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Dedicated
to
Dr. Edward B. Jelks

ARTICLES

Archeology vs. History

Edward B. Jelks

The Stone archeological site in McLennan County, Texas, is identified as the location of a Tawakoni village—named for its chief, Quiscat—that was visited by Athanase de Mézières in the 1770s. A discrepancy between the location of the Stone site and the location of the Quiscat village as described in Mézières's journals is resolved.

The first archeological site I worked on professionally, as Bob Stephenson's assistant, was the Stansbury site, a historic Indian village site on the east bank of the Brazos River at Whitney Reservoir in Hill County, Texas. Neither Bob nor I knew anything about the European trade goods we found there in the 1950 excavations (see Stephenson 1970:63-104), so we sent samples to Art Woodward and Carlyle Smith, both widely recognized as experts on trade goods, to see if they could identify any of them. They agreed that there were two occupations represented: an earlier one with French trade goods dating to the 18th century, and a later one with American trade goods dating to the early 19th century.

Bob assigned me the job of looking for historic references to an Indian village at the site, and I soon found an English translation of the journals of Athanase de Mézières, who in 1772 visited a Tawakoni village called the Quiscat village, named after the village's chief, located somewhere near the present city of Waco (Bolton 1914). De Mézières returned six years later and visited a second Tawakoni village, named for its chief Flechado, about eight miles upstream from the Quiscat village, and reportedly on the same side of the Brazos River as the Quiscat village. De Mézières noted that the Flechado village was right at the western edge of a narrow forest that he followed northward to the Red River. The Stansbury site is located at the western edge of what is now known as the Eastern Cross Timbers, which fits De Mézières's description of the forest exactly. Thus the presence of 18th century French trade goods at the remains of an Indian village on the Brazos River at the western edge of the Eastern Cross Timbers made the identification of the earlier occupation at Stansbury with the Flechado village a virtual certainty.

With the location of the Flechado village as an established geographical point of reference, the Quiscat village should have been about eight miles below the Stansbury site on the East bank of the Brazos River. So I contacted avocational archeologist Frank Watt of Waco, who for decades had searched for archeological sites along the central Brazos, and asked him if he knew of a historic Indian site on the East side of the river between Waco and Stansbury. Frank, who was very familiar with the Stansbury site and the kinds of native and European artifacts found on its surface, responded that he had walked the fields along that section of the river many times, that there was no such site there, and if there had been he could not have missed it. I trusted Frank's judgment enough that I did not go looking for a possible site myself.

A year or so later, going through the correspondence files of the Anthropology Department at The University of Texas (UT) looking for something or other, I came across a letter written in the 1920s from a Mr. Stone whose farm was on the *west* bank of the Brazos in McLennan County above Waco. He reported finding old gun barrels and other strange objects in one of his plowed fields. I went out to this farm in 1959 and there strewn all over the surface of a plowed field were historic trade materials and distinctive Indian pottery sherds like the ones at Stansbury. Frank Watt did not know about the Stone site as he had restricted his search for archeological sites to the east side of the Brazos.

The Stone site was exactly the right distance from Stansbury to fit De Mézières's location of the Quiscat village. And even though it was on the wrong side of the river according to Bolton's (1914) translation of the De Mezieres journals, it almost certainly was the Quiscat village site.

Then, following a hunch, I located an expert on 18th century Spanish at UT and asked him if he could dig up the original Spanish transcription of the De Mézières journals. A few days later he came by with the transcription and showed me that the passage Bolton had translated as "on the same bank of the river" actually should be translated "on the bank of the same river."

The old caveat that "much is lost in translation" seems surely to apply here, and the conclusion that the Stone site was the location of the Quiscat village and the Stansbury site was the location of the Flechado village is inescapable.

MORAL: When empirical archeological field evidence disagrees with a historical document, archeology trumps history.

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An 18th Century Native American Site (41ME273) in the Seco Creek Valley, Medina County, Texas

Thomas R. Hester
with the collaboration of Jay C. Blaine and Robert J. Mallouf

This paper describes a small assemblage of 18th century Native American artifacts found in 2005 in the Seco Creek valley of northwestern Medina County, Texas. Found on the surface, or just under a heavy leaf cover, were parts of an English tradegun, a French boucheron trade knife, a reworked small knife, tinklers, a buckle, and several parts of a bridle. Since the artifacts were in a tight cluster and there was no evidence of a grave or human remains, it is suggested that these might be objects associated with a tree burial. Adding to the evidence that someone had died and the body been disposed of at this locale was a 54 inch smooth-bore musket barrel, bent and broken in half. Data on early historic sites in the area are reviewed, as is the occurrence of tree burials among Plains Indians and Lipan Apache in the region.

In 2005, a ranch manager walking through a mott of trees, the surface heavily covered with leaves, tripped over a section of what he thought was a pipe. He picked it up and took it back to his home. Wondering why a pipe would be located in that part of the ranch, he took a closer look, and saw that it was part of a gun barrel. He and his wife returned to the locale, and looking closely in the area of the "pipe" discovery, found a series of Native American metal artifacts.

The manager (who asked that his name and the name of the ranch not be used) called me and since I lived at that time a few miles away, he brought them to my home. As we laid out the materials, it was quickly apparent that there were many parts of a flintlock musket, a couple of knives, a few horse trappings, tinklers, and other materials. Practically all of the material had been found on or under the very heavy leaf cover at the site; the manager did some exploration with a metal detector and more tinklers were found. I was able to visit the site, and was shown the area within which the artifacts were discovered.

Subsequently, I was able to photograph and document the specimens. I sent photographs of many of the artifacts to Jay C. Blaine, well-known member of the Texas Archeological Society and author of a number of studies of Historic Native American artifacts (cf. Blaine 1992, 1993; Blaine and Harris 1967). Mr. Blaine quickly replied, and provided identifications, and some preliminary interpretations, of the artifact assemblage.

In my visit to the site, I was able to photograph the area and get information on the context of the finds. The ranch manager showed me an area where the gun parts were found, and a scatter of other artifacts found nearby. In the small area of the site where he had scraped with a pocketknife, we did some additional scraping of soil just beneath the leaf cover and in the upper three cm of the surface, and found a few additional tinklers. No other subsurface exploration was done.

I was told then that the ranch owner and family were very concerned about archeologists working at the site. Most landowners in the region fear that site areas can be appropriated by the State or that some other restriction to their property rights might be imposed.

As the study of these artifacts, their context, and their chronology has gone on, a preliminary interpretation has been developed and is discussed at the end of this paper. At first, colleagues questioned whether these artifacts might have come from a disturbed inhumation. However, no trace of human bone is known from the site. But there are aspects of the artifacts, especially the barrel of the flintlock musket, that suggest that mortuary factors are behind the assemblage. The assemblage was confined to an area about 20 feet (six m) across. I strongly suggest that these artifacts derive from a "tree burial" of a Native American warrior. Scaffold and tree burials were widely used on the Plains, and elsewhere, well into Historic times. And there are also records of such treatment of a body in regional accounts.

For a variety of security concerns, the name of the property, the names of the persons involved (besides my own), and a detailed description of site location cannot be given. The site (41ME273) is on the east side of the Seco Creek valley, roughly 28 km southeast of Utopia (Figure 1). It has vegetation typical of the valley, and the site itself is marked by several dead oaks (Figure 2).

It is a smoothbore barrel, possibly of .62 caliber (20-gauge). Overall, it is a round barrel, although at the breech end it is octagonal, extending for 25 mm toward the muzzle end. The "front" (muzzle) end of the barrel is 66.5 mm long and the "back" half is 80 mm. Thus, the overall length of the barrel is 146.5 mm, just a bit over 54 inches. The barrel itself has a thickness of between four to five mm,

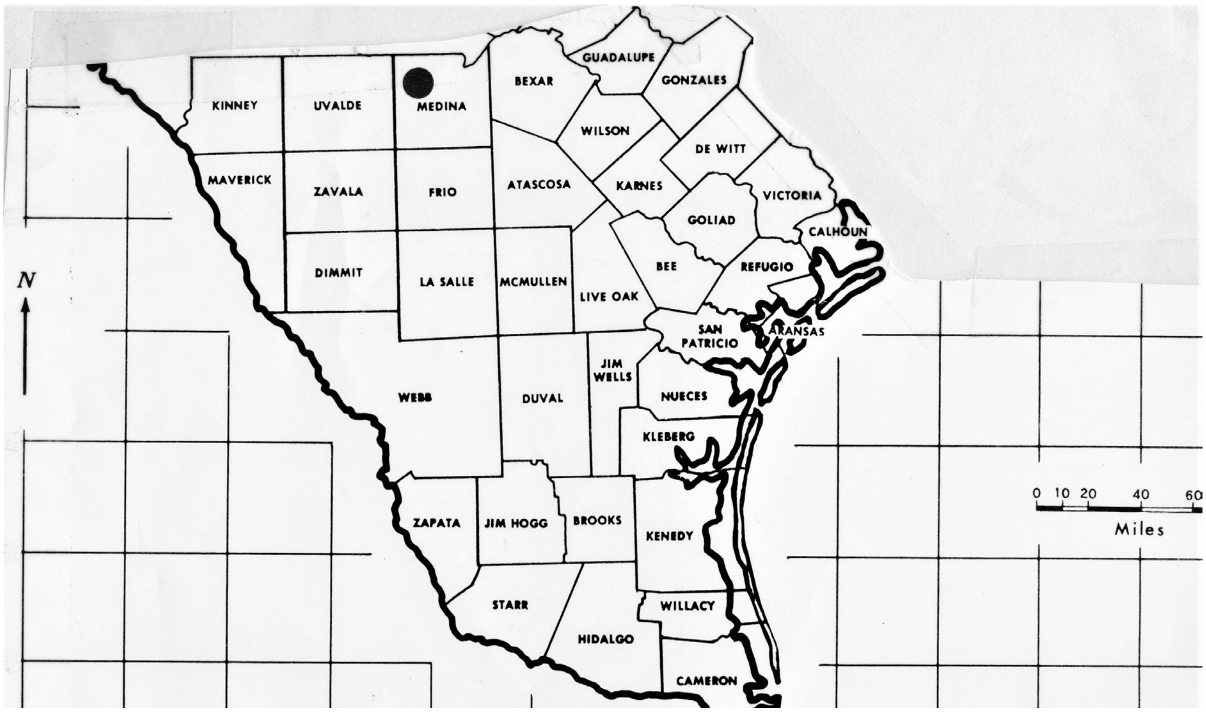

Figure 1. A map of South and South Central Texas showing the general location of 41ME273 in Medina County.

The Artifacts

Following are descriptions of the artifacts found at 41ME273. Initial identification of many of the specimens was through photographs sent to Jay C. Blaine, on December 11, 2005. Other data that helped in identification and terminology came from exchanges of ideas with Robert J. Mallouf (2015a, b). However, I hasten to add that neither of these gentlemen bear any responsibility for the mistakes that might be found herein.

The Gun

The artifact that led to the discovery of this site was the iron gun barrel, two views of which are shown in Figure 3. Actually, the barrel is broken into two pieces (Figure 4) and a visible bend is seen about 25-30 mm from the muzzle. as measured at the break. Distinguishing features of the barrel include a rear sight seat, slightly depressed (chiseled?) and 12 x 7 cm in size; the front sight seat is 18 mm from the muzzle and is also slightly depressed and 10 x 5 cm in size. The gun sights would have been put into the seats. On the underside of the barrel are two underlugs which would have engaged the ramrod. The end of the barrel has a straight tang breech plug with a screw through the tang (Figure 5a). Blaine observed, in 2005, that it was a "butt plate tang screw breech plug" of a type he had never seen. The plug was screwed into the threaded opening at the breech end. Another view, from the top, of the breech plug, and presumably the rear sight. is seen in Figure 5b.

The most distinctive part of the gun is the flintlock, which is seen half-cocked (Figures 6-7). The hammer (82 mm high, attached with a large slotted hammer screw), which would have held a gun flint,

Figure 2. A view of 4lME273, looking east-southeast.

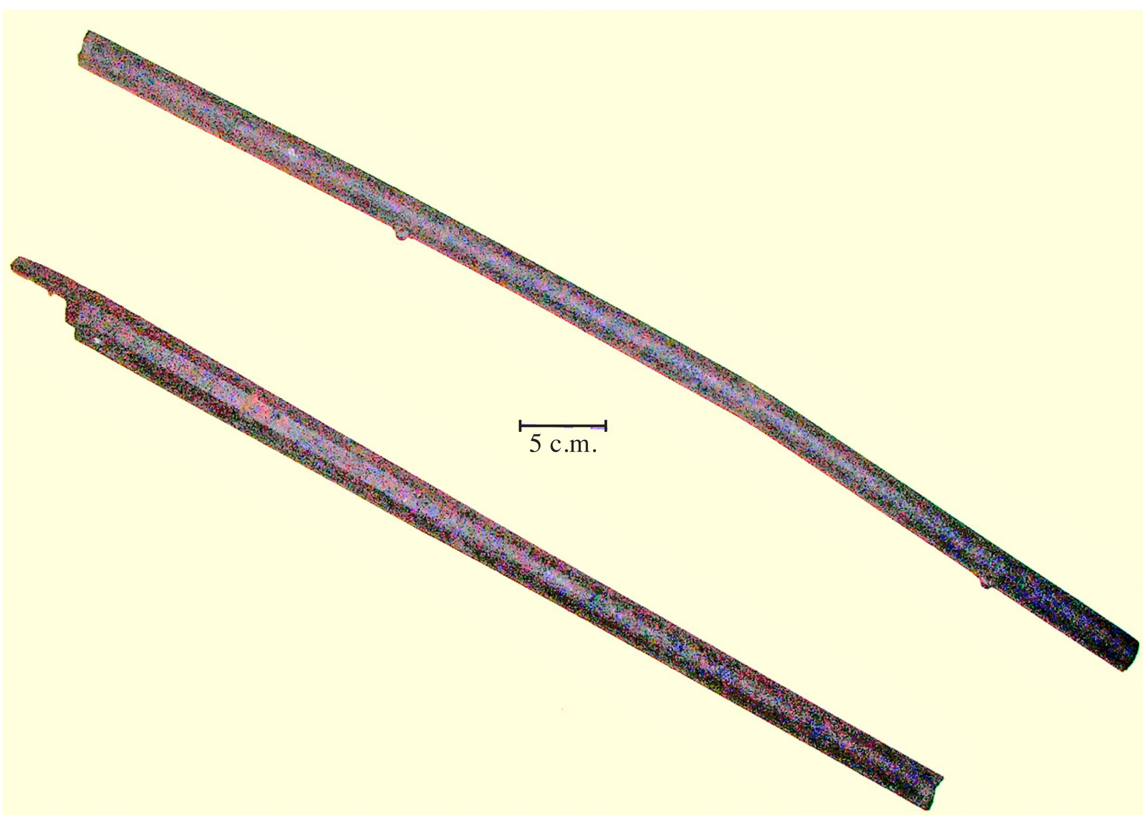

Figure 3. The musket barrel from 4lME273. Both pieces of the musket are shown here. See text for dimensions. Lower, breech end; note breech plug and octagonal barrel in this area; upper, muzzle end of barrel (muzzle at far right); note underlugs on this part of the barrel. Note bend in the muzzle portion of the barrel.

Figure 4. Close up of break in the middle of the musket barrel (see also Figure 3). Breaks are also seen in upper left of muzzle section and lower right of breech section in Figure 3.

Figure 5. Breech plug: a, breech plug at end, side view; b, breech plug at left; note octagonal part of barrel and also what appears to be the rear sight on the barrel.

is part of the three-screw gunlock. The side plate, seen in one side view, had an overall length of 153 mm, but the other side plate is missing. Blaine felt that the second side plate may have been engraved. Figure 7 shows the left side of the lock, with the mainspring clearly visible, and probably the sear spring at the other end (very rusted small parts, such as the tumbler, stirrup pin, and displaced sear appear to be present). The slotted lock screws are at either end, and have outsized heads that are more notable on English trade guns (Hamilton 1980:54). The right side, somewhat better preserved (see

Figure 6) shows the frizzen (41 mm high) which the gunflint would have struck, and the flash-pan below, which held the powder. Below the frizzen and pan (these are forged together) is the frizzen spring. Figure 8 should help the reader tie in some of the terms used above; this illustration is from Nesmith (1986:62-106), representing a Brown Bess flintlock.

Escutcheon

A single escutcheon, likely of iron, was found (Figure 9). It appears to be "plain" but is very rusted, and like all other parts of the gun, was unable to be cleaned. It is 93 mm long and 35 mm wide. There is an engraved line that seems to run around the inside edge on the convex face. Overall,

Figure 6. Left side view of the lock.

Figure 7. Right side view of the lock.

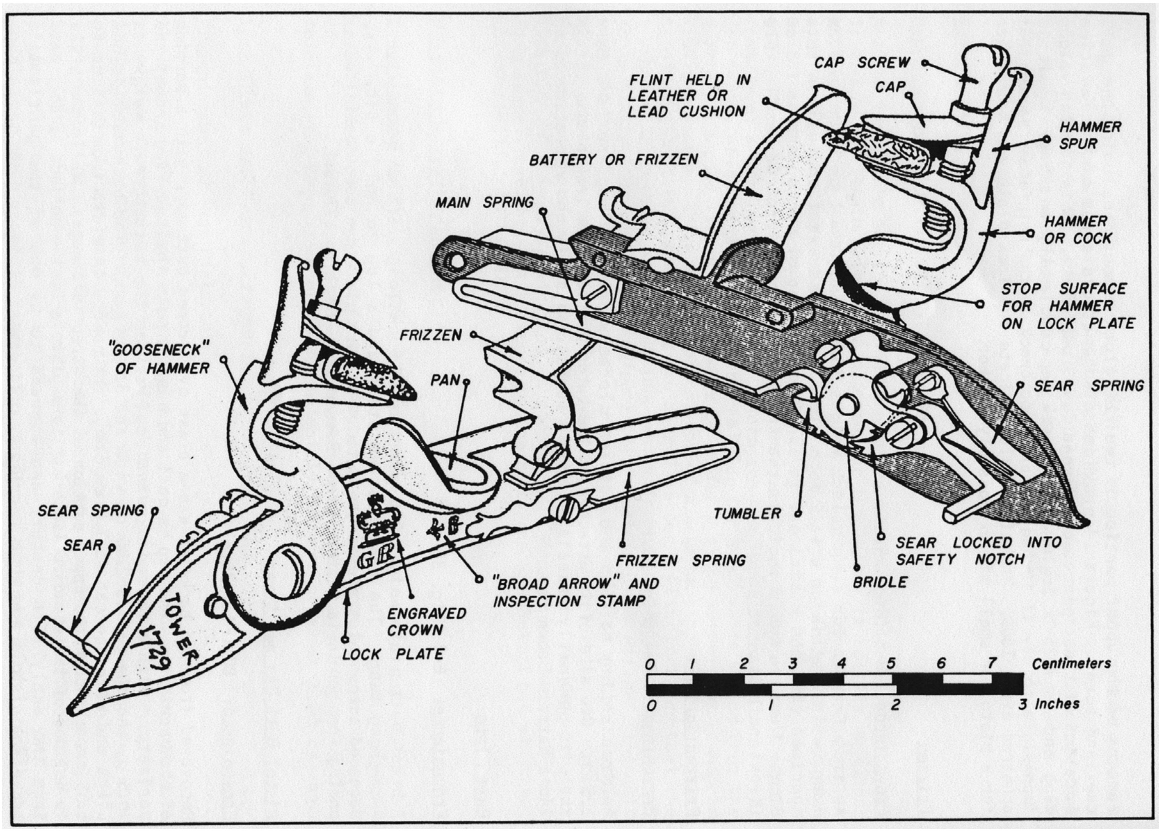

Figure 8. Technical drawing of gun lock, from Nesmith (1986). This is a "Brown Bess" lock but many details applicable to Figures 6 and 7 can be seen here.

Figure 9. Escutcheon, view from above.

it greatly resembles the escutcheon illustrated by Hamilton (1980:Figure 48d) from Ft. Frederica, St. Simons Island, Georgia, and further he noted that it is a variation on "the Type G tradegun escutcheon" and that it is similar to another "Type G tradegun" escutcheon from the Brown site in Missouri. Escutcheons were nailed to the stock with a spike at the top and the bottom (Figures 10-11).

Trigger guards

The assemblage included a flatted, elongated, two-hole trigger guard likely made of brass (Figure 12). At its widest point, it is 20 mm, and thickness is two mm. Broken in five parts, its overall reassembled length is 230 mm (right at nine inches). The front tang and finial are more elaborate A

Figure 10. Escutcheon, underside view, with nails or tacks showing. See also Figure 11.

Figure 11. Escutcheon, side view. Note nails or tacks with which escutcheon was mounted on the stock.

Figure 12. Long trigger guard, with front and rear finials. See text for details.

specimen published from Spanish Fort (Bell et al. 1967:173; and Figure 55j) has a rear tang (finial) that much resembles the specimen from 41ME273 (see also Blaine 1992:Figure 6).

A fragmented trigger guard bow is also present (Figure 13). It is brass or copper and it is 77 mm in length. The outer (convex) surface of the bow (Figure 14) has a precise engraving in the fashion shown in some examples from the Gilbert site (Blaine and Harris 1967:Figure 40). They note a portion of "an engraved floral design" which may represent a flower or a wicker-type basket (Blaine and Harris 1967:78), sounding much like the motif on the trigger guard bow from 41ME273.

Figure 13. Trigger bow guard.

Figure 14. Trigger bow guard, outside (convex) face with engraved "floral" motif.

The Origin and Age of the Gun

Based on the sources I have consulted, this flintlock musket can be identified as an English tradegun of the 1740s era. Mr. Blaine had initially identified the gun, in 2005, as an "English trade-gun," with a time frame estimated from 1700-1770s (see the discussion by Blaine 1993:174-175). Figure 15 (Blaine and Harris 1967:Figure 26) shows many of the elements found on a flintlock musket, as described above.

Knives

Large Knife

The case knife shown in Figure 16 is described as a *boucheron* (butcher knife), a classic French trade knife form (Gladysz and Hamilton 2011; Hickman n.d.). There are three rivet holes in the tang, indicative of a two-piece handle of bone or wood that was attached, if one was attached at all. The iron knife is heavily corroded and no marks, designs, or initials could be seen.

It is 331 m in length and 34 mm in maximum width. Thickness of the tang is 2.5 mm, and the rivet holes are five mm across. Thickness along the straight top edge of the knife varies from three to four mm, while the cutting edge remains rather "sharp," generally about 1 mm thick.

Small Knife

This is a reworked case knife (Figure 17, lower). It has a partially fragmented tang. Reworking of the blade caused the end to be slightly convex (or "rounded off"). It was probably used as a "skinning" or "fleshing" tool. It is 72 mm long, 25 mm

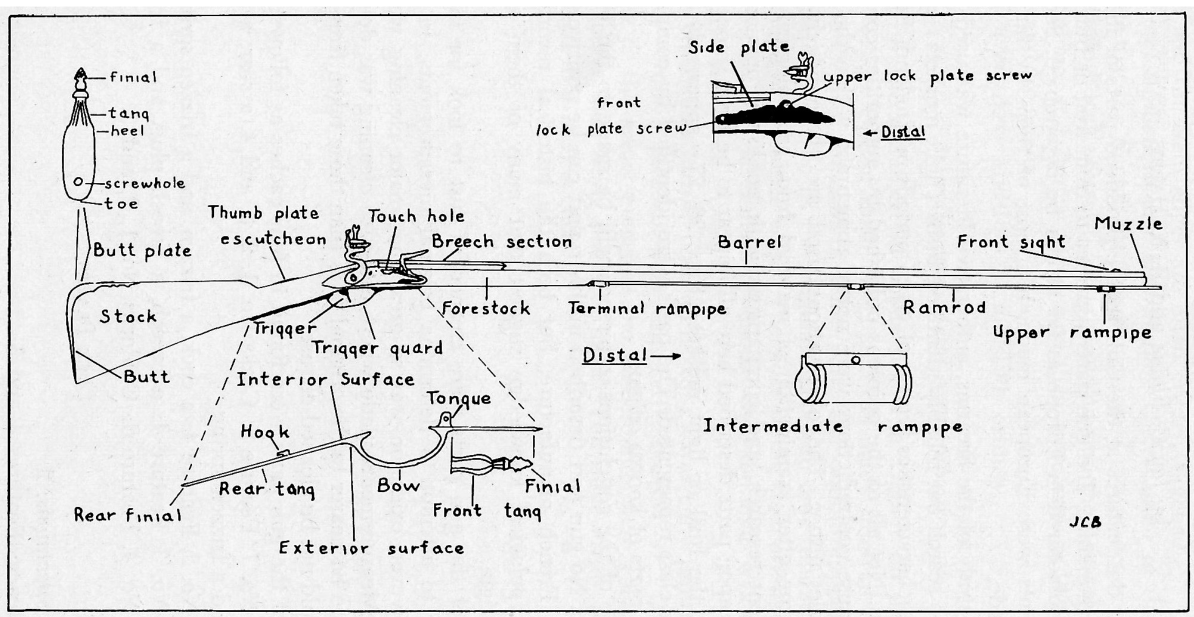

Figure 15. Technical illustration of 18th century flintlock musket (from Blaine and Harris 1967, and courtesy of the Texas Archeological Society). Some, but not all, of the features shown are known from 41ME273.

Figure 16. French trade knife, usually described as a *boucheron.*

Figure 17. Upper, buckle. Lower, small, reworked case knife.

wide at the reworked end, and 28 mm at the haft end. Length of the fragmented tang is 10 mm, and its thickness is six mm. Thickness along the top of the knife blade is three and one half mm.

Robert J. Mallouf has shared a photograph of a very similar specimen from Presidio County, Texas. That specimen has the tang intact and it is roughly 110 mm long.

Buckle

A heavily-rusted buckle, almost D-shaped in outline, is shown in Figure 17 (upper). In width it is 5.5 mm, and height, 4.2 mm. The tongue is 4.3 mm long. The buckle is not distinctive and could have been from a halter, a buckle on a saddle, or a belt on the rider.

Swivel

Probably from a horse bridle or trappings, this iron artifact (Figure 18) is 70 mm long and has a maximum width of 21 mm. Blaine said this was a "pivoted link," which he had not seen before in his own research. Identical specimens are seen on the ends of 16^{th}-18^{th} century bridles. Figure 19 illustrates a variant of a pivoted link at the bottom of a 17^{th} century bit with heavy curb chain (Botterell 2016).

Tinklers

A total of 51 tinkers were found, and a representative sample is shown in Figure 20. Most were of rolled sheet metal, but a few seem to

Figure 18. Pivoted link or swivel.

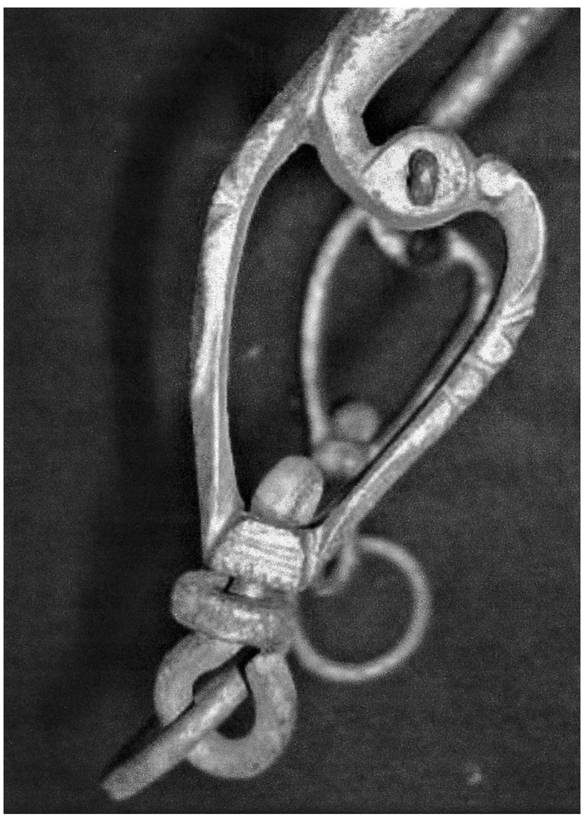

Figure 19. Pivoted link or swivel, close-up view, from lower part of a 17th century heavy curb chain bit (Botterell 2016).

have been made from copper strips. Their lengths ranged between 23-34 mm, and widths, 3-11 mm. Tinklers were used on clothing (e.g., on fringes), and on pouches and cases, among many other things. An excellent example is the small beaded pouch, obtained by Berlandier (1969:Figure 35). Indeed, the number of tinklers found on the pouch fringes far outnumber those from the present site. Stephenson (1970:Plate 9) illustrates a number of tinklers (which he terms "jinglers"), noting they were used as hair ornaments and on the fringes of clothing (Stephenson 1970:103).

Long bi-pointed object

This artifact may have been used in one or more of several functions. As Mr. Blaine interpreted it in 2005, it was a ring bit straightened out and somewhat reworked, and then made into a "perforator" (Figure 21). It is iron and badly rusted. Length is 25.5 mm, thicknesses at the ends, six to eight mm, and in the middle, 11 mm. The middle part of the object (around what might be called a "roller barrel") has been flattened as has one of the tips. It is possibly a vent (or touch) hole pick (to dislodge residue after several firings of the musket), or a tool related in some measure to maintain the English musket. Clearly it is larger than English or French-made tools of this sort (Maggard 1999).

Figure 20. A sample of tinklers from 41ME273.

Figure 21. Long, bi-pointed object. Made from a hammered ring bit.

Miscellaneous small metal objects

One specimen was a tack, perhaps part of the decoration of the wooden stock of the gun. The head of the tack is almost triangular, 19 mm long and 11 mm wide. The prong of the tack is 13 mm long. There was also a heavily rusted slotted screw, perhaps part of the metal assembly on some part of the gun. It is 38 mm long. There were also three thin rusted fragments of iron.

Pitted stone

The single stone object found with the historic materials from 41ME273 is an oblong chert cobble. It 166 mm long, 69 mm wide, and 30 mm thick. On both faces there are small areas marked by use, probably pecking of some sort. The areas are exceedingly shallow (ca. 1-1.5 mm). On one face (Figure 22), the "pecked" areas covers about 42 x 18 mm. On the opposite side (Figure 23), there are two small pecked areas, one 25 mm across, and the other, 13 mm. There is no speculation offered as to how these pecked areas developed. However, there are no prehistoric artifacts anywhere close to 41ME273 and it is assumed, by its surface association, to be linked to the historic Native American materials.

Summary and Interpretations

While histories, stories, and myths say much about the Native American presence in South Central Texas, these are based primarily on 19th century native groups. They deal almost entirely with peoples ultimately derived from the Great Plains and other regions outside Texas. Prior to that time, there are Spanish accounts of encounters with the hunters and gatherers in south and coastal areas, in northeastern Mexico, with the Caddo, and with North Central Texas peoples. As the 18th century progressed, there are growing accounts of Comanche, Lipan Apache, Tonkawa, and others.

The archeological record related to any of these Native Americans is very sparse in the Historic era. Primarily, 19th century groups are noted by rarely found iron arrow points (Chandler 1986, 1993). Then there are storied locations around the countryside in South Central Texas about the presence of a Comanche village over there, or a Lipan Apache camp on a nearby creek. For the most part, no Historic artifacts are found to confirm the presence of any group. At times, the prehistoric sites and projectile points found in great numbers in the region are attributed to "Comanche" or "Apache," without the realization that these remains were left over the past 12,000 years by the native hunter and gatherer cultures. Those who survived into the Historic era succumbed to Spanish disease, mission practices that replaced their hunting and gathering ways, and many died at the hands of some of the first waves of intrusive Plains Indians.

Some examples of 16th century to 19th century aboriginal occupations are noted here, and they are few. The oldest, a small rock shelter (41BN177) used by Spanish slave traders and silver miners, is in Bandera County, and has an inscribed date of 1577 (Maroney 2010; Figure 24). The Spaniards either came from the Saltillo area (agents of Alberto del Canto, founder of Saltillo, Coahuila) or an expedition under the direction of Luis de Carvajal y de la Cueva (headquartered in Cerralvo, Nuevo Leon). Carvajal is reputed to be the first Spaniard to have crossed the Rio Grande, and also it has been claimed he explored as far north as Austin by 1578. These Spaniards left us no information about the local peoples prior to the appearance of Plains Native Americans; all we know is that they were capturing hunters and gatherers to use as slaves.

Close to the route of the Spanish expeditions from the northeast Mexico missions to the San Antonio area in the 1700s is Fort Lincoln (Haas 1996) on Seco Creek near D'Hanis. It was established as an 1849 frontier fort, and at times, served as a Texas Rangers camp. John and Margaret Bergmann have told me of a 1755 Spanish coin found on the surface there.

There is also an mid-to-late 18th century Spanish belt knife (Jay C. Blaine, letter to author, December 12, 1990; Figure 25). It was found on the old Haby Ranch (now owned by Roy and Janelle Gazaway) on Seco Creek. Initially described by Headrick and Ellis (2002), it was an isolated find and whether it was left behind by a Spaniard, or a Native American who had obtained it, will always be unknown.

Near Montell, in Uvalde County (41UV74), H. Ray Smith has done extensive notes (kindly provided to me) and photographed a long metal lance point (at least 12.5 inches long, and 1 5/8 inches at its widest) found by Dr. Sterling Fly in 1953. It is an isolated find, surely dating to the 19th century.

A small rock shelter on the Nueces River south of Uvalde preserves pictographs of mounted riders

Figure 22. Pitted stone, one face.

Figure 23. Pitted stone, opposite face.

and bison. The Prade Ranch rock art panel in Real County has a variety of Historic Native American pictographs.

In no locality, known to the author, has even a modest concentration of historic Native American material culture been found. Thus, when the ranch manager discovered 41ME273, it was felt to be of great importance. Exploration of the area (roughly 20 ft, or less, across) revealed parts of an English trade gun, a French trade knife (*boucheron*), and other artifacts that were perhaps left or lost by a quickly moving hunting or raiding party. There was no "midden" or any other indication of a campsite, however brief it might have been. Given the general male affinities

Figure 24. View of 41BN177. It is on the protected hard limestone stratum that the Spanish date of 1577 is cut (Maroney 2010).

Figure 25. An 18th century Spanish belt knife from old Haby ranch, on Seco Creek, 15-20 miles upstream from 41ME273.

of the collected artifacts, I began to explore the idea that these were related to an individual that was a member of this group who died at or near this locale. Perhaps due to his status, or the hardness of the local rocky soil, the body was likely placed in a large bend or limb of a big live oak tree, and was probably lashed to it. This method of disposing of a corpse is widely known in the literature as a tree burial (cf. Yarrow 1881). With him were placed the artifacts that were his, or at least important to him. At the time of the "tree burial" his musket barrel was bent and broken, and other goods may have also been destroyed.

Figure 26. An Oglala Sioux tree burial near Fort Laramie, Wyoming. Photograph by Alexander Gardner, 1868. NARA 530913.

An example of an English tradegun (a "TR" gun), was examined by Burke (1980) in a collection at the Smithsonian Institution. The gun parts came from the Yuchi Townsite (eastern Alabama), and were apparently found with a burial. Burke (1980:68) noted that "the barrel had been bent double prior to burial, and is now broken apart at the bend. In Burke (1980:Figure 39c), the trigger guard from this same gun was described as having a "…twist…occurring when the gun was 'killed' by wrapping it around a tree at the time of burial."

There are additional references that point to the ritual destruction of a man's bow and arrows and other weapons at his death (Berlandier 1969:117; Yarrow 1881; Gelo 2002). The "killing" of muskets is not well documented.

This tree burial event took place at 41ME273 perhaps in the last part of the 18th century. Though the English trade gun dated earlier, and certainly, the *boucheron* could be equally as old, it has been suggested that the "lifetime" of a trade gun was something on the order of 30 years. Mr. Blaine used the dates of the artifacts and this use-life projection for the musket to suggest that deposition of these artifacts took place in the 1770s, but it admittedly could have been somewhat earlier. If this assemblage is part of a tree burial, as I have suggested, the artifacts gathered with the body fell to the ground as the corpse and burial wrappings deteriorated. Whether the "killed musket" was placed in the burial or thrown down nearby is unknown. Animals likely scattered some of the artifacts while the body was in place, and certainly

Figure 27. A tree burial of the Crow tribe. Burial placed in a cottonwood tree. Photograph by Frank Rinehart, Omaha, Nebraska, 1900.

Figure 28. An Oglala Sioux tree burial near Fort Bennett. Cheyenne River Agency.

could have further scattered them after they fell to the ground.

Tree burials and the more common scaffold burials were found among many Plains Indian tribes. The Comanche were known to practice this type of body disposal at times, though they more frequently used burial pits, placement in crevices or caves, or utilized scaffold cemeteries (Yarrow 1881; Gelo 2002). Indeed, Wallace and Hoebel (1986:150-151) state that Comanche used tree burials only in the "last half of the nineteenth century." A sample of published examples of tree burials by the Native Americans of the Plain are presented here in Figures 26-28.

It is of interest, for general comparison, that tree burials occurred into the 19th century in the South Central Texas region. Such burials were often done while the group was being pursued by local settlers or military units. One account is from north of Sabinal (Uvalde County), Texas, where in March 1860, a group of Lipan Apaches carried out a deadly raid. The next day a posse pursuing the raiders found several settler fatalities. "They also found a dead Indian, rolled in a blanket, and placed in the forks of a live oak tree, with his shield, bow, and arrows placed near it' (Michno 2011:35). Wilbarger (1889:653) reported this same event as an "account of 1860 pursuit of Indians on the West Sabinal River" where they "found the body of an Indian placed in the forks of a live oak tree, with his blanket rolled around him and his shield, bow and arrows and other equipment placed near it."

It would require more research to try to identify the individual at 41ME273 with a particular ethnic group. For example, Berlandier (1969:119) notes that "the Comanches were abundantly supplied with firearms. A people they call the Aguajes, known as Pananes over toward New Mexico, bring their guns in from Canada. These weapons must be of English manufacture, and that is why the American traders sell them so few guns. But, to make up for that, they sell a good deal of ammunition."

Blaine (1993:175-175), writing on gun parts found at the Vinson site (Limestone County), notes that the Texas Indians had initially obtained most of their guns from French traders. But, English guns among the Native American groups first appeared in significant numbers ca. 1770. Blaine (1993:183) also reports that the English guns at the Vinson site "were being produced before ca. 1740 and it is very unlikely they were still in production by ca. 1775." It is thought that the Vinson site represents Nortenos: the Wichita-speaking peoples in Texas. The Stansbury site (41HI9) also yielded fragments of English and French muskets dated largely to the late 18th century (Stephenson 1970).

Several authors who have reviewed the Native American populations in South Central Texas suggest that any major Lipan Apache presence was rare after the 1750s-1770s. Newcomb (1969) records the end, in 1771, of Mission San Lorenzo de la Santa Cruz, which had been established for the Lipan Apache. He further notes (Newcomb 1969:176) that they were being pushed into southern Texas and especially to northeastern Mexico. Chipman (1992:198ff) echoes this situation. Bolton (1962), Newcomb (1969), Chipman (1992), Jackson and Foster (1995) and Wade (2003:195ff) go into more detail about Spanish relationships with both the Lipan Apache and the Comanche in the late 18th century, the particulars of which are not directly relevant to this paper.

Finally, it is likely we will never know the reasons why this late 18th century Native American, presumably with a band of colleagues, passed though the Seco Creek valley. They may have been a raiding party; a group returning from an encounter in which one of their own might have been mortally wounded; they might have been enroute to San Antonio for trading purposes; they could have been on a hunt (see below); or it is just possible they were looking for mounts from among the wild horses that were common in the valley. Although a bit later in time, Berlandier (1980) set out from San Antonio with a hunting party of Spanish troops and 50-80 Comanches, all led by Col. Francisco del Ruiz. Making a loop to the west, through the drainages of the Guadalupe, Nueces, and their tributaries, Berlandier comments extensively on bison, and especially on the numerous black bears which were the focus of much of their hunting. Berlandier (1980:362-364) further offers some interesting aspects of the Seco Creek environs in a locale not all that far from the site described here:

> We spent the night (December 14, 1827) in a small valley watered by the stream known as the Arroyo Seco…Its banks, like those of the Frio, are frequented by wild horses whose tracks are seen everywhere… this is where the military of the presidio [San Antonio] …sometimes go to seek mounts when the government has not furnished them with any.

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Seed Beads at Mission Dolores and Mission San Miguel: A Preliminary Study of Groupings by Color

George E. Avery

In 2008 a shovel testing survey of Mission Dolores, combined with a geophysical survey of the area, was conducted. In 2014 test pits were excavated at places indicated by a geophysical survey at Mission San Miguel. In both cases, the geophysical survey met with limited success. However, the seed bead color patterns were virtually the same for Mission Dolores and Mission San Miguel. The possible meaning of this is discussed.

Seed beads are commonly found at 18th century sites in East Texas and Northwest Louisiana, especially when water screening archeological deposits through 1/16-inch mesh is employed. The function of seed beads during the 18th century was primarily for embroidery work on various articles of clothing, although they were also used in necklaces, earrings, and nose and hair ornaments (Karklins 2012:84). Seed beads measure up to four mm in diameter. There were 28 seed beads recovered from Mission Dolores (Figure 1) and 38 seed beads recovered from Mission San Miguel (Figure 2) in recent work. These are admittedly small amounts, so this should be considered an initial study. The seed beads were all mostly drawn beads; that is, rather than wound around and around (wound beads), drawn beads were pulled into a long rod with a hole in it. After this, the individual beads were broken off the rod, and the sharp edges were usually rounded off by tumbling the beads (Kidd and Kidd 1970). Sometimes the jagged edges were left "as is."

The description of the color of the beads is black, blue, clear, white, and red. This description is a simplified form of what was observed, particularly for the blue seed beads. There are several different kinds of blue observed—a navy blue, regular blue, and aquamarine—but all blues have been lumped together. The red beads are actually a compound, or two-part bead, with an amber center and red exterior. Sometimes these are referred to as Cornaline d'Aleppo beads. The white beads are also solid white, and have a white interior with a clear exterior. Both forms of bead are referred to as "white" for the purposes of this study. The black seed beads are an opaque black; sometimes a root beer color is indicated for "black" seed beads that are placed on a light table.

Mission Dolores and Mission San Miguel

Mission Dolores and Mission San Miguel represent the two easternmost missions of New Spain in the 18th century. They were administered by the College of Zacatecas. Dolores is located at San Augustine, Texas, and San Miguel is located near Robeline, Louisiana. Both sites date to 1721-1773, as based on archival documents. There was an earlier site for both missions, which date to 1717-1719, again, according to archival documents. This earlier site has not been located for either Mission Dolores or Mission San Miguel (see Corbin et al. 1990; Avery et al. 2016). Other contemporaneous sites in the area are very few.

Perttula (2016) has done an analysis on the pottery and diagnostic lithics from sites in the Ayish Bayou and the Palo Gaucho Bayou basins located by Gus Arnold in 1939. The Mission Dolores pottery assemblage is very unique compared to the other sites in the area. Perttula (2016:30) states, ". . . [the] Mission Dolores de los Ais ceramic assemblage stands apart in several distinctive ways from Late to Historic Caddo ceramic assemblages associated with Hasinai Caddo groups living in adjoining basins in this part of East Texas." Mission Dolores is unique in its relatively high proportion of shell-tempered pottery (14 percent), with 83 percent bone-tempered, 1 percent bone and shell-tempered, and two percent sand and hematite tempered pottery in the 60 shovel test sample (Avery 2016:59). In turn, Mission San Miguel is also distinctive concerning Louisiana sites—it has an unusually high percentage of bone-tempered pottery (24 percent) and bone and shell-tempered pottery (14 percent), with 59 percent of the sherds being shell-tempered. Three percent of the pottery at Mission San Miguel is grog-tempered. Also, Mission Dolores has Emory Punctated (Incised) and Natchitoches Engraved pottery recovered—these are two types that are not common in East Texas. These two types are both bone-tempered and shell-tempered at Mission Dolores. The same types are present at Mission San Miguel, and they are also both bone-tempered and shell-tempered.

Both mission sites have had geophysical surveys conducted there. Texas Historical Commision archeologists James Bruseth, Tiffany Osburn, and Bill Pierson, with an independent contractor, Chet Walker, did a magnetometer, ground penetrating radar, and EM-61 survey at Mission Dolores in 2008 (Bruseth et al. 2016:135-149; Walker 2016:151-158). Jami Lockhart of the Arkansas Archeological Survey was the primary person who did the geophysical survey at Mission San Miguel in 2013 (Lockhart 2016:102-116). Jeff Williams and Charles Ashton of Stephen F. Austin State University assisted Lockhart. There was also a shovel testing project of 60 shovel tests at Mission Dolores in 2008 (Avery 2016), and 10 1 x 1 meter units were excavated at Mission San Miguel in 2014 (Avery et al. 2016). The geophysical survey met with "limited success" at both sites, which may be due to the fact that there was only a small number of people who lived at each site who did not build structures or walls with very deep foundations. at either site.

The amount of excavation of the two projects included 5.4 m^2 for the Mission Dolores shovel tests, and 10.0 m^2 for the San Miguel excavation units. The excavations at Mission Dolores were 60 30 x 30 cm shovel tests on a 10 m grid across the entire mission compound. The excavations at Mission San Miguel were 10 1 x 1 m test units over a much smaller area. At San Miguel, the houses of the soldiers who were assigned to the missions were not included in the sample area. Excavations at Mission Dolores did include one feature [Shovel Test N89 W120 (Avery 2016:50)], but at Mission San Miguel, most of the features were identified, but not generally excavated. The one exception was the midden on the western end of the excavations, which was excavated to a sterile 10YR 3/6 silty clay zone at ca. 45 cm below surface (Avery et. al. 2016:45-46).

Figures 1 and 2 show the seed beads recovered from the recent work at Mission Dolores and Mission San Miguel. Figure 3 shows the color patterns for the seed beads at both missions. Figure 4 shows the seed bead color patterns for sites in the vicinity of Mission Dolores and Mission San Miguel. The sites are described in Table 1. Three of the four sites around Nacogdoches have color patterns dominated by blue (41HO64, Deshazo, and Stephens), while another site primarily has white seed beads (Spradley). A correspondence analysis (Avery 2008) revealed that the four sites are very similar in the colors of the beads in their assemblages. There are very few black seed beads from these four sites, while Mission Dolores and Mission San Miguel have roughly 25 percent black seed beads.

Discussion

Who is represented by the bead color pattern observed at Mission Dolores and Mission San Miguel? First, it is probably reasonable to suggest that the seed beads are not associated with the apparel of the religious personnel at the missions. Second, it must be stated that Indians typically did not live at the missions. This is always mentioned for Mission San Miguel, but for Mission Dolores, the Indians did come to live there for a short time in the 1750s. At both missions, the people living there would be a priest and lay brother(s). We do know that the Adaes and Ais Indians would come to the missions to visit and to help with the crops. Also, there were two soldiers, likely with families, who lived near the San Miguel compound. It is likely the soldiers and their families lived in, or very near, the compound at Dolores. It seems fair to say that the people represented at both missions by the seed beads were the Mission soldiers, their wives and children, and the Indians who came to visit the religious personnel. We can possibly also add a French trader.

There is clearly a difference in the bead color patterns between the Mission and Presidio at Los Adaes (see Figure 3). These two entities are fairly close in proximity. Father Solís (1931-1932) in his 1768 inspection of Mission San Miguel mentioned that most of the Indians, who came to the area, went to the Presidio at Los Adaes. It seems fair to suggest that it was probably only the Adaes Indians who were going to Mission San Miguel. It is important to recognize that the materials recovered from the missions do not necessarily represent

Figure 1. Mission Dolores seed beads.

Figure 2. Mission San Miguel seed beads.

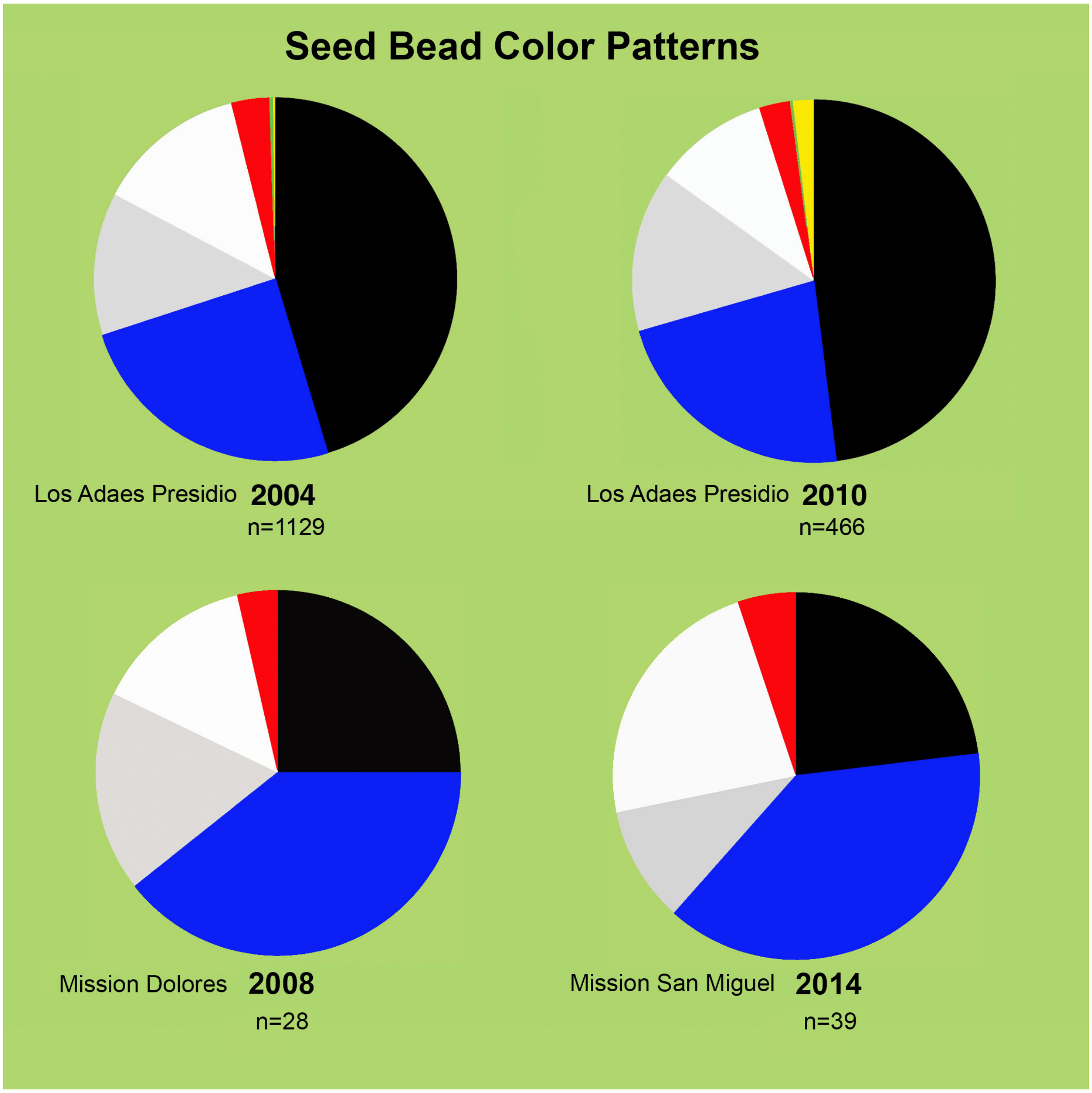

Figure 3. Seed Bead Color Patterns.

habitation behavior for the Ais and Adaes Indians. For example, the faunal remains collected at the missions are *not* representative of Ais and Adaes people. But the Ais and Adaes *do* contribute to the seed beads collected at the missions, although they are not the only ones to do so, as the soldiers, their wives, and children may also have contributed. Also, at Mission Dolores, French traders probably contributed seed beads (Corbin et al. 1990). In all the contexts recorded for this study, the seed beads represent an accidental loss.

Conclusions

The seed beads found at Mission Dolores and Mission San Miguel may represent the people who either lived at the missions or came to visit. These people would have included the Indians, the soldiers and their wives and children, and possibly French traders. They probably do not represent the religious personnel at either of the missions. The fact that the small samples from Mission Dolores and Mission San Miguel are similar may simply

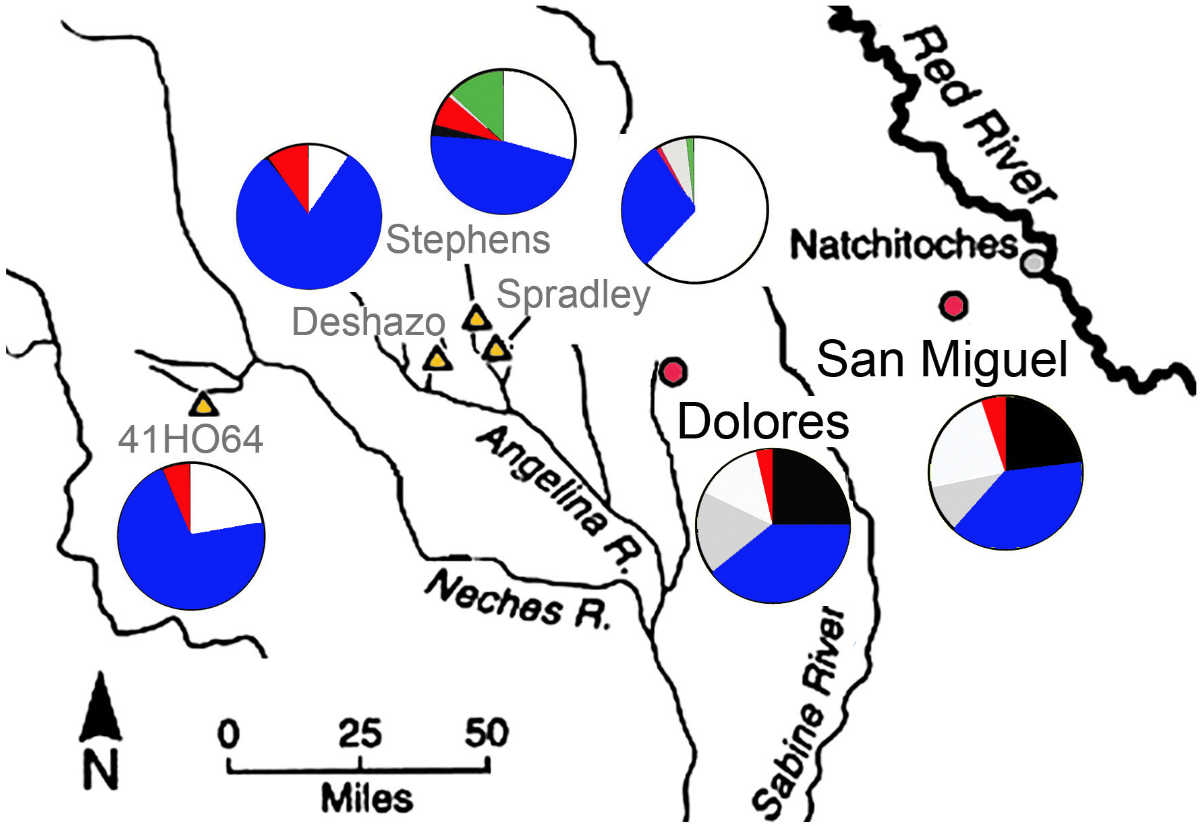

Figure 4. Map of Study Sites, with Color.

Table 1. Seed Bead Color Patterns for sites near Mission Dolores.

Site	Date of Occupation	Source	Black	Blue	Clear	White	Red	Green	Amber
41HO64	late 1600s, early 1700s	Perttula 2004	11	3698	0	1172	333	0	0
Deshazo (41NA27)	1686-1714	Creel 1982	33	2675	0	399	328	0	0
Stephens (41NA202)	1714-1830	Turner pers. comm. 2008	202	3267	73	2067	503	910	0
Spradley (41NA206)	late 1600s, early 1700s	Avery 2008	0	19	4	40	1	1	0
Mission Dolores (41SA25)	1721-1773	Avery 2016	7	11	5	4	1	0	0
Mission San Miguel (16NA16)	1721-1773	Avery et al. 2016	9	15	4	9	2	0	0

be a factor of small sample size. Or, it might mean that there was a common cadre of people that were involved in the interaction with the missionaries.

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Below-Ground Large Wooden Barrel Cisterns at Historic Frost Town: Defining a New Cistern Type For Texas

Douglas K. Boyd and Damon A. Burden

In 2016, the first of two phases of data recovery investigations was conducted at the historic Frost Town community (41HR982), along Buffalo Bayou just north of downtown Houston. More than 800 features were documented, and most of them are associated with early nineteenth- to early twentieth-century households. Nine below-ground cisterns were discovered during data recovery and previous survey investigations. Six of these were partially or completely excavated during the first phase of data recovery. Notably, two of the excavated cisterns are large wooden barrels that were buried at two different households. These features are reported here for the first time. Along with one similar cistern previously excavated at the historic San Felipe de Austin townsite, these large wooden barrels represent a new type of below-ground cistern for Texas. The dating of the construction of these features is not precise, but one of the wooden barrel cisterns at Frost Town appears to have been constructed, used, and abandoned by the 1880s. The other cistern probably was constructed in the late nineteenth century and abandoned by about 1915.

Texas Cistern Archeology and Typology

As a common type of archeological feature found all across Texas, cisterns are simple in one respect—each one once functioned as a water container. Beyond that commonality, however, cisterns vary widely in size, shape, materials, and construction techniques. Each individual cistern has its own unique history of installation, use-life, and abandonment. Understanding cisterns becomes even more complex when the variables of time, space, and the social identities of the cistern builders are added to the mix.

After many years of seeing and studying cisterns found in archeological investigations all over Texas, Mark Denton (2011) published a typology of historical underground cisterns with estimated dates of their manufacture or period of common use. The cistern types defined by Denton are:

- Bottle Cistern, ca. 1820s – 1870s
- Rectangular Cistern, ca. 1840s – 1860s
- Beveled-Shoulder Cistern, ca. Early 1860s – Late 1870s
- Bell Cistern, ca. 1880s –1900s
- Bell and Beveled-Shoulder Forms Modified
  - Semi-Masonry Cistern, ca. post-1860s
  - Well Cistern, ca. post 1860s

This typology is based primarily on the shape of the cistern container, but it also incorporates a temporal element, and, to some degree, the materials from which a cistern was constructed. But Denton also noted that the typology has some inherent limitations due to the nature of the archeological sample. He stated: "Unfortunately, the predominant lack of shoulder and neck cistern components in archeological context severely limits an archeologist's ability to date and classify cisterns" (Denton 2011:7). Like all typologies in their infancy, Denton's cistern typology is certainly an oversimplification, and it will undoubtedly be refined in the future to better account for variations in physical properties and cultural differences that vary temporally and geographically.

Cisterns are almost always filled with sediments and/or artifacts when they are found, and historical archeologists are keenly aware of the many issues relating to interpreting cistern fill. Understanding how, when, and why each cistern was filled can be a complex interpretive task. The sediments and artifacts deposited in a cistern may represent a single or multiple dumping/filling episodes. Temporally diagnostic artifacts recovered from a cistern's fill may or may not accurately reflect the actual time of the cistern's abandonment. Besides the issue of artifact lag time, some cisterns were filled rapidly soon after they were abandoned, while others may have been abandoned and unused for many years before being filled in. An open cistern might have simply been used as a convenient trash pit over an extended period of time, or it may have been intentionally filled in rather quickly for a variety of reasons (such as to eliminate a safety hazard or to fill a void and level an area for subsequent construction).

Notably, all of Denton's defined cistern types represent below-ground cisterns because that is what archeologists find and study. He did mention above-ground cisterns, observing that: "No doubt, most early home owners in Texas who had a drinking water cistern owned above-ground wooden or metal cisterns rather than the more expensive underground masonry cistern. While archeological evidence of above-ground cisterns is virtually nonexistent, archival records such as historic photographs and newspaper advertisements confirm the sale of above-ground cisterns" (Denton 2011:3–4). In contrast to the lack of archeological evidence for above-ground cisterns, large underground cisterns, regardless of how their walls were lined, are prominent features that have survived well in the archeological record.

Denton's typology did not include large wooden barrel cisterns among his defined types of below-ground archeological features. This is not surprising because at the time the article was written (late 2010), archeologists had found only one such feature and it was not yet fully reported. As described later in this article, Marek had excavated a large wooden barrel cistern in 2004–2005. It was mentioned in a popular article in 2005 and a preliminary report in 2007, but the final report was not completed until 2011 (Marek 2005, 2007, 2011a, 2011b). In 2016, Prewitt and Associates, Inc. (PAI), archeologists discovered two more of these large wooden barrel cisterns buried at the Frost Town site near downtown Houston. Based on Marek's previous find and PAI's recent finds, large wooden barrel cisterns can definitely be added to the list of underground cistern types for Texas.

Documenting Urban Cisterns: The Frost Town Archeological Project

PAI archeologists conducted the first substantial subsurface testing at Frost Town in 2004, and the results of this work were described by Boyd et al. (2005). It was during this project that the trinomial site number 41HR982 was assigned to the 8-block area called Frost Town. The Texas Department of Transportation (TxDOT) sponsored the archeological work in conjunction with the planned demolition and replacement of a 1950s-era bridge called the Elysian Viaduct. Subsurface investigations consisted of slow horizontal stripping in numerous Gradall trenches excavated across the Frost Town site. Three brick-lined cisterns were discovered in these Gradall trenches. TxDOT and the Texas Historical Commission agreed that the Frost Town site was eligible for designation as a State Archeological Landmark and for listing on the National Register of Historic Places. In 2009, a portion of the Frost Town site on private land was actually designated as a State Archeological Landmark (now State Antiquities Landmark) by the Texas Historical Commission.

As part of the same TxDOT road project, PAI returned to Frost Town in 2015 to conduct more intensive mechanical trenching. This work discovered more buried features, including a brick-lined cistern, and provided sufficient information for planning a comprehensive data recovery effort. PAI then began Phase I of a large-scale data recovery excavation effort in May 2016, and this work continued into November 2016. The Phase I investigations consisted of broad-area excavations using a trackhoe to remove overburden (artificial and disturbed fill) and carefully scrape the Frost Town target zone to identify cultural features. Over 800 cultural features were identified in this manner, and many of these were partially or completely excavated by hand.

During the Phase I data recovery effort, five more cisterns were found. All of these and a previously identified brick-lined cistern were partially or completely excavated. A total of nine cisterns have been documented thus far at the Frost Town site. Seven of these were brick-lined cisterns while only two were wooden barrel cisterns. Table 1 summarizes the attributes of the nine cisterns found at the Frost Town site.

Current plans are for the Phase II data recovery to be conducted in 2017, following the demolition of the old Elysian Viaduct bridge and prior to the construction of the new roadway. This work will concentrate on areas immediately underneath the viaduct, areas that were covered with road pavement, concrete curbs and sidewalks, and median areas between roadways that were too small to be investigated in Phase I. During this

Table 1. Summary of cistern features found at the Frost Town site*

2016 Feature No.	2004 Feature No.	Cistern Type	Frost Town Block	Level of Investigation	Maximum Interior Diameter (feet)	Maximum Depth (feet)	Volume (cubic feet)	Volume (gallons)
13	11-A	Brick-lined, beveled shoulder	C	Not yet excavated. Slated for investigation in Phase II data recovery.	7.0	--	--	--
23	12-A	Brick-lined, beveled shoulder	C	Not yet excavated. Slated for investigation in Phase II data recovery.	7.6	--	--	--
33	13-H	Brick-lined, beveled shoulder	C	Not yet excavated. Slated for investigation in Phase II data recovery.	7.0	--	--	--
57	18-1	Brick-lined, beveled shoulder	H	Fully excavated	8.0	8.7	437	3269
60	--	Brick-lined, beveled shoulder	Moody	Only one-half excavated. West half left intact	7.5	9.2	406	3037
183	--	Brick-lined, beveled shoulder	D	Fully excavated	8.0	10.6	532	3980
511	--	Brick-lined beveled shoulder	F	Fully excavated	7.9	9.2	451	3374
584	--	Wooden barrel, cylindrical	F	Fully excavated	5.3	3.7	85	636
805	--	Wooden barrel, cylindrical	H	Only one-half excavated. North half left intact	5.3	4.1	91	681

* NOTE: The tops of all cisterns were truncated by post-occupation activities. All brick-lined cisterns were truncated at the shoulder, so volume estimates are relatively accurate. It is not known how much of the upper portions were removed from the two wooden barrel cisterns."

phase of investigation, three cisterns under the old viaduct will be excavated, along with any more that may be found.

Cisterns are one of the most common types of features encountered during urban archeological projects all across Texas, and Houston is no exception. Frost Town is just one of many locations in and near downtown Houston where cisterns have been found. There is one primary reason that cisterns are so well represented in the urban archeological record, and that is that they are big and hard to miss. This is especially true for cisterns with walls made of concrete, mortared bricks, or rocks.

As part of our background research on historical archeology in Houston leading up to the current Frost Town data recovery effort, PAI archeologists examined many archeological reports. It is beyond the scope of this article to summarize and list references for all previous cistern finds in Houston. In this research, however, we identified dozens of sites where more than 50 cisterns or cistern-related features were discovered and archeologically investigated in or near downtown Houston. In all cases where the cisterns are adequately described, they are brick-lined cisterns. In the nineteenth century, brick was the material of choice for making cisterns throughout the Texas coast and East Texas regions because suitable rocks were scarce or nonexistent.

Large Wooden Barrel Cisterns: A New Cistern Type For Texas

Prior to the twentieth century, wooden barrels were commonly used as containers for holding and shipping many things, from nails and pickles to beer and whiskey. Barrels were a convenient way to ship things because they could be rolled by hand and loaded onto ships, trains, and wagons. Wooden barrels used for most products were relatively small, ranging in size from a few gallons up to about 60 gallons, so that they could be moved easily by one or two workers. However, coopers also made relatively large barrels for other purposes, and in the late nineteenth century large wooden barrels were marketed as cisterns[1] and were intended for capturing and storing rainwater that fell on commercial and residential structures. Figure 1 is a 1938 photograph by Lee Russell that shows a large wooden barrel cistern used in conjunction with a gutter system to capture the roof runoff. This particular example is from Louisiana, but it is typical of above-ground barrel cisterns found all across the southern United States.

Historically, it is certain that most wooden barrel cisterns were installed and used above ground (Denton 2011:3–4). While the burial of large wooden barrels to serve as residential cisterns seems to have been relatively rare, it did occur. To the author's knowledge, only three documented examples of below-ground, large wooden barrel cisterns have been archeologically investigated in Texas. The one at the historic town of San Felipe de Austin was investigated in 2004–2005 by Marek (2007, 2011a, 2011b). The other two were found and excavated in the Frost Town site during the 2016 data recovery investigations conducted by PAI archeologists. Both of these cisterns, Feature 584 in Frost Town Block F and Feature 805 in Frost Town Block H, were found by mechanical scraping using a trackhoe. Once located and determined to be cisterns, the following general methodology was used to investigate each: (1) a trackhoe was used to excavate a large area beside the feature so the exterior of the cistern could be documented; (2) one-half of the feature was removed by hand excavation to create a vertical cross-section and document the stratigraphic profile of the cistern fill. In both cases, all excavated fill was screened through 1/4 inch mesh to recover cultural materials. Feature 584 was completely excavated because it was in an area where the impacts of road construction would likely lead to its total destruction. Conversely, only about half of Feature 805 was excavated; the northern 60 percent was left in situ since it is not expected to be impacted by proposed road construction activities. Having recovered many hundreds of artifacts from the south half of Feature 805, there was no need to excavate the remaining half if it could be preserved.

San Felipe de Austin, Feature 20

Using grant funding from the Texas Preservation Trust Fund and lots of volunteer help, archeologist Marianne Marek directed several seasons of archeological investigations at San Felipe de Austin, the townsite that was evacuated and burned by the Texians on March 29, 1836, as they retreated from the advancing Mexican army. Marek published three preliminary reports on the work (Marek 2003, 2004, 2007) and a popular article (Marek 2005), followed by a two-volume final

Figure 1. Photograph of a wooden barrel cistern take in 1938 by Russell (1938). From the Library of Congress's Prints and Photographic Division, this image is titled: "Outdoor cistern of house near River Road, near Destrehan, Louisiana. These open cisterns are a great breeding place for mosquitoes and are prevalent throughout southern Louisiana."

report on all of the work at San Felipe de Austin from 2002 through 2006 (Marek 2011a, 2011b).

Two related cistern features were excavated in Lot 50 of the San Felipe town site during intermittent field sessions between 2004 and 2006. The two features included a larger plaster-lined cistern (Feature 28) and a smaller wooden barrel cistern (Feature 20) that was placed inside the larger cistern. These features are discussed extensively by Marek (2011a:95–107), and illustrated in numerous photos and plan and profile drawings (Marek 2016: Figures 52–65). A photograph of the cistern is reproduced here as Figure 2, and a redrawn stratigraphic profile is presented as Figure 3. Marek (2011a:95) notes that both of these cisterns were used to store drinking water by the residents of Lot 50.

The interpretation of the artifacts from the fill in these cistern features is complicated by the sequence of archeological excavation and flooding events. About half of both features was excavated (Figure 2), and artifacts were collected by levels within each respective feature. Unfortunately, the deep excavation pit for these cisterns had to be left open for extended periods, and it flooded several times before the work could be completed. The flooding caused the remaining fill to slump, and the deposits from the remaining halves of both cisterns were mixed together. Consequently, some materials in the cistern assemblages have better context than others.

From Marek's report, a sequence of events can be reconstructed to summarize the construction and abandonment histories of these two cisterns. The larger cistern (Feature 28) was built first. A cylindrical hole was dug into the clay sediments and the edges were plastered with a layer of mortar. Marek (2011a:102) noted that in some places, "sections of mortared brick were present behind the plaster surface." The mortared bricks had apparently been used to "fill" in areas where the pit was dug too wide or areas where the pit walls had caved in. Marek concluded that the Feature 28 cistern must

Figure 2. Photograph of cistern Features 20 and 28 at San Felipe de Austin, reproduced from Marek (2011a:Figure 53). Feature 20 is the wooden barrel cistern (note iron barrel hoops) that was placed inside the larger plaster-lined cistern.

have been built after the March 1836 evacuation and burning of the town of San Felipe. This conclusion is based on the fact that "some of the bricks had burned or glazed surfaces that were covered by plaster and mortar," and "this indicates that the cistern had been constructed by reusing Colonial bricks from the burned town site of San Felipe de Austin" (Marek 2011a:102). This large cistern was probably built by the original inhabitants of Lot 50, which was the homestead of Maria Cook some time prior to 1862. Marek (2011b:32) thinks the original cistern and house on Lot 50 were built in the 1850s.

Residents decided to abandon this cistern when portions of its wall began to collapse. Brick rubble found at the floor of this cistern indicates that it may have had a brick neck and mouth above the ground level, and that it may have collapsed (or been pushed) into the cistern. The residents filled it half way with sandy loam, which contained many discarded items, and then centered a large wooden barrel cistern (Feature 20) inside the partially backfilled feature. The wooden barrel was most likely constructed elsewhere and then lowered into the open hole as a single unit. Once this was done, the builders filled in the upper part of the old hole with more sandy loam, completely filling the void between the new barrel cistern and the old cistern walls. Marek (2011a:95) believes that the top of the barrel cistern, i.e., the above-ground portion, was constructed of brick and limestone rocks.

The upper parts of both features were disturbed and removed by post-depositional activities, so the actual heights of these cisterns are not known. The dimensions of the excavated portions do provide a minimum estimate of the capacities of each of the San Felipe cisterns. The dimensions are taken from the scaled plan and profile drawings rather than from the dimensions as stated in the text.[2] The larger plaster-lined cistern measured about 11 ft wide and 13 ft deep, for a volume of 1,235 cubic ft or 9,238 gallons. The wooden barrel cistern averaged about 5 ft wide and was 5 ft deep, for a volume of 98 cubic ft or 733 gallons. The wooden barrel cistern is not a true cylinder; it was wider

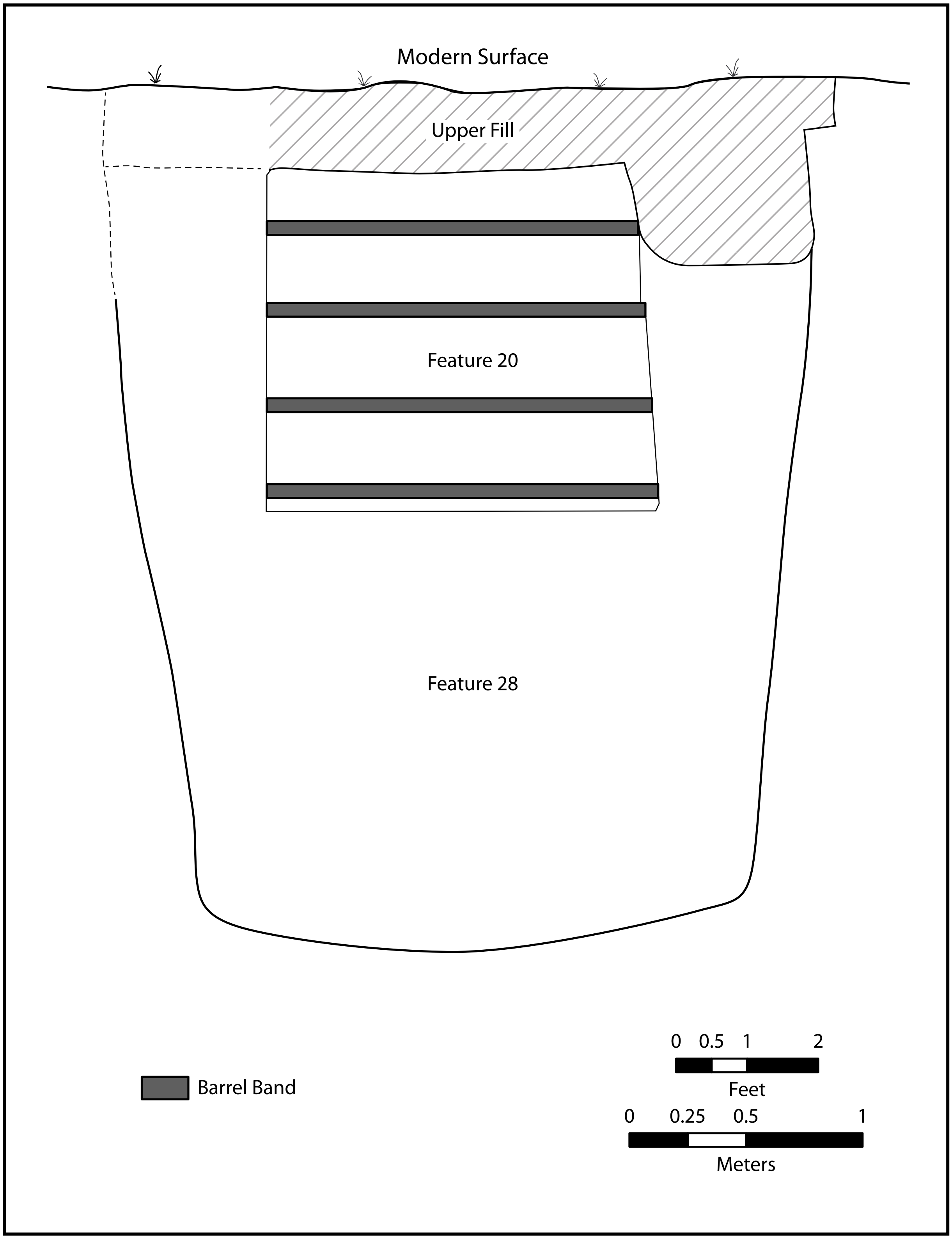


Figure 3. Profile drawing of cistern Features 20 and 28 at San Felipe de Austin. This profile is redrawn from Marek (2011a:Figure 59).

at the bottom (ca. 5.5 ft) and tapered towards the top. For both of these features, the volume calculations are minimum estimates, and the true volume is probably slightly higher. Although the original height of the wooden barrel is not known, four intact iron barrel hoops were found in situ. The iron bands were held together with rivets, and portions of two barrel staves were well preserved (Marek 2011a:Figure 61). The bottom iron band was the widest, and each iron band was slightly narrower than the one beneath it.

It is likely that the abandonment and filling of the large cistern, and the installation of the wooden barrel cistern were contemporaneous events. Thus, the artifacts found mixed in the sandy loam fill of the larger cistern may provide an approximate date for this event. The sandy loam that was placed into the abandoned larger cistern was probably obtained from the surrounding surface nearby, and Marek believes the sparse Native American and Colonial artifacts mixed in this fill are fortuitous (i.e., they were present in the sand that was scooped up to fill the hole). The sandy loam fill of Feature 28 turned out to be a "time capsule" of Colonial and mid-nineteenth-century artifacts that included the following items (Marek 2011a:102, Figures 62–65; Marek 2011b:79, 105, 140, Figures 77, 148, and Table 48):

- A "CSA" (Confederate States of America) General Service button cover;
- Two Spanish *reales*, "one of which was recovered from the fill immediately below the bottom of the Feature 20 wooden barrel well" (Marek 2011a:102);[3]
- A flintlock rifle lock identified as a "Kentucky Rifle style, gracile, gooseneck style;"
- A gunflint;
- Dark blue transfer-printed whitewares;
- Olive green wine bottle glass;
- Stem fragments from white clay smoking pipes;
- A white clay pipe bowl fragment (Type 4, with a distinctive style of rouletting).

The Feature 28 fill also contained a large amount of animal bones and abundant artifacts that are not temporally sensitive.

At some point, the residents of Lot 50 decided that the wooden barrel cistern was no longer functional, and they began to fill it in with trash. Marek (2011a:102) notes:

> The fill within Feature 20 contained dark colored soils with a dense amount of trash including ash, charcoal, coal and organic materials such as peach pits, pumpkin seeds, egg shells and fish scales. Other notable artifacts recovered from the fill of Feature 20 included fragments of a ceramic dolls head, ceramic pipe bowl, munitions including musket balls and lead bullets; slate and graphite, clothing hardware – buckles, eyelets, buttons; jewelry including a earring, fragments of a rubber comb, a key, ceramic doorknob, mirror shards, many broken ceramics and glass objects, nails and other metal items.

Two of the most diagnostic and youngest items found in the Feature 20 fill are a 10-gauge shotgun shell head and a 12-gauge shotgun shell head, both with distinctive headstamps—the "RIVAL" trademark of the Winchester Repeating Arms Company—that date their manufacture between 1891 and 1897 (Marek 2011b:Table 47, Bag 50-491). These were found in the upper level of the feature and seem to indicate that the wooden barrel cistern was completely filled in by the 1890s. Disregarding the uppermost level, the collective artifact assemblage from the Feature 20 fill is comprised of items that were manufactured primarily in the late nineteenth century. There are relatively few items that might have been manufactured after 1900, and none that absolutely post-date 1900.

Frost Town, Feature 584

According to the W. E. Wood map (1869), Feature 584 was in the northwest quadrant of Frost Town Block F, in the central portion of a lot that fronted the east side of Spruce Street. This cistern was likely associated with a structure that faced the same thoroughfare. Excavation revealed that at least the lower half of Feature 584 was intentionally backfilled in a brief period of time after abandonment. At some point after the cistern was completely filled in, a brick house pier (Feature 546) was built in a construction pit excavated in the southwest portion of the cistern (Figure 4a). Feature 546 was at the northeast corner of an L-shaped arrangement of brick piers that marked the north and west edges of a 41-ft -long, east-west aligned rectangular structure built above Feature 584. In addition, a trench excavation for an early-twentieth-century sewer line (Feature 568) clipped the east side of the Feature 584 builder's trench, but just missed the cistern itself.

Based on available evidence, Feature 584 consisted of a wood barrel with a maximum outer diameter of 5 ft 6 inches set within a pit about six ft in diameter. From the point where the top of the cistern was identified, the cistern extended to a maximum depth of 3 ft 8 inches. The interior diameters of three associated metal bands tapered from five ft six inches at base and middle to five ft one inch at the upper band. Some of the edge in-curvature apparent between the top and middle iron bands on the feature profile is likely attributable to sediment subsidence and/or expansion into voids left when the barrel decayed (Figures 4b and 5). Although not a perfect cylinder, the remaining

a

b

Figure 4. Photographs of Feature 584 barrel cistern: (a) overhead view of upper cistern after excavation of Feature 546 (brick pier and pier pit), and manual scrape/cleanup of the surrounding area. The dark fill at lower right is a modern intrusive pit, and the red pin flags mark the Feature 568 sewer line, (b) looking north at bisected Feature 584 with intact middle barrel band.

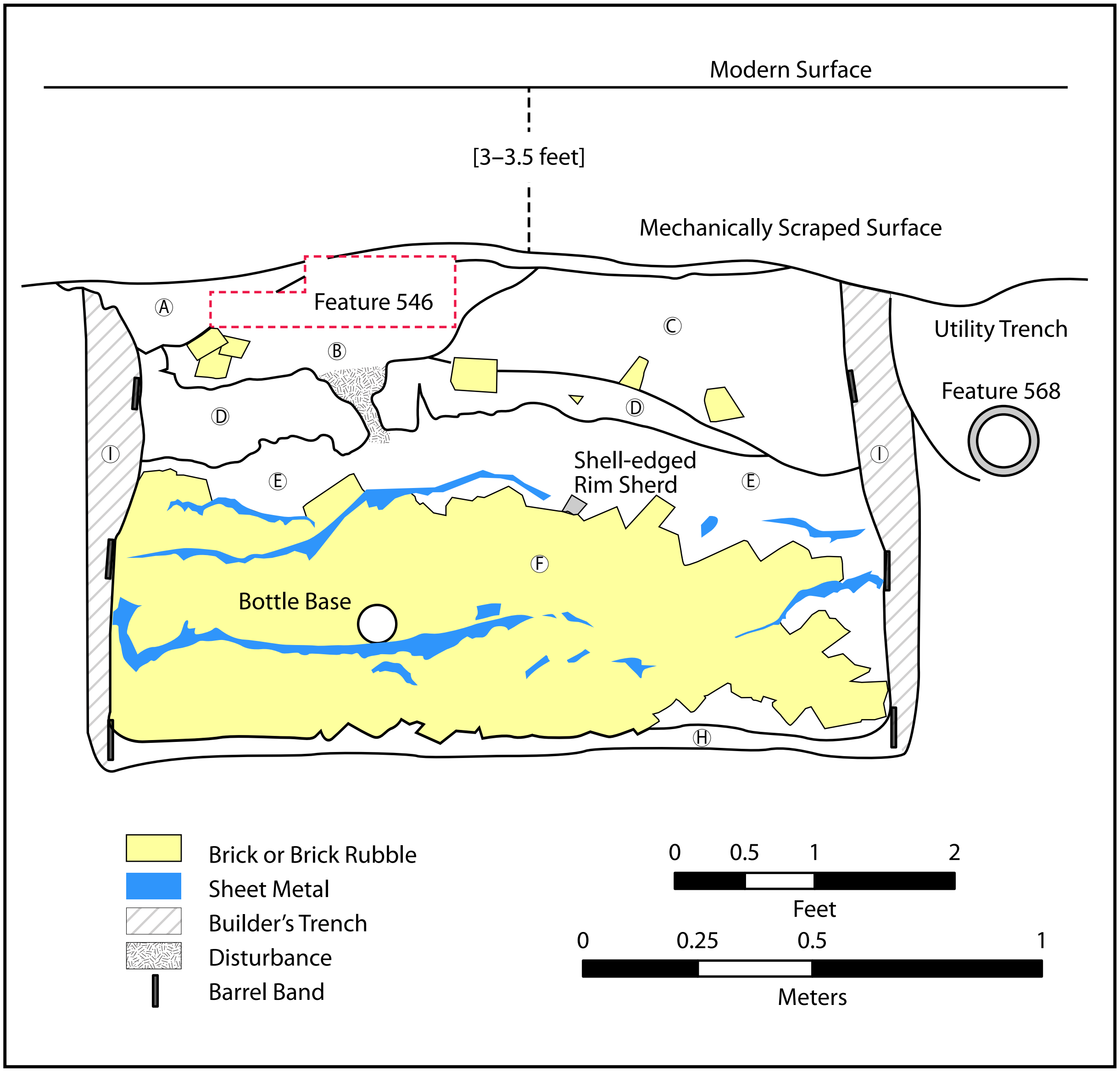


Figure 5. Feature 584 profile showing intrusive Feature 568 and relative position of intrusive Feature 546 built in a pit cut into the upper portion of the in-filled cistern. The outline of the brick pier is dashed because the north edge of that feature sat about five cm. south of the profile wall.

portion of Feature 584 had an estimated interior volume of 85 cubic ft or 636 gallons.

Little of the wood barrel remained aside from vertically oriented fragments of degraded wood along the upper inside edge of the builder's trench. The thickest of these suggest the original barrel staves may have been one to 1¼ inch thick. The bottom of the barrel was marked by a dark, 1 cm. wide stain in the clay below and around the lowest barrel band. Floor slat remnants were identified, and wood fragments attached to sheet metal in the lower portion of cistern fill may have been slats from the top of the barrel. Top and bottom slats originally may have been 3/4 to 1 inch thick. Stave and floor slat fragments were identified as hard pine wood (*Pinus* subgenus *Pinus*) (Bush 2017).

The three iron barrel bands were each spaced about one-foot apart (Figure 5). The top band, which was largely absent on the south half of the feature, consisted of a two inch wide band riveted to a 2 ft 2 inches long and 2¾-inches wide segment on the northeast side of the barrel. The middle band consisted of two 3½ inch wide strips riveted together on the northwest and southeast sides of the barrel. The bottom band consisted of a single 3½ inch wide strip riveted together on the east side of the barrel. All of the the barrel bands were ca. 1/4 inch thick.

In addition to the pale brown clay in the builder's trench surrounding the cistern (Zone I), feature bisection revealed five zones of sediment derived from natural deposition and intentional filling (Zones C–F, and H), and intrusive Zones A and B (Figure 5). The topmost stratum in the profile (Zone A) was a thin veneer of silty loam mixed with twentieth-century artifacts that may be derived from mechanical leveling and clearing of some of the last residential structures in the area in the 1980s. This layer capped a zone of carbon-enriched silty loam mixed with abundant brick fragments and artifacts (Zone B) that may correspond with construction of the brick pier (Feature 546) in the southwest quadrant of the cistern. Zone B truncated a unit of silty loam and clay loam (Zone C) that probably was derived from periodic intentional infill and episodic waterborne deposition. Zone D was a broken lens of sandy loam and sandy clay mixed with fragments of clay likely derived from the cistern builder's trench. Zone E consisted of silty loam and sandy loam mixed with few artifacts and scattered brick fragments.

The upper half of cistern fill was resting on a 16- to 23-inch thick layer of intentionally discarded brick rubble suspended in a loose sandy loam (Zone F). Numerous bottles and bottle fragments were found among the bricks, with most recovered in the top half of the brick rubble and most of the complete or near complete bottles found along the cistern margins. Discontinuous layers of degraded sheet metal in the middle and upper portions of the brick rubble may have been remnants of the barrel top.

Zone F was underlain by a thin, artifact-free layer of silty clay (Zone H) that was only a few inches thick. This layer marks precipitate that gradually accrued during use of the cistern and perhaps for a period after abandonment. While fragments of degraded slat wood were recovered in this layer, the barrel floor was no longer present, and Zone F was resting directly on Beaumont Formation clay.

The Feature 584 assemblage includes numerous glass and stoneware bottles and bottle fragments, abundant pieces of glass and historic ceramic sherds, numerous iron artifacts, a chert core, and abundant faunal bone and oyster shell. Items of note include a blue feather-edge, shell-edged, earthenware sherd recovered just above the brick rubble layer (base of Zone E), a handful of flatware sherds with maker's marks (not yet analyzed), and an iron crank handle and top of a probable coffee grinder (from the central brick rubble layer). The assemblage includes 14 complete or nearly complete stoneware bottles and the fragments of at least seven others (Table 2). Twelve of these are from the layer of brick rubble fill (Zone F). Two or three of the fragmentary vessels are parts of tall, narrow-diameter, one-handled, short-necked German/Prussian mineral water bottles, and similar bottles were found buried upside-down in a nearby bottle alignment during the 2015 archeological survey (Boyd and Norment 2016; Boyd et al. 2016). These vessel fragments bear portions of two distinct maker's marks (Figure 6a-b). The remainder of the stoneware bottles and bottle fragments are Bristol-style, salt-glazed vessels often referred to as ginger beer or ale bottles in common vernacular. Many of these bottles likely contained stouts or ales, and reuse of ceramic bottles by beer brewers was common. Maker's marks are stamped on nine of these bottles. Seven marks are from the Barrowfield, Bridgeton (Eagle), Caledonian, and Port Dundas pottery facilities in Glasgow, Scotland. These facilities were the largest Scottish stoneware producers in the nineteenth century. The two remaining bottles were manufactured by Price, Sons & Co. in Bristol, southwest England (Wood 2014).

The smaller but more varied glass bottle assemblage includes beverage, medicinal/condiment, bitters, and cologne bottles. Four nineteenth-century bottles of particular note are presented in Table 2. The Budweiser bottle was upended against the cistern wall in the upper, possibly disturbed fill (Zone B). The Hostetter's Stomach Bitters bottle, Caswell Hazard & Co. ginger ale bottle, and Corning's German Cologne bottle were collected in the brick rubble layer (Zone F).

Although the Feature 584 artifact assemblage has not been completely analyzed, review of the temporally diagnostic glass and stoneware bottles and characteristics of the cistern fill suggest most of the cistern was intentionally filled with debris in a relatively short span of time. The presence of Price Bristol stoneware bottles in the upper half of the brick rubble layer indicates this filling episode dates no earlier than about 1885 (see manufacturing date range for Price Bristol in Table 2). The relative uniformity exhibited in the types of bottles recovered in the brick rubble layer (Zone F) suggest that the bottom half of the cistern was filled in a very short period of time, perhaps in a single episode. The

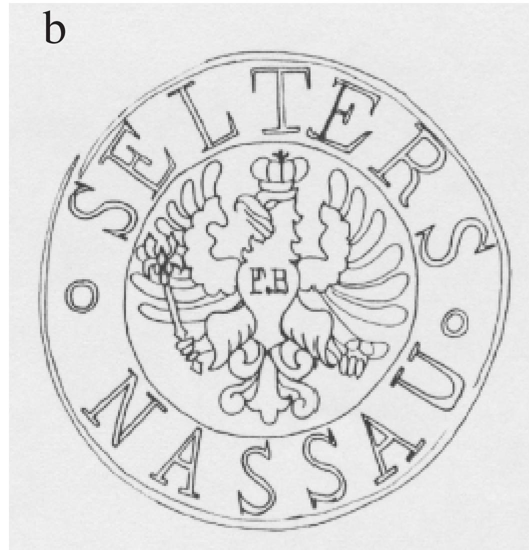


Figure 6. Complete examples of the partial maker's marks identified on two stoneware sherds collected in Feature 584. (a) Apollinaris-Brunnen-M-W-O; (b) Selters Nassau (image from Lockhart 2010:Figure 5-35).

absence of laminated sediments in overlying Zones D and E, and the presence of clay in Zone D that was very much like the clay in the cistern builder's trench suggest that these layers are also derived from rapid, intentional in-fill. Laminated sediments in Zone C indicates Feature 584 was left only partially filled for a some time, but the recovery of the Budweiser bottle that likely dates to 1878–1882 in disturbed fill near its top suggests the cistern was not left open for very long. The brick pier alignment, with one of the piers built on top of the cistern fill, suggests the cistern was filled in advance of anticipated house construction (see Historical Notes on the Frost Town Cisterns below).

Frost Town, Feature 805

Feature 805 was exposed in the northeast corner of the Block H investigation area, about 10 ft northeast of a brick-lined cistern. Both truncated feature remnants were capped with about seven feet of modern fill brought in soon after the razing of most of Frost Town during the mid 1950s construction of Elysian Viaduct. According to the Wood map (1869), Feature 805 was in Lot 12 in the south central portion of Block H. A possible intake feature (805-A) on the southwest side of the barrel cistern suggests Feature 805 was associated with a structure that fronted Arch Street on the south side of Lot 12 (Figure 7a).

Feature 805 consisted of a 5 ft 6 inch-diameter wood barrel with a maximum remaining height of about 4 ft 6 inches and approximate barrel depth of ca. 4 ft 1 inch, set within a 6 ft 6 inch-diameter cylindrical pit (Figure 8). The feature was bisected to provide a full profile of the cistern fill, and only the south half of the feature was excavated (the north half was left in situ). According to estimated interior barrel dimensions, the remaining portion of Feature 805 had an estimated volume of 91 cubic feet or 681 gallons. Barrel staves were 1¼-inch thick and ranged from 3¾ to 5 inches wide. The 1¼-inch-thick wood slats that served as the barrel floor were inset into the barrel staves about 3¼-inches above the basal ends (see Figure 7b). Samples of the stave (samples W-70 and W-75) and slat (samples W-71 and W-74) wood were subsequently identified as baldcypress (*Taxodium distichum*) (Bush 2017).

The barrel staves were held together with three iron bands spaced 18 to 24 inches apart. The upper and middle bands were 2 inches wide and the bottom band was $3\frac{1}{8}$ inches wide; all were about 3/16 inch thick. No riveted band segments were observed in the part of the cistern exposed during excavation. A section of the bottom band was collected as a sample. The barrel was coated inside

Table 2. Provenience and descriptive information for selected glass and stoneware bottles recovered from Feature 584.

Lot No.	Elevation/ Elevation Range (US survey feet)	Material	Embossed Lettering / Trade mark or Stamp on:			Finish	Comments, Identification, and Dating
			Bottle Base	Bottle Face	Bottle Heel		
780	34.48 - 33.63	Glass, aqua	CC&Co	C. CONRAD & CO.'S ORIGINAL BUDWEISER U. S. PATENT Nº 6376	--	Two part applied, tapered; cork top	Carl Conrad & Co., St. Louis, MO - established in 1876, bankruptcy declared in 1883. Company production dates: 1876-1882. - Based on base logo text style and placement, and absence of DOC (D. O. Cuningham) bottle production mark, this particular specimen likely manufactured from 1878-1882 (Lockhart et al. 2014). - Bottle is 11¼" tall and base diameter just under 3" - Recovered upside down against cistern wall at Zone B/D transition
779	34.45-33.79	Stoneware	--	APOLLINARIS- BRUNNEN-M-W-O (in circular stamp around anchor) -over- GEORG KREUZBERG AHRWEILER RHEINPREUSSEN ------------------------------- (Figure 6a)	--	n.d.	- Dates to 1876 or later (see below) - Specimen represented by partial maker's mark only. - Another Apollinaris Brunnen bottle recovered from nearby bottle alignment during previous survey is a tall, narrow-diameter (11½" x 3⅜") vessel with short neck and cork-top, ring-lip finish. Single loop handle on shoulder, opposite stamp. - Carbonated mineral water bottled in Bad Neuenahr, Germany. - 1853 - Georg Kreuzberg established CommandirGesellschaft Georg Kreuzberg & Cie. for sale of "Apollinaris Water." - 1873 - Apollinaris Company Limited established in London for international export; Kreuzberg died at end of that year. - 1876 - Kreuzberg's heirs transform the company into Actiengesellschaft Apollinarisbrunnen (Haffke and Ritter 2013; Lockhart et al. 2014; Red Wine Trail 2016). - Recovered in Zone B
746	34.12-32.81	Stoneware	--	--	PRICE BRISTOL	Square collared lip	- Price, Sons, & Company, Bristol, England (1884-ca. 1915) (Sodas and Beers 2017; Wood 2014). - Bristol-style stoneware bottle; 7⅞" tall, 4⅞" shoulder height, 3" base diameter. Some damage around bottle lip. - Body profile similar to Class T depicted in Graci (1995:96), but with a slightly narrower, taller neck. Bevel at heel. Straight sides taper in very slightly from base. Pronounced shoulders. Upper portion shows double glaze. - Recovered in arbitrary level that includes Zone D and parts of Zones C, E, and F.

Table 2. Provenience and descriptive information for selected glass and stoneware bottles recovered from Feature 584. (*Continued*)

Lot No.	Elevation/ Elevation Range (US survey feet)	Material	Embossed Lettering / Trade mark or Stamp on: Bottle Base	Bottle Face	Bottle Heel	Finish	Comments, Identification, and Dating
747	32.81-32.15	Glass, greenish aqua	--	CASWELL HAZARD & C$^{\underline{O}}$ NEW YORK GINGER ALE	--	Applied, machine-tooled finish; cork top	- Round end torpedo bottle manufactured between 1866-1876 - Caswell Hazard & Co. was a New York druggist/ pharmaceutical business conducted between the above dates. Company name changed to Caswell, Massey & Co. in 1876 (Mayo 1915). - Recovered in upper half of Zone F (brick rubble fill).
747-1	32.81-32.15	Stoneware	--	--	MURRAY & CO GLASGOW (oval stamp)	Ring-lip finish; cork top	- Murray & Co., Caledonian Pottery, Glasgow (1870-1898) (Ward 2002). - Bristol-style stoneware bottle; 8¼" tall, 3" base diameter - Body profile similar to Class I body form depicted in Graci (1995:91). - Recovered in upper half of Zone F (brick rubble fill).
747-5	32.81-32.15	Stoneware	--	--	GROSVENOR 2 GLASGOW (oval stamp)	Tapered lip	-Frederick Grosvenor, Bridgeton (or Eagle) Pottery, Glasgow (1869-1899) (Wood 2014). - Bristol-style stoneware bottle; 7¾" tall, 4⅞" shoulder height, 3" base diameter. - Body and shoulder profile similar to Class T body form, but taller with narrower neck (Graci 1995:96); shoulders prominent. - Recovered in upper half of Zone F (brick rubble fill).
747-7	32.81-32.15	Stoneware	--	--	MURRAY & CO GLASGOW (oval stamp)	n.d.	- Murray & Co., Caledonian Pottery, Glasgow (1870-1898) (Ward 2002). - Bristol-style stoneware bottle broken below finish; 4¾" shoulder height, 3" base diameter. - Body and shoulder profile similar to Class T body form but slightly narrower in body profile with concave taper of sidewalls; also taller with narrower neck than Class T (Graci 1995:96). Shoulders prominent. - Recovered in upper half of Zone F (brick rubble fill).
747-10	32.81-32.15	Stoneware	--	--	H. KENNEDY BARROWFIELD 15 POTTERY GLASGOW (oval stamp)	n.d.	- Henry Kennedy (& Sons) Ltd., Barrowfield Pottery, Glasgow (1866-1929) (CSP 2017; Ward 2002; Wood 2014). - Bristol-style stoneware bottle base. Wall segments taper inward slightly from base before trending outward; 3" base diameter. - Recovered in upper half of Zone F (brick rubble fill).

Table 2. Provenience and descriptive information for selected glass and stoneware bottles recovered from Feature 584. (*Continued*)

Lot No.	Elevation/ Elevation Range (US survey feet)	Material	Embossed Lettering / Trade mark or Stamp on: Bottle Base	Bottle Face	Bottle Heel	Finish	Comments, Identification, and Dating
747-11	32.81-32.15	Stoneware	--	--	PORT DUNDAS POTTERY COY. (circular stamp)	Tapered lip	- J. Miller & Co., Port Dundas Pottery, Glasgow (1857-1932) (Sodas and Beers 2017; Wood 2014). - Bristol-style stoneware bottle; 8” tall, 3⅛” base diameter. - Body profile similar to Class I body form depicted in Graci (1995:91), though neck on this specimen is narrower. - Recovered in upper half of Zone F (brick rubble fill).
755	32 2/7	Glass, dark amber (brown)	S. M^{C} KEE & Co.	D$^{R.}$ J. HOSTETTER’S STOMACH BITTERS	--	Applied tapered lip; cork top	- Dates to 1853 or later (see below) - Dr. Jacob Hostetter’s Stomach Bitters was first sold by the Pennsylvania firm Hostetter & Smith in 1853 (NPS 2017; Shipwreck Store 2017). - Bottle was manufactured by S. McKee & Co. glass plant in Pittsburgh, PA (1834-1908) (Glass Bottle Marks 2017a). - Base lettering is curved around a central relief mark that looks like a backwards “4” - Square case bottle with rounded shoulders - 8⅞” tall and base is 2¼” x 2⅛”. - Bottle profile and side lettering appear identical to bottle depicted by Switzer (1974:Figure 40). - Recovered in upper half of Zone F (brick rubble fill).
790	32.64-32.15	Glass, clear	--	CORNING’S GERMAN COLOGNE CORNING & TAPPAN NY	--	Prescription; cork top	Likely dates of bottle manufacture: 1876- 1880 - H. Tappan came to New York in 1876, and purchased the business interested of his partner Corning in 1880 (Morris 1894). - Recovered in upper half of Zone F (brick rubble fill).
790-1	32.64-32.15	Stoneware	--	--	PRICE BRISTOL	Square collared lip	- Price, Sons, & Company, Bristol, England (1884-ca. 1915) (Sodas and Beers 2017; Wood 2014). - Bristol-style stoneware bottle; 7⅝” tall, 4⅞” shoulder height, 3” base diameter. - Body profile similar to Class T depicted in Graci (1995:96), but with a narrower, taller neck. Bevel at heel. Straight sides taper in very slightly from base. Pronounced shoulders. Upper portion shows double glaze. - Recovered in upper half of Zone F (brick rubble fill).

Table 2. Provenience and descriptive information for selected glass and stoneware bottles recovered from Feature 584. (*Continued)*

Lot No.	Elevation/ Elevation Range (US survey feet)	Material	Embossed Lettering / Trade mark or Stamp on:			Finish	Comments, Identification, and Dating
			Bottle Base	Bottle Face	Bottle Heel		
790-2	32.64-32.15	Stoneware	--	--	PRICE BRISTOL	Square collared lip	- Price, Sons, & Company, Bristol, England (1884-ca. 1915) (Sodas and Beers 2017; Wood 2014). - Bristol-style stoneware bottle; 7¾" tall, 4⅞" shoulder height, 3" base diameter. - Body profile similar to Class T depicted in Graci (1995:96), but with a narrower, taller neck. Bevel at heel. Straight sides taper in very slightly from base. Pronounced shoulders. - Recovered in upper half of Zone F (brick rubble fill).
790-3	32.64-32.15	Stoneware	--	--	H. KENNEDY BARROWFIELD 2 POTTERY GLASGOW (oval stamp)	Tapered lip	- Henry Kennedy (& Sons) Ltd., Barrowfield Pottery, Glasgow (1866-1929) (CSP 2017; Ward 2002; Wood 2014). - Bristol-style stoneware bottle: 7¾" tall, ca. 5" shoulder height, 2⅞" base diameter. - Recovered in upper half of Zone F (brick rubble fill).
790	32.64-32.15	Stoneware	--	SELTERS NASSAU (in circular stamp around Prussian eagle) --------------------- (Figure 6b)	--	n.d.	- Dates to 1866 or later (see below) - Specimen represented by a partial maker's mark only - part of a Prussian Eagle is apparent on a single sherd. - The eagle was first used in the center of the round SELTERS NASSAU stamp when the Duchy of Nassau was annexed by Prussia in 1866 - these are referenced as Adler (Eagle) Selters (The History Blog 2017; Wieland n.d.). - Carbonated mineral water from Selters Spring in Niderselters, Germany, exported by the Nassau Selter Co., Ober Selter, Germany. These vessels are similar in morphology and style to those used by Apollinaris-Brunnen; they were manufactured in the Nassau District in western Germany (Lockhart 2010). - A separate sherd from the same lot inscribed with "M: Num 76" also may be part of an Eagle Selter bottle (Wieland n.d.) - Recovered in upper half of Zone F (brick rubble fill).

a

b

Figure 7. Photographs of Feature 805 barrel cistern. (a) Overhead view of Feature 805 shortly after exposure. A possible cistern intake (Feature 805-A) is visible just southwest of the larger circular area. (b) Looking north at bisected Feature 805 fill above intact barrel floor and bottom iron barrel band.

and out with tar that was as much as 1/4 inch thick in places. The diameter of the builder's pit indicates the barrel exterior was coated with tar prior to its placement in the ground; the barrel interior could have been coated before or after placement.

Feature bisection indicated cistern fill consisted of four zones of sediment (see Figure 8). The top three (Zones A–C) were composed of fine-grained sands, silty sands, and sandy silts mixed with occasional artifacts. Zone A was derived from natural and intentional episodic deposition punctuated by disturbance. If present prior to the demolition of nearby structures, then Zone A certainly would have been impacted when the area was mechanically cleared and leveled in the 1950s. Zones B and C were composed of water-lain sands. Zones A-C were inset into a thick, compacted refuse deposit (Zone D) primarily consisting of metal sanitary cans and other metal items in intervening sand (see Figure 7b). This deposit included alcohol, medicine, and condiment bottles; snuff jars; unidentifiable container glass and flat glass; historic ceramic sherds; pieces of milled lumber and other botanical remains; abundant faunal bone and shell; shoe parts and tooled leather fragments; fabric and cotton padding; solidified putty and paint; brick

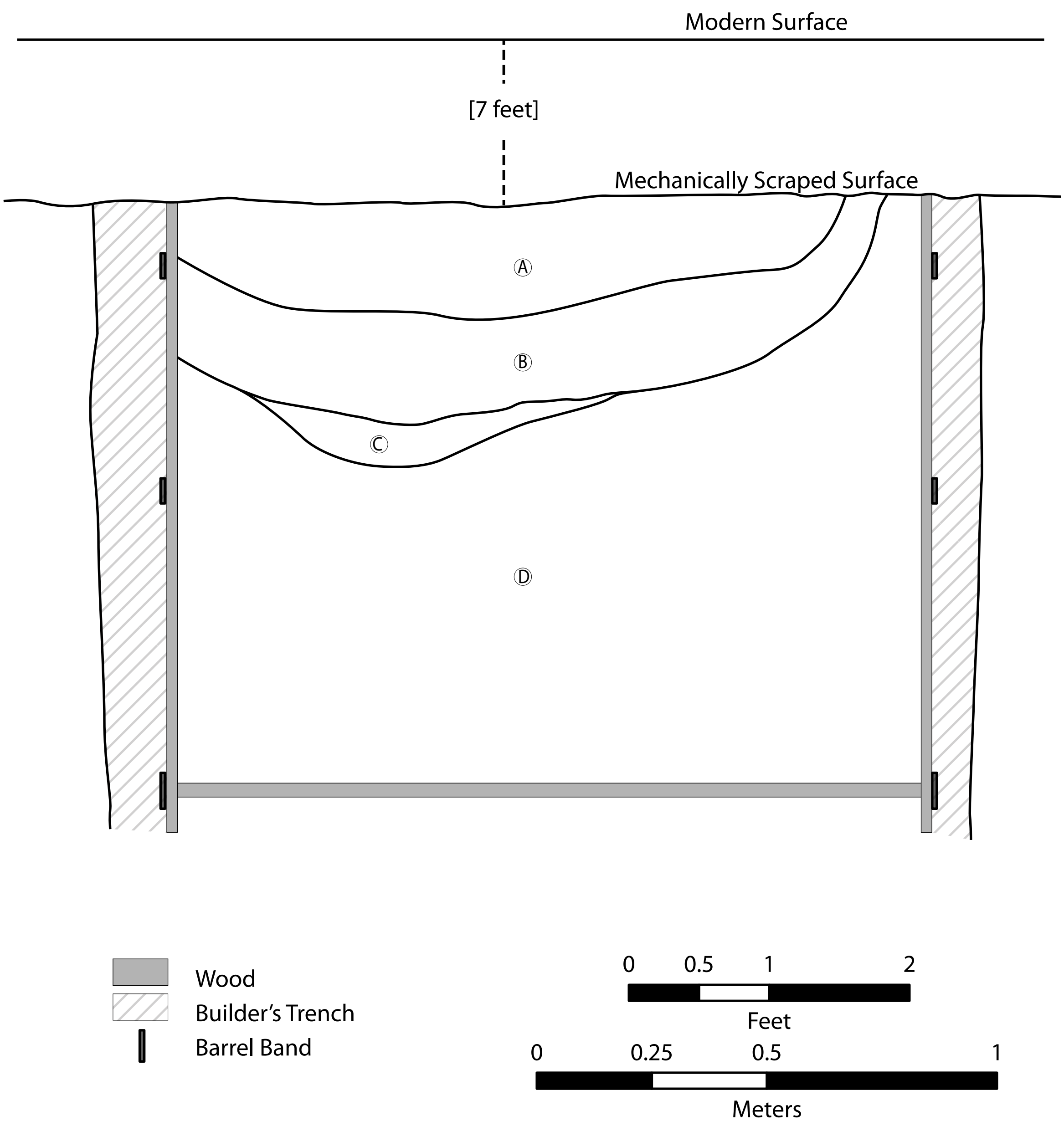


Figure 8. Feature 805 profile.

fragments; and natural gravels. Wood fragments were most prevalent in the bottom ca. 12 inches of this zone. Other artifacts found at the base of the cistern include a slat wood box on the cistern floor and the rusted frame of a possible baby pram just above it.

The character of the Feature 805 assemblage makes it quite clear that the cistern was used for refuse disposal after abandonment. In addition to the abundant metal, cistern fill included more than 100 bottles and jars. The bottom 12 inches of fill contained many complete or near-complete liquor/alcohol bottles, medicinal/pharmaceutical bottles, and snuff bottles. Aside from the brown snuff bottles, most are clear glass and most have cork top finishes. Clear bottles with cork top finishes and snuff bottles are present in the uppermost portion of cistern fill, but crown cap finishes are more common in this part of the assemblage, including some specimens with continuous thread finishes. A wider array of bottle (and jar) forms and glass colors is represented in the upperfill, which consists of medicinal/pharmaceutical bottles, condiment bottles and jars, beer and soft drink bottles, and health/beauty product bottles and jars.

Although this assemblage has yet to be fully catalogued and analyzed, cursory examination of some of the recovered bottles provides some indication of the period of time for the deposition of the cistern fill (Table 3). A bottle embossed with a design patent date of 1898 recovered in the bottom 12 inches of cistern fill suggests intentional infilling may have begun as early as the mid-to-late 1890s. However, company trade marks, product names, and patent dates embossed on several other bottles from top to bottom in cistern fill suggest refuse disposal began after ca. 1915. Recovery of a post-1925 product sample bottle at the very top of cistern fill prior to the start of excavation suggests refuse disposal in Feature 805 continued through the 1920s and possibly into the 1930s.

Historical Notes on the Frost Town Cisterns

No attempt has been made to synthesize all of the deed records and tax records for the two properties where the wooden barrel cisterns were found at Frost Town. This will be done in the future as part of the historical and archeological data analysis work. For the time being, historical maps provide some evidence for the possible associations of the cisterns with former houses, and therefore, some clues to the possible dating of the installation of the wooden barrel cisterns.

The Feature 584 cistern was in the northwest corner of Frost Town Block F, but no structures are shown anywhere near this location on W. E. Wood's 1869 map. Koch's 1873 bird's-eye map does show one house in the northwest corner of Block F, which would not have been far northwest of the cistern (Figure 9a). It is possible that Feature 584 was associated with the house that appears on the 1873 map. It is also possible that the cistern was associated with a house that was removed before W. E. Wood compiled his 1869 map. The cistern probably was abandoned in the 1880s, with the start of in-fill occurring no earlier than 1885. The brick pier alignment built over Feature 584 may relate to one of two structures depicted on the west side of Block F on the 1907 Sanborn map (Sanborn Map Company), which suggests that Feature 584 was completely filled in by ca. 1900 (Figure 9b).

The Feature 805 cistern was in or near Lot 12 on the south side of Frost Town Block H. However, no structures are shown anywhere near this location on W. E. Wood's 1869 map, and Koch's 1873 birds-eye map does not show any development north of Arch Street, which bordered the south side of Block H (see Figure 9a). Although considered to be more idealized and less accurate than the Koch's 1873 map, Westyard's 1891 birds-eye map does show two small houses in the south half of Block H along Arch Street. Feature 805 is relatively close to both houses and it could have been associated with either. This cistern's proximity to the back's of two houses depicted on the later 1907 Sanborn map again suggests it could have been associated with either structure (Figure 9b). The rectangular structure probably dates to or just after the turn of the twentieth century. The square house may date to the late-nineteenth century, which is a better fit with the Feature 805 construction and use-life estimates presented below. Feature 805 may have been abandoned by ca. 1910–1915, and used for refuse disposal between ca. 1915 and 1930.

All three historical wooden barrel cisterns documented in Texas—one in Austin County and two in Harris County—were constructed in the nineteenth century. The best-educated guess as to the dates of construction and abandonment of these features are provided in table 4.

The dating of these Frost Town cisterns likely will be refined once we have conducted a full analysis of the artifacts recovered from these features,

Table 3. Provenience and descriptive information for selected glass bottles recovered from Feature 805.

Lot No.	Elevation/ Elevation Range (US survey feet)	Glass Color	Embossed Lettering/ Trade Mark on: Bottle Base	Bottle Face	Bottle Shoulder	Finish	Comments, Identification, and Dating
958	30.40	Clear	A.S. HINDS CO	HINDS HONEY AND ALMOND CREAM A. S. HINDS CO. BLOOMFIELD N. J. U.S.A.	--	Continuous thread	- Cosmetic product. This sample bottle post-dates 1925, may date to the 1930s (Cosmetics and Skin 2017). - From top of cistern fill.
951	30.40 - 29.85	Brown	Owens Bottle Co trade mark	--	--	Crown cap	- Beer bottle? - Owens trade mark used 1919–1929 (Glass Bottle Marks 2017b). - From upper 6 inches of cistern fill.
952	29.85 - 28.35	Clear	H J HEINZ Co. 162 PAT D -------- Owens Bottle Co trade mark	--	--	Continuous thread	- Condiment bottle. Bottle base essentially the same as that pictured in Lockhart et al. (2016:Figure 14). - The "162" bottle code was used on Heinz Ketchup bottles produced from 1918–1923 (Cartwright 2006). - Owens trade mark used 1919–1929 (Glass Bottle Marks 2017b). - Bottle recovered 6-18 inches below top of cistern fill.
952	29.85 - 28.35	Clear	Illinois Glass Co trade mark (Diamond-I)	DR PRICE'S DELICIOUS FLAVORING EXTRACTS	--	Cork top	- Product first produced in 1874 (Griffin 2017) - This Illinois Glass Company trade mark used 1915 - 1929 (Glass Bottle Marks 2017c). - Bottle recovered 6-18 inches below top of cistern fill.
964	27.72	Clear with slight yellow green tint	HOUSTON TEX.	--	Coca Cola logo over: TRADE MARK REGISTERED BOTTLE PAT D NOV 16, 1915	Crown cap	- Note bottle patent date of 1915. - Bottle recovered in middle part of Zone D.
965	27.23 - 26.25	Clear	SANITIZED LYRIC	--	--	Cork top	- S & D in SANITIZED on bottle base are within an ornate shield outline. Embossed graduation marks on flat face; opposite is slightly curved. - "LYRIC" was assigned to a particular line of prescription/ druggist bottles produced by the Illinois Glass Company of Alton, Illinois. from ca. 1915 until it merged with the Owens Bottle Company in 1929 (Glass Bottle Marks 2017d). - From bottom 12 inches of Zone D fill.
965	27.23 - 26.25	Clear	DESIGN PATENTED PAT AUG 6 1898	--	--	Crown cap	- Note design patent date of 1898. - Alcohol/liquor bottle? Sides taper inward from shoulders to base. - From bottom 12 inches of Zone D fill.

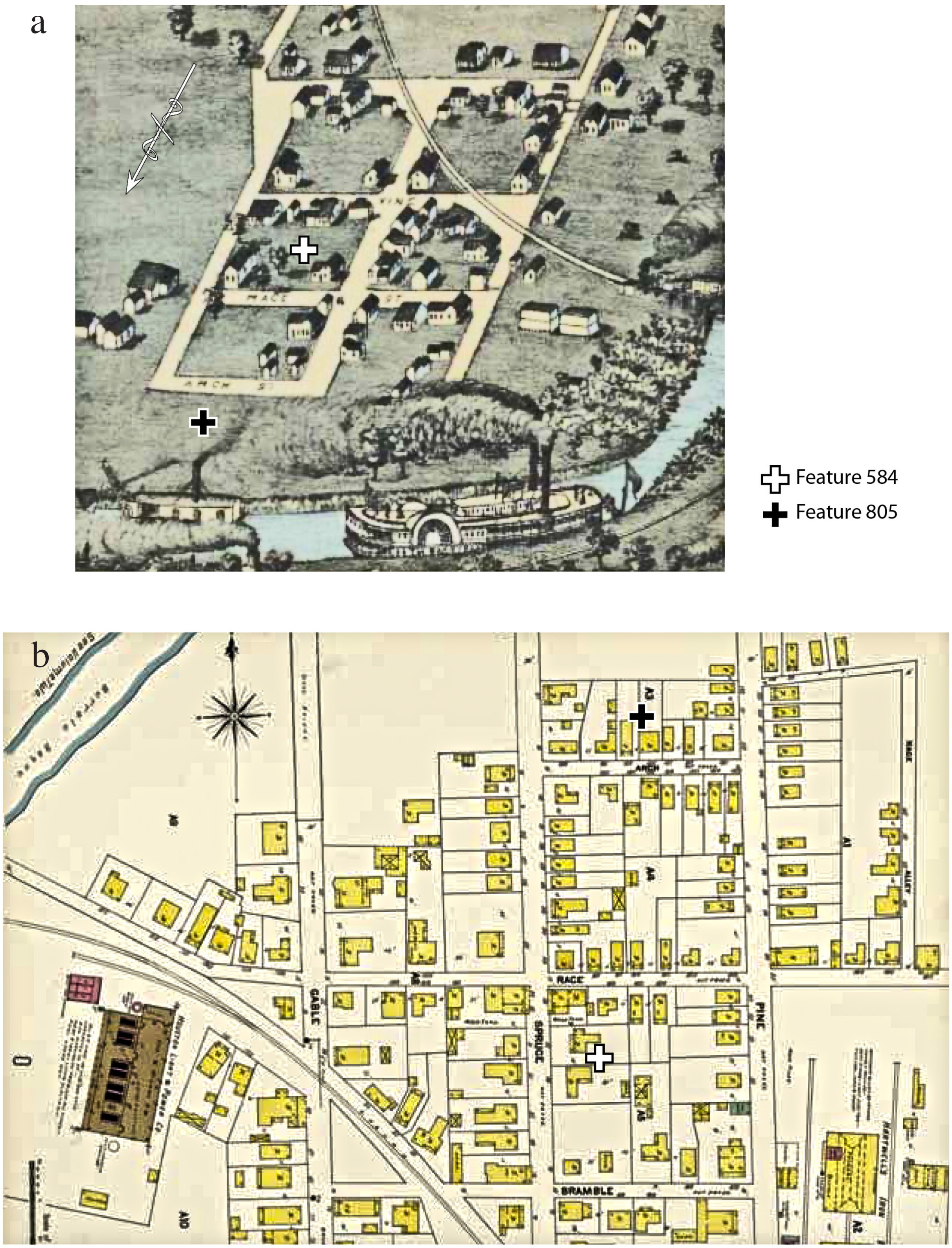


Figure 9. Locations of Features 584 and 805 (wooden barrel cisterns) overlain on historical maps that depict the Frost Town neighborhood: (a) Augustus Koch's 1873 bird's-eye map of Houston; (b) 1907 Sanborn Fire Insurance Company map of Houston.

Table 4. Dating The Large Wooden Barrel Cisterns

Wooden Barrel Cistern	Construction Date	Abandonment /Filling Date
Feature 20, San Felipe de Austin	1850s (prior to 1862)	ca. 1890s or ca. 1900
Feature 584, Frost Town	1860s–1870s	1880s / ca. 1885 or later, capped by 1907
Feature 805, Frost Town	1880s	ca. 1910–1915 / ca. 1915–1930

and once we have compiled all the archival evidence (e.g., property chain of title and ad valorem tax records) to reveal the histories of the city lots where these cisterns are located. Regardless, the current chronological evidence demonstrates that large underground wooden barrel cisterns were used over a long period of time in the Texas coastal region, and they were used contemporaneously with the more common brick-lined cisterns.

Historical Context for Wooden Barrel Cisterns in Houston

For much of the nineteenth century, cisterns served as the primary water storage and supply system for businesses and residents of Houston. It was not until after the construction of the city's public water system began that cisterns started to decline in popularity and use. But the public water system did not spread across Houston evenly and alleviate the need for cisterns everywhere at the same time. There is ample evidence that above- and below-ground cisterns continued to be used well into the twentieth century in many parts of the city, particularly in the more industrialized and lower economic areas.

Various public service systems came to Houston between about 1870 and 1890, including gas, electricity, telephone, and water. These utilities were installed first in the downtown area, and they spread slowly to other parts of the city, and the spread to various neighborhoods was likely dictated by economic status. City services spread very slowly into lower income residential areas like Frost Town. The Houston Water Works, a privately funded corporation, built the first municipal water system in 1878 (Aulbach 2012:243), but the original system used water from Buffalo Bayou and "it was totally unfit to drink and no one ever thought of using it for that purpose" (Young 1912:17). In 1887, the private water works company drilled its first artesian well, and by 1891 the city had 14 artesian wells (Aulbach 2012:243). This was a major improvement, but the water system still had many problems. One of the key problems was that in order to fight fires, the city had to pump water from Buffalo Bayou into the system, thereby contaminating the water for an extended period. In 1906, the City of Houston purchased the Houston Water Works Company, and within a year they had drilled more wells and made significant improvements and expansions to the system (Aulbach 2012:243–244; Young 1912:16–18; Roberts 1929:n.p.). Despite this, the 1907 and 1924 Sanborn maps show that water lines had not yet reached some areas of the city. Water lines were present along all of the streets in the downtown area and in the area immediately south of Frost Town (i.e., the Moody Addition). In contrast, water lines were present only at the southwest corner of Frost Town, and none were present in the five city blocks comprising the northern portion of Frost Town (Sanborn Map Company 1907, 1924).

A review of selected archival documents below provides a basis for understanding the general history of cisterns in Houston, the importance of cisterns as a water source for fire suppression, and, even more specifically, the occurrence of large wooden barrel cisterns in the City of Houston and in Frost Town. The summaries below do not represent comprehensive reviews of all possible archival sources. Rather, they are intended only to provide a modest level of background information and understanding the historical context of cisterns as components within a constantly evolving urban water supply system.

Archival Evidence of Cisterns in Houston

Archival evidence also speaks to the ubiquity of cisterns throughout Houston's history. Mentions of cisterns appear in many early Houston documents. A specific reference to a cistern at a residence in the Frost Town community appeared as an advertisement in the August 28, 1860 edition of *The Weekly Telegraph*, which read (Arto 1860):

> FOR SALE
> Four and one half lots, beautifully situated in Frost town, enclosed with a good new fence, separate from any other lots, by streets running on every side. On one lot is a fine one story house, of four well finished rooms, a good large cistern, large garden lot, and a most excellent collection of Fruit Trees of all kinds. These lots will be sold cheap for cash if applied for soon.
> March8. tf. JOHN ARTO

Mr. Arto placed this exact same advertisement in at least two other issues of *The Weekly Telegraph* published in 1860 (September and October). In all likelihood, this property had a below-ground, brick-lined cistern. John Arto was a prominent Houston businessman, and an advertisement in the 1877–1878 Houston city directory notes that he was the proprietor of the Houston Soda Water Factory (Mooney and Morrison 1877:D).

Public cisterns were mentioned in the 1866 Houston city directory, under the heading of "Compendium of Ordinances Now in Force" (Leonard 1866:61). The ordinance reads:

> CISTERNS, PUBLIC—It is unlawful to take from, and use water from the public cisterns for any purpose, unless to extinguish fires, under penalty of twenty-five dollars for each offence, or ten days' imprisonment. — (Passed Oct. 16, 1865.)

Cisterns were also mentioned in the 1866 City Directory within a discussion of the "Health of Houston" (Leonard 1866:117):

> …Some fears are apprehended of a visitation of cholera, while again an opinion prevails that our city will be exempted from this scourge for the reason that cistern water is used, while it is noticed that cholera is more common where the water is impregnated with lime.

As of 1910, the City of Houston had an "Ordinance to Require the Screening or Closing In of All Cisterns and Other Receptacles for Storing Water, in the City of Houston, So as to Prevent the Breeding of Mosquitoes Therein" (City of Houston 1910:69). The City's *Revised Code of Ordinances* for 1914 had an even more elaborate rule (City of Houston 1914:163–164):

> Sec. 425. Screening, Etc., of Cisterns, Etc.; Penalty—That it shall be unlawful to own, use, keep or maintain, in the City of Houston, any cistern or other receptacle for the storing of or that contains water, or in which water is kept for more than three days, without having the top of such cistern or other receptacle closed over securely by a cover of wood or other durable material, or by a wire screen or wire gauze or cloth netting, or by both, such cover and wire screen or wire gauze and cloth netting so constructed and adjusted as to prevent any mosquitoes from entering into or having access to the water in such cistern or other receptacle, or from coming in contact with the water therein.

The penalty for disregarding this ordinance was a fine not to exceed $10.00. This same rule was still in effect in 1922, published as Sec. 893 in the *Revised Code of Ordinances* for 1922 (City of Houston 1922:437).

The 1914 city ordinances also contained a rule on leaving wells and cisterns open (City of Houston 1914:302):

> Sec. 935. Leaving Wells, Cisterns, Etc., Open—Any person who permits, on premises owned or occupied by him, any well, cistern or other excavation to remain open or uncovered, to the danger of others, must be fined not less than One nor more than One Hundred Dollars.

This rule was absent from the 1910 city *Code of Ordinances*, so its appearance in 1914 has implications for archeological cisterns found in Houston. As of 1914, city residents could have been fined if an old cistern on their property was deemed unsafe. There may have been discrepancies regarding the extent to which this city code was actually enforced in different areas of Houston, but it does suggest that city residents would have had an incentive to make sure that abandoned cisterns on their properties were adequately capped or filled in.

Cisterns for Urban Fire Suppression

In urban areas, cisterns not only served as drinking water sources for city residents, but they also served as a critical water source for fighting fires. In a 1915 publication called *Fire Fighters of Houston, 1838-1915*, Charles Green (1915:17–18) described the importance of cisterns for fire suppression:

> Nearly every home and business house had its underground cistern, it being necessary for housing rain water for domestic use. The late winter rains were stored, and when cisterns were full, along about the first of April, the wooden gutter leading from the roof to the cistern was re-moved. Thus cool and wholesome water was provided during the summer. But firemen were no respecters of persons or quality of water, and woe betide the cistern located nearer the fire.

In his book, Green (1915:15, 17) added illustrations of two pieces of portable fire fighting equipment (Figure 10). The top image (Figure 10a) was simply a small water barrel with wheels attached for use by the "Bucket Brigade." The bottom image (Figure 10b) (shows a force pump mounted on a wagon drawing water from an underground cistern. Describing the latter device, Green (1915:19) noted that:

> In 1847, a force pump was mounted on a wagon frame and housed on Congress Avenue (Market Square), intended as an auxiliary to the Bucket Brigade, but its novelty and effectiveness so inspired the firemen that, instead of some going for the pump while others manned the buckets and ladders, practically every man made a dash for the "engine house."

By 1859, the City of Houston recognized the need for permanent water supply to fight fires in the downtown area, and they built several of their own cisterns to aid the fire fighters. Green (1915:21) describes the city contracts for constructing large cisterns as follows:

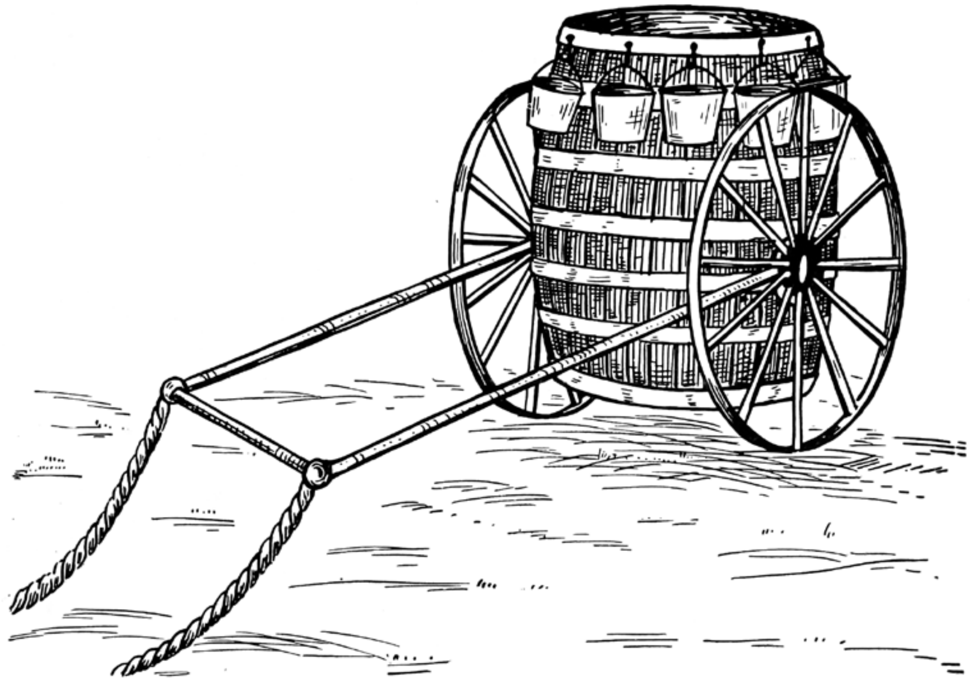
> Popular clamor and indignation finally caught the ears of the city fathers, and during April 1859, the council let contract to John Trentem to place an underground cistern 12 ft x12 ft at the intersection of Preston and Main streets, with laterals connecting with the buildings on the four corners for saving and storing rain water. After this cistern was finished a continued dry season followed and the scheme of thus securing water for fire extinguishment was found inadequate. Two additional cisterns were then placed, one at Congress and Main and another at Commerce and Main. The latter was of larger dimensions than the others, said to be 20 ft x12 ft. Later a cistern 12 ft x12 ft was placed at the intersection of Texas avenue and Main street, and a smaller one near the old J. T. D. Wilson home on Louisiana street. The method by which these cisterns were filled was by pumping from the bayou at the foot of Main street into the Commerce street cistern and from one to another in rotation. It was a two-days' task to fill these reservoirs. The cistern near the Wilson home was filled with rain water and seldom used. These old cisterns went out of service with the advent of the water works in 1879, and the last was filled in just previously to the paving of Main street with asphalt a few years ago.

These municipal cisterns were very large compared with average household cisterns. At 12 ft diameter and 12 ft deep, these municipal cisterns held approximately 10,151 gallons of water.

Wooden Barrel Cisterns in Houston

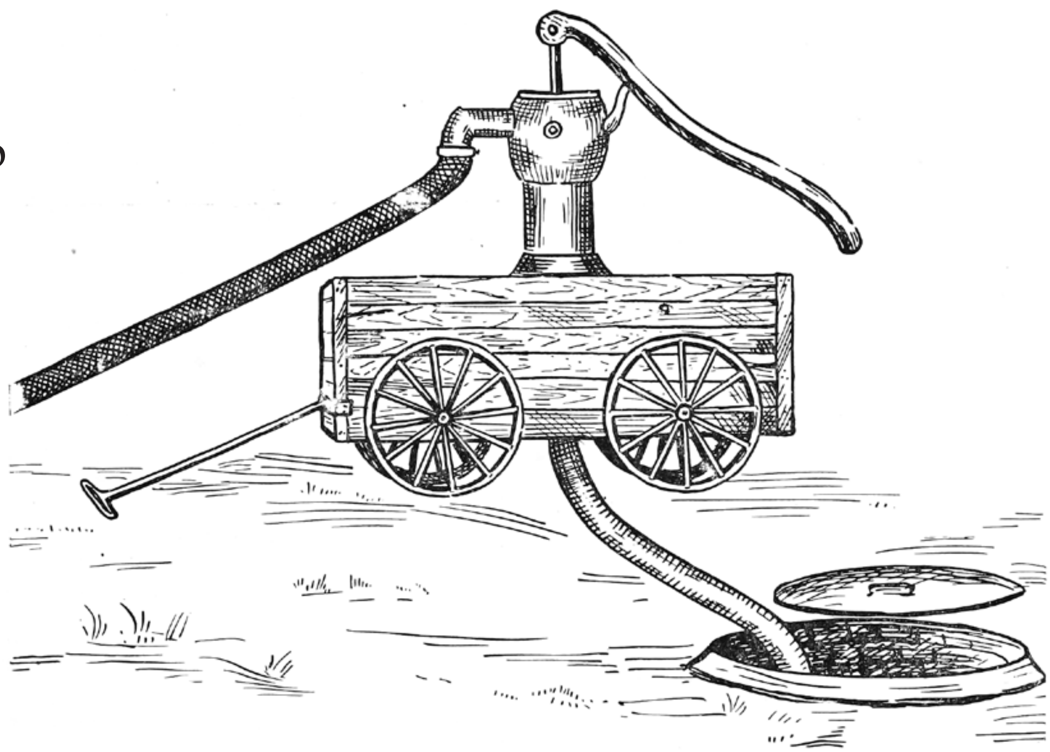
The discussion in this section is a chronological summary of archival sources where wooden barrel cisterns were mentioned in Houston newspapers, Houston city directories, and other published historical books. This is by no means an exhaustive review, but the consulted archival sources span almost a century. This evidence demonstrates that large wooden barrel cisterns were commonly brought to Houston or manufactured and sold in Houston from the 1830s up through the 1920s. In these entries, there is no mention of any wooden barrel cisterns actually being buried in the ground, but by the same token, there is only one mention of a wooden cistern actually having been above ground. While it is presumed that a majority of wooden barrel cisterns were installed above ground, we must admit that a fairly large number of these containers may have been installed as below-ground cisterns.

The earliest reference that we found to wooden cisterns in Houston is from the *Telegraph and Texas Register*, one of the first newspapers published in Texas and "the first newspaper in Texas to achieve a degree of permanence" (*Handbook* a



Apparatus Used in Frosttown (1842).

b



Home-made Fire Engine (Houston, 1847).

Figure 10. Illustrations of portable fire fighting equipment in *Fire Fighters of Houston, 1838–1915:* (a) apparatus used at Frost Town (1842), reproduced from Green (1915:15); (b) home-made fire engine (Houston, 1847), reproduced from Green (1915:17).

*of Tex*as 2017). The reference appeared in the Saturday paper on June 9, 1838, as an advertisement placed by Mic'l (Michael) Cronican, and it confirms that barrel cisterns made of cypress wood were being shipped to Houston in the 1830s. This advertisement stated:

> CISTERNS.
>
> A lot of superior cisterns will be received by the next arrival of the steam packet Columbia—made of the best *Cypress Lumber*, of various dimensions. Those wishing to furnish themselves with this valuable article, will do well to leave their orders with the subscriber, at the Union house, immediately, as the supply will be limited.
>
> May 9' 29-wtf MIC'L CRONICAN.

The 1866 Houston city directory (Leonard 1866) lists a number of individuals whose stated occupation was "cooper," but it is not know if any of these people made large barrels for use as cisterns. There is evidence that wooden barrel cisterns were in use in Houston that same year. On February 19, 1866, the *Tri-Weekly Telegraph* reported on a wooden cistern that burst and damaged a nearby building. The paper reported (Anonymous 1866):

> One of the heaviest rain storms of the season passed over this city yesterday afternoon. The streets were flooded and the waters in the bayou were very high. The large wooden cistern lately erected for Prof. Eika [or Erka?], in the rear of the Brashear building adjoining the Rusk House, burst with a tremendous report, and washed away a brick wall of the building. The Prof. estimates his losses at $700. We hear of many other buildings being damaged.

The 1873 Houston city directory (Tracy and Baker 1873:41) has a listing for "Harris, Geo H, cistern maker. Frost-town." Mr. Harris was a cistern maker living in Frost Town, but there is no way of knowing if he was a cooper who built wooden barrel cisterns or a mason who built brick-walled cisterns. The latter is perhaps more likely, given how common brick-lined cisterns are at Frost Town.

The 1877–1878 Houston city directory has a listing for the firm of "Rohde & Hoencke. (Fritz Rohde & Claus H. Hoencke), coopers, office Milam bet Commerce and Franklin" (Mooney and Morrison 1877:171), and at least three people employed by the firm were listed as "cooper" (Mooney and Morrison 1877:69, 155, 169). Advertisements in later city directories show that this firm specialized in making wooden barrel cisterns, and it is presumed that they were making them by 1877.

Advertisements in the Houston city directories from the 1880s also provide informative details about companies making wooden barrel cisterns. In the 1882 city directory (Morrison and Fourmy 1882), two firms had paid advertisements. The R. D. Gribble & Company ran a half-page ad that listed the various types of lumber they sold and noting "Heart Cypress Cisterns – A Specialty" (Figure 11). The ad featured a detailed line drawing of two men building a wooden cylindrical cistern that appears to be 4 to 5 ft wide and 6 to 7 ft tall with four metal hoops binding the staves. The firm's mill and yard was in the Fifth Ward north of Buffalo Bayou, between Providence and Conti streets, and between Semmes and Maffit streets.

The Houston Barrel Factory also placed a large advertisement in the 1882–1883 city directory (Morrison and Fourmy 1882:xxxviii). The firm's proprietors were Rohde and Hoencke, and the ad stated in bold print: "CISTERNS – For Which We Claim Superiority." The firm's address was listed as a post office box in Houston.

By 1889, the Houston Barrel Factory had changed its name to the Houston Barrel and Cistern Factory (Figure 12). The only proprietor listed in a full-page advertisement in the 1889–1890 Houston city directory was C. H. Hoencke (Morrison and Fourmy 1889). The ad noted: "Manufacturer of Cisterns of All Descriptions — We Claim Superiority over all others." It also stated: "Cisterns Made and Shipped to any part of the State. A large supply constantly on hand and ready for immediate shipment." The ad also notes that the company was established in 1872, and it features a drawing of a large wooden barrel cistern that is tapered toward the top and has five iron hoops binding the staves.

The 1894 book called *The Industrial Advantages of Houston, Texas, and Environs, Also Series of Comprehensive Sketches of the City's Representative Business Enterprises,* highlights three prominent companies that made wooden cisterns. One is the Houston Barrel and Cistern Factory, which was at the corner of Dowling Street and McKinney Avenue (Anonymous 1894:62). In 1894, the firm's plant covered a half block and included an "iron-clad" factory building that measured 75 ft x 250 ft, and the business employed 50 to 75 "skilled mechanics and others." The entry stated:

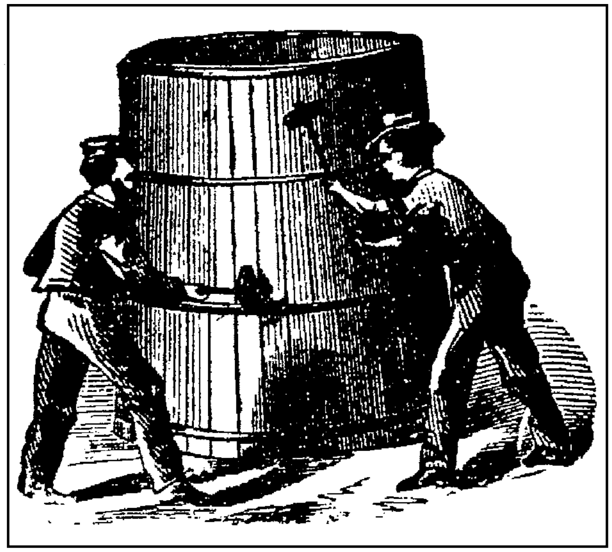
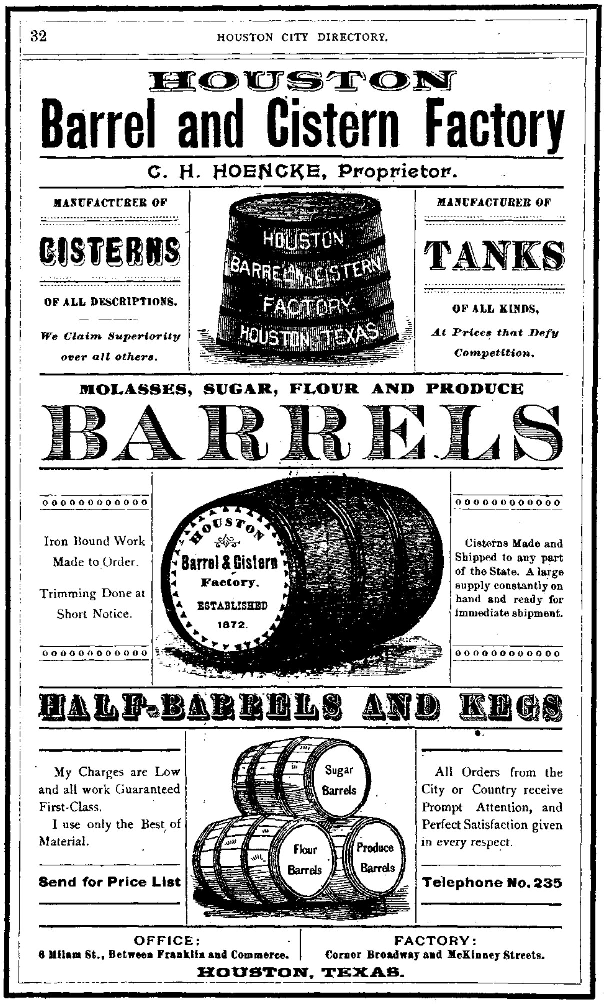


Figure 11. Half page advertisement for "Heart Cypress Cisterns" made by R. D. Gribble & Company in Houston, as printed in the 1882–1883 Houston city directory (Morrison and Fourmy 1882:30).

> The Houston Barrel and Cistern Factory manufactures everything in the way of tanks, barrels, cisterns, including oil and molasses barrels, beer kegs, etc. The entire work in all its details is executed on the premises. The staves and headings are cut by special machinery designed for the purpose, the remainder of the work being done by hand labor, the result being first-class products in every respect. The material used is oak and cypress which come from the forests of Louisiana and Arkansas, within a convenient shipping radius. The company's business is not confined to this city, large quantities of the goods being dispatched to various parts of the state and beyond. The company make [sic] and sell from 20,000 to 30,000 barrels annually, over 1000 cisterns, and a large number of beer kegs. They supply all the breweries in Houston.

A second firm described in the *Industrial Advantages* book is the Bayou City Lumber Company with an office and yard on Tenth Street at the Houston & Texas Central Railroad. Founded in 1893, they handled all types of lumber, including "cypress cisterns" (Anonymous 1894:103). The third firm mentioned is the R. D. Gribble & Company, and they advertised themselves as a "Planing Mill and Dealers in Lumber" (Anonymous 1894:70). They manufactured and sold "lumber of all descriptions, shingles, sash, doors, blinds and mouldings; also heart cypress tanks and cistern." The company description also noted: "The factory is adjacent to the railroad, enabling them to receive raw material and ship their goods with facility and economy. One of their specialties is the construction of heart cypress tanks and cisterns, and in this department they have a special reputation and the best facilities."



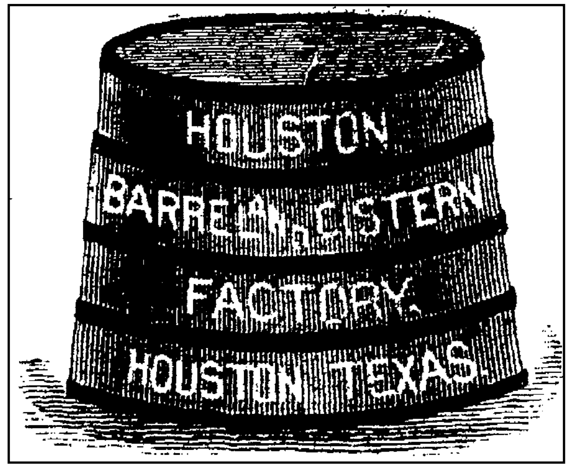


Figure 12. Advertisement of the Houston Barrel and Cistern Factory in the 1889–1890 Houston city directory (Morrison and Fourmy 1882:32).

Another prominent firm summarized in the 1894 *Industrial Advantages* book is the Phoenix Cornice and Sheet Metal Works at the corner of Fifth and Washington Streets (Anonymous 1894:126). Mr. E. K. Dillingham established it in 1893. The company review states: “One branch of the business which is rapidly growing and which daily requires and receives more attention is the manufacture of galvanized corrugated iron cisterns and windmill tanks (Harry’s Pat.), which, though comparatively new in South Texas, are extensively used in the northern part of the State.” This reference seems to denote that the beginnings of a transition from wooden barrel cisterns to galvanized tin cisterns.

Wooden cisterns were still being advertised as late as 1908. The Lone Star Cypress Cistern Shop was a company operating out of Houston’s Fifth Ward, and they ran advertisements in *The Houston Post* in 1904, 1906, and 1908. It is notable that when the 1920 Houston city directory came out (Morrison and Fourmy 1920–1921), some firms still made barrels of various sizes and advertised that they made “Tight barrels” (Hirsch Cooperage Co., p. 149) or “Tight Cooperage of All Kinds” (Texas Barrel Company, p. 185). But these barrel-making companies no longer specifically mentioned that they made cisterns. In contrast, several companies advertised that they made “Galvanized Iron Cisterns and Tanks.” The companies that made these galvanized tanks were Hotkamp’s Tin and Sheet Metal Works at 406-408 Capitol Avenue, Necco Sheet Metal Works at 311 Caroline Street, Phoenix Cornice Works at 1617 Congress Avenue, and Etie Bros at 1510 Washington Street (Morrison and Fourmy 1920-1921:278, 279, 313, 587, 752, 760, 1014). While it is likely that most of these galvanized water cisterns and tanks were probably intended for use above ground, the Phoenix Cornice Works advertised themselves as a "Manufacturer of Overground and Underground Galvanized Iron Cisterns…" (Morrison and Fourmy 1920-1921:279). This ad suggests archeologists might someday encounter below-ground metal cisterns somewhere in Houston.

In the 1926 Houston city directory (Morrison and Fourmy 1926), seven firms are listed under the heading of "Tank and Cistern Builders" (p. 2409), noting that entries in all capital letters denote that the firm also had an advertisement elsewhere in the directory:

Cypress Tank Co The, 2414 Sterrett

ETIE SHEET METAL WORKS (INC), 1510 Washington Street (See p. 374)

HOLTKAMP'S TIN & SHEET METAL WORKS, 406–8 Capitol av (See right bottom lines and p. 374).

NECCO SHEET METAL WORKS, 1505 Caroline (p. 374)

SANITARY APPLIANCE CO (INC), 308 Hughes on G H & H Ry (See Tank Mfrs)

SELINE L, 611 Clay av (p. 375)

WESTERN METAL MFT CO, 3400 block Muary (See p. 376)

Advertisements for two firms in this 1926 directory specifically mentioned cisterns. Holtkamp's Tin and Sheet Metal Works advertised that they made "Galvanized Cisterns and Tanks" in their one main ad (p. 374) and in numerous smaller border ads (e.g., p. 1115, 1505, 1843, 2131, 2375). The Necco Sheet Metal Works advertised the manufacture of "Galvanized Iron Cisterns and Oil Tanks" (p. 374).

It interesting that six of the seven cistern makers listed in the 1926 city directory were sheet metal companies that specialized in galvanized iron products. Only the Cypress Tank Company was still making wooden tanks and cisterns. This firm was based just north of Buffalo Bayou near the intersection of Sterrett and McKee Streets, which is less than a half mile north of Frost Town.

Cisterns in Texas

It is beyond the intended scope of this article to provide a comprehensive review of historic cisterns in Texas, but a few general thoughts are warranted. Cisterns are found across most of Texas, and they can be generally categorized as household, commercial, or municipal, depending upon who built them and the people they served. Household cisterns were generally constructed adjacent to houses and barns to capture and store rainwater for later use by a single family. Cisterns differ from hand-dug water wells, which are generally small-diameter cylinders dug deep to tap into a water table and lined with rocks or bricks (dry-laid or mortared) to prevent collapse. There are documented cases where cisterns were dug into water tables so that they had a dual function. In wet periods when the water table was high, they functioned as a well; and large storage tank that would fill itself. In dryer periods when the water table dropped, these features functioned only as cisterns for holding rainwater.

Archeologically, household cisterns are often investigated and described as stand-along features with little concern for the fact that were always part of a larger water-capturing system. This can be attributed, at least in part, to the fact that it is common for the upper portions of cisterns (i.e., necks and shoulders) and even the foundations of associated structures to have been removed. In such cases, attention should be paid to what was missing from the rest of the system. A cistern was the storage component of a water system that included a structure roof (the area to be drained), some type of rain-gutter that would gather the rainfall and drop it down to ground level or just below ground, and an inflow pipe that would transport the water to the cistern. The inflow pipes were generally below ground and they dipped gently from the structure to the point where they entered the upper wall of the cistern, usually at shoulder level. Cisterns might also have an outflow line that was intended to channel water out of the cistern during periods of high rainfall so that the water did not flow out the top opening. And every cistern had some type of mechanism for extracting water. This might be a wooden frame with an attached pulley, bucket, and rope, or it might have been a pipe that extended down into the cistern cavity and was attached to a hand-pump somewhere above ground (e.g., mounted on the cistern neck or inside the house near the kitchen sink). Household cisterns often had some type of water filtration system, and these became more common over time as the medical profession and general population learned more about the health benefits of clean water and the illnesses associated with contaminated water.

Cistern construction varies greatly across Texas, with the key variants being size, shape, and the materials used to line the cistern walls, although some cisterns were even dug into bedrock. All of these variables can and do have important socioeconomic implications. Large and better built cisterns, for example, may denote relative household wealth. Cistern size, shape, and construction also varied across time and space, although there is still much to be learned about the chronological and regional variations. Cistern attributes also varied according to who built them, and different ethnic groups employed mental templates for building cisterns. For example, one of the most important observations is that cisterns built by early German immigrants were often square or rectangular (Denton 2011:6, Figure 5). At present, however, there has been relatively little systematic study of ethnic variability in cisterns across Texas.

Most historic cisterns in Texas were lined with readily available local rocks such as tabular limestone or sandstone, or they are lined with bricks that were hand-molded or machine-made. The bricks and rocks were usually set with some type of mortar, and the interior walls were usually plastered with mortar. It is common to see evidence of repair episodes in cisterns, with replastering of the interior being a typical way of maintaining or improving the water holding capabilities. Cisterns may exhibit multiple layers of plaster, with older layers being soft grainy mortar and younger layers being concrete. In a very rare example in Texas, a cistern maker even etched his name into the concrete when he replastered the wall. This cistern is in Houston, and the etched name "W. Baugh" has been identified as a brick mason who lived in the neighborhood (Barrett 2016).

Concluding Thoughts on Wooden Barrel Cisterns

The holding capacity of an underground water storage container is a key attribute that reveals important information about the size of a household and to some extent the economic status of the owners. Looking back at Table 1, the estimated volumes of the Frost Town cisterns represent minimum estimates because the upper portions are missing from every feature. What is most notable, however, is that the two wooden barrel cisterns are considerably smaller than the brick-lined, beveled-shoulder cisterns. The four brick-lined cisterns have an average volume of 3,415 gallons, while the two wooden barrel cisterns have an average volume of 659 gallons. Even acknowledging that the wooden barrel cisterns may have extended up above ground a few ft , it is likely that those barrels did not hold over 1,000 gallons of water.

The coating of the interior of one of the wooden barrel cisterns with tar is an unusual phenomenon that was totally unexpected. Tar and pitch are defined as "viscous, dark-brown to black substances obtained by the destructive distillation of coal, wood, petroleum, peat, and certain other organic materials. The heating or partial burning of wood to make charcoal yields tar as a byproduct and is an ancient method for the production of both tar and pitch" (Columbia University 2012). Tar and pitch have long been used by mariners to make wooden ships watertight, and in the case of the Feature 805 cistern at Frost Town, the tar was presumably used to seal the large wooden barrel to make it water-tight. One wonders whether the tar coating might have made the water taste odd, but this may not have been much of an issue. An 1899 *Textbook on Architecture and Construction* notes that most cistern water accumulated from roofs with wooden shingles that were often treated with creosote, which is a byproduct of tar distillation. This textbook (International Correspondence Schools 1899:38–39) stated:

> When rain water from roofs is collected in a cistern, and used for domestic purposes, care should be taken, if creosote stain is used, to prepare the stain so that it will quickly dry-after application. The reason of this is that creosote, while uninjurious, is unpleasant to the taste; but upon drying rapidly will, after the first few rains, leave no foreign taste in the water. In fact, whether paint or stain is used on a roof surface, the first two or three rains should not be, on any account, collected, because, in the case of paint, the superfluous color is washed off and contaminates the water, while creosote affects its taste.

Because the Feature 805 cistern barrel had a thick tar coating inside and out, it may be surmised that the barrel was tarred some time before it was placed into the ground. If so, the tar was probably thoroughly dried well before the cistern began to collect water.

It is clear from historical documents that large wooden barrel cisterns were brought to Houston by 1838, and they were being manufactured in Houston by the 1880s, if not much earlier. Wooden barrel cisterns were being built in and used throughout the City of Houston as late as the 1920s, despite the fact that the city began constructing its water system some 40 years earlier. It appears that the manufacture of galvanized iron cisterns in Houston began by the 1890s, and that wooden barrel and galvanized iron cisterns were being manufactured simultaneously from the 1890s through the 1920s. Although this has not been confirmed in any archival sources, it is likely improvements in the manufacturing of galvanized iron containers led to a decline in the popularity and use of wooden barrel cisterns.

The wooden barrel cisterns found at San Felipe de Austin and in Frost Town are the first such features to be archeologically investigated and reported in Texas. Large wooden barrel cisterns are herein identified as a distinctive type of underground cistern. The three known examples are all located in towns, but this does not preclude the possibility that such features were constructed and used in rural areas. From a methodological standpoint, it is easy to imagine that underground wooden barrel cisterns are under-represented in the archeological record relative to the more substantial rock-walled and brick-lined cisterns. Historical archeologists are attuned to looking for clusters or alignments of rocks and bricks as key evidence of cisterns, and these features are often easily recognizable in surface surveys. The subtle signatures that characterize below-grade barrel cisterns will be more difficult to recognize. As a general rule, we should expect there to be little or no surface evidence to define the locations of large underground wooden barrel cisterns. The potential for discovering such features in urban settings is greatly increased by extensive horizontal stripping.

Notes

1. One semantic note is warranted here. In this discussion, the authors use the term "large wooden barrel" to distinguish true cisterns from smaller rain barrels that were often placed at the corners of houses. Although they may have functioned in the same manner, whether above or below the ground, larger wooden barrels held 500 gallons or more.

2. The stated dimension of these cisterns (4 ft wide and 4 ft deep for Feature 20 and 10 ft wide and 12 ft deep for Feature 28) are smaller than the dimension shown in the plan and profile views (Marek 2011a:95, 102, Figures 52 and 59).

3. The two Spanish reales are illustrated by Marek (2011a:Figures 64 and 65), but due to an unfortunate series of events, the coins were stolen before they could be thoroughly documented and identified.

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Historic Plants as Artifacts: Living Plants as a Type Classification for Historic Sites

Jennifer K. McWilliams

Despite familiarity with botanical remains as artifacts and the use of material culture to date human occupations, archeologists often fail to identify living plants as part of artifact assemblages. Like other historical artifact types, horticultural plants have a date of introduction and therefore can contribute to a better understanding of the overall artifact assemblage. This article introduces a concept for future evaluation: trademarked plant varieties are datable artifact types.

Extant vegetation plays a role in the identification of historic sites. Bulbs and flowering shrubs provide visible clues that can lead to the identification of features on historic sites. A casual observer can recognize an old East Texas home site by the presence of irises, daffodils, crepe myrtles, or especially old cedars. When field crews are surveying to find archeological sites, these plants provide a visual indicator of a historic site. Once observed, shovel testing to recover ceramic, glass, and metal artifacts begin but the extant plants are rarely reexamined.

Archeologists have utilized plants as botanical indicators of sites (Harris 2017; Pearson 1988; Schmiedlin 1993; Sykes 2017a; Yarnell 1965; Zeiner 1946). In North Texas, tree lines and flower beds were key visual indicators during a survey at Camp Maxey, where larger farm landscapes were investigated (Boyd et al. 2007). The project focused on the identification of historical cisterns. These brick-lined features, which were truncated and filled with sand in the 1960s, became lost and posed a danger to military training. Old home sites were found by following lines of older hackberry trees that had matured along former farm roads (Boyd et al. 2007:7, 33, and 41 and Figures 1, 7, and 13). Identification of the roads meant historical maps could be followed (Boyd et al. 2007:Figure 1) to find home sites, long since razed by the military (Boyd et al. 2007:11). Once a farmstead was located, flower beds and other landscape features often helped to define the orientation of houses and yard spaces and ultimately to locate the truncated remains of the cisterns (Boyd et al. 2007).

"Smitty" Schmiedlin (1993) proposed that the presence of anaqua trees may be indicative of Archaic and historic sites along the San Antonio and Guadalupe rivers in South Texas. In Northeast Texas, folk tradition holds that the coral bean or "Caddo bean" is an indicator of Caddo sites (Nelson 1999:72). The Caddo bean is well-adapted to the deep sands that also attracted the Caddo to settle and establish year-round occupied hamlets, but the association had not been evaluated (Nelson 1997:74, 72). After investigations at approximately 60 locations, the evidenced proved that there is a correlation between the coral bean and Caddo sites (Nelson 1997:72).

A trained observer can read the vegetative landscape and identify plants that are non-native as well as plants that are outside of their native range. Dr. Ed McWilliams is a retired professor of Horticulture at Texas A&M University. Since the early 1990s, McWilliams and I have discussed the general idea of the use of living plants as part of artifact assemblages. This article is a result of ideas from these conversations.

During a visit to the McQuire's Garden site (41FT425) in Freestone County (Gadus et al. 2002), Ed McWilliams identified a basswood tree along a creek that runs below the prehistoric occupation site. The tree was only about 90 m from the site. The strong, fibrous bark of the basswood was used by Native Americans much like a rope (Gilmore 1991; Horton 2010). McWilliams searched for additional specimens but found none. He was especially interested in this specimen because it was located near the western extent of its natural range. These observations lead McWilliams (personal communication, July 31, 2017) to believe that this tree was associated with the occupation of the site.

At the Ware Plantation in Rusk County, Ed McWilliams observed four or five old Chinese privet plants planted in a row. These are not to be confused with the more common and invasive Japanese privet found throughout Texas. The Chinese privet plants were popular exotic ornamentals introduced to the New World in 1852 (Dirr 1975). The straight row of privets suggested that these served as a hedge that defined yard space, either between plantation buildings or along a lane. McWilliams (personal communication, July 31, 2017) believed that these might be some of the earliest specimens in Texas because of their large size and proximity to the plantation structures.

In Texas, archeologists have included the analysis of botanical remains (charred wood and seeds and other remains from flotation recovery) in artifact assemblages since the 1940s, and more often since the 1980s (Crane 1982; Horton 2010; Jones 1949; Perry 2010; Perttula 2008). Regarding extant plants, field archeologists describe vegetation on site recording forms. However, typically use general terms (i.e., flowers, bushes, oaks) (Harris 2017) are used, but the specific living ornamental vegetation found on sites is generally not included in the larger part of the site analysis.

Plants as Artifacts

Selected living plants should be useful for dating historic sites in the same manner as historic ceramics (Pearson 1988). Cultivated plants have introduction dates that may reflect the *terminus post quem* (limit after which) the plant was introduced. As shown in Figure 1, technology was necessary to alter colors of ink found on transferware dishes that were popular in the late 18th and 19th centuries. Dark blue transferware was available in Texas by 1820; then inks for black and purple were developed and available in the 1820s; red and brown were available in Texas just before 1830; and finally, green became available in about 1845 (Blake and Freeman 1998:Figure 4). Technological trends in the development of improved crops are also well known. One example is the replacement of open-pollinated corn by double cross corn, single cross corn, and now genetically modified corn (Plant and Soil Science eLibrary 2017) Archeologists should work to generate similar sequences for varieties of bulbs, flowering shrubs, and trees, and incorporate

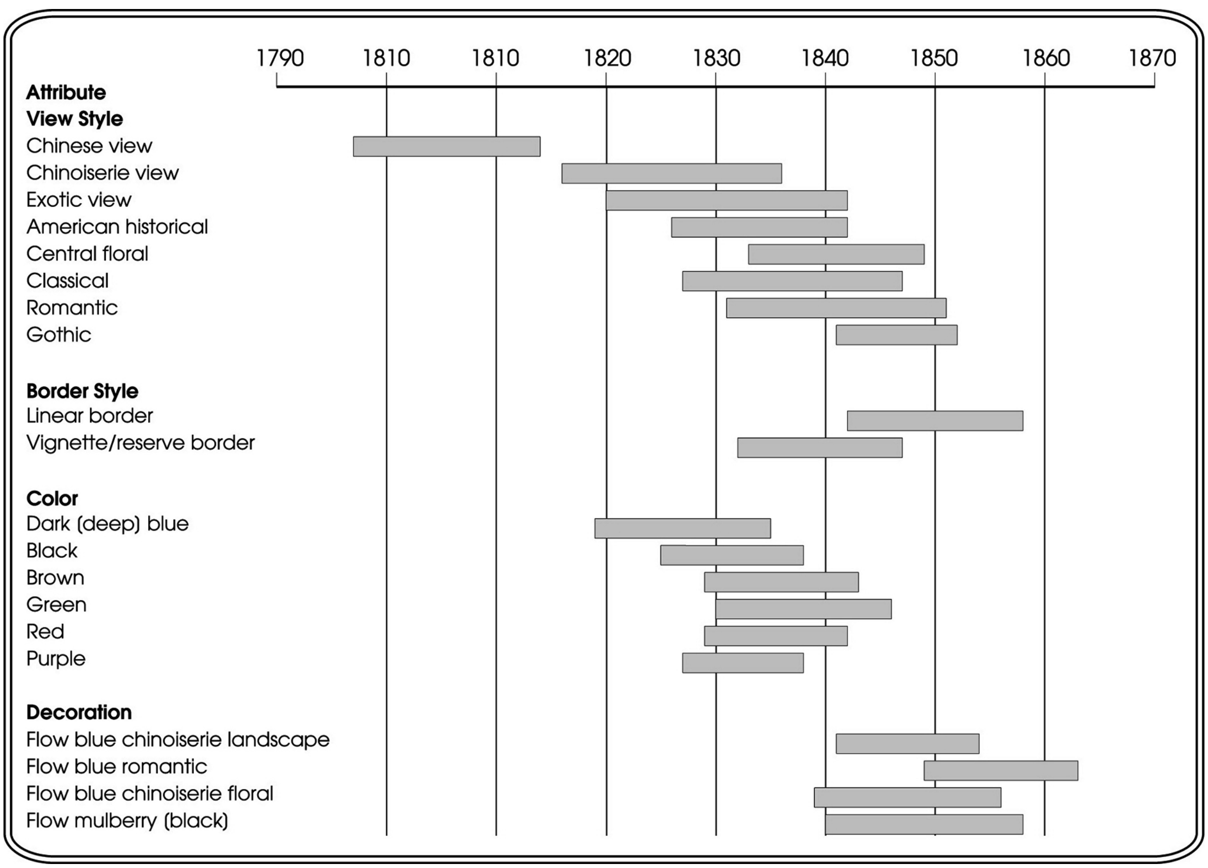

Figure 1. Transferware color and date chart (Blake and Freeman 1998:Figure 4).

information about these horticultural plants in site artifact assemblages.

Exotic ornamental plants, like other historic artifacts, have an introduction date—the date of cultivation—and like other artifact types, cultivars will not be found on a site before their introduction date. Per the International Code of Nomenclature for cultivated plants, a cultivar is "an assemblage of plants that (a) has been selected for a particular character or combination of characters, (b) is distinct, uniform and stable in those characters, and (c) when propagated by appropriate means, retains those characters" (Brickell 2009:6). Popular examples of trademarked varieties that have been introduced in our lifetimes include the 'Knock Out Rose' series (introduced in the early 2000s and increasingly popular in the 2010s) (Harp et al. 2008), dwarf crepe myrtle that emerged in the late 1950s (The Crape Myrtle Trails of McKinney 2017; McWilliams 2017b), and edible examples like the 1015 onion (Aggie Horticulture 2017), maroon carrot (Pike 1995), and fruits like the Pluot (Dave Wilson Nursery 2017).

Cemeteries are ideal sites to find historic plants, and crepe myrtles are common in historic cemeteries. To better understand the introduction of crepe myrtle varieties, the U.S. National Arboretum's (USNA) "*Lagerstroemia Check List*" (USNA 2005) was consulted. While plants like roses are well-known for their cultivar names and introduction dates, it was difficult to find introduction dates for crepe myrtles. The USNA provided dates embedded in descriptions in text form, but dates were not available in a sortable listing. I compiled a spreadsheet of over 500 crepe myrtle varieties listing names, descriptions, and selected introduction dates that ranged from 1825 (the earliest available through the USNA) through 1963 (McWilliams 2017b). After 1963, there was an increased rate of new cultivars.

Challenges and Limitations of Living Plants as an Artifact Category

The use of plants as an artifact category has many of the same challenges as other artifact classifications. Family heirlooms may be kept in a household for many generations, well after their usefulness has passed. Medicine bottles of the late nineteenth century were regularly refilled by pharmacists and used in homes until they broke or single-use containers were developed. The presence of these earlier artifacts may influence the estimated date of occupation. Transportable living plants (bulbs and seedlings) have many of the same challenges because heirloom varieties are becoming more popular and are selected for planting in historical settings, which could complicate the future study of historical plant varietals.

Historically, bulbs were brought to Texas by immigrants and were planted at homes (Klingaman 2013; Welch and Grant 2011:43), and later planted at the graves of loved ones. Bulbs are easily transportable because they are small, compact, and require little care when dormant (Martin 2014:4). Unlike other material culture, plants naturally self-propagate, disperse, and die, with or without the aid of human intervention. The challenge is in identifying and selecting the applicable plants for each region. There will be many limiting factors that negate the use of many plants for historic archeological interpretation. These include nomenclature, geographic region or natural range (including climatic variations), significant weather events, method of propagation (seed distribution vs. root-sprouts), longevity, genetic regression, and seasonal issues (McWilliams 2015).

Nomenclature

Common plant names are listed with their botanical names in Table 1. In West Texas, Dr. Leslie Bush (personal communication, March 15, 2017) noted that "a single plant may have four or five common names deriving from Spanish, English, Nahuatl, German, and a literal translation of the (Latin/Greek) botanical name." Archeological site forms are peppered with common names that are often misunderstood in portions of the state where those common names are not used. If multiple common names for the same plant are known, it is best to provide as many as possible (Leslie Bush, personal communication March 15, 2017). This will help to communicate that information effectively with a specialist.

Within a Latin name, the genus and species of a plant relate it to other plants, as well as to physical or geographic descriptions. Hybrids, such as the Pluot (a cross between a plum and an apricot), are written with an *x* between the two species names. Variety names are written following the abbreviation *var*. or within single quotation marks. Trade names are trademarked specifically for sales and marketing.

Table 1. Common and Latin plant names mentioned in the text and listed in alphabetical order.

Common name	Genus and species
1015 Onion	*Allium cepa*
Amaryllis	*Amaryllis*
Basswood	*Tilia* sp.
Caddo Bean, Coral Bean	*Erythrina herbacea*
Canna	*Canna* sp.
Cemetery Iris	*Iris germanica*
Chinese Tallow	*Triadica sebifera*
Chinese Privet	*Ligustrum sinense*
Crepe Myrtle	*Lagerstroemia indica*
Daylily	*Hemorocallis altissima*
Dwarf Crepe Myrtle	*Lagerstroemia indica*
Dwarf Magnolia	*Magnolia coco (Magnolia pumilia)*
Dwarf Nandina	*Nandina domestica*
Hackberry	*Celtis occidentalis*
Japanese Privet	*Ligustrum japonica*
Knock Out Rose	*Rosa* 'Radrazz'
Maroon Carrot	*Daucus carota*
Nandina	*Nandina domestica*
Oleander	*Nerium oleander*
Pluot	*Prunus armeniaca x domestica*
Variegated Pittosporum	*Pittosporum tobira*
Vinca (variegated)	*Vinca major* or *Vinca minor*

Geographic Range

Unlike ceramic, glass, and metal artifacts, plants only grow in certain conditions. A plant's natural range is determined by average temperature range, rainfall, light, and soil conditions. Plants are hardy within a geographic range, where each of these circumstances is most favorable. They may adapt to areas outside their range, but conditions may not be ideal, and they will suffer as a result of environmental stress. A tree's growth rate, for example, depends on its local and regional adaptations to weather, nutrients, other species, and shelter: trees that are well adapted to a region with the right conditions will grow faster than trees found outside their natural range where one or more of these conditions is limiting (Krebs 1988:31).

Macro-and Micro-Climates

Climate plays a vital role in a plant's hardiness. Plant hardiness zones are one way to identify broad environmental regions. Maps of plant hardiness zones first appear in the literature in the mid-20th century (Del Tredici 1990). The first reference the USNA provides for crepe myrtle hardiness zones was in 1950 (McWilliams 2017b). Plant zone maps have been reissued numerous times in the past 70 years, providing a visual reference for climate changes (Del Tredici 1990).

Environmental change can be observed within more restricted areas as well. Ed McWilliams has studied the variation of temperature on plant distribution within microclimates. Temperatures tend to be a degree or two higher on hill tops compared to creek bottoms, and with recent extremes in temperature ranges, this can be a make or break factor in plant survival. McWilliams (personal communication, July 31, 2017) focused some of his plant studies on cemeteries because these environmental niches often provide an example of these differences. He noted that cemeteries were commonly established on the highest ground across a landscape. Temperatures are slightly elevated on hill tops, creating a microclimate. The author has observed that cemeteries of less-fortunate peopleswithin a community were placed in marginal lands, usually in low-lying portions of the landscape. For plants, each of these geographic situations introduces a microclimate opportunity or a limitation to thrive, such as the microclimate found on these high points and marginal lands.

Weather

Significant weather events affect human occupations and plant adaptiveness alike. Colonization patterns in Texas offer examples of weather-related incidents: hurricanes along the coast drove pioneers to resettle inland, tornados and fires destroyed cities, and droughts forced farmers to seek out arable land elsewhere. Major weather events have impacted historical plants in Texas. These include especially long freezes and droughts such as state-wide freezes in 1899 and 1918, and droughts in 1917, 1956, and 2010-2011 (Texas Almanac 2017). Similarly, droughts and associated fire impact the survival of vegetation in historic sites. Implications of weather-related impacts may also be regional, such as the 2011 Bastrop fires.

Propagation

Methods of reproduction or propagation vary among species and impact how a plant propagates naturally. Seeds may be spread by wind, water, or animals, including humans. Seeds that disperse and are well adapted for a region will spread quickly and can become invasive. For example, the Chinese Tallow is not aggressively invasive in Central Texas, but it is problematic in Southeast Texas where it is well adapted (Ed McWilliams, personal communication, July 31, 2017; The USDA Natural Resources Conservation Service 2017). There are many factors involved in how a plant becomes invasive, including other invasive species, such as birds that are attracted to the seeds, resulting in increased dispersal. Conversely, many cultivated varieties are sterile or produce very few viable offspring, such as dwarf *Nandina* (Ed McWilliams personal communication, July 31, 2017).

Longevity

The longevity of each plant needs to be considered. Longevity ranges from a single season to many hundreds of years (Preservation Tree 2015). Annuals only live a single year; however, if they are well adapted to a region, they can produce viable seeds year after year. At this point, these plants would become naturalized. Bulbs may flourish and increase by forming more bulbs for many years if they are well adapted to a region. The life span of flowering shrubs may be in the tens of years or much longer (Leslie Bush, personal communication March 15, 2017; Preservation Tree 2015). The "Thousand-year Rose" (*Rosa canina*) which grows up the wall of a Catholic cathedral in Germany is thought to be over 800 years old (Hildesheimer Dom n.d; Trove 1893). In Texas, the life of trees may range from 20 years for some smaller trees (including fruit trees such as peaches) to several hundred years old for larger trees such as live oaks (Preservation Tree 2015). Trees may produce viable seeds that may have been dispersed by birds, mammals, wind, or water. Crepe myrtles are long-living woody shrubs that could be identified to the cultivar-level and would provide a *terminus post quem* (McWilliams 2017a, this volume). Magnolias and pecan varieties are easily dated as the dates of introduction are well-known among specialists.

Regression

At any given time, certain plant varieties found at historic sites may be regressing; that is, slowly losing the specific trait for which they were selected for use. The selected traits of a new plant variety may be permanent, or the traits may regress back to less-desirable traits. For example, the leaves of variegated plants will regress back to green leaves (which is a more beneficial state for the plant) within a few generations (Mueller 2005). White "cemetery iris" may have once been tall and colorful, but has regressed back to short plants with white flowers, closer to the parent plants from which they were selected (Mueller 2005).

Seasonal Needs of Cultivar Identification

The archeological concern with gardening or larger-scale environmental interests like Master Naturalists rely on knowledge of nomenclature and regional flora; however, the experience required to identify and date a cultivar is beyond most avocational horticulturists. Collaboration with specialists will be necessary.

The most obvious challenge to varietal identification is seasonal. Deciduous plants will be difficult to identify in the winter, spring flowers may be key to identifying a plant to its variety, and summer fruits may be required to identify some plants. It would be unrealistic to expect fieldwork to fall within a certain season for the sole purpose of botanical identification.

Artifact analysis commonly takes place after the field season ends. There are some practices (such as wrapping charred remains or bone in foil) that are utilized to stabilize or store the specimen for transportation and subsequent analysis. But with living plants, one either needs (1) identifiable leaves and/or flowers to photograph; (2) to be able to return to the site later to photograph specimens; or (3) to collect samples (cuttings, bulb, or seeds) for growth until flowering or maturity permits a specific identification. A collection and transportation procedure will need to be defined.

Available Publications: A Starting Point

Historic archeologists commonly use catalogs and publications to determine the function and dates of artifacts. Similarly, with cultivars, seed and bulb catalogs can be referenced. Local libraries or archives may house plant catalogs from early nurseries in the vicinity. Ramsey's Nursery, which operated in Burnet County and later in Austin's Hyde Park neighborhood (Collins 1998), produced annual catalogs between 1879 and 1947, which are on file at the Austin History Center (Ramsey 1879-1963).

Regional gardening books provide some introduction dates. *Plants of Colonial Williamsburg* (Dutton 1993) may be an applicable publication for certain portions of Texas. Williamsburg is in Zone 6 on the USDA plant hardiness map (The USDA 2017) and the book provides a listing of historic and native plants that may also be found in far North Texas. Additionally, Dutton (1993) provides native regions (including Texas) within her descriptions. *Small Period Gardens: A Practical Guide to Design and Planting* provides a listing of plants that were popular from the 15th to 20th centuries in British, Scottish, and some early American gardens (Strong 1992). Only one regionally southern-specific publication, Dr. Bill Welch and Greg Grant's (2011) *Heirloom Gardening in the South*, is geared to period plantings. They list "Easy to Grow" plants for southern cemeteries (Welch and Grant 2011:83-84). Julie Ryan's (1998) *Perennial Gardens for Texas* also provides dates.

Specialized publications provide introduction dates for selected flowering ornamentals: amaryllis (Schultz 1954; Traub 1958); cannas (Cooke 2001); camellias (Herbert 1959); daylilies (Hill and Hill 1991); iris (Kohlein 1988); and oleanders (Eggenberger and Eggenberger 1996); and trees such as magnolias (Magnolia Society International 2017) are examples applicable to Texas. Many of these resources have been compiled; most of these are available online: The Council on Botanical and Horticultural Libraries, Inc., The Smithsonian Libraries Botany and Horticulture Library, and The United States National Arboretum (USNA 2017).

The National Arboretum provided plant introduction dates for research on crepe myrtle cultivars (McWilliams 2017b). Other resources for local popularity of plantings may be found in local garden club yearbooks, which chronicle the most popular plantings of the day.

Future Research

The goal of this article is to introduce a concept for future evaluation in historic archeological research: introduction dates for selected living plant varieties are available, and plants can be included as part of the broader consideration of artifacts on historic sites (Pearson 1988). Little has been written on the subject; in fact, only one reference could be found (Pearson 1988). This article serves as a first step to introducing the topic and evaluating the concept.

The author is in the process of testing the idea. During a winter visit to a rural cemetery in Burleson County, dense thickets of unidentifiable crepe myrtle were observed. These thickets were a result of root sprouts that had grown up from the excavation of graves. The density and size of the saplings indicated that the planting of the original crepe myrtle predated most of the surrounding graves. Cuttings were taken and are growing for later identification.

Archeologists will benefit by moving away from using general plant terms (i.e., flowers, shrubs) and work toward specific identification of historic plants on sites. A field guide to historic plants would supply archeologists with a broader knowledge of plant identification and taxonomy within a region. Such a field guide may also present examples of specimens that are found outside their usual ranges. Dr. Leslie Bush (personal communication, March 14, 2017) has found many examples of specimens or populations outside their usual natural range, such as sotol discovered in the ruins of a historic farmstead in south Austin.

Archeology is a collaborative endeavor. Historical archeologists reference Sears, Roebuck catalogs (Sears, Roebuck and Co., Inc. 1897, 1902, 1906, 1927) for the first use of historic artifacts and rely on the knowledge of specialists for identification of burial hardware (Pye 2014). Archeologists send faunal and botanical samples to specialists for analysis. Thus, in plant research, collaborations will be crucial as will be partnerships with horticulturalists who can identify both species and variety.

Regional syntheses of available bibliographic references should be made available to archeologists interested in this specialized area of study. Cultivar and species listings found on websites provide dates of introduction (see McWilliams 2017a, this volume). These listings need to be culled for appropriate and hardy plant types. Plant catalogs from historic nurseries, such as Ramsey's Nursery in Austin, are available at local libraries and archives. These can be inventoried for availability, providing a better understanding of regional introduction of specific plants. Timelines of availability and popularity may also be created. Additionally, regional listings of dependable plants should be a realistic goal. These should include flowering shrubs; iris, daffodil, crinum, gladiolus and other flower bulbs; as well as fruit trees, berries, grapevines, and other edible plants. Historic vegetation is at risk of being lost forever. Inventories of extant historical plants are therefore necessary and time is of the essence.

Another possibility is the development of a laboratory-greenhouse. Such a place could be developed by a specialist to grow and identify plants collected in the field. In this scenario, bulbs, seeds, and cuttings would be grown to identify cultivars to be added to the artifact assemblage of the historic site where they were collected.

Finally, the inclusion of historic plants as an artifact for study and analysis can be applied worldwide. Investigations can also be restricted to regions within a larger context, such as at state and county levels, for more detailed consideration of plant use. Collaboration with horticultural specialists is the first step.

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Recent Data on Mesoamerican Obsidian from Archeological Sites in the Rio Grande Delta and Other Areas in Southern Texas

Thomas R. Hester, Michael D. Glascock, Frank Asaro, and Fred H. Stross

Nearly two dozen obsidian artifacts from Mesoamerican geologic sources have been found in sites in the southern part of Texas. These sources are located both in central Mexico and from western Mexico, hundreds of miles from the sites. Most notable is the occurrence of multiple obsidian specimens from Mesoamerica in the Rio Grande Delta. Coupled with the presence of Late Postclassic Huastecan ceramics and greenstone ornaments, there is abundant evidence for trade between the Delta and the Huastecs, extensively discussed here. We also report obsidian artifacts from South and South Central Texas sites that have been sourced largely to western Mexico, beginning in Paleoindian times.

The Texas Obsidian Project (TOP) was initiated in 1970 by Thomas R. Hester, along with colleagues at the University of California, Berkeley, and it has made a long-term effort to study the small amounts of obsidian that came into the state during prehistoric times. Basically, when a provenienced obsidian artifact was found and brought to the attention of Hester, he was able to secure a geochemical analysis of the specimen in the hope of determining its geologic source. Since artifact-quality obsidian does not occur in Texas, determining the sources of these rare obsidian specimens would likely shed light on trade and exchange patterns in the region.

Beginning in 1970, geochemists at the University of California, Berkeley, analyzed Texas obsidians as part of their much broader research on the trace element analysis and sourcing of artifacts from various parts of the world. Robert Jack did initial studies, and then Fred Stross, Frank Asaro, and their associates accepted this chore in their obsidian studies at the Lawrence Berkeley National Laboratory (LBNL). The Berkeley researchers were working at that time on obsidian sourcing in Mesoamerica, California, and Nevada (Stross et al. 1976). There were other researchers scattered around the country who shared their data with the LBNL, and over decades most of the important sources of obsidian were identified. For example, in the 1970s and 1980s, the LBNL recognized a recurring type of obsidian, called 'Escondido Ranch," since its geologic source was unknown. Then, the LBNL was able to obtain data on sources of obsidian in Idaho and Wyoming, and "Escondido Ranch" was linked to the Malad obsidian source in southern Idaho. It has turned out to be one of the most common obsidians found in Texas sites (Hester 1986).

There are a variety of scientific techniques for the sourcing of obsidian and other types of artifacts (Hester 1996:664), the details of which cannot be covered here except in brief summaries. In this study, high-precision x-ray fluorescence (PXRF) and neutron activation analysis (NAA) were used. Only NAA requires the destruction of a specimen (or a part thereof), while the other techniques do not alter the specimens (except in rare cases).

XRF uses a primary x-ray to display and affect the inner shells of atoms in order to produce fluorescent x-rays characterizing the various elements in an obsidian artifact to be detected and measured (see Hampel 1984:21), particularly the trace elements, such as zirconium, rubidium, strontium, magnesium, iron, zinc, and many others. This allows the basic composition to be established, and then compared with such data from known obsidian sources. Theoretically, each obsidian source has a unique chemical "fingerprint" different from every other source. At the LBNL, a "low power" XRF was used for many years, until they developed a "high-precision XRF method" (PXRF) in the early 1990s (Giauque et al. 1993).

Over the years, XRF has been steadily improved as a technique and in its application. For example, most of the XRF identifications done by Michael D. Glascock (e.g., Glascock 2012) were done using a handheld portable XRF (Bruker Tracer III-V). Use of such equipment greatly speeds up the sourcing process. This approach emphasizes measurements of rubidium, strontium, zirconium, yttrium, and niobium, as Glascock's research shows that these elements produce reliable data for small artifacts. His laboratory also utilizes energy dispersive XRF (EDXRF), though throughout his many publications and reports, he traditionally uses "XRF" to indicate this approach.

NAA is a more expensive technique to use in "fingerprinting" obsidian. Some laboratories use it whenever XRF applications are not providing good source data (e.g., typically for very small artifacts). In the example of TOP 49 (discussed below) from Kincaid Rockshelter (Figure 1), XRF showed trace element data resembling obsidian from sources at El Paraiso, Queretaro, which has two sub-sources. Asaro, Stross, and their colleagues subsequently felt that NAA would be more precise (Hester et al.1985:146). Thus a piece of the TOP 49 sample was removed, to allow preparation of a "pill" for NAA. This approach yielded a precise source of El Paraiso B obsidian.

NAA involves a nuclear process by which an obsidian sample is bombarded by neutrons. Radioactive isotopes result, and precise and sensitive multi-element analyses can be done. NAA results are directly comparable with other laboratories, unlike XRF. A thorough overview, prepared by Glascock, director of the Archaeometry Laboratory at the University of Missouri Research Reactor (MURR), can be found online at http://archaeometry. missouri.edu/NAA_overview.html.

In the early part of the 2000s, staff at LBNL began to retire and their involvement slowed greatly. Beginning in 2005, Hester began working with MURR and its Archaeometry Laboratory directed

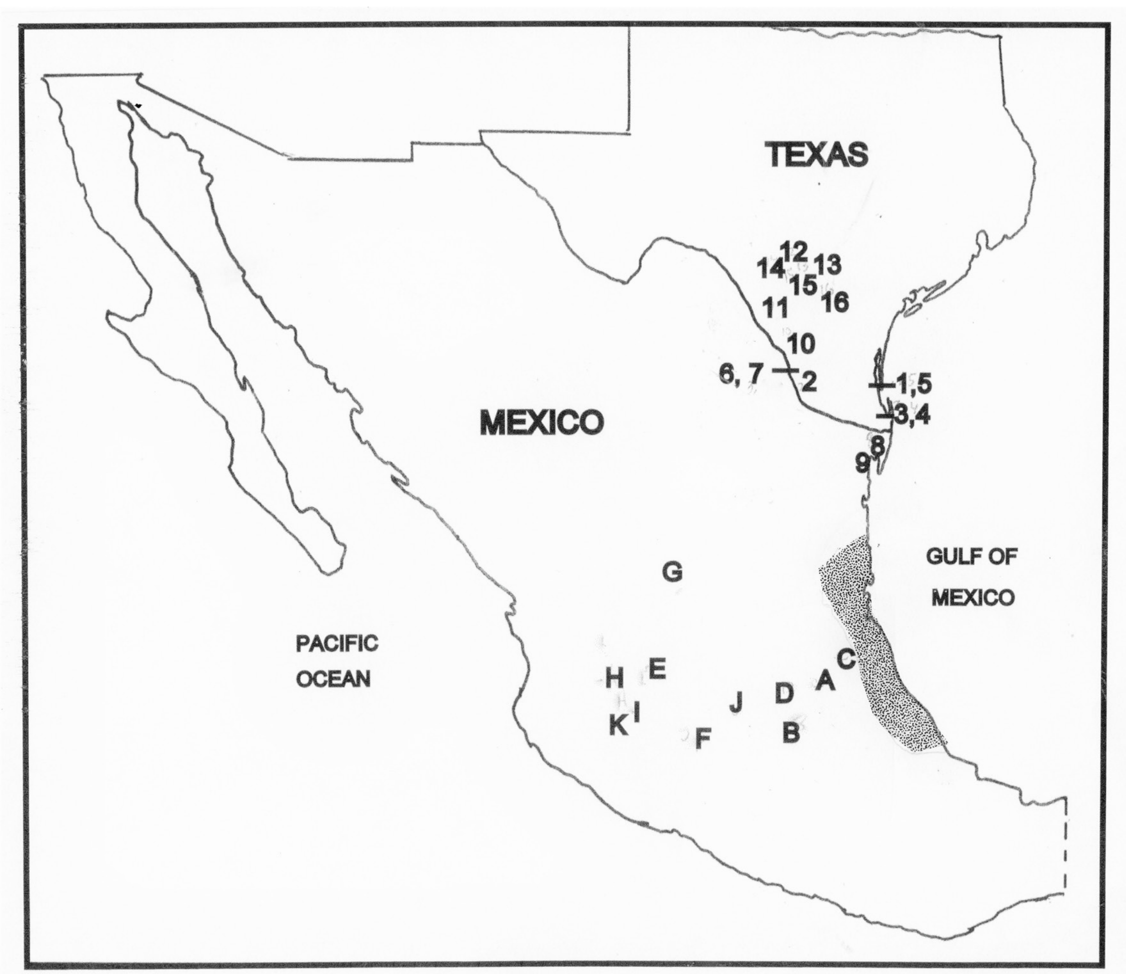

Figure 1. Sites and sources cited in Texas. An approximation of the Huasteca is shown as the darkened area: 1, 41WY71-72; 2, TOP 88; 3, TOP 195-196 4-5, T0P 53-54; 6-7, TOP 187, TOP 193; 8, TOP 183; 9, TOP 201;10, TOP 293; 11, TOP 2, TOP 3; 12, TOP 229, TOP 235, TOP 236a, TOP 238;13, TOP 209; 14, TOP 49; 15, TOP 62; 16, TOP 203; A, Sierra de las Navajas; B, Otumba; C, Zacualtipan; D, El Paraiso; E, Huitzila; F, Cerro Varal; G, Ojo Zarco; H, Teuchtitlan; I, San Isidro; J, Ucareo; K, Santa Teresa.

by Glascock. This laboratory is exceedingly active and well respected, and Glascock and his team have published dozens of papers on geologic obsidian sources in many areas, especially in the American Southwest and Mesoamerica. Their work in the Trans-Mexican Volcanic belt is particularly relevant here (Figure 2).

The initial and the continuing discovery of the sources for Texas obsidian artifacts showed that New Mexico sources located in the Valles Caldera of the Jemez Mountains were the most common obsidian sources for Texas obsidian. But other sources figured in, especially the Malad source, Obsidian Cliff (Wyoming), and a few well known Mexican sources. Hester and his colleagues have published much of the TOP data (Hester et al. 1991a, 1991b; Hester et al. 2007; Hughes and Hester 2009; Hester et al. 2017; Mitchell et al. 1980).

Goals of this Study

The purpose of the present paper is to review the occurrences of Mexican obsidian found in southern Texas sites (Figure 1). Some of the TOP specimens from Mexico have already been published, especially from the lower Rio Grande valley (Hester et al. 1996, 1999), that are from sources in central Mexico, including Sierra de las Navajas [Pachuca], Otumba, and Zacaultipan, all located in the state of Hidalgo, and in 1985, the LBNL group determined that a basal fragment of a Clovis point from Kincaid Rockshelter, Uvalde County (Figures 2 and 3) was linked to the El Paraiso B source in the Mexican state of Queretaro (Hester et al. 1985).

Thus, the TOP project demonstrated that obsidian from Mexico had made its way into Texas beginning around 13,000 years ago, and, sporadically, into

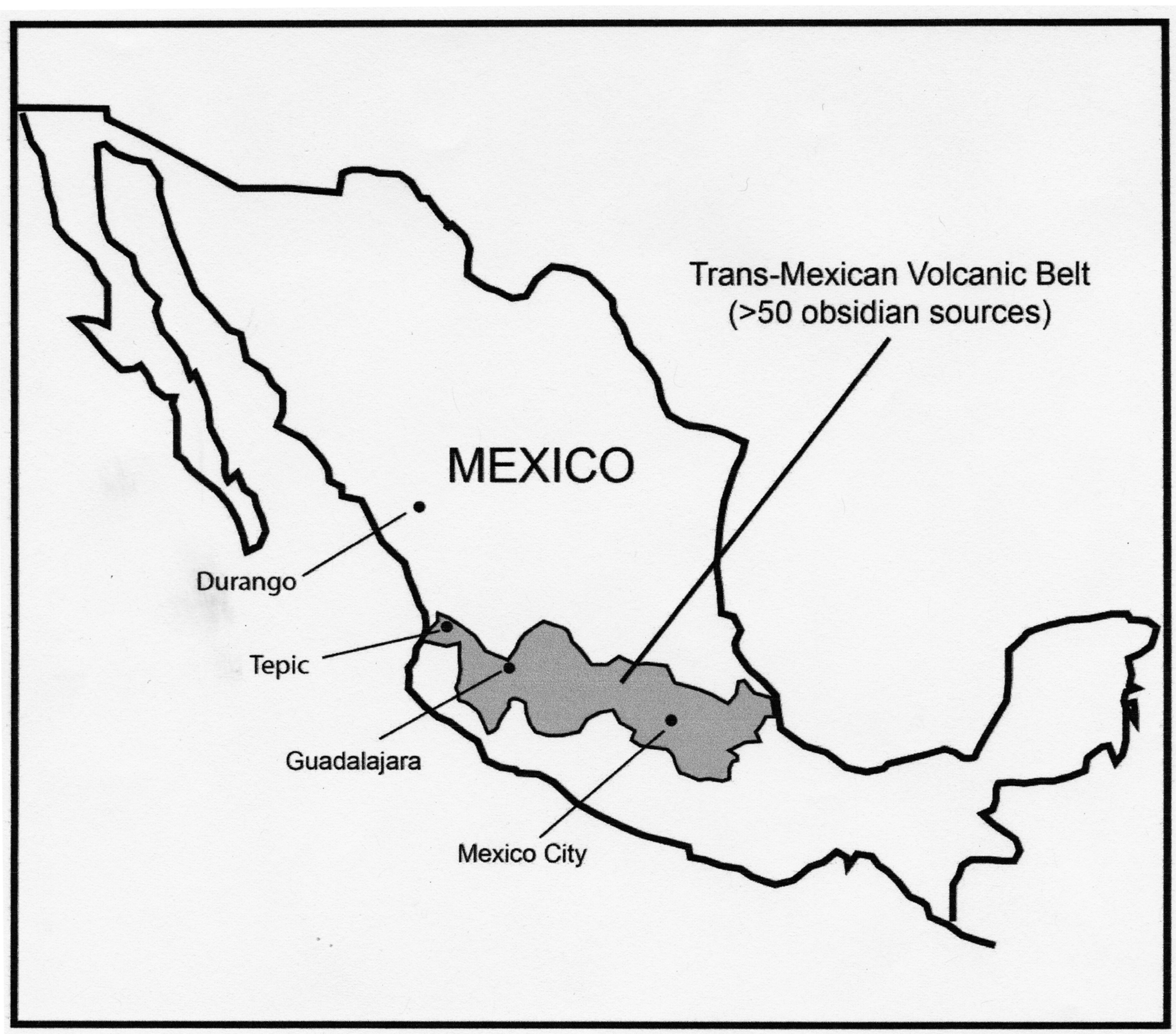

Figure 2. The Trans-Mexican Volcanic Belt. Mapped by Glascock et al. (2010: Figure 2).

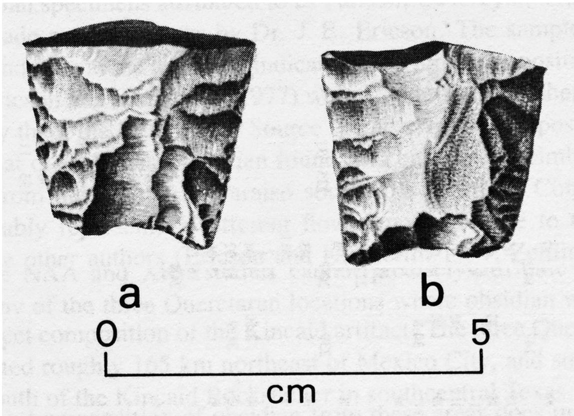

Figure 3. The Clovis Obsidian Base from Kincaid Rockshelter,TOP 49. Drawing by Hal Story.

Archaic and Late Prehistoric times. The focus in this paper will be on Mexican obsidians found in sites in the Rio Grande valley, South, and South Central Texas. The sites or locales where these Mexican artifacts were found are described, along with the source(s) of obsidian from these sites. The data will be presented by the sub-regions: Lower Rio Grande Valley, South Texas, and South Central Texas.

Lower Rio Grande Valley

Through the help provided by the Texas Archeological Research Laboratory (TARL) at The University of Texas at Austin, by Don Kumpe and Mike Kryzwonski, by D. William Day of Prewitt and Associates, Inc. Robert J. Mallouf, James Boyd, David O. Brown, and Clint Davis, Mexican obsidian has been documented in the Lower Rio Grande valley and up the Rio Grande to about the city of Zapata. Much of this material has been published, but it is useful to review it here. They will be discussed under their TOP number, and where possible, the site number or name.

41WY71 and 41WY72

During fieldwork in Willacy County (Day 1981:56-58), a single green obsidian flake was found at 41WY71 and six other green flakes were recovered from 4lWY72. Though these came from excavations, there were few other artifacts (and no time-diagnostic artifacts) found at the sites (see Figure 1). At the request of Prewitt and Associates, Hester visually inspected these in 1981 and concluded that they represent Sierra de las Navajas (Pachuca) obsidian. Elton Prewitt sent two pieces of the green obsidian (his lot 6-3) to LBNL and one green flake was sourced to Sierra de las Navajas (using XRF; TOP 168).

There are numerous published studies and observations involving the widespread procurement of Sierrra de las Navajas obsidian (see Figure 1). Very through reviews are presented by Charlton and Spence (1982:11-26) as well as Aguilar et al. (1989).

TOP 88

The specimen is the distal tip of a thin, well-flaked biface (Figure 4). It was collected from the surface by Don Kumpe, at a site that he designated as 14P in Zapata County. The site is roughly half way between Zapata and Rio Grande City and about nine miles from the Rio Grande. The site was on a root-plowed low rise, and according to Kumpe "hundreds of dart points" have been found here by several individuals. All of the lithics are Archaic in age.

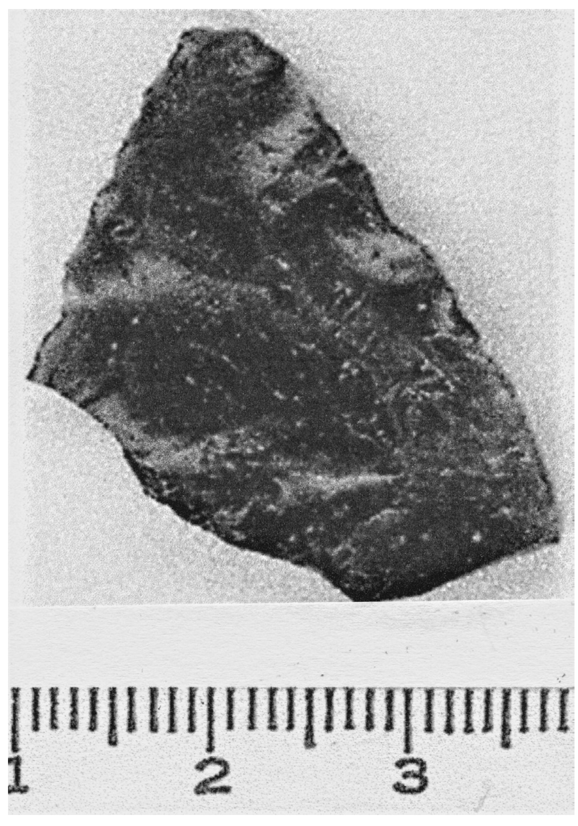

Figure 4. TOP 88, Zapata County, Texas. Sourced to Huitzila, Zacatecas.

The initial study was done by the LBNL in 1984-1985, and the specimen was found to be similar to two sources in the Mexican state of Jalisco. XRF and NAA were used for analysis at LBNL (Table1). But a definite assignment could not be made. However, a recent analysis was done courtesy of Michael D. Glascock (2016) and the piece was found to be from an obsidian source at Huitzila, Zacatecas (see Figure 1). Most of the western Mexico obsidian sources were unknown in 1984, and indeed, it was not until the work of Glascock and colleagues that dozens of new sources were found and chemically characterized in a comprehensive manner (Glascock et al. 2010). The Huitzila source has also been intensively studied by Darling and Hayashida (1995) and Darling and Glascock (1998).

Huitzila is located in the Sierra Madre Occidental in southern Zacatecas (see Figure 1), roughly 40 miles northwest of the city of Guadalajara. Darling and Hayashida 1995:249) note that the prehistoric exploitation of the source involved small-scale mining and "harvesting" obsidian nodules from outcrops and gravel exposures. A wide range of quarry debris typical of Mexican obsidian sources was found, including cores, biface blanks, decortication flakes, and raw materials testing. The straight-line distance between the TOP 88 find spot and the Huitzila source is about 467 miles.

Table 1. Abundances of elements of obsidian from 41ZP88, in ppm except where otherwise indicated. These analyses (2192-P) were done by Frank Asaro and Fred Stross at LBNL, and then subsequently analyzed by XRF (8140, bottom; 2016) by Michael Glascock. He attributed the artifact to the Huitzla, Zacatecas obsidian source.

	NAA Measurements (2192-P)	+/-
Al	5.75	0.13
Ba	18.0	11.0
Ce	158.5	1.6
Co	0.25	0.05
Cs	2.72	0.07
Dy	11.77	0.14
Eu	0.195	0.007
% Fe	1.734	0.017
Hf	16.58	0.18
% K	3.71	0.27
La	79.15	1.96
Mn	387.0	9.0
% Na	3.44	0.07
Rb	153	5.0
Sb	0.47	0.06
Sc	0.87	0.02
Sm	12.77	0.13
Ta	3.35	0.03
Th	15.97	0.16
U	4.62	0.07
Yb	8.14	0.08
	XRF Measurements (8140M)	
Zr	768.0	-
Rb/Zr	0.191	0.003
Sr/Zr	0.004	0.002

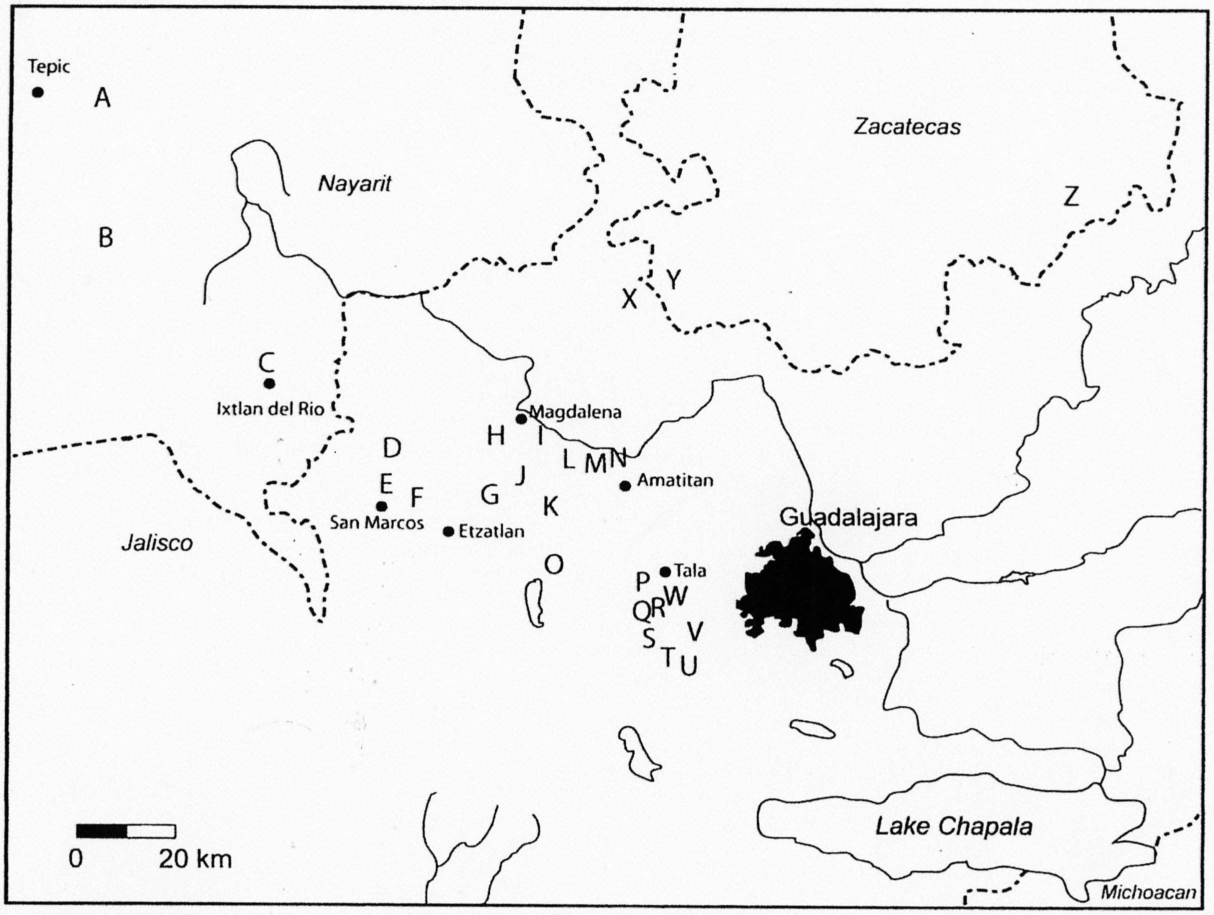

Figure 5. Map Showing Locations of Many Obsidian Sources in the Western Part of the Trans-Mexican Volcanic Belt. Adapted from Glasscock et al. 2010: Figure 3), noting only those sources found in southern Texas sites. L, Santa Teresa; O, Teuchtitlan, W, San Isidro, Y, Huitzila.the Western Part of the Trans-Mexican Volcanic Belt. Adapted from Glascock et al. 2010: Figure 3), noting only those sources found in southern Texas sites. L, Santa Teresa; O, Teuchtitlan, W, San Isidro, Y, Huitzila.

TOP 195-196

Two pieces of obsidian, one a flake fragment (TOP 196) and the other a flake or perhaps a shattered small biface (TOP 195) were found at Kryzwonski site 165 near Caballo Island in Cameron County. TOP 195 is 16 mm long, 14 mm width and 4 mm thick TOP 195 is 30 mm in length, 12 mm in width, and has a thickness of 6 mm. Both pieces were opaque black to gray black specimens and were of the same type of obsidian, but in 2000, the LBNL researchers did not know of the source. Using high-precision XRF data from the LBNL, Glascock (personal communication, 2017) found that the two specimens match the source of Cerro Varal in central Michoacan (see Figures 2 and 5).

*TOP 198*A

Is a tiny obsidian proximal flake fragment (10 mm long, 8 mm wide, and 2 mm thick) that was collected from Kryzwonski site 85 in the San Martin Lake area of Cameron County. XRF studies by the LBNL determined the source to be Zacaultipan, Hidalgo, outside of the Basin of Mexico (see Hester et al. 1996:4; Cobean 2002). Zacualtipan has vast deposits of worked obsidian around quarries and open pit mines. In addition to Cobean (2002), a detailed discussion and a site map for Zacaultipan can be found in Charlton and Spence (1982:9-11).

TOP 53-TOP 54

Robert J. Mallouf provided two pieces of obsidian for sourcing; both were found at 41WY40 in Willacy County (see Figure 2; Mallouf et al. 1977). One is a thin flake (TOP 53) and the other (TOP 54) is a fragment of an interior or biface thinning flake.

41WY40 is a "blowout" in an active sand dune, part of a dune field area west of Port Mansfield in northeastern Willacy County. In addition to the two obsidian flakes at the site, there were several cores, numerous flakes, a stemmed dart point, a biface fragment, a small "gouge," crude bifaces, trimmed/utilized flakes, and a mano.

In 1978, the LBNL carried out XRF and NAA analyses (the flakes had to be powdered and made into "pills" for NAA, and this was done with the permission of Mallouf given on March 13, 1978). But they could not determine the source. In 1994, using PXRF, and with a broader reference collection on sources, they were able to link both specimens to the Ojo Zarcos source, now referred to as the Penjamo. The 1994 identification had been made possible by the LBNL's analysis of source samples collected northwest of the city of Queretaro in the eastern bajio of Guanajuato. The source had been mapped by David O. Brown and Clint Davis, and they collected source samples that Hester sent to the LBNL. These samples provided the measurements needed to recognize the parameters of the source (the sample was designated TOP 164), thus permitting the identification of the sources for TOP 53 and TOP 54.

Falcon Reservoir

Two obsidian artifacts are known from this locality (Hester et al. 1996:2). One specimen was surface collected at 41ZP8 (T0P 187). It was a fragment of a plano-convex biface (Figure 6a), and XRF analysis at the LBNL linked it to the well-known Otumba source in the state of Hidalgo, in the central Mexican highlands. Otumba and the other major Hidalgo obsidian source of Sierra de las Navajas (Pachuca; see below) supplied obsidian to the ancient city of Teotihuacan. The Otumba outcrops encompass several localities, with some obsidian chunks exposed on the surface, and other obsidian obtained through shallow pits and tunnel complexes. Major tool forms produced were end scrapers and point or knife preforms. A lengthy discussion of the various locales and sources of Otumba obsidian can be found in Charlton and Spence (1982:39-50).

Another obsidian artifact was in the early 1950s collections of the Falcon Reservoir salvage project. The specimen (TOP 193) was found at an unknown site. It is the distal portion of an end scraper exhibiting heavy use wear. The specimen has a distinctive green color, with a golden surface sheen. It could be visually identified as Sierra de las Navajas (Pacucha) obsidian (see Figure 6d). Indeed, Spence (1985:83) describes the obsidian's appearance as a "particular variant" from that source and he notes its heavy use in Aztec times.

Tamaulipas

From the Mexican side of the Rio Grande delta is TOP 183 (see Figure 6b), the medial section of an obsidian blade. Don Kumpe collected this many years ago at his site T63 near Matamoros (see Figure 1). XRF analysis at LBNL revealed that it is from the Zacualtipan, Hidalgo, obsidian source (Table 2; Hester et al. 1996:3).

TOP 201

This obsidian artifact (see Figure 6c) was found at TM29 (Specimen 29.2) in coastal Tamaulipas, west of the Laguna el Rabon (see Figure 1). It is a medial biface, the faces of which have been "sand blasted" from exposure on the site surface. It resembles the surfaces of the dart point from 41JF50 and the Clovis point from Port Lavaca, Calhoun County (Hester et al. 1988: Hester et al. 1992) that have been both heavily modified by wave action ("beach rolling"). However, site TM29 is not close to a beach and we assume the abrasion came from wind-blown sand particles. The specimen was sourced to Zacualtipan, Hidalgo (see Table 2). The length of the specimen is 18 mm, its width is 15 mm, and it is 7 mm thick.

Nuevo Leon

TOP 184

This obsidian artifact is from the state of Nuevo Leon, Mexico, and was found about 35 miles west-southwest of Reynosa. The site is along the Arroyo Paraguay near the town of Pena Blanca. The

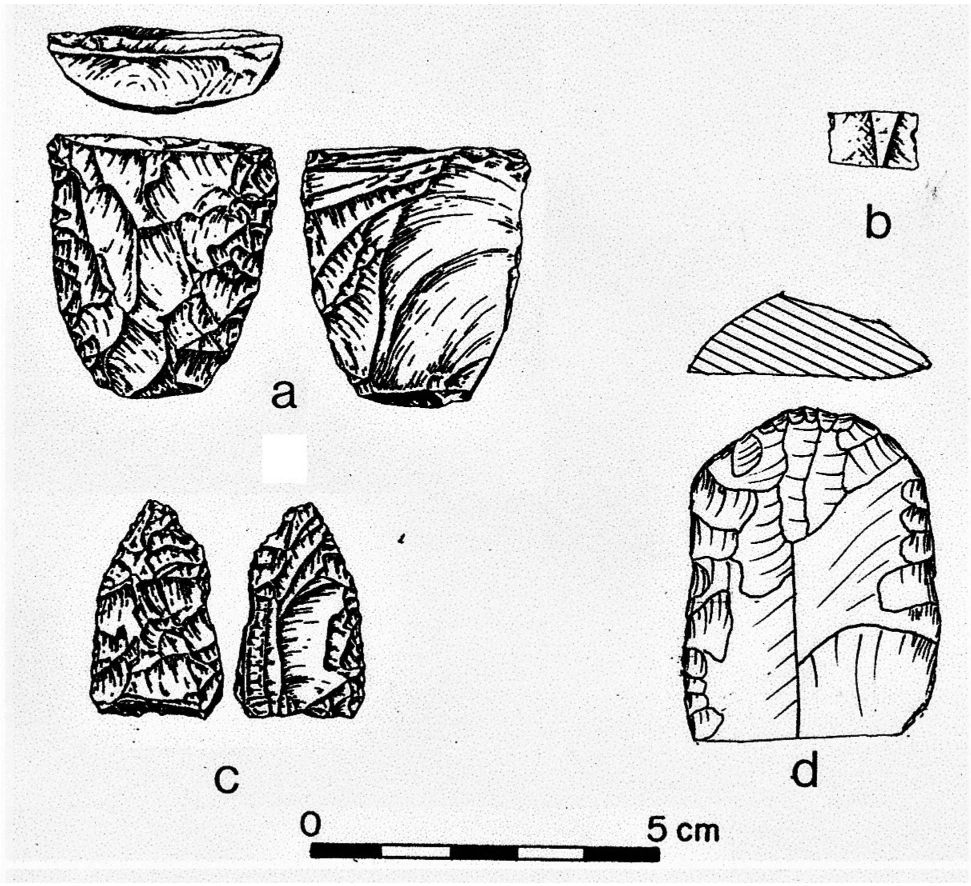

Figure 6. Obsidian from Texas and Tamaulipas sites. a, plano-convex biface, Falcon Lake (TOP187; 41ZP8; Otumba); b, medial blade fragment, near Matamoros (TOP 183); c, small distal biface, coastal Tamaulipas (TOP 201); d, end scraper of Sierra de las Navajas obsidian found at Falcon Lake (TOP 193).

specimen is the distal tip of a biface, likely a dart point. While it was expected that the specimen would be from a Mesoamerican source, XRF analysis at the LBNL linked the artifact to Obsidian Ridge in the Jemez mountains of northern New Mexico. This is the southernmost occurrence of Obsidian Ridge material yet documented.

South Texas

Webb County

A small cobble of obsidian largely covered by cortex, but with several flake removals, was found in the middle of a large ranch 6-7 miles northeast of Laredo and east of Interstate 35 (see Figure 1). It was on the surface, but apparently in a non-site context. The finder was under contract to a San Antonio environmental firm and could not disclose the precise location. He did allow Hester to remove a flake for XRF analysis from the 9 cm long nodule.

The flake (designated as TOP 239) was analyzed by Glascock using the XRF technique. He linked it to the source of Teuchitlan, Jalisco (TOP 238 from Eagle Bluff is from the same source) (see Figures 1 and 5).

Dimmit County

Three artifacts of obsidian from Dimmit County (TOP 1, TOP 3, and TOP 4) were among the earliest sourced specimens in this project, with XRF analysis by Robert Jack (Department of Geology and Geophysics, University of California, Berkeley; see Hester et al. [1975] for more details). TOP 1 was the medial of a flake, with part of a flake, with some flake removals along the edge. It was surface collected by J. W. House at the Armstrong site, on Tortugas Creek, in northeastern Dimmit

Table 2. Source assignment of TOP 201 obsidian to the Zacualtipan, Hidalgo, obsidian source (1). Data compiled and text written by Frank Asaro and Fred Stross, LBNL.

Element Abundances	TOP 201 PXRF	PXRF errors this work (2)	Zacaultipan refs. TOP 183 PXRF (3)	Zacaultipan refs. INAA (4)	Dev. (5)
Elements that agree with reference values					
Ce	190.0	7.0		111.2 ± 1.3	2.2
Fe%	1.09	09.0	0.02	1.06 ± 0.02	3.0
La	56.5	8.0		54.7 ± 0.7	3.2
Nb	19.9	0.4	19.3		3.0
Rb	304.0	3.0	302.0		0.7
Y	46.5	0.09	46.7		0.4
Zr	229.0	3.0	219.0		4.4
			Average deviation, seven elements= 2.4		
Elements slightly deviant from the reference values					
Fe Fe%%Ba	294	3.0	272.0		7.5
Sr	41.7	0.5	38.2		8.5
			Average deviation, nine elements= 3.6		

(1) Element abundances are in parts per million except for Fe, which is in %.

(2) For Nb, the measurement error was taken as the counting error. For other counting errors, such as Rb and Ba, the error was taken as 1%. In addition, a minimum error of 0.5 ppm was used for Sr because of interference from other elements. For all other elements, the coefficients of variation calculated from six artifacts assigned to Cerro Toledo Rhyolite (New Mexico) were used to obtain measurement errors.

(3) The Zacaultipan PXRF reference was to an artifact previously assigned to the Zacaultipan source (TOP 183) in 1996.

(4) The INAA references were one source sample (ZACU-1, 846-V) obtained from Terrence Stocker, and one artifact (COXC-20, 853-Z) previously assigned to the Zacaultipan source. The artifact was obtained by Edward B. Sisson via Thomas Hester (May 14, 1974). The INAA errors are taken as the average counting errors, as the standard deviations of the two measurements are accidentally smaller than the counting error, and 1% for all the other elements.

(5) Deviations (in %) = 100 x (PXRF abundances in artifact/PXRF abundances in reference) – 1.

County. Fred H. Stross (LBNL) was involved in the TOP 1 activities beginning in 1971 and he used the data obtained by Jack to tentatively link TOP 3 to the Guadalupe Victoria, Puebla, source. However, this attribution can now be dismissed, as later analysis of the TOP 1 obsidian, by the LBNL in the 1980s, clearly linked it to Obsidian Ridge, New Mexico

TOP 3 and TOP 4 are bifaces (Figure 7) from the Garcia site (41DM27; east of Asherton), an extensively eroded site well known to the senior author; these specimens were found by a collector in two parts of the site. Both of these artifacts, as reported in Hester et al. (1975), have been attributed to the San Isidro, Jalisco, source (see Figures 1 and 5).

South Central Texas

Eagle Bluff

Four obsidian flakes (Figures 8-9) have been recovered during the archeological investigations at 41ME147, the Eagle Bluff site on Hondo Creek in Medina County (Hester 2011; see Figures 1 and

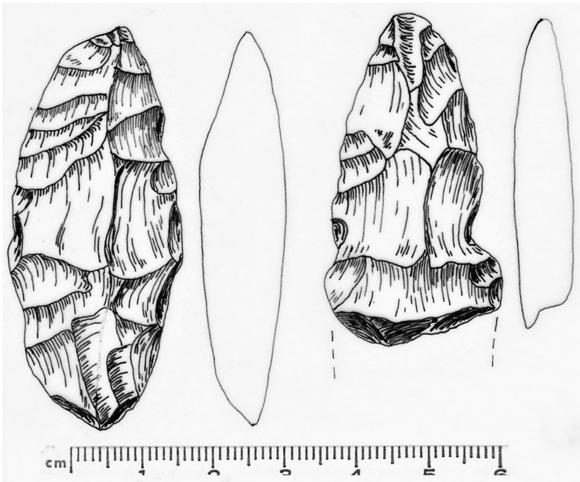

Figure 7. Two obsidian bifaces from the Garcia Site (41DM27), Dimmit County, Texas. TOP 3 and TOP 4 are both sourced to the Santa Teresa, Jalisco source.

Figure 8. Three obsidian flakes from 41ME147, Medina County, Texas. Upper, TOP 238 (Lot 63-2); middle, TOP 235 (Lot 62); bottom, TOP 229 (#90, STAA). All three were sourced to San Isidro, Jalisco.

Figure 9. Another obsidian flake from 41ME147. TOP 236A (Lot 282a), sourced to Teuchtitlan, Jalisco.

5). One flake was found during Southern Texas Archaeological Association testing at the site in 2006 (TOP 229). During the 2010 Texas Archeological Society Field School held at Eagle Bluff, a second obsidian flake (TOP 236A) was found in back dirt at Area 1, and two more pieces (TOP 235 and TOP238) were also from Area 1. Unfortunately, there was no dateable context for the latter two pieces.

TOP 229, TOP 235, TOP 236, and TOP 238 were analyzed by Glascock and the first three were attributed to the San Isidro source in Jalisco, Mexico (see Figures 1 and 5), some 750 airline miles from 41ME147. TOP 236A (see Figure 9), also studied by Glascock, came from Teuchtitlan, Jalisco (Table 3). The two sources are less than 20 miles apart (see Figures 2 and 5), both produced high quality obsidian, and there is extensive evidence of obsidian mining (including tunnels at San Isidro). Both are in the western part of the Trans-Mexican Volcanic Belt (Glascock et al. 2010; see Figure 2). Details on the mining and exploitation of obsidian near Teuchtitlan are described by Weigand and Spence (1989).

Table 3. Concentrations of elements measured in obsidian artifacts from 41ME147, listed in parts per million or %. The right column on the Teuchitlan, Jalisco, obsidian source is shown as means and standard deviations identified and listed in parts per million or %. The TOP 236A obsidian flake was linked to this source. Trace element data obtained and compiled by Michael Glascock, MURR.

Element	TOP 236	TOP 237	TOP 238	Teuchtitlan, Jalisco
K (%)	3.61	3.54	3.57	3.59 ± 0.08
TI	657	581	694	705 ± 94
Mn	512	872	646	355 ± 70
Fe (%)	0.69	0.61	1.72	1.44 ± 0.10
Zn	43	162	129	165 ± 17
Ga	17	32	17	25 ± 2
Rb	95	568	171	172 ± 4
Sr	86	<1	<1	<1
Y	18	79	62	74 ± 4
Zr	116	121	559	633 ± 16
Nb	30	199	69	59 ± 3
Th	9	43	21	20 ± 2

Mangold Site

The Mangold site (41ME132) was almost entirely excavated by H. W. (Buddy) Mangold in the 1990s, and a follow up testing program was done in 2004 by the Southern Texas Archaeological Association summer field school. The site is unusual in that it has a heavy deposit of Uvalde gravels atop a small rise, overlooking a small unnamed creek (see Figure 1). However it is also near seep springs about 0.25 miles to the north/northeast. The springs and the bogs that formed around them might have been the major attraction to the site.

Mangold's excavations uncovered a large number of artifacts, including Wilson, Angostura, and Golondrina dart points, along with many Archaic and Late Prehistoric points and tools. In addition, there were two Guerrero points from the Spanish Colonial era (Turner et al. 2011; Hester 1989). Within the Mangold Site artifact assemblage was a piece of a small obsidian biface tip (TOP 209), which was submitted for XRF analysis and the results published by Hughes and Hester (2009).

Results showed the specimen to be derived from the Ojo Zarco source in Guanajuato, west central Mexico (see Figures 1 and 5). Samples from this source had been obtained by Clint Davis and David O. Brown in the 1980s. Interesting (as described earlier) two obsidian flakes from 41WY40 in the Rio Grande Delta were also sourced to Ojo Zarco (Hester et al. 1996).

Kincaid Rockshelter

During the excavations at Kincaid Rockshelter (41UV2) in the late 1940s-early 1950s, the base of an obsidian Clovis point (TOP 49) was found in the Clovis occupation at the top of Zone 3. The rockshelter is on the west side of the Sabinal River, roughly four miles north of the town of Sabinal (see Figure 1). Excavations were first conducted by the Texas Memorial Museum, and subsequently by a University of Texas field school. The artifact was submitted to the LBNL and they carried out both XRF and NAA analysis. The results are summarized by Hester et al. (1985). The source of the obsidian was attributed to the state of Queretaro, coming from either the San Martin, Cadereyta, or El Paraiso localities, the chemical composition of TOP 49 falling within the trace element composition of those three obsidian locales (Ericson and Kimberlin (1977). The LBNL analysts later refined the source to "El Paraiso B" (see Figure 1).

Cunningham Site

In 1981, Thomas C. Kelly received a letter and other materials from K. C. Cunningham of Uvalde, Texas, detailing a number of artifacts that came from a ranch his family once owned four miles west of Sabinal, Texas. This locality is in eastern Medina County (see Figure 1).

Among the Archaic points and bifaces, he had also collected a fragmentary stemmed obsidian point (TOP 62; Figure 10). The specimen was found on the crest of a small hill, which was described as "Area 1," an eroded campsite, that Mr. Cunningham plotted on a section of the USGS Sabinal topographic sheet, as south of Old Highway 90, now County Road 511. Near the obsidian point, a La Jita point was found.

The LBNL did XRF on the specimen and linked it to Otumba, a major obsidian source (as discussed earlier, with TOP 187). Otumba was also one of the obsidian sources for the great site of Teotihuacan. Thus, it is of considerable interest to note that this obsidian point is of the style labeled by Michael Spence as a "Teotihuacan Stemmed J" dart point (identified from an image provided by Harry Iceland, personal communication, 2016).

Interestingly, a second Teotihuacan-style obsidian dart point has been reported from a cemetery site near Rio Hondo, Texas (Hester 1969:Figure 1A). In 1956, T. N. Campbell drew outline sketches of this specimen, a Matamoros dart point, two shell disc-shaped beads, and two perforated coyote canine teeth. About 20-40 burials had been exposed at the site, although the stemmed obsidian point was said to be from the surface. Since the site had been destroyed by agricultural land-leveling, its provenience remains unclear. Further, it has never been possible to access the specimen for trace element analysis.

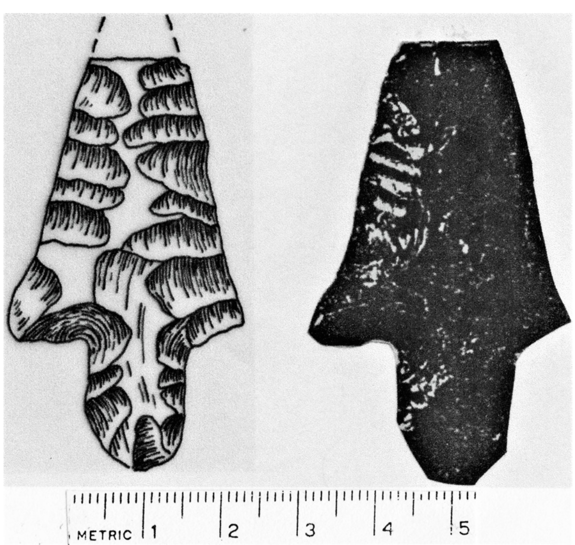

Figure 10. Obsidian point from the Cunningham site in Medina County, Texas. TOP 62 was sourced to Otumba.

Historic San Antonio

During testing in 1997 at Mission San Juan Capistrano (41BX5) (see Figure 1), a medial fragment of an obsidian flake (TOP 203) was found by archeologists from The University of Texas at San Antonio (Hester et al. 2003). It came from Unit 2, level 4, at 18-24 inches below the surface. The top four levels of this unit had been disturbed, mixing Spanish colonial artifacts with those of post-colonial times.

This obsidian is almost certainly from the Mission Indian occupations at San Juan Capistrano. It was analyzed by XRF at the LBNL and conclusively sourced to the Ucareo, Michoacan, locality (see Figures 2 and 5). This source is about five miles from another important source known as Zinapecuaro (often referred to as Ucareo's "twin source"). However, with detailed comparative data available, the Ucareo source was confirmed. This locale is 800 airline miles to the southwest of San Juan Capistrano.

Summary and Obervations

We have summarized here the source analyses of 24 obsidian artifacts found at sites from three regions in the southern part of Texas. All of the specimens were determined to be from geologic sources in Mesoamerica (see Figures 1 and 5), except TOP 184 which was sourced to Obsidian Ridge in New Mexico. The source data came from trace element analysis done first at the Department of Geosciences (Berkeley), then by LBNL, and later at the MURR. While obsidian artifacts have been analyzed from most parts of Texas, and even into Nuevo Leon, the bulk come from sources in the Valles Caldera in the Jemez Mountains of northern New Mexico, from the Malad source in southern Idaho, and Obsidian Cliff at Yellowstone National Park. In previous publications and papers delivered at professional meetings, there has been a good deal said about the mechanisms and routes that might have contributed to the spread of North American obsidian into Texas.

While our sample size of Mesoamerican obsidians from southern Texas remains fairly small, it does represent nearly four decades of research, as scattered pieces of obsidian, often as tiny flake fragments, have been found in contemporary survey and excavations, in collections of avocational archeologists, and those materials from earlier years housed at TARL. Most of the specimens have been handled by the Texas Obsidian Project and has relied on the expertise of chemists and other scientists at the three laboratories noted above.

In the past, when we had a much smaller sample of Mesoamerican obsidian, and when most of it was derived from sites in or near the Rio Grande Delta, it had been suggested that the obsidian resulted from interaction or trade with the Mesoamerican culture known as Huastec (see Figure 1). Indeed, such connections have been proposed as early as 1935 (Mason 1935), when archeologists compared some of the large painted vessels found in some burials in the Rio Grande valley with those documented from archeological sites in the Huasteca. Pottery has continued to be the strongest indicator of Huastec-Rio Grande valley connections (Ekholm 1947; Wagner 2000), while discoveries of jade artifacts (more properly, "greenstone") have also been cited (Hester 1969; see also White and Weinstein 2008:291).

In recent years, there have been some suggestions made that a "salt trade" also was part of this interaction, with the great salt pans of the Rio Grande Delta as the source of salt gathered for Mesoamerican trade. Indeed, newspaper and other popular venues (Cisneros 1998) have speculated that in addition to the Huastecs, the Aztecs also sought Rio Grande valley salt. The only scientifically oriented synopsis of these ideas that we have seen appears in Fort (2006). While ceramics and jade were certainly part of the context, we doubt that salt played any sort of role with the Mesoamerican groups, since the Huastecan territory on the east is the Gulf Coast (indeed an early salt production site in southern Veracruz has been identified by Santley [2004]). Andrews (1983:50) notes "estuarine lagoons that are well-suited for solar evaporation or extraction" on the coast of northern Veracruz and Tamaulipas (for example, at Alta Mira, Soto la Marina, and San Fernando). The Maya are well known for intensive salt production in the Campeche and Yucatan coasts (Eaton 1978; Andrews 1983) and exported the salt into southern Veracuz and adjacent areas. Even less likely competitors for the Rio Grande valley salt would have been the Aztecs. The Late Postclassic peoples of the Basin of Mexico had many salt production locales, some of them continuing even today and which have been the locales of ethnoarcheological documentation (Parsons 1994).

What would the Huastecan traders have been exchanging with the hunters and gatherers of the Rio Grande Delta? There could have been commodities that have not survived in the archeological record. But what is firmly established archeologically is that the peoples of the Delta mass-produced shell ornaments in great numbers. In addition to finished artifacts, manufacturing debris, manufacturing failures (Figure 11) and tiny rod-shaped chert drills for working shell are all documented (summarized in Terneny [2005]). The finished shell forms included shell disk beads (Figure 11), conch columella projectile points, conch gorgets, and especially pendants or "tinklers" made from the shell of *Oliva sayana* (Figure 12). The olive shell had the spire removed and the opposite end perforated by a groove technique (Figure 12). Some finished shell even featured perforated coyote canines hanging as "clappers" inside the tinklers (Collins et al. 1969:Figure 9). Some *Oliva* shells or pieces of the shell were also made into beads.

The shell ornament complex might have been a key reason for Huastec trade. Olive shell pendants are seen around the necks of sculptured Huastec figures. Ekholm (1944:Figure 52p-w) illustrates, from the site of Las Flores (northwestern part of the city of Tampico), six "so-called shell tinklers or bells…made by cutting off the closed end of *Oliva* shells, some are perforated for suspension by a saw cut [groove] and others by drilling" (Ekholm 1944:482). A history of studies at the site is provided by Ramirez Castillla (2000).

There are not many publications stemming from excavations and survey along the Tamaulipas and northern Veracruz coast (Wagner and Valdez 2005:196-197), and it is hard to say if local villages in the Huasteca had access to the same quantity and quality of shell to have produced these ornaments on their own. However, Valdovinos Perez (2014), reporting shell ornaments from the coastal plain near Altamira, Tamaulipas, illustrates only a few ornaments resembling the Rio Grande Delta specimens. Norteworthy is one *Oliva* pendant not made in Delta style (Valdovinos Perez 2014:Figure 5). Indeed, it is perforated like some Ekholm (1944) noted from the site of Las Flores.

It is also possible, although difficult to prove, that masses of shell ornaments procured from the Delta might have been among the mix of tributes required by the Aztecs from their Huastec subjects. Many examples of the *Oliva* shell tinklers or pendants occur from contexts such as the Templo Mayor in Tenochtitlan. Matos Moctezuma (1988:81) illustrates specimens of this sort (Offering H at Temple B) and

Figure 11. Manufacturing sequence of conch shell disk beads from the A. E. Anderson Collection, Cameron County. These are curated in the Texas Archeological Research Laboratory. The top row illustrates beads in early stages of preparation ("blanks"); the middle row shows roughed-out beads, perforated and ready for stringing and rolling the edges smooth on an abrasive surface (as done by California Indians; Hudson and Bates 2016); bottom row, finished shell beads of the sort traded to the Huastecans.

Velazquez-Castro (2012:Figure 10) illustrates additional examples. He also notes that *Oliva* "pendant" specimens, along with *Pinctada mazatlani* ornaments, that he studied from the Templo Mayor excavations constituted "61.46% of the complete pieces in the overall research corpus." Of this sample, 891 were complete or fragmentary *Oliva* shell pendants. He notes the dominance of the two species in all construction stages of the Templo Mayor and the sacred precinct of Tenochtitlan, and reported that *Oliva* pendants were also found in other Late Postclassic "dominions in the Basin of Mexico" (Velazquez-Castro 2012:240, 242). Because he believed that the *Oliva* pendants were all made at Tenochtitlan (in contrast to the "academic circles" who link them to tribute materials; Matos Moctezuma 1988:55, 116), he devoted much time and effort to experimental replication of the pendants (readers interested in the times needed to replicate such artifacts should see his Table 5). He favors "full time artists" at Tenochtitlan for their manufacture, and that the "style" of *Oliva* shell pendants "can be identified to Tenochtitlan." But, he does not note that specimens of identical manufacture, right down to the groove and perforation technique, are ubiquitous in the Rio Grande Delta. In a subsequent paper, however, Velazquez-Castro (2014) links some *Melongena* columella artifacts from the Templo Mayor to the Huastecs, based on comparisons with materials from Huastec sites in Queretaro and San Luis Potosi.

This discussion leads us to regard the *Oliva* shell tinklers or pendants at Tenochtitlan as possibly originating through Huastec trade with the Delta. While Matos Moctezuma considers them

Figure 12. ***Oliva sayana*** **artifacts from the A. E. Anderson Collection, Cameron County. Shell "tinklers" are shown in various levels of manufacture. Three have grooved slots that were yet to be perforated; in the top right is a peforated "tinkler;" others have been modified (spires cut off) to presumably be used as beads.**

as coming from tributes to the Aztecs, the detailed lists of Aztec tribute lists published by Berdan and Blanton (1996) indicate marines shells among the tribute extracted from Cuetlaxtlan, on the Gulf coast of southern Veracuz.

Whatever sort of interregional trade took place, it almost certainly was initiated by the Huastecans, principally in Late Postclassic (Period IV) times (Ekholm 1944). The large ollas, greenstone, and obsidian came to the Rio Grande valley in that fashion. In return, we suspect quite strongly that the Huastecans received copious amounts of shell disk beads, shell tinklers, conch gorgets, and other artifacts of shell. The obsidian from Zacualtipan, Otumba, and Sierra de las Navajas (Pachuca) surely came via the Huastecans, as did, apparently, the more distance sources from western Mexico, at Cerro Varal, Huitzila, San Isidro, Santa Teresa, Ucareo, and Ojo Zarco (all in the Trans-Mexican Volcanic Belt; see Figure 1; Glascock et al. 2010: Figure 2). Figure 2 shows the location of the sources from this geological region that have been recognized in Texas (Glascock et al. 2010: Figure 3).

There is also the question of the time frame in which these sources reached the Delta. The area has been known, archeologically, for decades as the Brownsville Complex, being Late Prehistoric in age, marked by cemetery sites, small triangular arrow points, the Huastecan trade goods noted above, and most of all, by the immense amount of shell ornaments (Anderson 1932; MacNeish 1947). This time frame would equate with Period VI from Ekholm's (1944) ceramic sequence. For many years, the Brownsville Complex has remained an important cultural pattern about which relatively little is known (Hester 2004:147-150; Ricklis 2004:178-180).

Indeed, in her dissertation, Terneny (2005:178ff) obtained radiocarbon dates from the Floyd Morris and Ayala sites, dates suggesting that the so-called Brownville Complex has greater time depth, perhaps representing a Middle to Late Archaic pattern that, given the sharing of traits between the two, may well have developed into what we call the Brownsville Complex. Her dates for the Ayala site place it into "Brownsville" (Hester and Rodgers 1971), while Floyd Morris may be a long-lived cemetery locale dating from Archaic to "Brownsville" times. Terneny (2005) maps probable "Brownsville Complex" traits in many parts of Texas. This, by itself, is misleading in that many of the Central and South Texas sites with such artifacts are limited to one or two specimens (Hester 1970). From the perspective of the senior author, occupation sites and burials with some numbers of Delta shell artifact forms occur within a range of 100-120 miles up the Rio Grande or up the Lower Coast.

In South and South Central Texas, only four sources are shared with the Delta. These include Ojo Zarco (41ME132), Teuchtitlan (Eagle Bluff [41ME147] and Webb County), and Otumba (Cunningham site, Uvalde County), all represented by one specimen each. One site, Eagle Bluff (41ME147) has four obsidian artifacts, one from Teuchtitlan, and three from San Isidro, Jalisco. The other sources include El Paraiso B (Clovis base, Kincaid Rockshelter) and two specimens from Santa Teresa, Jalisco (41DM47).

So, the South and South Central Texas obsidian artifacts, save for the specimen from Otumba, came from western Mexico, at distances of more than 550 miles to nearly 800 miles. Not only are the distances formidable, but there were intervening mountains and deserts. There is no evidence of other Mesoamerican artifacts from the regions, except for the randomly occurring figurine head and spindle whorls (all of whose validity can be challenged; Hester [1972]). No evidence of any sustained trade connection exists. Indeed, the specimens probably represent group-to-group transfer, perhaps initiated by Mexican trade networks, or down the line trading through which some Texas hunter-gatherers ended up with relatively small pieces of obsidian. Indeed, they could have all come up from the Rio Grande Delta, but the several sources from South and South Central Texas that are known in that area argue against that scenario. Additionally, the age range of the South and South Central Texas obsidian types have greater time depth (back to Clovis) than those in the Rio Grande valley.

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Plants as a Reflection of Culture and Popularity in Historic Cemeteries in Central and East Texas

Jennifer K. McWilliams

Botanical decorations or memorials are often planted near the graves of loved ones. The choice of the vegetative offering is often personal and a result of culture, availability, and popularity. Like all material culture, certain cultivated plants have popular trends in their use and these trends can be observed in cemeteries. The plantings are frequently found in association with a dated monument providing possible information on their age. Since cemetery plantings are rarely tended in the long-term, these specimens comprise examples of hardy vegetation within a region. By inventorying plants in cemeteries, one can begin to create a list of hardy, popular, and culturally significant plants that may be found in historic sites.

Historic cemeteries offer a cultural, temporal, and an individual view of the people who once lived in a community. Cemetery features are both above and below ground and include the burials themselves, grave shafts, headstones, fencing, curbing, and also decorative botanical plantings, or memorials. Each of these aspects is an archeological feature and as such provide a framework of the choices of those who commemorate the dead (McWilliams 2015).

Terry Jordan's 1982 book, *Texas Graveyards,* set the foundation for discussions about historic Texas cemeteries. Jordan was a cultural geographer at the University of North Texas in the 1960s-1980s. One of Jordan's influences, Dr. Fred Kniffen, wrote in 1967, "there can be few other subjects as untouched or as promising as the geographical study of burial practices" (Jordan 1982:10). This statement is as accurate today as it was in the 1960s. Headstones are, of course, a focal point of most cemeteries and are therefore the most studied. However, aside from Jordan's (1982) publication, and before the 2016 publication of Dr. Kenneth Hafertepe's *The Material Culture of German Texans,* very little had been written about the rich cultural treasures that are found in Texas' historic cemeteries. Both authors present cultural associations of headstone styles and iconography, but Hafertepe initiates the study of headstone-type chronologies.

In 2013, Hafertepe presented select research for *German Texans* to the Texas Gravestone Studies in New Braunfels (Hafertepe 2013). This presentation introduced the author to a field of study: the dating of headstones by availability and popularity of materials. The importance of the introduction of new technologies to work with harder stones influenced the popularity of materials. Early Texas graves were marked with available local materials: wood, limestone, ironstone, sandstone, petrified wood, quartz, and fieldstones or piled river cobbles. Hafertepe (2016:400-401) found the earliest use of white marble in New Braunfels dated to the late 1850s to 1860s. White marble is relatively easy to cut and carve using hand tools. The increased popularity of gray granite was the result of the introduction of "pneumatic hammers, diamond saws, and polishing machines" (Hafertepe 2016:404). These innovations became available to German Texas stone masons in the 1880s (Hafertepe 2016:404-405). Hafertepe (2013) hypothesized that the popularity of the use of pink granite headstones began with the construction of the Texas State Capitol in in the 1880s with this material. The availability of excess quarried materials from the construction, combined with a sense of Texas pride, increased the use of pink granite for grave markers.

Both Jordan (1982:110-113) and Hafertepe (2016:417, 422) also looked at the symbolism depicted on historic Texas headstones: the rose or yellow rose and the five-pointed star. The rose is common on early German Texas grave markers and may also be associated with state pride and independence (Hafertepe 2013). The five-pointed star may have an association with the Texas state flag. The author has observed the five-pointed star on hundreds of cast-cement headstones made by an apparent regional cottage industry in East Texas.

Although the styles vary, they are all adorned with a five-pointed star at the upper center of the monument. The majority of these headstones are found in African-American cemeteries, and the author believes that the star does represent Texas pride and independence.

Culture and religion obviously play a prominent role in cemeteries. Jordan (1982:6-7) noted that a community's cemetery embraces older traditions: that is, they are "conservative" in their cultural traditions. In Texas, the predominant burial orientation is east-west, symbolically preparing the deceased to rise and face the sunrise, toward Jerusalem, to greet Christ on Judgement Day (Jordan 1982:30). Another common tradition of Christian burials is the placement of the husband in relation to his wife: he is buried to the right of his wife, duplicating their positions in their wedding ceremony (1982:30).

The trends in headstone materials, iconography, and inscriptions have been well-documented, but not so for memorial plantings. Botanical grave decorations are another example of cultural and temporal trends that can be observed in cemeteries. The topic of cemetery plants has become popular in garden books and magazines (Busse 2012; Neighbors 2011; White 2015). Like all fashion, plants—or rather, varieties (or cultivars)—also have trends in use and provide a temporal context for a landscape. The goal of this article is to introduce botanical decorations found in cemeteries that are useful in assessing vegetation found in various historic settings.

Popularity of Ornamental Plants in the United States

The role of the U. S. Department of Agriculture (USDA) in the early popularity of ornamental plants in the United States is outlined by Griesbach and Berberich (1995). President Abraham Lincoln is credited with the creation of a federal agriculture department in 1862 (Griesbach and Berberich 1995:421). Early horticulture staff members established parameters of the USDA: "To produce seeds, cuttings, bulbs, and plants from foreign and domestic sources and test their merits in various local conditions," as well as "to hybridize plants for superior traits, to cultivate hedge plants and show their usefulness," and "to collect and cultivate the best fruit trees and plants" (Griesbach and Berberich 1995:421).

The division of Foreign Seed and Plant Introduction was established at that time. Plant introductions by USDA staff in the early 1870s gained popularity with the seedless navel orange (*Citris sinensis* Osbeck) imported from Brazil (Griesbach and Berberich 1995:421). The importance of sales and distribution of fruit trees on Texas horticulture can be seen in Ramsey Nursery catalogs (Ramsey 1879-1963). Central Texas native Frank T. Ramsey was so popular for his reputation of selling fruit trees, he gained the nickname of "Fruit Tree" Ramsey (Collin 1998:1).

Ornamental plants increased in popularity after the turn of the 20th century when the USDA worked toward "evaluating species for winter hardiness, heat tolerance, and general ability to grow under conditions in the United States…From 1900 to 1935, extension research was conducted on bulbs, roses (*Rosa* L.*),* carnations (*Dianthus* L.), dahlia (*Dahlia* Cav.), chrysanthemums (*Dendranthema grandiflora* Tzelev.), and azaleas (*Rhododendrun* L.)" (Griesbach and Berberich 1995:422). "Dooryard" or backyard rose gardens gained popularity during the USDA's project "designed to create the ideal American rose garden" (Griesbach and Berberich 1995:422). The National Arboretum has continued the tradition of new plant introductions.

From the 1910s to the late 1930s, USDA greenhouse plant shows were fashionable. They often featured President Franklin D. Roosevelt and First Lady Eleanor Roosevelt (for whom a chrysanthemum was named); in 1938, it is estimated that one show attracted more than 60,000 visitors (Griesbach and Berberich 1995:423).

A final example of the role of the USDA is the Congressional Seed Distribution Program, where "seeds, bulbs, and plants were propagated and given to senators and congressmen for distribution to their constituents" (Griesbach and Berberich 1995:423). Griesbach and Berberich (1995:423) estimated that the "project supplied 110,000 tulip (*Tulipa* L.*)* bulbs and 100,000 to 150,000 daffodil (*Narcissus* L.) bulbs per year to the Congressional Seed Distribution Program." Undoubtedly, many of these free bulbs, primarily daffodils, ended up in yards and cemeteries across Texas.

Informative Opportunities in Cemetery Plants

Ornamental plants found in cemeteries can be equated with other cemetery features, such as the headstones, fencing, and curbing. Archeologists can use cemetery plantings as a sample or testing ground of what may be found at historic homesteads and vice-versa. In fact, memorial plantings can be seen as another historic artifact type, and their presence is a result of availability, affordability, innovation (cultivation), as well as popularity during a particular time (McWilliams 2017a). Additionally, cemeteries offer a unique but oftentimes harsh environment for plants. Rural cemeteries rarely pipe water into the grounds. Consequently the hardiness of the plants is necessity for survival. Most cemetery plantings are left to the whims of the Texas climate and must be hardy enough to survive decades of neglect.

While it may sound daunting to learn a new artifact type, one does not need to learn all of the popular plants that entered Texas by way of immigrants and popular imports, but only the hardy perennials that survive within a given region. Additionally, not all vegetation is being considered; native vegetation is ubiquitous, but the focus is on the key hardy ornamental plants with reliable temporal evidence of use. Within a cemetery, one can study the use of plantings within a dated context, as a headstone supplies a death date for the individual buried with a headstone, and therefore, a *possible* age of the associated planting. Exceptions to this may be: (1) an offering planted well after the death date and (2) the recent increased popularity of planting heirloom varieties. The natural loss of poorly-chosen cemetery plantings prevents these non-hardy varieties from clouding the cemetery's landscape.

Cemeteries can provide *local* confirmation of historical plants that may corroborate the availability of varieties within a geographic region, as well as substantiate a planting date as observed on associated headstones. During the spring of 2015, the author and a horticultural specialist considered this hypothesis at Tatum Cemetery in Rusk County. At a distance, a tree associated with a headstone was selected and the specialist was asked to estimate the age of the tree. Once a date range was determined, the death date on the headstone was examined. The specialist was correct the majority of the time (Figure 1a-b). When perplexed, the specialist would attempt to determine additional factors that affected the growth of the specimen. Most factors were environmental (i.e., significant droughts or freezes).

Figure 1. Magnolia tree and headstone death date in the Tatum Cemetery in Rusk County: a, the size and age of this magnolia tree appears to reflect a planting date in the 1940s; b, the death date on a headstone is May 25, 1940, and this correlates with the estimated age of the tree.

Challenges

If one looks back at the evolution of Texas grave markers, the trajectory of impacts to vegetation can be discerned in cemeteries. During the 1970s, Jordan (1982) tested a hypothesis set out in Donald G. Jeane's (1967) "The Traditional Upland South Cemetery" (Alcorn 1975; Gough 1975; Pitchford 1979; Schroeder 1974; Stone 1975; Templeton 1976). Scraped earth is the tradition of removing vegetation from graves, mounding soil, gravel, or sand above the ground surface (Jordan 1982:16-18; Stone 1975:4). Jeane (1967) noted that the tradition is useful in visually identifying grave locations, and he ascertained that scraped earth cemeteries were common in the Southern Upland tradition. The tradition also compensated (temporarily) for the natural settling of the soil in the grave shaft. Jeane (1967) suggested that the tradition continued occasionally for maintenance and social gatherings and/or reunions (Stone 1975). Jordan (1982:4-16) added that the scraped earth tradition has two functions: to keep livestock from grazing on the graves and to prevent fires from destroying wooden grave markers. Jordan found the tradition on a sharp decline within the decade between the Jeane publication and his students' cemetery visits. Historically, when headstones changed from wooden markers to local and imported stone markers, fires were less of a concern.

The availability and affordability of stone grave markers eventually replaced the older wooden grave markers. The author has observed four destructive introductions that began in the 1950s or 1960s: (1) artificial flowers began replacing living plants as decorative memorials; (2) the popularity of turfgrasses (St. Augustine or Bermuda, for example) found in the popular lawn-park cemeteries replaced many native and ornamental plants that originally grew in the rural cemeteries; (3) in neglected cemeteries, cemetery clean-up efforts that may have been well-intentioned resulted in the loss of botanical memorials. Intentional plant removal or extreme maintenance (i.e., over-pruning or the use of herbicide) can kill plants that were intended as memorials. Finally, plant restrictions are becoming more common as cemetery associations choose to landscape with turfgrasses. A sign posted outside the cemetery may state rules and regulations of the cemetery and include regulations about vegetation. Restricted memorials on cemeteries, including vegetative offerings, is a direct result of the movement away from family-oriented annual maintenance, like Decoration Day or family reunions, toward a manicured lawn that is most easily mowed and edged.

Plant Categories

The importance of vegetation in cemeteries can be found in the names of cemeteries around the state. Popular cemetery names found in the Texas Historical Commission's Cemetery Database include common plant names: oak (n=193), cedar (n=69), evergreen (n=46), olive (n=31), myrtle (n=11), pine (n=54), and hickory (n=19). Plant names are not as popular as geographic descriptors, however: hill (n=440), creek (n=337), Mount/Mt. (n=255), and prairie (n=114). Of course, many of the geographic names are also indicative of biblical associations.

Terry Jordan (1982:28) observed neatly tended asparagus and blackberry plants on a grave in a Cherokee County cemetery. While these plants are not common to cemeteries, strong trends in the popularity of certain vegetal decorations are found in Texas cemeteries. Inspired by Welch and Grant's (2011:83-85) listing of "Easy to grow plants for Southern cemeteries" and Jordan's (1982) discussions of plants found in the context of Texas'most common cultural groups, the following section provides some themes in the choice of plantings found in Central and East Texas cemeteries, organized by plant categories: bulbs, flowering bushes, trees, and groundcovers.

Bulbs

Bulbs (including corms and tubers) are perhaps the most popular cemetery plant, likely due to their hardiness. Bulbs are easily transportable; they are small and require little attention when dormant (Martin 2014:4), and these physical attributes may have fostered their appearance in cemeteries. However, there is another, more personal reason for the use of these flowering plants in cemeteries. Martin (2014:77-79) commented on the "sentimentality" of bulbs, "[b]oulbous plants are ideal heirlooms because they are generally easy to divide and move over great distances. Because of this fact, there are greater chances for bulbs to be preserved due to emotionally imposed associations to people, memories, and events." Evergreen lanceolate leaves may be symbolically protective, and this increased their use in cemeteries. The iris and gladiolus leaves may represent protection (similar to a sword's), palm fronds, or in children's graves, possibly the Nile reeds that hid the infant Moses (Jordan 1982:30). Several subgroups/cultivars thrive in Central and East Texas: German or Bearded Iris, Dutch, Siberian, Japanese, and Louisiana Iris.

In Central and East Texas cemeteries, the popularity of *Narcissus* is second only to iris. The genus Narcissus includes daffodils, jonquils, and narcissus. Daffodils and jonquils have naturalized along the roads and ditches of Northeast Texas. Julie Ryan (1998:228) noted that older cultivars are longer-lived than the modern varieties and this is especially important for archeologists studying popular plant varietal trends. The American Daffodil Society provides a searchable database for daffodils that were introduced prior to 1940 (The American Daffodil Society 2017).

Amaryllis is a close third to iris and narcissus in popularity of bulb cemetery plantings. Amaryllis such as Rain (*Zephyranthes* and *Habranthus)*, and Oxblood or Schoolhouse Lily (*Rhodophiala bifida*), are commonplace in cemeteries. Native to Argentina and Uruguay, these bulbs were sold in nursery catalogs near the turn of the 20th century (Welch and Grant 2011:490), including Ramsey's Nursery in Austin. These bulbs are not widely sold in today's catalogs (Welch and Grant 2011:277-278). The pink, copper, and white blooms of the rain lilies are very short-lived (less than a week), but they are self-sowing evergreens that do not lose their foliage in the winter. Cannas, Crinums, Gladiolus, Lycoris (Spider lily), and Snowdrops are also commonly found in historic cemeteries and historic home sites.

Flowering Shrubs

Roses. The association between roses and graves is common. The Texas Rose Rustlers is a "rose-hunting" organization that has contributed extensively to the knowledge of antique roses in Texas (Shoup 2012:186-189). However, there is one rose worth mentioning here because it may easily be misidentified on historic sites. The MacCartney Rose (*R. bracteata*) is aggressively adapted to Central and East Texas environments. This species of rose may appear to be an heirloom if found in a historic context, and while it was introduced "to southeast Texas in the past century for use as a natural hedge row"(Texas Invasives 2017), it has naturalized and is a heavy invasive in East Texas. It was dispersed into pastures "by cattle and bird-dispersed seeds" (Texas Natives.org 2017).

Boxwood. Greg Grant (Welch and Grant 2011:164-166) notes that Boxwoods (*Bruxes)* have been in cultivation in America for over 200 years, and they were present in Colonial Williamsburg, Boston, and southern plantations. Although the boxwood appears in nursery catalogs in the South as early as 1851, Grant (Welch and Grant 2011:166) observed that it did not seem to have been very common in Texas.

Crepe Myrtle. Crepe myrtles (*Lagerstroemia indica)* are notable not only because they are popular in historic sites and cemeteries, they have several features that are easily identifiable that can be correlated with introduction dates. Bark color (either light brown or dark cinnamon brown) from *Lagerstroemia fauriei* and mildew resistance from *L. indica* became available in the mid-to-late 1960s and became increasingly popular in the 1970s. Dwarf varieties were introduced in the 1960s (McWilliams 2017b). At the time, it was not known how tall the resulting hybrids would be. The author used the U.S. National Arboretum Plant introduction website to compile crepe myrtle varieties in a spreadsheet to sort by name, flower color, and date of introduction (McWilliams 2017b). The earliest variety listed is the Atroruba, a crimson flowering crepe myrtle that was first published in the Prince Nursery of Flushing, New York, in 1825. Susan Owens' blog "The Wide Diversity of Crepe Myrtles" published for the McKinney, Texas, "Crepe Myrtle Trails" lists 120 varieties found in North Texas (Crepe Myrtle Trails of McKinney 2017).

Camellia. Camelia's horticultural range limits them primarily to far eastern Texas. Camellias first appear in Houston at the turn of the 20th century (Welch and Grant 2011:178). Dr. Bill Welch relied on the River Oaks Garden Club archives to find that the camellia "craze" was a result of the 1936 River Oaks Garden Club Azalea Trail. Camellia bushes flank a mother's grave at the Oddfellows Cemetery in the community of Anderson in Grimes County; this is at the western extent of the plant's natural region. These specimens may be fertilized to amend the soil, allowing them to grow outside their natural range.

Spirea, Oleander, Gardenia, and Mimosa

Spirea (species) are another popular flowering shrub found in cemeteries. Welch and Grant (2011:464) note that spireas "have been an important shrub in the South since the mid-1800s." Yardener (2017) observed that "old-fashioned spireas can grow a gangly, arching, 6 feet tall and almost that wide. However, the new hybrid types tend to be more compact, ranging from 3 to 5 feet tall and spreading more compactly from 3 to 4 feet wide" (Yardener 2017).

Native to Jamaica, oleanders (*Nerium Oleander)* were introduced into Galveston in the early 1840s by a local businessman (Wilkerson and Johnson 2017). Gardenia and Mimosa (*Albizia julibrissin*) are popular in cemeteries but are primarily limited to the eastern portion of the state.

Trees

Evergreens are popular botanical decorations or memorials in cemeteries (Figure 2a-b). As with all plant types, the selection of evergreen varieties varies regionally. In Texas, this includes cedar, Deodor Cedar, cypresses such as arborvitaes (*Thujas)* and Italian Cypress (also called graveyard cypress), and non-conifer evergreens such as boxwood, Ligustrum, and holly.

The Cedars of Lebanon is a biblical tree that was prized for their strong wood. Since these varieties were not native to the New World, early Texans utilized hardy conifers: Ashe or Mountain Juniper (*Juniperus ashei*) found in central and southwest Texas and Red Cedar (*Juniperus virginiana*) found throughout Texas. Jordan (1982:29) associated evergreens with a Germanic influence, where the needle leaf of an evergreen is a symbol of eternal life, hence the use of a Christmas tree. Red cedar and Ashe juniper are the most common conifers found in Texas cemeteries, but Jordan (1982:29) observed one Yew (*Taxus*), at Scottsville cemetery in Harrison County.

Figure 2 Arborvitae trees and headstone in the Tatum Cemetery in Rusk County: a, found flanking a headstone, where they were probably planted in the late 1980s; b, the death date on the headstone is June 26, 1988.

Groundcovers

Ornamental groundcovers are also popular in historic cemeteries. Dense patches of Vinca occur at a reported cemetery for enslaved people in Anderson, Texas. Plants such as Climbing fig (*Ficus pumila*), English ivy, and Wandering Jew (*Tradescantia pallida*), which require dense shade and moisture, have been observed in cemeteries in East Texas.

While many people like the look of turfgrasses, the popularization of this ground cover is possibly one of the most destructive plant introductions into rural cemeteries in East and Central Texas, at times resulting in the loss of history. Preparation of the soil (tilling) for the installation of turfgrasses may have dislodged smaller stone markers and footstones. Grounds may have been treated with herbicide to give carpet grass an advantage, also killing vegetative grave memorials. Once installed, this groundcover may be continually re-treated, removing any remnants of vegetal memorials, some of which may have been the only visible marker for graves. Finally, the cost of installation, the sod itself, and watering grass takes away funds from other maintenance, such as fence repair and tree trimming, leading to longer-term destruction of the cemetery.

Conclusions and Future Investigations

A better understanding of plants in cemeteries may lead to both anthropological and archeological studies. In cemeteries, development of a model of plant use may assist in the identification of graves where plants have survived beyond other grave markers. Mapping existing botanical plantings will provide a useful tool for archeologists interested in the historic settlement and use o2f the land, all of which may also lead to an archeological field guide to ornamentals on historic sites. Eventually, up-to-date summaries of the geographic extent of availability and popularity of such plants may result.

The author hopes to build on this material by continuing to collect publications that provide introduction dates for hardy ornamental plants for the southern states, including Texas, as well as to encourage inventories of cemetery plantings. Glenwood Cemetery in Houston has been the subject of a tree inventory (Turner and Wilson 2010) that lists trees planted as grave offerings as well as native trees. More of these types of inventories should be completed. Additionally, researchers should photographically document surviving ornamental vegetation found on historic sites and cemeteries.

It is time to reassess the findings in Terry Jordan's (1982) publication and revisit previously recorded conditions and practices of Texas cemeteries. The author hopes to reinvestigate the cemeteries visited by Terry Jordan's students, which were reported on in their class papers. Many of these papers serve as an inventory (albeit brief) of cemetery plantings. Jordan's students recorded many scraped-earth cemeteries and it is probable that very few of these remain. It is thought that many have been planted in grass (if they are maintained) or returned to native vegetation as aging grounds keepers are no longer able to keep up the tradition. Jordan (1982:6) established the idea that folk cemeteries in Texas were "conservative" in their cultural tradition, but the author has observed that this has not been the case for the *maintenance* of these places any longer.

Regarding historic cemeteries, Terry Jordan (1982:123) stated that "Texans are in the process of squandering this priceless legacy…Recently, at a cemetery in Athens in East Texas, a family plot, carefully scraped, mounded, and decorated with shells, was reportedly leveled and planted to grass at the order at the perpetual care association." The author has also noted poor maintenance choices in cemeteries throughout Texas. These destructive choices, combined with the loss of our traditional family or community Decoration Day, and our youth's lack of interest in the maintenance of these places, will result in additional loss of this "rich, endangered, and heretofore largely ignored heritage of traditional art, craftsmanship, and customs" (Jordan 1982:123).

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An Expanded Inventory of Radiocarbon Dates from the Lower Pecos Region of Texas and the Northern Mexican States of Coahuila and Nuevo León

Solveig A. Turpin and Herbert H. Eling, Jr.

The addition of 108 radiocarbon assays to the 268 dates reported in 1991 does not measurably altered the age estimates of an 10-part chronology originally proposed by David S. Dibble and largely derived from projectile point styles, cave stratigraphy, and radiocarbon dates. None of the assays run in the last 27 years notably change the overall prehistoric trajectory of the Lower Pecos region, especially when it is recognized that the putative boundaries are fluid and permeable. Twenty-six dates, 24 of which are new, on bundled burials confirm that they are primarily a Late Archaic/Blue Hills mortuary practice. In general, sinkhole burials are earlier and cremations range from 380 to 2100 B.P. Various fiber features and artifacts in dry rock shelters gained in representation largely due to the inclusion of 41TE307, a small site on the far western periphery of the Lower Pecos, and to targeted subjects, such as sandals, painted mats, and bundled burials. Many of the other dates are derived from thermal features, such as burned rock middens and exposed hearths, to the degree that suggests it is probably time to concentrate on other aspects of the material culture.

A list of 153 radiocarbon dates applicable to Northern Mexican prehistory is intended to provide students and researchers in the north convenient access to 14C assays done by American scientists or laboratories, beginning with W.W. Taylor's series from Frightful Cave excavated in the 1940s. In some ways the list is prone to minor error depending on whether the dates were originally reported as conventional, corrected, or calibrated but the general trend is shown. The sample bias toward rock shelters, mortuary sites, and large open hearth fields may falsely indicate population trends but it is clear that occupation began over 10,000 years ago and endured well past the so-called Spanish conquest.

An inventory of radiocarbon dates from the Lower Pecos Region of Texas (Figure 1) was published in 1991 to see how the chronological framework proposed by Dibble fit with the chronometric data (Turpin 1991). One goal was to confirm that the traditional division of prehistory into Paleoindian, Early, Middle, and Late Archaic, and Late Prehistoric periods could be made more precise given the large number of sites that had been radiocarbon dated and that had produced a long list of temporally diagnostic artifacts for comparison. At that time, the inventory consisted of 268 assays divided into 10 subperiods that did not necessarily completely fit the established Five-part chronology (Table 1). The Lower Pecos chronology is now defined by 329 entries of which 106 are new (Table 2). Not included are experimental rock art assays and the Mexican dates are now tabulated in Table 3. Forty-six of the 1991 dates came from Coahuila or Nuevo León, Mexico, as a result of the early University of Texas' NEMAP project, directed by Jeremiah F. Epstein. The inventory of Mexican dates now numbers 153, plus 43 from southern Nuevo León which are not included because we do not have definitive information about their provenience. That is, site names are given but the intrasite provenience or discussion of site types are not.

The two geographical areas are presented in different formats. The Lower Pecos conventional dates are presented in chronological order, oldest to most recent and inserted in sequence in the original table sans Mexico. The Mexican dates are listed by site and then by chronological order within the site, or in the case of Boca de Potrerillos, by site and subarea. The reasoning here is that the Lower Pecos has a long established regional chronology accumulated from many sites and refined over many decades. The Mexican assays provide a local chronology since no definitive regional sequence has been proposed and supported by radiocarbon or other chronometric measures. In addition, most of the sites are outside the Lower Pecos area of northern Mexico, ranging from western Coahuila to eastern Nuevo León.

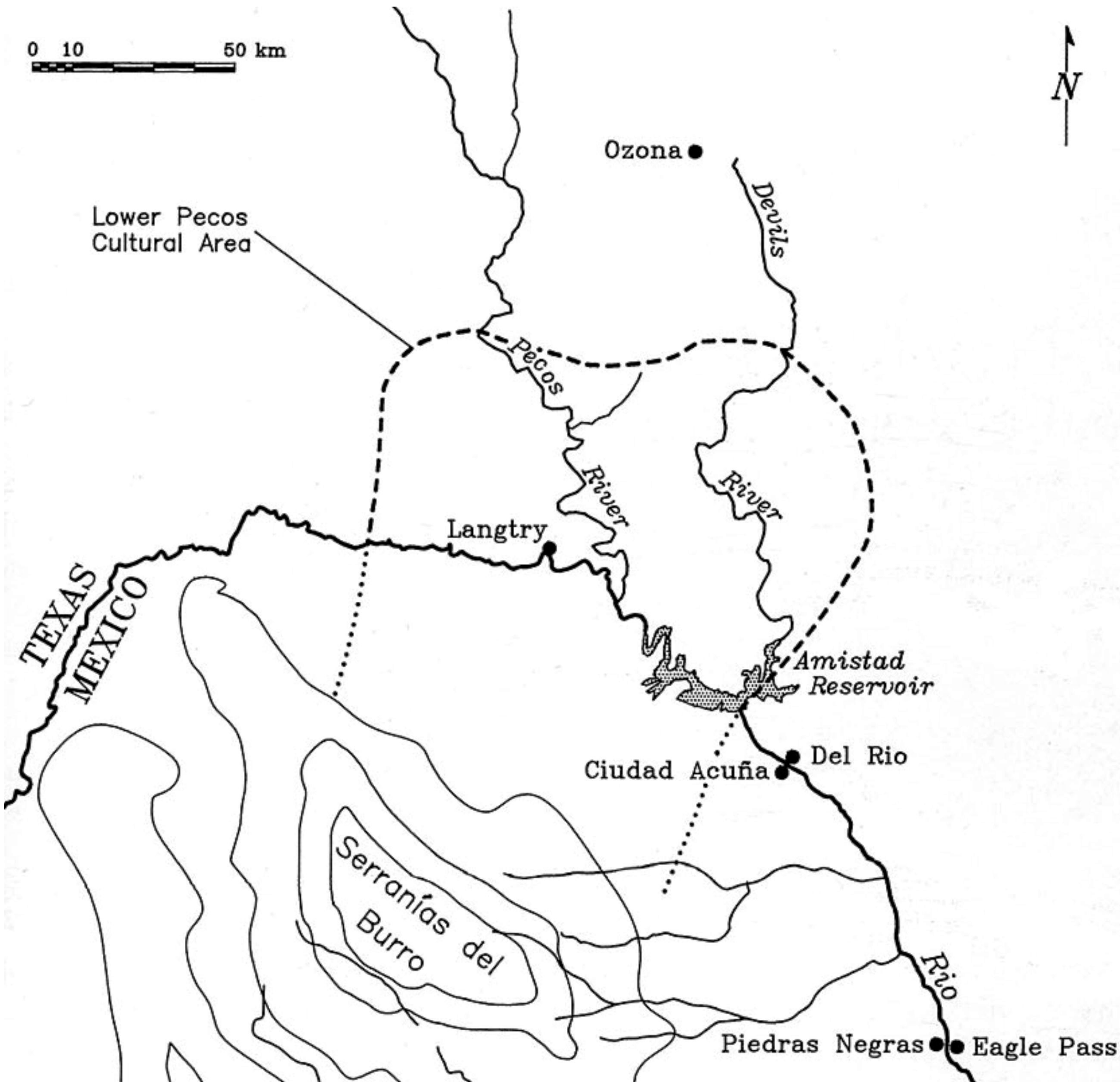

Figure 1. Map of Lower Pecos River Region (all dates are from sites north of the Rio Grande).

The Lower Pecos Region of Texas

The assays run in the 26 years since the first inventory of Lower Pecos dates was published are predictably weighted toward the more recent end of the temporal sequence (Table 2). The three earliest subperiods—Aurora, Bonfire, and Oriente—span over 5500 years but are represented by only 18 dates, a total that has not changed since 1991. These three are divisions of what are traditionally called the Paleoindian and Late Paleoindian periods, beginning around 14300 B.P. and transitioning to the succeeding Viejo subperiod, the beginning of the long Archaic period ca. 8780 B.P. This equivalent of the Early Archaic period is 3170 years long as defined by 43 assays, only seven of which are new. Fiber and grass features make their appearance in two assays from Wroe Ranch (41TE307; Turpin 1998), joining the earliest dated sandals which had been left in Hinds Cave 1500 years before. Shafer (2009) obtained two dates on a disturbed burial from the Horseshoe Caves, 41VV171, making this the oldest human remains yet recovered in the Lower Pecos. Three assays from 41VV156 date the lowest levels of this highly disturbed site and, by extension, the first painted pebble to appear in the archeological record (Turpin 1999). The earliest sinkhole burials also date to this period and extend into the next (Turpin et al. 1988).

The Eagle Nest subperiod begins around 5550 B.P. and endures until 4100 B.P., thus encompassing

Table 1. Periodization of the traditional chronology as interpreted from 268 radiocarbon dates in 1991.

Period	Subperiod	Radiocarbon Years (B.P.)	
Paleoindian		<12,000-9,800	
	Aurora		14,500-11,900
	Bonfire		10,700-9,800
Late Paleoindian		9,400-9,000	
	Oriente		9,400-8,800
Early Archaic		9,000-6,000	
	Viejo		8,900-6,500
Middle Archaic		6,000-3,000	
	Eagle Nest		5,500-4,100
	San Felipe		4,100-3,200
Late Archaic		3,000-1,000	
	Cibola		3,150-2,300
	Flanders		2,300??
	Blue Hills		2,300-1,300
Late Prehistoric		1,000-350	
	Flecha		1,320-450
	Infierno (phase)		450-250
Historic		350-0	

the first 1450 years of what was usually called the Middle Archaic period. Fifty-one radiocarbon assays fall within this time span; 11 are new—five date peyote effigies from 41VV113 (Terry et al. 2006); three are from middens (Cliff et al. 2003; Howard 2016), two are features in 41TE307, and one was produced by assay of a specialized “hunters kit” from Horseshoe Caves, 41VV171, once again by Shafer (2009). The next 860 years and 32 radiocarbon dates constitute the San Felipe subperiod. Twelve of the 32 are new since 1991; 10 of them are thermal features, either burned rock middens, hearths, a rock-filled pit, or charred strata. The other two are again from Horseshoe Caves (41VV171) where a most elaborate bundled baby burial was wrapped in finely woven and painted weavings and accompanied by shell and wooden artifacts (Turpin 2011a, b).

The break between the Middle and Late Archaic corresponds to the beginning of the Cibola subperiod, notable for the migratory bison herds that reached into the Lower Pecos ca. 3100 B.P. and lasted until about 2310 B.P. as defined by 26 radiocarbon dates, six of which are new. Four of those are thermal features; the fifth is from the burial of a 60-year-old man in one of the Shumla Caves, 41VV113 (Smithsonian notes) and the sixth is an infant bundle from an unknown site on the Pecos River. These interments come near the end of the period and are in fact the first examples of a mortuary practice that dominates the chronology of the succeeding Flanders/Blue Hills composite time frame from 2300 to 1400 B.P. The two subperiods are combined because we could find no clear distinction between them in the data list.

Of the 61 radiocarbon dates that fall within this composite time period, 38 are new. Ten of these are thermal features—either burned rock middens or buried hearths. The 22 new and two previously reported dates related to bundled burials are the result of a special project to fix this distinctive funerary custom in time while complementing an on-going DNA study of the Lower Pecos mortuary population (Turpin 2012b). It is now clear that the bundling of the dead and their burial in dry rock shelter deposits was primarily a Late Archaic—Blue Hills trait. Two cremations, one from Morehead Cave (41VV55) and another in the Museum of the Big Bend (site unknown) show a variation in mortuary practices although both were contained in woven bags (Maslowski 1976; Setzler 1934).

The last subperiod was named Flecha because it marks the introduction of the bow and arrow into the Lower Pecos ca. 1400 B.P.; the 98 radiocarbon dates, 34 of which are new, run up well into the

Table 2. Inventory of Lower Pecos Radiocarbon Assays.

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
				Aurora SubPeriod	
14300	220	TX881	41VV162A; Cueva Quebrada	Unit lc 30 in; extinct fauna	Radiocarbon 19(2); Collins 1976; Lundelius 1984
13920	210	TX880	41VV162A; Cueva Quebrada	Unit Ic 54 in; extinct fauna	Radiocarbon 19(2); Collins 1976; Lundelius 1984
12430	490	AA344	41VV218; Bonfire Shelter	Bone Bed 1 Str H1; extinct fauna	Bement 1986
12280	170	TX879	41VV162A; Cueva Quebrada	Units I II 41-47in; extinct fauna	Radiocarbon 19(2); Collins 1976; Lundelius 1984
				Bonfire SubPeriod	
11550	190	TX2739	41VV456; Hinds Cave	Inconsistently early	Radiocarbon 21(2); Lord 1984
10300	400	TX80	41VV82; Coontail Spin	12 ft lowest level; below Lerma; Plainview	Radiocarbon 6; Nunley et al.1965
10280	430	AA346	41VV218; Bonfire Shelter	Bone Bed 2; Folsom; Plainview	Bement 1986
10230	160	TX153	41VV218; Bonfire Shelter	Bone Bed 2 hearth; Folsom; Plainview	Radiocarbon 7; Dibble & Lorrain 1968
10100	300	TX658	41VV218; Bonfire Shelter	Bone Bed 2 hearth; Folsom; Plainview	Radiocarbon 12(1); Dibble 1970
9920	150	TX657	41VV218; Bonfire Shelter	Bone Bed 2 hearth; Folsom; Plainview	Radiocarbon 12(1); Dibble 1970
9610	130	TX897	41VV218; Bonfire Shelter	Bone Bed 2 Str A; Folsom; Plainview	Radiocarbon 19(2); Dibble & Lorrain 1968
9550	190	TX668	41VV99; Arenosa Shelter	Str 38; below Early Barbed Series	Radiocarbon 12(1); Patton & Dibble 1982
				Oriente SubPeriod	
9180	220	RL828	41VV213; Baker Cave	Zone 8; Golondrina; hearth	Hester 1983
9120	90	TX2866	41VV456; Hinds Cave	AU8; deepest occupation lens	Radiocarbon 21(2); Lord 1984
9030	230	TX129	41VV213; Baker Cave	Zone 1; Plainview-like; Golondrina	Radiocarbon 7; Word & Douglas 1970
9020	150	TX2466	41VV213; Baker Cave	Zone 8; Golondrina hearth	Radiocarbon 20(2); Hester 1983
8910	140	TX128	41VV213; Baker Cave	Zone 1; Plainview-like; Golondrina	Radiocarbon 7; Word & Douglas 1970
8780	310	TXS26	41VV188; Devils Mouth	Zone P; Paleoindian	Radiocarbon 10; Sorrow 1968
				Viejo SubPeriod	
8760	150	TX107	41VV167; Eagle Cave	Str V hearth; Early Barbed	Radiocarbon 7; Ross 1965
8760	150	TX141	41VV167; Eagle Cave	Str V Early Barbed	Radiocarbon 7; Ross 1965
8680	150	TX108	41VV167; Eagle Cave	Str V hearth; Early Barbed	Radiocarbon 7; Ross 1965
8680	180	TX197	41VV167; Eagle Cave	Str V; Early Barbed	Radiocarbon 7; Ross 1965
8540	120	TX140	41VV167; Eagle Cave	Str V (average of 2 samples)	Radiocarbon 7; Ross 1965
8490	130	TX2734	41VV456; Hinds Cave	AU 7; Bandy; Golondrina	Radiocarbon 21(2); Lord 1984
8280	80	TX2314	41VV456; Hinds Cave	AU7 100-101cm; ash lens	Radiocarbon 20(2); Lord 1984
8250	80	TX2745	41VV456; Hinds Cave	AU 6-7; Early Archaic; Early Barbed	Radiocarbon 21(2); Lord 1984
8180	110	TX2737	41VV456; Hinds Cave	AU 7; Early Archaic; coprolites; sandals	Radiocarbon 21(2); Lord 1984
8080	80	TX2931	41VV213; Baker Cave	Zone 17 Level 6; Early Triangular	Radiocarbon 30(2); Hester 1983
8010	50	B265843	41VV171, Horseshoe Caves	Burial AV1	Shafer 2009
7950	110	TX2867	41VV456; Hinds Cave	AU 7; Early Barbed; Bandy	Radiocarbon 21(2); Lord 1984
7530	120	TX2865	41VV456; Hinds Cave	AU 7; Early Barbed; Bandy	Radiocarbon 21(2); Lord 1984

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
7490	100	TX2736	41VV456; Hinds Cave	AU 7; Early Barbed	Radiocarbon 21(2); Lord 1984
7470	120	TX2738	41VV456; Hinds Cave	AU 7; Bandy	Radiocarbon 21(2); Lord 1984
7470	50	B259575	41VV171, Horseshoe Caves	Burial AV1	Shafer 2009
7430	240	TX314	41VV264; Devils Rockshelter	Zone 5; Early Barbed	Radiocarbon 9; Prewitt 1966
7240	220	TX152	41VV218; Bonfire Shelter	Intermediate Zone hearth	Radiocarbon 7; Dibble & Lorrain 1968
7220	60	TX2315	41VV456; Hinds Cave	AU7 60-80 cm; coprolites; Early Barbed	Radiocarbon 20(2); Lord 1984
6950	90	TX2751	41VV456; Hinds Cave	AU7; above Early Barbed Series	Radiocarbon 21(2); Lord 1984
6800	160	TX4335	41VV76; Black Cave	Remnant hearths 2 m above floor	Radiocarbon 30(2); Turpin 1982
6780	60	TX9395	41VV156	F6, ash pit, 220 cm bd	Turpin 1999
6750	100	TX2316	41VV456; Hinds Cave	AU7; rock-lined pit; Early Barbed	Radiocarbon 20(2); Lord 1984
6650	110	TX1758	41VV162; Conejo Shelter	Lens 125; basal deposit; Early Barbed	Radiocarbon 19(2); Alexander 1974
6640	120	TX109	41VV167; Eagle Cave	Str V; scattered charcoal on screen	Radiocarbon 7; Ross 1965
6540	70	TX2744	41VV456; Hinds Cave	AU 6; Early Archaic	Radiocarbon 21(2); Lord 1984
6530	620	TX41	41VV191; Centipede Cave	36-48in depth; Almagre; Langtry; Shumla	Radiocarbon 6; Epstein 1963
6400	180	TX9120	41TE307, Wroe Ranch	F21, fiber nest	Turpin 1998
6340	100	TX4871	41VV218; Bonfire Shelter	Intermediate Zone; hearth	Radiocarbon 30(2); Bement 1986
6230	90	TX2732	41VV456; Hinds Cave	AU 6; Bandy	Radiocarbon 21(2); Lord 1984
6160	80	TX2735	41VV456; Hinds Cave	AU 6; Bandy	Radiocarbon 21(2); Lord 1984
6140	60	TX9394	41VV156	F7, 210 cm bd, painted pebbles	Turpin 1999
6110	110	TX138	41VV167; Eagle Cave	Str III	Radiocarbon 7; Ross 1965
6070	60	TX9393	41VV156	Fea. 4, hearth, 150 cm deep	Turpin 1999
6060	120	TX139	41VV167; Eagle Cave	Str IV	Radiocarbon 7; Ross 1965
5920	120	TX6947	41VV930; Skyline Shelter	Unit 3 Level 30; Baker; Bandy; Gower	Turpin n.d.
5900	200	TX82	41VV76; Black Cave	Remnant hearths 2m above floor	Radiocarbon 6; Turpin 1982
5750	140	AA1315	41VV620; Seminole Sink	Skeletal deposit (δ13C corrected)	Turpin 1988
5730	70	TX9181	41TE307, Wroe Ranch	F23, fiber nest	Turpin 1988
5710	80	TX2459	41VV456; Hinds Cave	AU 5; coprolites	Williams-Dean 1978; Lord 1984
5650	140	TX4336	41VV76; Black Cave	Remnant hearths 2m above floor	Radiocarbon 30(2); Turpin 1982
5590	180	AA1313	41VV620; Seminole Sink	Skeletal deposit (δ13C corrected)	Turpin 1988
5590	70	TX2458	41VV456; Hinds Cave	AU 5; coprolites	Williams-Dean 1978; Lord 1984
				Eagle Nest SubPeriod	
5550	130	TX117	41VV167; Eagle Cave	Str ll-4; Pandale	Radiocarbon 7; Ross 1965
5520	280	TX1976	41VV99; Arenosa Shelter	Str 28; Pandale	Radiocarbon 19(2); Dibble 1967
5510	80	B14733	41VV213; Baker Cave	Angostura point	Brown, personal communication
5500	80	TX4334	41VV76; Black Cave	Remnant hearths 2m above floor	Radiocarbon 30(2); Turpin 1982

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
5410	50	TX9181	41TE307, Wroe Ranch	F11, grass nest	Turpin 1998
5360	170	TX313	41VV99; Arenosa Shelter	Str 32 & lower; Early Barbed Series	Radiocarbon 9; Dibble 1967
5270	60	TX8594	41TE307, Wroe Ranch	F10, ash pit	Turpin 1998
5210	70	TX6878	41VV930; Skyline Shelter	Unit 3 Level 24; Early Triangular	Turpin n.d.
5210	35	CAM86046	41VV113, Shumla Cave 5	Peyote effigy	Terry et al. 2006
5200	35	CAM86045	41VV113, Shumla Cave 5	Peyote effigy	Terry et al. 2006
5160	45	CAM86846	41VV113, Shumla Cave 5	Peyote effigy	Terry et al. 2006
5150	70	B14732	41VV213; Baker Cave	Large pit	Brown, personal communication
5150	70	TX6334	41VV930; Skyline Shelter	Unit 1 Level 22; Pandale; Early Barbed	Turpin 1990
5080	310	TX42	41VV191; Centipede Cave	23.5in; contracting stem side-notched	Radiocarbon 6; Epstein 1963
5030	65	Ua12433	41VV113, Shumla Cave 5	Peyote effigy	Bruhn in Terry et al. 2006; El Seedi et al. 2005
5020	80	TX1763	41VV162; Conejo Shelter	Lens 87; Pandale	Radiocarbon 19(2);Alexander 1974
4990	70	TX2743	41VV456; Hinds Cave	AU 5; Pandale; Nolan	Radiocarbon 21(2); Lord 1984
4950	70	TX1762a	41VV162; Conejo Shelter	Lens 103; Pandale	Radiocarbon 19(2); Alexander 1974
4900	100	TX525	41VV188; Devils Mouth	Zone N-O Fea 3; Early Barbed Series	Radiocarbon 10; Sorrow 1968
4890	90	TX1760	41VV162; Conejo Shelter	Lens 115 beginning of Pandale; Nolan	Radiocarbon 19(2); Alexander 1974
4885	60	Ua12434	41VV113, Shumla Cave 5	Peyote effigy	Bruhn in Terry et al. 2006; El Seedi et al. 2005
4850	80	TX4870	41VV218; Bonfire Shelter	lntermediate Zone; hearth withTX5084	Radiocarbon 30(2); Bement 1986
4790	140	TX312	41VV99; Arenosa Shelter	Str 2.5; Pandale points	Radiocarbon 9; Dibble 1967
4760	70	TX2747	41VV456; Hinds Cave	AU 5; correlated with Pandale	Radiocarbon 21(2); Lord 1984
4740	140	TX137	41VV167; Eagle Cave	Str ll-4; Pandale	Radiocarbon 7; Ross 1965
4690	140	RL829	41VV213; Baker Cave	Upper Pre-Archaic	Hester 1983
4685	100	SI1398	41VV99; Arenosa Shelter	Str 21; general	Dibble 1967
4671	64	AA1314	41VV620; Seminole Sink	Skeletal deposit (δ13C corrected)	Turpin 1988
4670	70	TX773	41VV99; Arenosa Shelter	Str 30 lowest; Pandale	Radiocarbon 12(2); Patton & Dibble 1982
4630	100	SI1401	41VV99; Arenosa Shelter	Str 28; hearth	Radiocarbon 19(2) comments; Dibble 1967
4610	70	TX2750	41VV456; Hinds Cave	AU 5; coprolite lens; Early Barbed Series	Radiocarbon 21(2); Lord 1984
4590	90	TX1762	41VV162; Conejo Shelter	Lens 103; Pandale	Radiocarbon 19(2); Alexander 1974
4580	110	TX196	41VV167; Eagle Cave	Str ll-4; Pandale	Radiocarbon 7; Ross 1965
4550	130	O137	41VV167; Eagle Cave	Zone B	Scheutz 1957
4520	120	TX203	41VV167; Eagle Cave	Str ll-4; hearth; Pandale	Radiocarbon 7; Ross 1965
4510	70	TX2742	41VV456; Hinds Cave	AU 5; Middle Archaic; Pandale; Nolan	Radiocarbon 21(2); Lord 1984
4465	110	SI1399	41VV99; Arenosa Shelter	Str 23b	Dibble 1967
4450	150	TX1979	41VV99; Arenosa Shelter	Str 28; hearth; Pandale	Radiocarbon 19(2); Patton & Dibble 1982
4440	110	TX660	41VV99; Arenosa Shelter	Str 30a; Pandale; (possibly contaminated)	Radiocarbon 12(1)

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
4430	140	TX78	41VV82; Coontail Spin	Windscreen (withTX79)	Radiocarbon 6; Nunley 1965
4430	80	TX538	41VV99; Arenosa Shelter	Surface of Str 25A; hearth; Pandale	Radiocarbon 12(1); Patton & Dibble 1982
4410	70	TX2749	41VV456; Hinds Cave	Middle Archaic	Radiocarbon 21(2); Lord 1984
4360	120	TX195	41VV167; Eagle Cave	Str III; Pandale	Radiocarbon 7; Ross 1965
4300	40	B168035	41VV1893	Midden 1	Cliff et al. 2003
4270	60	TX5084	41VV218; Bonfire Shelter	Intermediate Zone; hearth; withTX4870	Radiocarbon 30(2); Bement 1986
4260	40	B168040	41VV1893	Midden 2	Cliff et al. 2003
4200	40	B259574	41VV171, Horseshoe Caves	Hunters kit	Shafer 2009
4200	70	TX4812	41VV408; Hidden Shelter	Top 20cm beneath Langtry; Val Verde	Radiocarbon 30(2); Turpin 1984
4170	80	TX193	41VV74; Fate Bell Shelter	Zone III Level 2; Pandale	Radiocarbon 7; Parsons 1965
4140	30	B391412	41VV48	Midden, Ensor, Langtry, Pandale	Howard 2016
4100	150	TX324	41VV99; Arenosa Shelter	Str 23d; Pandale; Almagre; Val Verde	Radiocarbon 9; Dibble 1967
San Felipe SubPeriod					
4080	380	TX287	41VV99; Arenosa Shelter	Upper Str 23; Langtry; Val Verde; Almagre	Radiocarbon 9; Dibble 1967
4030	100	B10532	41VV620; Seminole Sink	Sediment above skeletal deposit	Turpin 1988
4030	80	TX4811	41VV408; Hidden Shelter	Upper 20cm below Langtry; Val Verde	Radiocarbon 30(2); Turpin 1984
4000	40	B168039	41VV1833	Midden 2	Cliff et al. 2003
3985	100	SI1400	41VV99; Arenosa Shelter	Str 25B	Dibble 1967
3970	90	B10533	41VV620; Seminole Sink	Sediment above skeletal deposit	Turpin 1988
3950	120	TX79	41VV82; Coontail Spin	Windscreen (withTX78);	Radiocarbon 6; Nunley et al. 1965
3930	40	B168038	41VV1893	Midden 1	Cliff et al. 2003
3890	40	B168036	41VV1893	Midden 1	Cliff et al. 2003
3875	55	SI1402	41VV99; Arenosa Shelter	Str E general	Dibble 1967
3840	70	TX2740	41VV456; Hinds Cave	AU 3; Middle-Late Archaic; Langtry-Val Verde	Radiocarbon 21(2); Lord 1984
3840	40	B168042	41VV1893	Midden 3	Cliff et al. 2003
3780	70	TX2741	41VV456; Hinds Cave	AU 3; Late Archaic; Langtry; Val Verde	Radiocarbon 21(2); Lord 1984
3730	80	TX6635	41VV930; Skyline Shelter	Unit 1 Level 16; Pandale	Turpin 1990
3680	80	TX2748	41VV456; Hinds Cave	AU 3; Middle Archaic	Radiocarbon 21(2); Lord 1984
3650	50	B168049	41VV1897	Midden	Cliff et al. 2003
3640	80	TX662	41VV99; Arenosa Shelter	Str 22x; hearth; Langtry	Radiocarbon 12(1); Patton & Dibble 1982
3620	40	B168038	41VV1893	Midden 1	Cliff et al. 2003
3600	70	TX1975	41VV99; Arenosa Shelter	Str 23; Val Verde; Langtry; Almafire	Radiocarbon 19(2); Patton & Dibble 1982
3530	30	B298515	41V171, Horseshoe Cave	Infant mummy bundle AV2	Turpin 2012a, b
3480	80	TX6964	41VV930; Skyline Shelter	Unit 3 Level 11; bison bone (δ13C corrected)	Turpin n.d.
3480	40	B293744	41V171, Horseshoe Cave	Infant mummy bundle AV2	Turpin 2012a, b

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
3460	220	TX6734	41VV930; Skyline Shelter	Unit 1 Level 18; lower Pandale (suspect)	Turpin n.d.
3410	80	TX136	41VV167; Eagle Cave	Str III; Langtry; Val Verde	Radiocarbon 7; Ross 1965
3350	85	C193SI1403	41VV99; Arenosa Shelter	Str 22C	Patton & Dibble 1982
3330	110	TX19	41VV74; Fate Bell Shelter	Zone III Level 1; Langtry; Val Verde	Radiocarbon 7; Parsons 1965
3310	50	B113889	41VV444, San Felipe Springs	Zone C, burned rock layer	Mehalchick & Boyd 1999
3310	90	TX1761	41VV162; Conejo Shelter	Lens 50; Val Verde	Radiocarbon 19(2); Alexander 1974
3280	60	B113884	41VV444, San Felipe Springs	EU34, 290 bs	Mehalchick 1999
3260	60	B113887	41VV444, San Felipe Springs	Feature 11, rock filled pit	Mehalchick 1999
3220	40	B168030	41VV1893	Midden 3	Cliff et al. 2003
3220	70	TX701	41VV99; Arenosa Shelter	Str 21, Langtry, Val Verde	Radiocarbon 12(2); Patton & Dibble 1982
				Cibola SubPeriod	
3100	70	TX6636	41VV930; Skyline Shelter	Unit 1 Level 13; Bison bone; Marshall	Turpin 1990
3080	90	TX663	41VV263; Cueva del Diablo	Str 6 lower; Marshall	Radiocarbon 12(1); Prewitt 1970
3050	120	TX40	41VV191; Centipede Cave	48-59 in.; Langtry; Shumla (suspect)	Radiocarbon 6; Epstein 1963
2920	130	TX148	NL92; Cueva de la Zona	Level 15 3.5-3.75ft; Shumla l; Tortugas	Radiocarbon 7; McClurkan 1966
2910	40	B168031	41VV1893	Midden 3	Cliff et al. 2003
2850	80	TX570	41VV301; Nopal Terrace	Level 7a; Montell; Shumla	Radiocarbon 12(1); Sorrow 1968
2820	40	B168029	41VV1893	Midden 3	Cliff et al. 2003
2810	110	TX47	41VV218; Bonfire Shelter	Bone Bed 3; Castroville-like; Montell	Radiocarbon 6; Dibble & Lorrain 1968
2790	80	TX57l	41VV188; Devils Mouth	Zone 9; lowest Montell	Radiocarbon 12(1); Sorrow 1968
2785	75	SI1396	41VV99; Arenosa Shelter	Str 9; basal	Dibble 1967
2780	110	TX106	41VV218; Bonfire Shelter	Bone Bed 3; Castroville-like; Montell	Radiocarbon 6; Dibble & Lorrain 1968
2780	55	SI1120	41VV67; Goat Cave	Mat fragment 1.7 ft bs E200	Prewitt 1970
2710	50	TX5987	41VV456; Hinds Cave	Infant burial (incorrect)	see Steelman et al for correct date
2690	80	TX1759	41VV162; Conejo Shelter	Lens 38; Montell; Marcos; Shumla; Ensor	Radiocarbon 19(2), Alexander 1974
2610	30	B301409	41VV2139	Burned rock midden, Langtry points	Howard 2016
2560	100	TX291	Felton Cave,D337 Sutton Co	Ring midden; Late Archaic (suspect)	Radiocarbon 9; Greer1968b
2540	75	SI1397	41VV99; Arenosa Shelter	Str 10; general	Dibble 1967 ‘
2520	50	TX1977	41VV99; Arenosa Shelter	Str 11; Montell	Radiocarbon 19(2); Dibble 1967
2510	100	TX131	41VV218; Bonfire Shelter	Bone Bed 3; Castroville-like; Montell	Radiocarbon 7; Dibble & Lorrain 1968
2480	90	B113885	41VV444, San Felipe Springs	EU6, Feature 3, rock-filled pit 291 cmbs	Mehalchick 1999
2440	140	TX311	41VV99; Arenosa Shelter	Lower Str 11; Montell	Radiocarbon 9; Dibble 1967
2410	140	TX286	41VV99; Arenosa Shelter	Upper Str 11; Montell	Radiocarbon 9; Dibble 1967
2400	125	TX6166	Unknown Pecos River Site	Infant bundled burial	Turpin 2012b
2390	35	SI0212	41VV113, Shumla Cave 5 - 8	Male burial, 60 yrs old	Smithsonian Instituttion, notes

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
2330	90	TXl92	41VV74; Fate Bell Shelter	Zone ll; pointed stem dart points (Langtry)	Radiocarbon 7; Parsons 1965
2310	210	TX46	41VV218; Bonfire Shelter	Bone Bed 3; Castroville-like; Montell Flanders/Blue Hills SubPeriods	Radiocarbon 6; Dibble & Lorrain 1968
2300	160	TX76	41VV82; Coontail Spin	5.5ft; late Shumla; early Ensor	Radiocarbon 6; Nunley et al. 1965
2280	60	TX2746	41VV456; Hinds Cave	AU2; Late Archaic	Radiocarbon 21(2); Lord 1984
2250	60	B113888	41VV444, San Felipe Springs	Feature 12, rock filled pit	Mehalchick 1999
2240	40	UCR3698	41VV113, Shumla Cave 5	Female burial, 45-49 yrs	Smithsonian Institution, notes
2230	50	S11130	41VV55; Moorehead Cave	Possible disturbed human burial	Maslowski 1978
2230	80	TX696	41VV99; Arenosa Shelter	Upper Str 9; early Ensor; Frio	Radiocarbon 12(2); Patton & Dibble 1982
2222	15	K149831	41VV341, High & Dry Shelter	Adult female, private collection	Turpin 2012b
2220	50	B113890	41VV444, San Felipe Springs	EU6, Feature 5, shallow basin, stained soil	Mehalchick 1999
2210	30	B449747	41VV74, Fate Bell Shelter	Adult male, Grave L-3	Pearce and Jackson 1932
2200	30	B457378	41VV74, Fate Bell Shelter	Adult male, Grave L-2	Pearce and Jackson 1932
2170	15	K149830	41VV341, High & Dry Shelter	Adult male bundle burial, private collection	Turpin 2012b
2165	70	SI1395	41VV99; Arenosa Shelter	Str 7; general	Dibble 1967
2150	30	B368660	41VV74, Fate Bell Shelter	Adult male, Grave L-4	Pearce and Jackson 1932
2150	30	B465919	41VV113, Shumla Cave	Adult male with copious grave goods	see Shafer (ed) 1986
2150	80	TX536	41VV99; Arenosa Shelter	Str 7; basal Ensor; Frio	Radiocarbon 12(1); Dibble 1967
2135	11	various	41VV456?, Hinds Cave	Infant mummy bundle, donated	Steelman et al. 2004
2130	15	K149829	41VV341, High & Dry Shelter	Adult male bundle burial, private collection	Turpin 2012b
2130	30	B466514	41VV113, Shumla Cave	Infant 2-3 mos old	
2130	105	SI1394	41VV99; Arenosa Shelter	Str 5; basal	Dibble 1967
2120	40	B028379	Unk so. of Shumla Bend	Infant mummy bundle, private hands	Turpin 2012b
2120	40	B301424	Museum of the Big Bend	Painted cremation bag, donated	Turpin 2012a
2100	30	B302186	Museum of the Big Bend	Painted infant burial bag, donated	Turpin 2012a
2070	140	TX285	41VV99; Arenosa Shelter	Lower Str 9; Marcos; Shumla; Frio	Radiocarbon 9; Dibble 1967
2050	30	B300561	Museum of the Big Bend	Unusual basket w/burial pouches, donated	Turpin 2012b
2050	40	UCR3701	41VV112, Shumla Cave 1	Female burial, 40-44 yrs.	Smithsonian Institution, notes
2040	60	B140484	41VV1207	Feature FX11- hearth basin	Johnson & Johnson 2008
2010	40	B283080	Unk so. of Shumla Bend	Female bundle burial, private collection	Turpin 2012b
2010	15	K149832	41VV341, High & Dry Shelter	Juvenile, with adult burials	Turpin 2012b
2000	40	B168045	41VV1897	General dispersed midden	Cliff et al. 2003
1990	40	B281017	41VV341, High & Dry Shelter	Male bundle burial, private collection	Turpin 2012b
1990	60	AA1316	41VV620; Seminole Sink	Skeletal deposit	Turpin et al. 1988
1980	30	B368659	41VV74, Fate Bell Shelter	Adult male, Grave L-1	Pearce and Jackson 1932

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
1980	50	TX8602	41TE307, Wroe Ranch	F24, fiber nest	Turpin 1998
1980	500	TX1704	41CX95; Three Dog Site	Hearth assoc. with burned rock midden	Radiocarbon 19(2)
1980	80	GX16198	41VV162; Conejo Shelter	Lens 17; burial level	Huebner1991
1970	110	TX284	41VV99; Arenosa Shelter	Surface of Str 7 hearth; Ensor; Frio	Radiocarbon 9; Dibble 1967
1930	30	B327522	41VV656, Mummy Shelter	replaceTX980, mummified male bundle	Turpin et al 1986, Turpin 2012a, b
1910	70	TX537	41VV99; Arenosa Shelter	Str 5; Ensor; Frio	Radiocarbon 12(1); Patton & Dibble 1982
1880	50	TX8596	41TE307, Wroe Ranch	F19a, hearth	Turpin 1998
1860	90	TX6735	41VV930; Skyline Shelter	Unit 1 Level 25; bottom of site (suspect)	Turpin n.d.
1850	50	TX8603	41TE307, Wroe Ranch	F19, grass bed	Turpin 1998
1840	400	TX39	41VV191; Centipede Cave	Lowest zone; 48-59in (suspect)	Radiocarbon 6; Epstein 1963
1830	40	B283081	41VV237, Leaping Panthers	Female & child burials, private collection	Turpin 2012b
1820	70	TX2733	41VV456; Hinds Cave	AU 1; Ensor; burned rock & fiber midden	Radiocarbon 21(2); Lord 1984
1810	70	TX1757	41VV162; Conejo Shelter	Lens H; Late Archaic	Radiocarbon 19(2); Alexander 1974
1810	40	B281018	41VV341, High & Dry Shelter	Male bundle burial, private collection	Turpin 2012b
1790	110	B113886	41VV444, San Felipe Springs	Zone B, rock layer	Mehalchick 1999
1710	40	TX9120	41TE307, Wroe Ranch	F2, fiber net	Turpin 1998
1700	70	SI1131	41VV55; Moorehead Cave	Double burial female & cremated male	Maslowski 1978
1690	80	TX194	41VV218; Bonfire Shelter	Fiber layer hearths; Castroville; Ensor	Radiocarbon 7; Dibble & Lorrain 1968
1680	40	B168028	41VV1892	General dispersed midden	Cliff et al. 2003
1670	40	B168024	41VV1892	General dispersed midden	Cliff et al. 2003
1660	70	TX1705	41CX95; Three Dog Site	Hearth assoc. with burned rock midden	Radiocarbon 19(2)
1650	45	SI1119	41VV67; Goat Cave	Burial in grass-lined pit; 1.2ft bs; yucca	Maslowski 1978; Prewitt 1970
1620	50	TX8593	41TE307, Wroe Ranch	F22, ash pit	Turpin 1998
1610	90	TX6736	41VV930; Skyline Shelter	Unit 1 Level II	Turpin n.d.
1470	60	B140483	41VV1207	FX33, basin-shaped hearth	Johnson & Johnson 2008
1460	40	B168046	41VV1897	General dispersed midden	Cliff et al. 2003
1440	40	B168034	41VV1893	Midden 2	Cliff et al. 2003
1430	60	TX1709	41CX95; Three Dog Site	Hearth assoc. with burned rock midden	Radiocarbon 19(2)
1400	130	TX151	41VV218; Bonfire Shelter	Fiber layer hearth; Castroville; Ensor Flecha SubPeriod	Radiocarbon 7; Dibble & Lorrain 1968
1380	60	TX661	41VV99; Arenosa Shelter	Str 2a; Ensor; arrow points	Radiocarbon 12(1); Patton & Dibble 1982
1380	50	TX8595	41TE307, Wroe Ranch	F19A, hearth	Turpin 1998
1320	40		41VV661, 2 m bs	Terrace site, buried features	Gustafson & Collins 1998
1290	50	TX622	41VV87; Perry Calk Site Pit	(average of 2 dates - suspect)	Radiocarbon 12(1); Collins 1969
1270	110	TX81	41VV82; Coontail Spin	Upper zone; Ensor	Radiocarbon 6; Nunley et al. 1965

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
1260	40	B250376	41VV1991, Lost Midden	Burned rock midden, Feature 1	Roberts & Alvarado 2011
1250	50	41VV661, 2 m bs	Terrace site, buried features	Gustafson & Collins 1998	
1230	90	TX5897	41VV456; Hinds Cave	Infant burial (replaced see Steelman et al.)	Turpin n.d.
1200	60	TX2777	41CX217; Ring midden	Ensor	Radiocarbon 30(2); Luke 1983
1160	70	TX645	41CX30; Parker Midden	Ring midden; 40 to 50cm bs; Ensor	Radiocarbon 12(2); Sommer 1968
1150	70	TX980	41VV656; Mummy Shelter	Intestinal contents; male bundle, see B327522	Turpin et al. 1986
1130	40	B168048	41VV1897	General dispersed midden	Cliff et al. 2003
1120	40	B262710	41VV1991, Lost Midden	Burned rock midden, domed, Feature 2	Roberts & Alvarado 2011
1120	40	B262712	41VV1991, Lost Midden	Burned rock midden, domed, Feature 2	Roberts & Alvarado 2011
1120	40	B168025	41VV1892	General dispersed midden	Cliff et al. 2003
1100	100	B15634	41VV213; Baker Cave	Grass-lined pit	Brown, personal communication
1070	40	B262713	41VV1991, Lost Midden	Rock oven in midden, Feature 3	Roberts & Alvarado 2011
1070	40	B262711	41VV1991, Lost Midden	Burned rock midden, domed, Feature 2	Roberts & Alvarado 2011
1050	140	TX130	41VV218; Bonfire Shelter	Fiber level hearth (disturbed)	Radiocarbon 7; Dibble & Lorrain 1968
1050	70	TX646	41CX30; Parker Midden	Ring midden; 50 to 60cm bs; Ensor	Radiocarbon 12(2); Sommer 1968
1040	60	TX1510	41SU2; Perro Salvaje	Ring midden; Level 4; Late Archaic	Radiocarbon 19(2); Jarvis & Crawford 1974
1020	140	TX1706	41CX95; Three Dog Site	Hearth?	Radiocarbon 19(2)
970	70	TX647	41CX30; Parker Midden	Ring midden; Ensor points	Radiocarbon 12(2); Sommer 1968
960	40	B262708	41VV1991, Lost Midden	Burned rock midden, Feature 1	Roberts & Alvarado 2011
940	120	TX310	41CX5; Dunlap Site	Slab-lined basin; Ensor; arrow points	Radiocarbon 10; Greer 1968
940	70	TX6638	41VV930; Skyline Shelter	Unit 1 Level 6 Fea 7; arrow point	Turpin 1990
920	40	B168033	41VV1893	Midden 3	Cliff et al. 2003
920	70	TX1508	41SU2; Perro Salvaje	Ring midden; Level 2; Late Archaic	Radiocarbon 19(2); Jarvis & Crawford 1974
910	60	TX1507	41SU2; Perro Salvaje	Ring midden; Level 3; Late Archaic	Radiocarbon 19(2); Jarvis & Crawford 1974
910	30	B391410	41VV2205	Burned rock midden, mussel shell	Howard 2016
890	40	B262714	41VV1991, Lost Midden	Rock oven in midden, Feature 3	Roberts & Alvarado 2011
890	40	B168026	41VV1892	General dispersed midden	Cliff et al. 2003
890	70	TX3065	41TE170; Sorcerers Cave	Wooden mortar	Prewitt 1981
890	30	B391408	41VV2120	Open camp, burned rock middens	Howard 2016
870	30	B391441	41VV2225	Crescent midden, dart & arrow point	Howard 2016
860	40	B262709	41VV1991, Lost Midden	Burned rock midden, Feature 1	Roberts & Alvarado 2011
860	30	B391413	41VV837	6 burned rock middens, dart & arrow	Howard 2016
860	60	TX1509	41SU2; Perro Salvaje	Ring midden; Level 3; Late Archaic	Radiocarbon 19(2); Jarvis & Crawford 1974
840	70	TX1708	41CX95; Three Dog Site	Hearth assoc. with burned rock midden	Radiocarbon 19(2); Jarvis & Crawford 1974
830	100	TX38	41VV191; Centipede Cave	8-14in; Ensor; Frio; arrow points	Radiocarbon 6; Epstein 1963

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
830	40	TX633	41VV422; Techo Bajo	Fiber level; Ensor (average of 2 dates)	Radiocarbon 12(1); Collins 1969
830	80	TX6637	41VV930; Skyline Shelter	Unit 1 Level 1; cemented hearth	Turpin 1990
820	40	B262715	41VV1991, Lost Midden	Rock oven in midden, Feature 3	Roberts & Alvarado 2011
820	70	TX1707	41CX95; Three Dog Site	Hearth assoc. with burned rock midden	Radiocarbon 19(2)
790	50	TX2782	41CX252	Circular lined pit	Radiocarbon 30(2); Luke 1983
780	40	B168041	41VV1895	General dispersed midden	Cliff et al. 2003
780	90	TX1703	41CX95; Three Dog Site	Hearth assoc. with burned rock midden	Radiocarbon 19(2)
740	90	TX2781	41TE61	Hearth	Brown et al. 1976
740	60	TX630	41VV422; Techo Bajo	Fiber level; Ensor	Radiocarbon 12(1); Collins 1969
730	60	TX2780	41CX216; Ring midden	Arrow point	Radiocarbon 30(2); Luke 1983
720	40	B168027	41VV1892	General dispersed midden	Cliff et al. 2003
710	80	TX362	41VV257; Hodge Site	Ring midden; Late Archaic points (suspect)	Radiocarbon 10; Greer 1968b
690	50	TX629	41VV87; Perry Calk	Ash pit	Radiocarbon 12(1); Collins 1969
670	80	TX351	41CX5; Dunlap Site	Slab-lined basin; Ensor; arrow points	Radiocarbon 10; Greer 1968b
660	60	TX2778	41CX217; Ring midden	Ensor; Frio; Paisano	Radiocarbon 30(2); Luke 1983
660	50	B108718	41VV446, Infierno Camp	Hearth? with tipi rings, pottery, arrow points	
660	50	B108178	41VV661, hearth 1.5m bs	Terrace site, buried features	Gustafson & Collins 1998
650	40	B168047	41VV1897	General dispersed midden	Cliff et al. 2003
640	90	TX2480	41TE61	Hearth	Brown et al. 1976
630	110	TX5431	41TE307; Wroe Ranch	Mummified child burial (withTX5430)	Turpin 1998; F44 National Register files
630	90	TX357	41CX5; Dunlap Complex	Slab-lined basin; Ensor; arrow points	Radiocarbon 10; Greer 1968b
625	185	TX227	41VV260; Cammack Site	Ring middens; trench 1.5-2ft; arrow points	Radiocarbon 8; Greer 1968a
620	60	TX2778	41CX136	Hearth	Radiocarbon 30(2); Luke 1983
610	80	TX361	41VV260; Cammack Site	Ring middens; arrow points	Radiocarbon 10; Greer 1968a
600	80	B116160	41VV444, San Felipe Springs	EU 24 292 bs	Mehalchick 1999
600	190	TX77	41VV82; Coontail Spin	4.5ft; Late & Middle Archaic (suspect)	Radiocarbon 6; Nunley et al. 1965
590	60	TX620	41VV87; Perry Calk	Hearth; Ensor; arrow points	Radiocarbon 12(1); Collins 1969
570	100	TX359	41CX5; Dunlap Complex	Stone-lined basin; Ensor; arrow points	Radiocarbon 10; Greer 1968b.
570	70	TX5430	41TE307; Wroe Ranch	Mummified child burial (withTX5431)	Turpin 1998; National Register files
570	70	TX6838	Unknown Crockett Co	Rush matting	McGregor 1991
540	100	TX358	41CX5; Dunlap Site	Stone-lined basin; Ensor; arrow points	Radiocarbon 10; Greer 1968b
520	50	TX2779	41CX216	Ring midden	Radiocarbon 30(2); Luke 1983
520	50	TX2794	41CX125	Hearth	Radiocarbon 30(2); Luke 1983
500	40	B168043	41VV1895	General dispersed midden	Cliff et al. 2003
490	60	TX2478	41TE61	Hearth	Brown et al. 1976

Table 2. Inventory of Lower Pecos Radiocarbon Assays. (*Continued*)

Age		ID	Site No. & Name	Internal Provenience/Associations	Reference
480	50	B116161	41VV444, San Felipe Springs	EU24 292 cmbs	Mehalchick 1999
480	70	TX2781	41CX162	Square hearth	Radiocarbon 30(2); Luke 1983
470	150	AA946	41VV620; Seminole Sink	Cremation atop talus (with B10472)	Turpin 1988
450	90	TX2479	41TE61	Hearh	Brown et al. 1976
410	60	TX2793	41CX121	Hearth, Level 2	Radiocarbon 30(2); Luke 1983
400	70	TX2786	41CX136	Hearth	Radiocarbon 30(2); Luke 1983
400	60	TX649	41CX8; Sotol Site	Zone D; hearth; Perdiz & pottery	Radiocarbon 12(1); Lorrain 1968
390	80	B10472	41VV620; Seminole Sink	Cremation atop talus (with AA946)	Turpin et al. 1988
390	60	TX2476	41TE61	Hearth	Brown et al. 1976
340	40	B180787	41VV236, Lewis Canyon	Shallowly buried hearth	Turpin 2005
370	60	TX650	41CX8; Sotol Site	Hearth; Fresno; Garza	Radiocarbon 12(1); Lorrain 1968
360	80	TX2475	41TE61	Hearth	Brown et al. 1976
360	40	B140482	41VV1752	FX4, Unit 2, 14 cmbs	Johnson & Johnson 2008
360	60	TX2787	41CX136	Hearth	Radiocarbon 30(2); Luke 1983
320	40	B168054	41VV1895	General dispersed midden	Cliff et al. 2003
310	40	B140481	41VV1752	Hearth, 14 cm bs	Johnson & Johnson 2008
300	60	TX2477	41TE61	Hearth	Brown et al. 1976
290	60	TX2792	41CX131	Stone-lined pit	Radiocarbon 30(2); Luke 1983
290	50	TX2789	41CX131	Stone-lined pit	Radiocarbon 30(2); Luke 1983
260	50	TX2791	41CX131	Stone-lined pit	Radiocarbon 30(2); Luke 1983
240	60	TX72022	41VV236, Lewis Canyon	Shallowly buried hearth	Turpin 2005
200	60	B184784	41VV236, Lewis Canyon	Shallowly buried hearth	Turpin 2005
170	50	TX2790	41CX131	Stone-lined pit	Radiocarbon 30(2); Luke 1983

A-Arizona;. B- Beta Analytic; CAM-Livermore; H-Humble Oil; K-Koch; RL-Dublin; S-Smithsonian; TX-Texas; UCR-Riverside

Historic Period, ca. 170 B.P. The majority are from burned rock features, in keeping with the findings of the 1991 inventory wherein the first ring middens appear ca. 1100 B.P. The one new insight is the confirmation that the large tipi ring site, Infierno Camp, is a late Flecha phenomenon, one that Dibble designated as a separate phase characterized by small triangular arrow point, four-beveled knives, steeply beveled end scrapers and plain ceramics.

Discussion

The addition of 108 radiocarbon dates to the inventory published in 1991 resulted in very few changes in our understanding of the cultural trajectory of the Lower Pecos people. There may well be other unreported assays that we could not access but it is comforting to know that they are unlikely to drastically affect the chronology as described here. Middens come on the scene at the end of the Eagle Nest subperiod at the same time that the preponderance of Pandale dart points is diluted by the Langtry-Val Verde complex. Midden building continues until historic times but—as noted above—ring middens seem to be Flecha period features along with the introduction of the bow and arrow—a transition marked a continued reliance on the trusty Ensor dart point often found with arrow points.

The many dates run on bundled burials and burial pouches confirm the popularity of this particular mortuary custom during the Late Archaic—Blue Hills time period. The practice of arranging the deceased in a fetal position, wrapping them in layers of woven mats—some intricately woven and others painted—may have started ca. 3500 yBP although there is only one example—the child bundle from Horseshoe Caves (Turpin 2011, 2012a, b)—and may have lasted a few hundred years into the Flecha subperiod but the sole grave from this time period is a mummified child laid on a bed of greenery and covered with an antelope skin shroud and buried in a Terrell County shelter ravaged by relic hunters (Turpin 1998). Shafer's (2009) two dates on a partially disturbed grave, also in Horseshoe Caves, identify the oldest burial yet found in the Lower Pecos but it is unclear if the deceased was bundled. Three dates on sinkhole burials precede the earliest bundles but the three reported cremations are Blue Hills and Flecha phenomena.

Texas Parks and Wildlife's inventory of sites in one section of the Devils River State Natural Area was represented by six assays (Howard 2013) but the largest block of dates came from sponsored excavations—one at San Felipe Springs in Del Rio (Mehalchick 1999); one at a buried midden site in Seminole Canyon Park (Roberts and Alvarado 2011); and one in a highway right-of-way (Cliff et al. 2003). A fourth excavation carried out by the Texas Archeological Society field school (Johnson and Johnson 2008) added another three hearths to the temporal continuity of a buried hearth site that was previously part of a geoarcheological study of the Rio Grande environs (Gustafson and Collins 1998). Given the overwhelming representation of burned rock middens and hearths, it is probably time to rethink the need for more assays of the same. It is noteworthy that ring middens are a late phenomenon whether by virtue of their association with Plains Indians or as a result of the vagaries of preservation.

Coahuila and Nueva León, México

This compendium of radiocarbon dates from North Central Mexico was compiled because students and researchers in these two states have no access to many of the reports in which the dates are given so they are essentially doomed to reinvent the wheel. The 1991 publication of radiocarbon dates relevant to the archeology of the Lower Pecos Region included some but not all the assays from sites in adjacent Nuevo León and Coahuila. The following table attempts to remedy that data gap by listing 153 radiocarbon assays from those two states (Table 3). Primarily, the Mexican dates included in the original list were from sites excavated in the 1960s by Dr. J. F. Epstein's students as part of the University of Texas Northeast Mexico Archaeological Project (NEMAP). One goal of NEMAP's surveys and excavations was to establish a regional chronology, with an emphasis on lithic tools, with data best found in rock shelters such as La Calsada (Nance 1971), Cueva de la Zona de Derrumbes (McClurken 1966) and Cueva Ahumada (Epstein 1972). Prior to Epstein's work, the largest body of comparable data came from Walter W. Taylor's 1940's excavations in the Cuatro Ciénagas area, most specifically Frightful Cave but also Nopal and Fat Burro caves. Originally, three samples from Frightful, all wood, were submitted to the University of Michigan radiocarbon laboratory and demonstrated the great age of the

Table 3. Inventory of Northern Mexican Radiocarbon Assays

C14	SD	Cal. BP	68% Prob	Lab No.	Associations	Material	Citation
C105, Hearths							
140	140	179	30-328	TX337	Surface hearth field	charcoal	Radiocarbon 9; Varner 1967
540	80	576	519-632	TX338	Surface hearth field	charcoal	Radiocarbon 9; Varner 1967
1230	90	1151	1054-1248	TX331	Surface hearth field Gary/Langtry dart points	charcoal	Radiocarbon 9; Varner 1967
1250	90	1166	1073-1259	TX332	Surface hearth field Gary/Langtry dart points	charcoal	Radiocarbon 9; Varner 1967
Coahuila Project							
340	55	401	338-472	OS10547	Hearth, animal bone, stone tools, human burial	charcoal	Butzer et al. 2008:261
7170	140	8004	7860-8148	OS10661	Basin hearth, debitage, petroglyph	charcoal	Butzer et al. 2008:255
7890	130	8762	8584-8940	OS10559	Narrow bedrock pass, petroglyph	charcoal	Butzer et al. 2008:255
Fat Burro/Nopal Caves							
1430	50	1343	1309-1376	SI1077	Sewn sandal frag, top level, rear of cave	Nolina	Taylor 1988
1875	80	1814	1724-1903	SI1078	Sewn sandal frag, top level, rear of cave	Nolina	Taylor 1988
1965	105	1928	1798-2057	SI1076	Coiled basket frag, top level, lower middle	Nolina	Taylor 1988
3930	55	4367	4286-4447	SI1074	Plaited 2-warp sandal frag, upper bottom, rear	Nolina	Taylor 1988
4755	90	5470	5364-5576	SI1075	Plaited 2-warp sandal frag, front middle	Nolina	Taylor 1988
5245	85	6050	5942-6158	SI1073	Plaited 2-warp sandal frag, lower bottom, front	Nolina	Taylor 1988
Cave CM 59							
1000	45	897	839-954	SI1080	Coiled basketry	Yucca	Taylor 1988
2100	70	2105	2000-2210	SI1079	Coiled basketry	Yucca	Taylor 1988
Cave CM 79							
835	35	816	714-782	UCL96517	Peyote from string of nine	Peyote	Terry et al. 2005, Bruhn et al. 2002
920	75	837	764-910	SI1083	Matting with secondary burials	Sotol	Taylor 1988
1000	60	898	829-967	SI1082	Matting with secondary burials	Sotol	Taylor 1988
1200	70	1131	1039-1223	SI1081	Matting with secondary burials	Sotol	Taylor 1988
Coyote Cave							
1295	45	1232	1187-1276	SI1153	Sandal from mummy bundle, left foot	Lechuguilla	Taylor 1988
6010	130	6886	6714-7057	SI1177	Second part of sandal from mummy bundle	Lechuguilla	Taylor 1988

Table 3. Inventory of Northern Mexican Radiocarbon Assays. (*Continued*)

C14	SD	Cal. BP	68% Prob	Lab No.	Associations	Material	Citation
Candelaria Cave							
745	110	704	601-806	TX51	Human bone from bundled burial	bone	Aveleyra 1964
745	90	693	610-776	TX50	Textile from bundled burial	fiber	Aveleyra 1964
950	30	865	817-912	B378112	Folded mat, sent to A. Krieger by Aveleyra	fiber	Turpin, n.d.
El Fuste							
1000	60	898	829-967	B180968	Braided sandal	fiber	Turpin 2003
1110	60	1042	973-1111	TX7814	Basket in child burial, in narrow shaft	fiber	Turpin et al. 1993
1300	60	1221	1161-1280	B180970	Checker pad sandal, diagonal weave	fiber	Turpin 2003
1340	80	1249	1176-1321	TX7804	Sandal	fiber	Turpin 2003
1410	80	1331	1268-1394	B180969	Checker pad sandal, diagonal weave	fiber	Turpin 2003
Cueva Encantada							
700	40	632	583-681	TX8383	Hearth, Area A, Feature 6	charcoal	Turpin 1997
1230	50	1167	1095-1238	TX9242	Grass-lined basin, sandals, Area C, Feature C2	fiber	Turpin 1997
1310	50	1237	1190-128	TX8382	Hearth, Area A, Feature A1	charcoal	Turpin 1997
1500	50	1412	1347-1477	TX8386	Hearth, Area A, Feature 2	charcoal	Turpin 1997
1620	40	1498	1441-1554	TX9243	Grass-lined basin, sandals in Feature C8	fiber	Turpin 1997
1750	50	1666	1601-1730	TX8467	Sandal, checkerpad in Feature A3	fiber	Turpin 1997
1870	60	1807	1739-1875	TX8443	Agave, prickly pear baby bed, Area B, Feature 13	prickly pear	Turpin 1997
2440	50	2533	2405-2661	TX8385	Hearth, Area A, Feature 11	charcoal	Turpin 1997
2500	50	2589	2486-2691	TX8384	Hearth, Area A. Feature 3B+G15	charcoal	Turpin 1997
3340	50	3574	3574-3640	TX8508	Area B, Feature 10, sotol padding	sotol	Turpin 1997
3870	190	4295	4026-4563	TX8442	Area B, Feature 10, woven sedge mat	sedge	Turpin 1997
Cueva Pilote							
600	50	601	560-642	B117276	Unit X, 40 cm-bedrock	gourd	Turpin & Eling 1999
690	40	628	580-676	TX9311	Unit H, 10-20 cm bd, dessicated fiber pad	agave	Turpin & Eling 1999
700	35	633	585-680	TX9340	Unit C, 118 cm bd, tree limb	walnut	Turpin & Eling 1999
1060	50	992	942-1041	TX9331	Unit J, 40-50 cm bd, beneath painted scapula	wood	Turpin & Eling 1999

Table 3. Inventory of Northern Mexican Radiocarbon Assays. (*Continued*)

C14	SD	Cal. BP	68% Prob	Lab No.	Associations	Material	Citation
Frightful Cave							
1660	50	1569	1496-1641	SI1071	2-warp sandal, passage 0.5-1 m deep	Hesperaloe	Taylor 1988
1755	45	1671	1612-1730	SI1133	Cache bag with seeds, 0-.5 m deep	Sotol	Taylor 1988
1955	75	1911	1828-1994	SI1059	2-warp sandal, upper mid-level at front	Hesperaloe	Taylor 1988
2?15	80	date missing		SI1134	Unburned seeds of hallucinogen	Buckeye	Taylor 1988
2210	45	2235	2168-2302	SI1060	2-warp sandal, top level at front, 0-.5 m deep	Hesperaloe	Taylor 1988
2495	75	2560	2435-2685	SI1063	2-warp sandal, center of middle level	Hesperaloe	Taylor 1988
2700	85	2839	2762-2915	SI1148	Cut stick, passage 0-.5 m deep	wood	Taylor 1988
2945	55	3116	2991-3240	SI1068	2-warp sandal, top level at rear, 0-.5 m deep	Hesperaloe	Taylor 1988
3125	55	3342	3279-3405	SI1144	Worked sticks, top level at back, 0.5 m deep	wood	Taylor 1988
3180	110	3403	3258-3547	SI1139	Pointed wood, top level, center 0.25-.5 m deep	wood	Taylor 1988
3200	250	3420	3103-3736	M193	Miscellaneous wood fragments, top level	wood	Crane & Griffin 1958, Taylor 1956
3310	55	3549	3482-3615	SI1140	Worked wood, lower top level at center, .5-1 m	wood	Taylor 1988
3445	60	3724	3640-3808	SI1141	Cut wood, top level at center	wood	Taylor 1988
3495	60	3776	3702-3848	SI1065	2-warp sandal, upper top levelcenter 0-.25 m deep	Hesperaloe	Taylor 1988
3590	50	3904	3841-3966	SI1062	2-warp sandal, upper bottom level	Hesperaloe	Taylor 1988
3610	60	3938	3854-4021	SI1064	2-warp sandal, top level at center 25 cm deep	Hesperaloe	Taylor 1988
3665	75	4007	3904-4109	SI1137	Pointed piece of wood, upper top level 0-25 cm	Hesperaloe	Taylor 1988
3710	100	4077	3932-4221	SI1147	Pointed stick, mid-level in passage, 0.5-1m deep	wood	Taylor 1988
3780	50	4166	4090-4241	SI1058	2-warp sandal, lower middle level at front, 1-1.5 m	Hesperaloe	Taylor 1988
3815	85	4225	4095-4355	SI1138	Worked wood, top level at center, .25-.5 m deep	wood	Taylor 1988
3825	90	4235	4101-4369	SI1136	Pointed stick, top level at center, .25-.5 m deep	wood	Taylor 1988
3840	80	4256	4136-4375	SI1072	2-warp sandal, bottom level rear 0-.25 m deep	Hesperaloe	Taylor 1988
4225	75	4742	4637-4846	SI1061	2-warp sandal, lower bottom level center	Hesperaloe	Taylor 1988
4380	85	5046	4892-5199	SI1069	2-warp sandal, bottom of passage	Hesperaloe	Taylor 1988
4530	140	5194	4988-5399	SI1088	Rope fragment, burial 1, bottom level below 1 m	Yucca	Taylor 1988
4600	65	5285	5136-5434	SI1067	2-warp sandal, mid-level rear .5-1 m deep	Hesperaloe	Taylor 1988
4665	55	5412	5341-5482	SI1070	2-warp sandal, lower mid-level, passage	Hesperaloe	Taylor 1988
5070	90	5809	5712-5905	SI1145	Cut wood, bottom level, rear passage below 1 m	wood	Taylor 1988
5690	70	6499	6413-6584	SI1146	Cut wood, lower mid-level, passage, 1-1.5 m deep	wood	Taylor 1988
6130	105	7018	6882-7154	SI1066	2-warp sandal, between 1 m deep and roof spall	Hesperaloe	Taylor 1988

Table 3. Inventory of Northern Mexican Radiocarbon Assays. (*Continued*)

C14	SD	Cal. BP	68% Prob	Lab No.	Associations	Material	Citation
7050	70	7875	7807-7942	SI1057	Human feces, upper of bottom level, front, 1.5-2 m	feces	Taylor 1988
7380	75	8199	8096-8302	Si1143	Atlatl fragment, mid-level at back, .5-1 m deep	wood	Taylor 1988
7770	125	8628	8461-8795	SI1135	Unworked piece of wood, 2-2.5 m deep	wood	Taylor 1988
7795	120	8661	8483-8839	SI1142	Worked piece of wood, on floor atop spall 1-1.5m	wood	Taylor 1988
9215	85	10400	10295-10504	SI1026	Pointed wood, bottom, on floor at front, 2 m deep	wood	Taylor 1988
9300	400	10558	9998-11117	M192b	Wood fragment,middle level	wood	Crane & Griffin 1958, Taylor 1956
9540	550	10600	10190-11802	M192a	Miscellaneous wood fragments, top level	wood	Crane & Griffin 1958, Taylor 1956
Cueva Ahumada							
3820	90	4229	4094-4363	TX573	Level 20b 200-210cm bs	charcoal	Radiocarbon 12(1); Epstein 1972
4440	90	5089	4936-5242	TX572	Level 20a 200-210cm bs	charcoal	Radiocarbon 12(1); Epstein 1972
4480	90	5124	4981-5266	TX574	Level 21a 210-220cm bs	charcoal	Radiocarbon 12(1); Epstein 1972
4520	90	5162	5023-5300	TX576	Level 22 220-230cm bs	charcoal	Radiocarbon 12(1); Epstein 1972
4650	100	5341	5170-5512	TX575	Level 21B 210-220cm bs	charcoal	Radiocarbon 12(1); Epstein 1972
La Calsada							
580	60	594	549-639	TX707	Unit 1-2 Level 2 20-30cm	charcoal	Radiocarbon 12(2); Nance 1971
1050	80	964	870-1078	TX706	Unit 1-2 Level 3 30-40cm; arrow points	charcoal	Radiocarbon 12(2); Nance 1971
4310	90	4895	4752-5037	TX708	Unit 3 Level 9 90-100cm	charcoal	Radiocarbon 12(2); Nance 1971
4400	90	5061	4905-5217	TX709	Unit 3 Level 8 110-120cm	charcoal	Radiocarbon 12(2); Nance 1971
4460	120	5106	4937-5275	TX765	Unit 4 Level 2 130-140cm	charcoal	Radiocarbon 12(2); Nance 1971
4790	90	5492	5381-5602	TX764	Unit 4 Level 3 130-140cm	charcoal	Radiocarbon 12(2); Nance 1971
5400	100	6164	6046-6281	TX710	Unit 3 Level 9 120-130cm bs	charcoal	Radiocarbon 12(2); Nance 1971
5710	120	6520	6392-6647	TX711	Unit 4 Level 1 120-130cm bs	charcoal	Radiocarbon 12(2); Nance 1971
5940	160	6791	6590-6992	TX768	Unit 4 Level 2 110-120cm bs	charcoal	Radiocarbon 12(2); Nance 1971
6520	150	7417	7286-7547	TX767	Unit 4 Level 4 140-150cm bs	charcoal	Radiocarbon 12(2); Nance 1971
7040	180	7880	7712-8047	TX769	Unit 5 Level 2 140-150cm bs	charcoal	Radiocarbon 12(2); Nance 1971
7920	190	8804	8570-9037	TX354	Unit 5 Level 2 150-160cm	charcoal	Radiocarbon 12(2); Nance 1971
7990	130	8854	8676-9031	TX766	Unit 5 Level 2 160-170cm bs	charcoal	Radiocarbon 12(2); Nance 1971
8610	100	9645	9533-9757	TX771	Unit 5 Level 7 190-200cm bs	charcoal	Radiocarbon 12(2); Nance 1971
9270	150	10494	10306-10681	TX353	Unit 5 Level 7 200-210cm	charcoal	Radiocarbon 12(2); Nance 1971
9310	160	10557	10333-10780	TX770	Unit 5 Level 5 200-210cm	charcoal	Radiocarbon 12(2); Nance 1971

Table 3. Inventory of Northern Mexican Radiocarbon Assays. (*Continued*)

C14	SD	Cal. BP	68% Prob	Lab No.	Associations	Material	Citation
9550	130	10692	10642-11085	TX895	Unit 6 Level 12-13 300-320cm; Lerma	charcoal	Radiocarbon 12(2); Nance 1971
9670	70	11016	10868-11164	TX772	Unit 6 Level 2 220-230cm; Lerma	charcoal	Radiocarbon 12(2); Nance 1971
9940	150	11510	11270-11750	TX352	Unit 6 Level 2 230-240cm; Lerma	charcoal	Radiocarbon 12(2); Nance 1971
10640	210	12461	12171-12750	TX875	Unit 6 Level 5-6 250-270cm; Lerma	charcoal	Radiocarbon 12(2); Nance 1971
La Morita							
9230	45	10,400	10250-10518	OXa17377	Level V (lowest in site), fossil horse teeth	charcoal	Valadez & Carpinteyro 2011
8935	66	10,170	9943-10170	A?	Level IV, Folsom	charcoal	Valadez & Carpinteyro 2011
Cueva de la Zona							
1290	15	1235	1199-1271	K149827	Adult female with serrated teeth	bone	
1370	15	1298	1293-1303	K149828	Young adult male	bone	
845	115	798	699-896	TX205	Level 5; 1-1.25ft; Toyah; Fresno; Starr	charcoal	Radiocarbon 7; McClurkan 1966
980	130	911	779-1043	TX204	Level 3 .5-.75ft; Toyah; Fresno; Starr	charcoal	Radiocarbon 7; McClurkan 1966
1165	75	1096	1005-1186	TX144	Level 6 1.25-1.5ft; Ensor; arrow points	charcoal	Radiocarbon 7; McClurkan 1966
1410	130	1329	1192-1466	TX207	Level 9; 2-2.25ft; terminal Shumla dart points	charcoal	Radiocarbon 7; McClurkan 1966
1670	110	1581	1451-1710	TX206	Level 8; 1.75-2ft; side-notched points	charcoal	Radiocarbon 7; McClurkan 1966
1990	140	1960	1788-2132	TX209	Level 11; 2.5-2.75ft; Shumla dart points	charcoal	Radiocarbon 7; McClurkan 1966
2100	100	2109	1968-2250	TX147	Level 14 3.2.5-3.5ft; Tortugas	charcoal	Radiocarbon 7; McClurkan 1966
2160	100	2150	2031-2287	TX208	Level 10; 2.25-2.5ft; terminal Shumla	charcoal	Radiocarbon 7; McClurkan 1966
2320	90	2371	2211-2531	TX145	Level 12 2.75-3.ft; Shumla maximum	charcoal	Radiocarbon 7;McClurkan 1966
2470	140	2543	2381-2704	TX146	Level 13; 3-3.25ft; Shumla	charcoal	Radiocarbon 7; McClurkan 1966
2920	130	3089	2921-3256	TX148	Level 15 3.5-3.75ft; Shumla l; Tortugas	charcoal	Radiocarbon 7; McClurkan 1966
3130	140	3324	3145-3502	TX149	Level 17 4.25-4.5ft; Shumla I; Tortugas	charcoal	Radiocarbon 7; McClurkan 1966
4700	120	5406	5254-5557	TX236	Occupation layer 1; beneath 5ft gravel bed	charcoal	Radiocarbon 8; McClurkan 1966
4755	110	5470	5352-5587	TX237	Occupation layer 2; beneath 5ft gravel bed	charcoal	Radiocarbon 8; Epstein 1972
4840	220	5560	5924-5826	TX150	Levels 21 22 5-5.5ft; small lanceolates	charcoal	Radiocarbon 7; McClurkan 1966
4880	120	5628	5487-5769	TX254	Occupation layer 1 beneath 5ft gravel bed	charcoal	Radiocarbon 8; Epstein 1972
4950	160	5699	5520-5877	TX235	Occupation layer 3 below 5ft gravel bed	charcoal	Radiocarbon 8; Epstein 1972

Table 3. Inventory of Northern Mexican Radiocarbon Assays. (*Continued*)

C14	SD	Cal. BP	68% Prob	Lab No.	Associations	Material	Citation
Las Casitas							
380	40	419	349-488	TX8312	Hearth assoc. with subterranean houses	charcoal	Turpin et al. 1997
430	50	444	372-515	TX8311	Hearth assoc. with subterranean houses	charcoal	Turpin et al. 1997
Los Remotos							
1960	50	1949	1864-1973	TX8054	Feature 3, surface hearth	charcoal	Turpin & Cummings 2011
2470	50	2533	2438-2673	TX8053	Feature 2, 40 cmbs	charcoal	Turpin & Cummings 2011
3010	60	3207	3108-3305	TX8120	Feature 4, surface hearth	charcoal	Turpin & Cummings 2011
3760	80	4075	4035-4217	TX8052	Feature 1, hearth 1.1 mbs	charcoal	Turpin & Cummings 2011
Boca de Potrerillos							
720	60	701	665-737	TX7466	Hearth 4, 10 cm bs	charcoal	Turpin et al. 1994
1120	60	1052	979-1124	TX7456	Hearth 2, 1.5 m bs	charcoal	Turpin et al. 1994
1150	50	1074	1003-1145	TX8049	Hearth, Promontory, 3.4 m bs	charcoal	Turpin et al. 1994
1210	50	1151	1079-1222	TX8050	Hearth, Promontory, 3.0 m bs	charcoal	Turpin et al. 1994
1270	60	1192	1121-1263	TX7437	Hearth, 2.5 m bs	charcoal	Turpin et al. 1994
1300	50	1232	1184-1279	TX8047	Hearth, Promontory, 4.0 m bs	charcoal	Turpin et al. 1994
1380	60	1301	1255-1347	TX7455	Hearth 3, 2.5 m bs	charcoal	Turpin et al. 1994
1510	50	1420	1355-1485	TX7296	Humates, Profile 1, cutbank	soil	Turpin et al. 1994
2490	50	2578	2471-2684	TX7933	Humates, cutbank	soil	Turpin et al. 1994
270	40	359	297-420	TX7913	Surface hearth 3, Coconos	charcoal	Turpin et al. 1994
4300	60	4899	4837-4960	TX8051	Surface hearth 6, Coconos	charcoal	Turpin et al. 1994
4620	70	5308	5165-5450	TX8048	Surface hearth 5, Coconos	charcoal	Turpin et al. 1994
4780	60	5486	5394-5578	TX7911	Hearth 1, .4 m bs, Coconos	charcoal	Turpin et al. 1994
6930	70	7775	7703-7847	TX7912	Hearth 2, .8 m bs, Coconos	charcoal	Turpin et al. 1994
230	40	232	156-308	TX8257	Hearth 5, Loma San Pedro	charcoal	Valadez et al. 1998
950	50	841	806-916	TX8256	Hearth 6, Loma San Pedro	charcoal	Valadez et al. 1998
1570	50	1465	1412-1518		Hearth 1, Loma San Pedro	charcoal	Valadez et al. 1998
4910	50	5658	5612-5704		Hearth 2, Loma San Pedro	charcoal	Valadez et al. 1998
5190	60	5978	5907-6049		Hearth 3, Loma San Pedro	charcoal	Valadez et al. 1998
6960	60	7790	7728-7869		Hearth 4, Loma San Pedro	charcoal	Valadez et al. 1998

B-Beta Analytic, M-Michigan, OX+A109-Oxford, S-Smithsonion, TX-Texas, UCL-Livermore; Blanks indicate missing data.

lowest levels (Crane and Griffin 1958:1104, Taylor 1956). Much later, Dr. James Adovasio submitted the listed samples from Frightful, Nopal/Fat Burro, Coyote and CM79 caves to the Smithsonian in time for Taylor to include them in his 1988 treatise on sandals and sandal typology. Much later, peyote from the burial cave CM79 was dated along with samples from Texas by Terry et al. (2005).

Subsequently, the chronology was augmented by a series of dates from Cueva Encantada (Turpin 1997), Boca de Potrerillos (Turpin et al. 1993, 1994, 1995), Cueva Pilote (Turpin and Eling 1997), and other smaller localities like Los Remotos (Turpin and Cummings 2011) and Las Casitas (Turpin et al. 1999) (Figure 2). These sites, most especially Boca, produced various data that contributed to

Figure 2. Map of Nuevo León and Coahuila showing locations of the most significant sites. (drawn by Brenda Cristán)

paleoenvironmental reconstruction. The largest and most detailed geo-environmental study followed in Karl Butzer's Laguna Project. Only three of the 163 assays analyzed by Butzer incidentally included archeological material; the rest provided the context for his wide-ranging geomorphological study of southwestern Coahuila (Butzer et al. 2008).

Chronological reconstructions began when Taylor (1966) divided Coahuila into four "congeries of traits" that he called the Ciénagas, Coahuila, Jora, and Mayran complexes. These are temporally very general periods but they were placed in a rough sequence beginning with Ciénagas—the earliest and probable equivalent of the Paleoindian period; then the Coahuila complex which absorbs what is generally called the Archaic; followed by the Jora complex, otherwise known as the Late Prehistoric period. The Mayran complex encompassed the mortuary sites and practices (Taylor 1966). In these early days, Taylor lacked chronological data points that would fix his complexes in time but he was able to generate a number of theoretical concepts based on his grasp of the broader cultural mosaic of Coahuila (see Taylor 1964, 1966).

Later researchers divided their local chronologies by stratigraphic levels, tool types, and radiocarbon assays (Nance 1971; McClurkan 1966), Nance defined five periods—I through V- at La Calsada; McClurkan's stratigraphy was truncated but he also used five periods, also numbering them from bottom to top. A hypothetical cultural sequence sees the Paleoindian period—Taylor's Ciénagas Complex—beginning around 10,600 years ago and trending into the Archaic–Taylor's Coahuila Complex–ca. 7000 BP. Artificial divisions of the Archaic into Early (7000-5000 B.P.), Middle (5000-3700 BP) and Late (3700-1000 B.P.) segue into Taylor's Jora Complex which is roughly equivalent to the Late Prehistoric period in Texas. A probable age of 1200 B.P. until the time of Spanish contact also absorbs the Mayran Complex which solely refers to a mortuary concept based on cave repositories such as Cueva de la Candelaria and other sites with bundled—sometimes mummified—burials (Aveleyra et al. 1964).

With the exception of two ambiguous Candelaria dates and two recent findings from La Morita II, the assays listed in the following table were generated by Americans for American funded studies in a wide variety of facilities—Texas (TX), Michigan (M), the Smithsonian (SI), Oxford (OS or OxA), Keck-UCI (K), Uppsala (Ua) and Beta Analytic (B). It should be noted that the listed ages are the conventional dates, some of which were corrected and others were not. For instance, correction factors were estimated and applied to the Smithsonian sequence from Frightful Cave but no such adjustments were made to the La Calsada dates. For the sake of consistency, the on-line calibration program Calpal was used to adjust the entries to a statistically probable calendric age, keeping in mind that the older series have not been corrected for material type.

In addition, Araceli Rivera Estrada of INAH-Nuevo León obtained 43 radiocarbon dates on sites in southern Nuevo León from the INAH laboratory. All remain unpublished and—although we have the list—the details of the site types and internal provenience are lacking. Colleague Moises Valadez Moreno has four dates from La Morita II, two of which are among the most ancient yet recorded in Nuevo León. The lowest level (V) produced a date of 9230±45 (OxA-17377) which when calibrated has a 95.4 percent probability of falling between 8303 and 8568 B.C. or 10,400 B.P. Corroboration is provided by a date from level IV, credited to Vance Holliday at Arizona, 8935+66 B.P. with a 68.4 percent probability range between 9943 and 10,170 B.P. or 10,057 B.P. Valadez also has three more samples from Cueva Ahumada being processed at the INAH lab. This inventory can be expanded at any time to include any relevant dates that researchers can contribute as this chronology is an evolving construct.

Two relatively recent Candelaria dates were cited in confusing fashion (Pineda et al. 2009; Hucher et al. 2013) but we were unable to gain clarification from the authors or Oxford. Pineda (et al. 2009:280) state "a bone retrieved from the cave range (sic) from 1100 to 1300 A.D. and the skull…" was dated 1020+28 B.P." Hucher (et al. 2013), citing Pineda, thinks the radiocarbon dates "indicates that the funerary deposits are considerably more ancient (A.D. 940 ± 24 and 1020 ± 28)." Whether the dates are A.D. or B.P., they do not drastically contradict the earlier two samples run at the Texas lab. In order to partially resolve the questions about the age of this mortuary cave, we submitted a few loose remnants of a folded textile from Candelaria which is tagged "sent by Aveleyra to AK" (Alex Krieger), from Mexico City in 1950 and is still curated at the University of Texas (Figure 3). The result was 950±30 BP which is about 200 years later than the two run in 1964 and relatively close to the cited dates whether A.D. or B.P.

Figure 3. Textile from Candelaria Cave (courtesy of the Texas Archeological Research Laboratory)

A few notes about the sites will help provide a context for their local sequences. The largest inventories came from Frightful Cave (37), La Calsada (20) and Boca de Potrerillos (20). La Calsada reached back around 10,000 B.P. as did La Morita II (Valadez 2008, 2011; Valadez and Espinosa 2011). Boca was not far ahead, with two areas ca. 7800 B.P. which is somewhat surprising given that all the samples were taken from surface hearths or those exposed in the arroyo walls by erosive down-cutting. The site is huge and was divided into four areas: the main Arroyo, Promontory, Coconos, and Loma San Pedro—the <7800 B.P age was confirmed at the latter two. The Frightful Cave sequence is based on a series of 34 samples submitted by Adovasio but reported by Taylor (1988) in what he planned to be the first of several volumes on the Coahuila project. The radiocarbon section also includes smaller sites in the same area but unfortunately the inventory for Fat Burro is duplicated for Nopal Cave. A major discrepancy between two dates run on what is described as a sandal on the foot of a mummy in a bundle that was unwrapped by Taylor (1968) may soon be resolved by analysis currently in progress. That mummy bundle came from Coyote Cave, also in the Cuatro Ciénagas Basin.

NEMAP provided the data used by Nance (1971) in his doctoral dissertation on La Calsada, by Heartfield (1976) in her dissertation on material from the Laguna district, by McClurkan (1966) in his thesis on Cueva de la Zona, and by Varner (1967) in his thesis on open sites recorded in their survey of Coahuila. Cueva Ahumada was never fully reported but Epstein (1972) listed the radiocarbon assays. He made a major mistake when transferring the raw data to calendrics, converting TX573 from 3820 B.P. to 1070 B.C. which is some 800 years too young. He then considered TX573 as aberrant and concentrated on the other four dates which range from 4440 to 4650 B.P. (uncalibrated). Since NEMAP's excavations at Cueva Ahumada were only partly reported, INAH-Nuevo León carried out further work there in 1997, adding three dates that we were unable to verify.

Some of the assays were run for specific purposes—such as the peyote button from CM79—and say little about the regional chronology. The El Fuste series refers to a private collection of fiber artifacts, mostly sandals, from different sites in the Sierra El Fuste, near Ocampo (Turpin et al. 1993). Las Casitas is a village of subterranean houses dug into the desert floor near Boca de Potrerillos, much like other sites in the vicinity such as California and Las Ovejas (Turpin et al. 1997). The *subterraneos* still in use would make an interesting study in the effects of poverty on house types.

Open sites are generally hearth fields, some with subsurface components. The most productive is Boca de Potrerillos, declared a national monument because of hundreds if not thousands of petroglyphs and hearths exposed by erosion that range in age from 270 to 7800 calB.P. Different parts of the site produced different information, with Coconos, the oldest area, differentiated by the number of incised pebbles found on the surface. The area called Loma San Pedro also contained incised stones but in a different style. In the so-called Promontory, the cutbank of the arroyo demonstrated a benign climate between 1150 and 1380 B.P., in contrast to the erosion that ripped a broad canyon through the site before and after the clement interval. A very similar but much smaller site, Los Remotos, was also dated by charcoal collected from hearths exposed by headward erosion and downcutting of its dendritic arroyo (Turpin and Cummings 2011).

Although many of the radiocarbon assays were done to date specific objects or classes of artifacts—like sandals or bundled burials—others may provide the basis for regional typologies and chronology. However, taken in composite, some of the series suggest lines of inquiry that might resolve issues in regional prehistory. When placed in chronological order, this admittedly biased sample of dates identifies periods in prehistory that merit further investigation. Six calibrated dates from La Calsada, La Morita II and Frightful are over 10,000 years old, thus presumably in Taylor's Ciénagas Complex, and equating to the Bonfire (Folsom) period in the Lower Pecos. A Clovis projectile point found by the authors near the Coahuila-Chihuahua border testifies to an earlier presence, still in the Ciénagas Complex but also consistent with Dibble's Aurora subperiod (Figure 4).

Clues to the climatic history of the region are found at Boca de Potrerillos, Cueva Encantada, Cueva de la Zona, and La Calsada. All of these evidence major events that transpired around 4000-5000 years ago. The absence of perishable artifacts and the presence of a travertine flow at Cueva Encantada can be attributed to water saturating the cave sometime around 4000 B.P. McClurkan (1966) encountered five ft of gravel that was apparently deposited in Cueva de la Zona after 3130 and before 4700 B.P. Nance (1972) noted what he interpreted as evidence for the Altithermal between his units 3 (4310-5400 B.P.) and 4 (4460-6520 BP) at La Calsada. The various areas that experienced differential erosion at Boca de Potrerillos indicate a clement climatic interval between 1100 and 1300 BP preceded by a massive erosional event ca. 4800 BP (Turpin et al. 1994). Butzer (et al. 2008) presents an in-depth geomorphological analysis of a section of Coahuila that includes Saltillo and extends to Torreón. He posits a cycle of "wet years" based on 40 stratigraphic profiles, ^{14}C, and OSL dates. Clearly, the environmental trajectory of these now-arid lands is of critical importance to understanding their cultural evolution of the people that lived there.

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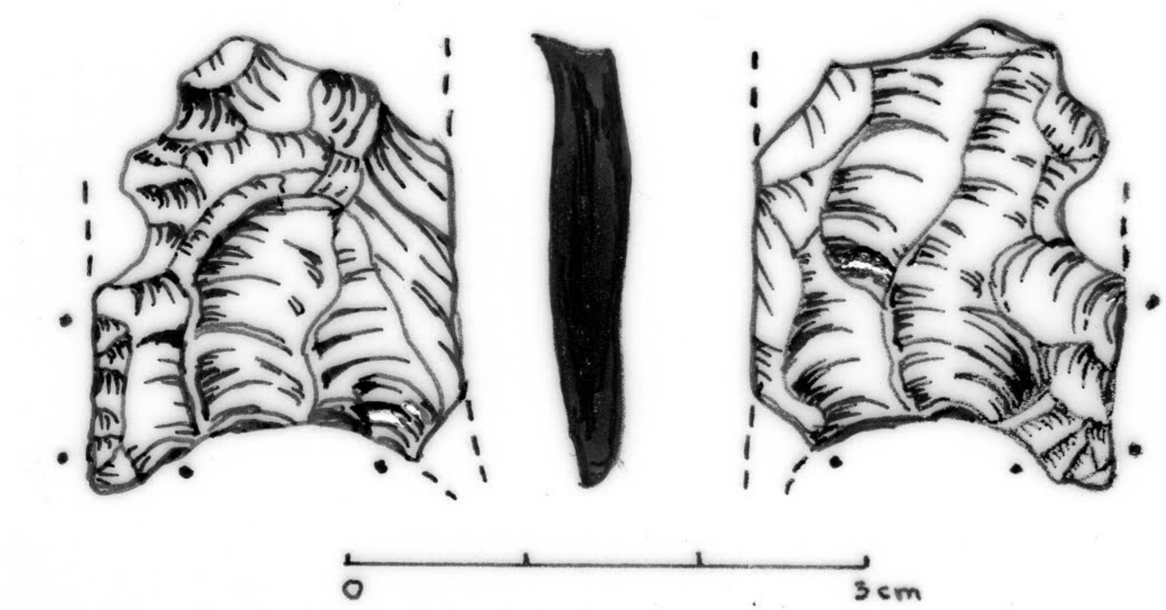

Figure 4. Clovis point from the Chihuahua-Coahuila border region.

Oxford labs were contacted for information that would clarify discrepancies or fill in some missing data, none of them replied. Our thanks to Billy Turner for refining the map of the Lower Pecos, and to Brenda Cristán for drawing the location map of Northern Mexico, and to Lee Bement for his comments.

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Conservation of Fiber Sandals from Conejo Shelter, Texas

Elanor Sonderman

This article concerns the exploratory conservation analysis of nine previously treated fiber sandals from the perishable artifact assemblage of Conejo Shelter. Sandals that were likely treated in the field during initial excavations in 1967 and 1968 had become brittle, discolored, and unnaturally glossy. These specimens were assessed to determine the original treatment procedures. Efforts were taken to remove or reverse the negative effects of the initial treatment and re-treat the artifacts according to modern conservation standards.

Research Background

Site Setting

Conejo Shelter (41VV162) is among the many dry rockshelters that riddle the Lower Pecos. The shelter sits on a high bluff overlooking a tributary canyon of the Rio Grande, about 0.5 miles north of the confluence of the Rio Grande and Pecos Rivers. Testing and excavation at Conejo took place during mitigation work by the Texas Archeological Salvage Program (TASP) preceding the inundation of Amistad Reservoir. Over the field seasons of 1967 and 1968, a number of test pits and a 20 x 25 ft. excavation block produced hundreds of fiber artifacts (as well as lithic artifacts, animal bone, plant remains, and coprolites). Very short reports on the initial archeological discovery and testing of the site are in Graham and Davis (1958) and the TASP overall report for the 1967 field season (Collins 1969). Robert Alexander, who led the main portion of the site excavations, wrote his dissertation on the dietary component of the site, evaluating whether the cultural stasis model proposed for the region's lithic technology could be applied to diet as well (Alexander 1974). Hundreds of perishable artifacts including sandals, basket fragments, net fragments, and cordage were recovered. Beyond simple inventory, little analysis of these materials has been conducted.

Initial Conservation

Following the initial analysis for his dissertation, Alexander took much of the assemblage with him on his post-graduate endeavors hoping to complete a full site report for the Conejo Shelter work. Unfortunately, this never happened. Portions of the assemblage were returned to the Texas Archeological Research Laboratory (TARL) piecemeal between the years of the excavation and the mid-1990s, when the last few artifacts were relinquished by Alexander (Site files and correspondence, TARL). The entire collection is now stored at TARL and has undergone a remarkable re-housing process so that all of the materials are in curation quality storage. The majority of the sandal assemblage is intact and well preserved. A few specimens, however, were in particularly poor shape. With appropriate permissions from Amistad National Recreation Area and TARL, I began an assessment of 10 sandals and a mat fragment to determine the best procedures for ensuring that these artifacts did not degrade any further. Nine sandals from the assemblage exhibited signs of previous, but poorly executed, conservation treatment. Through examination of these artifacts, some testing, and expert opinion, it was determined that the likely previous treatment was an inappropriately viscous solution of polyvinyl acetate and acetone (PVA) (Donny Hamilton, personal communication, 2016). While this treatment is a fairly common conservation practice, the quality of the results is highly dependent on viscosity of the solution and the method of application (Hamilton 1998; Hamilton and Bratten 2001; Norton 1990). Fortunately, treatment with PVA is largely reversible (Hamilton 1998). Under the guidance of Donny Hamilton from the Conservation Research Lab at Texas A&M (CRL), I developed a procedure to re-treat the sandals to bring them to a more stable condition and more natural appearance.

Conservation Considerations

As with all conservation procedures, anything that we do to an artifact changes it in some way (Norton 1990). With this in mind, developing treatment procedures and justifying their necessity is critical. In the case of fiber artifacts from dry sites like Conejo Shelter and much of the Lower Pecos, the best treatment is to do nothing. The perennially dry sediments in many of the high shelters in the region allow the fiber artifacts to desiccate slowly, preserving them in situ. Of course, during excavation, the micro-environments surrounding the artifacts change, introducing the potential for deterioration (Helen Dewolf, personal communication, 2017). In most cases, maintaining very stable environmental conditions (cool temperatures and low and non-fluctuating relative humidity) are sufficient to maintain the condition of fiber artifacts (Norton 1990; Hamilton 1998).

It is likely that the sandals that were field treated were exceptionally fragile and could not be removed from the shelter sediments without some initial consolidation. Field consolidation is often, understandably, less carefully implemented than in the lab. All of the sandals had an unnaturally glossy appearance, some even showing visible clumps of resin. Several of these were also uncharacteristically dark. Some degree of darkening and surface gloss are fairly common problems during artifact consolidation. These effects are typically a result of too-rapid evaporation of the solvent, too high resin viscosity, or the application of too much consolidant (Norton 1990). The discoloration seen in a few of the sandals extended beyond what might be expected from overly hasty field conservation. At some point, after excavation, a number of these sandals were water damaged, as noted in the records at TARL. Water is not one of the many solvents for PVA and thus could have caused additional damage to the artifacts. The extent of the water damage is not known but is potentially the cause of the blackened surfaces of some of the affected sandals. Because the sandals were in poor physical condition and had such unnatural color and sheen, a decision was made to move forward with new conservation treatment. It was important to develop procedures that would be reversible with the recognition that even the removal of a treatment would impact the artifact in some way.

Conservation Procedures

During assessment and re-treatment, the sandals were kept in curation-grade bags and boxes in the climate controlled CRL in the Anthropology Building at Texas A&M University. Prior to any treatment, all sandals were photographed and current condition was documented. Each sandal had a particular set of conservation-related issues, but they were consistent enough to create a general plan of treatment. Despite the previous conservation treatment, all of the sandals were still very brittle. The artifact bags with the sandals all had several small fiber fragments that had broken off from the main body of the artifact. These fragments were targeted for solvent testing.

These fragments were placed in dishes with just enough acetone, ethanol, or acetone + toluene to cover them. Solvents were allowed to evaporate. Residues left behind on the dish indicated the effectiveness of the solvent in removing prior treatment from the fragment. After testing, each sample was photographed and its condition recorded. Testing confirmed that the sandals had been treated with PVA. For most of the tests, each of the solvents were equally effective at removal of the previously applied resin. The testing dishes showed significant removed residues from the fiber fragments (Figure 1). In some cases, the addition of toluene caused color to leach from the sample, so this solvent was not used in additional procedures. In the case of PVA, both ethanol and acetone are suitable solvents. Ethanol is more commonly used in the field because it evaporates more slowly than acetone. Either solvent can be used to remove excess PVA, regardless of which solvent was used in the original solution.

Following testing, the sandals were treated based on their condition. Three of the nine sandals were relatively stable and intact. These were fully submerged for five minutes in a very dilute (approximately 5 percent) solution of acetone and paraloid (also acryloid) B-72. The decision to use B-72 over PVA was largely a matter of convenience as it is the standard consolidant glue used at the CRL. The difference between PVA and B-72 is negligible; both are dissolved by acetone and ethanol. Generally, B-72 has the advantage of drying with less gloss than PVA and holds up better in less than ideal curatorial conditions. Sandals were dipped in

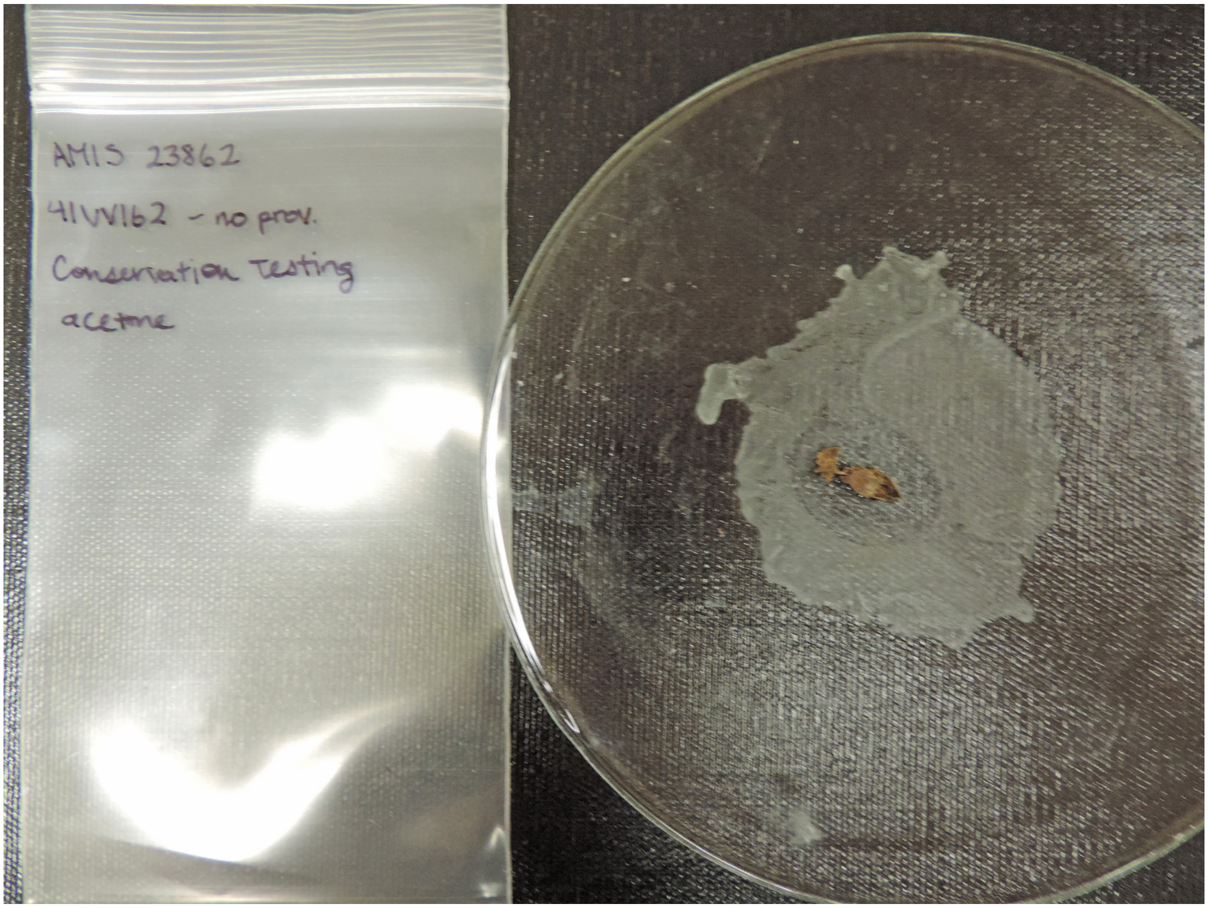

Figure 1. Residues removed during sample testing.

acetone to remove any excess B-72 clinging to the surface and then allowed to dry. Some spot treatments of additional acetone were applied with a paintbrush where previously applied consolidants were particularly thick.

The remaining six sandals required different treatments. Among these, five had been marked as being water-damaged so a variation of the above procedures was used. The water-damaged sandals were very discolored, almost black. One of the sandals (AMIS 23865) was selected for one additional step to test if any foreign materials had adhered to the sandal causing the discoloration. Dr. Chris Dostal conducted an X-ray fluorescence analysis of the sandal. No unexpected elements were identified. This supported the initial assumption that the discoloration was a result of the water damage and not adherence of a foreign substance. The sandals were wrapped in a fine, micro fiber cloth and submerged first in a bath of acetone for five minutes to remove the heavily applied consolidant and some of the discoloration (Figure 2a-b). The cloth wrapping ensured that any pieces that fell off the sandal during re-treatment would remain in place. Sandals were removed from the acetone, allowing the excess acetone to run off. While the sandal was still wet, it was submerged (still wrapped in the cloth) in a 5 percent solution of acetone and B-72. Following two trials with sinking the sandal into the solution, pouring the solution over the sandal was determined to be a better procedure. This new method was more effective at consolidating the full body of the sandal without applying pressure to the artifact during submersion. Sandals soaked in the solution for about one minute, were removed, and allowed to dry. Spot treatments were implemented where there was excess consolidant.

Figure 2a. Adjusted conservation procedure, sandal wrapped in micro-fiber cloth.

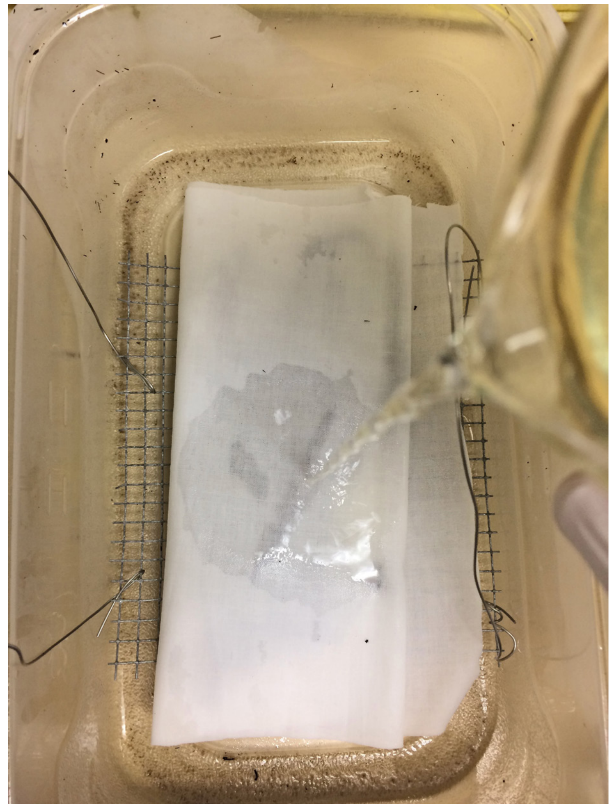

Figure 2b. Adjusted conservation procedure, sandal wrapped in micro-fiber cloth.

Figure 3. AMIS 23769 before and after new treatment.

Figure 4. AMIS 23768 before and after new treatment.

Figure 5. AMIS 23865 before and after new treatment.

Results and Conclusions

The procedures implemented during this project were, for the most part, very effective at removal of previous treatments. Sandals that were overly glossy and not additionally water damaged were returned to a state that much more closely resembles the untreated sandals from the site. Excess consolidant was removed without disrupting the integrity of the artifact. Discoloration was reduced for most of the sandals that were water damaged. These treatments, however, were not able to completely return the artifacts to a more natural-looking state. The fibers are still quite dark, but the gloss on them was significantly reduced. Figures 3-5 show select sandals before and after treatment.

This experimental conservation analysis was conducted to test the potential for reversal of certain conservation treatments. It was fortunate that the previous treatments on these sandals used polyvinyl-acetate (PVA) rather than a more permanent resin, such as a lacquer. Acetone and ethanol were both effective in removing the majority of the previously applied PVA. The overall goals of the project were achieved, as I was able to determine the nature of previous treatments and some strides were made toward returning the sandals to a more natural-looking state.

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The Curbo Biface Cache in Hill County, Texas

Harry J. Shafer, Charles Boyd, and David L. Carlson

The Curbo biface cache consists of 60 Stage 3 reduction bifaces, all but one is Edwards chert visibly sourced to western Bell or Williamson counties. The cache was found by a farmer in a peanut field in Hill County, Texas. The cache was an isolated find in a location outside of any known habitation site context. The cache and a selection of bifaces are described. Precise chronological placement of the cache is undetermined; however, the size of the bifaces suggests either they are Paleoindian or Archaic in age, and we argue that they are most likely Archaic. We further suggest that the cache was made by highly mobile groups, and a likely period of time was the Bell/Andice/Calf Creek interval. The chert type and the geographical location of the find suggest transporting raw materials by groups following migratory movements of game or for exchange from one chert-rich production region to a chert-impoverished consumption region. A sample of 40 of the bifaces is compared to the Stillman Pit cache, a Calf Creek component cache in Oklahoma. The biface assemblages in the two caches are similar in width and thickness but the Curbo cache is more variable in length. The comparison does not negate the suggested temporal placement of the Curbo cache in the Andice-Bell-Calf Creek interval.

The mobility of hunting and gathering groups necessitated the transporting of raw materials from one region to another either for use along the way or as items of trade. Caching was one way of banking the raw materials for retrieval for use or exchange. This article reports on a large cache of 60 Stage 3 bifaces of Edwards chert recovered along the Little Aquilla Creek valley in Hill county (Figure 1). All but one specimen is of chert that is visibly sourced to an area along the upper reaches of Buttermilk Creek in the vicinity of the Gault site in western Bell and Williamson counties, Texas.

It is not the purpose here to review caches, their functions, or cache behavior, but rather to report the Curbo Cache as yet another example of the movement of raw material among hunters and gatherers in a partially reduced state. We will, however, advance our thoughts on why it was left in the prairie along Little Aquilla Creek. Previous reported caches in Texas include publications by Bartlett (1994), Chandler and Kumpe (1996), Galan (2007), Hester and Green (1972), Hester and Calame (2003), Lintz and Saner (2002), Miller (1993), Shafer and Green (2008), Shafer and Walters (2010, 2011), Shafer et al. (2012), Tunnell (1978), and Waters and Jenkins (2015), among others. Caches also were left as votive offerings in burials in Central Texas (Bement 1994:67-70) and the south-central part of the state at the Loma Sandia (Taylor and Highley 1995) and Silo (Lovata 1997) sites.

The Curbo Cache

Little is known about the actual discovery of the cache but the find was made by the Curbo brothers in a peanut field in the Little Aquilla Creek watershed west of Hillsboro in Hill County. The cache was not associated with any known archeological site or apparent feature other than the cache itself. The bifaces were reportedly "stacked" vertically. Half of the collection of 60 bifaces was loaned to Dr. Charles Boyd by Mike Callaway and Earl Crow, who took them to the Texas A&M University Department of Anthropology for study. The bifaces were photographed by the senior author and drawn by Lynn O'Kelley. O'Kelley also measured the bifaces. Selected examples of the bifaces are shown in Figures 2-5, and Figure 6 is O'Kelly's drawings. Unfortunately, the bifaces were not available for further inspection at the time of this writing and only a sample of the 60 bifaces was documented for description. Regardless, the chert type and geographic location of the find are worthy of reporting as is the consideration of the cache's chronological time interval.

Reduction Stage

The reduction of bifaces from the blank stage to the finished artifact is a linear trajectory that is measured by stages of reduction based on the removal of series of flakes and the relative thickness

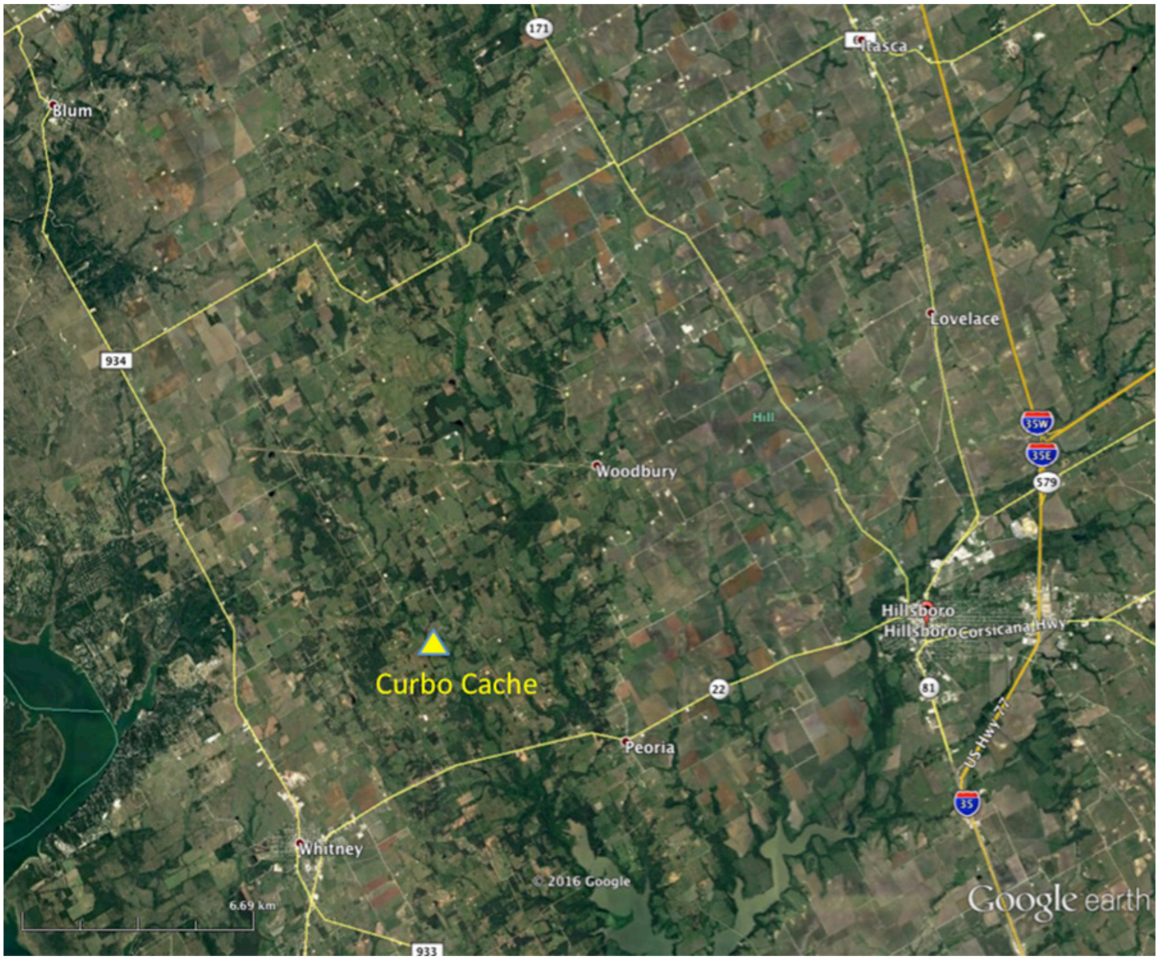


Figure 1. Approximate location of the Curbo cache.

of the biface. Stage descriptions are used to illustrate the reduction process and trajectory. Arbitrarily segregating reduction stages aids in artifact description but in reality the completion of the linear trajectory is contingent on the successful removal of each flake. We use the linear reduction model applied by Goode (2002:30-34) because his model was based on Archaic reduction systems and experimentation. Stage models have been proposed for Clovis reduction (Bradley et al. 2010:56-106), for biface reduction in Central Texas (Goode 2002), and for East Texas Woodland (Shafer and Green 2008; Shafer et al. 2012) and Early Caddo period cobble and pebble reduction (Shafer 2011:Figure 7). The linear reduction trajectory can be stopped at any point in the process, and broken specimens fossilize the reduction trajectory. The first stage of reduction often takes place at the lithic source or quarry (Shafer 1994) to reduce the mass for transportation. A second stage may occur at the quarry or a habitation site nearby (Dickens and Dockall 1994). Bifaces may be reduced to Stage 3 in preparation for long-distant transport to limit their bulk and to contain enough mass to reduce the chances of breakage. The Curbo cache bifaces reached the middle stage or Stage 3 in Goode's (2002:34) linear trajectory.

Technology

Table 1 provides the measurement data for 40 of the specimens. The overall form is generally ovate but there is some variation (see Figures 2-6). The 39 Edwards chert bifaces in the study sample range in length from 7.8 to 17.3 cm, with an average of 11.3 cm. Width varies from 5.3 to 9.7 cm with an average of 7.1 cm, and thickness ranges from 0.8 to 3.0 cm, with an average of 1.7 cm. The smallest specimen is a varicolored brown-streaked chert of unknown origin that measures 6.3 cm in length, 5.3 cm in width, and 1.7 cm in thickness.

The bifaces were thinned by implements producing a bending fracture. Hard-hammer percussion

Figure 2. Selected examples of Curbo cache bifaces.

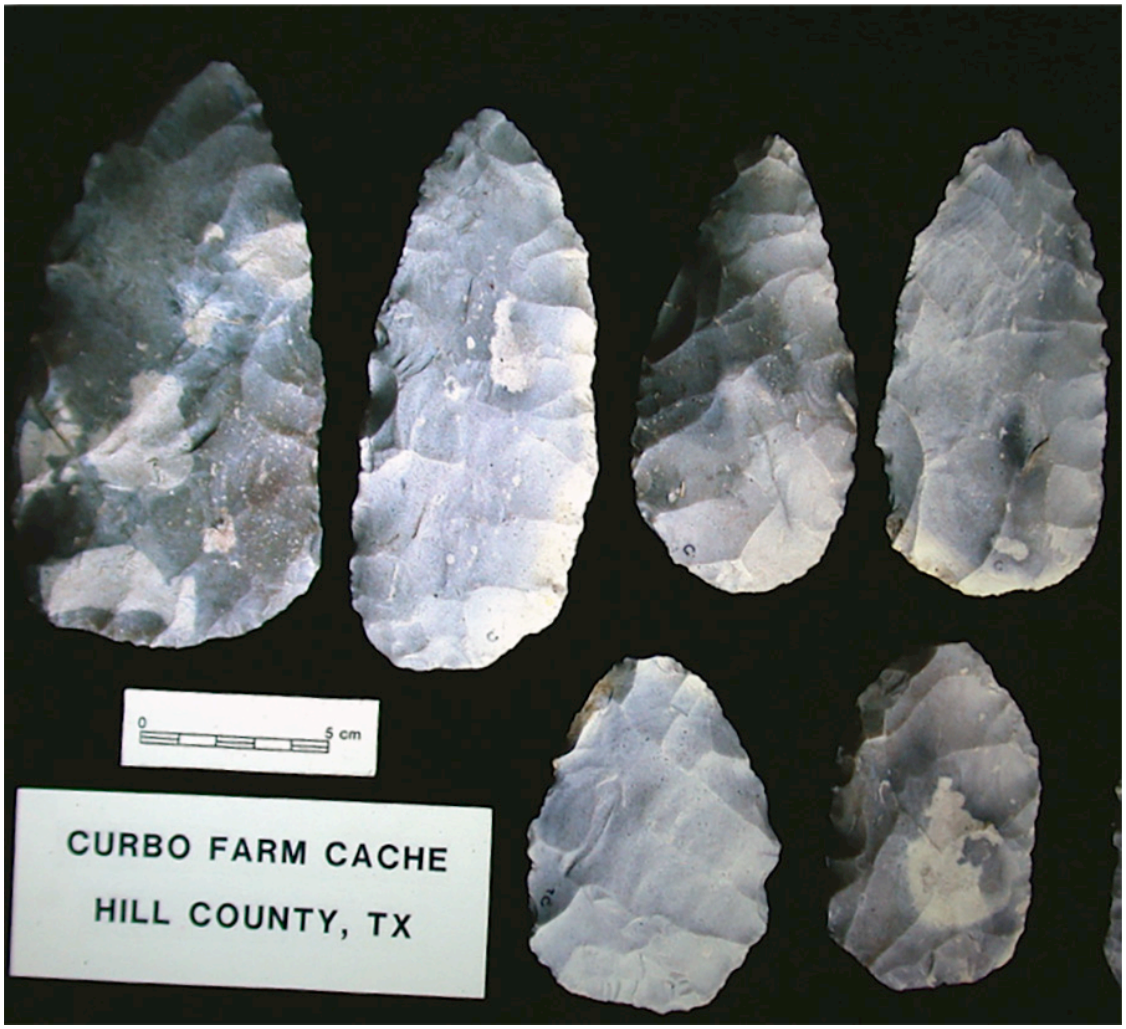


Figure 3. Further examples of Curbo cache bifaces.

Figure 4. Additional selected examples of Curbo cache bifaces.

Figure 5. More examples of Curbo cache bifaces.

leaves a deep negative scar created by a Hertzian cone of percussion. Soft-hammer percussion creates a bending fracture that leaves a subtle bulb of percussion and a lipped striking platform caused by bending away part of the biface edge (Shafer 2011; Whittaker 1994:177-217). Lithic analysts, including the senior author, learned that the soft-hammer was the result of employing an antler billet as the percussor. Alternative methods of creating the soft-hammer results, however, have been realized and include the use of an antler punch or drift in indirect percussion. The application of a soft indirect percussor such as the base of a white-tailed deer antler is much like those used by Early Postclassic flintknappers in Colha, Belize (Shafer 1985). The proposed indirect method of applying force was by placing the tool at the desired spot against the edge of the biface and striking the antler drift with an implement of some kind, possibly stone or wood.

This indirect approach allows a flintknapper to have more control in removing a thinning flake than if the flintknapper relies on his/her skill using a billet alone (see Goode 2002:35). The control is much like that for pressure flaking where the pressure tool is applied directly to the edge of the biface prior to removing the flake. Use of an antler billet is plausible, although white-tailed deer antlers are relatively small and lightweight compared to elk and other materials used by modern flintknappers. Indirect percussion could provide more force and therefore be more effective in reducing larger bifaces. Experiments by Chris Ringstaff using the indirect method has duplicated the attributes noted on the Curbo cache bifaces.

The reasoning behind this proposed method of thinning is several fold. Antler billets if correctly identified are rare in Texas archeological assemblages. It is arguable that tools identified as antler billets were misidentified and were more likely used in indirect percussion. Modern knappers prefer to use elk antler or copper billets to thin bifaces and do very well with them, but neither material was available to the Texas Archaic flintknappers. Antler punches or drifts, however, are more common in the archeological record and examples were recovered from the tool kits at Horseshoe Ranch Cave (41VV171, Shafer 2011:110 and Figure 7), from an adult male burial at Lemens Rockshelter

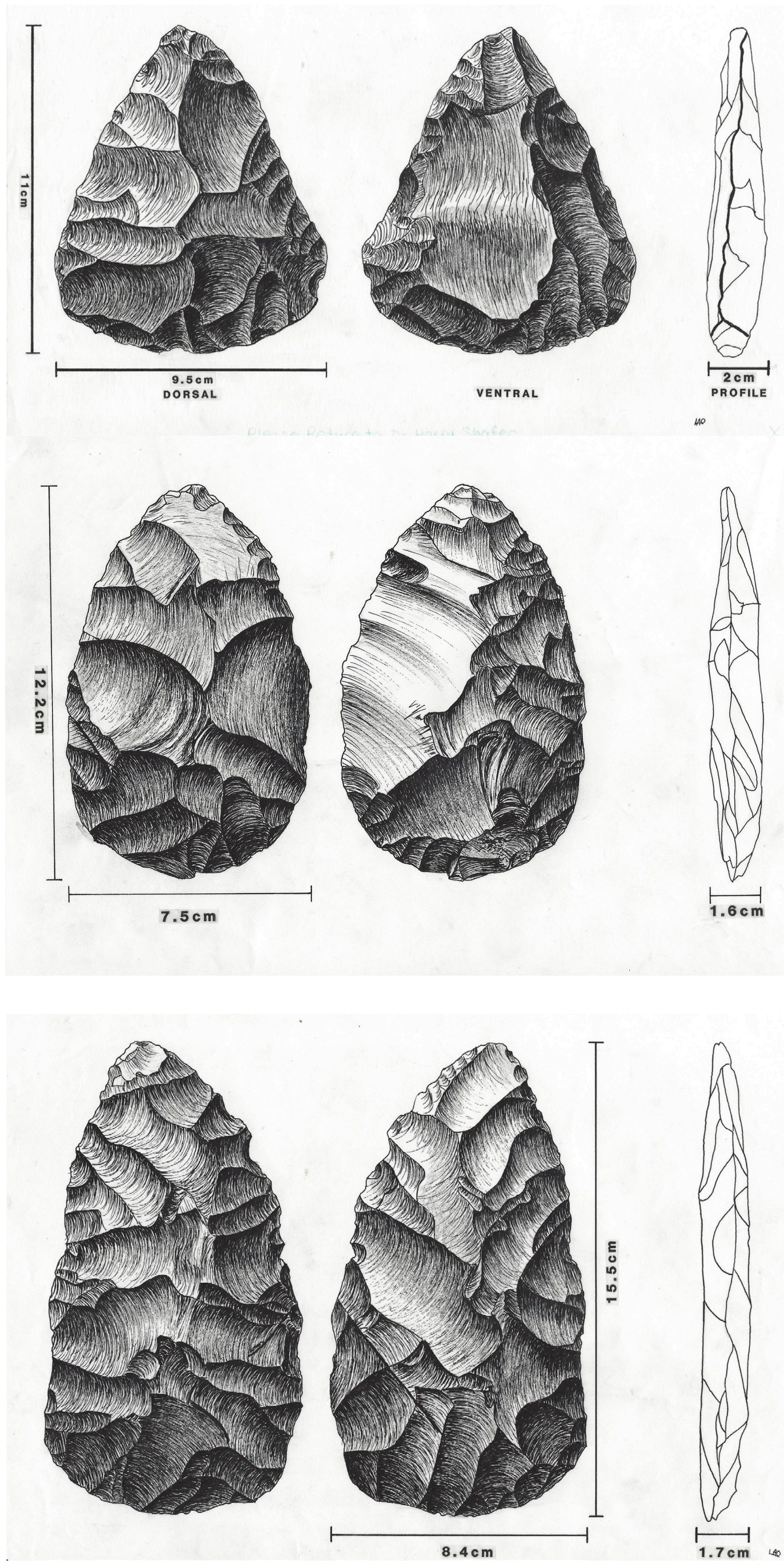
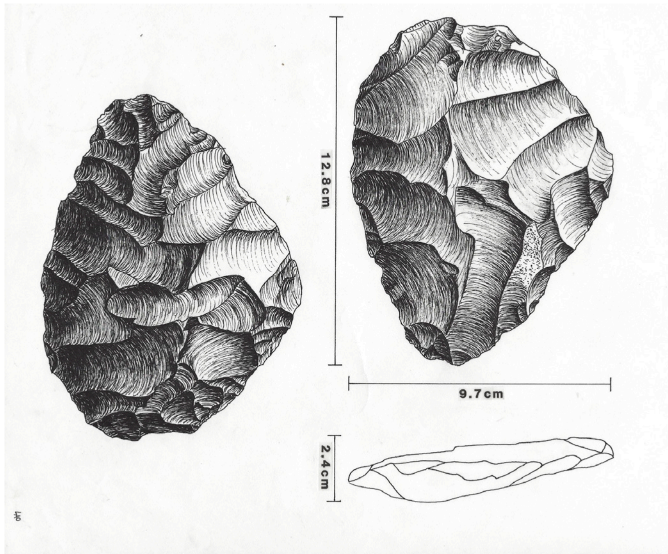
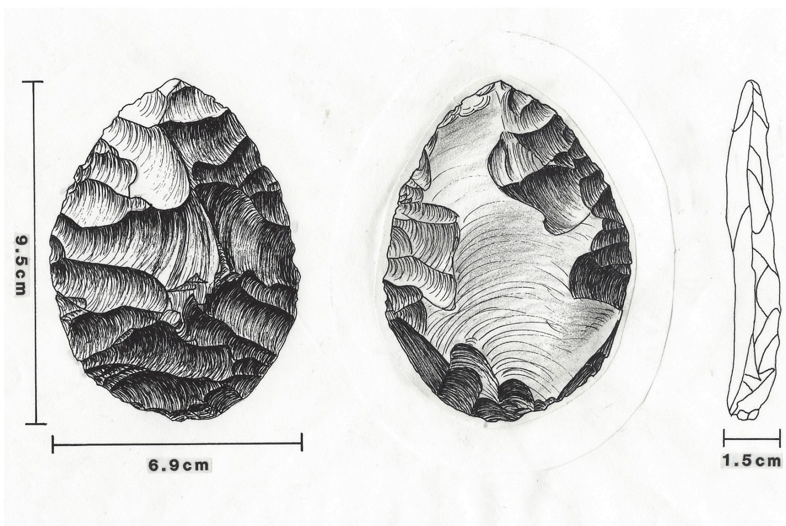


Figure 6. Drawings of selected Curbo cache bifaces by Lynn O'Kelly.





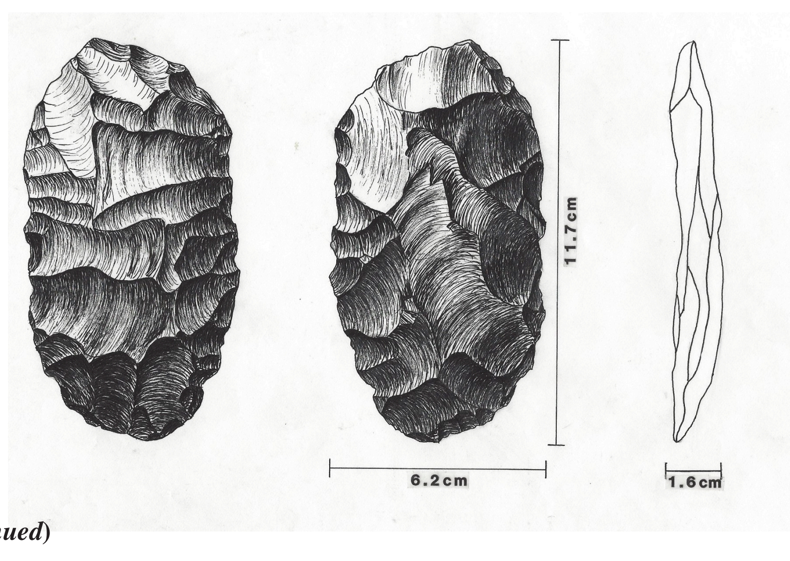


Figure 6. (*Continued*)

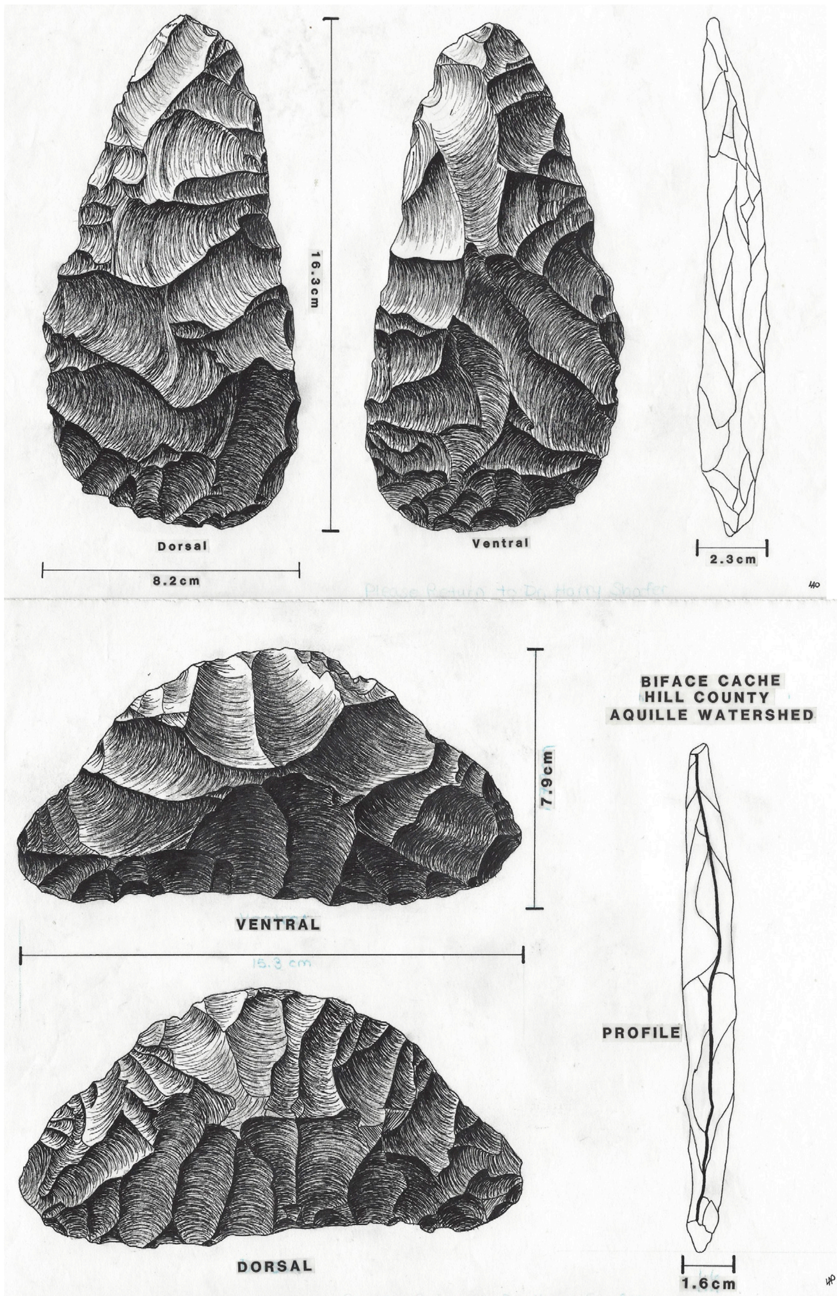


Figure 6. (*Continued*)

(41SV60, Smith et al. 1994:Figure 7), and Burial 119 at Morhiss (41VT1, Dockall and Dockall 1999). Interestingly, all of the flintknapper kits contained antler punches and hammerstones; those from Horseshoe Ranch Cave and Lemens Rockshelter contained middle stage reduction bifaces.

One of the Edwards chert bifaces in the cache has a pinkish tint suggesting some degree of heat exposure, perhaps heat treating, although the remainder of the cache the senior author inspected does not appear to have been heat-treated. Heat treating of toolstone by Calf Creek Interval folks is well documented in Oklahoma (Bartlett 1994).

Possible Chronological Placement

The precise age of this isolated cache is unknown, but the shape and technology of the bifaces would seem to place them in the Archaic. The cache was not found within any identifiable cultural component or habitation site that would provide some hint of its antiquity. Given the type

Figure 7. Antler punches or drifts contained in a hunter's tool cache from 41VV171 (photo by Laura Nightengale courtesy of the Texas Archeological Research Laboratory, The University of Texas at Austin).

of Edwards chert for all but one of the specimens, the likely source of the Edwards chert raw materials was in western Bell or Williamson counties. The distance from source to the cache is about 120 km, and this would suggest a period of time when Archaic people were highly mobile. Periods of time when Archaic groups in Central Texas would likely have been highly mobile would be when bison were present. According to Lohse et al. (2014), two likely intervals fit this pattern, either in the Bell-Andice Calf Creek (BACC) interval (ca 6,000-5,500 cal. B.P.) or the Castroville-Montell interval (3.000-2,300 cal. B.P.), periods associated with extensive bison exploitation. Speculation is made here that the cached bifaces were intended as preforms for Bell-Andice-Calf Creek style points. The BACC interval in Texas prehistory is associated with bison hunting and a period of high mobility for Archaic hunters and gatherers based on the widespread diagnostic point distribution and the sourcing of toolstone (Lohse et al. 2014; Wyckoff 1994). Furthermore, many of the bifaces in the cache would be appropriate for BACC preforms based on overall size and morphology. Since BACC points are much more widespread than are Castroville-Montell points (see Prewitt 1995; Turner et al. 2011), the BACC interval seems to be the more likely candidate. Realizing that this is purely speculative, we think the caching is related to mobility, and since the BACC people were highly mobile bison hunters, they are an Archaic population of interest.

Stillman Pit Calf Creek Cache Comparison

Curbo cache bifaces are compared to the Stillman Pit cache in Murray County, Oklahoma, described by Bartlett (1994). This is one of the best documented Calf Creek component caches on record and provides an excellent comparison to the Curbo cache. The Stillman Creek cache was found at the Stillman Pit site (34MR71) along the Washita River near the Arbuckle Mountains. The cache consisted of 21 sub-triangular to ovate bifaces and eight large flakes of Frisco chert. Most specimens were heat treated. The Stillman Pit bifaces are remarkably consistent in form and because of their context are regarded to be reliably from a Calf

Table 1. Curbo cache measurements in cm.

No.	Material	Length	Width	Thickness
1	Unknown	6.3	5.3	1.7
2	Edwards	16.3	8.2	2.3
3	Edwards	15.3	7.9	1.6
4	Edwards	11.7	6.2	1.6
5	Edwards	11.0	9.5	2.0
6	Edwards	15.5	8.4	1.7
7	Edwards	9.5	6.9	1.5
8	Edwards	12.8	9.7	2.4
9	Edwards	12.2	7.5	1.6
10	Edwards	10.4	8.0	1.7
11	Edwards	7.8	5.7	0.8
12	Edwards	15.0	6.7	1.9
13	Edwards	13.2	9.5	1.9
14	Edwards	9.5	5.8	1.3
15	Edwards	12.1	6.1	1.9
16	Edwards	10.0	6.7	1.7
17	Edwards	10.2	7.1	1.8
18	Edwards	9.5	6.3	1.7
19	Edwards	11.2	9.0	2.3
20	Edwards	7.4	5.0	2.0
21	Edwards	17.3	8.0	2.0
22	Edwards	8.2	6.8	1.5
23	Edwards	14.5	5.5	1.7
24	Edwards	12.6	7.8	1.7
25	Edwards	11.1	8.2	2.0
26	Edwards	9.9	7.8	1.6
27	Edwards	8.6	7.3	1.5
28	Edwards	9.4	7.0	1.5
29	Edwards	11.6	8.1	1.7
30	Edwards	10.9	7.0	1.7
31	Edwards	9.3	6.6	1.7
32	Edwards	9.8	6.5	1.8
33	Edwards	9.7	6.8	1.7
34	Edwards	9.5	6.2	2.0
35	Edwards	8.9	7.2	1.1
36	Edwards	8.7	6.4	1.2
37	Edwards	11.6	6.8	1.7
38	Edwards	9.6	6.8	1.6
39	Edwards	10.8	7.1	1.6
40	Edwards	12.5	6.2	3.0

Creek component. Consequently, they provide a good measure of middle stage or Stage 3 preforms for Andice-Calf Creek-Bell points style points.

Table 2 provides the measurement data for the Stillman Pit cache bifaces. Length of the Stillman Pit bifaces range from 9.9-14.9 cm compared to 7.8-17.3 cm for the Curbo specimens. The width of Stillman Pit bifaces varies from 6.1-9.0 cm compared to 5.3 to 9.7 cm for the Curbo bifaces; and the thickness of the Stillman Pit bifaces ranges from 0.95-1.47 cm compared to 0.8-3.0 cm for the Curbo cache. There is more variation in the Curbo cache when compared to Stillman Pit cache but they cluster quite closely together. The Stillman Pit cache bifaces show slightly more reduction based on thickness and consistency in form.

The length and width of bifaces in the two caches are very similar, but Stillman Pit cache bifaces are less variable. Figure 8 plots their length and width and includes ellipses that comprise about two-thirds (68 percent) of the data points. The figure also indicates the position of Stillman Pit biface #21, which is unusually thick. While the median thickness for the Stillman Pit bifaces is 1.28 cm, biface #21 is 5.23 cmm thick. The second thickest biface is only 1.47 cm. For that reason biface #21 is removed from further consideration of the differences between the two caches. Figure 9 plots the length and thickness of the bifaces after excluding Stillman Pit biface #21. The plot shows that not only are Stillman Pit bifaces less variable in mean dimensions than the Curbo cache bifaces, they are also consistently thinner.

We can test hypotheses that the two groups have similar mean dimensions using Hotelling's T^2 test. Just considering length and width, the T^2 statistic is 1.488 with 2 and 57 degrees of freedom and a p-value of .23. In other words, the two caches are not significantly different from one another in terms of length and width. Adding thickness increases the T^2 statistic to 17.53 with 3 and 56 degrees of freedom and a p-value much less than .001, so we would reject the null hypothesis of no difference between the groups.

All Stillman Pit cache bifaces are 1.47 cm or thinner (except #21) and only four Curbo bifaces are that thin. Predicting a biface belongs to the Stillman cache if it is 1.47 cm or less and belongs to the Curbo cache if it is greater results in the correct assignment of 56 of the 60 bifaces (93 percent) from

Table 2. Stillman Pit Cache, measurements in cm.

No.	Length	Width	Thickness
1	12.4	8.7	1.2
2	11.4	8.5	1.28
3	12.9	8.3	1.24
4	12.6	9.1	1.28
5	12.6	7.3	0.95
6	13.3	7.6	1.3
7	13.8	6.3	1.15
8	14.9	7.3	1.19
9	12.4	6.4	1.4
10	10.3	7.7	1.33
11	10.4	7.8	1.21
12	10.9	7.8	1.32
13	11.7	8.2	1.37
14	10.5	8.0	1.3
15	9.9	7.1	1.21
16	12.1	6.8	1.23
17	12.3	6.5	1.42
18	12.4	7.7	1.47
19	10.5	6.5	1.02
20	10.9	7.2	1.18
21	10.7	6.1	5.23

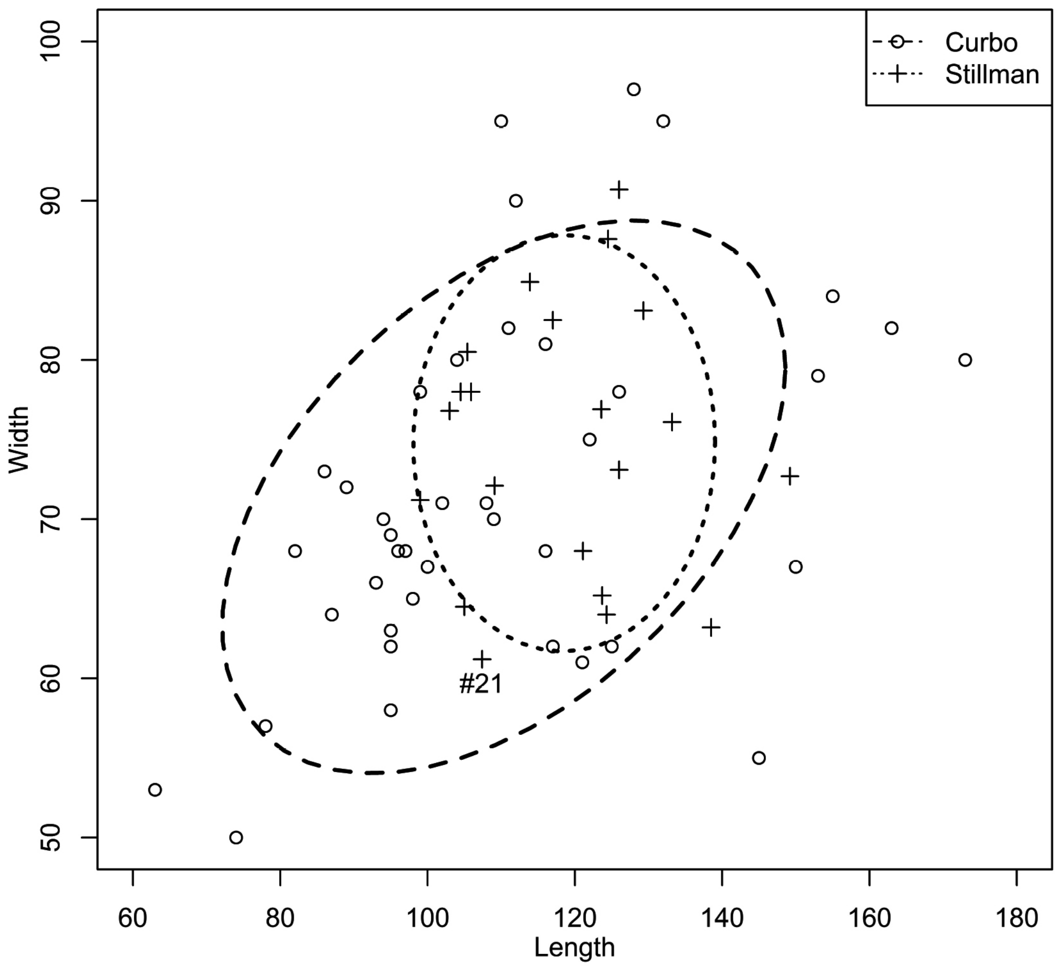


Figure 8. This figure plots length and width and includes ellipses that include about two-thirds (68 percent) of the data points. The figure also indicates the position of the unusually thick Stillman Pit biface #21.

the two caches. The greater variability within the Curbo cache compared to the Stillman Pit cache may be due to more than one flintknapper being responsible for biface production. Conversely, the greater consistency in the Stillman Pit cache may indicate a single flintknapper was involved.

Discussion

If we are correct in assuming the association of the Curbo cache to the BACC interval, to which the Stillman Pit cache arguably also belongs, it would appear that one rather distinctive behavior at that time was a propensity to leave biface caches. These two caches may not be alone.

Two interesting caches were found reported online in the web site *Arrowheadology.com* in 2009. One cache of 23 bifaces (Figure 10), reported by Chad Gilbert of Denton, Texas, was found in Denton County and is similar morphologically to the Curbo cache but unfortunately there is no scale in the picture. There appears to be more variability in the cherts in the Gilbert cache; however, some of the specimens appear to be Edwards chert. The other cache (Figure 11) reported on the same web site is mentioned by J. Maduzia. This was a cache of 15 bifaces from Limestone County. Here again, the material used appears to be more varied than in the Curbo cache, but by appearance there could be several from the same or similar source area as the Curbo cache. The morphology and scale of the bifaces in the Maduzia cache also is comparable to those in the Curbo cache. The context and association of these two caches is unknown, but the general morphology similarities and Stage 3 reduction are notable.

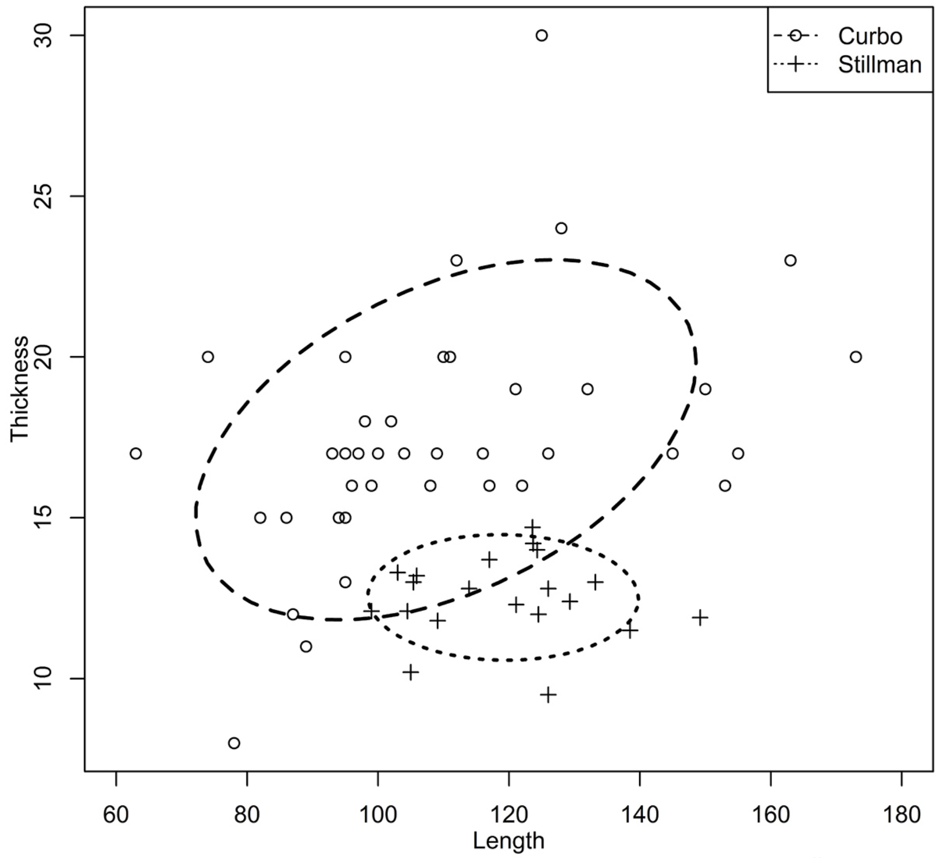


Figure 9. This figure plots length and thickness of the bifaces after excluding the Stillman Pit #21 biface. The plot shows that not only are the Stillman bifaces less variable in length and thickness than the Curbo cache bifaces, they are also consistently thinner.

Figure 10. Gilbert cache from Denton County.

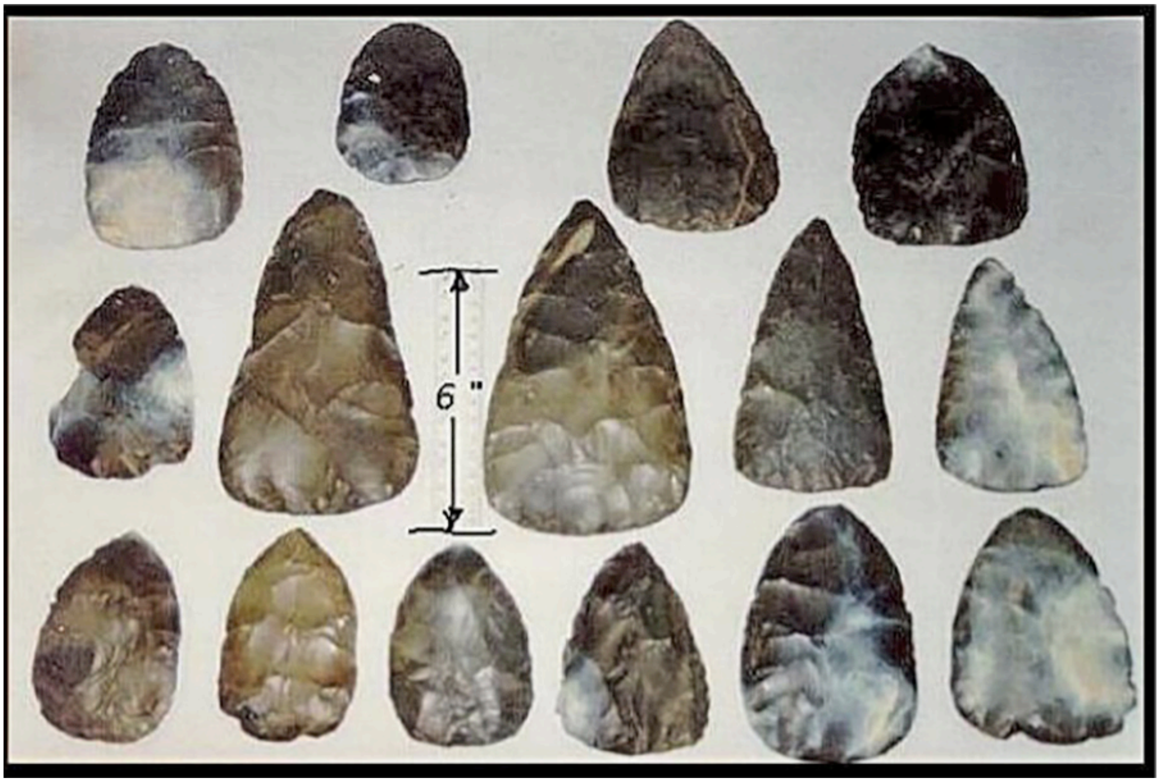


Figure 11. Maduzia cache from Limestone County.

Admittedly we do not know the age of any of these caches other than the Stillman Pit cache. What is clear, however, is that high quality chert bifaces reduced to about Stage 3 in the reduction process were cached in regions where those chert types do not occur naturally, but they are within the known region of BACC diagnostics (Figure 12). Our case that these caches are likely BACC is built on the assumption that whoever left them were part of groups that followed a highly mobile lifeway, probably in pursuit of bison.

Conclusions

The Curbo cache is an example of the movement of high quality Edwards chert from a production area in Central Texas to a consumption area in the prairies of North Central Texas. Figure 12 from Lintz and Dockall (2009) shows the extent to which Edwards chert was moved into areas deficient in quality lithic resources. The Stage 3 or middle reduction stage, size, and general ovate shape of the bifaces are consistent with a trajectory toward projectile point manufacture. Unfortunately, there is no way to absolute date the cache but the argument here is that it was related to highly mobile groups probably in pursuit of bison. The two intervals that seem to best fit this behavior expectation are the BACC interval folks and the Castroville-Montell interval folks. The distribution of the diagnostic Andice-Calf Creek points shown by Collins et al. (2011:Figure 16) and plotted by Prewitt (1995), shown in Figure 13, coupled with the geographic distribution of the BACC horizon presented in Figure 14, would seem to place the BACC culture as the most likely producer of the Curbo cache. In summary, the BACC horizon seems the best candidate for temporal placement of the Curbo cache based on arguments regarding group mobility, preform size and their state of reduction, and the known distribution of BACC diagnostics.

Acknowledgments. The authors would like to thank Mike Callaway and Earl Crow for making part of the cache available for study. Chris Ringstaff successfully performed experiments to replicate the Curbo Stage 3 reduction using indirect percussion. Lynn O'Kelly did the excellent drawings and calculated the measurements for each biface presented in Table 1. John Dockall provided useful comments and suggestions on an earlier draft of this manuscript.

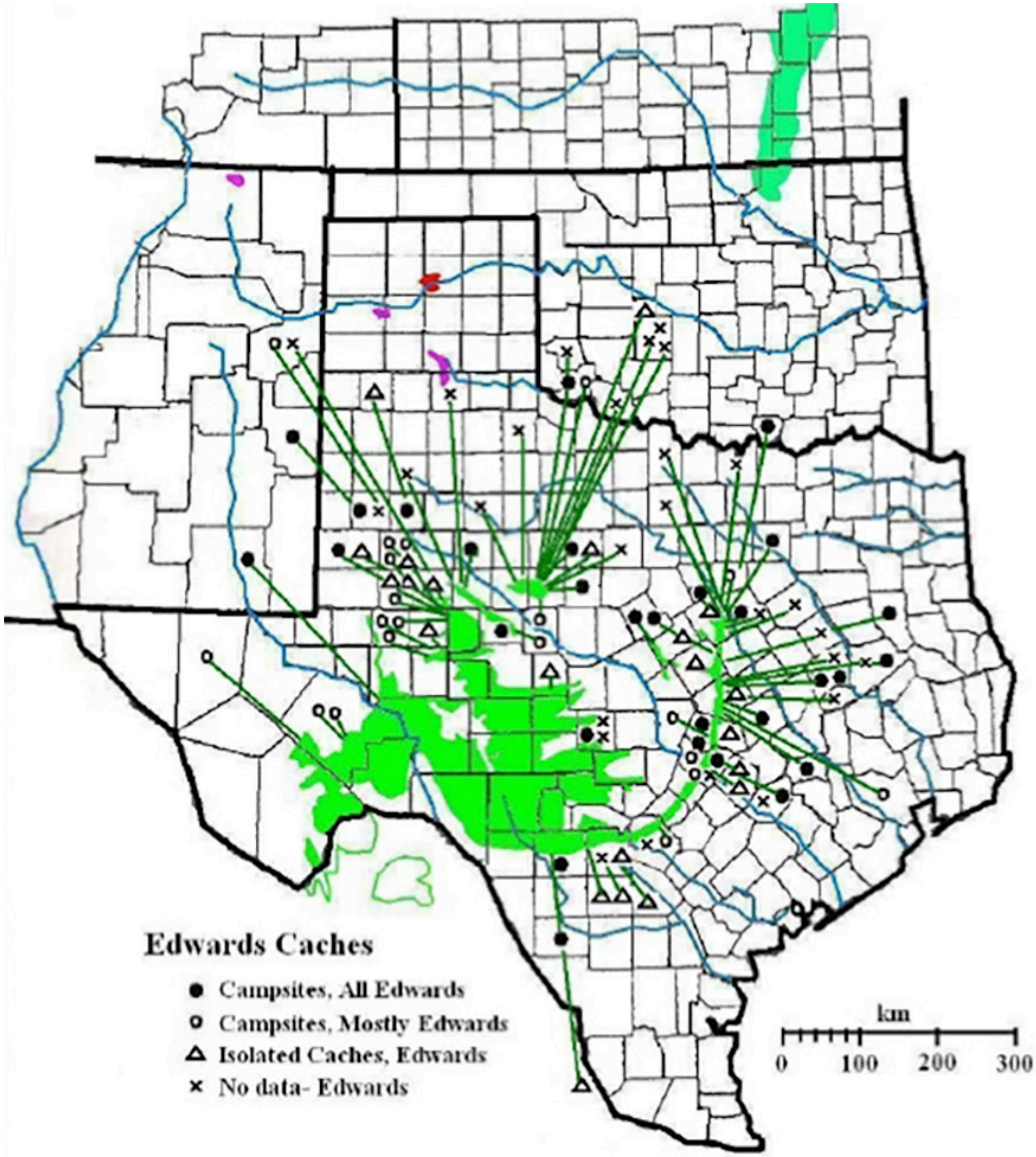


Figure 12. Distribution of known Edwards caches (after Lintz and Dockall 2009).

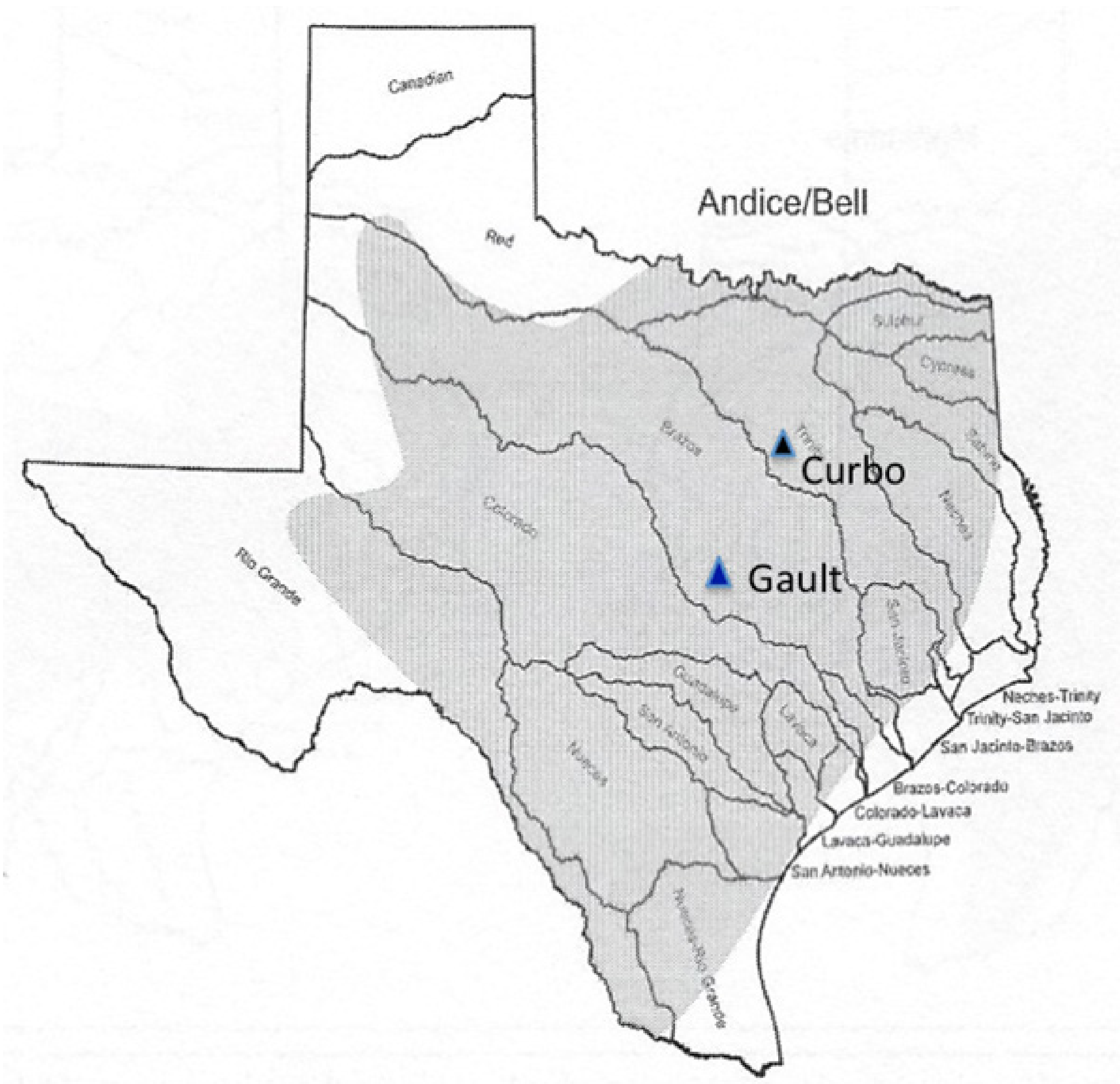


Figure 13. Andice/Bell distribution in Texas (after Collins et al. 2011:Figure 16 and Prewitt 1995:Figure 3) and the location of the Gault site, the probable source area for the Curbo bifaces, and the general location of the Curbo cache in Hill County.

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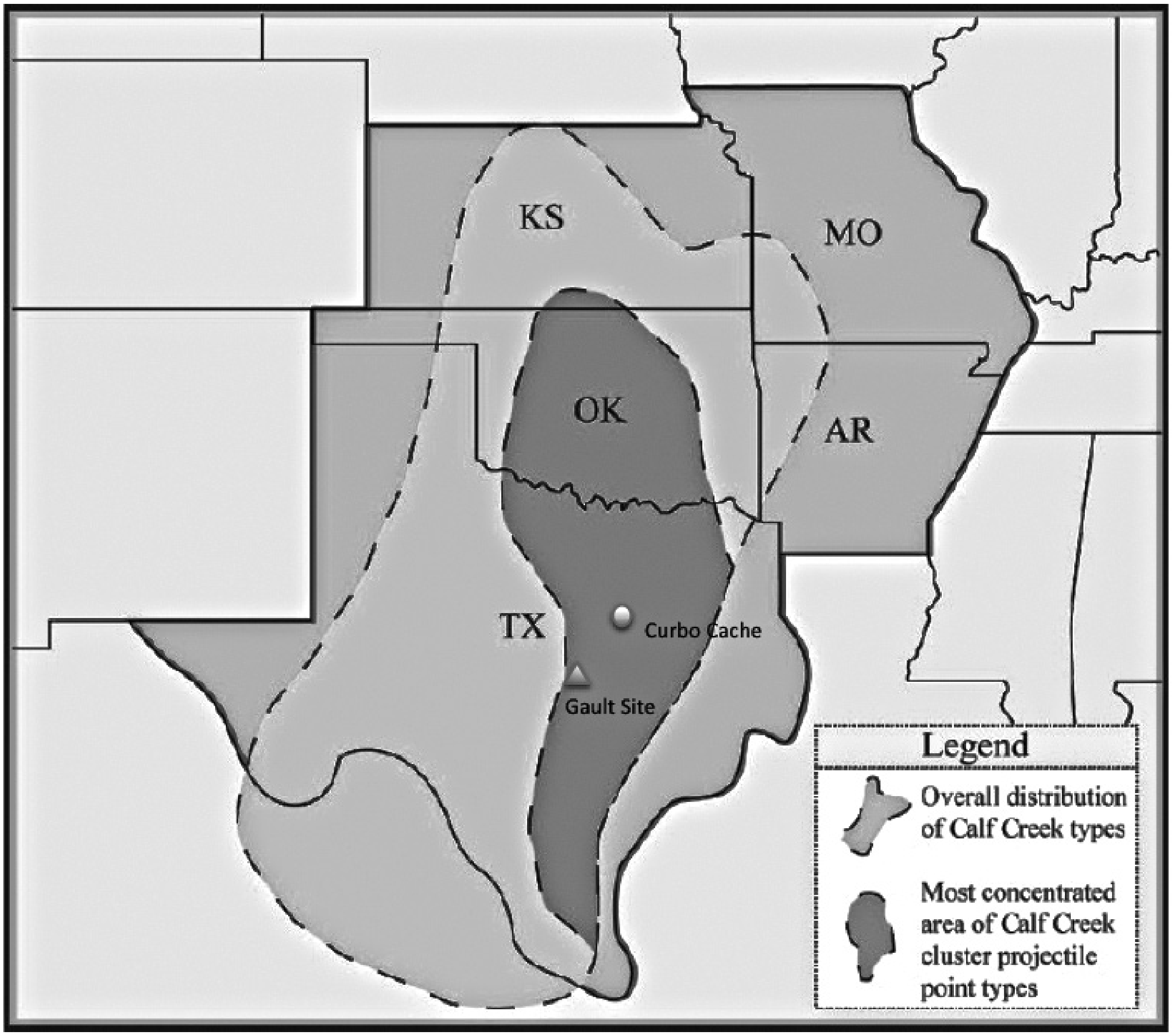

Figure 14. Location of the Curbo cache and Gault site area within the Calf Creek Horizon (adapted after Walter 2013).

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The First Reported Occurrence of Clovis Artifacts from Liberty County, Texas

Wilson W. Crook, III

The Houston Archeological Society in conjunction with the Sam Houston Regional Library and Research Center in Liberty, Texas, has undertaken a study of a large private artifact collection donated to the Center in order to create a new interactive display on the prehistory of Southeast Texas. The collection includes over 30,000 artifacts from 95 archeological sites from nine counties. In the course of this study, a number of diagnostic Clovis artifacts were discovered from the Wood Springs site (41LB15) in Liberty County. As there are no previously reported occurrences of Clovis artifacts from Liberty County, this paper serves to both document the site and describe the nine artifacts of probable Clovis affinity. The artifacts described herein are also compared to other nearby Clovis occupations, notably that at the Timber Fawn site (41HR1165) in Harris County.

The Sam Houston Regional Library and Research Center in Liberty, Texas, is currently in the process of renovating its entire museum display. A major component of their future exhibits will be the prehistory of Southeast Texas utilizing the extensive Andy Kyle Archeological Collection. The collection of prehistoric artifacts was a gift to the museum by the late Mr. Andy Kyle, long-time resident of Liberty County and avid avocational archeologist. The collection comprises well over 30,000 artifacts from 95 archeological sites from nine counties in Southeast Texas. These include sites in Liberty, Polk, Jasper, Sabine, Tyler, Hardin, Angelina, San Augustine, and Newton Counties. The sites present in the collection represent an area that is essentially between the Trinity and Sabine Rivers (Figure 1).

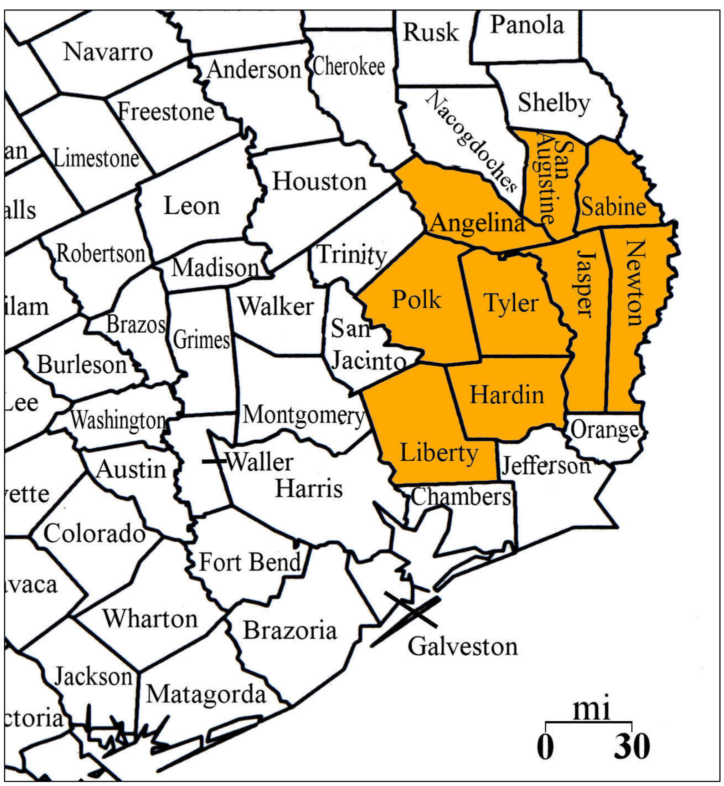


Figure 1. Map of Southeast Texas showing the nine counties represented in the Andy Kyle Archeological Collection.

In early 2017, members of the Houston Archeological Society (HAS) were asked to assist the Sam Houston Regional Library's project by going through the entire Andy Kyle Archeological Collection and identifying distinctive artifacts from each chronological period for the new display. A number of hitherto unrecorded discoveries were made during this process that will be the subject of future publications from the HAS. One of the more spectacular finds was the discovery of several diagnostic Clovis artifacts from the Wood Springs site (41LB15). The artifacts mark the first reported occurrence of Clovis people in Liberty County (Bever and Meltzer 2007; David Meltzer, personal communication, 2017) and push the date for the first occupation of the area back to at least 13,000 years ago.

The Wood Springs Site (41LB15)

The Wood Springs site is located approximately 3 km northwest of Liberty, Texas, on the west side of a small stream known as Wood Springs Creek or Atascosito Springs. This stream is fed by several perennial springs and is a minor tributary of the Trinity River 0.8 km to the west. The location is 0.6 km southeast of the Sam Houston Regional Library and Research Center. The site lies on either side of Sandune Road on a sandy terrace on the northwest side of the creek. A natural gas pipeline right-of-way crossing bisects the site and serves as a marker for the approximate middle of the occupation (Figure 2). The site's location was originally described and registered by Elton R. Prewitt in 1973 as part of the Louisiana Loop Survey. Wood Springs was subsequently investigated by Sheldon Kindall and other members of the HAS during their research on the Andy Kyle Archeological Collection during the mid-1980s. The site was one of the many sites from which Mr. Andy Kyle collected artifacts between 1946-1986.

Occupational material at Wood Springs covers at least 0.5 acres and possibly as much as 5 acres (Sheldon Kindall, personal communication, 2017). While Mr. Kyle only collected artifacts on the surface, several shovel tests were excavated by the HAS in 1986 as well as recently by the author. The artifact-bearing horizon is a pale brown (10YR 7/3) to light gray (10YR 7/2) sand that extends to a depth of at least 1 m. Based on artifacts collected by Mr. Kyle, the Wood Springs site represents a long-term occupation that extends from the earliest Paleoindian period (Clovis) through the Late Prehistoric. Construction of the natural gas pipeline has disturbed much of the site such that Paleoindian, Archaic, Woodland, and Late Prehistoric materials are found alongside each other

Figure 2. View looking southwest across the main part of the Wood Springs site (41LB15) as it appears today.

on the surface. Artifacts from the site represent the following archeological periods: (1) Paleoindian – ca. 13,000-8,000 B.P. (marked by Clovis, San Patrice and Pelican points) (Bradley et al. 20110; Stanford and Bradley 2012; Bousman et al. 2004; Jennings 2008), (2) Archaic – 8,000-2,000 B.P. (marked by Bell, Carrollton, Trinity, Bulverde, Williams, Pedernales, Ellis, Yarbrough, Kent, Ellis, Ensor, and Gary points, unifacial Clear Fork gouges, clayballs, etc.) (Crook 2007, 2008; McClure and Patterson 1988; Patterson 1983, 1991), (3) Woodland phase – 2,000-1,400 B.P. (marked by Gary and Kent points and plain ceramics) (Patterson 1991), and (4) Late Prehistoric 1,400-500 B.P. (marked by Alba, Catahoula, and Perdiz points, and both locally manufactured and imported Caddo ceramics) (Suhm et al. 1954; Suhm and Jelks 1962; Kindall and Patterson 1987; Patterson 1991; Aten and Bollich 2002).

Clovis Occupation at the Wood Springs Site

A total of nine artifacts of probable Clovis affinity were identified in the Kyle Collection from the Wood Springs site. These include the bases of two fluted points, two large blades, two overshot flakes, two small (<50 mm) prismatic blades, and a side scraper—perforator made from a broken blade. The artifacts have been studied in detail including physical measurements, high power microscopic examination, and trace element geochemical analysis using X-Ray Fluorescence (XRF). Each artifact is described in detail below.

Both fluted points are represented by basal fragments, the points having been broken due to fracture (Figure 3). Comparative measurements versus the State mean as reported in the most recent Texas Clovis Fluted Point Survey of 408 specimens (Bever and Meltzer 2007) are shown in Table 1. In general, point #2 is slightly wider at the base than the State average, but other measurements including width of fluting, thickness of the point at the flute, etc. are in general agreement with the range reported from other Clovis points across the State. Examination of both bases by the staff members at the Gault School of Archeological Research (GSAR) at Texas State University confirmed that Point #1 is of Clovis manufacture; Point #2 may represent Clovis, and its basal thinning technique was more akin to that seen in some western Clovis points.

Figure 3. Two fluted bases from the Wood Springs site (41LB15): right - point #1; left - point #2.

Table 1. Comparative Measurements of Wood Springs Fluted Points to State Average (Texas Fluted Point Survey, see Bever and Meltzer 2007).

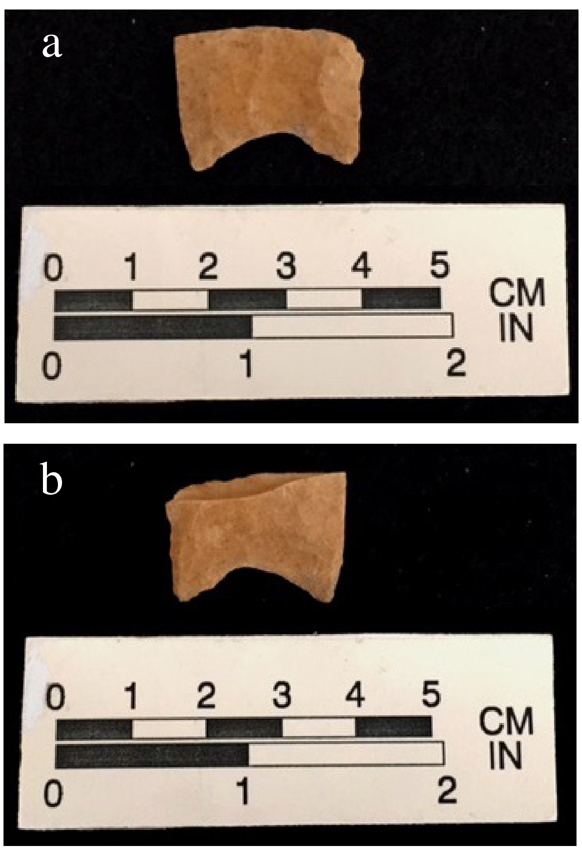
Characteristic	Clovis Point 1	Clovis Point 2	State Mean[2]
Maximum Length (mm)	16.5[1]	18.5[1]	65.0
Maximum Width (mm)	33.8	25.0	28.0
Width at Base (mm)	31.9	22.2	23.9
Maximum Thickness (mm)	4.8	5.5	7.4
Length of Flute (mm)	-	-	25.2
Ave. Width of Flute (mm)	17.7	14.1	13.5
Max. Thickness of Flute (mm)	3.0	3.8	5.7
Basal Depth (mm)	4.1	5.1	3.1
Length Basal Grinding (L)	11.9[1]	15.0[1]	26.2
Length Basal Grinding (R)	16.5[1]	18.5[1]	26.2

[1] Point is broken near the base.
[2] Based on 408 Clovis points recorded in Texas Clovis Fluted Point Survey (2007).

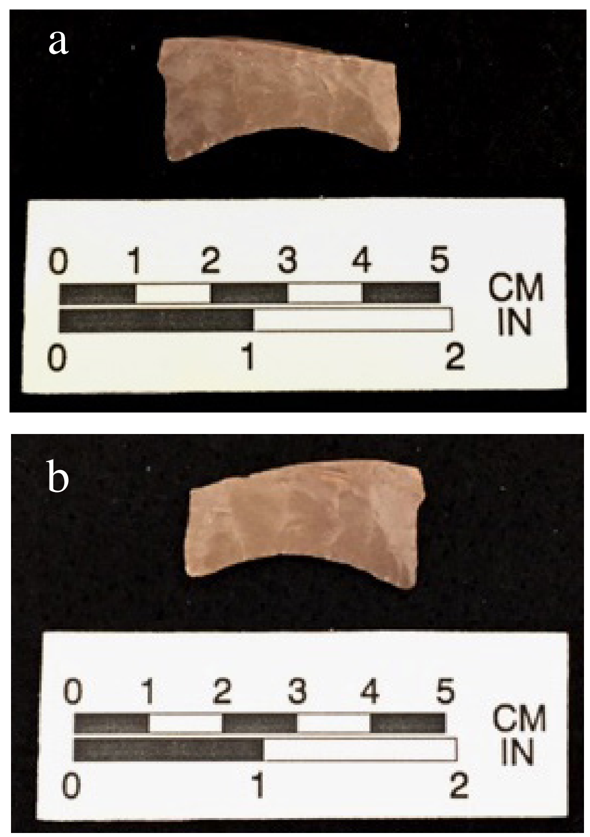
The first Clovis point is constructed from a brownish-yellow chert (10YR 6/6) (Figures 4a-b). Prominent fluting scars are present on both faces and the lateral edges of the point are heavily ground from the base up to the point of breakage. The base of the point is only weakly ground. The break appears to be due to a bending fracture rather than from impact, which could have occurred either during use or sometime after its discard. The point fluoresces a dull dark orange color under long-wave UV radiation. The point has a relatively deep basal depth (4.8 mm) but it is within the range of known Clovis points from Texas (Bever and Meltzer 2007). After discovery of this point, all the boxes containing material from the Wood Springs site were thoroughly searched but no other parts of this point or of point #2 was found.

The second fluted point (Figures 5a-b) is made from a gray-colored chert (2.5YR 5/1). Prominent basal thinning is present on both the obverse and reverse faces and the lateral edges and base are heavily ground from the base to the point of breakage. The break appears to be ancient and, like point #1, is from a bending fracture and not from impact. The chert fluoresces a strong yellow-orange color under both short and long-wave UV radiation indicating it is likely made of material from the Edwards Plateau of Central Texas (Hofman et al. 1991).

While the examination of the many boxes of recovered materials from the Wood Springs site did not reveal any additional Clovis points, several other artifacts of potential Clovis affinity from the site were identified. The first are two blades; one is made from dark greenish-gray chert (GLEY1 4/1) and is snapped at a distance of roughly 49 mm from the bulb of percussion (Figure 6). Given the width of the blade, its original length could have been in excess of 100 mm. The lack of cortex, coupled with two small flake scars on the dorsal surface, suggests it was an interior blade struck from a prepared core. One lateral edge has been retouched into use as a side scraper. While the blade has affinities with Clovis technology, the small flake scars seen on the dorsal surface are not Clovis-like (Collins 1999; Collins and Lohse 2004; Bradley et al. 2010), thus the artifact may have been



Figures 4a-b. Clovis Point #1, Wood Springs site, Liberty County, Texas; a – obverse face, b – reverse face.



Figures 5a-b. Clovis Point #2, Wood Springs site, Liberty County, Texas: a – obverse face, b – reverse face.

Figure 6. Blade #1, Wood Springs site, Liberty County, Texas.

picked up and re-used by later people occupying the Wood Springs site (Tom Williams, personal communication, 2017).

The second blade (Figure 7) is complete and appears to be made from a reddish-gray-white material that is similar in coloration to Alibates dolomite (reddish gray [2.5YR6/1] to pinkish gray [7.5 YR6/2] to light brownish-gray [10YR6/2] to reddish brown [2.5 YR5/3]. However, both blades fluoresce yellow-orange under UV radiation which suggests an Edwards Plateau origin for the chert (Hofman et al. 1991; Hillsman 1992), and the mottled coloration on Blade #2 is likely due to heat treating rather than it being Alibates material; Alibates dolomite typically does not strongly fluoresce under UV light. The heat treating appears to be post-creation of the blade and was thus done to possibly aid in affixing the blade to a hafted material.

Measurement of the two blades using the comparative methodology developed by Collins (1999) and Collins and Lohse (2004) for the Gault project are shown in Table 2. These are compared to the mean data from the three complete Clovis blades recovered from the Timber Fawn Clovis site (41HR1165), located 45 km to the west in northeastern Harris County. Because of the breakage in Blade #1, the data cannot be plotted against other Clovis blades. However, Blade #2, when plotted on a triangular

Figure 7. Blade #2, Wood Springs site, Liberty County, Texas.

configuration diagram, is similar in terms of length, width, and thickness ratios to Clovis blades from the Timber Fawn (41HR1165) site, as well as blades from the Gault (41BL323) and Keven Davis (41NV659) sites. This relationship supports the observation that at least Blade #2, and most likely Blade #1 as well, are of Clovis affinity.

Other artifacts of definite Clovis affinity are two overshot flakes (Figures 8-9). The first overshot flake is a green-gray chert (GLEY1 6/1 – GLEY2 5/1) and is highly fluorescent (deep yellow-orange) under UV radiation. The flake is 40 mm in length with a prominent bulb of percussion as well as a diving distal edge. The length of the flake is terminated by the presence of cortex along the distal edge. Overshot flakes exhibit a characteristic distal curvature that is the result of a plunging termination that removes a portion of the opposite side of a biface (Collins 1990; Collins and Hemmings 2005; Bradley et al. 2010; Waters et al. 2011). While this flake is smaller than most Clovis overshot flakes, its length is likely affected by the presence of the cortex on the edge of the biface, the removal of which appears to have been the purpose of the flake. The second overshot flake is a larger,

Table 2. Wood Springs Site (41LB15), Liberty County, Texas, Blade Data.

Measurements	Blade No. 1	Blade No. 2	Timber Fawn Large Blade Mean
Maximum Length (mm)	48.9*	68.3	83.6
Maximum Width (mm)	33.5	22.7	22.6
Max. Thickness (mm)	7.1	6.1	9.3
Platform Angle (°)	111°	113°	112°
Platform Width (mm)	9.1	5.1	6.5
Platform Depth (mm)	5.1	3.0	3.1
Index of Curvature	N/A	10.2	12.0
Ratio Length:Width	1.46*	3.00	3.42
L + W + T (mm)	89.5*	97.1	117
Ratio L/L + W + T	0.55*	0.70	0.71
Ratio W/L + W + T	0.37*	0.23	0.21
Ratio T/L + W + T	0.08*	0.06	0.09
Approximate % Cortex	None	None	N/A
Blade Material	Gray Chert	Alibates Dolomite	
Comments	* Blade Snapped	Complete	

Figure 8. Overshot flake #1 recovered from the Wood Springs site, Liberty County, Texas. The bulb of percussion is at the bottom end of the flake.

Figure 9. Overshot flake #2 recovered from the Wood Springs site, Liberty County, Texas. The bulb of percussion is on the right hand side (small end) of the flake.

more classic Clovis biface thinning flake in that it is longer (thus from a wider biface), and has a very prominent distal curvature (Figure 9). The length of the flake is 59 mm and it is a light gray (10YR 7/1) colored chert with prominent white patination on its dorsal surface.

Other potential Clovis artifacts are two relatively small, narrow prismatic blades with relatively small bulbs of percussion and a very low index of curvature. Dimensions of the blades are 45.5 x 13.1 x 4.0 mm and 42.5 x 11.5 x 3.0 mm, in length, width, and thickness, respectively. When viewed from the side, both flakes are almost flat. The dorsal surface of both blades shows a rippling effect from the production of the blade. These features are characteristic of indirect percussion, which is not typical of most Clovis blades (Collins 1999; Collins and Lohse 2004; Williams 2014). However, small prismatic blades have been found at the Gault site and other Clovis occupations so their possible affinity to Clovis cannot be ruled out (Tom Williams, personal communication, 2017). Moreover, the distal end of prismatic blade #1 has been reworked into a finely pointed graver, a Clovis trait (Figure 10). The first blade is made of a gray-brown mottled chert (5Y 6/1-2.5Y 5/3-5/4) and fluoresces a strong yellow-orange color under both short and long-wave UV light. This is very similar to the so-called "Gray-Brown-Green Mottled" variety of Edwards chert described by Dickens (1995) from the Fort Hood Military Reservation in Bell and Coryell counties. The flake has an overall waxy sheen and there are areas of reddish coloration near the distal end that could be signs of heat treatment (see Figure 10). The second flake is a dark greenish-gray chert (GLEY1 4/1) and appears to be made of the same material as Blade #1 (Figure 11). It too fluoresces a yellow-orange color under UV light. It should be noted that Mr. Kyle literally collected every piece of debitage from each site he visited. Thus, there are hundreds of flakes in the collection from the Wood Springs site but only two display the prismatic characteristics seen in these two small blades. Therefore, while it cannot be unambiguously determined that these two artifacts are of Clovis affinity, they are clearly unique, not only in the Wood Springs material but in all the studied lithic material from the entire Kyle collection.

The last tool of possible Clovis affinity from the Wood Springs site is an elongate side scraper which appears to have been made from a blade that subsequently broke during use and was then re-purposed (Figure 12). The artifact is 70.0 mm in length and 13.4 mm in maximum width. Maximum thickness near the proximal end is 12.0 mm. Examination of the artifact shows that the blade was originally much wider when it was used as an end scraper. This tool then broke during use and subsequent to this break, a fine retouch was done on the left lateral edge. At the same time, the tip of the tool was re-shaped into a perforator. Study of the tip under a Dino-Lite AM4111-T digital microscope at 40-60X shows extensive circular polish on the perforator tip. The artifact is made from a light greenish-gray chert (GLEY1 7/1-8/1) that fluoresces a strong yellow-orange color under UV light.

In addition to the nine chert artifacts of probable Clovis affinity, two small fragments of proboscidean teeth from either a mastodon (*Mammut sp.*) or a mammoth (*Mammuthus sp.*) were also found

Figure 10. Small prismatic blade of possible Clovis affinity recovered from the Wood Springs site, Liberty County, Texas.

Figure 11. Second small prismatic blade of possible Clovis affinity recovered from the Wood Springs site, Liberty County, Texas.

Figure 12. Side scraper and perforator made from a blade of possible Clovis affinity recovered from the Wood Springs site, Liberty County, Texas.

in the collections from the Wood Springs site. The larger of the two fragments displays part of a cusp characteristic of mastodon molars (Figure 13). This larger fragment is extremely polished and may have even been used as a tool.

X-Ray Fluorescence Analysis of Artifacts

All nine of the lithic artifacts of probable Clovis affinity are made from high quality chert that is not native to the Southeast Texas area. The artifacts also display a strong yellow to yellow-orange fluorescence under both short and long-wave UV radiation, characteristic of Edwards Plateau chert. Based on these results, it was assumed that the Edwards Plateau was the potential source for the chert in the Wood Springs artifacts. It was therefore decided to analyze each chert artifact for its trace element geochemistry using X-Ray Fluorescence (XRF) technology in order to see if the exact provenance of the chert could be determined. The Sam Houston Regional Library and Research Center

Figure 13. Proboscidean tooth fragments recovered from the Wood Springs site, Liberty County, Texas.

graciously gave the author permission to conduct research using XRF technology on the two points, the two blades, the two overshot flakes, the two small prismatic blades, and the side scraper/perforator to see if the chert used can be sourced to known outcrops in Texas.

Historically, archeologists have been challenged in sourcing chert due to the combination of the mineral's microcrystalline character, the destructive nature of many geochemical analytical techniques (wet chemistry, X-Ray powder diffraction, Neutron Activation analysis, etc.), and the complex trace element chemistry of cherts (Gauthier et al. 2012). Cherts are cryptocrystalline rocks that frequently contain sub-microscopic minerals that are difficult to determine in polarized light microscopy, even for experienced sedimentary petrographers. UV fluorescence, both shortwave and long-wave, has historically been used to make some preliminary determinations. This is especially true for Edwards chert, which has traditionally been identified by its strong yellow to yellow-orange fluorescence under short-wave and particularly long-wave UV radiation (Hofman et al. 1991; Hillsman 1992). However, other non-Edwards Plateau cherts also fluoresce under UV radiation and thus UV light alone cannot be considered a reliable tool for absolute chert source identification. Moreover, within the Edwards Plateau, UV light alone cannot distinguish amongst the many individual sources of chert. These facts argue strongly that a geochemical analysis remains the best technique available to archeologists for potentially sourcing cherts.

Within the spectrum of geochemical analytical techniques currently available, the best non-destructive methods are X-Ray Fluorescence (XRF) and Laser Ablation analysis (Laser Ablation Inductively Coupled Plasma Mass Spectroscopy or LA-ICP-MS). Of these two techniques, the latter requires access to highly specialized equipment typically not available to most archeologists. Thus, XRF would appear to be the ideal choice for non-destructive sourcing. In this regard, archeologists have had considerable success in sourcing obsidians using a basic seven to nine trace element profile (Glascock et al. 1998; Jenkins et al. 1995; Shackley 2011). However, when the same technique has been applied to the more complex geochemistry present in cherts, XRF analyses have had mixed success (Gautier et al. 2012; Kendall 2010; Luedtke 1978, 1979; Tykot 2004). As a result, Williams and Crook (2013; Crook and Williams 2013) adopted a much larger, multi-element approach based on the techniques for Laser Ablation analysis as developed by Speer (2014).

The nine Wood Springs chert artifacts were subjected to a trace element geochemical analysis using a portable X-Ray Fluorescence spectrometer (pXRF) in order to attempt to determine their provenance. The analyses were conducted using a Bruker Tracer III-SD handheld energy-dispersive XRF spectrometer equipped with a rhodium target X-Ray tube and a silicon drift detector with a resolution of ca. 145 eV FWHM (Full Width at Half Maximum) at 100,000 cps over an area of 10 mm^2. Data was collected using a suite of Bruker pXRF software and processed running Bruker's empirical calibration software add-on. The sample area on each artifact analyzed was carefully selected to specifically avoid any inclusions within the chert and, where possible, only on flat surfaces such as a flake scar to reduce the scattering effects due to surface topography. Analyses were conducted in April 2017 at the laboratory of the Gault School of Archeological Research (GSAR) located within the Prehistory Project at Texas State University in San Marcos.

All artifacts were measured using operating parameters of 40keV, 36.2μA, using a 0.12 mm aluminum/0.01 mm titanium filter in the X-Ray path, and a 300 second live-count time. Multiple measurements were taken on both the obverse and reverse faces of each artifact and the measurements then averaged for each sample. Peak intensities for $K\alpha$ and $L\alpha$ peaks were measured for a suite of 22 elements including calcium, titanium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, rubidium, strontium, yttrium, zirconium, niobium, molybdenum, tin, antimony, barium, lead, thorium, and uranium. From these measurements, the peak intensities for each element were calculated as ratios to the Compton peak of rhodium and converted to parts-per-million (ppm).

All the raw data was processed using a multivariate discriminant analysis "Fishers Discriminant Analysis" (Fisher 1936; Krzanowski 1977; Friedman 1989; Rencher 1992). This statistical method was utilized as, unlike principal component analysis, it allows data to be analyzed by individual region. By using this type of statistics, a discrete variance in geochemical signatures can be analyzed and compared. Table 3 provides all raw data collected in ppm on the nine artifacts from the Wood Springs site.

Provenance analysis of the trace element data collected from the artifacts was conducted using an Edwards Plateau chert data base initially constructed by Williams and Crook (2013) and subsequently augmented by Williams. Based on the results of the XRF analysis, the nine chert artifacts from the Wood Springs site could not be unambiguously sourced to any specific Edwards Plateau cherts within the current database. This leaves two possibilities: (1) all nine of the chert artifacts from the Wood Springs site were made from non-Edwards chert, or (2) the current small database used at the GSAR does not reflect the many different cherts and their geochemistry that occur all across the Edwards Plateau. Examination of the measurements of the Wood Springs artifacts in Table 3 shows that they share a very similar trace element geochemistry, especially for elements such as cobalt, nickel, copper, zinc, arsenic, rubidium, strontium, yttrium, zirconium, niobium, molybdenum, tin, antimony, lead, thorium, and uranium. Based on this high degree of similarity, it would seem that many of the artifacts are from cherts from the same general location. Given the fact that all nine artifacts strongly fluorescence a yellow to yellow-orange color under UV light, something which almost all cherts from East Texas and Louisiana have been found not to do (Hillsman 1992;

Table 3. XRF Results: Trace Element Geochemistry of Wood Springs Clovis Artifacts (ppm).

Element	Clovis Point #1	Clovis Point #2	Blade #1	Blade #2	Overshot Flake #1
Calcium	4555	4427	4481	4384	14392
Titanium	371	221	174	220	150
Chromium	-	-	-	-	-
Manganese	207	71	92	77	67
Iron	5953	2861	2614	2624	2624
Cobalt	6	3	3	3	3
Nickel	12	10	12	11	8
Copper	-	-	-	-	-
Zinc	-	-	-	-	-
Arsenic	-	-	-	-	-
Rubidium	10	10	10	9	10
Strontium	19	23	11	16	15
Yttrium	22	22	23	22	23
Zirconium	34	34	34	34	34
Niobium	6	6	6	6	7
Molybdenum	49	49	51	49	49
Tin	2	2	1	2	2
Antimony	-	-	-	-	1
Barium	600	603	1273	598	807
Lead	7	7	7	7	7
Thorium	6	6	6	6	6
Uranium	2	1	12	5	12
Probable Source	Unknown	Unknown	Unknown	Unknown	Unknown

Element	Overshot Flake #2	Prismatic Blade #1	Prismatic Blade #2	Side-Scraper on Blade
Calcium	4545	3862	4172	4382
Titanium	221	169	268	201
Chromium	-	-	-	-
Manganese	66	75	76	79
Iron	2561	2715	3256	3071
Cobalt	3	2	3	3
Nickel	10	5	8	11
Copper	-	-	-	-
Zinc	-	-	-	-
Arsenic	-	-	-	-
Rubidium	9	11	10	10
Strontium	19	12	19	15
Yttrium	22	20	22	23
Zirconium	32	28	33	33
Niobium	6	5	6	6
Molybdenum	46	36	46	50
Tin	2	2	2	1
Antimony	-	14	4	-
Barium	604	2440	1038	675
Lead	7	7	7	8
Thorium	6	6	6	6
Uranium	5	13	2	13
Probable Source	Unknown	Unknown	Unknown	Unknown

Williams and Crook 2013), it is likely that they are from the Edwards Plateau, just from areas which are currently not in the GSAR database.

Conclusions and Discussion

The earliest occupation present in the Andy Kyle Collection from the Wood Springs site in Liberty County is Clovis. This early period is represented by several diagnostic artifacts including two broken fluted point bases, two large Clovis blades, and two overshot flakes. Additionally, two small prismatic blades and a side scraper/perforator made from a large blade may also be part of the Clovis occupation at the Wood Springs site. Moreover, the Wood Springs site was the only locality in the entire collection that had extinct fauna and their association with the one site that had Clovis material is likely not coincidental. While Clovis points have been found elsewhere in Southeast Texas (Angelina County, n=16, Jasper County, n=3, Polk County, n=2, Tyler County, n=1, and Jefferson County, n=97) (Bever and Metzger 2007), the two points from the Wood Springs site mark the first reported occurrence of Clovis people in Liberty County. Clovis sites have now been firmly dated between 13,500 and 12,900 years B.P. (Stanford and Bradley 2012), thus establishing the region's earliest human occupation to have been no later than approximately 13,000 years ago.

The Wood Springs site would not have been a permanent campsite but more likely a seasonal site periodically visited by bands of Clovis hunters following big game animals. The site has abundant water and would have made an ideal campsite. The Clovis people at the Wood Springs site were likely a small band of nomadic hunters who camped at the site because of its permanent source of water. The springs were also a likely draw to the area's mammals, which would have also made the location an opportunistic hunting area. This supposition is supported by the fragments of proboscidean enamel found in the same collection as the other artifacts of Clovis affinity. It should be noted that sea level was considerably lower 13,000 years ago than it is today due to the large volume of water taken up in Late Pleistocene ice sheets. As such, the area encompassed by Liberty County today was more of an open grassland prairie and would have been much less wooded 13,000 years ago (Ricklis and Weinstein 2005).

Trace element geochemical analysis of the Clovis artifacts from the Wood Springs site could not unambiguously show that they are made from Edwards chert. Thus a geochemical relationship to artifacts found at the Timber Fawn Clovis site (41HR1165) located less than 50 km to the west in Kingwood, Texas, could not be proven (Crook et al. 2016). Clovis sites with eastern Edwards Plateau cherts have now been found at the Hogeye cache in Bastrop County (Waters and Jennings 2015), at the Timber Fawn site in Harris County (Crook et al. 2016), in Polk County (Williams and Crook 2013), and at McFaddin Beach in Jefferson County (Long 1977; Williams and Crook 2013). The location of these occurrences indicates a possible southeastward movement from the Edwards Plateau which may represent seasonal journeys to collect salt along the Gulf Coast while hunting large game animals along the way (Crook et al. 2016). The possible connection between the Clovis occupation at Wood Springs and other sites east of the Edwards Plateau is intriguing and may represent a movement pathway across Southeast Texas. Hopefully, expansion of the geologic database at the GSAR XRF laboratory will ultimately show a connection between the artifacts at Wood Springs and those from other Clovis sites, including Timber Fawn.

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Shelters in Space: A Study of How Rockshelters Affect Settlement Patterns in the Big Bend Region of Texas

Caitlin Gulihur

In July and August 2015, 400 hectares of land in the eastern part of Brewster County received a 100 percent pedestrian survey. Thirty-three prehistoric sites were recorded in the 16 surveyed quadrats. Sixteen are rockshelters, seven are lithic procurement sites, six are open campsites, and four are lithic scatters. The sites, dated using temporally diagnostic projectile points, ranged in age from the Middle Archaic to the Late Prehistoric. The locational information of these sites was then analyzed using statistical and geospatial methods in order to determine if the location of open sites—lithic procurement sites, lithic scatters, and open campsites—are influenced by the presence of rockshelters. The statistical and geospatial analyses show a strong positive correlation between the location of rockshelters and the location of open sites. While a causal relationship cannot be proven, it is clear that open sites are located near rockshelter sites located in fixed geological features. This indicates that the prehistoric hunter-gatherers of the Big Bend chose to position their open sites in areas which were easy to access from a rockshelter.

Settlement Pattern Studies in the Big Bend Region of Texas

The Big Bend region of Texas is a large expanse that is relatively poorly known archeologically, especially when compared to surrounding regions in the United States. Most large-scale archeological investigations have focused on Big Bend National Park and Big Bend Ranch State Park, in western and southern Big Bend. The rest of the region, including the area around the research area (Figure 1), lacks detailed archeological data.

One of the largest archeological surveys in the eastern part of the Big Bend region was William Marmaduke's (1978a) Bear Creek survey, which contains important information about settlement patterns. Marmaduke noted that site density for each time period seemed to increase throughout time and made the case that the two environmental zones that he surveyed, the ridgeline and the valley, experienced alternating periods of use.

Other than this inferred increased site density through time, which also has been noted by Mallouf (2005:230), little has been done in terms of

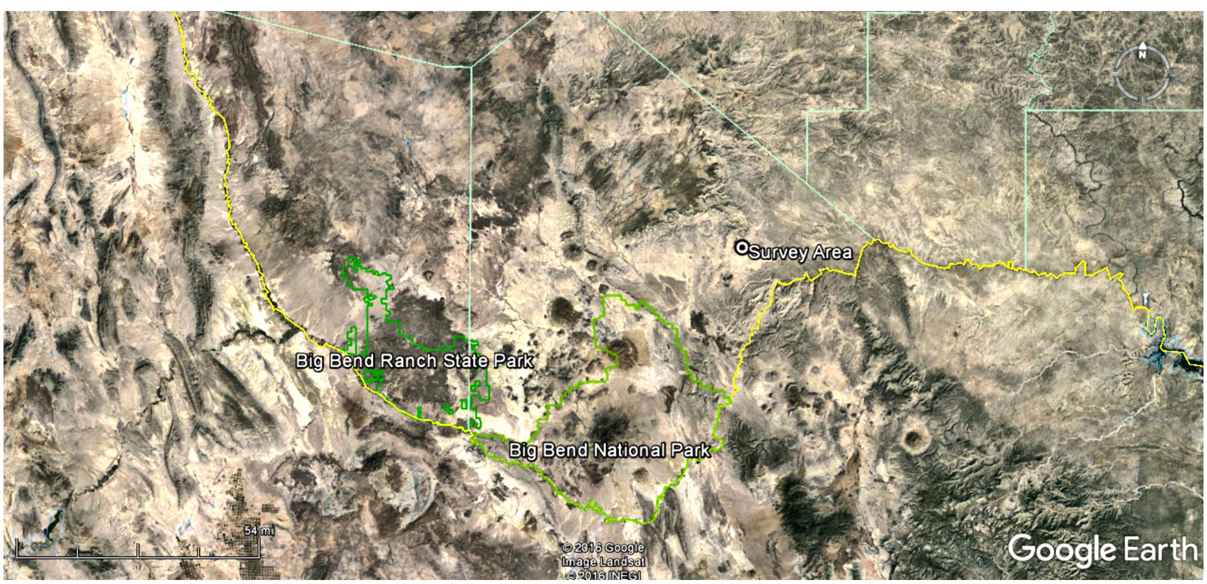

Figure 1. Location of survey area compared to Big Bend National Park and Big Bend Ranch State Park.

researching settlement patterns in the region. It has been observed that Late Prehistoric Cielo Complex sites tend to be located on hilltops (Mallouf 2013:50), and that mountaintops were preferred ritual site locations (Mallouf 2005:235). Most mountaintop ritual sites date to the Late Prehistoric, but some date to the Late Archaic or earlier. As for the Late Archaic, sites of this age are thought to be located in rockshelters and near springs and dry basin arroyo systems (Mallouf 2005:230-231). Other archeologists have noted that Middle Archaic sites tend to be clustered around springs, and occasionally rockshelters (Ohl 2011:82). Although not strictly a settlement pattern survey, a recent study hypothesized that certain sites were inhabited to take advantage of areas with high ecological variability within a day's forging distance (Riggs 2014:19).

Other inferences can be made by examining survey reports from the Big Bend region. During a survey of a small area of Big Bend Ranch State Park, Ohl and Cloud (2001:73-74) noticed that open campsites exhibited strong clustering near large drainages. Notably, no rockshelters were recorded on this survey. Another survey in Big Bend Ranch State Park, this time focusing on the Upper Fresno Canyon Rim, recorded the vast majority of the sites in the foothills region (Sanchez 1999:43). A large scale survey of Big Bend Ranch State Park described the vast majority of open campsites as being in the foothill region, less than 300 m from a water source (Ing et al. 1999:80). That same report also noted that while most occupied rockshelter sites were located near water sources, some were located very far away from water and thus either other ecological resources or the rockshelter itself must have been more important than easy access to water (Ing et al. 1999:85).

The strong tendency for sites to be located near water is unsurprising, given the desert environment. It has been theorized that the hunter-gatherers in the Big Bend practiced mobility patterns tethered to water sources (Taylor 1964). Other resources that may have tied prehistoric peoples to an area should also be considered. Patch-choice models state that resources are not evenly distributed on the landscape, and hunter-gatherers must balance the energy necessary to reach resource patches with the energy they will gain from exploiting them (Bettinger 1991:87-90). Central place foraging models take this one step further by taking into account the time necessary to reach these patches, exploit the resources, then to return to the starting point (Bettinger 1991:93-97).

These optimal foraging theories can be considered in light of the previously mentioned site data from the Big Bend. The tendency for sites to be located in the foothills, even in areas without easy access to water, can be understood as the inhabitants positioning themselves on the landscape in such a way that they can take advantage of several different resource patches from one central place. Foothills themselves are often areas with high densities of sotol and lechuguilla, important food resources (Maxwell 1968:94). In the context of this study, rockshelters can be thought of either as central places from which to forage, or as resource patches offering shade and cooler temperatures in the summer, warmer conditions in winter, and shelter from rain. Whether rockshelters are convenient central places from which to forage or resources unto themselves, it stands to reason that these sites would have a strong effect on the settlement and subsistence patterns of local hunter-gatherer populations.

Environmental Setting

The Big Bend is a unique and complex area of Texas. Geologic processes have shaped a dramatic landscape while creating several resources, such as rock shelters and stone for tools, which are vital for human habitation. Lying within the Chihuahuan Desert, this is a hot, dry climate with little rainfall, generally mild winters, and harsh summers. In this section, the geology and geoarcheology of the region are discussed. Information about the climate, flora, and fauna is also summarized.

Geology

The Big Bend region has a complex geological history. Although the hard rock geology of the area has been extensively studied (Henry 1998; Maxwell et al. 1967; Maxwell 1968; Turner et al. 2011), the Quaternary geology and geoarcheology of the region was most extensively studied and described in Kelley et al. (1940). This report is one of the seminal works of the region. An article by Claude Albritton and Kirk Bryan (1939) defined the allostratigraphic units upon which Kelley et al. (1940) based their observations. Although Albritton and Bryan (1939) based their descriptions on sediments seen in the Davis Mountains, Kelley et al. (1940) applied the sequence to sediments they observed at buried sites throughout the Big Bend region. Marmaduke (1978b) found these sediment layer identifications to be accurate in his investigations across the region.

Albritton and Bryan (1939) identified three allostratigraphic sediment and soil layers, separated by periods of erosion. The oldest of these layers, the Neville formation, was deposited during a period when the climate was wetter than in the present and contained remains of mammoths and ancient horses and is clearly Pleistocene in age. The next oldest layer, the Calamity formation, contains only modern forms of fauna. The youngest layer is the Kokernot formation.

Kelley et al. (1940:91) did not find any archeological materials associated with the Neville formation, although given that it likely dates to the Pleistocene, it is possible that early Paleoindian remains could be preserved in the formation. They did describe several sites contained in the Calamity formation. Kelley et al. (1940:91) described these sites as related to the Santiago complex or Pecos River focus; today they would be described as Middle Archaic sites. As for the Kokernot formation, at least one site was believed to be associated with an historic ranching complex, as faunal bones embedded in the formation were believed to be from cows (Kelley et al. 1940:96).

Climate

Today, most of the Big Bend region is classified as subtropical arid, with a few higher elevation areas classified as mountain climates (Larkin and Bomar 1983:2). Modern temperatures in the Big Bend Region vary little year to year; annual and diurnal temperature ranges are fairly wide (Schmidt 1986:44-45). As is expected for a desert region, rainfall throughout the year is generally low, with most rainfall occurring in the late spring and summer months, with occasional winter snowfalls more common at higher elevations. The highest average temperatures occur in May and June, while the lowest are in January (Larkin and Bomar 1983). The average annual low ranges from 50-55 degrees Farenheit, the average annual high is over 80 degrees Farenheit, and the wind blows constantly, with some strong gusts (Larkin and Bomar 1983).

Flora and Fauna

All of the Big Bend region lies within the Chihuahuan Desert, and has incredibly diverse vegetation. The region contains multiple ecological zones divided by elevation as well as vegetation (Wauer and Fleming 2002:21-22). The plant communities range from low elevation desert scrub communities to montane woodland communities (Henrickson and Johnston 1986:20). These different vegetation communities grade into one another, based on geology and elevation. Of course, the vegetation of a region affects the fauna also present in that region.

At 1800-4000 feet in elevation is the River Floodplain-Arroyo Formation along the Rio Grande and its tributaries (Wauer and Fleming 2002:22). The plants here are mostly dense, broadleaf trees and shrubs. The Shrub Desert Formation lies at 1800-3500 feet in elevation (Wauer and Fleming 2002:22). Vegetation is sparse, with succulents and semi-succulents dominating (Wauer and Fleming 2002:22). The third major vegetation zone is the Sotol-Grassland Formation, from 3200-5500 feet in elevation (Wauer and Fleming 2002:24). The plants of the Shrub Desert Formation continue into this zone with the addition of grasses (Wauer and Fleming 2002:24).

The Woodland Formation occurs at 3700-7800 feet in elevation (Wauer and Fleming 2002:25). This high elevation vegetation zone contains broadleaf and coniferous trees (Wauer and Fleming 2002:25). The rarest vegetation zone is the Moist Chisos Woodland Formation, which lies at a similar elevation as the Woodland Formation (Wauer and Fleming 2002:25). It consists of high elevation canyons with forest vegetation (Wauer and Fleming 2002:25). The Shrub Desert Formation and the Sotol-Grassland Formation, when taken together, comprise the vast majority of the Big Bend region. The Big Bend area is home to diverse animal species, ranging from the fish in the Rio Grande to the Carmen Mountains White-Tailed Deer (*Odocoileus virginianus carminis*), a species of deer only seen in the mountain woodlands.

Culture History

The cultural history of the Big Bend is divided into the Paleoindian, Archaic, Late Prehistoric, Protohistoric, and Historic periods. The Paleoindian period is divided into the early and late periods, while the Archaic is divided into early, middle, and late periods. Kelley et al. (1940) did not use these terms, but they did describe several cultural aspects and phases within the Midwestern taxonomic system (McKern 1939), then called foci. Most of these cultural groups (e.g., Pecos River focus, Livermore focus, La Junta focus) are from the Late Archaic and Late Prehistoric. Although the terms that Kelley et al. (1940) coined are still in use (Cloud and Piehl 2008:17-28) today, many reports from the area use the more generalized terms of Middle Archaic or Late Archaic.

Paleoindian

Paleoindian remains are rare throughout the Big Bend region. Even inspections of projectile points in private collections from the region yield few Paleoindian points and virtually all are from the late Paleoindian period (Gray 2013:15). Few Paleoindian sites have been found, and it is speculated that this is due to the depths these sites are likely to be buried (Mallouf 1986:70). Recently, two late Paleoindian sites have been excavated near Alpine (Cloud 2012; Mallouf 2012; Walter and Cloud 2014). Besides their potential to shed light on a little known time period of the region, these sites are particularly interesting for a different reason. Both the Genevieve Lykes Duncan site and the Searcher site, located within three miles of each other, show evidence for the use of hot rock cooking features, something unusual for the Paleoindian period. The earliest reported date for the Genevieve Lykes Duncan site is 9480±40 B.P. (Walter and Cloud 2014:8). The earliest feature at the Searcher site dates to 7280-7050 B.C. (Mallouf 2012:3). The Genevieve Lykes Duncan site, the oldest recorded site in Brewster County, also reportedly contained metate fragments (Cloud 2012:2). This is also unusual, as the use of ground stone is not typical for the Paleoindian period. These sites are also interesting in that they give evidence for the theory that the eastern Big Bend may have been the site for the earliest transition from Paleoindian to Archaic hunter-gatherer lifestyles in Texas (Mallouf 1981:12). Another site with a Paleoindian component, located in the Chisos Basin in Big Bend National Park, dated to 8890±90 B.P. (Alex 1999:10).

Early Archaic

Like the preceding Paleoindian period, the Early Archaic is not well known in the region. The same studies of projectile points in private collections reveal a similar lack of Early Archaic points (Gray 2013:15). This might indicate that Early Archaic deposits are deeply buried, although the lack of data about this time period has been noted as being unusual (Mallouf 1986:71). In general, the Early Archaic is characterized by an increasing reliance on plant resources that required processing to be edible (Miller and Kenmotsu 2004:221). Thus, there is a corresponding increase in the use of earth ovens and grinding stones. In addition, the Early Archaic also marks the transition from lanceolate-shaped projectile points to stemmed points. Despite the general lack of information from the Early Archaic, it seems clear that it was during this period that the Archaic hunter-gatherer lifestyle for the region was developed. Nine sites from the Big Bend region have been dated to the Early Archaic, with dates ranging from 7750-7580 B.P. to 5290-4850 B.P. (Boren 2012:109).

Middle Archaic

The Middle Archaic is analogous to what Kelley et al. (1940:24-27) called the Pecos River focus of the Big Bend Cave aspect. This time period in the Big Bend region is not well understood. Despite the general lack of data, it seems to be apparent that the Middle Archaic represents a period of increasing population due to increasing numbers of sites, as well as the exploitation of a wide range of environmental zones (Sanchez 1999:33-34). Although the Middle Archaic groups might have utilized a wide range of environments, there was a definite preference for the foothills (Ohl 2006:15). This is likely related to an increased reliance on desert succulents. Contracting stem dart points are the typical projectile point for this time period.

Late Archaic

The Late Archaic is better represented in the archeological record than the earlier time periods for this region. This time period corresponds with what Kelley et al. (1940:27-29) called the Chisos focus of the Big Bend Cave aspect. Buried deposits from the Late Archaic have been dated from 2500 to 1300 B.P. (Mallouf 2005:226). In general, this time period was characterized by increasing population and the utilization of a wide range of economic zones. The climate at the time was characterized by a shift towards more mesic conditions, before a more xeric climate was retrenched during the latter part of the Late Archaic. In terms of projectile points, the contracting stem points of the Middle Archaic are replaced by side-notched to parallel stemmed dart points. Although Late Archaic people certainly exploited desert succulents, the variety and density of Late Archaic dart points suggests that they also heavily focused on hunting (Mallouf 2005:238).

Despite the discovery of Late Archaic sites from rockshelters near the Rio Grande (Mallouf and Tunnell 1977) to the tops of mountains (Mallouf et al. 2006), and the widespread and highly archeologically visible remains of earth ovens, the Late Archaic remains poorly defined. This seems unusual at first, considering the impressive site density for the region (Mallouf 2005:230). It is more understandable when it is taken into account that Late Archaic people heavily utilized rockshelters. Many of these deposits of Late Archaic material were excavated in the early days of archeological research in the area and the scientific data from these excavations are minimal. In general, the Late Archaic is thought to represent a period of long-lived adaptations to life in the desert, with an increased focus on desert succulents in response to population pressures and the increasingly xeric environment in the latter part of the time period (Ohl and Cloud 2001:27-28).

Late Prehistoric

The Late Prehistoric period has been more heavily researched and defined than earlier time periods. This is primarily due to the interest in the La Junta region and the Cielo complex (Ing et al. 1996:26-27). In addition, the Late Prehistoric was a time of cultural change, making it easier to recognize archeologically without having to utilize temporally diagnostic projectile points. This time period marked the beginnings of agriculture in the region, the introduction of the bow and arrow, and the increased significance of ritual sites (Mallouf 2005:235). While there is some evidence for the origin for several of these traits in the Late Archaic, it is in the Late Prehistoric when these cultural patterns fully developed.

The Cielo complex, one of the rare cultural phases not defined by Kelley et al. (1940), is the archeological manifestation of a mobile hunter-gatherer group that ranged across the Big Bend. The Cielo complex is particularly defined by the presence of circular to oval-shaped above ground wikiup foundations that typically have narrow entrances (Mallouf 1986:75, 2013:48-50). These features are present at Cielo complex base camps and short term campsites. These sites tend to be located on elevated areas (Cloud 2013:154), and the stone structures are occasionally found in lowland settings (Lintz 2014).

One general trend in the Late Prehistoric is the introduction of the bow and arrow, evidenced by the regional change in projectile point styles from dart points to arrow points. It is important to note that there is evidence of the use of atlatls, and therefore dart points, into the Late Prehistoric (Mallouf 2005:228). This indicates a level of technological continuity despite the innovation of the bow and arrow. The continued use of the atlatl is not the only evidence for cultural continuity in the area. The relative abundance of ritual sites in the Late Prehistoric has roots in the Middle Archaic, with some sites seeing repeated ritual usage (Mallouf et al. 2006:133). However, maize agriculture is considered unique to the Late Prehistoric, as archeological evidence for maize in the Late Archaic lacks secure context even though it is well documented at that time farther west (Mallouf 2005:238; Hard and Roney 1998). The use of ceramics is another aspect that divides the Late Prehistoric from the Late Archaic.

Previous Research

Previous research on the ranch that contains the study area is limited. In the early 1960s Colonel Thomas C. Kelly studied several rockshelters in the area, testing some and excavating others more fully (Kelly 1963; Kelly and Smith 1963). Three of the shelters excavated were assigned site trinomials: 41BS1, 41BS2, and 41BS3. Kelly's work was not part of a systematic survey. He only studied rockshelters, and made no mention of any open sites. He selected the rockshelters to study by consulting with the landowners (Kelly and Smith 1963:167). The sites studied by Kelly received varying amounts of investigations. Kelly's Cave Numbers 1 and 2 were tested with a single test pit (Kelly and Smith 1963:168). Cave Number 4 (41BS2) was more thoroughly excavated. This was the only site that Kelly noted had not been disturbed.

Cave Number 3 (41BS1) was partially excavated, and was also located in a quadrat that was surveyed during the course of my research.

Temporally diagnostic projectile points such as Langtry, Paisano, and Livermore found during the excavations at this rockshelter date the use of this site from the Middle Archaic to the Late Prehistoric.

The site that is the best reported is Roark Cave (41BS3, Kelly 1963). The site contained numerous bedrock grinding features that ranged from shallow depressions to deep bedrock mortars. Excavations inside the cave revealed a grass-lined pit, which Kelly speculated was used for food storage. Projectile points found included Langtry, Ensor, Paisano, Livermore, and Perdiz, and date the use of the site from the Middle Archaic to the Late Prehistoric.

Methodology

After a pre-fieldwork reconnaissance trip in order to determine the survey area, fieldwork was carried out using a systematic sampling strategy. Areas both with and without rockshelters were surveyed. All sites found were recorded using GPS units, as GIS information was critical to answering the research question. Statistical analysis methods, such as Chi-square tests, were also utilized.

Pre-Fieldwork Methodology

Stovall Ranch is an 80,000 acre private ranch located in eastern Brewster County encompassed by the Shrub Desert and Sotol-Grassland Formations. There have been no archeological surveys in the ranch. Despite the lack of large scale archeological surveys, many of the sites on the ranch are well known to the landowner. Previous to this research, three sites had been recorded on Stovall Ranch: one open campsite (41BS987) and two rockshelters (41BS1, 41BS3).

During a reconnaissance trip, two areas on the ranch stood out as having both a large number of rockshelters, and easy access. The ease of access to these two area was considered to be vital due to the remoteness of the ranch and the small size of the survey team, in case of any accidents. The locations of the rockshelters found on this reconnaissance survey were recorded with a Trimble Juno 3B GPS unit, but not studied or documented in any detail. The two survey area boundaries were placed in such a way that they encompassed the largest potential number of rockshelters and the greatest possible variation of terrain types. The two survey areas were each divided into 25 500 x 500 m blocks, resulting in 50 potential survey quadrats 25 hectares in size. The survey areas were plotted in ArcMap before being imported into the Trimble GPS unit so that the survey quadrats could be easily located while in the field.

As the entire area could not be surveyed, a 20 percent random sample was deemed appropriate given the available time and crew size; five quadrats in each survey area were selected for archeological survey. As the research focus is concerned with rockshelters, it was necessary that the randomly selected survey quadrats contain some of the known rockshelters. Thus, one quadrat with a marked rockshelter and four quadrats without marked rockshelters were selected in each survey area.

Within this stratified sampling strategy, the surveyed quadrats needed to be randomly selected to avoid researcher bias. To accomplish this, quadrats without rockshelters located on the preliminary trip were sequentially numbered in each survey area, and four quadrats were randomly selected using a random number generator (random.org). In the northern survey area, quadrats 1-21 were the ones that did not contain a rockshelter marked in the reconnaissance survey. In the southern area, quadrats 1-22 were the quadrats without rockshelters. Then, the remaining quadrats with known rockshelters were also sequentially numbered and one was selected using the same random number generator. Quadrats 22-25 were the rockshelter quadrats in the northern survey area, and quadrats 23-25 were the ones with rockshelters in the southern area. During the course of the survey, quadrats were referred to by their assigned numbers with the prefix N or S depending on whether they were in the northern or southern survey area (Figures 2 and 3).

After the survey of the original 10 survey quadrats, six additional quadrats were added. This time, three rockshelter and three non-rockshelter quadrats were selected to be surveyed. As the northern survey area had a greater number of quadrats with marked rockshelters, two rockshelter quadrats and one non-rockshelter quadrat were selected using the previously described random selection method. In the southern survey area, two non-rockshelter quadrats and one rockshelter quadrat were randomly selected using the random number generator (see Figures 2 and 3).

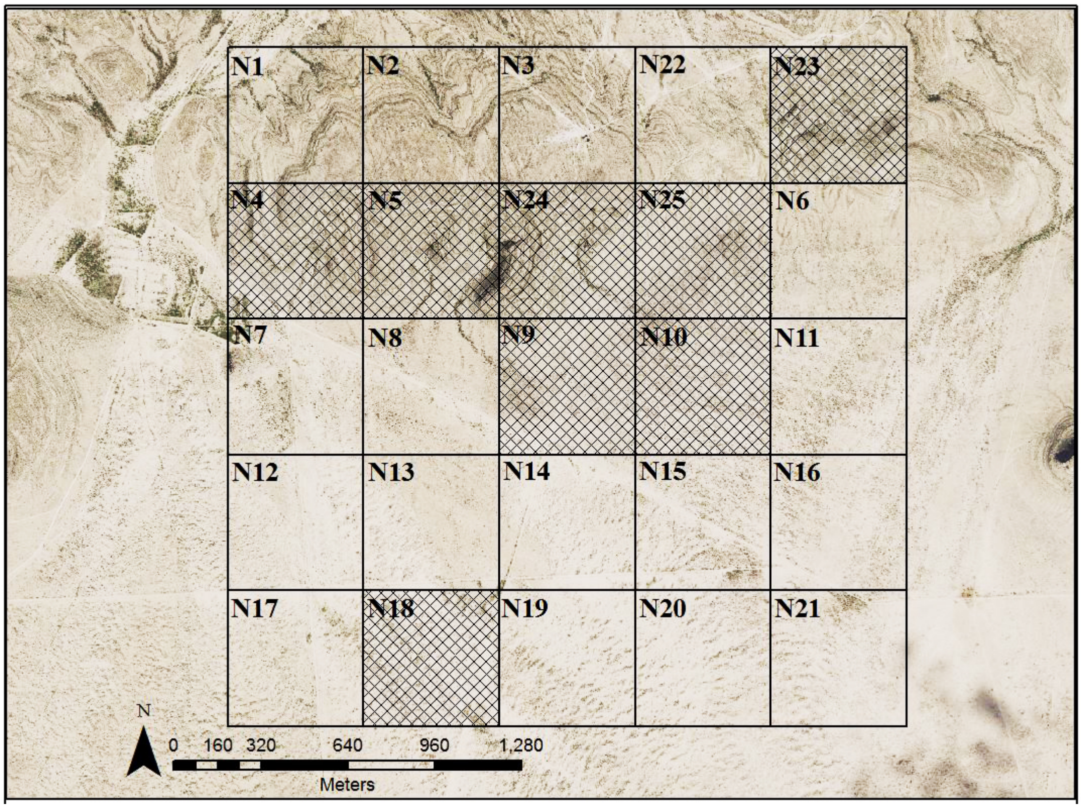

Figure 2. Selected quadrats in the northern survey area.

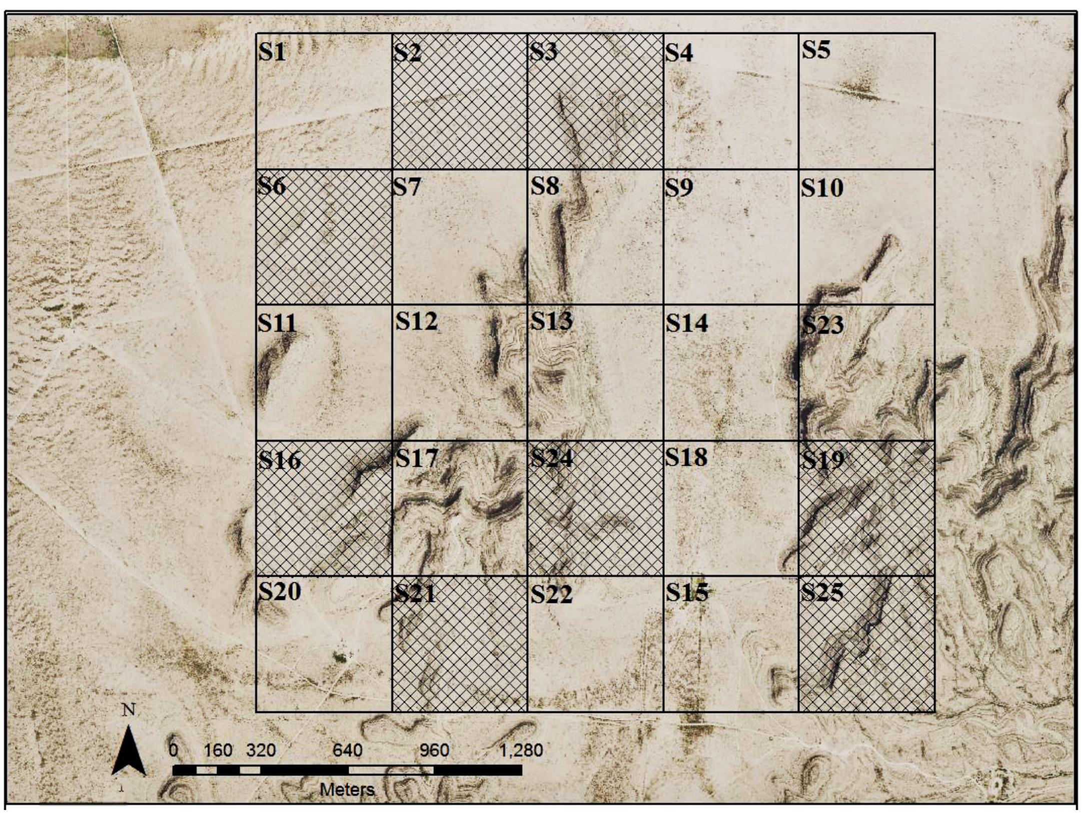

Figure 3. Selected quadrats in the southern survey area.

Fieldwork Methodology

The survey grid, along with a background map, were loaded into a Trimble Juno 3B GPS unit running TerraSync software. When the survey quadrat for the day was selected, the GPS unit was used to locate whichever corner of the survey quadrat was most easily accessible. In areas of flat, or relatively easy to walk terrain, the crew surveyed in a north-south pattern, spaced at intervals of 10-15 m. This spacing was appropriate given that the aim of this survey was to locate sites, not isolated finds. Given the steepness of the hill slopes, survey in these areas was concentrated on the areas likely to contain rockshelters, such as just under the hill rim. Hilltops were surveyed by walking with the landscape contours of the hilltop topography, as straight survey transects were often not practical. As only one Trimble unit was available, the person holding the unit was responsible for making sure the entire survey quadrat had been covered. No shovel tests were used in the survey, as is typical for surveys in the area due to good ground surface visibility because of sparse vegetation and the general presence of shallow soils or exposed bedrock (Ing et al 1996:73-78; Sanchez 1999:39-40; Ohl and Cloud 2001:38-39). In addition, most post-Pleistocene sediment depositions occur near the Rio Grande or large drainages, neither of which are located near the survey area (Turner et al. 2011:9-12).

If fewer than 10 artifacts were found in a 5 x 5 m area, it was called an isolated find. Isolated finds were given the prefix IF and then numbered sequentially in the order that they were found. Isolated finds were photographed, marked with a GPS point, and briefly described in the day's survey notes, but were not extensively studied or documented. If any discrete locale with 10 or more artifacts in a 5 x 5 m area was found, it was classified as a site. When a site was found it was classified according to site type (Table 1). Sites were identified in the field with a prefix that designated the site type, and then sequentially numbered with a temporary field number within the specific group site types. Open campsites were given the abbreviation OC, lithic scatters were LS, procurement/quarry sites were designated LP, rockshelters were RS, and the one historic dam recorded was given the prefix HD. Although two rockshelters did have some examples of rock art, their primary function was not deemed to be as a rock art site, thus those sites were given the standard rockshelter prefix.

Statistical Analysis Methodology

In order to determine if the number of sites found in rockshelter quadrats was significantly different than the number of sites in quadrats without rockshelters, statistical tests were necessary. As site counts are nominal data, Chi-square tests are the most appropriate tests to determine statistical significance. A Chi-square goodness of fit test was completed to determine whether the difference in the number of sites in quadrats with rockshelters and quadrats without rockshelters was statistically significant. Yates' correction for continuity was then run. To determine whether different types of open sites are influenced differently by

Table 1. Site definitions.

Site Type	Description
Open Campsite	Sites containing artifacts and features, such as bedrock grinding features, burned rock middens, or other stone features
Lithic Scatter	Sites which contain lithic artifacts but lack features
Lithic Procurement Site	Sites where activities such as quarrying activities or primary reduction are observed
Rockshelter	A habitable and protected space in bedrock or large boulders that has signs of human utilization, either in the form of artifacts or features
Rock Art Site	Sites with pecked or painted rock art
Historic Site	Any site with historic artifacts or features
Isolated Finds	Any discrete locale with less than 10 artifacts in a 5 x 5 m area

the presence of rockshelters, a Chi-square test of independence was completed. All statistical tests were run in Microsoft Excel using the Real Statistics add-in.

Geospatial Analysis Methodology

To answer the question of how rockshelters affect the location of open sites, a form of geospatial analysis was necessary. Cost distances created in ArcMap were deemed to be the most appropriate geospatial analysis to employ to answer this question, as it breaks down areas into how difficult they are to travel to from a particular feature based on elevation changes. To accomplish this, the locational information for the sites found on the survey was uploaded to ArcMap 10.4, then divided by survey area and site type. The survey areas were also uploaded into the program.

Several steps are necessary in ArcMap to create cost distances. First, a raster layer containing elevation data is required. The 10 m Dove Mountain USGS Digital Elevation Model (DEM) quadrangle was downloaded from the U.S. Department of Agriculture's Geospatial Data Gateway; this file was then added to ArcMap. Next, a file containing information about the change in elevation was made. This was done using the Slope tool, located in Spatial Analyst toolbox under Surface tools. The Dove Mountain DEM was the basis for determining the slope; in order to reduce the time necessary to run this analysis, the processing extent was clipped to the north survey area boundaries. Thus, these steps had to be repeated for the south survey area.

Once slope layers for both the north and south survey areas were completed, the next step was to create the cost distance layers. This required the Cost Distance tool, located in the Spatial Analyst toolbox under Distance tools. The input feature class was the point shapefile of the rockshelters, and the input cost raster was the slope raster, created in the previous step. Again, the processing extent was clipped to the survey boundaries. To avoid researcher bias, the default settings of the Cost Distance tool were not changed; the tool created 10 cost distance classes at equal intervals. Originally, cost distances were going to be created based on potential water sources as well, but no permanent or intermittent streams are recorded on the Dove Mountain USGS quadrangle within either survey area.

Results

Thirty-three prehistoric sites were found during the course of this survey. Twenty-one sites are located in the north survey area, and 12 are located in the south survey area. Sixteen sites were rockshelters, six sites were classified as open campsites, four were lithic scatters, and seven sites were lithic procurement sites.

Chi-Square Goodness of Fit

To determine whether site frequency recorded in those quadrats with rockshelters was significantly different than site frequency recorded in quadrats without rockshelters, a Chi-Square Goodness of Fit test was conducted. The null hypothesis (H0) was that there is no difference in the frequency of sites between these two categories. The alternate hypothesis (H1) was that there was a significant difference in the frequency of sites between quads with rockshelters and those without. The number of survey quadrats was used to estimate the expected number of sites in each category (e.g., expected number of sites in quadrats with rockshelters = 7/16*33, with 7 being the number of quadrats containing a rockshelter, 16 being the number of rockshelters, and 33 being the total number of sites). The Chi-Square Goodness of Fit (Table 2) resulted in a value of 25.92, degrees of freedom=1, p value = 0.0000004, after applying the Yates correction

Table 2. Chi-Square Goodness of Fit test combined north and south survey area quadrants.

	Number of Quadrats	Number of Sites Observed	Number of Sites Expected
Quads with Rockshelters	7	29	14.4
Quads without Rockshelters	9	4	18.6
Totals	16	33	

for continuity (Madrigal 2012:175). This indicates, with a very high degree of statistical certainty, that these samples are significantly different; the null hypothesis can be rejected and the alternate hypothesis that rockshelters affect non-rockshelter site distributions can be accepted.

Chi-Square Test of Independence

After the Chi-Square Goodness of Fit test determined that there was a significant difference between the numbers of sites in quadrat with and without rockshelter quadrats, I examined how different site types are located across the landscape and how they are distributed within these two categories. In order to determine this, a Chi-Square Test of Independence (Table 3) was calculated. Lithic procurement sites, lithic scatters, and open campsites were all considered in this test. To have a statistically significant data set, rockshelters were included as either lithic scatters or open campsites based on which site description they better fit. The null hypothesis (H0) was that there is no difference in the number of sites based on site type between quadrats with and without rockshelters. The alternate hypothesis (H1) was that there is a difference in site numbers based on site type between quadrats with and without rockshelters.

When the Test of Independence was calculated (see Table 3), it resulted in a p-value of 0.015 (χ^2 values of 8.457, df = 2). This indicates a significant difference in the number of sites in quadrats with and without rockshelters based on site type; the Cramer's V= 0.506 indicates only that it is a moderate, not a strong, pattern. However, this does not indicate which types of sites are significant. To determine that, adjusted residuals must be considered. An adjusted residual value of 1.96 and higher or -1.96 and below is considered to be statistically significant. After adjusted residuals were determined for this data set (Table 4), it became clear that the values for two site types influence the significant result in the Test of Independence. There are significantly more lithic procurement sites found in quadrats without rockshelters and significantly more open campsites found in quadrats with rockshelters than would be expected if the distributions were even. Lithic scatters are not patterned spatially in relation to rockshelters.

Geospatial Analysis

In addition to the statistical analyses described above, a form of geospatial analysis was undertaken. As the driving research question behind this survey was how rockshelter locations affect where other sites are located on the landscape, a method analyzing the distances between rockshelters and other sites was necessary. Since the topography of an area influences how people move on a landscape and how much effort it takes them to move from one location to another, a method that takes

Table 3. Observed and expected values for Chi-Square Test of Independence (Observed/Expected).

	Quadrats without Rock shelters	Quadrats with Rockshelters	Totals
Lithic Scatter	1/1.21	9/8.79	10
Lithic Procurement	3/0.85	4/6.15	7
Open Campsite	0/1.94	16/14.06	16
Totals	4	29	33

$\chi 2$ = 8.457, df = 2, p value = 0.015, Cramer's V=0.506.

Table 4. Adjusted residuals for Chi-Square Test of Independence.

	Quadrats without rock shelters	Quadrats with Rockshelters
Lithic Scatter	-0.25	0.25
Lithic Procurement	2.81	-2.81
Open Campsite	-2.07	2.07

into account the changes in elevation along these distances was vital. Thus, it was decided to analyze the sites in the survey areas using cost distances from rockshelters. Cost distances from water sources were not calculated, as the Dove Mountain USGS topographic quad does not contain any marked permanent or intermittent streams within either survey area.

North Survey Area

When the northern survey area is analyzed using cost distances from rockshelters, the results are striking (Figure 4). The cost distances are represented on a gradational scale with the blues indicating low cost distances, the greens are medium cost distances, and yellow, orange, and red indicate increasingly higher cost distances. Eight of the 10 open sites fall into the lowest four cost distance categories from rockshelters. Two of the three open campsites, including the largest open campsite recorded during the survey, lie within the second cost distance from the rockshelters. The pattern continues to hold true when the actual pattern of the survey, the light gray cross-hatched areas, is taken into consideration. Several areas of high cost distance were surveyed, with no sites being found in these areas. If lithic procurement sites are excluded from the analysis, using the logic that their location is more a function of geology than of human choices, the results become even more striking (Figure 5). All of the lithic scatters and open campsites lie within the lowest four of ten cost distances from rockshelters.

South Survey Area

When the cost distances from rockshelters in the south survey area are analyzed, the results are almost as striking (Figure 6) as those of the north survey area. Four of the seven open sites are located in the lowest three of 10 cost distance categories from rockshelters. All of the open campsites are located in areas of low cost distances. Like the north survey area, the pattern remains striking when the surveyed areas, the cross-hatched areas, only are considered. When lithic procurement sites are not considered (Figure 7) in the analysis, four of the five sites are located in the lowest three cost distance categories. A small lithic scatter is the only site that lies at a much higher cost distance.

Conclusions

Results of statistical and geospatial analyses of the possible effect of rockshelter locations on the landscape relative to open sites in eastern Brewster County in this exploratory study are very promising. Statistical analysis showed that there was a significant difference in the number of sites between survey quadrats that contained rockshelters and those that did not. Other statistical analyses showed that there was a significant lack of open campsites in quadrats that did not contain rockshelters. As for the geospatial analysis, cost distances on the Stovall Ranch north and south survey areas showed a strong tendency for open sites, especially open campsites and lithic scatters, to be located at low cost distances from rockshelters.

The statistical and geospatial analyses suggest a strong correlation between the locations of rockshelters and open sites, especially open campsites and lithic scatters. This indicates that prehistoric hunter-gatherers in the Big Bend region tended to locate their open sites near rockshelters. This tendency could either be because the rockshelters acted as convenient central foraging places, or because the rockshelters were themselves important resources, providing shade and cooler temperatures in summer, warmer temperatures in winter, and protection from rain. However, the case for a causal relationship between these variables should not be forced. That being said, a positive correlation could be used as the basis for a predictive model in the future.

Like all studies, there are some issues which must be taken into account when considering this research. The Stovall Ranch survey should be seen as a preliminary survey and analysis. The area surveyed was a little under 1,000 acres and by necessity focused on areas that had large numbers of rockshelters. While this means that the influence of the rockshelters' locations was strongly felt, it also means that how sites at distances far from rockshelters are patterned was not studied. The small survey area only had 33 sites that were recorded; this small sample size makes it difficult to make conclusions with statistical certainty and the discerned patterns may not be robust. In addition, the question of how these patterns change through time was not able to be determined, as the ages of only a few sites could be determined during the survey work.

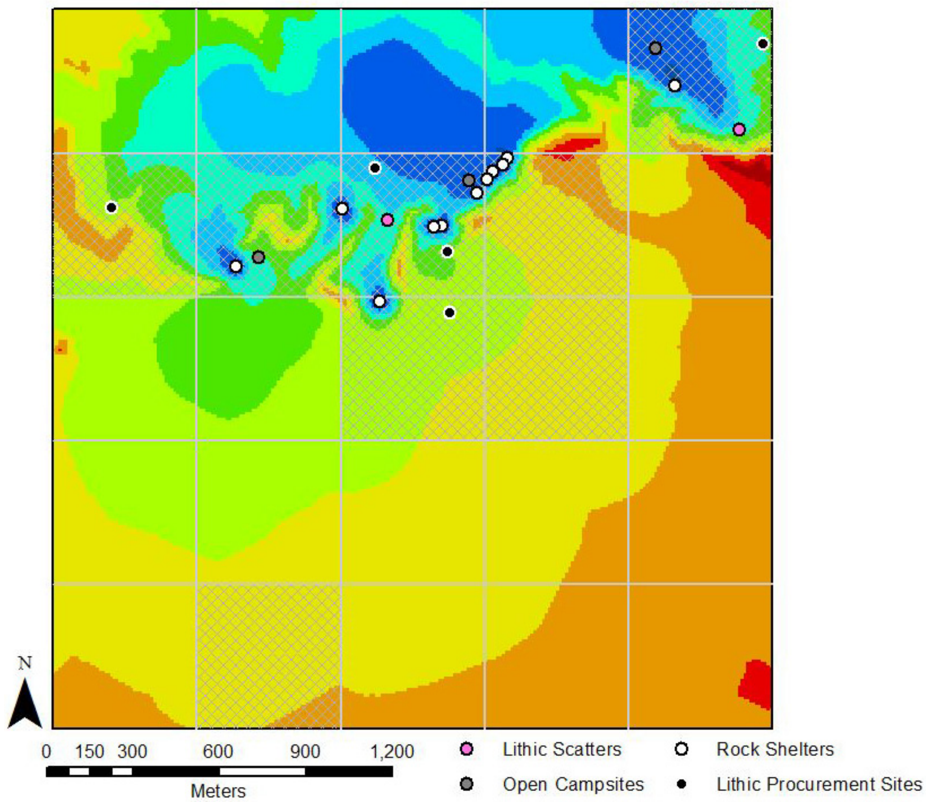

Figure 4. Cost distances from rockshelters in the northern survey area.

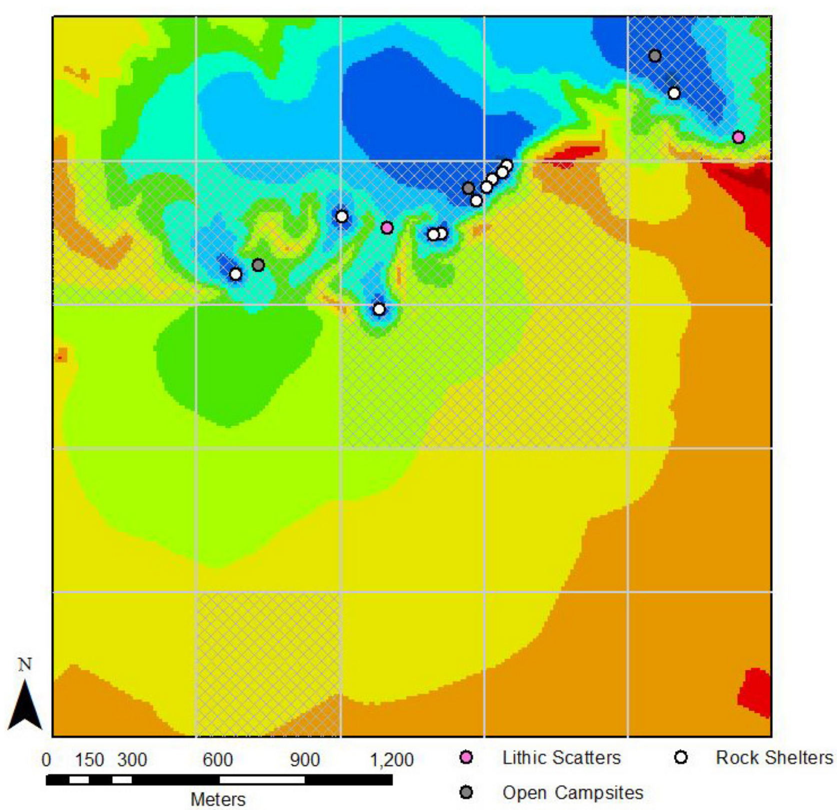

Figure 5. Cost distances from rockshelters in the northern survey area, excluding lithic procurement sites.

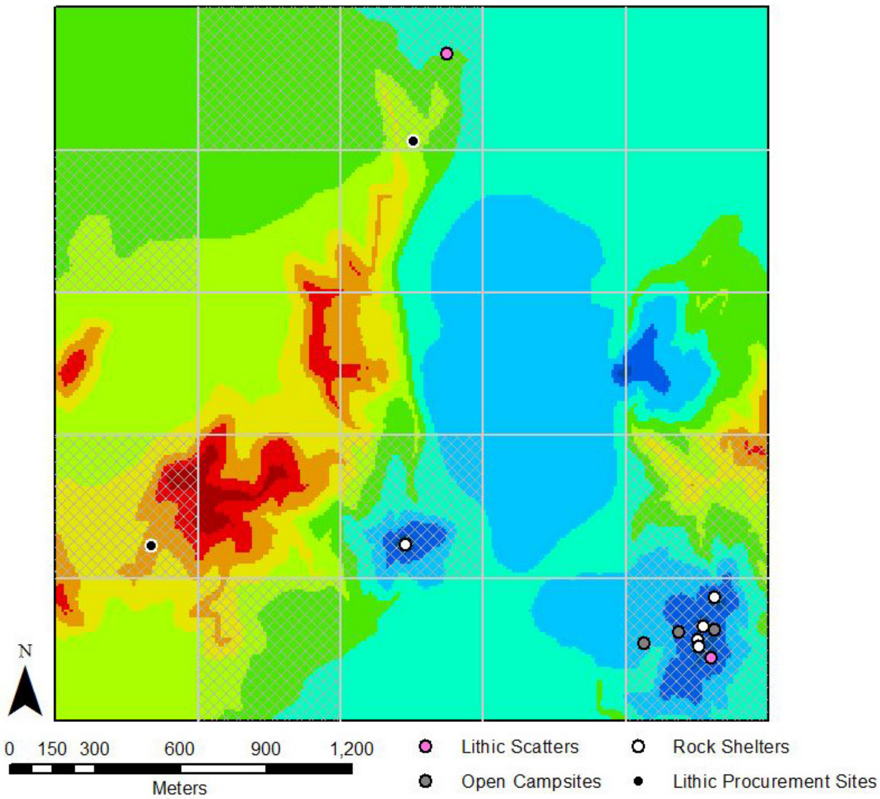

Figure 6. Cost distances from rockshelters in southern survey area.

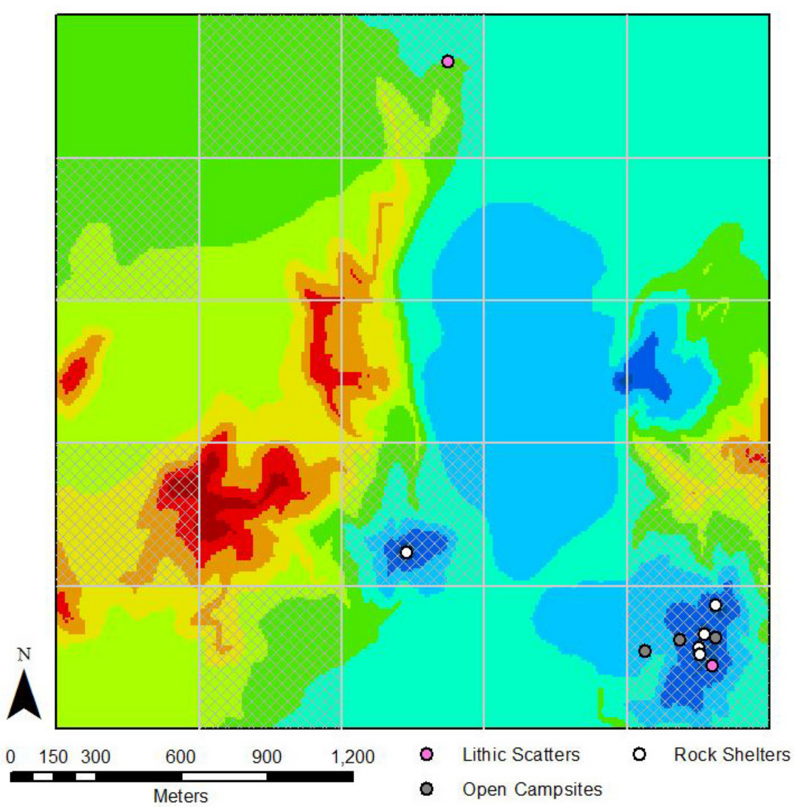

Figure 7. Cost distances from rockshelters in southern survey area, excluding lithic procurement sites.

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