102f.

The seven ground stones consisted of four manos, two plant-processing stones, and one pitted anvil stone. Examples of each ground stone category are illustrated on Figure 102a–c.

Use-wear analysis was performed on a biface fragment (Figure 102d) and a Clear Fork uniface (Figure 102e). The biface, recovered from 50–60 cmbd in Unit 43S, exhibits use-wear indicative of being utilized first as a dart point and later as a butchering tool. The uniface was found in Unit 52 at 60–70 cmbd, and is a well-made tool that was likely used as a hide scraper, even after the tool had been fractured. The association of these Archaic-aged tools with the Block 2 features is uncertain, though they may have been reused by the early Historic period occupants at 41CW104, as Archaic tools are common in the area and were often observed on eroded upland surfaces near the site.

Table 30. Feature 8 Rock Attributes

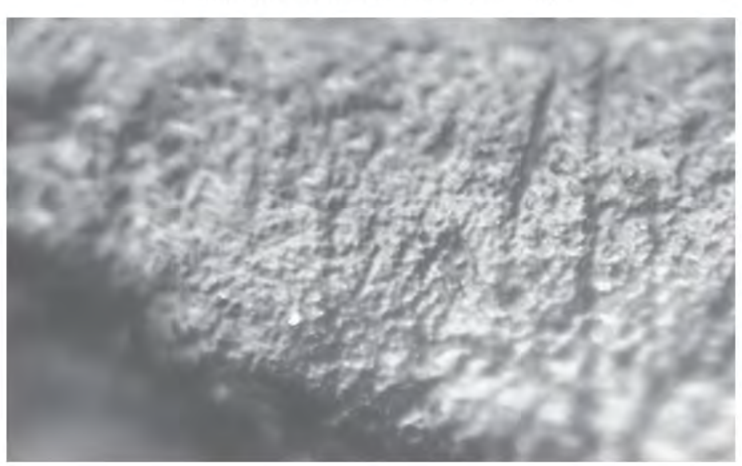
Rock No	Material	Maximum dimension (cm)	Weight (g)	Observations
1	Quartzite	10.1	214	Pink
2	Quartzite	7.0	221	Pink
3	Quartzite	8.7	291	Pink on cortex
4	Chert	8.7	176	Red at cortex
5	Quartzite	7.3	285	Pink, red at cortex
6	Quartzite	5.0	170	Pink
7	Chert	8.9	326	Pink, red at cortex, potlids
8	Quartzite	8.5	434	Pink at cortex
9	Quartzite	6.7	273	Pink
10	Quartzite	7.2	396	Pink at quartex
11	Quartzite	7.2	269	Pink, red at cortex
12	Quartzite	5.9	208	Pink
13	Quartzite	8.2	266	Pink
14	Quartzite	8.2	230	Pink at cortex
15	Quartzite	13.7	744	Pink/red at cortex
16	Quartzite	8.0	196	Pink
17	Quartzite	9.2	417	Pink
18	Chert	8.1	399	Red
19	Quartzite	8.5	219	Pink, red at cortex
20	Quartzite	6.7	131	Pink
21	Quartzite	6.7	144	Pink,
22	Quartzite	5.8	113	Pink, red at cortex
23	Quartzite	8.1	174	Pink
24	Quartzite	5.3	92	Pink at cortex
25	Chert	6.8	43	Red
26	Quartzite	5.7	47	Pink
27	Quartzite	4.2	17	Pink, red at cortex
28	Quartzite	5.0	38	Pink
29	Quartzite	3.9	14	Pink
30	Chert	4.2	16	Red
31	Chert	4.8	10	Pink, red at cortex
32	Quartzite	3.9	8	Pink
33	Quartzite	8.2	4	Pink
34	Chert	3.4	8	Red
35	Quartzite	4.1	44	No visible alteration
36	Chert	4.8	49	No visible alteration
37	Quartzite	4.2	80	No visible alteration
38	Quartzite	8.0	314	Grayish pink
39	Chert	10.1	380	Pink, red at cortex
40	Quartzite	8.6	278	Pink, red at cortex
41	Quartzite	8.7	243	Grayish pink, red at cortex
42	Chert	8.0	244	Red at cortex

a) Lot 425.1
Mano

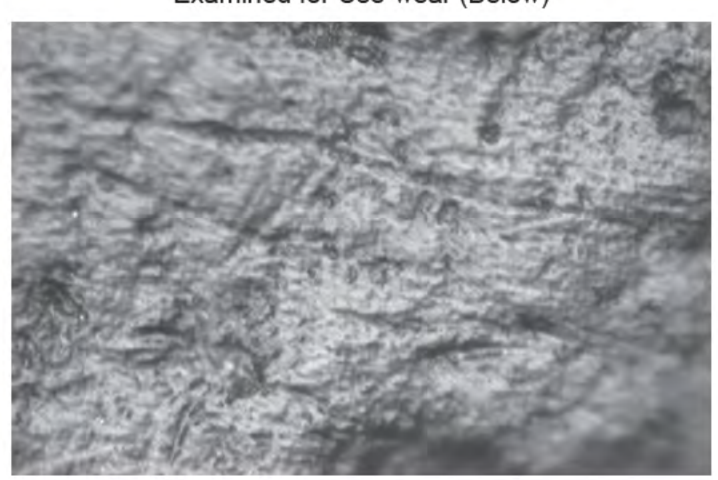
b) Lot 415.1
Plant-processing Stone

c) Lot 142.1
Pitted Lower Anvil Stone

d) Lot 374
Biface (Above)
Examined for Use-wear (Below)



e) Lot 395
Clear Fork Uniface (Above)
Examined for Use-wear (Below)



f) Lot 132.1
Body Sherd
Bone in a Very Fine
Sandy Paste
INAA/PETRO

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Figure 102

Selected Block 2
Excavation Artifacts

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Table 31. Macrobotanical Identification from Block 2 Flotation Samples

Feature	Unit	Depth (cmbd)	Plant Part	Botanical Name	Number
7	49	70–80	wood	hardwood	1
7	49	70–80	nutshell	Juglandaceae	3
7	49	70–80	wood	not examined	6
7	49	80–90	wood	*Ilex* sp.	3
7	49	80–90	nutshell	Juglandaceae	5
7	49	80–90	wood	not examined	8
7	49	70–80	wood	hardwood	1
8		50–60	seed (caryopsis)	Poaceae	1
8		50–60	wood	Indeterminate	1
8		50–60	nutshell	*Carya* sp.	1
8		60–70	wood	Indeterminate	1
8		60–70	nutshell	*Carya* sp.	1
8		matrix	wood	*Quercus* sp.	1
8		matrix	wood	*Quercus* sp.	1

Five of the feature rocks from Feature 8 were submitted for fatty acid (lipid) analysis. Three yielded positive results; two contained extremely high fat content associated with seeds and nuts, and one had lipids consistent with plant or medium-fat-content food.

Feature 9

Feature 9 is interpreted as a simple hearth consisting of 14 TAR (1 chert and 13 quartzite); 3 petrified wood specimens displayed no evidence of thermal alteration (Table 32). Feature 9 was between Scraped Areas 2 and 3 from NRHP testing, and is the northernmost feature. The majority of the rocks were subrounded, although some rocks exhibited angular fracture patterns. The rocks appeared to be arranged in a circular pattern. There were two layers of rocks. The bottom layer was flat and was a ring of rounded cobbles with a few angular rock fragments. The upper layer consisted mostly of fragmented rocks and created a convex top to the feature. The feature was located at the bottom of the Anthropic Zone approximately 55–75 cmbd. The feature measured about 50 x 70 cm, long axis north-south (Figure 103).

The E horizon was significantly thinner in this location, and a few of the feature rocks were embedded in the underlying argillic horizon. The sandy soil immediately above this horizon appeared burned, as it was mottled with a 10YR 3/2 very dark gray-brown color and was firm. However, no charcoal was noted.

Table 32. Feature 9 Rock Attributes

Rock No.	Material	Maximum dimension (cm)	Weight (g)	Observations
1	Petrified Wood	6.5	168	No visible alteration
2	Quartzite	8.6	240	Pink
3	Quartzite	7.8	273	Pink
4	Quartzite	6.6	232	Pink
5	Quartzite	10.9	613	Pink, red at cortex
6	Quartzite	8.8	254	Pink
7	Quartzite	6.6	231	Pink at cortex
8	Quartzite	7.1	244	Pink, red at cortex
9	Quartzite	3.9	265	Red
10	Quartzite	10.0	486	Pink
11	Quartzite	7.2	70	Pink at cortex
12	Petrified Wood	4.3	80	No visible alteration
13	Petrified Wood	5.0	22	No visible alteration
14	Quartzite	4.5	21	Pink
15	Quartzite	5.3	30	Pink, red at cortex
16	Chert	3.9	10	Red, potlids
17	Quartzite	12.3	9	Pink

Block 3 Excavation Results

Artifacts recovered from Block 3, excavated in the investigation of Feature 9, include 2 lithic tools (1 utilized flake used for scraping medium-soft materials and 1 mano) and 97 pieces of unmodified debitage. Approximately 2 kilograms (kg) of TAR (n = 55) were recovered from the excavations. Flotation of feature fill yielded 8 fragments of carbonized hardwood, interpreted as the remains of fuel.

DISCUSSION

Six burned rock features, Features 1, 2, 6, 7, 8, and 9, were excavated during NRHP eligibility testing and data recovery excavations at the Santa Maria Creek site. These features are interpreted as being the remains of simple hearths, and with the exception of Features 8 and 9, which appear to be relatively intact, most are quite scattered. The features may roughly correlate with occupational zones, though postdepositional processes, including bioturbation and groundwater channelization, have undoubtedly affected associations among the features' rocks, artifacts, and organic remains.

The feature rocks consist primarily of chert and quartzite cobbles, with a few pieces of petrified wood, conglomerate, and hematitic sandstone. Most if not all were likely obtained from the Quaternary lag gravel deposits that occur in abundance in uplands surrounding the site. They have

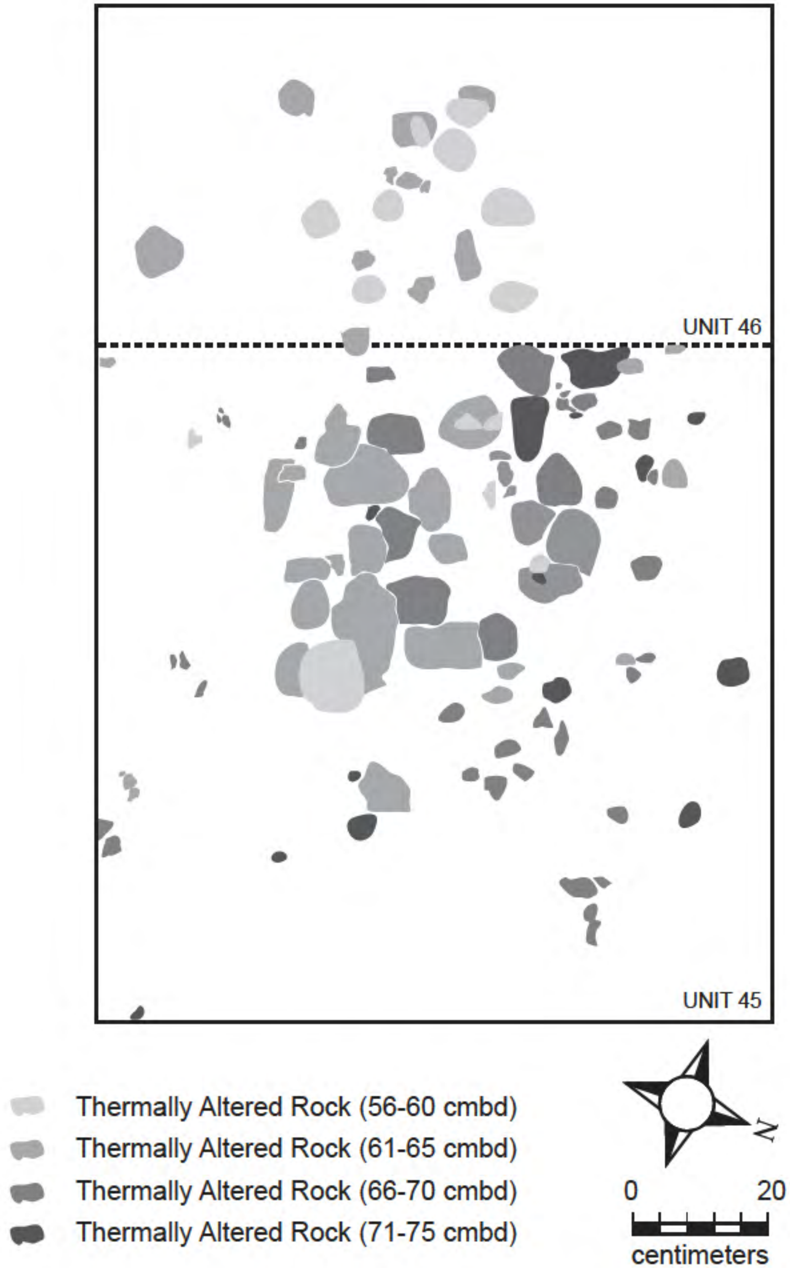

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Figure 103

Feature 9 Plan View

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Drafted by: C. Wallace

undergone various degrees of thermal alteration, reflecting their position in relation to the heat source as well as the duration and intensity of heating. Some exhibit only slight alteration, with one or two fracture planes, and generally appear pink in color. Others have been moderately altered, and while commonly exhibiting fracture planes, are generally intact. These typically exhibit a pink, sometimes potlidded cortex that when viewed in cross section appears reddened on the interior. Finally, some of the rocks exhibit evidence of having undergone intensive thermal alteration. These display angular fracture patterns over most surfaces and have a deeply reddened cortex. Interior surface colors range from pink to red. Potlidding is common in this group.

As mentioned above, all of the prehistoric features are interpreted as being the remains of simple hearths. Most appear scattered or disarticulated, probably from postdepositional disturbances, but two (Features 8 and 9) remain largely intact. While even the scattered rocks are herein referred to as simple hearths, they are often classified as rock scatters, though this term has no behavioral connotations (Black and McGraw 1985:242–245).

The term simple hearth is somewhat misleading as these kinds of features are generally associated with a host of food-preparation techniques, including smoking, roasting, drying, grilling, direct boiling, and parching, as well as food consumption (Ellis 1997:62–66; Prewitt 1982:32–34; Thoms 2008:Table 1)). They can also serve as scenes of everyday work activities such as tool making and repair or communal/family activities (Binford 1983:149–163). They can occur inside and outside of structures. Because of the array of activities that can take place around such hearths, it is only when conditions are favorable for the preservation of subsistence data or spatial patterns emerge from recovered artifacts that much more can be said as to their function. Unfortunately, in general the features found at 41CW104 lack this evidence. Organic remains recovered from the excavations around the features resulted only in a few pieces of hardwood charcoal, which likely represent fuel. While the absence of any recognizable postholes suggests that these were exterior hearths, simple temporary shelters may have been erected of which there is no visible trace.

As pointed out in Chapter 2, the site has suffered from the effects of postdepositional disturbances common to sandy mantle sites. Foremost among these has been bioturbation. These impacts are especially notable in the primary excavation area, where the cultural material occurs in thick alluvium. While the cultural features described in this chapter are found in much shallower sediments, and appear to be intact, they have nonetheless been subject to these same forces. Thus, while the large rocks comprising the features may largely be in place, much of the material surrounding them has been altered, rendering direct associations tentative at best.

Despite these shortcomings, there is evidence from the analysis of lipids as well as microwear on stone tools found near Features 7 and 8 that activities involving plant processing were being carried out around these features. In addition, the relatively large amount of debitage found in the excavations around the features suggests the manufacturing and/or repair of stone tools.

Breakage patterns discernible on the feature rocks were compared with those on rocks used in experimental hearth construction, and the results supplied additional information regarding the thermal history of the features. Petrographic analysis of thin sections made from feature and experimental rocks contributed similar kinds of data.

Whatever functions and activities took place around these simple hearth features at 41CW104, they must have differed from activities that occurred in the primary excavation area (Block 1) south of the features, where most of the TAR were recovered. These differences are most pronounced in the size of the rocks utilized and in the presence/absence of complete specimens. Most of the hearth feature rocks described above were complete or nearly complete specimens with maximum dimensions (with the exception of Features 1 and 2) of 7.5 cm (Feature 7) and 7.0 cm (Features 8 and 9). In comparison, the bulk of the TAR recovered from the primary excavations (based on preliminary examination) contained virtually no complete specimens and averaged less than about 5 cm in maximum dimension. Based on the results of extensive experimentation (see Chapter 14), it was concluded that the TAR recovery from the primary excavations represents the remains of stone boiling.

10

FAUNAL ANALYSIS

by Haley Rush and Michael A. Nash

INTRODUCTION

The recovery of animal bones can provide clues pertinent to prehistoric subsistence patterns, duration and season of occupation, utilization of bone material for tools or ornamentation, and animal population density. Unfortunately, relatively few specimens of animal bone were recovered from 41CW104, and the degraded nature of the remains severely limited taxonomic identification of much of the assemblage. Observations regarding other attributes, including minimum number of individuals (MNI), total animal biomass, age distribution of species, observed pathology, differential preservation of various skeletal parts, taphonomy, or butchering evidence were also limited.

METHODS

Thirty-eight faunal fragments were recovered during NRHP eligibility testing and data recovery investigations at 41CW104 (Table 33). Two shell fragments were also recovered and included an eggshell fragment from a large bird and a small river mussel shell fragment (see Table 33). Faunal identifications were made by comparing the specimens with the extensive type collection housed at the Atkins Archeology Laboratory. Identifiable as well as unidentifiable fragments were quantified in order to try to determine to what extent the native peoples were utilizing animal resources at 41CW104. Taxonomically unidentifiable fragments may still be useful when assessing cultural practices such as marrow extraction or bone grease rendering. Quantifications related to cultural practices followed the methods developed by Alan Outram (1998:105–128, 2000:401). All fragments, both identifiable and unidentifiable, were also sorted by size. Size classes used were small, medium, and large; in most cases, animal size could be determined. The small size category refers to animals in the size range of rabbits, raccoons, or turtles. Only mammals were identified in the medium category; medium mammal refers to animals that are in the size range of deer or antelope. In the size category of large, both mammal and avian were identified; this would include mammals the size of a bison or cow, and large avian would be a turkey or large waterfowl. In cases where size was not possible to ascertain, it was designated as unidentified.

The specimens were further classified by element. In many cases, while an exact identification could not be made, the fragment could be generally identified. In the cases of long bones, for instance, the diaphysis or epiphysis portion of the bone can be identified, even if the specific long

Table 33. Faunal Identifications and Classification Criteria

Lot No.	Unit No.	Level	Depth (cmbd)	Depth (cmbs)	Faunal Count	Adjusted Count	Fresh Break	Size	ID	Skeletal Element	Portion	Frag / Complete	Side	Age	Fracture Angle	Fracture Type	Fracture Texture	Size	Burned	Burned Color	Comments
5	1	5	70-80		2	2	Yes	Medium Mammal	na	Longbone	Epiphyseal	Fragment	Unknown	Unknown	-	-	-	3	No	na	
40	Scrape Area 1			30	8	1	Yes	Large Mammal	Bison / Cow	Metatarsal	Medial	Fragment	Right	Young	2	2	2	4	No	na	Carnivore gnawing
58	1	3	70-80		2	1	Yes	Unidentified	na	Longbone	Epiphyseal	Fragment	Unknown	Unknown	-	-	-	2	Yes	Part Black/ Part Gray	
62	4	1	45-58		2	1	Yes	Small Reptile	Turtle	Carapace or plastern	Unknown	Fragment	Unknown	Unknown	-	-	-	1	No	na	
156	22	3	60-70		1	1	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	1	2	2	2	No	na	
168	24	1	47-57		2	1	Yes	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	1	1	2	2	No	na	
171	24	2	57-67		1	1	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	-	-	-	1	Yes	All Gray	
177	25	5	80-90		1	1	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	2	2	2	3	No	na	
177	25	5	80-90		5	5	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	2	2	2	2	No	na	
177	25	5	80-90		1	1	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	1	2	2	2	No	na	
177	25	5	80-90		1	1	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	-	-	-	1	No	na	
190	22	5	80-90		1	1	na	Small Reptile	Turtle	Carapace or plastern	Unknown	Fragment	Unknown	Unknown	-	-	-	1	No	na	
193	22	6	90-100		1	1	Yes	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	1	2	2	3	No	na	
219f	30	3	66-76		1	1	na	Small Reptile	Turtle	Carapace or plastern	Unknown	Fragment	Unknown	Unknown	-	-	-	1	No	na	
223	27	5	84-95		1	1	na	Small Mammal	na	Mandibular	Unknown	Fragment	Unknown	Unknown	-	-	-	2	No	na	
228	31	2	50-60		1	1	Yes	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	2	2	2	2	No	na	
274	33	5	80-90		4	1	Yes	Unidentified	na	Unknown	Unknown	Fragment	Unknown	Unknown	-	-	-	1	Yes	Calcined	
277	33	6	90-100		1	1	Yes	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	2	2	2	2	No	na	
281	33	7	100-110		1	1	na	Medium Mammal	na	Longbone	Diaphyses	Fragment	Unknown	Unknown	2	1	2	2	No	na	
306	35	6	100-110		1	1	na	Small Mammal	na	Tooth Enamel	Unknown	Fragment	Unknown	Unknown	-	-	-	1	No	na	
Totals:					38	25															

bone cannot be named. The diaphysis of a bone refers to the midsection of the long bone, and the epiphysis is the rounded end of the long bone. There was only a single specimen where the animal the element was from could be determined. This specimen was also the only fragment for which age of the animal was ascertained. Certain features of the bones were photographed at TARL using 10x magnification microscopy photography. The features that are illustrated in this manner are fracture texture, fracture angle, and bone modification. These features are discussed in detail below.

Once the identification of species and elements had been completed, the fragments were further analyzed using a "fracture freshness index" (FFI) to determine how fresh the bone was when it was broken. Determining "freshness" relies on the assumption that if humans utilized the animal bones for marrow or bone grease extraction, this would typically have occurred sooner rather than later (Outram 1998:105–155). It can also demonstrate whether the fragments were intentionally broken (Gilmore 2007). In assessing the FFI, three separate criteria—fracture angle, fracture outline, and fracture texture—are scored on a scale of 0 to 2, and the combined scores equate with the FFI. This method can be applied relatively quickly and allows for the inclusion of small indeterminate bone fragments that might otherwise be excluded from consideration of past food resource exploitation (Outram 2000; Outram et al. 2005). However, the method is most effectively applied to long bone fragments.

Fracture angle refers to the angle of the broken edge of the bone to the cortical surface of the bone. A score of 0 allows for up to 10 percent of the bone to be broken at a 90-degree angle, a score of 1 means between 10 and 50 percent of the bone is broken at a right angle versus an acute or obtuse angle, and a score of 2 means that more than 50 percent of the bone is broken at a right angle (Outram 1998:124). In determining the fracture outline, a score of 0 indicates that the fracture is characterized by only helical outlines, a score of 1 means that the bone has both helical and other fracture characteristics, and a score of 2 means that no helical features are present (Figure 104). Lastly, in assessing fracture texture, a score of 0 indicates an absence of roughness, a score of 1 denotes some roughness is present, and a score of 2 is assigned when the facture texture is mostly rough (Figure 105).

Once the scores have been obtained, they are averaged to get an overall FFI for the analyzed portion of the assemblage (Table 34). A score of 0 means the assemblage as a whole demonstrates characteristics that should be consistent with all of the bones being freshly fractured. A score of 6 would indicate that none of the assemblage has characteristics consistent with being freshly fractured. Thus, the closer the number is to 0 the more likely the bone was fractured when fresh, and a score closer to 6 would indicate the bone was not fresh and was perhaps fractured by other taphonomic processes. To further quantify the bone fragments, the size of the fragments was measured on a five-class scale using methods outlined by Ricklis and Collins (1994), Outram (1998), and Gilmore (2007). The five classes are Class 1, less than 1.5 cm; Class 2, between 1.5 and 3 cm; Class 3, between 3 and 6 cm; Class 4, between 6 and 9 cm; and Class 5, greater than 9 cm. In order to remain consistent, a series of measured graduated circles was drawn and bone fragments

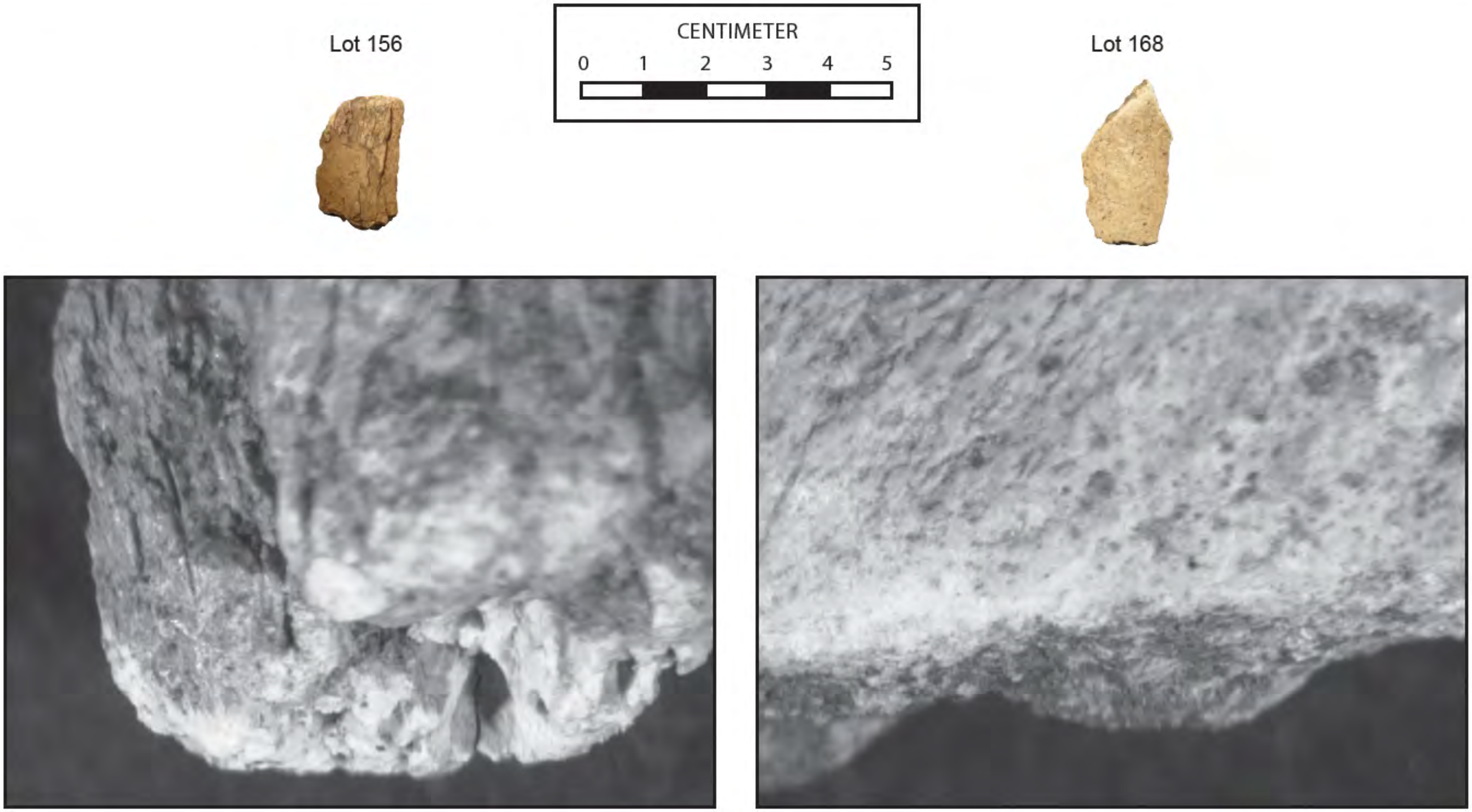

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Figure 104

Fracture Angle Examples

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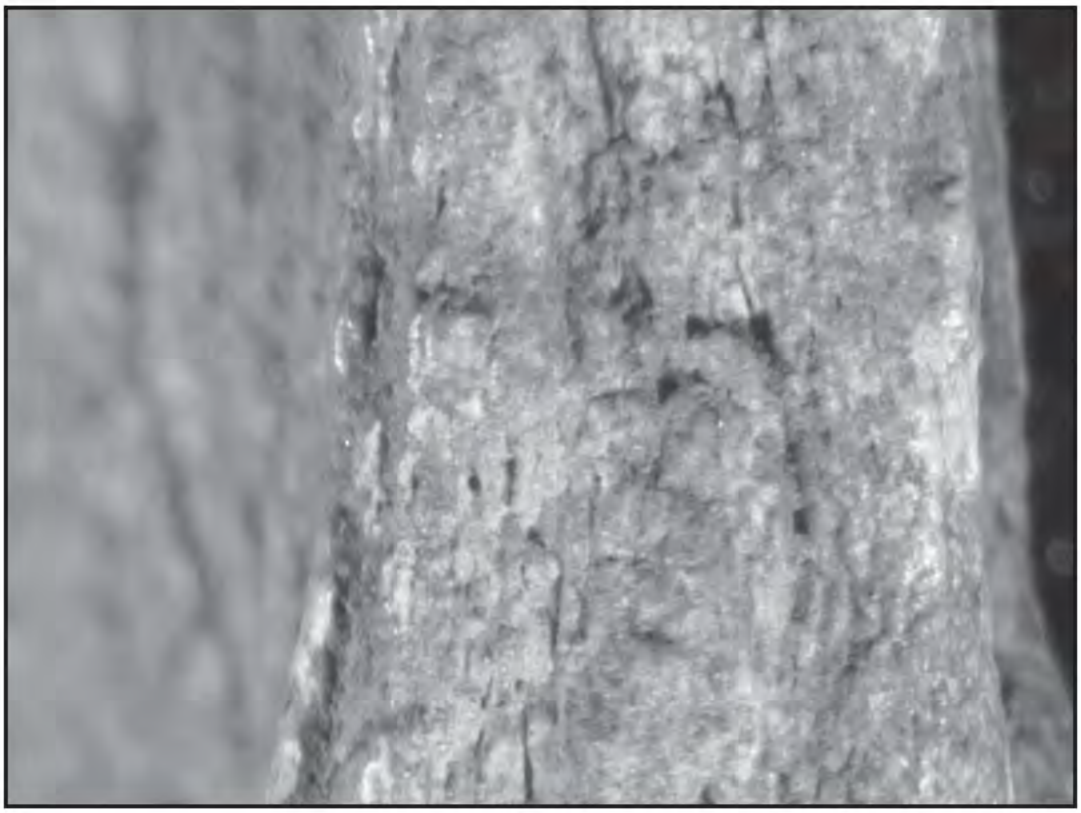

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0 1 2 3 4 5

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Figure 105

Lot 156
Texture Example

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were placed inside the circle and classified by the smallest circle they completely fit into. Bones that were in size Class 1 were not examined for the freshness factor because the small size of these fragments prohibits making an accurate determination.

Table 34. Fracture Freshness Index (FFI)

Lot No.	Fracture Angle	Fracture Type	Fracture Texture
5	-	-	-
40	2	2	2
58	-	-	-
62	-	-	-
156	1	2	2
168	1	1	2
171	-	-	-
177	2	2	2
177	2	2	2
177	1	2	2
177	-	-	-
190	-	-	-
193	1	2	2
219f	-	-	-
223	-	-	-
228	2	2	2
274	-	-	-
277	2	2	2
281	2	1	2
306	-	-	-
Total	**8**	**9**	**10**
FFI	**1.6**	**1.8**	**2**
Total Score	**5.4**		

The specimens were also examined for evidence of modification. The most common modification appears to be burning. Evidence of burning was recorded by absence or presence, color of the burned bone, and whether the burning was present on the entire fragment or only a portion. It should also be noted that heat-treated bone fractures more easily than unburned bone; the burned fragments were not included in the analysis for the freshness factor (Gilmore 2007:54). No other cultural modification was apparent on any of the specimens. The only other postmortem modification present appears to be animal gnawing present on a metatarsal fragment attributable to a bison or cow (Figure 106).

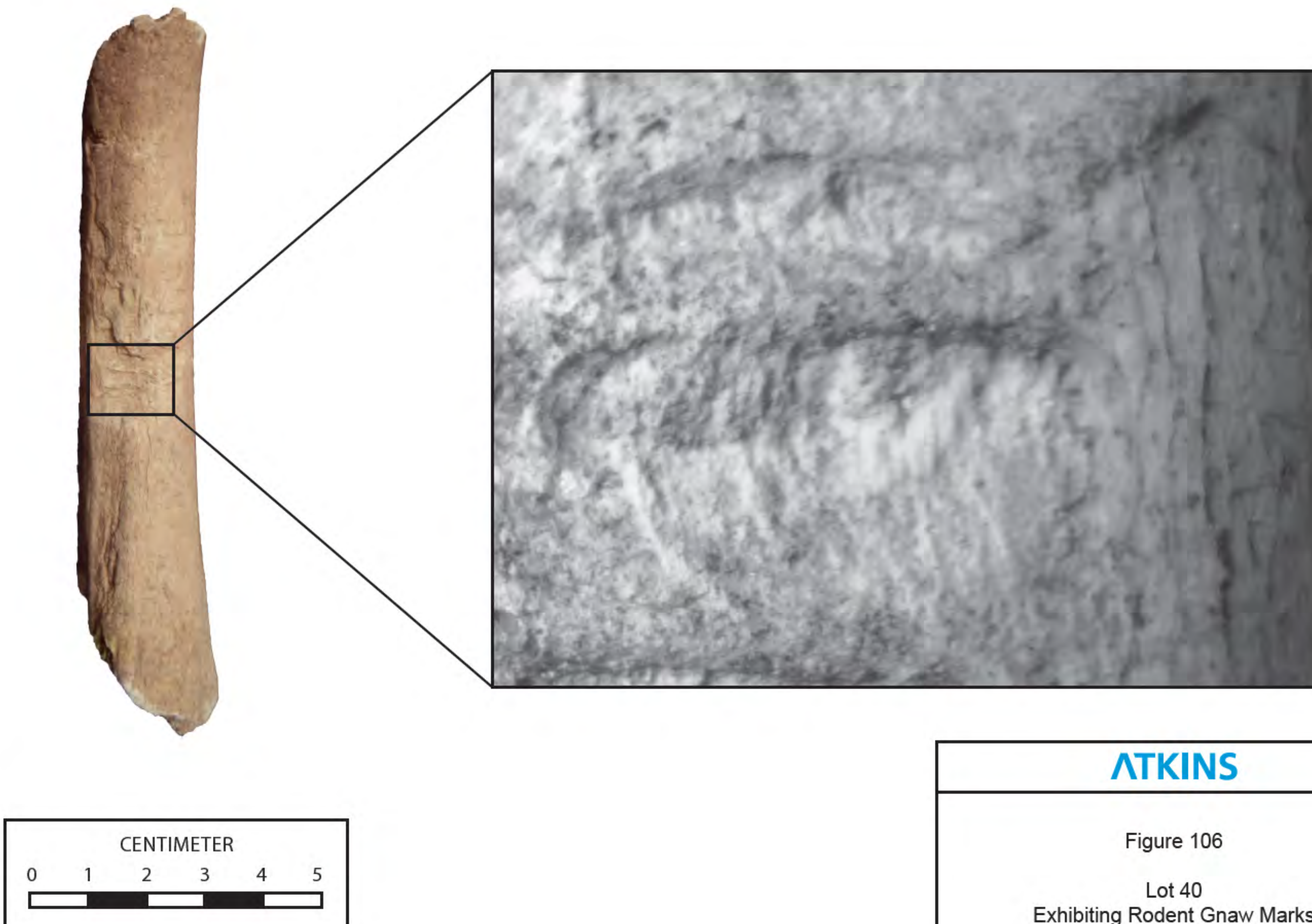

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Figure 106

Lot 40
Exhibiting Rodent Gnaw Marks

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MNI was also calculated for identifiable bones. Though the shortcomings of this method are known, it assumes that both the right and left sides of an animal would be represented equally across taxon; however, it can still be a good indicator of quantity of animals utilized by a population.

ANALYSIS

Upon examination of the 38 fragments, fresh breaks and fitters were assessed. As a result, the number of faunal fragments decreased to 25. Fresh breaks were identified by the color of the fractured edge when compared with the rest of the specimen; often these fragments appear to have been fragmented after collection. If fresh breaks were present, that edge was not used to determine the freshness factor, and the original break was used instead.

The three indicators for freshness were summed. The fracture angle total is 16, the fracture type is 18, and the fracture texture is 20. There are 10 specimens from which the freshness factor of each of the three criteria were taken. When the three scores were added and averaged for the 10 specimens, a score of 5.4 was reached. As mentioned above, the closer the score is to 6, the less likely the bones were fragmented when fresh. These fresh breaks and the high FFI indicate that other taphonomic processes were at work that affected the faunal remains at the site (see Tables 33 and 34).

Twenty of the fragments are identified as mammals of various sizes (see Table 33). Mammalian remains make up the largest portion of the faunal assemblage at 74 percent. One is identified as a large mammal, 17 as medium mammal, and 2 as small mammal remains. The vast majority of the mammalian remains are medium-sized animals at 85 percent, small mammals make up 10 percent, and the large animal fragment constitutes just 5 percent of the assemblage. The large mammal fragment is identified as a medial fragment of a right metatarsal of a juvenile bison or modern cow, probably 1 to 1.5 years old. Further distinction of the specific species could not be determined; this fragment also has evidence of rodent gnawing. This single individual is the only bone fragment present for which an MNI determination could be made. The remainder of the mammal fragments are long bone fragments; two are epiphysisal ends, the rest are diaphysis fragments. These could not be quantified using MNI. No evidence of sex or pathology was present on any of the faunal specimens.

Three of the fragments are identified as turtle carapace or plastern fragments. They could not be identified more specifically. Turtle remains make up 11 percent of the total faunal assemblage.

The two unidentified fragments make up 7 percent of the faunal assemblage.

There are two shell fragments; one is from an aquatic bivalve (mussel), and the other is an eggshell from a large avian such as a turkey or large waterfowl. These fragments were not considered when assessing what percentage of the faunal collection was made up of the different taxon.

Only 3 of the 25 fragments (excluding the 2 shell fragments) demonstrate evidence of burning. These are both unidentified mammal remains; the extent to which these were burned made them difficult to separate into a more specific analytical category. Each fragment displays a difference in burn color; one was part black, one was all gray, and one was calcined.

The highly fragmented nature of the assemblage is evidenced also by the size categories of the fragments. Seven are from size class 1 (28 percent), 13 in size class 2 (52 percent), 4 in size class 3 (16 percent), and only 1 from size class 4 (4 percent). Both the shell fragments are in size class 1, although they are not included in these percentages.

CONCLUSIONS

The analysis of the faunal assemblage showed that the degraded and fragmented nature of the assemblage was not likely due to human processing of the bone. Other taphonomic processes were likely at work including trampling, weathering, and scavenging of remains. It is possible the lack of faunal material could also be attributed to lack of preservation.

Though preservation could account for some of the sparseness, the small size of the assemblage and the lack of evidence (freshly broken fragments) for marrow extraction and/or grease rendering suggest that animal resources were not the dietary focus of the people utilizing this locale.

Though the sample size is quite small, a comparison was made of the FFI at 41CW104 to another Late Prehistoric site (41SP220) that utilized FFI for a sizable collection (>4,000 fragments). An average score of >3 resulted, which indicated that a great deal of subsequent fragmentation took place after the bone began to mineralize (Gilmore 2007:58–59). Site 41SP220 is a Late Prehistoric Toyah campsite in south Texas. It is included as a comparison because the faunal materials were analyzed using both traditional methods and Outram's methods. The conclusions at this site were based on a much larger collection, but give weight to the validity of conclusions made on the freshness of bone fractures at 41CW104.

The presence of gray, calcined, and part black burning was interpreted as evidence of intensive exposure to firing in the large faunal assemblage at the Toyah Bluff site (41HY209) in nearby Hays County (Ricklis and Collins 1994:422). Although the burned faunal fragments from 41CW104 display the same colors, the small size of the assemblage limits similar interpretations.

Better comparisons are possible between the assemblage from 41CW104 and the Sandbur site (41FY135) in Fayette County. The faunal assemblage at that site, while larger than 41CW104, was relatively small (620 fragments). The analysis of the Sandbur assemblage concluded that the bones were highly fragmented and were extensively affected by taphonomic processes that were not cultural in nature (Kalter et al. 2005:74). These likely include trampling and scavenging.

In conclusion, the analysis of the faunal assemblage from 41CW104 and subsequent comparisons with other site assemblages in the area suggest that different sites were focused on different resources depending on what was available. It also suggests that the subsistence base at 41CW104 was not focused on animal resources.

11

MACROBOTANICAL ANALYSIS

by Leslie L. Bush and J. Phil Dering

Twenty-nine flotation samples and 20 charcoal samples from the data recovery excavations at 41CW104 were submitted for identification and analysis for macrobotanical remains. This total includes 8 flotation samples and 8 macrobotanical samples submitted to Phil Dering in 2007, and 21 flotation samples submitted to Leslie L. Bush in 2012.

PLANT REMAINS FROM TESTING AT 41CW104

by Phil Dering

Atkins submitted eight sediment samples for flotation processing and botanical analysis. The flotation samples were recovered from Feature 8 and from general contexts. In addition, eight macrobotanical samples were submitted for identification. This report presents a description and assessment of the plant materials from this site.

Methods

Flotation. Flotation is the process by which organic remains, especially charred plant fragments, are recovered from archeological sediments using water as the separating agent. The samples from 41CW104 were processed using a simple screen and swirl technique by inserting a 5-gallon bucket into a 55-gallon water-filled drum. The heavy material, consisting of large clasts, some bone, and occasionally heartwood charcoal or nut charcoal, falls to the bottom of the bucket, and the lighter material, including most of the plant material, both carbonized and uncarbonized, floats to the surface. The floating material is directed onto a 0.45-mm screen, a mesh small enough to catch the smallest seeds. This floating material is called the light fraction. The material that sinks to the bottom of the bucket, termed the heavy fraction, is passed through a 1-mm stainless steel screen. Both fractions are tagged and slowly dried before they are examined in the laboratory.

Laboratory Analysis. In the current study, the heavy fraction was limited to a few fragments of rock in a single sample; no heartwood or other organic materials were noted. The analysis follows standard archeobotanical laboratory procedures. Each flotation sample is passed through a nested set of screens of 4-, 2-, and 0.450-mm mesh and examined for charred material, separated for identification. Because of the high rates of deterioration at most open archeological sites in North America, including those located in arid regions, only carbonized plant materials are considered to be part of the archeological record. Carbonized wood from the 4- and 2-mm screens (smaller pieces are seldom identifiable) is separated in a 25-piece grab sample and identified. Care is taken to select representative materials from both levels (cf. Diehl 2003:213; Huckell 2002:645; Miksicek 1994:243). When a sample contains more than 25 wood fragments, the additional material is scanned and sorted into wood charcoal types. For each type with more than 25 fragments, the volume of each type is measured in milliliters and reported along with its weight. The material caught on all of the sieve levels, including the bottom pan, was scanned for floral parts, fruits, and seeds.

Identification of carbonized wood was accomplished by using the snap technique, examining them at 8 to 45 magnifications with a hand lens or a binocular dissecting microscope. All plant specimens are identified by comparing them to references in the archeobotanical herbarium and to seed or wood keys and identification manuals.

Disturbance Indicators. Sample content may be affected by various biological disturbance factors, including insect or small mammal activity and plant root growth. In an effort to assess this impact, the amounts of insect parts, termite pellets, gastropods, mammal remains (including fecal pellets), and modern uncharred seeds are estimated for each flotation sample. These amounts are reported on a scale of 1–5 (+), 6–25 (++), 26–50 (+++), and over 50 (++++). Termite pellets occur in higher numbers when samples are taken from an area containing wood that has been exposed to the elements for a long time before burning. In the desert, this can occur in dead trees or roots, in which case the termite pellets can appear in any locus where this wood is burned, such as in a hearth or roasting pit. However, evidence of termite infestations seems to be more frequent and intense in samples drawn from the remains of burned prehistoric habitations with vertical elements constructed of wood.

Results

Archeobotanical Assemblage

The flotation sample summary is presented in Table 35, the flotation sample results in Table 36, and the identification of macrobotanical samples in Table 37. Disturbance indicators were dominated by roots and uncarbonized seeds of recent origin.

Of the eight flotation samples, seven contained identifiable plant remains, but FS 761 contained only tiny flecks of charcoal. The total charcoal weight for all the flotation samples was less than 0.6 g, none of the samples contained fragments larger than 0.5 mm, and no sample contained more than 0.1 g of total charcoal. The samples from Feature 8 contained the only evidence—and it was scant—of food remains. Two very small nut fragments were recovered from samples FS 519 and 522, and a single charred grass seed (caryopsis) was noted in FS 519.

Table 35. Flotation Sample Summary

FS No.	Volume (l)	Feature	Level	Light Fraction Fol (ml) and wt (g)	Insect Parts (ip), Roots (r), Rabbit/Rodent Pellets (rp), Leaves (l)	Uncharred (Modern) Seeds	Wild Plant Seed(s)/ Nut Taxa (n)	Total Charcoal Weight (grams)
137	3.8	–	3	71; 12.9	r +++	0	0	0.1
149	3.0	–	5	14; 1.8	r +++	0	0	<.1
259	3.0	–	4	31; 63.3	r +++	*Mollugo*	0	0.1
267	1.8	–	5	27; 2.1	r +++	0	0	0.1
519	3.0	8	1	34; 6.7	r +++	0	1 (S), 1 (N)	0.1
522	4.0	8	60–70 cmbd	29; 3.4	r +++	0	1(N)	0.1
605	2.0	8	57–77 cmbd	22; 1.4	r +++	*Mollugo*	0	<.1
761	3.0	–	7	4; 0.9	r ++	*Mollugo*	0	0

Table 36. Flotation Sample Results

FS No.	Taxon	Common	Part	Count	Wt. (g)
761	No identifiable plant remains	NA	–	–	–
137	*Quercus* sp.	Live oak type	Wood	14	0.1
522	Indeterminate	NA	Wood	1	<0.1
522	*Carya* sp.	Hickory or pecan type	Nut	1	<0.1
519	Poaceae	Grass family	Seed (caryopsis)	1	<0.1
519	Indeterminate	NA	Wood	1	
519	*Carya* sp.	Hickory or pecan type	Nut	1	<0.1
267	*Quercus* sp.	Live oak type	Wood	12	0.1
605	*Quercus* sp.	Live oak type	Wood	1	<0.1
259	*Quercus* sp.	Live oak type	Wood	8	<0.1
259	Indeterminate	NA	Wood	12	<0.1
149	*Quercus* sp.	Live oak type	Wood	10	<0.1

Table 37. Macrobotanical Samples

FS No.	Lot No.	Taxon	Common	Part	Count	Vol. (ml)	Wt. (g)
356	273	*Quercus* sp.	Oak	Wood	2		0.2
356	273	*Quercus* sp.	Oak	Wood	7		5.4
356	273	*Quercus* sp.	Oak	Wood	2		0.3
356	273	*Quercus* sp.	Oak	Wood	4		0.6
356	273	*Quercus* sp.	Oak	Wood	10		1.5
356	273	*Quercus* sp.	Oak	Wood	6		<0.1
356	273	*Quercus* sp.	Oak	Wood	4		0.6
356	273	*Quercus* sp.	Oak	Wood	4		1.4
355	273	*Quercus* sp.	Oak	Wood	25+	28	7.8

Oak wood or live oak wood type charcoal, was noted in seven of the eight flotation samples. The macrobotanical samples contained abundant wood charcoal, totaling 17.8 g. All of the wood was identified as oak.

Discussion and Conclusion

The botanical assemblage is quite reduced at this site. Remains of plant food resources include one grass seed fragment and two nut fragments, all recovered from Feature 8. One of the nut fragments is thin-shelled, resembling a pecan fragment, but it is too small to identify beyond the general category of hickory/walnut family. The single grass seed is eroded and impossible to identify to genus. These remains may suggest nut processing in the fall, but the material is too small and the fragments too few in number to ascertain much about plant use or land use. The samples submitted from 41CW104 indicate that the site has little potential to produce new botanical information for the region.

FLOTATION SAMPLES FROM DATA RECOVERY
by Leslie L. Bush

Twenty-one flotation samples totaling 88 liters of soil matrix from the Santa Maria Creek site (41CW104) were submitted for identification and analysis of botanical macroremains (Table 38). The site is a prehistoric occupation located on a terrace remnant along the east bank of the West Fork of Plum Creek in southern Caldwell County. Plum Creek drains into the San Marcos River and eventually into the Guadalupe River. Soils at the site are clay loams. The site is currently in pasture with notable vegetation consisting of oak and mesquite trees, bull nettle, and sparse, short grasses (THC site form September 27, 2006).

Table 38. Flotation Samples from Plum Creek (41CW104)

Lot	Unit	Feature	Level	Depth	Liters Processed
170	25		3	60–70	4
174	25		4	70–80	5
177	25		5	80–90	7
178	25		6	90–100	5
181	25		7	100–110	5
186	25		8	110–120	5
219	30		3	66–76	3
229	30		6	96–106	2
230	30		7	106–116	3
235	30		8	116–126	2
294	35		3	70–80	4
299	35		4	80–90	6
302	35		5	90–100	5
306	35		6	100–110	4
309	35		7	110–120	6
311	35		8	120–130	2
364	45	9	2	65–75	5
365	46	9	2	55–65	2
384	49	7	3	70–80	3
389		9		55–74	6
399	49	7	4	80–90	4
Total					88

Ferdinand Roemer, traveling between Columbus and Gonzales, Texas, in 1846, provides an early account of vegetation in the area:

> On the following morning we passed through a post oak forest several miles in width. These forests, which cover a wide area in Central Texas between the Brazos and the Guadalupe, have a remarkable resemblance in winter to the cultivated German oak forests, 6 to eighty years old. . . . In other forests of North America many varieties of trees are usually found, but in the post oak forests all are excluded with the exception of a few walnuts. Underbrush is also lacking. The soil upon which the post oaks grow is usually of average fertility, but also often sterile and unproductive. (Roemer 2011: Chapter V)

Although Roemer writes of walnut (*Juglans nigra*), the closely related black hickory *(Carya texana*, associated with the uplands) and pecan *(Carya illinoinensis*, associated with stream valleys) are more common in the Southern Post Oak Savannah today. Benny Simpson notes that walnut trees in Texas have been extensively harvested (Simpson 1999:178), so in Roemer's day walnuts may well have been more common, although none were identified in this study.

As Roemer's account anticipates, ecologists today place southern Caldwell County in the Post Oak Savannah ecological region (Diggs et al. 2006:Figure 63; Gould 1962).

In summary, presettlement vegetation of the Post Oak Savannah was probably a complex mosaic of prairie, post oak-blackjack oak savannah/woodland/forest, xeric sandyland, isolate pine-oak forests (e.g., "Lost Pines" of Bastrop County), dry-mesic forests (particularly in the north), bogs and other wetlands, and river bottom forests (Diggs et al. 2006:117).

Upland vegetation on the Post Oak Savannah is characterized by a mixture of trees and grasslands. Oaks and hickories are the common trees, especially post oak (*Quercus stellata*), blackjack oak (*Q. marilandica*), and Texas hickory (*Carya texana*) (Bezanson 2000; Diggs et al. 2006). Yaupon (*Ilex vomitoria*) is a typical understory plants (Bezanson 2000). In the past, areas of tall grasses interspersed among the woodlands would have included native grasses such as Indiangrass (*Sorghastrum nutans*), little bluestem (*Schizachyrium scoparium*), and switchgrass (*Panicum virgatum*) (Diggs et al. 2006). Floodplain forests in the Post Oak Savannah tend to be dominated by various oak species, but elms (*Ulmus* spp.), green ash (*Fraxinus pennsylvanica*), and juniper (*Juniperus virginiana*) may also be present, and along some streams these latter species are dominant (Diggs et al. 2006:122). Pecan is also a common constituent of streamside forests.

In the immediate vicinity of the Santa Maria Creek site, the upland trees and grasses and bottomland forests associated with the creek would have been the most important communities. The famous Ottine wetlands, including Soefje swamp, Hershop Bog, and Palmetto State Park, lie less than 15 km south-southeast of the site along the San Marcos River (Bousman 1998; Fleenor and Taber 2009; Graham and Heimsch 1960), but there is no indication in this study that wetland vegetation was directly exploited by site inhabitants.

Methods

Flotation samples from the Santa Maria Creek site were processed at Atkins' Austin offices in a Flot-Tech closed flotation system. Light fractions were caught in a 0.212-mm mesh, and heavy fractions were caught in 1.0-mm bottom mesh before being sorted through a stack of geologic mesh with square openings of 19, 9.5, and 4.75 mm to remove larger rocks. Heavy-fraction material smaller than 2 mm and carbonized plant material picked from larger-sized fractions were sent to Macrobotanical Analysis along with the light fractions. Heavy fractions were scanned under the microscope, and all carbonized botanical material was removed and added to the light fractions prior to sorting. Only light fractions (including the botanical material retrieved from heavy fractions) are reported here.

Samples were treated according to standard procedures at the Macrobotanical Analysis laboratory in Manchaca, Texas. All samples were subject to full radiocarbon protocols to retain suitability for radiocarbon dating. Samples were sorted on freshly cleaned glassware and handled only with latex gloves and metal forceps. Screens used to size-sort material were cleaned between samples. Contact with paper and other plant products was avoided. Only one sample was open at a time in the laboratory. Writing instruments used for data recording of samples were plastic mechanical pencils.

Sorting of flotation samples was also accomplished according to standard procedures (Pearsall 2000). Each sample was weighed on an Ohaus Scout II 200 x 0.01 g electronic balance before being size-sorted through a stack of graduated geologic mesh. Material that did not pass through the No. 10 mesh (2-mm square openings) was completely sorted, and all carbonized botanical remains were counted, weighed, recorded, and labeled. Uncarbonized botanical material larger than 2 mm (roots and rootlets) was weighed, recorded, and labeled as "contamination." Material that fell through the 2-mm mesh ("residue") was examined under a stereoscopic microscope at 7–45X magnification for carbonized botanical remains. Any identifiable plant material that had not been previously identified in the material larger than 2 mm was removed from residue, counted, weighed, recorded, and labeled. Uncarbonized macrobotanical remains were recorded on a presence/absence basis on laboratory forms.

Wood charcoal identification was attempted for 20 randomly selected specimens larger than 2 mm from each sample. When fewer than 20 fragments were present, identification was attempted for progressively smaller fragments until identification became impractical or until 20 fragments were identified. Wood charcoal fragments were snapped to reveal a transverse section and examined under a stereoscopic microscope at 28–180X magnification. When necessary, tangential or radial sections were examined for ray seriation, presence of spiral thickenings, types, and sizes of intervessel pitting, and other minute characteristics that can only be seen at the higher magnifications of this range.

Botanical materials were identified to the lowest possible taxonomic level by comparison to materials in the Macrobotanical Analysis comparative collection and through the use of standard reference works (Core et al. 1979; Davis 1993; Hoadley 1990; Martin and Barkley 2000; Musil 1963; Panshin and de Zeeuw 1980). Botanical nomenclature follows that of the PLANTS Database (United States Department of Agriculture, Natural Resources Conservation Service 2012).

Results

Table 39 summarizes carbonized and semicarbonized plant material identified in the 21 flotation samples; the identifications are detailed by lot number in Table 40. As discussed below, at least some of the semicarbonized material is likely modern and all of it should be interpreted with caution. Table 41 lists the uncarbonized, modern plant taxa identified on the site; Table 42 details modern plant material by lot.

Table 39. Carbonized and Semicarbonized Plant Remains
from the Santa Maria Creek Site (41CW104)
Site Totals

		Number	Weight (g)
Wood Charcoal			
Quercus subg. *Lobatae*	Red group oak	65	0.72
Quercus subg. *Quercus*	White group oak	51	0.93
Quercus sp.	Oak	34	0.18
Quercus fusiformis	Plateau live oak	5	0.03
Fabaceae	Legume	4	0.02
Ilex sp.	Holly	4	0.04
Ehretia anacua	Knockaway	3	0.02
Juniperus sp.	Juniper	3	0.01
Celtis sp.	Sugarberry	2	0.03
Rhus sp.	Sumac	1	0.18
Indeterminable	Indeterminable	2	0.02
Diffuse-porous hardwood	Diffuse-porous hardwood	1	0.01
Hardwood	Hardwood	21	0.07
Not examined	Not examined	467	2.21
Nutshell			
Juglandaceae	Hickory/walnut family	10	0.04
Quercus sp.	Acorn	3	0.03
Small seeds			
Indeterminable	Indeterminable	6	
Poaceae	Grass family	3	
Rhus sp.	Sumac	1	
Verbena sp.	Verbena	2	
Semicarbonized bark		20	0.09
Semicarbonized wood			
Quercus sp.	Oak	3	0.03
Celtis sp.	Sugarberry	1	0.02
Juniperus sp.	Juniper	1	0.01
Ulmus sp.	Elm	1	0.01

Table 40. Carbonized and Semicarbonized Plant Remains from the Santa Maria Creek Site (41CW104) (by Lot)

Lot	State	Plant Part	Botanical Name	Common Name	Number	Weight (g)	Comments
170	Carbonized	Wood	Fabaceae	Legume	3	0.01	
170	Carbonized	Wood	*Juniperus* sp.	Juniper	3	0.01	
170	Carbonized	Wood	Not examined	Not examined	30	0.03	<2 mm
170	Carbonized	Wood	*Quercus fusiformis*	Plateau live oak	4	0.01	
170	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	1	0.01	
170	Carbonized	Bark			1	0.01	
170	Carbonized	Stem			1	0.01	
170	Carbonized	Seed	Indeterminable	Indeterminable	1	0.01	seedcoat fragment
174	Carbonized	Wood	Not examined	Not examined	273	1.80	
174	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	7	0.13	
174	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	13	0.53	
177	Carbonized	Seed	Indeterminable	Indeterminable	3	0.01	
177	Carbonized	Wood	Not examined	Not examined	66	0.18	
177	Carbonized	Seed	Poaceae	Grass family	3	0.01	
177	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	17	0.24	
177	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	3	0.06	
177	Carbonized	Seed	*Rhus* sp.	Sumac	1	0.01	
178	Semi-carbonized	Wood	*Juniperus* sp.	Juniper	1	0.01	
178	Carbonized	Wood	Not examined	Not examined	7	0.01	
178	Carbonized	Wood	*Quercus* sp.	Oak	3	0.02	
178	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	5	0.03	
178	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	10	0.09	
178	Semi-carbonized	Wood	*Ulmus* sp.	Elm	1	0.01	
181	Carbonized	Seed	Indeterminable	Indeterminable	1	0.01	
181	Carbonized	Wood	*Quercus* sp.	Oak	3	0.01	
181	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	3	0.01	
181	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	14	0.17	
186	Carbonized	Wood	*Quercus* sp.	Oak	2	0.01	
186	Carbonized	Nutshell	*Quercus* sp.	Acorn	1	0.01	
219	Carbonized	Wood	*Celtis* sp.	Sugarberry	1	0.01	
219	Carbonized	Wood	Not examined	Not examined	15	0.01	<2 mm
219	Carbonized	Wood	*Quercus* sp.	Oak	6	0.02	
219	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	1	0.01	
219	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	3	0.02	

Table 40 (Cont'd)

Lot	State	Plant Part	Botanical Name	Common Name	Number	Weight (g)	Comments
229	Carbonized	Wood	*Ehretia anacua*	Knockaway	3	0.02	
229	Carbonized	Wood	Hardwood	Hardwood	1	0.01	
229	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	3	0.03	
229	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	1	0.01	
229	Semi-carbonized	Bark			20	0.09	
230	Carbonized	Wood	Indeterminable	Indeterminable	1	0.01	< 2 mm
230	Carbonized	Nutshell	*Quercus* sp.	Acorn	1	0.01	< 2 mm
230	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	1	0.03	
235	Carbonized	Wood	Hardwood	Hardwood	4	0.01	< 2 mm
235	Carbonized	Wood	Indeterminable	Indeterminable	1	0.01	< 2 mm
235	Carbonized	Nutshell	Juglandaceae	Hickory/walnut family	1	0.01	< 2 mm
235	Carbonized	Wood	*Quercus* sp.	Oak	2	0.01	< 2 mm
294	Carbonized	Wood	*Celtis* sp.	Sugarberry	1	0.02	
294	Semi-carbonized	Wood	*Celtis* sp.	Sugarberry	1	0.02	
294	Carbonized	Wood	Fabaceae	Legume	1	0.01	
294	Carbonized	Wood	*Ilex* sp.	Holly	1	0.01	
294	Carbonized	Wood	Not examined	Not examined	24	0.04	< 2 mm
294	Carbonized	Wood	*Quercus* sp.	Oak	6	0.05	
294	Semi-carbonized	Wood	*Quercus* sp.	Oak	3	0.03	
294	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	7	0.03	
294	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	1	0.01	
294	Carbonized	Wood	*Rhus* sp.	Sumac	1	0.18	
299	Carbonized	Seed	Indeterminable	Indeterminable	1	0.01	seedcoat only
299	Carbonized	Wood	Not examined	Not examined	33	0.10	
299	Carbonized	Wood	*Quercus fusiformis*	Plateau live oak	1	0.02	
299	Carbonized	Wood	*Quercus* sp.	Oak	2	0.01	
299	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	15	0.15	
299	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	2	0.02	
299	Carbonized	Seed	*Verbena* sp.	Verbena	2	0.01	
302	Carbonized	Wood	Diffuse-porous hardwood	Diffuse-porous hardwood	1	0.01	
302	Carbonized	Nutshell	Juglandaceae	Hickory/walnut family	1	0.01	
302	Carbonized	Wood	*Quercus* sp.	Oak	3	0.01	
302	Carbonized	Nutshell	*Quercus* sp.	Acorn	1	0.01	

Table 40 (Cont'd)

Lot	State	Plant Part	Botanical Name	Common Name	Number	Weight (g)	Comments
302	Carbonized	Wood	*Quercus* subg. *Lobatae*	Red group oak	5	0.05	
302	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	2	0.01	
306	Carbonized	Wood	Hardwood	Hardwood	7	0.01	<2 mm
306	Carbonized	Wood	*Quercus* sp.	Oak	2	0.01	<2 mm
309	Carbonized	Wood	Hardwood	Hardwood	2	0.01	<2 mm
309	Carbonized	Wood	*Quercus* sp.	Oak	2	0.01	<2 mm
309	Carbonized	Wood	*Quercus* subg. *Quercus*	White group oak	2	0.01	
311	Carbonized	Wood	Hardwood	Hardwood	3	0.01	<2 mm
311	Carbonized	Wood	*Quercus* sp.	Oak	3	0.02	
364	Carbonized	Wood	Not examined	Not examined	3	0.01	<2 mm
365	Carbonized	Wood	Hardwood	Hardwood	3	0.01	<2 mm
384	Carbonized	Wood	Hardwood	Hardwood	1	0.01	<2 mm
384	Carbonized	Nutshell	Juglandaceae	Hickory/walnut family	3	0.01	broken for ID
384	Carbonized	Wood	Not examined	Not examined	6	0.01	<2 mm
389	Carbonized	Wood	Not examined	Not examined	2	0.01	<2 mm
399	Carbonized	Wood	*Ilex* sp.	Holly	3	0.03	
399	Carbonized	Nutshell	Juglandaceae	Hickory/walnut family	5	0.01	
399	Carbonized	Wood	Not examined	Not examined	8	0.01	<2 mm

Preservation. In all except the driest areas of North America, uncarbonized plant material on open-air sites can be assumed to be of modern origin unless compelling evidence suggests otherwise (Lopinot and Brussell 1982; Miksicek 1987:231). Caldwell County receives an annual average of 34.7 inches (881 mm) of precipitation (Natural Fibers Information Center 1987), and it is not arid enough that routine preservation of uncarbonized plant remains on open sites can be expected. Uncarbonized plants are interpreted as parts of modern plants currently or recently growing on the site. The semicarbonized elm wood from Unit 25, Level 6 is probably also modern, since elm was otherwise recovered only in uncarbonized form. The semicarbonized oak and sugarberry (*Celtis* sp.), both from Unit 35, Level 3, are more likely to be ancient since they were also recovered in carbonized form in that same level, but they should be interpreted with caution nonetheless. Juniper was recovered in carbonized, uncarbonized, and intermediate states and should also be interpreted with caution.

Table 41. Uncarbonized Plant Taxa* from the Santa Maria Creek Site (41CW104)

Plant Part	Botanical Name	Common Name
Seed	*Ambrosia* sp.	Ragweed
Seed	*Croton* sp.	Croton
Seed	Cyperaceae	Sedge family
Seed	*Cyperus* sp.	Flatsedge
Wood	Diffuse-porous hardwood	Diffuse-porous hardwood
Leaf	*Juniperus* sp.	Juniper
Seed	Lamiaceae	Mint family
Seed	Malvaceae	Mallow family
Seed	*Mollugo verticillata*	Carpetweed
Seed	*Oenothera/Calyophus* spp.	Evening primrose
Seed	*Oxalis* sp.	Woodsorrel
Seed	Panicodae	Panicoid grass
Seed	Poaceae	Grass family
Seed	*Portulaca* sp.	Purslane
Seed	*Rudbeckia/Echinacea* spp.	Coneflower
Seed	*Setaria* sp.	Bristlegrass
Leaf	*Ulmus crassifolia*	Cedar elm
Seed	*Ulmus crassifolia*	Cedar elm
Seed	Unknown	Unknown
Seed	*Verbena* sp.	Verbena
Bark		

*Rootlets were present in all samples

Discussion

Wood charcoal. A total of 663 fragments of wood charcoal weighing 4.47 g were recovered from the Santa Maria Creek site. Identification was attempted for 196 wood charcoal fragments, of which 172 could be identified to family, genus, or species. Of these, 155 (90.1 percent) belonged to the oak genus. Red group (*Quercus* subg. *Lobatae*), white group (*Quercus* subg. *Quercus*), and live oaks (*Quercus fusiformis*) were all identified. Post oak is the most common white group oak in the region, and blackjack oak is the most common red group oak. The remaining 10 percent of the identifiable wood charcoal assemblage consists of legume family (Fabaceae), yaupon (*Ilex* sp.), knockaway (*Ehretia anacua*), juniper, sugarberry, and sumac (*Rhus* sp.). The legume family wood lacks the tyloses and aliform/confluent parenchyma that characterize mesquite and acacia. It is most likely honeylocust (*Gleditsia triacanthos*).

Table 42. Uncarbonized Seeds and Leaves from the Santa Maria Creek Site (41CW104) Presence/Absence

Lot	Plant Part	Botanical Name	Common Name
170	Seed	*Cyperus* sp.	Flatsedge
170	Leaf	*Juniperus* sp.	Juniper
170	Seed	Lamiaceae	Mint family
170	Seed	*Mollugo verticillata*	Carpetweed
170	Seed	*Oxalis* sp.	Woodsorrel
170	Seed	Unknown	Unknown
174	Seed	*Croton* sp.	Croton
174	Seed	*Cyperus* sp.	Flatsedge
174	Leaf	*Juniperus* sp.	Juniper
174	Seed	*Mollugo verticillata*	Carpetweed
174	Seed	*Oenothera/Calyophus* spp.	Evening primrose
174	Leaf	*Ulmus crassifolia*	Cedar elm
177	Seed	*Croton* sp.	Croton
177	Seed	*Cyperus* sp.	Flatsedge
177	Leaf	*Juniperus* sp.	Juniper
177	Seed	*Mollugo verticillata*	Carpetweed
177	Seed	*Rudbeckia/Echinacea* spp.	Coneflower
178	Seed	*Croton* sp.	Croton
178	Seed	*Cyperus* sp.	Flatsedge
178	Leaf	*Juniperus* sp.	Juniper
178	Seed	*Mollugo verticillata*	Carpetweed
178	Seed	*Oenothera/Calyophus* spp.	Evening primrose
178	Seed	*Oxalis* sp.	Woodsorrel
178	Seed	*Portulaca* sp.	Purslane
178	Seed	*Rudbeckia/Echinacea* spp.	Coneflower
181	Leaf	*Juniperus* sp.	Juniper
181	Seed	*Mollugo verticillata*	Carpetweed
181	Leaf	*Ulmus crassifolia*	Cedar elm
186	Leaf	*Juniperus* sp.	Juniper
186	Seed	*Mollugo verticillata*	Carpetweed
186	Seed	*Oxalis* sp.	Woodsorrel
186	Leaf	*Ulmus crassifolia*	Cedar elm
219	Seed	*Cyperus* sp.	Flatsedge

Table 42 (Cont'd)

Lot	Plant Part	Botanical Name	Common Name
219	Leaf	*Juniperus* sp.	Juniper
219	Seed	Lamiaceae	Mint family
219	Seed	Malvaceae	Mallow family
219	Seed	*Mollugo verticillata*	Carpetweed
219	Seed	*Portulaca* sp.	Purslane
229	Leaf	*Juniperus* sp.	Juniper
229	Seed	*Mollugo verticillata*	Carpetweed
229	Leaf	*Ulmus crassifolia*	Cedar elm
230	Leaf	*Juniperus* sp.	Juniper
230	Seed	*Mollugo verticillata*	Carpetweed
230	Leaf	*Ulmus crassifolia*	Cedar elm
235	Seed	Cyperaceae	Sedge family
235	Wood	Diffuse-porous hardwood	Diffuse-porous hardwood
235	Leaf	*Juniperus* sp.	Juniper
235	Seed	*Mollugo verticillata*	Carpetweed
235	Seed	*Rudbeckia/Echinacea* spp.	Coneflower
235	Leaf	*Ulmus crassifolia*	Cedar elm
294	Seed	*Cyperus* sp.	Flatsedge
294	Leaf	*Juniperus* sp.	Juniper
294	Seed	Lamiaceae	Mint family
294	Seed	*Mollugo verticillata*	Carpetweed
294	Seed	*Oenothera/Calylophus* spp.	Evening primrose
294	Seed	*Oxalis* sp.	Woodsorrel
299	Seed	*Cyperus* sp.	Flatsedge
299	Leaf	*Juniperus* sp.	Juniper
299	Seed	Lamiaceae	Mint family
299	Seed	*Mollugo verticillata*	Carpetweed
299	Seed	*Oenothera/Calylophus* spp.	Evening primrose
299	Seed	*Oxalis* sp.	Woodsorrel
299	Seed	Poaceae	Grass family
299	Seed	*Portulaca* sp.	Purslane
299	Seed	*Rudbeckia/Echinacea* spp.	Coneflower
299	Seed	*Setaria* sp.	Bristlegrass
299	Leaf	*Ulmus crassifolia*	Cedar elm

Table 42 (Cont'd)

Lot	Plant Part	Botanical Name	Common Name
299	Bark		
302	Seed	*Cyperus* sp.	Flatsedge
302	Leaf	*Juniperus* sp.	Juniper
302	Seed	Lamiaceae	Mint family
302	Seed	*Mollugo verticillata*	Carpetweed
302	Seed	*Oenothera/Calylophus* spp.	Evening primrose
302	Seed	*Oxalis* sp.	Woodsorrel
302	Seed	Panicodae	Panicoid grass
302	Seed	*Portulaca* sp.	Purslane
302	Leaf	*Ulmus crassifolia*	Cedar elm
302	Seed	Unknown	Unknown
302	Seed	*Verbena* sp.	Verbena
306	Leaf	*Juniperus* sp.	Juniper
306	Seed	*Mollugo verticillata*	Carpetweed
306	Seed	*Oxalis* sp.	Woodsorrel
306	Seed	Poaceae	Grass family
306	Leaf	*Ulmus crassifolia*	Cedar elm
309	Leaf	*Juniperus* sp.	Juniper
309	Seed	Lamiaceae	Mint family
309	Seed	*Mollugo verticillata*	Carpetweed
309	Seed	*Oxalis* sp.	Woodsorrel
309	Seed	Panicodae	Panicoid grass
309	Seed	*Portulaca* sp.	Purslane
309	Leaf	*Ulmus crassifolia*	Cedar elm
311	Seed	*Mollugo verticillata*	Carpetweed
364	Seed	*Cyperus* sp.	Flatsedge
364	Leaf	*Juniperus* sp.	Juniper
364	Seed	*Mollugo verticillata*	Carpetweed
365	Leaf	*Juniperus* sp.	Juniper
365	Seed	*Mollugo verticillata*	Carpetweed
365	Leaf	*Ulmus crassifolia*	Cedar elm
365	Seed	*Ulmus crassifolia*	Cedar elm
384	Seed	*Cyperus* sp.	Flatsedge
384	Leaf	*Juniperus* sp.	Juniper

Table 42 (Cont'd)

Lot	Plant Part	Botanical Name	Common Name
384	Seed	*Mollugo verticillata*	Carpetweed
389	Seed	*Ambrosia* sp.	Ragweed
389	Seed	*Cyperus* sp.	Flatsedge
389	Leaf	*Juniperus* sp.	Juniper
389	Seed	Lamiaceae	Mint family
389	Seed	*Mollugo verticillata*	Carpetweed
389	Leaf	*Ulmus crassifolia*	Cedar elm
399	Seed	*Cyperus* sp.	Flatsedge
399	Leaf	*Juniperus* sp.	Juniper
399	Seed	*Mollugo verticillata*	Carpetweed
399	Leaf	*Ulmus crassifolia*	Cedar elm

The wood charcoal assemblage at the Santa Maria Creek site is made up of trees that would be expected in the immediate site vicinity. Oak is by far the most common tree in the area, and it makes a high quality fuel wood, burning slowly at high temperatures and with excellent coaling properties.

Nutshell. Thirteen fragments of nutshell were recovered from the site, most of them smaller than 2 mm. Three fragments are acorn nutshell, and 10 were identifiable only to the family Juglandaceae, which includes walnut, hickory, and pecan. None of the Juglandaceae species were recovered in other forms (e.g., wood charcoal) at the site, leaving little basis for speculating which of the three the nutshells might represent.

Small seeds. Twelve small seeds or seed fragments were recovered from the Santa Maria Creek site in carbonized form. Of these, only half were sufficiently complete and in good enough condition to be identifiable. Three belong to the grass family (Poaceae), one is sumac, and two are verbena (*Verbena* sp.).

The two verbena seeds were recovered from Unit 35, Level 4. Uncarbonized verbena seeds were recovered from Level 5 of that unit, the only other context on the site that produced verbena in any form. The coincidence casts some doubt on the antiquity of the Level 4 verbena. It is possible that these specimens, although black, are not carbonized but merely humified (Cook 1964). Ethnographically recorded uses of verbena among Native Americans are few and primarily medicinal (Moerman 1998:591–592). One food use is recorded among California Indians, who ground the seeds into a sort of pinole (Moerman 1998:592).

Grasses were the most common carbonized seed recovered, but even these were found in only a single context, Unit 25, Level 5. Grasses are important fiber plants, and their seeds are edible—although not always easily separated from the rest of the grass caryopsis. The third identifiable wild seed type, sumac, was also recovered from Unit 25, Level 5. Sumac fruits are edible and important for providing Vitamin C in winter. Sumac bark, leaves, roots, and/or fruits were used to make various colored dyes. Leaves were used in smoking mixtures or smoked by themselves (Moerman 1998:471–475). Roemer records a Texas example of this practice, noting that his Shawnee guides smoked a mixture of tobacco and what was probably evergreen sumac (*Rhus virens*) along the banks of the San Saba River (Roemer 2011:Chapter XXI). Sumac wood charcoal was also recovered from the Santa Maria Creek site.

Summary

Macrobotanical remains recovered from the Santa Maria Creek site (41CW104) consist primarily of wood charcoal, with approximately 90 percent of the wood being oak and the remaining 10 percent consisting of species that would be expected along the creek. A few fragments of acorn and other nutshell suggest nut-processing activities at the site. The small seeds present may represent uses of those plants for food, medicine, or fiber.

12

ANALYSIS OF THE FATTY ACID COMPOSITIONS FROM ARCHEOLOGICAL ROCK RESIDUES

by M.E. Malainey. Ph.D.

A total of five fire-cracked rock fragments were submitted for analysis; where necessary, subsamples were taken. Samples were crushed, and absorbed lipid residues were extracted with organic solvents. Fatty acid components of the lipid extracts were analyzed using gas chromatography. Residues were identified using criteria developed from the decomposition patterns of experimental residues. The first section of this report outlines the development of the identification criteria. Following this, analytical procedures and results are presented.

FATTY ACIDS AND DEVELOPMENT OF THE IDENTIFICATION CRITERIA

Introduction and Previous Research

Fatty acids are the major constituents of fats and oils (lipids) and occur in nature as triglycerides, consisting of three fatty acids attached to a glycerol molecule by ester-linkages. The shorthand convention for designating fatty acids, Cx:yωz, contains three components. The "Cx" refers to a fatty acid with a carbon chain length of x number of atoms. The "y" represents the number of double bonds or points of unsaturation, and the "ωz" indicates the location of the most distal double bond on the carbon chain, i.e., closest to the methyl end. Thus, the fatty acid expressed as C18:1ω9, refers to a mono-unsaturated isomer with a chain length of 18 carbon atoms with a single double bond located nine carbons from the methyl end of the chain. Similarly, the shorthand designation, C16:0, refers to a saturated fatty acid with a chain length of 16 carbons.

Their insolubility in water and relative abundance compared to other classes of lipids, such as sterols and waxes, make fatty acids suitable for residue analysis. Since employed by Condamin et al. (1976), gas chromatography has been used extensively to analyze the fatty acid component of absorbed archeological residues. The composition of uncooked plants and animals provides important baseline information, but it is not possible to directly compare modern uncooked plants and animals with highly degraded archeological residues. Unsaturated fatty acids, which are found widely in fish and plants, decompose more readily than saturated fatty acids, sterols, or waxes. In the course of decomposition, simple addition reactions might occur at points of unsaturation (Solomons 1980) or peroxidation might lead to the formation of a variety of volatile and nonvolatile products, which continue to degrade (Frankel 1991). Peroxidation occurs most readily in fatty acids with more than one point of unsaturation.

Attempts have been made to identify archeological residues using criteria that discriminate uncooked foods (Loy 1994; Marchbanks 1989; Skibo 1992). Marchbanks's (1989) percent of saturated fatty acids (%S) criteria has been applied to residues from a variety of materials including pottery, stone tools, and burned rocks (Collins et al. 1990; Marchbanks 1989; Marchbanks and Quigg 1990). Skibo (1992:89) could not apply the %S technique and instead used two ratios of fatty acids, C18:0/C16:0 and C18:1/C16:0. He (1992) reported that it was possible to link the uncooked foods with residues extracted from modern cooking pots actively used to prepare one type of food; however, the ratios could not identify food mixtures. The utility of these ratios did not extend to residues extracted from archeological potsherds because the ratios of the major fatty acids in the residue changed with decomposition (Skibo 1992:97). Loy (1994) proposed the use of a Saturation Index (SI), determined by the ratio: SI = 1- [(C18:1+C18:2)/C12:0+C14:0+C16:0+C18:0)]. He (1994) admitted, however, that poorly understood decompositional changes to the original suite of fatty acids make it difficult to develop criteria for distinguishing animal and plant fatty acid profiles in archeological residues.

The major drawback of the distinguishing ratios proposed by Marchbanks (1989), Skibo (1992), and Loy (1994) is they have never been empirically tested. The proposed ratios are based on criteria that discriminate food classes on the basis of their original fatty acid composition. The resistance of these criteria to the effects of decompositional changes has not been demonstrated. Rather, Skibo (1992) found his fatty acid ratio criteria could not be used to identify highly decomposed archeological samples.

In order to identify a fatty acid ratio unaffected by degradation processes, Patrick et al. (1985) simulated the long-term decomposition of one sample and monitored the resulting changes. An experimental cooking residue of seal was prepared and degraded in order to identify a stable fatty acid ratio. Patrick et al. (1985) found that the ratio of two C18:1 isomers, oleic, and vaccenic, did not change with decomposition; this fatty acid ratio was then used to identify an archeological vessel residue as seal. While the fatty acid composition of uncooked foods must be known, Patrick et al. (1985) showed that the effects of cooking and decomposition over long periods of time on the fatty acids must also be understood.

Development of the Identification Criteria

As the first stage in developing the identification criteria used herein, the fatty acid compositions of more than 130 uncooked Native food plants and animals from western Canada were determined using gas chromatography (Malainey 1997; Malainey et al. 1999a). When the fatty acid compositions of modern food plants and animals were subject to cluster and principal component analyses, the resultant groupings generally corresponded to divisions that exist in nature

(Table 43). Clear differences in the fatty acid composition of large mammal fat, large herbivore meat, fish, plant roots, greens, and berries/seeds/nuts were detected, but the fatty acid composition of meat from medium-sized mammals resembles berries/seeds/nuts.

Samples in cluster A, the large mammal and fish cluster, had elevated levels of C16:0 and C18:1 (see Table 43). Divisions within this cluster stemmed from the very high level of C18:1 isomers in fat, high levels of C18:0 in bison and deer meat, and high levels of very long chain unsaturated fatty acids (VLCU) in fish. Differences in the fatty acid composition of plant roots, greens, and berries/seeds/nuts reflect the amounts of C18:2 and C18:3ω3 present. The berry, seed, nut, and small mammal meat samples appearing in cluster B have very high levels of C18:2, ranging from 35 to 64 percent (see Table 43). Samples in subclusters V, VI, and VII have levels of C18:1 isomers from 29 to 51 percent, as well. Plant roots, plant greens, and some berries appear in cluster C. All cluster C samples have moderately high levels of C18:2; except for the berries in subcluster XII, levels of C16:0 are also elevated. Higher levels of C18:3ω3 and/or very long chain saturated fatty acids (VLCS) are also common except in the roots that form subcluster XV.

Secondly, the effects of cooking and degradation over time on fatty acid compositions were examined. Originally, 19 modern residues of plants and animals from the plains, parkland, and forests of Western Canada were prepared by cooking samples of meats, fish, and plants, alone or combined, in replica vessels over an open fire (Malainey 1997; Malainey et al. 1999b). After 4 days at room temperature, the vessels were broken and a set of sherds analysed to determine changes after a short term of decomposition. A second set of sherds remained at room temperature for 80 days, then was placed in an oven at 75 °C for a period of 30 days in order to simulate the processes of long-term decomposition. The relative percentages were calculated on the basis of the 10 fatty acids (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1w9, C18:1w11, C18:2) that regularly appeared in Precontact period vessel residues from Western Canada. Observed changes in fatty acid composition of the experimental cooking residues enabled the development of a method for identifying the archeological residues (Table 44).

It was determined that levels of medium chain fatty acids (C12:0, C14:0, and C15:0), C18:0 and C18:1 isomers in the sample could be used to distinguish degraded experimental cooking residues (Malainey 1997; Malainey et al. 1999b). These fatty acids are suitable for the identification criteria because saturated fatty acids are stable and the mono-unsaturated fatty acid degrades very slowly, as compared to polyunsaturated fatty acids (deMan 1992). Higher levels of medium chain fatty acids, combined with low levels of C18:0 and C18:1 isomers, were detected in the decomposed experimental residues of plants, such as roots, greens, and most berries. High levels of C18:0 indicated the presence of large herbivores. Moderate levels of C18:1 isomers, with low levels of C18:0, indicated the presence of either fish or foods similar in composition to corn. High levels of C18:1 isomers with low levels of C18:0 were found in residues of beaver or foods of similar fatty acid composition. The criteria for identifying six types of residues were established experimentally;

Table 43. Summary of Average Fatty Acid Compositions of
Modern Food Groups Generated by Hierarchical Cluster Analysis

Cluster	**A**				**B**						**C**				
Subcluster	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**	**XV**
Type	Mammal Fat and Marrow	Large Herbivore Meat	Fish	Fish	Berries and Nuts	Mixed	Seeds and Berries	Roots	Seeds	Mixed	Greens	Berries	Roots	Greens	Roots
C16:0	19.90	19.39	16.07	14.10	3.75	12.06	7.48	19.98	7.52	10.33	18.71	3.47	22.68	24.19	18.71
C18:0	7.06	20.35	3.87	2.78	1.47	2.36	2.58	2.59	3.55	2.43	2.48	1.34	3.15	3.66	5.94
C18:1	56.77	35.79	18.28	31.96	51.14	35.29	29.12	6.55	10.02	15.62	5.03	14.95	12.12	4.05	3.34
C18:2	7.01	8.93	2.91	4.04	41.44	35.83	54.69	48.74	64.14	39.24	18.82	29.08	26.24	16.15	15.61
C18:3	0.68	2.61	4.39	3.83	1.05	3.66	1.51	7.24	5.49	19.77	35.08	39.75	9.64	17.88	3.42
VLCS	0.16	0.32	0.23	0.15	0.76	4.46	2.98	8.50	5.19	3.73	6.77	9.10	15.32	18.68	43.36
VLCU	0.77	4.29	39.92	24.11	0.25	2.70	1.00	2.23	0.99	2.65	1.13	0.95	2.06	0.72	1.10

VLCS- Very Long Chain (C20, C22 and C24) Saturated Fatty Acids

VLCU - Very Long Chain (C20, C22 and C24) Unsaturated Fatty Acids

Table 44. Criteria for the Identification of Archeological Residues Based on the Decomposition Patterns of Experimental Cooking Residues Prepared in Pottery Vessels

Identification	Medium Chain	C18:0	C18:1 isomers
Large herbivore	≤15%	≥27.5%	≤15%
Large herbivore with plant OR bone marrow	low	≥25%	15% ≤ x ≤25%
Plant with large herbivore	≥15%	≥25%	no data
Beaver	low	Low	≥ 25%
Fish or corn	low	≤25%	15% ≤ x ≤27.5%
Fish or corn with plant	≥15%	≤25%	15% ≤ x ≤27.5%
Plant (except corn)	≥10%	≤27.5%	≤15%

the seventh type, plant with large herbivore, was inferred (see Table 44). These criteria were applied to residues extracted from more than 200 pottery cooking vessels from 18 Western Canadian sites (Malainey 1997; Malainey et al. 1999c; Malainey, Przybylski, and Sherriff 2001). The identifications were found to be consistent with the evidence from faunal and tool assemblages for each site.

Work has continued to understand the decomposition patterns of various foods and food combinations (Malainey et al. 2000a, 2000b, 2000c; Malainey, Malisza et al. 2001; Quigg et al. 2001). The collection of modern foods has expanded to include plants from the Southern Plains. The fatty acid compositions of mesquite beans (*Prosopis glandulosa*), Texas ebony seeds (*Pithecellobium ebano Berlandier*), tasajillo berry (*Opuntia leptocaulis*), prickly pear fruit and pads (*Opuntia engelmannii*), Spanish dagger pods (*Yucca treculeana*), cooked sotol (*Dasylirion wheeler*), agave (*Agave lechuguilla*), cholla (*Opuntia imbricata*), piñon (*Pinus edulis*), and Texas mountain laurel (or mescal) seed (*Sophora secundiflora*) have been determined. Experimental residues of many of these plants, alone or in combination with deer meat, have been prepared by boiling foods in clay cylinders or using sandstone for either stone boiling (Quigg et al. 2000) or as a griddle. In order to accelerate the processes of oxidative degradation that naturally occur at a slow rate with the passage of time, the rock or clay tile containing the experimental residue was placed in an oven at 75 °C. After either 30 or 68 days, residues were extracted and analysed using gas chromatography.

The results of these decomposition studies enabled refinement of the identification criteria.

METHODS

Descriptions of the samples are presented in Table 45. Possible contaminants were removed by grinding off exterior surfaces with a Dremel® tool fitted with a silicon carbide bit. Immediately thereafter, the sample was crushed with a hammer mortar and pestle and the powder transferred to an Erlenmeyer flask. Lipids were extracted using a variation of the method developed by Folch et al. (1957). The powdered sample was mixed with a 2:1 mixture, by volume, of chloroform and methanol (2 x 30 milliliters [mL]) using ultrasonication (2 x 10 minutes). Solids were removed by filtering the solvent mixture into a separatory funnel. The lipid/solvent filtrate was washed with 16 mL of ultrapure water. Once separation into two phases was complete, the lower chloroform-lipid phase was transferred to a round-bottomed flask and the chloroform removed by rotary evaporation. Any remaining water was removed by evaporation with benzene (1.5 mL); 1.5 mL of chloroform-methanol (2:1, v/v) was used to transfer the dry total lipid extract to a screw-top glass vial with a Teflon®-lined cap. The sample was flushed with nitrogen and stored in a –20 °C freezer.

Table 45. List of Fire-cracked Rock Samples Analyzed

Lab No.	Feature	FS No.	Provenience	Sample Size (g)
8PB 5	Earth Oven	480	Level 6, N114 E93	31.317
8PB 6	Hearth Stone	611	Feature 8, Depth 59 cmbd	35.097
8PB 7	Earth Oven	481	Level 6, N114 E93	32.090
8PB 8	Hearth Stone	612	Feature 8, Depth 59 cmbd	36.985
8PB 9	Earth Oven	465	Level 5, N114 E93	36.665

A 450-microliter (μL) sample of the total lipid extract solution was placed in a screw-top test tube and dried in a heating block under nitrogen. Fatty acid methyl esters (FAMES) were prepared by treating the dry lipid with 6 mL of 0.5 N anhydrous hydrochloric acid in methanol (68 °C; 60 minutes). Fatty acids that occur in the sample as di- or triglycerides are detached from the glycerol molecule and converted to methyl esters. After cooling to room temperature, 4 mL of ultrapure water was added. FAMES were recovered with petroleum ether (3 mL) and transferred to a vial. The solvent was removed by heat under a gentle stream of nitrogen; the FAMES were dissolved in 75 μL of *iso*-octane then transferred to a GC vial with a conical glass insert.

Solvents and chemicals were checked for purity by running a sample blank. The entire lipid extraction and methyl esterification process was performed, and FAMES were dissolved in 75 μL of *iso*-octane. Traces of contamination were subtracted from sample chromatograms. The relative percentage composition was calculated by dividing the integrated peak area of each fatty acid by the total area of fatty acids present in the sample.

The step in the extraction procedure where the chloroform, methanol, and lipid mixture is washed with water is standard procedure for the extraction of lipids from modern samples. Following Evershed et al. (1990), who reported that this step was unnecessary for the analysis of archeological residues, previously the solvent-lipid mixture was not washed. This step was recently adopted to remove impurities so that clearer chromatograms could be obtained in the region where very long chain fatty acids (C20:0, C20:1, C22:0, and C24:0) occur. It was anticipated that the detection and accurate assessment of these fatty acids could be instrumental in separating residues of animal origin from those of plant (Malainey et al. 2000a, 2000b, 2000c; Malainey, Malisza et al. 2001).

In order to identify the residue, the relative percentage composition was determined first with respect to all fatty acids present in the sample (including very long chain fatty acids) (see Table 44) and secondly with respect to the 10 fatty acids utilized in the development of the identification criteria (C12:0, C14:0, C15:0, C16:0, C16:1, C17:0, C18:0, C18:1w9, C18:1w11, and C18:2) (not shown). The second step is necessary for the application of the identification criteria presented in Table 44.

It must be understood that the identifications given do not necessarily mean that those particular foods were actually prepared because different foods of similar fatty acid composition and lipid content would produce similar residues. It is possible only to say that the material of origin for the residue was similar in composition to the food(s) indicated.

Gas Chromatography Analysis Parameters

The gas chromatography analysis was performed on a Varian 3800 gas chromatograph fitted with a flame ionization detector connected to a personal computer. Samples were separated using a DB-23 fused silica capillary column (30 m x 0.25 mm I.D.; J&W Scientific; Folsom, California). An autosampler injected a 1-μL sample using a split/splitless injection system. Hydrogen was used as the carrier gas with a column flow of 1.6 mL/minute. Column temperature was programmed from 140 to 230 °C at 4 °C per minute. The lower temperature was held for 2 minutes; the upper temperature was held for 10 minutes. Chromatogram peaks were integrated using Varian MS Workstation® software and identified through comparisons with external qualitative standards (NuCheck Prep; Elysian, Minnesota).

RESULTS OF ARCHEOLOGICAL DATA ANALYSIS

Sufficient fatty acids were recovered from three of the five residues; their fatty acid compositions are presented in Table 46. The term, Area, represents the area under the chromatographic peak of a given fatty acid, as calculated by the Varian MS Workstation® software minus the solvent blank. The term, Rel%, represents the relative percentage of the fatty acid with respect to the total fatty acids in the sample. Insufficient lipids were present in residues 8PB 5 and 8PB 7, both from earth ovens, to attempt identification.

The level of C18:1 isomers in residues 8PB 6 and 8PB 8, were extremely high, 66.27 and 75.34 percent, respectively. Similar levels are observed in the decomposed residues of foods of very high fat content seeds or nuts, such as piñon. Rendered fats of certain mammals (other than large herbivores) also exhibit very high levels of C18:1 isomers, but only when fresh. Given the extremely low levels of C18:0 in these residues, both are probably of plant origin. The fire-cracked rock sample from which residue 8PB 8 was extracted contained a nodule of hematite/red ochre, which is particularly interesting. Lipids were extracted from the rock shell, which surrounded the nodule, not the hematite.

Table 46. Lipid Composition and Identification of Residues

	8PB 6		8PB 8		8PB 9	
Fatty Acid	Area	Rel %	Area	Rel %	Area	Rel %
C12:0	42871	2.26	46743	1.92	58956	7.97
C14:0	49370	2.60	101292	4.16	73620	9.95
C14:1	9976	0.52	30606	1.26	23825	3.22
C15:0	17075	0.90	33374	1.37	32505	4.39
C16:0	228509	12.02	439762	18.07	357246	48.30
C16:1	50480	2.66	48310	1.99	28207	3.81
C17:0	6051	0.32	51147	2.10	7915	1.07
C17:1	10941	0.58	1099	0.05	7239	0.98
C18:0	18219	0.96	0	0.00	0	0.00
C18:1s	1432045	75.34	1612920	66.27	123343	16.67
C18:2	20707	1.09	52638	2.16	14804	2.00
C18:3w3	3232	0.17	5761	0.24	6817	0.92
C20:0	2739	0.14	3037	0.12	444	0.06
C20:1	6329	0.33	7020	0.29	3638	0.49
C24:0	2118	0.11	9	0.00	1154	0.16
Total	1900662	100.00	2433718	100.00	739713	100.00
Identification	Extremely high fat content nuts and seeds		Extremely high fat content nuts and seeds		Medium Fat Content Plant OR Medium Fat Content food with Low Fat Content Plant	

Residue 8PB 9 is characterized by C18:1 isomer levels of 16.67 percent, which is consistent with the preparation of medium fat content foods, such as corn, cholla, and mesquite beans. Decomposed freshwater fish residues are also similar, but levels of C14:0, and sometimes C16:1, tend to be much higher. Fat-depleted late winter elk can also produce medium fat content decomposed cooking residues. Levels of medium chain fatty acids are quite high in residue 8PB 9, which is due to the presence of plant material. The decomposed residues of some medium fat content plant foods have high levels of medium chain fatty acids. Consequently, residue 8PB 9 may arise from either the preparation of medium fat content plant material or from a combination of a medium fat content food (plant or animal) and low fat content plant. Low fat content plants include most greens, roots, and certain berries; however, the decomposed cooking residue of camel's milk is high in the medium chain fatty acid, C14:0, as well.

High-temperature gas chromatography and high-temperature gas chromatography with mass spectrometry may confirm or clarify the origins of these residues. The presence of the sterol, cholesterol, would indicate the presence of animal products; whereas stigmasterol and β-sitosterol would indicate the presence of plant material.

13

SPECIAL GEOMORPHOLOGICAL STUDIES

by Robert Rogers and Charles Frederick, Ph.D.

SOIL MICROMORPHOLOGY

Micromorphological analysis was performed on five soil samples from three proveniences at 41CW104. The purpose of this analysis was to provide a detailed characterization of the sediments across the site. Five soil blocks were examined from three proveniences at the site: three from Unit 20 and one each from Unit 30 and Trench 2. Units 20 and 30 were in or adjacent to the floodplain of the West Fork of Plum Creek, while Trench two was upslope on a Quaternary Terrace. Samples were examined of the A horizon, the paleosol or 2Ab horizon, and the 2Bt horizon.

The soil samples were taken as 6-x-6-inch blocks, which were cut and removed from the unit or trench wall using a trowel. Each block was wrapped in tissue paper and covered with postal tape. The provenience of each block was recorded, as was its orientation. The blocks were sent to Spectrum Petrographics for impregnating with epoxy and thin sectioning.

The samples were examined using an Olympus BH-2 polarizing microscope. The following descriptions are provided for the samples from each of the site. The descriptions utilize nomenclature outlined in Bullock et al. (1985).

Sample 1A, Unit 20, A Horizon: This is a sample of the A Horizon and contains moderately sorted sands composed primarily of monocrystalline quartz (80 percent), with lesser amounts of chert (15 percent), and opaque material, which may include Fe-rich minerals and organics. Grains are subround to subangular. Measurable sand ranges from 0.07 to 0.60 mm, with the mean grain size being at the upper end of fine sand (0.247 mm). Finer materials (groundmass) appear yellowish brown in Plane Polarized Light (PPL). Microstructure is characterized by single grains and simple packing voids. The relationship between the coarse and fine particles (c/f distribution) is classified as Enaulic and is characterized by a skeleton of larger fabric units (sands) with silts and clays in the interstitial spaces. The c/f ratio is estimated at 85:15.

Sample 1B, Unit 20, 2Ab Horizon: This sample from the 2Ab horizon contains moderately sorted sands composed primarily of monocrystalline quartz (85 percent), with lesser amounts of chert (10 percent), and opaque material, which may include Fe-rich minerals and organics. Groundmass appears yellowish brown in PPL. Grains are subround to subangular. Measurable sand ranges from

0.08 to 0.67 mm, with the mean grain size being 0.262 mm (medium sand). Microstructure is characterized by single and weakly bridged grains and simple packing voids. The c/f distribution is Enaulic. There is a very slight increase in fine material over that of the A horizon, and the c/f ratio is estimated at 80:20. A few fragments of the underlying Bt horizon were seen in the sample, possibly displaced upwards by postdepositional disturbance (Figure 107).

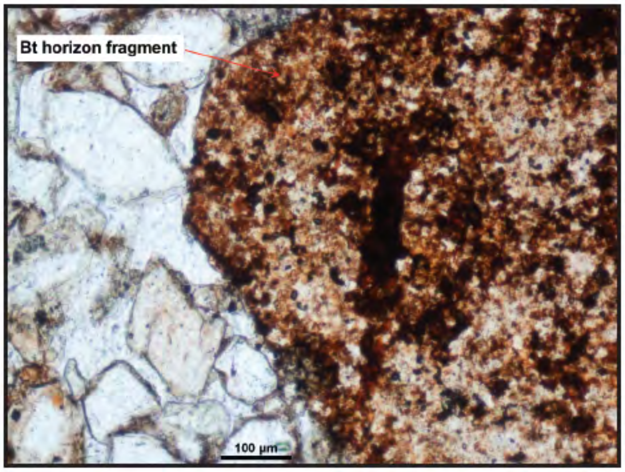
Samples 2A and 2B, Unit 20, Bt Horizon: These samples from the Bt horizon contain moderately sorted sands composed primarily of monocrystalline quartz (85 percent), with lesser amounts of chert (10 percent), and opaque material, which may include Fe-rich minerals and organics (see Figure 107). There is a trace of feldspar and polycrystalline quartz. Groundmass appears reddish brown. Measurable grains are subround to subangular and range from 0.09 to 0.55 mm, with the mean grain size being 0.250 mm (medium sand). Microstructure is characterized by bridged grains and simple packing voids. The amount of silt and clay has increased substantially as a result of illuviation, and the c/f ratio is estimated at 60:40. The c/f distribution is Enaulic.

Sample 3A, Unit 30, 2Ab Horizon: This sample from the Ab horizon contains moderately sorted sands composed primarily of monocrystalline quartz (85 percent), with lesser amounts of chert (10 percent), and opaque material, which may include Fe-rich minerals and organics (see Figure 107). There are traces of feldspar and polycrystalline quartz. Groundmass appears yellowish brown. Measurable sand ranges from 0.09 to 0.63 mm, with the mean grain size being 0.286 mm (medium sand). Grains are subround to subangular. Microstructure is characterized by single grains and simple packing voids. The c/f distribution is weakly Enaulic, and the c/f ratio is estimated at 80:20.

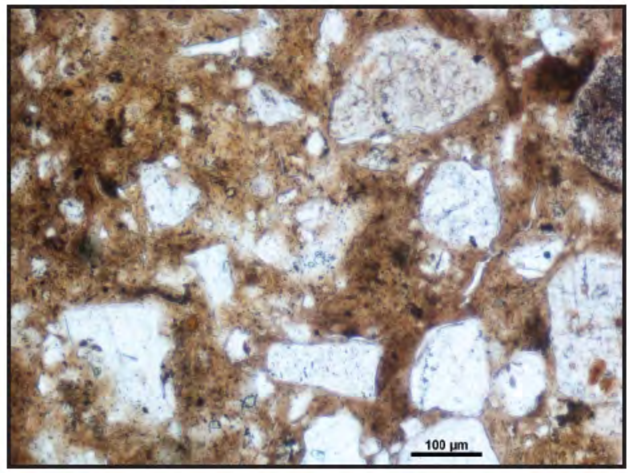
Sample 7A, Trench 2, A Horizon: This sample from the A horizon contains moderately sorted sands composed primarily of monocrystalline quartz (85 percent), with lesser amounts of chert (10 percent), and opaque material, which may include Fe-rich minerals and organics, including modern spores. Groundmass appears yellowish brown. Measurable sand ranges from 0.09 to 0.75 mm, with the mean grain size being 0.307 mm (medium sand). Grains are subround to subangular. Microstructure is characterized by single grains and simple packing voids. The c/f distribution is weakly Enaulic, and the c/f ratio is estimated at 70:30 (see Figure 107).

Discussion

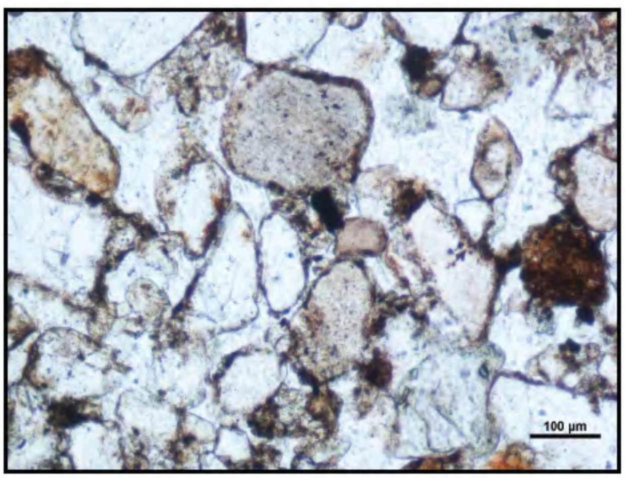
The samples examined from the three proveniences at the site exhibit very similar micromorphological characteristics. The mineral suites are all dominated by microcrystalline quartz, with lesser amounts of chert, and opaque material. Modern spores were observed in the A horizon sample from Trench 2. The mean grain size of all measurable grains was within the medium sand size, and grains were subround to subangular. Microstructure is characterized by single grain and weakly bridged grains, and voids are of the simple packing type. The c/f distribution in all samples is Enaulic, and the c/f ratio ranged from a high of 90:10 to 60:40.



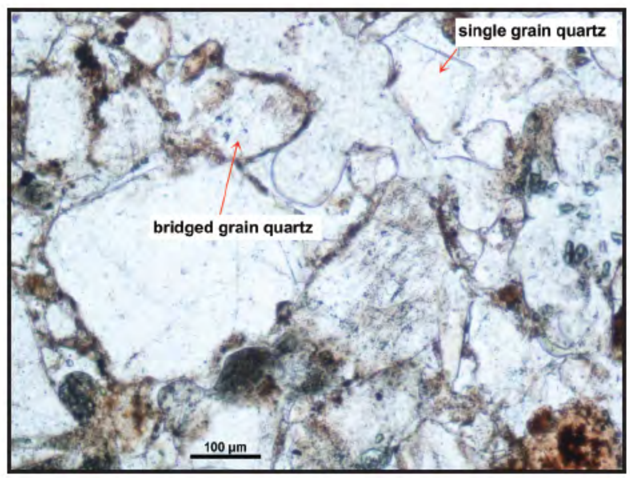
Sample 1B
Unit 20, 2Ab Horizon



Sample 2B
Unit 20, Bt Horizon



Sample 3A
Unit 30, 2Ab Horizon



Sample 7A
Trench 2, A Horizon
10-25 cmbs

ATKINS

Figure 107

41CW104
Micromorphology Samples

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Drafted by: C. Wallace

The only differences in any of the samples can be attributed to pedogenisis and includes a change in groundmass color from yellowish-brown in the A and 2Ab horizons to reddish-brown, and an increase of silts and clays in the 2Bt horizon.

PARTICLE SIZE ANALYSIS AND MAGNETIC SUSCEPTIBILITY

Three strata were observed within the excavations: (1) an A horizon, (2) a 2Ab or buried A horizon or paleosol, and (3) a 2Bw horizon. In 2007 a suite of magnetic susceptibility samples were examined from several excavation units (Table 47). A third profile from excavation unit 10 was examined in 2012 for particle size, magnetic susceptibility, and loss-on-ignition. Magnetic susceptibility was determined on a Bartington MS2 meter with a MS2b sensor, and the results are reported as the low-frequency mass-corrected magnetic susceptibility (X_{lf}) and the coefficient of frequency dependence (X_{fd}). Texture was determined on a Beckman-Coulter LS 13-320 laser particle size analyzer and all samples were pretreated with concentrated hydrogen peroxide in order to remove organic matter, and dispersed with a 5 percent solution of sodium hexametaphosphate. Loss-on-ignition was performed in a muffle furnace at temperatures of 450 °C after drying overnight at 100 °C.

In all of the samples the A horizon exhibits low-frequency magnetic susceptibility values equal to or in excess of the underlying buried A horizon, although the loss on ignition values as well as visual examination of the profile indicate that the paleosol most likely contains more organic matter. The Unit 10 profile, sampled for particle size analysis, was submitted from samples retrieved at 10-cm intervals. This appears to have obscured some of the variation present within the buried A horizon. Comparison of the low-frequency mass-corrected magnetic susceptibility (X_{lf}) shows the gentle curve of the more widely spaced sample from Unit 10 versus the significant yet subtle variation in magnetic susceptibility shown by the profiles that were sampled at more-closely spaced intervals. In particular, of the latter, Unit 37 shows a peak in the A horizon near the modern surface, and a second, broader peak in the middle of the paleosol, and then a dramatic decline below that. The profile from Unit 20, on the other hand, shows two peaks in the paleosol, one near the top at 25 cm, and a second in the middle of the zone around 45 cm. The latter peak correlates with a similar peak in TAR. In the profile for Unit 37 there are peaks in the 2Ab horizon in Levels 5 and 8. In Unit 41 there is a peak at the boundary of the A and 2Ab horizons. The large peak in the 2E horizon in the profile for Unit 42 is most likely the product of pedogenesis.

The particle size analysis collected from sediments in Unit 10 shows that the deposits fine upward slightly from the base of the excavation to the modern ground surface, but in general shows very little variation, with all of the samples assayed classifying as loamy sands (Table 48). The trend in mean particle size shows this nicely with values around 3 phi in the 2Bw horizon near the base of the excavation (fine sand) and ending around 2.6 phi (medium to fine sand) at the top of the profile.

Table 47. Magnetic Susceptibility Data, Units 20, 33, 37, 41, and 42

Unit	Sample	Xlf	Depth (cmbs)	Depth (cmbd)	Excavation Level	Thermally Altered Rock (g)	Debitage	Horizon
20	1	36.6	2	37	1	507.6	23	A
	2	29.3	10	45	1			A
	3	30.5	16	51	2	569.9	25	A
	4	30.7	20	55	3	424.8	37	A/2Ab
	5	30.2	24	59	3			2Ab
	6	29.9	30	65	4	517.7	23	2Ab
	7	29.0	36	71	4			2Ab
	8	30.9	44	79	5	1186.6	30	2Ab
	9	29.4	50	85	6	276.5	15	2Ab
	10	24.7	56	91	6			2Bw
	11	22.3	60	95	7	277	9	2Bw
	12	13.7	68	103	7			2Bw
	13	12.4	74	109	8	135.4	11	2Bw
33	1	32.0	14	50	1	477.4	79	A
	2	29.1	20	56	2	565.9	118	A
	3	29.3	24	60	3	516	96	A
	4	29.9	30	66	3			A
	5	30.3	34	70	4	270.1	49	A
	6	36.2	40	76	4			A
	7	29.5	44	80	5	281.7	71	A
	8	29.2	50	86	5			2Ab
	9	42.0	54	90	6	204	30	2Ab
	10	31.2	62	98	6			2Ab
	11	30.1	66	102	7	668.3	32	2Ab
	12	32.7	72	108	7			2Ab
	13	27.6	76	112	8	289.6	27	2Ab
	14	27.8	82	118	8			2Ab
	15	26.0	86	122	8			2Ab
37	1	30.3	8	51	1	257.5	25	A
	2	29.2	16	59	2	783.9	64	A
	3	31.0	22	65	3	484.1	62	A
	4	35.9	26	69	3			A/2Ab
	5	33.7	32	75	4	458.5	33	2Ab
	6	29.3	36	79	4			2Ab
	7	29.6	42	85	5	139.1	31	2Ab

Table 47 (Cont'd)

Unit	Sample	Xlf	Depth (cmbs)	Depth (cmbd)	Excavation Level	Thermally Altered Rock (g)	Debitage	Horizon
	8	34.4	46	89	5			2Ab
	9	28.4	52	95	6	378.5	41	2Ab
	10	27.9	56	99	6			2Ab
	11	28.9	62	105	7	402.7	32	2Ab
	12	27.8	66	109	7			2Ab
	13	32.7	72	115	8			2Ab
	14	22.5	76	119	8	200.1	22	2Ab/2Bw
	15	19.0	82	125	8			2Bw
41	1	40.7	6	47	1	180.8	26	A
	2	27.7	12	53	2	423.2	43	A
	3	27.8	18	59	2			A
	4	28.9	24	65	3	455.4	25	A
	5	49.1	30	71	3			A/2Ab
	6	30.4	34	75	4	252.7	35	2Ab
	7	28.6	42	83	5	374.3	42	2Ab
	8	29.2	46	87	5			2Ab
	9	30.6	52	93	6			2Ab
	10	27.6	56	97	6	272.5	24	2Ab
	11	28.8	60	101	6			2Ab
	12	29.0	64	105	7	625.2	30	2Ab
	13	28.2	68	109	7			2Ab
	14	25.0	72	113	8			2Ab
	15	25.2	76	117	8	696.2	27	2Ab
	16	21.9	80	121	8			2Ab
	17	22.4	84	125	9	166.9	11	2Ab
42	1	29.8	10	46	1	180.8	26	A
	2	32.6	20	56	2	423.2	43	A
	3	30.6	30	66	3	455.4	25	2A/Ab
	4	31.7	40	76	4	252.7	35	2Ab
	5	29.0	50	86	5	374.3	42	2Ab
	6	21.2	60	96	6	272.5	24	2Ab
	7	72.0	70	106	7	(not dug)		2E
	8	12.4	80	116	8	(not dug)		2Bw

Table 48. Particle Size Data, 41CW104

Stratum	Sample	Horizon	Depth (cmbs)	Plot Depth (cm)	Sand (%)	Silt (%)	Clay (%)	Mean (phi)	Median (phi)	Sorting (phi)	Skewness (phi)	Kurtosis (phi)	Xlf ($10^{-8} m^3 kg^{-1}$)	Xfd (%)	Loss-on-Ignition (%)
I	Level 3	A	20-30	25	86.4	10.16	3.44	2.62	2.49	1.57	0.31	2.07	29.8	5.4	0.48
I	Level 5	A	30-35	32.5	85.9	10.33	3.77	2.61	2.42	1.59	0.43	2.16	31.9	5.7	0.52
II	Level 6	2Ab	40-45	42.5	84.4	11.86	3.74	2.67	2.43	1.65	0.45	2.07	29.6	5.0	0.73
II	Level 7	2Ab	53-58	55.5	82.5	13.48	4.02	2.79	2.49	1.71	0.49	1.98	26.7	3.9	0.65
II	Level 8	2Ab	60-65	62.5	84.4	11.8	3.8	2.66	2.41	1.63	0.46	2.04	24.8	2.3	0.53
III	Level 9	2Bt	70-75	72.5	81.4	14.11	4.49	2.79	2.46	1.83	0.50	1.97	19.5	3.3	0.33
III	Level 10	2Bt	80-88	84.5	79.1	15.61	5.29	2.95	2.54	2.01	0.50	1.96	18.4	1.5	0.33

All particle size was U.S. Department of Agriculture Textural Class = loamy sand

There is no clear change in particle size from the paleosol to the overlying A horizon, which suggests that this was most likely a change in sedimentation rate with more-rapid deposition characterizing the A horizon, and slower sedimentation associated with the paleosol.

14

SUBSISTENCE AT THE SANTA MARIA CREEK SITE: THERMALLY ALTERED ROCK REPLICATION EXPERIMENTS

by Robert Rogers

INTRODUCTION

The large amount of TAR and the simple hearth features at 41CW104 invited research into assessing the food preparation practices of the aboriginal occupants at the site. While some dietary evidence was recovered from the excavations, it was limited to a relatively meager faunal assemblage and even sparser macrobotanical remains. An analysis of fatty acids taken from TAR suggests that plants played an important role in subsistence at the site, but this evidence offers no insight into the actual cooking methods that were employed.

Siliceous lag gravels deposited by ancient fluvial systems occur in abundance in the upland terraces surrounding 41CW104. While these deposits would have supplied a readily available source of material for chipped and ground stone tools, they are primarily represented at the site as TAR. Indeed, TAR was found in every excavation unit. This material is composed of stream-rolled cobbles of chert, lesser amounts of quartzite, and occasional fragments of silicified wood, sandstone, or igneous rocks. With the exception of complete rocks found within the simple hearths, all of the TAR at the site was fragmented.

This chapter presents the results of efforts to ascertain the cooking methods utilized at the site through a series of experiments utilizing three cooking methods: stone boiling, rock ovens, and simple hearths. The experiments attempted to replicate breakage patterns and other characteristics found on the TAR at the site, using stones collected from the site vicinity.

Similar replication experiments have been conducted in the past using limestone, sandstone, igneous rocks, and metamorphic rocks. An overview of this research is provided below. The experiments undertaken for the current study that follow represent a continuation of this research, utilizing siliceous rocks not usually associated with hot rock cooking.

BACKGROUND STUDIES

Burned rock as an artifact type has, until recent decades, received relatively little attention in the archeological literature for North America. However, as will be seen, a number of researchers have performed experiments that have shed new light on interpreting the various uses of burned rocks by prehistoric peoples. These studies have focused primarily on fracture mechanics, the effects of fire on rock properties, and how rocks fracture from exposure to fire.

Schalk and Meatte (1988) described the various forms of thermal stresses that rocks undergo during heating. These stresses are typically associated with differential rates of expansion of the minerals within a rock and the rock itself. Wyatt (1994) termed these stresses “thermal fatigue,” which mainly were caused by the differential expansion of adjacent grains that have dissimilar coefficients of thermal expansion. These differences in the coefficient of thermal expansion cause tensile stresses along grain boundaries and can often lead to microfractures at those locations. This process occurs gradually and is not dependent on the rate of temperature change.

Thermal shock refers to the differential expansion a rock undergoes from rapid changes in temperature, whether from heating or cooling. Factors that can affect the response of a rock to thermal shock include composition, shape, size, type of heating and cooling, and the magnitude of the temperature differential. When heated, the exterior of a rock expands faster than does the center, while the exterior contracts faster during cooling. When water is converted to steam, it is accompanied by large increases in volume. Because of this expansion, heating saturated rocks can result in the rock fragmenting by exploding if the water within it cannot vaporize. This form of rock failure is known as rock expansion.

Lucas and Frederick (1998) noted that the observations regarding rock responses to temperature occur when chemical changes result in variations in color and mineralogy, and physical changes influence the mechanical integrity of the rock. Color is a characteristic that has proven difficult to quantify and is generally thought to be a chemical process. Studies have been made of the discoloration of various lithologies. Pagoulatos (1992) found that the reuse of granite cobbles for stone boiling resulted in discoloration that changed with increasing use from black to red hues. Studies using central Texas limestone and caliche have also been performed with varying degrees of success (Bearden and Gallagher 1980; Collins 1994; Lintz 1989). These studies have resulted in observations that are founded more upon intuition that empirical evidence. As mentioned, no studies have been performed on the effects of heat on the discoloration of chert in regard to its use as thermal elements in cooking features, though research, both experimental and ethnographic, has been conducted documenting the effects of thermal alteration of chert in regard to heat treatment associated with knapping (Hester 1972:63; Hester and Collins 1974:222).

The importance of how a rock breaks, or the mechanical failure or fracture of rocks exposed to heat, has been widely noted, as evidence by the term “fire-cracked rock” often cited in the archeological literature. While other fields, including geology and engineering, have noted that a relationship exists between fire and rock fracture, it is only recently that the subject has entered the archeological literature. There are several mechanical responses of rocks to fire, including spalling, crumbling, explosions, cleaving, and potlidding. Spalling occurs when the surface of a rock is rapidly heated. This could happen naturally from forest fires (Bierman and Gillespie 1991) or in a setting such as a hearth. Spall fractures feather outward to meet the rock surface, resulting in acute edge angles on the newly created rock fragment. Crumbling, also known as granular disintegration, is the reduction in strength a rock undergoes from heating (Craddock 1992). Angular fragments form from concentric and radial cracks that occur from thermal shock; the fragments are generally larger than those produced by spalling (Ollier and Ash 1984).

Explosions of rocks are often witnessed by archeologists conducting aboriginal stone-cooking experiments, especially when crystalline rocks are used. It is likely, given that chert and quartzite were the most commonly utilized rock types at 41CW104, that such rock explosions often occurred at the site. Cleaving or vertical fracturing occurs when a rock undergoes a thermal shock. It was first described by Ollier and Ash (1984) who witnessed the effects of natural fires on granodiorite rocks in Australia. A clean break through the entire rock characterizes this mechanical response. Potlids leave circular-shaped, concave depressions and produce fragments that are typically circular in plan and plano-convex in cross section. They are most commonly associated with fine-grained rocks.

Contraction-cracked rocks are believed by some researchers to be the result of quenching of heated rocks and are associated with stone boiling (Schalk and Meatte 1988; Thoms 1989). The resultant fragments have been described as angular and blocky as opposed to curvilinear fractures or potlids from rocks that have either been cooled gradually or heated rapidly. Tarr (1915) quenched granite cubes that had been heated in a muffle furnace to 500 to 750 °C; the rapid cooling of the cubes in water caused minute cracks to develop on the surface of the cube. The stress cracks at the edge of the rock are different from those associated with heating, suggesting that stone boiling does indeed leave a fingerprint.

In early 1996 as part of the investigations at the Higgins site (41BX184) in Bexar County, Texas, Jason Lucas and Charles Frederick began a series of experiments that were intended to replicate breakage patterns on burned limestone rocks (Lucas and Frederick 1998). The primary hypothesis of the experiment was that posited by Thoms (1989) and Schalk and Meatte (1988) that rocks fragmented during use in rock ovens are distinguishable from rocks used as boiling stones on the basis of their shape, fracture angles, or other physical properties. In particular, the research was directed at learning if the cracks that form in a rock from thermal fatigue significantly decrease the performance of the rock as a heat-transfer device, and thus account for the vast amount of discarded burned rocks that occurs at prehistoric sites throughout Texas. The rock type chosen for the experiments was limestone, as this is the material found at the Higgins site. The specimens used in the experiments were primarily Edwards Limestone cobbles collected from along Salado Creek in Bexar County.

Six earth ovens were constructed. Each oven consisted of a layer of hot limestone cobbles upon which was placed a layer of packing material (prickly pear pads or grass) and food. All of this was covered with a layer of the earth removed when the pit was dug. The temperatures at the base of the oven and in the earthen cap were measured using a digital thermometer and thermocouples. After the ovens were opened and cooled, the rocks were examined for evidence of mechanical failure, discoloration, and other signs of thermal alteration. Twenty rocks were chosen for the experiments and reused in each oven. There were differences in the way the ovens were constructed, but the equilibrium cooking temperature (about 100 °C) in all of the ovens was similar. After the initial oven, 65 percent of the rocks had cracked or spalled, and by the end of the sixth oven, 6 of the 20 rocks had fragmented, and almost all of them had cracked or spalled.

Lucas and Frederick (1998) also conducted a stone boiling program using limestone cobbles. The program had two goals: the main goal was to generate a population of rocks broken by use as boiling stones for comparisons with archeological samples. A secondary goal was to determine the heat exchange between the stone and the fluid medium to ascertain the ability of rocks to absorb heat after multiple uses. This was accomplished by heating several stones of known mass in a fire and measuring the temperature using a thermocouple. Later the experiment was conducted using a muffle furnace, which provided a more controlled environment. After heating, the stones were added to a known volume of water (3 liters), and the temperature of the water was measured over time until it began to decrease. The resulting values were used in a mathematical formula to calculate the specific heat of the cobble. The average specific heat for all boiling stones was 827 Joules per gram-Kelvin. For each stone, this value decreased for each iteration, indicating a decrease in the ability of the stones to absorb heat (Lucas and Frederick 1998:174).

The replication experiments of Lucas and Frederick (1998) produced data regarding the morphology of the heated stones and to test the aforementioned hypothesis that stone boiling and rock ovens result in rock fragments that are visibly distinctive. Both internal and external fracture angles and rock shape were noted, as were differences in fracture morphology and fractography. When the fracture angles of both stone boiling and pit oven rocks were compared, it was apparent that there is considerable overlap. The pit oven rocks exhibited a slightly wider range of fracture angles, and there was little variation between the interior and exterior fracture angles except for a slightly greater proportion of obtuse (115- to 150-degree range) interior angles. The stone boiling rocks had exterior angles that clustered around 90 degrees, while the interior fracture angles were similar to those of the pit oven rocks. The authors noted that while this suggests that stone boiling rocks might be characterized by a narrow distribution of exterior fractures around 90 degrees, the degree of overlap between the two groups indicates that it would be difficult to distinguish between the two stone boiling and rock ovens based on fracture angles alone (Lucas and Frederick 1998:175).

Similar results were obtained when rock shape was considered. Rock shape is categorized by ratios of the lengths of the three axes of a given fragment: long, intermediate, and short. As with the interior and exterior angles, there is a considerable amount of overlap in rock shape created by stone boiling and earth ovens. The overlap in fracture angles and morphology likely reflects the fact that the two uses share partial thermal histories as both involve sudden or gradual heating in a hearth. Thus, the initial, or first-cycle, heating that occurs in a hearth can be responsible for many cracks reflected in the overlap in the morphology of stone boiling and earth oven rocks (Lucas and Frederick 1998:183).

Citing that while the conclusions of their study should be considered tentative because of the small sample size and limited rock type (limestone), the most notable difference found between stone boiling rocks and those used in earth ovens was in the morphology of the fracture patterns. Stone boiling rocks were found to often have jagged or serrated edges adjacent to the exterior of the rock. While not present on all stone boiling rocks, the patterns occurred on an average of 65 percent of the rocks. This characteristic was absent from the earth oven rocks. The authors note that this difference is one of fracture morphology (fractography) rather than fragment shape or fracture angle. Rock failure associated with both methods was slow, with total failure of rocks used for stone boiling requiring between 7 and 16 iterations. Of the rocks used in earth ovens, 30 percent failed sufficiently to necessitate replacement after six iterations.

Jackson (1998) conducted a series of ethnoarcheological replication experiments to assess the geothermodynamics of the production of TAR. He utilized low-power microscopy and thin-section examination of heated and unheated specimens of igneous (gabbro, basalt, and granite) and sedimentary (quartzose sandstone, agate, sandstone, and limestone) rocks. Rocks were heated in a small electric furnace and cooled by one of four methods to replicate stone boiling, sweatbath, rock griddle, and earth oven facilities. The results of the experiments indicated that heated rocks of all examined types notably changed color and developed an increase in the amount of microscopic cracking. The experiments also found that rock characteristics most important to the control of thermal weathering include (1) strength of the grain/crystal bond, (2) porosity, (3) mineralogy, (4) presence and magnitude of discontinuities, and (5) grain/crystal size.

THE TAR ASSEMBLAGE AT 41CW104

TAR at 41CW104 is the most abundant artifact type recovered during the excavations there. It was ubiquitous, being found in every level of every excavation unit, and totaled over 145 kg. Of this total, about 25 kg composed the simple hearth features described earlier in this report. The remaining 120 kg of TAR occurred as fragments recovered in the forty 1-x-1-m units contained in the primary excavation block (Block 1), and it is this large assemblage of TAR that is the subject of most of the replication experiments presented in this chapter. Within this large area, the TAR found in four adjoining excavation units (Units 25, 29, 31, and 33) was initially chosen for examination. These units were selected because, in addition to relatively large amounts of TAR, they also contained relatively high concentrations of wood charcoal. This combination of TAR and charcoal suggests that this part of the site saw some of the more intensive activities related to food preparation, and the TAR within these units might possess evidence as to the type(s) of cooking techniques practiced there.

The analysis of the TAR from these four excavation units focused on examining those rock specimens large enough to determine the approximate size of the rock prior to its use in stone boiling or earth ovens. This was accomplished by processing the TAR from each excavation level within the units through nested sieves. Only those fragments larger than ½ inch that retained a sufficient percentage of the original rock were examined.

The breakage characteristics of the TAR from these units are shown in Table 49. Figure 108 depicts some of the rocks from the four units.

Table 49. Characteristics of TAR from Units 25, 29, 31, and 33

Unit	Level	Rock Type	Fracture Angle (degrees)	Contraction Cracks
25	6	Chert	70–85	Yes
25	6	Quartzite	95–110	No
29	3	Chert	90	Yes
29	6	Chert	90	Yes
29	6	Chert	90–100	Yes
29	6	Chert	85–100	Yes
31	8	Chert	90	Yes
31	8	Chert	80–110	No
31	8	Quartzite	90	Yes
31	8	Quartzite	90–100	Yes
31	8	Quartzite	80–100	Yes
33	3	Quartzite	100–110	No

In addition to the TAR from the four units described above, TAR from five units (Units 1, 2, 3, 13, and 17) scattered across the site having relatively high amounts of this material were examined. Thus, when viewed in conjunction with the TAR from the four adjacent units, a general assessment of the TAR from the site is provided. As with the rocks described in Table 49, only specimens large enough to estimate overall size were examined. Selected rocks from these units are depicted on Figure 109. Table 50 lists their general characteristics.

TAR REPLICATION EXPERIMENTS

The upland terraces surrounding 41CW104 were revisited in September 2011, and a collection was made of cobbles suitable for use in the experiments. The rocks were transported to the archeological laboratory at Atkins for preliminary treatment. This consisted of numbering, measuring (length, width, and thickness), weighing, and assessing the rock type of each specimen. The rocks used in the first stone boiling experiment were dried in a conventional oven for approximately 24 hours at 400 degrees °F to remove any residual water. While this method was obviously not practiced by native peoples, it was believed, based on previous studies (Lucas and Frederick 1998), that a steep, rapid rise in temperature that occurs in the muffle furnace requires

a) Lot 178
Unit 25, Level 6

b) Lot 207
Unit 29, Level 3

c) Lot 215
Unit 29, Level 6

d) Lot 247
Unit 31, Level 8

e) Lot 270
Unit 33, Level 3

CENTIMETER
0 1 2 3 4 5

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Figure 108

Thermally Altered Rocks
Units 25, 29, 31, and 33

L:\Projects\He1\CL ENTS\TXDOT\100022694_41CW104 Final\Final Report\Figures\Figure 108_Characteristics of TAR, Units 25, 29, 31, and 22 Drafted by: C. Wallace

a) Lot 63
Unit 1, Level 5

b) Lot 59
Unit 2, Level 4

c) Lot 60
Unit 3, Level 4

d) Lot 115
Unit 13, Level 6

e) Lot 115
Unit 13, Level 6

f) Lot 130
Unit 17, Level 4

CENTIMETER
0 1 2 3 4 5

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Figure 109

Thermally Altered Rocks
Units 1, 2, 3, 13, and 17

L:\Projects\He1\CL ENTS\TXDOT\100022694_41CW104 Final\Final Report\Figures\Figure 109_TAR, Units 1, 2, 3, 13, and 17

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Table 50. Characteristics of TAR from Units 1, 2, 3, 13, and 17

Unit	Level	Rock Type	Fracture Angles (degrees)	Contraction Cracks
1	5	Chert	80	Yes
1	5	Quartzite	75–115	Yes
2	4	Chert	90	Yes
3	4	Chert	105	Yes
13	5	Quartzite	90	Yes
13	6	Chert	80–120	Yes
13	6	Chert	80, 95	Yes
13	6	Chert	90	Yes
13	6	Quartzite	80, 90	Yes
13	6	Chert	40, 90	Yes
17	3	Chert	90	Yes
17	3	Quartzite	80–100	No
17	4	Chert	85, 90	Yes

that all moisture be removed from the rocks prior to heating in the furnace. Failure to remove all moisture could result in the rocks violently exploding, which could cause injury should the door of the furnace not withstand the impact of the explosions. However, it was learned that in the case of the siliceous rocks from 41CW104, particularly with regard to the chert specimens, exposure to heat above 700 °F in a Thermo Scientific Thermolyne benchtop muffle furnace resulted in disintegrating rocks, whether they had been dried beforehand or not. Indeed, as will be seen, the use of the muffle furnace was curtailed entirely, and all of the experiments were conducted outdoors in wood-fueled fires.

Most of the following experiments were performed at the geoarcheological laboratory of Dr. Charles Frederick in Dublin, Texas, on December 9, 2011, and March 3, 2012. Stone Boiling Experiment 4, and Simple Hearth Experiment 3 were undertaken on the property of the Principal Investigator in Pflugerville, Texas, on April 17 and May 18, 2012.

Rock Oven Experiment

The rock oven experiment was intended to generate broken rocks that could be compared with those from 41CW104. A total of 25 rocks (chert and quartzite) were used in the experiment. Measurement data collected for the rocks prior to the experiment, as well as thermal characteristics recorded afterwards, are provided in Table 51.

A circular pit having a surface diameter of 1 m was excavated to a depth of 50 cm. A piece of ¼-inch-mesh hardware cloth was placed over the bottom of the pit to facilitate the collection of rock fragments after the experiment was completed.

Table 51. Rock Characteristics, Rock Oven Experiment

Rock No.	Type	Maximum Dimension (mm)	Weight (g)	Observations
RO1	Chert	51	478	Unbroken, numerous cracks
RO2	Chert	46	307	Not recovered
RO3	Quartzite	48	461	Broken into three pieces, crenulated interior
RO4	Chert	40	376	Exfoliated exterior
RO5	Chert	48	264	Broken into two pieces, 90° angles and cracks
RO6	Chert	54	436	Crenulated interior
RO7	Chert	72	794	Totally fragmented
RO8	Chert	45	Not recorded	Totally fragmented
RO9	Chert	48	Not recorded	Totally fragmented
RO10	Chert	52	Not recorded	90° fracture angle
RO11	Chert	53	Not recorded	Exfoliated exterior
RO12	Chert	56	Not recorded	Totally fragmented
RO13	Chert	47	Not recorded	Reduced to minute fragments
RO14	Chert	75	Not recorded	Totally fragmented, partially reddened
RO15	Chert	41	Not recorded	Totally fragmented
RO16	Chert	55	Not recorded	Totally fragmented
RO17	Chert	46	Not recorded	Pitted exterior, crenulated interior
RO18	Chert	70	Not recorded	Totally fragmented
RO19	Quartzite	64	Not recorded	Not recovered
RO20	Chert	41	Not recorded	Totally fragmented
RO21	Chert	61	Not recorded	Totally fragmented, reddish interior
RO22	Chert	44	Not recorded	Unbroken, cracks
RO23	Chert	57	Not recorded	Reddish interior
RO24	Not recorded	Not recorded	Not recorded	Totally fragmented
RO25	Not recorded	Not recorded	Not recorded	Exfoliated exterior, numerous cracks

Figure 110 depicts the construction of the rock oven. The rocks were arranged at the bottom of the pit, in numerical order in five rows of five rocks each. A thermocouple was placed among the rocks. Kindling was then added and a fire was lighted at 10 A.M. Wood, consisting of 7 kg (15.4 pounds [lbs]) of plum, 13 kg (28.6 lbs) of mountain juniper, and 6 kg (13.2 lbs) of cedar was added, and the fire was allowed to burn for approximately 1 hour. A layer of prickly pear pads, collected locally, was then placed onto the fire. Next, two beef roasts, each weighing about 2 lbs and wrapped in foil, were placed on the cactus. A second layer of prickly pear pads was then added to cover the meat. Following this, earth from the pit's excavation was used to seal the oven.

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Figure 110

Rock Oven Experiment

The oven was allowed to burn for about 7 hours. It was then opened and the meat removed. The meat was thoroughly cooked. The lower layer of prickly pear pads was also thoroughly cooked. The upper layer of pads was only partially cooked. Figure 111 shows the temperature gradient for the experiment.

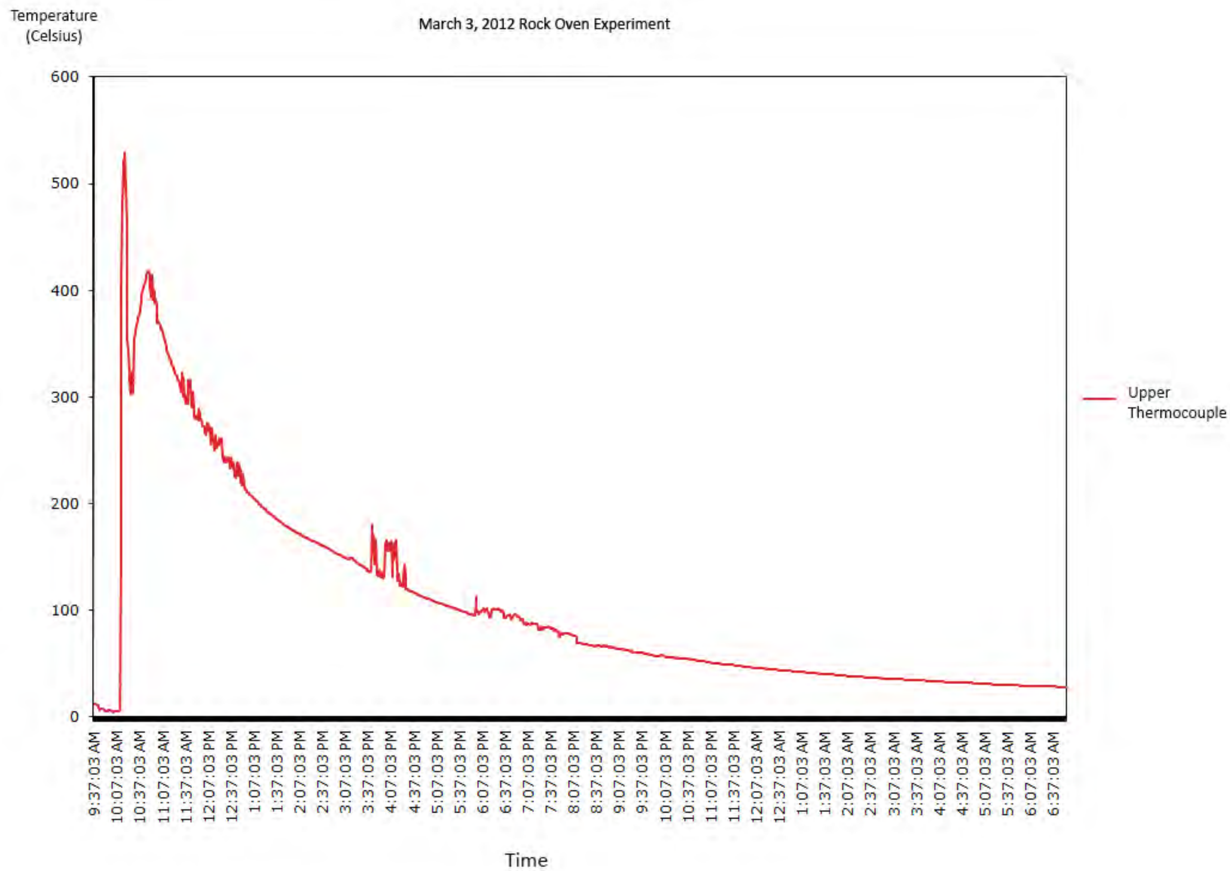

Figure 111: Temperature Gradient, Rock Oven Experiment

After the meat was removed, the oven was allowed to burn out overnight. The following morning the rocks and rock fragments were collected and bagged individually. The intensity of the fire had fractured nearly all of the rocks, often to such a degree that it was difficult to identify which rock they represented.

Perhaps the most notable thermal characteristic of the rocks used in the experiment was their exterior and interior colors. Almost without exception, the rocks, regardless of type, were thermally discolored shades of gray, from light gray to nearly black. Presumably, the reduced environment in which they were heated caused this discoloration. Another characteristic common to all of the rocks was the brittleness that they attained. It is uncertain whether this was a response to the lack of oxidation or merely reflects the intensity of the fire. Lastly, the fragments generated by the high temperatures produced during the experiment included a large amount of extremely small pieces only a few millimeters in diameter. Figure 112 depicts some of the rocks from the experiment.

Stone Boiling Experiments

Four stone boiling experiments were conducted in order to provide a number of fragments broken during quenching to compare with the archeological samples from 41CW104. Stone Boiling Experiments 1, 3, and 4 were conducted on an outdoor wood-fueled fire. Stone Boiling Experiment 2 was conducted using a muffle furnace. Rock types included chert and quartzite.

Thin sections were made from heated and unheated specimens of both quartzite and chert cobbles used in the stone boiling experiment. The thin sections were examined for changes in color, mineralogy, microscopic cracking, and differences in grain/crystal size.

Stone Boiling Experiment 1

The purpose of the first stone boiling experiment was to assess the effects of heating of rocks and rapid cooling in water. A fire was built using 2.2 kg of plum wood and 2.7 kg of mountain juniper. Temperatures were maintained using an Omega HH309 data logger thermometer with insulated thermocouples. The fire ranged from 500 to 800 °C. A total of 10 rocks were selected for the experiment. Their characteristics are listed in Table 52.

Table 52. Rock Characteristics
Stone Boiling Experiment 1

Rock No.	Type	Maximum Dimension (mm	Weight (g)	Fracture Angle (degrees)	Contraction Cracks
BS1	Chert	59	160	90	Yes
BS16	Chert	60	110	90	Yes
BS27	Chert	61	218	–	–
BS29	Chert	68	113	–	–
BS32	Chert	52	151	90	Yes
BS44	Chert	71	114	–	–
BS45	Chert	85	179	–	–
BS52	Chert	59	70	Unbroken	Yes
BS66	Chert	56	80	70	Yes
BS72	Quartzite	58	80	85–90	Yes

All of the rocks were placed in a shallow pit approximately 10 cm in depth and 30 cm in diameter. Kindling was added, and once ignition was achieved, all of the wood was added and allowed to burn for approximately 1 hour and 15 minutes. Four of the rocks (BS27, 29, 44, and 45) fractured in the fire and were not quenched. The remaining rocks were removed one at a time with tongs and placed in a stainless steel pot containing 3 liters of cool water. All fractured when quenched. Fracture angles ranged from 70 to 90 °C. Contraction cracks were evident on all of the specimens.

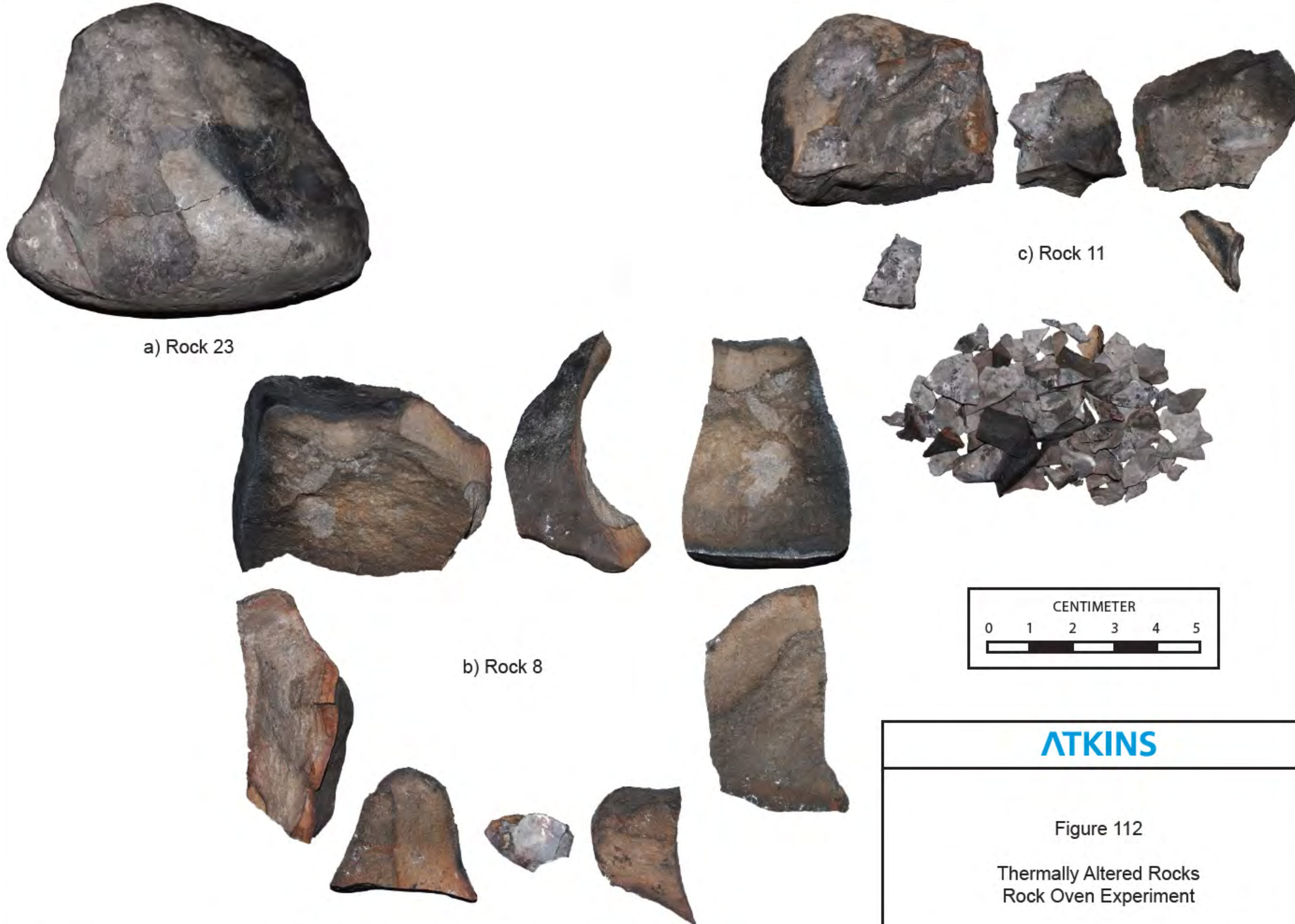

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Figure 112

Thermally Altered Rocks
Rock Oven Experiment

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Stone Boiling Experiment 2

This experiment attempted to use the muffle furnace for a heat source. Six rocks were selected for this experiment. Their characteristics are given in Table 53. The rocks were placed in the oven for 1 hour at 700 °C. Three of the rocks exploded in the oven and were reduced to minute fragments. Of the remainder, all but BS6 fractured into small fragments upon quenching. It was apparent that the high temperatures and longevity of the heating episode were not replicating conditions at 41CW104. In addition, the small size of the furnace limited the number of rocks that could be heated at a given time. Therefore, it was decided that the remaining experiments would all be conducted in outside fires.

Table 53. Rock Characteristics
Stone Boiling Experiment 2

Rock No.	Rock Type	Maximum Dimension (mm)	Weight (g)	Fracture Angle (degree)	Contraction Cracks
BS6	Chert	73	194	90	Yes
BS26	Chert	63	185	–	–
BS28	Conglomerate?	73	227	–	–
BS33	Chert	77	162	–	–
BS61	Quartz	60	93	–	–
BS74	Conglomerate	53	82	–	–

Stone Boiling Experiment 3

The third stone boiling experiment was conducted to provide additional specimens that had been quenched in water after being heated in a fire for a short duration. A total of nine rocks were used in this experiment (Table 54).

Table 54. Rock Characteristics
Stone Boiling Experiment 3

Rock No.	Rock Type	Maximum Dimension (mm)	Weight (g)	Fracture Angle (degree)	Contraction Cracks
SB100	Quartzite	57	118	–	–
SB101	Quartzite	69	181	90	Yes
SB102	Fine-grained Quartzite	66	140	–	–
SB103	Chert	57	162	90	Yes
SB104	Quartzite	69	248	80	Yes
SB105	Chert	68	140	90	Yes
SB106	Chert	60	117	Unbroken	Yes
SB107	Chert	58	204	–	–
SB108	Chert	60	114	–	–

A thermocouple was placed amidst the rocks. Figure 113 shows the temperature gradient for the duration of the experiment. A piece of ¼-inch-mesh hardware cloth was placed underneath the rocks used in the stone boiling experiment to keep them separated from the underlying rocks associated with the simple hearth experiment. The rocks were then heated in batches of three for approximately 20 minutes, and immersed in 1 liter of water. A separate plastic beaker was used for each rock in order to collect all fragments.

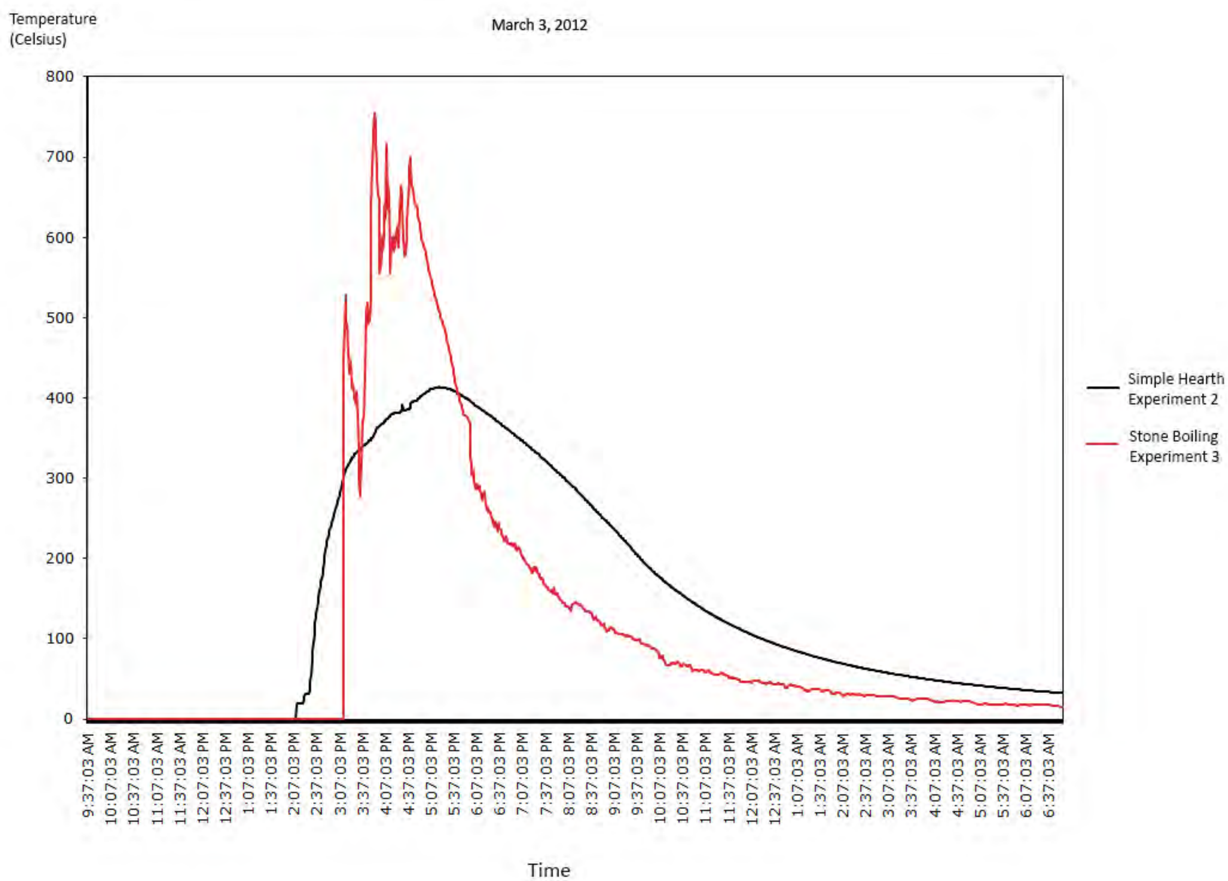

Figure 113: Temperature Gradient, Stone Boiling Experiment 3

Each of the nine rocks displayed some fracturing after the first episode, though three (SB100, SB101, and SB102) were intact enough to repeat the procedure of burning and quenching, All of these were quartzite. Only rock SB100 survived the second treatment, and it fractured during the third quenching episode. Specimen SB106, while not breaking on being quenched, significantly cracked and was not subjected to another heating cycle.

Fracture angle could only be measured on a few specimens as most of the rocks broke into several small fragments. Specimens SB103, SB104, and SB105 broke into several fragments, the largest of which had exterior angles of about 90 degrees.

Stone Boiling Experiment 4

The fourth and final stone boiling experiment was designed to determine the amount of rocks necessary to boil water for a given amount of time. This experiment was not initially included in the research design written for the current study, but arose from the observation that nearly all of the rocks used in the stone boiling experiments described above fractured the first time they were immersed in water. This tendency to fracture suggests that rocks were unlikely to have been reused by the site's occupants in preparing food using this cooking technique. Thus, if the amount of rock required to prepare a meal could be ascertained even in very general terms, the weight of the rock residue could then be collected and compared with the amount of TAR recovered at the site, and the result of this comparison might contribute to our understanding of the nature of the aboriginal occupation(s) there. The breakage patterns recorded for the rocks in the experiment were also used for comparisons with breakage patterns on TAR collected from selected excavation units at the site. Table 55 lists some of the physical attributes of the rocks before and after heating.

Table 55. Rock Characteristics
Stone Boiling Experiment 4

Rock No.	Type	Maximum Dimension (mm)	Weight (g)	Fracture Angle (degree)	Contraction Cracks
SB4-1	Quartzite	50	90	93	
SB4-2	Chert	60	114	90	Yes
SB4-3	Quartzite	Unrecorded	Unrecorded	Unbroken	None
SB$-4	Quartzite	Unrecorded	95	95	Yes
SB4-5	Quartzite	62	108	98	Yes
SB4-6	Chert	66	217	Unbroken	Yes
SB4-7	Chert	Unrecorded	100	Pot lids	Yes
SB4-8	Chert	62	155	Unbroken	Yes
SB4-9	Chert	68	141	90–105	Yes
SB4-10	Chert	74	129	Unbroken	Yes
SB4-11	Chert	60	102	90	Yes
SB4-12	Quartzite	Unrecorded	Unrecorded	80–90	Yes
SB4-13	Quartzite	64	170	Unbroken	Yes
SB4-14	Chert	70	195	85	No
SB4-15	Chert	74	214	Unbroken	Yes
SB4-16	Quartzite	70	156	90	Yes
SB4-17	Quartzite	65	118	80	Yes
SB4-18	Chert	52	110	90	Yes
SB4-19	Chert	92	322	Unbroken	Yes
SB4-20	Quartzite	77	221	90	Yes
SB4-21	Chert	68	210	110, 115	Yes
SB4-22	Chert	99	365	Unbroken	Yes
SB4-23	Chert	71	210	110	Yes
SB4-24	Quartzite	72	183	Unbroken	No

In conducting the experiment, rocks were heated in a fire for approximately 15 minutes. Based on previous experiments, this was sufficient time for heating without the risk of thermal fracture. The heated rocks were added one at a time to 3 liters of cold water in a metal bucket. About 10 rocks were required to bring the water to a boil. Additional rocks were added to keep the water boiling. A total of 24 rocks, weighing about 4.5 kg (including both rocks and rock fragments), were used to keep the 3 liters of water boiling for approximately 20 minutes. All of the rocks used in the experiment were collected for subsequent analysis.

Of the 24 rocks used in completing the experiment, only 2 exhibited no breakage or contraction cracks. Both of these specimens were quartzite. Of the remaining rocks, most cracked and then fractured into two or more pieces. The exterior fracture planes of these specimens ranged from 80 to 115 degrees, averaging about 90 degrees. Seven of the rocks developed contraction fractures upon immersion, but did not separate into fragments. Three of these later broke into fragments upon examination. The remaining rocks included two specimens that displayed only minor amounts of contraction fractures, and might have survived a second heating episode. The others were severely cracked and would very likely have broken if heated again. Figure 114 depicts some of the rocks used in the experiment after heating and quenching.

Simple Hearth Experiments

The three simple hearth experiment were designed to produce TAR that could be compared with those found in the simple hearth features at 41CW104 and with rock fragments found in the block excavations. The experiments constructed simple hearths similar in appearance to the three hearth features uncovered at the site. Rock types included chert and quartzite. Fires were built in shallow pits lined with numbered, weighed, and described cobbles. The type and weight of the wood used in the experiments was also recorded.

Simple Hearth Experiment 1

A total of 10 rocks were used in the first simple hearth experiment (Table 56). These were placed in a shallow pit and covered with wood, consisting of 1.7 kg of mountain juniper, 3 kg of plum, and 6.5 kg of oak. The fire was allowed to completely burn itself out, which occurred over a period of over 12 hours.

All but one of the rocks used in the experiment thermally fractured, most into several pieces. It was thought at the time that the degree of fracturing reflected the small size of the rocks utilized in the experiment, as the single rock (RH12) that survived unbroken was the largest used in the experiment. It would later be realized that the intensity and duration of the firing was more likely responsible.

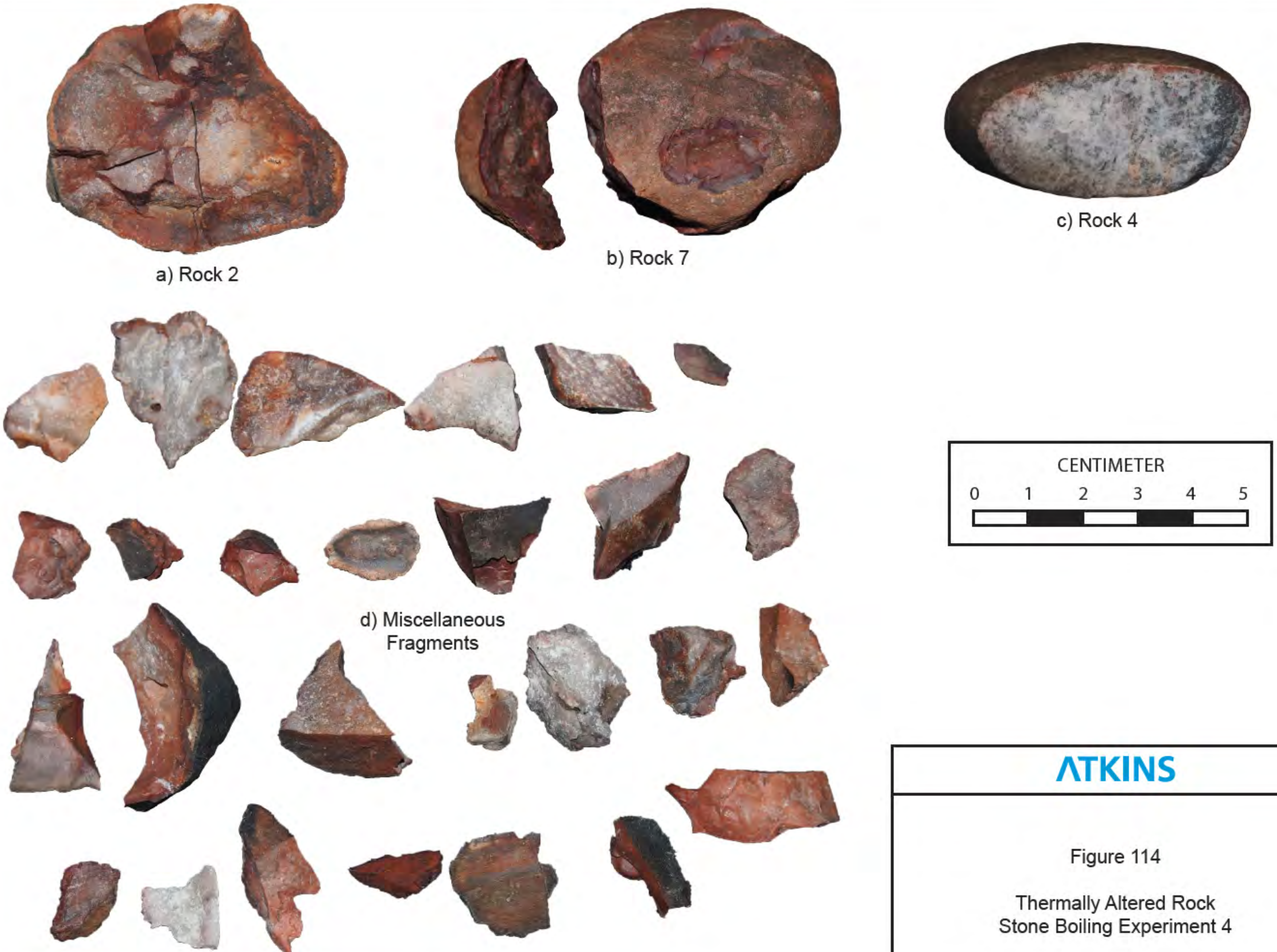

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Figure 114

Thermally Altered Rock
Stone Boiling Experiment 4

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Table 56. Rock Characteristics
Simple Hearth Experiment 1

Rock No.	Rock Type	Maximum Dimension (mm)	Weight (g)
RH2	Conglomerate	51	155
RH3	Chert	43	211
RH8	Chert	41	171
RH12	Quartzite	35	265
RH13	Chert	46	107
RH35	Chert	48	127
RH37	Chert	46	121
RH40	Chert	40	120
RH60	Chert	32	166
RH83	Quartz	16	42

Simple Hearth Experiment 2

Fifteen cobbles collected from near 41CW104 were labeled (SH1–SH15), weighed, and measured (Table 57). In this second simple hearth experiment, the size of the selected specimens was increased to more closely approximate the rocks recovered from the hearth features at 41CW104.

Table 57. Rock Characteristics
Simple Hearth Experiment 2

Rock No.	Type	Maximum Dimension (mm)	Weight (g)
SH1	Chert	106	699
SH2	Chert	126	1,206
SH3	Chert	95	756
SH4	Chert	84	503
SH5	Chert	98	555
SH6	Chert	85	463
SH7	Chert	82	245
SH8	Chert	97	380
SH9	Quartzite	68	257
SH10	Chert	78	341
SH11	Chert	64	231
SH12	Chert	96	465
SH13	Chert	97	627
SH14	Chert	84	205
SH15	Chert	76	201

The rocks were placed in a shallow (5-cm-deep) pit approximately 30 cm in diameter and arranged in a roughly circular shape. A thermocouple was placed amidst the rocks. A fire was started using kindling, and 26.4 lbs (12 kg) of cypress and 11 lbs (5 kg) of pecan wood were added to the fire. The fire was allowed to burn itself out over several hours. Afterwards, the ash and charcoal were cleaned from around the rocks, and the rocks were collected and bagged individually. None of the rocks used in the second simple hearth experiment survived intact. Many were reduced to fragments, some of which were minute.

It is likely that the high failure rate of the rocks used in this experiment is due to the intensity of the fire, as well as the duration of the heating episode.

Simple Hearth Experiment 3

The third and final simple hearth experiment was performed to better replicate the characteristics of feature rocks found at the site by lessening both the intensity of the heat source and the duration of heating. The shallow pit used in the fourth stone boiling experiment was also used in this experiment. However as the location was in the Blackland Prairie, the clay-rich Vertisol (Stephens soil series) was amended with the addition of sand to more closely approximate the fine sandy loam soils at 41CW104. Fifteen cobbles were selected for this experiment. Rock type, maximum dimension, and weight of the rocks are listed in Table 58. Included in the table are thermal effects observed on the specimens after completion of the experiment. Of the thermally discolored red or pink rocks, five (6, 7, 11, 13, and 14) exhibited only minor amounts of discoloration on the interior cortex.

Table 58. Rock Characteristics
Simple Hearth Experiment 3

Rock No.	Type	Maximum Dimension (cm)	Weight (g)	Fracture	Thermally Discolored Red or Pink
1	Chert	7.5	454	No	No
2	Chert	6.3	183	No	No
3	Chert	10	797	No	No
4	Chert	11.7	890	No	No
5	Chert	8.8	360	No	No
6	Chert	10.6	472	Yes	Yes
7	Chert	9.8	709	Yes	Yes
8	Chert	9.7	360	Yes	Yes
9	Chert	7.9	333	Yes	Yes
10	Chert	10	504	Yes	Yes
11	Chert	10.8	815	No	Yes
12	Chert	8.6	442	Yes	Yes
13	Chert	6.9	340	Yes	Yes
14	Chert	11.7	543	Yes	Yes
15	Chert	10.3	434	No	No

Figure 115 illustrates how the 15 cobbles were placed in the shallow pit. A fire was then started using approximately 8 kg of plum and 3 kg of mountain juniper and allowed to burn for 30 minutes. The charred wood and embers were raked away from the rocks, which remained very hot for over an hour. They were allowed to cool without quenching, and afterwards collected for analysis.

Eight of the rocks fractured during the experiment, but only rocks 6, 9, and 13 fractured significantly. Most of the fractured rocks were potlidded or spalled, and the fragments removed were quite large and flakelike in appearance. Fracture angles were small, typically less than 45 degrees. The TAR were positioned in and around the center of the hearth where temperatures were obviously the greatest. The thermal alteration of the rocks along the periphery of the hearth was much less apparent. Figure 116 shows some of the rocks and rock fragments from the experiment.

Of the three simple hearth experiments, the final experiment came closest to replicating the feature rocks from the site. It is apparent from the first two simple hearth experiments that long-term exposure to an intense heat source will result in fragmented specimens that differ in appearance from the simple hearth feature rocks at the site. Short-term moderate heating appears to have been practiced by the native peoples. Perhaps closer approximations to the 41CW104 feature rocks may have resulted under multiple short-term heating cycles. The use of these hearths for short-term moderate heating may imply they were used for purposes other than cooking, such as for heating shelters in cold weather.

MICROSCOPIC ANALYSIS OF SELECTED TAR SPECIMENS

Petrographic analysis was conducted of thin sections prepared from rocks used in the rock oven, stone boiling, and simple hearth experiments as well as rocks collected from two of the cultural features at 41CW104. The purpose of the analysis was to assess changes in the rocks that occurred as a result of thermal exposure undergone during the various treatments.

A total of 12 thin sections were made from seven rocks. Single thin sections were made from one rock each from Features 8 and 9, while two thin sections were made from five rocks used in the various experiments, one thin section being made before and one after heating. Single rocks from the Rock Oven Experiment, Stone Boiling Experiments 2 and 3, and Simple Hearth Experiment 2 were examined.

Changes to the rocks from the various types of heating included the presence of cracks and changes in color. Cracks were present in rocks used in the rock oven, the stone boiling experiments, and in one of the examined feature rocks. Changes in color was most noticeable in the stone boiling experiments, but was present in one of the feature rocks. The thin sections made from the simple hearth rocks did not display cracks or changes in color.

ATKINS

Figure 115

Simple Hearth Experiment 3

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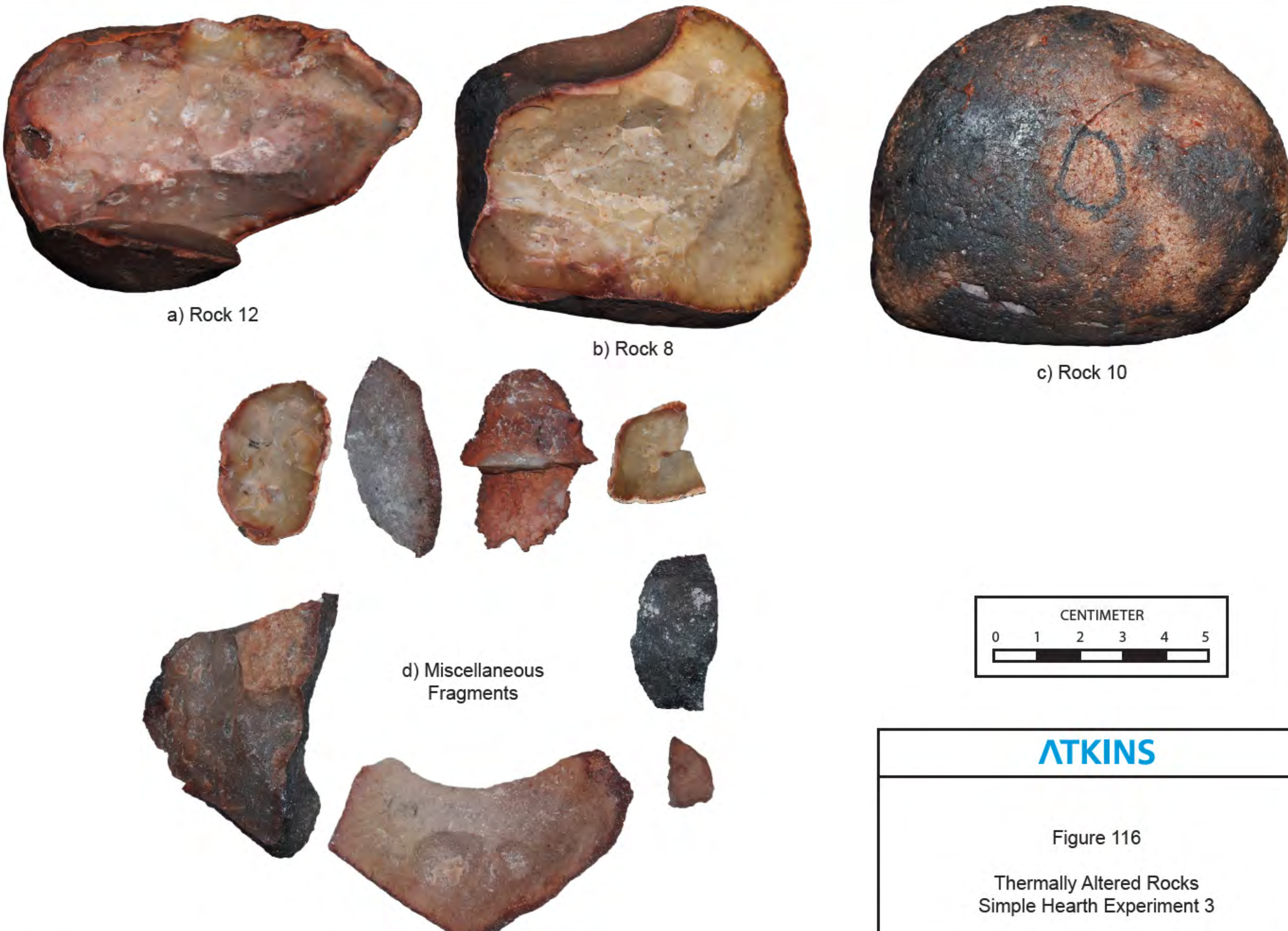
Drafted by: C. Wallace



ATKINS

Figure 116

Thermally Altered Rocks
Simple Hearth Experiment 3

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Drafted by: C. Wallace

The TAR at the site was noted for the presence of cracks and changes in coloration

Rock Oven Experiment

Rock 7 (RO7), a chert cobble, was selected from the Rock Oven Experiment (Figure 117). Figure 117a is a scan of the sample in plane light before heating. An enlargement of this scan is provided on Figure 117b. No thermal cracks are visible in the sample, though old and mineralized cracks, filled in with microquartz, can be seen. Figure 117c is a plane light scan of a thin section of RO7 after being heated in the rock oven. A network of prominent cracks, seen as light lines with blue epoxy filling the cracks, is clearly visible. The light and dark gray pattern that dominates the groundmass in the rock is shown on Figure 117d. Most of the light-colored areas appear to be cored by minute cracks, whereas the dark-colored areas are situated between extant cracks (Figure 117e).

Stone Boiling Experiments

Rock BS33 is a chert cobble taken from the second stone boiling experiment. Figure 118a is a view of the specimen in plane light before it was heated. An enlarged view of some of the cracks in the specimen (Figure 118b) suggests that, based on the absence of blue epoxy, they occurred when the thin section was made. A plane light scan of the sample after heating is shown on Figure 118c. Contraction cracks, infilled with blue epoxy, are evident in the photo and on Figure 118d. The mottled pattern that dominates the groundmass does not appear to be cracked, but under higher magnification (Figure 118e), a myriad of small cracks, infilled with blue epoxy, becomes visible.

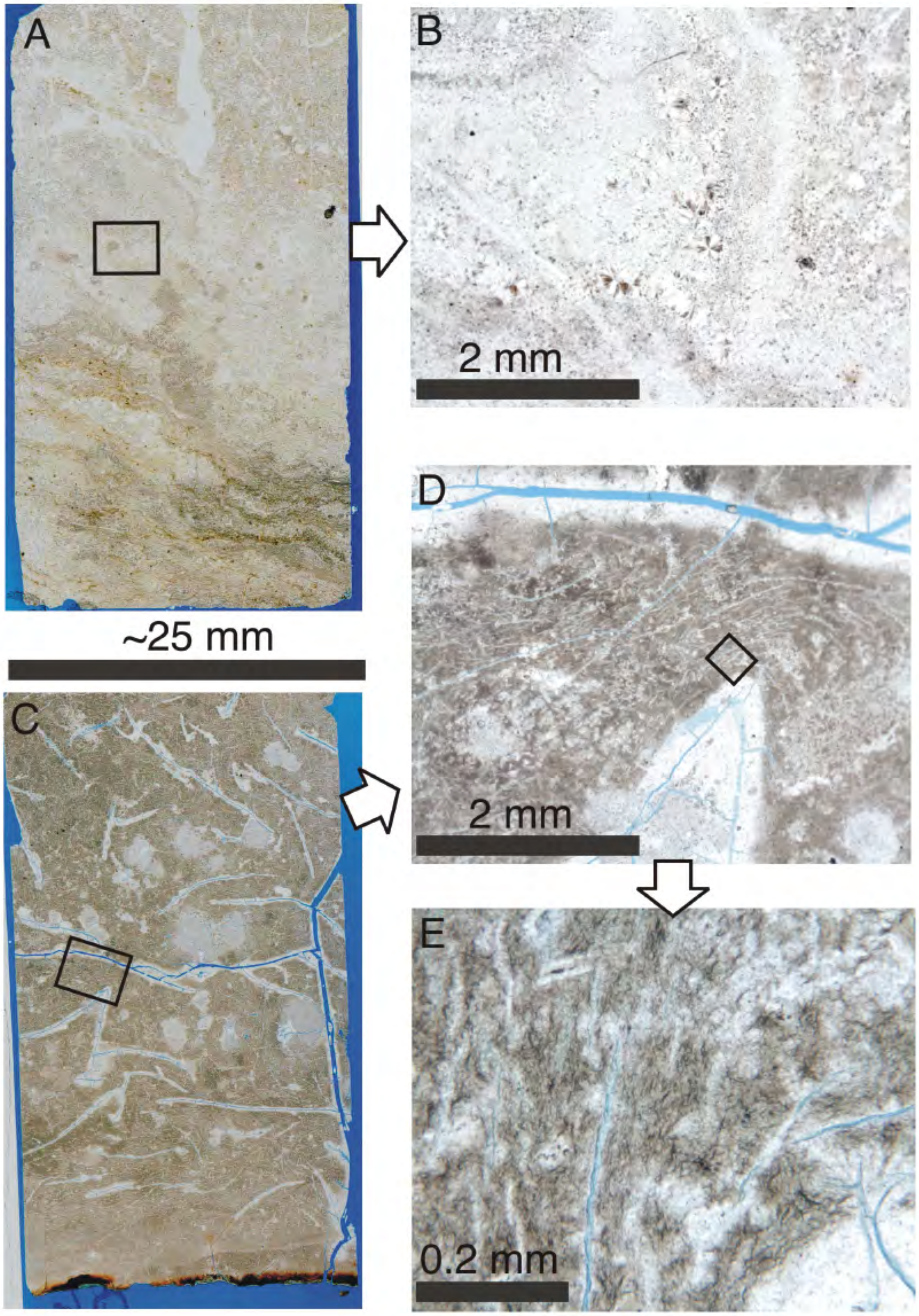
Rock SB101 is a quartzite cobble selected from Stone Boiling Experiment 3. Several cracks and linear vughs that occurred in the rock before it had been heated are shown on Figure 119a, while a view of one of these cracks that broke across the individual quartz grains, and was subsequently the site of quartz mineralization, can be seen on Figure 119b. A plane light scan of the specimen after it had been used in stone boiling is seen on Figure 119c. A reddening of many of the framework grains and the much more extensive crack network is evident. This area is enlarged on Figure 119d. An additional enlargement depicting the postheating contraction cracks that cut across the quartz grains is shown on Figure 119e.

Simple Hearth Experiment

Two rocks (SH6 and SH9) were selected for thin sectioning from Simple Hearth Experiment 2. Both were quartzite cobbles. Neither specimen exhibited any obvious thermal damage or discoloration.

Feature Rocks

Single specimens were thin sectioned from rocks taken from Feature 8 and Feature 9 at 41CW104. The rock from Feature 8 was a quartzite cobble. Red discoloration and a single thermal crack could



A) Before heating, plane light
B) Before heating, plane light
C) Postheating thermal cracks, plane light
D) Groundmass, postheating, plane light
E) Enlarged view of thermal cracks, plane light

ATKINS

Figure 117

Rock Oven
Specimen RO7 (Chert)

L:\Projects\He1\CL ENTS\TXDOT\100022694_41CW104 Final\Final Report\Figures\Figure 117_Rock Oven, Specimen RO7 (Chert)

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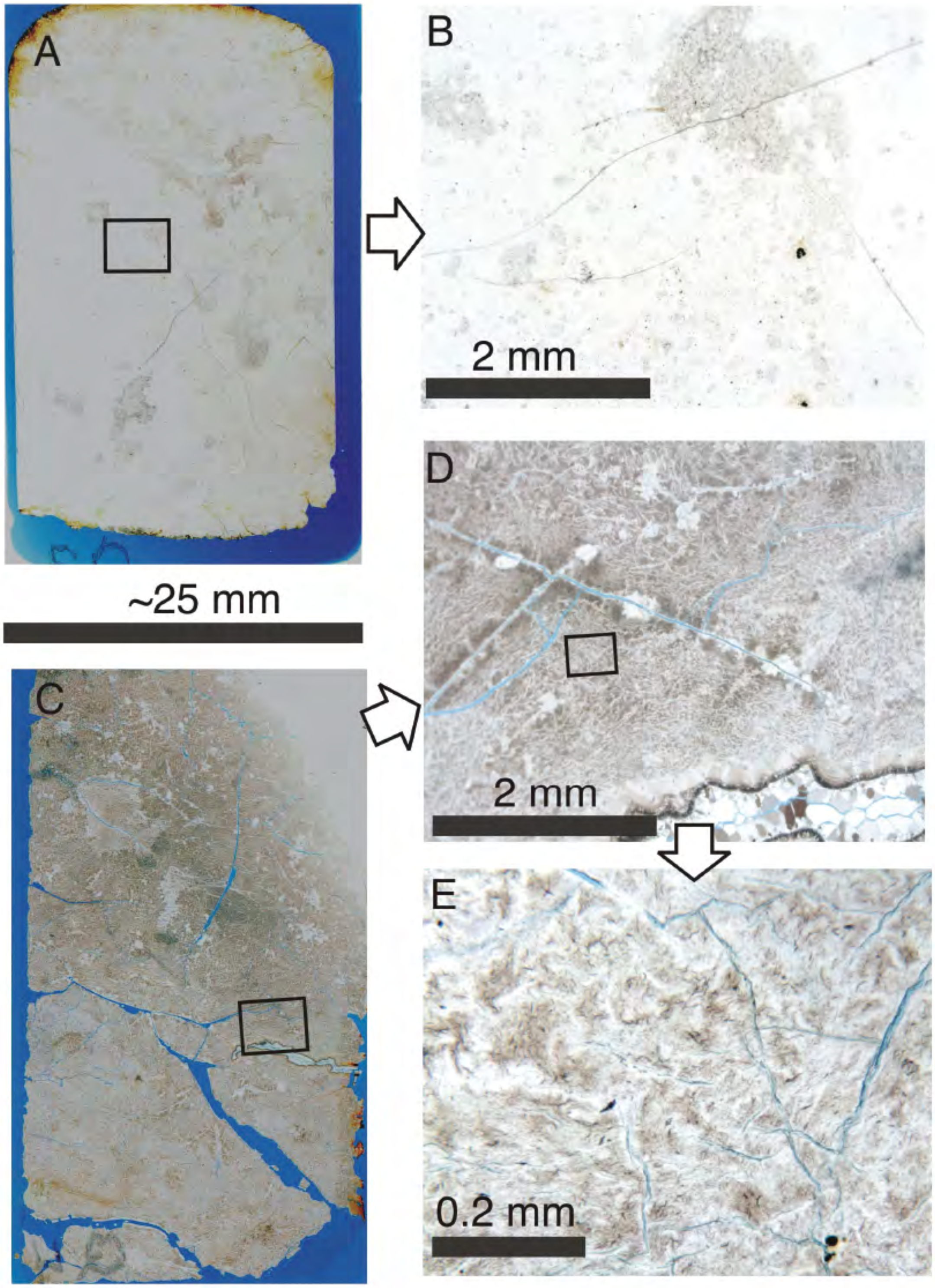

A) Before heating, plane light
B) Cracks from thin sectioning, before heating, plane light
C) Postheating contraction cracks, plane light
D) Enlargement of contraction cracks, plane light
E) Enlargement of contraction cracks, plane light

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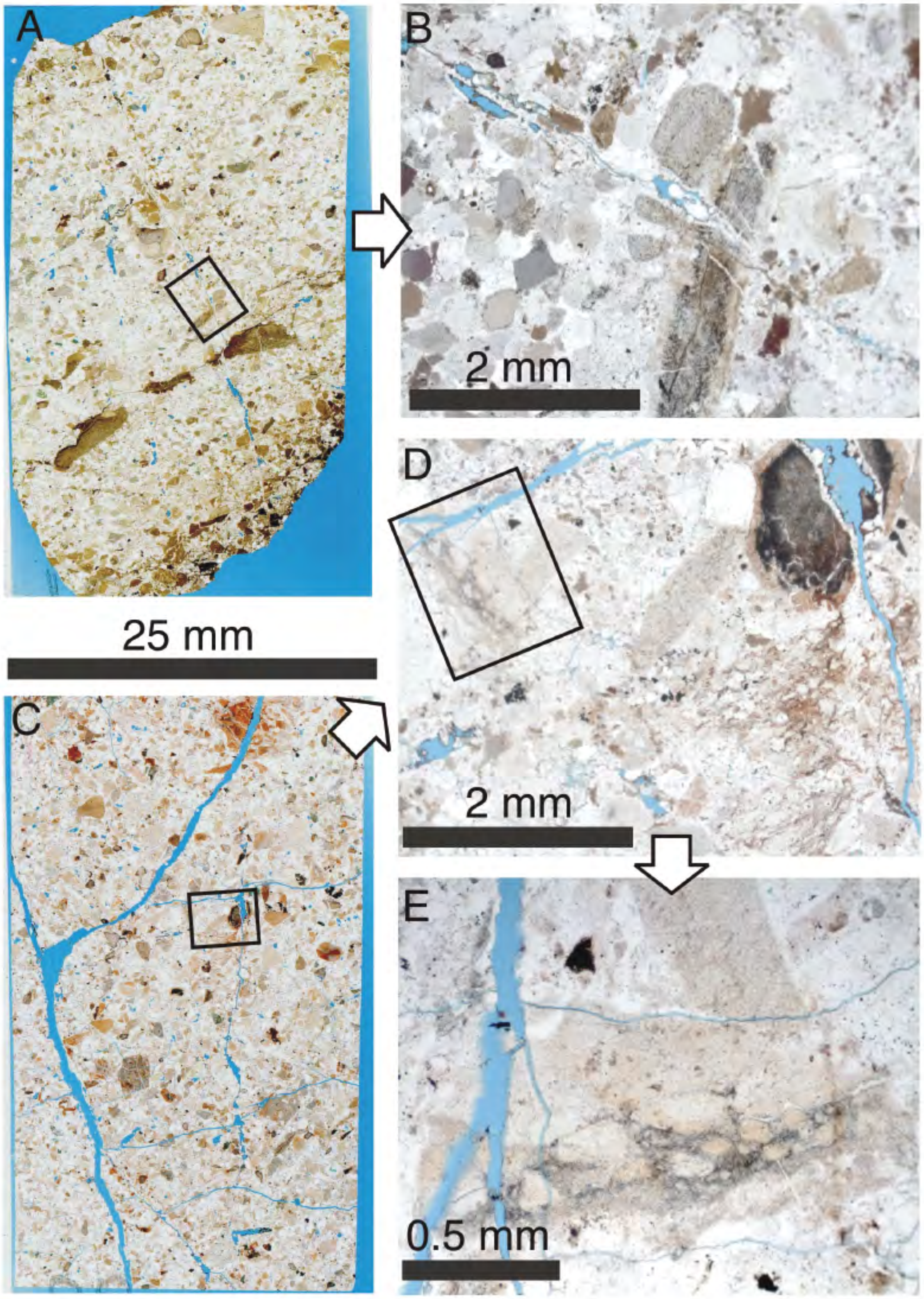
Figure 118

Stone Boiling,
Specimen BS33 (Chert)

L:\Projects\He1\CL ENTS\TXDOT\100022694_41CW104 Final\Final Report\Figures\Figure 118_Stone Boiling, Specimen BS33 (Chert)   Drafted by: C. Wallace



A) Before heating, plane light
B) Preexisting cracks across grains, plane light
C) Contraction cracks and reddening, postheating, plane light
D) Enlargement of contraction cracks, plane light
E) Enlargement of contraction cracks, plane light

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Figure 119

Stone Boiling
Specimen SB101 (Quartzite)

L:\Projects\He1\CL ENTS\TXDOT\100022694_41CW104 Final\Final Report\Figures\Figure 119_Stone Boiling, Specimen SB101 (Quartzite)

Drafted by: C. Wallace

be seen in thin section. The rock from Feature 9 was a chert cobble. It exhibited no evidence of discoloration, but did display a single thermal crack at high magnification.

SUMMARY AND CONCLUSIONS

The TAR replication experiments presented above were intended to help determine whether thermal properties could be identified and associated with particular cooking practices or features (stone boiling, simple hearths, and rock ovens), which were also present in the TAR assemblage at 41CW104. A second purpose was to approximate the thermal alteration present on the rocks found at the simple hearth features at the site. These goals were outlined in the research design prepared for the production of the current report. During the course of the experiments, it was noted that all but a very few of the rocks used in the stone boiling experiments fractured on initial quenching in water, and thus were unlikely to have served for more than a single cooking episode. If it could be demonstrated that much of the TAR at the site was the result of stone boiling, this information might provide some indication of the nature of the occupations represented in the excavations.

Some of the experiments, particularly the first few stone boiling and simple hearth replications, were not very successful in demonstrating anything other than the inexperience of those conducting the experiments. Extremely high temperatures from an excess of fuel, coupled with overly long heating episodes, both in outside fires and in the muffle furnace, resulted in the destruction of many rocks before they could be properly utilized. Despite these early failures, the experiments proceeded and improved, eventually achieving their purposes. The following conclusions are presented for each of the replication efforts.

Rock Oven Experiment

While to a large extent the problem of generating large amounts of fragments encountered during the early experiments mentioned above also plagued the rock oven experiment, it was believed necessary to create high thermal temperatures in order to provide a heat source capable of cooking for the extended period required by this technique. Indeed, the weight of wood used in the experiment was considerably less than that used in other rock oven experiments (Lucas and Frederick 1998). In addition, large amounts of rock fragments characterize much of the TAR assemblage at 41CW104.

Based on the results of the rock oven experiment, as well as observable characteristics within the TAR assemblage, it is unlikely that earth ovens played a major role in the occupational history of 41CW104. The relatively small size of the cobbles present in the TAR assemblage from the site would not likely have been chosen for these long-term cooking features, especially when much larger rocks, capable of retaining heat for much longer duration, were readily available. In addition, the foodstuffs generally associated with earth ovens are typically xeric species that require several hours to prepare. While it is known that prickly pear pads (nopales) can be prepared in ovens, they (and especially the immature pads, or nopalitos) can be quickly prepared by charring the needles off in a simple hearths and boiling the pads. A ground stone tool apparently used in scraping plants was found near Features 7 and 8 at 41CW104, and may have been used in preparing this foodstuff. The importance of the prickly pear in the diet of protohistoric peoples east of the Edwards Plateau is known from ethnohistoric accounts, and as mentioned in the Settlement Patterns chapter (Chapter 3) of this report, one of the streams in the vicinity of 41CW104 was known by the natives as "place of prickly pear and mesquite." While nopales were certainly eaten, it seems that it was primarily the fruit, or tuna, of the plant, which ripened in the fall, that was most often mentioned. Tubers such as wild onion and false garlic were prepared in earth ovens, but could also be cooked in other ways. Camas, a valuable root food in some areas, is scarce in the region presently, but may have been more abundant in the past. In the account of Cabeza de Vaca, tubers were difficult to gather as the labor necessary to dig and prepare them made them a food chosen at times when other, more easily obtainable foods were in short supply. The location of the Santa Maria Creek site in a riparian setting within the Post Oak Savannah, where a wide array of plant and animal foods was available, would seemingly have made it an unlikely location for the preparation of difficult to secure foods in rock ovens.

Stone Boiling Experiments

Four stone boiling experiments were conducted. Of these, Experiments 3 and 4 were the most successful, as the intensity and duration of the fires used in the first two experiments resulted in fracturing most of the rocks prior to their being quenched. Once the procedure had been refined, it was found that rocks could be heated sufficiently enough to boil water in 15 to 20 minutes, and that a period greater than 1 hour was likely to result in fragmented rocks. Once immersed in water, the rocks usually cracked and broke into two or more fragments. This was particularly true of chert specimens, and reflects the large number of inclusions or impurities in the lag gravels at the site. Even those specimens that remained whole exhibited sufficient cracking to make survival in another heating cycle unlikely. A few quartzite specimens remained unbroken, but these usually exhibited some contraction cracks. A few of these were recycled two or three times.

The exterior fracture angle of most of the boiling stones averaged about 90 degrees. It was the presence of contraction cracks and exterior fracture angles of about 90 degrees that distinguished stones used in boiling. These characteristics were also noted on specimens of TAR found in the examined excavation units. Another characteristic of the rocks used in stone boiling was the variety of colors they assumed from heating in a oxygen-rich environment. While rocks heated in the simple hearths also discolored, those rocks were larger and did not fracture as badly. The rocks heated in the reduced environment of the rock oven did not display this range of discoloration.

It is the combination of these characteristics that is offered as the best evidence that the primary cooking technique used at 41CW104, at least in the large southern excavation area (Block 1), was stone boiling. The tributary channel of the West Fork of Plum Creek, located only a few meters south of the site, likely served as the source of water for the stone boiling.

Finally, the inability of most of the boiling stones to withstand more than one heating and quenching episode suggests that the occupations represented by the excavations at 41CW104 occurred over a relatively short period of time. This conclusion was based on the results of Stone Boiling Experiment 4, which examined the amount of rock necessary to bring 3 liters of water to a boil and continue boiling for about 20 minutes. The amount of rock required to do this (4.5 kg) was them compared to the amount of TAR recovered from the excavations (excluding feature rocks), which totaled about 120 kg. The ratio between the rocks used in the experiment and the total TAR corresponds to less than 25 similar cooking episodes, clearly an indication of limited occupation duration. It is of course necessary to caveat such findings by reminding the reader that the excavations at the site were confined to a 50-ft-wide ROW and therefore may not represent the full extent of the occupations at the site.

Simple Hearth Experiments

Like the initial stone boiling experiments, the first two simple hearth experiments failed to replicate the features at 41CW104 because of the intensity and overly long duration of heating. However, with the completion Simple Hearth Experiment 3, similarities between the experimental rocks and the rocks recovered from the site features became apparent. By restricting the duration of the heating episode to 30 minutes, and raking the coals away from the underlying rocks, excessive breakage was prevented. The rocks remained very hot and would undoubtedly have served as a griddle to cook on. However, their use as warming features in or outside of aboriginal huts cannot be discounted. Thermal discoloration was found to depend on the rock’s positioning in the fire. Rocks in the center of the pit that were closest to the heat source were the only specimens to discolor red or pink. Rocks at the margins of the hearth largely remained unaltered. The degree of thermal alteration of the rocks in the experiment matched those of the features relatively well, but none of the experimental rocks achieved the deep reddish hues of some of the feature rocks. This may simply have been a matter of a slight difference in the duration or intensity of the heating, or the feature rocks may have undergone multiple firing episodes.

15

SUMMARY AND CONCLUSIONS

by Robert Rogers

This report has documented the results of NRHP testing and data recovery at the Santa Maria Creek site (41CW104), located in Caldwell County, Texas. The investigations described herein include NRHP testing and data recovery carried out to mitigate the adverse impacts to the site by then highway construction consisting of widening of the FM 86 bridge over the West Fork of Plum Creek. The investigations were conducted for TxDOT-ENV by Atkins.

Site 41CW104 was recorded by Atkins during a cultural resources survey for proposed improvements to FM 86 in 2006. Later that year, beginning on December 18, 2006, and continuing until January 9, 2007, NRHP eligibility testing occurred at the site. This began with the mechanical excavation of two trenches totaling approximately 85 linear meters. Four 1-x-1-m test units were then hand excavated in two areas found to contain relatively dense buried cultural deposits: two excavation units were placed approximately 40 m north of the unnamed tributary of the West Fork of Plum Creek, and one was located farther upslope. Later that year, between August 8 and October 31, data recovery investigations were performed. These consisted of the excavation of forty-two 1-x-1-m units. A 300-m^2 area north of the excavation block was mechanically scraped. Eleven additional excavation units were placed around rock hearth features that were located during scraping. Data recovery investigations consisted of the excavation of forty-two 1-x-1-m units.

Regionally, there are three ecoregions and seven subregions within 50 km of the site. The site is situated in the floodplain of the West Fork of Plum Creek and the adjacent slopes of the Quaternary-aged terraces that abut against it. Buried within the alluvial- and colluvial-derived sediments at the site are the remains of Late Prehistoric to early Historic period occupations. In the greater part of the site, the materials are contained in soils mapped as belonging to the Gowen series. These sandy soils include a modern A horizon, at least one underlying buried soil or 2Ab horizon and a 2Bw horizon. Deposition in this part of the site was principally governed by flood events, but as one proceeds upslope colluvium is also present. The sediments in this part of the site are much shallower and lack the 2Ab horizon. Soils here belong to the Crockett series, with the horizon sequence consisting of an A horizon overlying a Bt horizon.

Characteristic of most prehistoric sites situated in the sandy mantle sediments in the Post Oak Savannah, the soils and sediments at the Santa Maria Creek site have been affected by postdepositional disturbances. Principal among these has probably been bioturbation by plants (primarily trees) and burrowing and tunneling animals and insects. This is apparent from the stratigraphic distribution of the radiocarbon dates. However, rather than representing a palimpsest, and thus being difficult to unravel, the occupations at the site were limited, primarily occurring during the Early Historic and to a lesser extent the Late Prehistoric period. The effects of bioturbation should not be overemphasized.

Two basic research themes underlie the site investigations. The first of these was to attempt to identify patterns of behavior in the archeological record at the site that might be used with recorded ethnohistorical and ethnographical data to identify the people who were at the site, and identify a cultural area they might be aligned to. While the identification of native groups is discussed at length, it was found during the course of the research that the identification of a specific cultural area, at least one with firm geographic boundaries, remains elusive. This in large part, as will be seen, reflects the state of flux the native cultures were undergoing during much of the time that 41CW104 was occupied. Intense pressures from the Spanish in Mexico and New Mexico, and the movement of powerful native groups such as the Apache, were forcing new peoples into the area and displacing existing populations.

The diaries and journals kept during the Spanish expeditions to east Texas during the late seventeenth and early eighteenth centuries provided valuable information on a host of topics relevant to the occupations at 41CW104. Particular attention was paid to these accounts as they passed the vicinity of the site. Identifications of native peoples, plants, animals, and the geography of the traversed lands afford an exceptional glimpse into an environment that has since been greatly altered by man. One of the most telling revelations of the diaries is the scarcity of indigenous peoples residing in the area. When native groups were encountered, they were typically traversing the area for either trade, as exemplified by the 2,000–3,000 Jumano, Cibolo, Casqueza, Choma, Cantona, and Mandones encountered by Alarcón near the Guadalupe River in 1691, or the defensive villages of amalgamated bands of *ranchería* Indians found on the Colorado River by Espinosa-Olivares-Aguirre in 1709. Clearly, by the time of the expeditions, the effects of cultural displacement were well established in the area.

Occasionally, small groups of peoples, such as the Mayeye recorded on Barriento's map of the 1727 Rivera expedition, were encountered. Mazanet, who accompanied Terán in 1691–1692, noted that the area around the Guadalupe River formed a boundary between native linguistic groups. South of the river, all spoke one common language, while from the Guadalupe to the Tejas many languages were spoken, as one encountered the following nations: Catqueza, Cantona, Emet, Cavas, Sana, Tojo, Toaa, and others. He also tells us that one of streams (believed to have been in the vicinity of 41CW104) was called Techaconaesa, which means place where there are prickly pears and mesquites. Both of these were important foodstuffs and may have contributed to the presence of native groups from areas such as the Inland Coastal Plain, where they were not readily available.

Map resources dated from as early as 1520 were reviewed in an attempt to identify any documents that might portray historic trails and traces and/or provide information about native peoples associated with the Santa Maria Creek site. Maps from this time through the end of the seventeenth century were based on the accounts of explorers who had only a limited knowledge of how to measure their geographic location and were often poorly replicated by numerous cartographers. Most of the published maps from this period provided little information regarding settlement patterns in the vicinity of 41CW104 during the period of first contact. In general, the Texas interior remained uncharted and unexplored between the early expeditions of the 1520s and subsequent explorations during the last decade of the seventeenth century. Later, maps such as those of Barrientos mentioned above did provide useful data. In addition, later maps demonstrate the close proximity of the Santa Maria Creek site to important historic roads, most notably the *caminos reales.*

The second research theme involved the subsistence base at the site. Addressing this topic focused on assessing the food preparation practices used by the aboriginal occupants at 41CW104. While some dietary evidence was collected from the excavations, overall the direct evidence retrieved thus far was meager and offered little insight into the actual cooking methods that were employed there. Therefore, a series of replication experiments were conducted (see Chapter 14) in attempts to reproduce breakage patterns and other characteristics of the TAR found at the site. TAR represented the primary artifact type found during the excavations at the site. It was found in every excavation unit, and totaled over 121 kg (267 pounds). TAR is abundant in the site area and is composed of stream-rolled cobbles of chert and quartzite that originated from lag gravel deposits that occur in the Quaternary-aged terraces. It, along with the waters of the West Fork of Plum Creek, and the useful plants and animals found in the surrounding countryside, were the *raison d'être* for the site.

The experiments utilized rocks collected from the surface of the Quaternary terraces near the site. These were used to ascertain the cooking methods utilized at the site through a series of experiments utilizing three cooking methods: stone boiling, rock ovens, and simple hearths. Despite some initial failures, the overall results were successful and demonstrated that the primary cooking method represented in the large amount of TAR at the site was stone boiling.

In addition to identifying the principal cooking method, the experiments contributed valuable information regarding the nature of the occupations. The inability of most of the boiling stones to withstand more than one heating and quenching episode suggests that the occupations represented by the excavations at 41CW104 occurred over a relatively short period of time. This conclusion was based on the results of Stone Boiling Experiment 4, which examined the amount of rock necessary to bring 3 liters of water to a boil and continue boiling for about 20 minutes. The amount of rock required to do this (4.5 kg) was then compared to the amount of TAR recovered from the excavations (excluding feature rocks), which totaled about 120 kg. The ratio between the rocks used in the experiment and the total TAR corresponds to less than 25 similar cooking episodes, clearly an indication of limited occupation duration. It is of course necessary to caveat such findings by reminding the reader that the excavations at the site were confined to a 50-ft-wide ROW and therefore may not represent the full extent of the occupations at the site.

A substantial amount of this report focused on the analysis of the over 13,000 artifacts. The examination of the stone artifacts followed a four-step process in accordance with TxDOT Lithic Analysis Protocol (see Chapter 6). Chipped stone tools were first categorized by their initial manufacturing technique and were recorded in one of the following categories: simple detachment-based, complex detachment-based, and core-based. Raw materials recognized in the analyzed assemblage sample predominantly consisted of chert (96 percent), with very minor amounts of metaquartzite, quartz arenite, and silicified wood.

An array of tools was found during the investigations, including several dating to the Archaic period. However, most of these were surface finds or occurred in shallow nondepositional contexts away from the primary excavations. Late Prehistoric projectile points were found in the primary excavations, and include Scallorn and Fresno types. Scallorn points attest to occupations at the site that occurred before about A.D. 1200. The Fresno points may be further evidence for ties to the southeast which were seen in the INAA analysis.

Microwear analysis (Chapter 7) proved to be a useful tool in interpreting the function of stone tools. This study revealed that while some tools were used to butcher animals, the majority were used in plant processing.

A relatively small ceramic assemblage of only 25 sherds was found at the site. The textural differences between the 25 sherds suggest that different “paste recipes” were used to manufacture the ceramics found at the site. Given their overall sandy matrix and general textural differences, the Santa Maria Creek ceramics closely resemble those found in assemblages located to the south-southeast. Additional evidence for ties to the south and southeast includes the floated exterior and interior surfaces and low percentage of smudged surfaces.

Detailed analysis was performed on the assemblage, including petrography and INAA. These studies revealed that the assemblage is important in several ways. First, there is very little variation in the pottery. Petrographic analysis revealed a mineral suite dominated by monocrystalline quartz in the fine to medium sand size range with small amounts of chert and traces of feldspar. Bone was used as a tempering agent, but never in high percentages. Grog was only occasionally seen.

INAA shows a relationship is likely with the assemblage from the Sandbur site and others to the south. When comparisons were made between the ceramics from the 41CW104 and the Sandbur site, there is evidence of small-scale production and localized exchange between the two sites. This suggests that the bone-tempered ceramics found at sites in this transitional zone may indeed represent a series of localized regional ceramic types. Whether or not these localized regional ceramics could be considered varieties of Leon Plain or a distinctive "Toyah" ware remains to be demonstrated.

Just when was the Santa Maria Creek site occupied? While we know that there were Archaic period occupations in the site area, based on the calibrated 2-sigma radiocarbon dates (see Appendix A), the earliest occupations occurred between A.D. 730 and 970 (Beta 319867 and 319868). These occupations were probably responsible for the two Scallorn arrow points and align with the Austin phase of the Late Prehistoric period. Another Late Prehistoric date of between A.D. 1270 and 1380 aligns with the Toyah phase, but since no artifacts diagnostic of the Toyah culture were found at the site, little can be said regarding this possible occupation.

By far the majority of the radiocarbon dates from the Santa Maria Creek site align with occupations that occurred between about A.D. 1670 and 1770. The pottery at the site is associated with these occupations, and it is probable that most of the remaining artifacts and TAR are as well.

A picture, though faint and faded, begins to emerge regarding those who camped at the site at this time. Based on ethnohistorical and archeological data, it appears that they were a small group, perhaps some of the Mayeye or one of the Sanan-speaking tribes with ancestral ties outside of the immediate area, probably to the south or southeast. They were hunting animals, but gathering wild plants seems to have been more important. They cooked their food by stone boiling. They may have built temporary structures, but the duration of their occupations were probably quite short. Repeated visits perhaps by the same people may have occurred.

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