The Journal

Houston Archeological Society

The Journal

Houston Archeological Society

Number 137 2017

Wilson W. Crook, III, Editor

Published

by the

Houston Archeological Society

2017

ISBN 978-1548183608

Foreword

The ***Journal of the Houston Archeological Society*** is a publication of the Society. Our Mission is to foster enthusiastic interest and active participation in the discovery, documentation, and preservation of cultural resources (prehistoric and historic properties) of the city of Houston, the Houston metropolitan area, and the Upper Texas Gulf Coast Region.

The Houston Archeological Society holds monthly membership meetings with invited lecturers who speak on various topics of archeology and history. All meetings are free and open to the public.

Membership is easy! As a nonprofit organization, membership in the Houston Archeological Society is open to all persons who are interested in the diverse cultural history of Houston and surrounding areas, as well as the unique cultural heritage of the Upper Texas Gulf Coast Region. To become a member, you must agree with the mission and ethics set forth by the Society, pay annual dues and sign a Code of Ethics agreement and Release and Waiver of Liability Form.

The Membership Form and the Code of Ethics agreement and Release and Waiver of Liability Form are available from the HAS website: http://www.txhas.org/membership.html

Current subscription rates are: Student $15, Individual $25, Family $30, Contributing $35+

Mail the completed and signed forms and a check for the appropriate amount to:

Houston Archeological Society
PO Box 130631
Houston, TX 77219-0631
Web Site: www.txhas.org

Editor's Message

I am pleased to present Issue Number 137 of *The Journal*, the first issue to be published by the Houston Archeological Society in 2017. This issue does not have a specific theme but contains a record thirteen articles about various aspects of Texas archeology covering the Paleoindian, Archaic, Late Prehistoric, and Historic periods.

The first two papers cover attempts to source turquoise artifacts from two sites in northeast Texas using X-Ray Fluorescence technology. First is my paper based on the research I presented to the HAS membership in January, 2017, and describes in detail the difficulties in attempting to use X-Ray Fluorescence as an archeological sourcing tool, especially for complex minerals like turquoise. The second paper demonstrates how this methodology may have successfully sourced turquoise beads found in a burial excavated at the Goss Farm site in Fannin County (41FN12) in the 1940's to a distant source in Arizona. The turquoise sourcing papers are followed by three short articles by noted ancestral Caddo archeologist, Tim Perttula, and deal with ceramic collections from Falls, Limestone and Navarro Counties which are currently curated at Baylor University. Tim focuses on identifying Caddo sherds which are present in the collections from these areas west of the traditional ancestral Caddo homeland. The Caddo ceramic articles are followed by a comprehensive study on the damage observed on arrow points from the Late Prehistoric sites along the East Fork of the Trinity River. The paper attempts to quantify observed damage with arrow point design and how their design may have changed over time. Next is a short paper on some unusually large projectile points found in a few Late Prehistoric age sites along the East Fork in Collin, Rockwall and Dallas Counties. This is followed by two papers by Mike Woods which deal with some very unique ground stone artifacts from Middle to Late Archaic sites in Jasper County. Lastly, are three papers that deal with Paleoindian points from Texas. These include a brief description of an unusual Fishtail-like point which was recently discovered in a private collection of a local avocational archeologist from McFadden Beach. The artifact and its possible relationship to South American Fishtail points is discussed. The next paper describes the discovery and analysis of two new artifacts from the Timber Fawn Clovis site (41HR1165), including another broken fluted point. Next is a description of a Clovis point found in the R. Don Patton Collection and includes both a description as well as a trace element geochemical analysis which sources the chert used to make the point to the general Gault-Fort Hood area of Central Texas. The last paper in this issue is a munitions analysis by Tom Nuckols of two Minnie balls recovered at the Levi-Jordan Plantation.

Please note that our new publishing policy now has an expanded the range of subjects to include any topic of archeological interest that is studied and written by a HAS member. First preference will be given to subjects along the Gulf Coast / Houston area, followed by archeological subjects within the State of Texas. Material from outside Texas and the U.S. would receive next consideration. So if you have worked on a site in Europe, Africa, Meso-America, etc., write it up and submit it to *The Journal*.

As always, we are very open to receiving any new submission that deals with an archeological subject. Do not worry that your paper may not be "perfect"; your editor is more than willing to work with you to create a publishable result. *The Journal* is the ideal vehicle for young and older authors alike to either begin or expand your published resume. Please send all submissions and inquiries to Dub Crook at the following email address:

dubcrook@kingwoodcable.com

Or call me with questions at 281-360-6451 (home) or 281-900-8831 (cell).

Contents

DIFFICULTIES IN SOURCING TURQUOISE ARTIFACTS USING X-RAY FLUORESCENCE

Wilson W. Crook, III

Introduction

Artifact provenance analysis utilizing X-Ray Fluorescence (XRF) was pioneered using obsidian from the western United States (Shackley 2005). XRF analysis is well-suited for this task as most obsidian sources can be distinguished by analyzing a small suite of seven to nine elements, and sometimes even less (Glascock et al. 1999; Glascock and Ferguson 2012; Shackley 2009, 2013). For example, Duff et al (2012) found that for some northern New Mexico sources in and around the Jemez Caldera, a bivariate plot of rubidium versus zirconium coupled with a similar elemental plot of yttrium versus zirconium was enough to unambiguously distinguish individual obsidian sources. This is possible due to the relatively short periods of time between volcanic eruptions in the Jemez Caldera area which are then reflected in the differentiated composition of the remaining magma and manifested in the associated extruded volcanic glass (Gardner et al. 1986; Shackley 2005, 2013).

However, when the same relatively simple elemental technique has been applied to the more complex trace element geochemistry present in other minerals, such as 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) adopted a more complex, multi-element approach based on the techniques developed for Laser Ablation analysis as developed by Speer (2014). Even so, the technique was shown to only be as good as the geologic database the analysis was referenced to (Williams and Crook 2013; Crook and Williams 2013).

Analysis of other minerals found in archeological contexts, such as turquoise, which show complex variations in cation site substitution, present similar problems in terms of trying to determine their source (Weigand et al. 1977). In the past, researchers have tried to source turquoise artifacts from the American Southwest using a wide range of analytical techniques including Atomic Emission Spectroscopy (Sigleo 1970), Electron Microprobe Analysis (Ruppert 1982), Neutron Activation Analysis (Mathein 1981; Weigand et al. 1977; Harbottle and Weigand 1992), X-Ray Fluorescence (Mathein and Olinger 1992) and Proton Induced X-Ray Emission (Kim et al. 2003), all with limited success. More recently, Hull et al. (2014) and Thibodeau et al. (2012; 2015) have developed new methodologies for sourcing turquoise using copper and hydrogen isotopes and strontium and lead isotopes, respectively.

The extended drought over the period 2010-2013 in North Central Texas significantly affected the lakes along the East Fork of the Trinity River which resulted in both Lake Lavon (Collin County) and Lake Ray Hubbard (Rockwall and Dallas Counties) being well below conservation levels (National Weather Service 2014). As a result, many archeological sites that had been inundated by the lakes back in the 1960's and 1970's were re-exposed. One of these is the Branch site (41COL9), a large Late Prehistoric occupation in central Collin County.

Over 40 years of wave action had severely deflated the site with most of its original stratigraphy now no longer intact. In particular, the upper gray-black soil horizon that contained the site's cultural materials had mostly been eroded away along with the site's major surface features, including the once prominent rim-and-pit structure (Crook and Hughston 2015). With erosion of the topsoil, lithic, bone and ceramic artifacts have been exposed on the surface of an impermeable yellow-tan sandy clay that originally formed the underlying soil horizon at the site. While the precise placement of the rim-and-pit structure can no longer be physically seen, its location can be fairly accurately inferred from previous excavation notes by both Robert L. Stephenson (1952) and the Dallas Archeological Society (Harris 1965) that are in my possession, as well as a limited past excavation conducted at the site by the author (Crook 2007).

The rim-and-pit structure at the Branch site was originally oblong in shape, 18 by 15 meters in size, oriented approximately North-South. Beginning in late 2012, a number of shell and stone beads, a single small turquoise pendant, and nine lithic artifacts of obsidian were exposed in the area of the southern rim of the pit. Three turquoise artifacts, including a large bead, a very small bead, and the above mentioned pendant, were recovered. These artifacts have been subjected to a detailed analysis using X-Ray Fluorescence in an attempt to determine their probable source area. A more detailed description and analysis of the shell and obsidian artifacts recovered from the Branch site can be found in Crook (2013, 2015) and Crook and Hughston (2015).

Artifact Description

Two of the turquoise artifacts discovered in the area of the southern rim of the rim-and-pit structure at the Branch site were found in late 2012 with a small cache of beads, including three small tabular shell beds and three perforated *Olivella* shells. As shown in Figure 1, the first turquoise bead is very small (2.2 x 0.8 mm) and is similar in size to the three tabular shell beads found in association with it. The other bead found in this cache was a much larger and thicker bead (12.0 x 5.5 mm), also made from turquoise. Physical data including size and color of the two turquoise beads is shown in Table 1.

In December, 2013 another group of tabular shell beads was discovered about three meters west of where the first bead cache was located. A total of 20 small (4-7 mm) shell beads were found over an area of 0.5 x 2 meters along with nine obsidian arrow points and three pieces of worked obsidian (Crook 2015). In addition, a small turquoise pendant was also recovered (see Table 1). The pendant is 15.9 mm in length, 10.0 mm along the base and 7.1 mm at the top end near the single perforation. Thickness of the artifact is a uniform 2.5 mm. Diameter of the perforation is 1.5 mm.

The obverse face of the pendant is similar in color to the two turquoise beads, ranging from a very

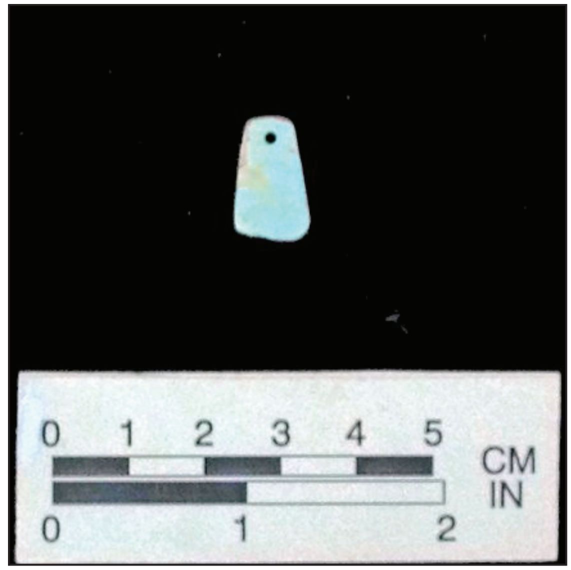

Figure 2. Obverse face of the turquoise pendant recovered from near the southern rim of the rim-and-pit structure at the Branch site (41COL9), Collin County, Texas.

pale blue (5B 8/2) to very pale green (10G 8/2) (Figure 2). The reverse face of the pendant is considerably paler in color, ranging from a bluish white (5B 9/1) to grayish yellow (5Y 8/4). This face was exposed on the surface when the artifact was discovered. As the color of turquoise is known to be affected by prolonged exposure to sunlight and heat, the color difference between the two sides of the pendant is likely due to exposure on the surface.

The Mineral Turquoise

The term “turquoise” has historically been used to describe, in the chemical sense, a specific mineral

Figure 1. Contents of the small bead cache found near the southern rim of the rim-and-pit structure at the Branch site (41COL9), Collin County, Texas.
L to R: Three small shell and one turquoise bead, three perforated Olivella shells, and a larger turquoise bead (right).

Table 1. Branch Turquoise Artifact Measurements

Artifact	Material	Color	Outside Diameter (mm)	Inside Diameter (mm)	Thickness (mm)
Small Bead	Turquoise	Very Pale Blue 5B 8/2 to Very Pale Green 10G 8/2	2.2	1.2	0.8
Large Bead	Turquoise	Pale Blue-Green 5BG 7/2 to Pale Blue 5B 6/2	12	2.4	5.5
			Length (mm)	**Width (mm)**	**Thickness (mm)**
Pendant	Turquoise	Very Pale Blue 5B 8/2 to Very Pale Green 10G 8/2	15.9	7.1-10.0	2.5

with a variable chemical composition, and in the cultural sense, a wide range of pale-blue to blue-green to green semi-precious stones. When the stone was first introduced into Europe, supplies traveled along the Silk Road from Persia through Turkey and thus the mineral was named "Türkis", meaning Turkish, or in the *lingua franca* of the day, "turquoise".

Turquoise is a basic hydrous phosphate of aluminum and copper, with an ideal stoichiometric formula of $CuAl_6(PO_4)_4(OH)_8{\cdot}4\ H_20$. Based on this formula, stoichiometric turquoise would have the ideal chemical composition of:

CuO	9.78%
Al_2O_3	37.60%
P_2O_5	34.90%
H_2O	17.72%
Total	100.00%

However, chemical analyses of turquoises from a number of worldwide locations show both the copper and aluminum cation sites typically have a considerable amount of elemental substitution, with minor substitution potentially occurring in the phosphate radical as well. Moreover, with exposure to sunlight and air, there is also substantial variation in the mineral's free water content (Palache et al. 1951; Kostov 1968).

Mineralogically, turquoise is one of six isostructural end members, between which both partial and complete solid solution series exist (Foord and Taggart 1999). The general Turquoise Group formula is thus $A_{0\text{-}1}B_6(PO_4)_{4\text{-}x}(PO_3)_x(OH)_8{\cdot}4H_2O$. Substitution in the A site produces the following minerals: (1) Planerite – vacancy in copper (copper is less than 1), (2) Turquoise – copper in the A site, (3) Faustite – zinc in the A site, (4) Aheylite – ferrous iron in the A Site, and (5) Coeruleolactite – calcium in the A site. Substitution in the B cation site has produced one mineral so far: Chalcosiderite – with ferric iron substituting for aluminum. Elemental substitution also occurs in the phosphate radical, primarily as arsenic and/or silica for phosphorus, but the amount of substitution is limited and there is no evidence of a solid solution series exists to a hypothetical arsenate or silicate end member.

As stated above, it is unclear if a complete solid solution series exists between turquoise and all of the above minerals. For example, the zinc-rich end member (faustite) and the ferrous iron end-member (aheylite) both exist but it is unclear if there are natural examples that span the complete spectrum between the end-members and turquoise (Erd et al. 1953; Foord and Taggart 1999). Similarly, calcium can be present in turquoise examples but a complete solution series to coeruleolactite is doubted (in fact, ceoruleolactite's existence as a valid mineral species is questionable) (Foord and Taggart 1999). Similarly, ferric iron-rich turquoise specimens have been found but a copper-rich chalcosiderite has not yet been discovered (Abdu et al. 2011; Foord and Taggart 1999).

The one end-member which seems to have the most viability with turquoise is planerite, wherein copper in the A cation site is depleted. As the A-site vacancy increases (1-x), pronation occurs to a maxi-

Table 2. Minerals of the Turquoise Group

A Site	B Site	$(PO_4)_{4-x}$	$(PO_3,OH)_x$	Mineral Name
Vacant	Aluminum	2	2	Planerite
Copper	Aluminum	4	0	Turquoise
Zinc	Aluminum	4	0	Faustite
Iron (+2)	Aluminum	4	0	Aheylite
Calcium	Aluminum	4	0	Coeruleolactite
Copper	Iron (+3)	4	0	Chalcosiderite

mum of two of the phosphate groups; overall charge balance is maintained through the development of phosphite (PO_3) and (OH) groups (Foord and Taggart 1999). Planerite is white to pale blue to pale green in color and has been found in abundance near Avant in Garland County, Arkansas as well as near Mount Ida in Montgomery County, Arkansas. In both Arkansas occurrences, the copper cation site is about two-thirds vacant and the blue and green colors are derived from small percentages of chrome and vanadium in conjunction with copper (Smith 1985; Foord and Taggart 1999). Chemical analyses of mineral specimens labeled as "turquoise" from around the world show the copper content can be as low as 3 weight percent to as high as 12-15 percent (Pogue 1972; Snow 1973; Weigand et al. 1977). Foord and Taggart (1999) believe that stoichiometric copper-rich turquoise is actually fairly rare and most specimens (both mineralogic and archeologic) that have been labeled "turquoise" around the world are actually the mineral planerite, with varying degrees of copper vacancy. A summary of the Turquoise Group chemistry is shown in Table 2.

The color of stoichiometric turquoise is unique in nature and as a result, the color "turquoise blue" was created to describe the mineral's coloration. With the addition of either ferrous iron (+2) in substitution for copper or ferric iron (+3) for aluminum, turquoise changes color from blue to a blue-green. The addition of more iron (ferric and/or ferrous) plus zinc, changes the mineral's color to a deeper green. Many turquoise specimens from Nevada have been shown to be zinc and iron-rich which result in a rich green color (Palache et al. 1951). Substitution of calcium for copper and arsenic and/or silica for phosphorus does not seem to have much effect on color.

Turquoise can become very brittle and susceptible to fracturing and discoloration with exposure to light and air. Los Cerrillos, New Mexico turquoise has been noted to have a deep blue color when found underground that rapidly fades to a paler blue when brought to the surface and exposed to heat and sunlight (Milford 1994; Snow 1973). The discoloration is believed to be in part due to a loss of water (Pogue 1972; Guthrie and Bish 1991). Water content of analyzed turquoise has been shown to be quite variable, ranging from 12-20 weight percent.

As mentioned above, minor substitution of arsenic and/or silica for phosphorus has also been reported (Palache et al. 1951; Strunz 1968). As a result, the phosphate content in turquoise has been observed to range from 30-34 weight percent. The presence of silica in turquoise can potentially be used as a source identifier for some specimens. For example, most older wet chemical analyses of Los Cerrillos, New Mexico turquoise have been recalculated to 100 percent after the removable of several percent of "insoluble residue", most of which is silica (Palache et al. 1951).

The varied geochemistry of turquoise is due to its origin as a secondary copper mineral. Turquoise is almost always found in dry, arid environments and less than 30 meters (100 feet) from the surface. It is typically formed by the supergene alteration of groundwaters on aluminum-rich volcanic rocks, mainly monzonites, latites and trachytes. These rocks are rich in potash feldspars (sanidine) and quartz with minor apatite, pyrite, copper sulfides, hornblende and biotite. Groundwaters leach the copper from the sulfides, aluminum from the feldspars, and the phosphate from apatite to form turquoise. Turquoise is almost always found in association with other secondary minerals such as limonite (FeO(OH) and kaolinite clay.

As can be seen from the above discussion, turquoise can be extremely variable in composition, not only from location to location, but also within one given area and even within a single vein or mineral specimen. In their analysis of southwestern U.S. turquoises, Weigand et al. (1977) found that turquoise could usually be geochemically clustered from a single mine, but not always between mines in the same general area. Moreover, other aluminum phosphates, such as variscite ($AlPO_4 \cdot H_2O$) and wavellite ($Al_3(PO_4)_2(OH)_3 \cdot 5H_2O$), are also known to contain small amounts of copper; enough to color them green and make them occasionally mistaken for turquoise. The same mistaken identification has been made with other secondary copper minerals such as azurite, malachite and chrysocolla (Thibodeau et al. 2015). As such, turquoise presents a considerable challenge to the archeologist wishing to try and source artifacts. This observation is borne out by the recent work of Hull et al. (2014) who, despite using a sophisticated analytical method of measuring and using ratios of copper and hydrogen isotopes, were only able to effectively source about 50 percent of the archeological artifacts analyzed.

Previous Analytical Attempts to Source Turquoise

Over one million pieces of turquoise have been recovered from archeological sites in Mexico and the Southwestern U.S.; between 200,000 and 500,000 from Chaco Canyon alone (Mathein 2001; Thibodeau et al. 2012). Considering the amount of turquoise that has been found, the physical hardships associated with prehistoric mining, and the distances between the known geologic deposits and some of the archeological sites, turquoise was clearly a significant status symbol and an important luxury commodity of aboriginal trade structures. Yet despite this fact, little is known about the acquisition and exchange of turquoise by Native Americans because the geologic sources of the turquoise artifacts are poorly understood.

For decades, archeologists have sought to chemically fingerprint turquoise. These studies have included Atomic Emission Spectroscopy (Sigleo 1970), Neutron Activation (Weigand and Harbottle 1977; Harbottle and Weigand 1992), Electron Microprobe Analysis (Ruppert 1982), X-Ray Fluorescence (Salmon and Ronzio 1962; Ronzio and Salmon 1967; Mathein and Olinger 1982) and Proton Induced X-Ray Emission (Kim et al. 2003). In general, all of these studies have met with very limited success due to four major reasons: (1) the intrinsic limitations of trace element chemistry on such a complex mineral as turquoise that can vary chemically not only within a single deposit but often within a single sample; moreover, turquoise can also contain numerous mineral inclusions at the micrometer scale, (2) other blue-green secondary copper minerals have frequently been mistaken for turquoise, (3) the geology and formation processes of turquoise deposits are very similar between provenance regions, and (4) the weathering of turquoise can cause variations in the trace element chemistry; turquoise is stable in very specific geological environment and conditions and will alter when removed from these conditions (Abdu et al. 2011; Thibodeau et al. 2015).

Due to the complexity of turquoise trace element geochemistry, a large multi-element approach was seen to be more effective in trying to fingerprint turquoise sources. In the 1970's, Weigand et al. (1977) used Neutron Activation Analysis (INAA) to source over 2,000 pieces of turquoise from both Mesoamerica and the Southwestern U.S. A large geologic database of turquoise mineral specimens from a number of Southwestern U.S. locations was analyzed along with the archeological artifacts. Their analysis focused on 20 elements including sodium, potassium, calcium, scandium, chromium, manganese, iron, copper, zinc, arsenic, rubidium, silver, antimony, cesium, barium, lanthanum, europium, hafnium, gold and thorium. The results showed that with the exception of copper, iron and calcium, all the other elements were present only in extremely low concentrations (few parts per million to parts per billion). Copper was seen as highly variable, ranging from as low as 3 weight percent to as high as 15 percent (stoichiometric turquoise has a copper content of 9.78 weight percent) (Weigand et al. 1977; Harbottle and Weigand 1992). While repetitive analysis of the same sample yielded similar results, large deviations in trace element chemistry was observed even from samples from the same mine. As a result, source identification was only partially successful. Moreover, long-term bombardment in the reactor was shown to change the color of many of the archeological artifacts from blue to a dull gray-green, and some artifacts were even destroyed, reduced to a black powder by exposure to long-term radioactive bombardment.

More recently, three new methodologies have been developed to source turquoise using rare earth element (REE) trace element fingerprints and isotope analysis using copper and hydrogen and strontium and lead. Qin et al (2014) analyzed a number of geologic samples of turquoise and three artifacts from the Hubei Province in China using Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). The analysis focused on 14 rare-earth elements (lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium) plus 12 additional elements primarily focused on uranium, vanadium and molybdenum. Collective rare earth element patterns seemed to be unique for each geologic source area with some overlap, and thus the three Bronze Age artifacts analyzed could be generally matched to the mine closest to the archeological site (Qin et al. 2014). The analysis is however, completely destructive as the sample has to be powdered prior to analysis.

Hull and Fayek (2012) and Hull et al. (2014) have devised an experimental analytical methodology using Secondary Ion Mass Spectroscopy (SIMS) and measuring the isotope ratios of hydrogen ($^2H/^1H$) and copper ($^{65}Cu/^{63}Cu$) to try and determine turquoise sources. The methodology is expensive and in part destructive to the sample (the area to be analyzed needs to be polished flat and coated with gold prior to analysis). Moreover, the technique has been shown to be only partially successful in terms of identifying the original turquoise source area (only 54 percent of 74 artifacts analyzed were able to be sourced). A further drawback to the copper-hydrogen isotope methodology is that altered turquoise samples cannot be reliably analyzed because alteration of the turquoise affects both the copper and hydrogen isotope composition (Thibodeau et al. 2015).

Most recently Alyson Thibodeau has devised a methodology looking at strontium and lead isotopes using a Multi-Collector Thermal Ionization Mass Spectrometer (Thibodeau et al. 2012; Thibodeau et al, 2015). In her analysis, Thibodeau analyzed 137 geologic samples from 19 mining districts across Arizona, New Mexico, Nevada, California, Colorado and Sonora (Mexico). Samples, which ranged from 25-200 mg, were rinsed in Milli-Q ultra-pure water to remove all external contaminants prior to analysis. The samples were then dissolved in concentrated hydrochloric acid (HCl) and analyzed for a range of strontium (Sr^{87}/Sr^{86}) and lead (Pb^{206}/Pb^{204}, Pb^{207}/Pb^{204}, Pb^{208}/Pb^{204}) isotopes. Against this database, 10 artifacts from three Zuni sites in the El Moro Valley of New Mexico were analyzed and sourced to the Los Cerrillos, New Mexico area (Thibodeau et al. 2015). Since then, Thibodeau has further refined her isotope methodology and has had success in sourcing very small (less than 10 mg) samples; the key to her approach is the comprehensive geologic database which covers geochemical variability across the mine districts (Alyson Marie Thibodeau, personal communication, 2015).

While Thibodeau's strontium and lead isotope approach seems to be the most promising methodology for sourcing turquoise developed so far, her analysis is still destructive to the artifact sample. In Mesoamerica and the Southwestern U.S. where turquoise artifacts can be very numerous, this makes imminent sense. However, in an area like the East Fork of the Trinity River, where a total of three small turquoise artifacts have been found, sample destruction is not a viable option. As a result, a less destructive analysis has been attempted here on the turquoise artifacts from the Branch site (41COL9) using X-Ray Fluorescence and the same large, multi-element approach developed for sourcing chert (Williams and Crook 2013; Crook and Williams 2013).

X-Ray Fluorescence Analysis

The three turquoise artifacts from the Branch site 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 analysis was conducted using a Bruker Tracer III-SD handheld energy-dispersive X-Ray Fluorescence 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. Analyses were conducted in April and December of 2014 and August, September and November of 2015 at the laboratory of the Gault School of Archeological Research located at Texas State University in San Marcos, Texas. All samples were rinsed in Milli-Q ultra-pure water to remove all external contaminants prior to analysis.

Previous XRF analyses of turquoise by Mathein and Olinger (1992) and Mathein (2001) focused on trying to source Ancestral Puebloan artifacts to the Los Cerrillos, New Mexico area. The analyses were conducted at 22 keV and concentrated on 14 elements including chromium, manganese, iron, nickel, copper, zinc, arsenic, rubidium, strontium, yttrium, zirconium, niobium, molybdenum and lead. Mathein and Olinger's results showed that chromium, nickel, molybdenum and manganese occurred in very small concentrations (<1 ppm) with little variability and were thus of no use in source fingerprinting. Conversely, iron, zinc, zirconium and strontium varied widely across the Cerrillos district, even from the same area, and thus also were of little use in identifying a specific source. Copper content was the highest at both the Chalchihuitl Hill area in the southern end of the Cerrillos district, as well as at the Castillian Mine in the northern area. Not coincidentally, these two mines produced the deepest blue color turquoise from the Los Cerrillos area. Lastly, high yttrium contents were seen in two mines (O'Neill, Bonito), high rubidium at the Castillian mine, and high niobium from Chachihuitl Hill. Despite these results, Mathien (2001) concluded that "it may never be possible to obtain a clear-cut chemical profile of Los Cerillos turquoise and thus sourcing turquoise by XRF might not be possible".

As a result of Mathein's experience, the Branch turquoise artifacts were measured at both low energy (15 keV, 23µA) and high energy (40 keV, 36.2µA), using no filter at the lower energy and a 0.3 mm aluminum / 0.02 titanium filter in the X-Ray path for the higher energy readings. In both analyses a 300 second live-count time was used and at least two measurements taken per sample and averaged. For the turquoise samples, peak intensities for Kα peaks of 22 elements including sodium, magnesium, silicon, potassium, calcium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, rubidium, strontium, yttrium, zirconium, niobium, molybdenum, and barium, and the Lα peaks for lead, thorium, and uranium were calculated as ratios to the Compton peak of rhodium and converted to parts-per-million (ppm). With the exception of copper, this elemental analysis focused on the trace element spectrum.

A significant number of Ancestral Puebloan ceramic sherds (n = 29) as well as worked pieces of obsidian (n = 15) have been found in four sites belonging to the Late Prehistoric period along the East Fork of the Trinity River and its tributaries, including the Branch site (Crook 2013, 2015). With the exception of two Mimbres Black-on-White sherds, all the Puebloan ceramics have been sourced to the general north central New Mexico area (Santa Fe Black-on-White, Chaco Black-on-White, Black Mesa Black-on-White, Rio Grande Glaze, etc.). Likewise, the majority of the obsidian artifacts have also been sourced to the area in and around the Jemez Caldera (El Rechuelos, Cerro Toledo, and Valles Rhyolite) west of Santa Fe. As a result, it was postulated that the most likely source for the turquoise would be in the same north central New Mexico area. The major source of turquoise for the north central New Mexico area are the mines in the Los Cerrillos area, located about 30 kilometers southwest of Santa Fe in Santa Fe County, New Mexico.

Los Cerrillos turquoise is known to have mainly copper in the A cation site; small amounts of calcium have been reported but Los Cerrillos turquoise has little to no zinc (Palache et al. 1951; Disbrow and Stoll 1957; Weigand et al. 1977). Los Cerrillos turquoise is also known to contain small amounts (2-4 weight percent) of iron in substitution for either copper in the A cation site or for aluminum in the B cation site. Lastly, as mentioned above, most of the early wet chemical analyses of turquoise from Los Cerrillos reported anomalous amounts of silica. X-Ray Diffraction analysis shows the silica is likely either in substitution for phosphorus in the turquoise structure or possibly as micro inclusions of amorphous SiO_2 (chalcedony).

One of the key findings in Tom Williams' and my work on sourcing Texas Clovis chert artifacts using XRF was the realization that even with a large multi-element approach, accurate sourcing was only as good as the geologic data base. In this regard, we collected nearly 500 chert samples from locations all over the Edwards Plateau which enabled us to separate Edwards from non-Edwards specimens as well as pinpoint individual regions within the Edwards Plateau (Williams and Crook 2013; Crook and Williams 2013). Likewise, the analytical experience of Thibodeau (Thibodeau et al. 2015) and Weigand and Harbottle (1977) demonstrated that a comprehensive geologic database is equally important in sourcing turquoise. In this regard, the author obtained a number of well-documented polished specimens of Los Cerrillos turquoise to use as reference type specimens. The Charles Lewis Tiffany company of New York purchased the mines of Turquoise Hill and mined the area for gem quality turquoise from 1892-1922 (Jeff Cathrow, personal communication, 2014). While the mines are now played out and abandoned, a small amount of this authenticated type material remains available on the market. Geologic specimens from the Los Cerrillos area analyzed as part of this study included Chalchihuitl Hill, the Little Chalchihuitl Mine, the Muniz Mine (American Turquoise company, Turquoise Hill), the Castillian Mine (Blue Bell Claim), the Little Blue Bell Mine, and the Morning Star Claim.

In addition to samples from the Los Cerrillos area, I attempted to obtain well provenanced turquoise samples from as many Southwestern U.S. and northern Mexico (Sonora) locations as possible. Samples were specifically acquired to represent the broadest range of both color (bright green to turquoise blue) as well as locations which were known to have produced archeological turquoise artifacts. Care was taken that only samples with proven provenance were used in constructing the geologic database. Locations of samples comprising the geologic database for this analysis are shown in Table 3 below.

Using the known chemical markers for Los Cerrillos turquoise, the two turquoise beads and the pendant (see Figures 2 and 3) as well as the 31 geologic samples from 18 locations in five Southwestern U.S. States and Mexico were analyzed using the multi-element methodology described above. All samples were rinsed in Milli-Q ultra-pure water prior to analysis in order to remove any contaminants that might impact the analysis. The results of the XRF analysis of the Branch artifacts are shown in Table 4 below. The analyses of the 31 geologic turquoise samples are shown in Appendix I. While copper was measured for in each analysis, the high amounts

Table 3. Turquoise Geologic Database

Location	Specimen
New Mexico	
Los Cerrillos, NM – Chalchihuitl Hill	5.1 gm from site of ancient workings
Los Cerrillos, NM – Chalchihuitl Hill	3.0 gm from site of ancient workings
Los Cerrillos, NM – Chalchihuitl Hill	2.2 gm from site of ancient workings
Los Cerrillos, NM – Chalchihuitl Hill	0.4 gm small cabochon
Los Cerrillos, NM – Little Chachihuitl Mine	8.8 gm slab from mine workings
Los Cerrillos, NM – Turquoise Hill	2.7 gm from Tiffany Mine area
Los Cerrillos, NM – Turquoise Hill	2.4 gm from Tiffany Mine area
Los Cerrillos, NM – Muniz Mine	12.0 gm from Tiffany workings
Los Cerrillos, NM – Morning Star Claim	2.1 gm from Tiffany workings
Los Cerrillos, NM – Blue Bell Claim	1.8 gm from Tiffany workings
Los Cerrillos, NM – Little Blue Bell Mine	2.9 gm slab from mine workings
Burro Mountains, Grant Co., NM	1.0 gm from vein outcrop
Tyrone Mine, Grant Co., NM	3.6 gm cut slab from mine workings
Old Hachitos, Grant Co., NM	3.8 gm from mine workings
Arizona	
Morenci, Greenlee Co., Arizona	1.0 gm from mine workings
Sleeping Beauty, Globe, Gila Co., Arizona	5.9 gm from mine workings
Kingman Mine, Mohave Co., Arizona	50.0 gm nugget
Kingman Mine, Mohave Co., Arizona	2.6 gm nugget (stabilized)
Kingman Mine, Mohave Co., Arizona	7.1 gm cut slab (stabilized)
Nevada	
Royston, Nye Co., Nevada	8.4 gm from mine workings
Paiute Mine, Lander Co., Nevada	2.0 gm weathered nugget
Ajax Mine, Lander Co., Nevada	25.6 gm cut slab
Emerald Valley, Lander Co., Nevada	3.6 gm cut slab
Battle Mountain (Blue Gem), Lander Co., Nevada	20.0 gram nugget
Fox Mine, Cortez, Lander Co., Nevada	1.4 gm weathered nugget
Pilot Mountain, Mina, Mineral Co., Nevada	1.2 gm nugget
Colorado	
Cripple Creek, Teller Co., Colorado	2.3 gm from mine workings
Sonora, Mexico	
Campitos, Sonora, Mexico	7.7 gm cut slab (stabilized) with pyrite
Campo Frio, Cananea, Sonora, Mexico	10.8 g, from mine workings
Nacozari, Sonora Mexico	12.6 gm cut slab
Nacozari, Sonora, Mexico	12.1 gm cut slab (stabilized)

Table 4.
XRF Results – Trace Element Geochemistry of Turquoise Artifacts from the Branch Site (41COL9), Collin County, Texas Compared to a Range of Analyses from the Chachihuitl Hill Area, Los Cerillos, New Mexico.

Element	Branch Pendant	Branch Bead #1	Branch Bead #2	Range Chalchihuitl Hill, Cerrillos, NM (5 analyses)
Sodium	1,074	1,088	1,096	1-206
Magnesium	1,526	1,410	1,476	738-1,753
Silica	9,793	9,310	8,988	4,452-10,679
Potassium	414	404	397	0-889
Calcium	491	888	956	1,130-5,091
Titanium	227	247	121	41-258
Vanadium	18	21	28	17-36
Chromium	11	8	14	9-16
Manganese	100	79	91	36-671
Iron	3,564	2,775	3,013	2,862-42,671
Cobalt	17	23	18	13-21
Nickel	122	115	142	37-114
Zinc	0	0	0	0
Arsenic	29	65	56	13-164
Rubidium	5	11	10	6-26
Strontium	56	40	55	17-158
Yttrium	6	7	9	4-7
Zirconium	15	11	10	7-40
Niobium	3	2	1	1-3
Molybdenum	2	3	10	2-21
Barium	176	69	72	59-272
Lead	5	12	9	7-10
Thorium	2	2	2	2-5
Uranium	1	1	1	0-9
Mineral	Turquoise	Turquoise	Turquoise	Planerite-Turquoise

(sometimes in excess of 10% or 100,000 ppm) is really above the accuracy limits for X-Ray Fluorescence which is designed to focus on smaller trace elements rather than on major element analysis. As such, the copper contents have not been recorded either in Table 4 or in Appendix I. However, it was easy to determine which specimens had significant copper present and thus were true turquoise versus those in which copper was absent to a major degree (planerite). Thus the mineral determinations for all specimens (turquoise vs planerite) have been included in the geochemical tables.

As can be seen in Table 4, the three Branch artifacts have very a similar trace element geochemistry which is characterized by very high silica (near 1%), absolutely no zinc, trace arsenic (29-65 ppm), trace strontium (40-56 ppm) and anomalously high amounts of barium (69-172 ppm). Moreover, the presence of significant amounts of copper conclusively shows that the Branch artifacts are all made from turquoise and not some other copper-bearing aluminum phosphate such as planerite or variscite. Iron in the Branch artifacts averages about 0.3 weight percent, which is consistent with the high copper content allowing little substitution of ferrous iron for copper.

When compared to the 31 geologic samples (see Appendix I at the end of this paper), these characteristics most closely match those of the five geologic samples taken from the southern end of the Los Cerrillos, New Mexico district, specifically the area in and around Chalchihuitl Hill. Chalchihuitl Hill turquoise is also characterized by high copper (especially turquoise blue specimens as opposed to "Chalchihuitl Green"), and as shown in Table 4, a complete absence of zinc, low arsenic, relatively high barium (as compared to other Southwestern turquoises), and anomously high silica (0.4-1.0 weight percent).

Turquoise samples from several Nevada localities (Emerald Valley, Ajax, Fox Mine) as well as Campitos, Mexico are all characterized by the presence of zinc which is completely absent from Chalchihuitl Hill and other Cerrrillos turquoise. Almost all Southwestern U.S. and Mexican turquoise have arsenic contents which exceed those from the Chalchihuitl Hill area. Moreover, with the exception of specimens from Tyrone and Old Hachita, New Mexico, most other turquoises contain low concentrations of barium which is present in higher amounts at Chalchihuitl Hill. Lastly, Los Cerrillos turquoise contains anomalously high amounts of silica, typically much higher than seen in other Southwestern U.S. or Mexican turquoise specimens. Repeated spot analysis showed the silica to be present in association with copper. As such it was not possible to determine if the silica was inherent in the turquoise crystal structure or is present as minute inclusions of chalcedony (SiO_2). Thus while not unambiguously conclusive, when taken as a whole, the trace element geochemistry of the three Branch artifacts most closely fits the range of geochmistries measured for Chalchihuitl Hill in the Los Cerrillos, New Mexico district.

Los Cerrillos, New Mexico Turquoise Mines

The Los Cerrillos Hills, located 30 km south of Santa Fe, are the oldest established mining district in North America. Ten areas in and around Turquoise Hill and Chalchihuitl Hill have been recognized as having prehistoric mining activity dating back to as early as possibly ca. A.D. 700 (Snow 1973; Weigand et al. 1977; Milford 1994; Magnus 2012). Chalchihuitl Hill in particular has five small ruins approximately one kilometer to the east which are believed to have been the living quarters of seasonal Ancestral Puebloan miners (Wiseman and Darling 1986; Weigand et al. 1977; Milford 1994). Based on ceramic sherds recovered from the area (Red Mesa Black-on-White, Santa Fe Black-on-White, Galisteo Black-on-White), the structures have been tentatively dated to ca. A.D. 900-1140 (Snow 1973). However, due to the occurrence of Los Cerrillos turquoise in archeological sites in both Mesoamerica and the Southwestern U.S. dated prior to A.D. 900, mining is believed to have started several centuries before the structures were built. A few sherds of Lino Gray (ca. AD 650-800) have been found in the area of Chachihuitl Hill to support this earlier date.

A large number of large stone tools (mauls, axes, picks, hammerstones, anvils, lapidary stones) have been found around the mine workings at Chalchihuitl Hill, some weighing as much as 20 pounds (Schroeder 1979; Warren and Weber 1979). Almost all of these early mining tools have been constructed of local unaltered monzonite (Warren and Weber 1979). Scoops and/or scrapers made from ceramic sherds are also present but their exact function in the mining process is unknown (Warren and Weber 1979).

The Cerrillos Hills are the remnants of Oligocene (?) volcanic activity that intruded into the sediments of the Espinosa Formation (Disbrow and Stoll 1957; Klautz et al. 1981). The area was the site of extensive intrusive and extrusive volcanic activity characterized by the emplacement of a series of light gray to pink-colored monzonitic porphyry stocks and laccoliths. These volcanics, which range from monzonite to latite to trachyte in composition, also contained primary copper and lead sulfide mineralization. At the end of this period of igneous intrusion (34-29

Figure 3. Large mined-out area at Chalchihuitl Hill, Los Cerrillos, New Mexico. Photo courtesy of Mr. Todd Brown, Casa Grande Trading Post, Los Cerrillos, New Mexico.

million years ago), a series of dikes and sills of both monzonite and trachyte composition were extruded near the surface (Klautz et al. 1981; Lisenbee and Maynard 2002). After consolidation of the youngest intrusion, a system of fracturing developed (Disbrow and Still 1957; Akright 1979). Subsequent mineralizing solutions formed mineral deposits of lead, copper, zinc, silver and gold along these fracture. Primary ore minerals include galena, chalcopyrite, sphalerite and pyrite with quartz, ankerite, calcite, siderite, barite, opal and chalcedony as common gangue minerals (Akright 1979).

A major supergene event, estimated to have occurred in the Pliocene 3-4 million years ago, oxidized the sulfides in the near surface igneous rocks producing sulfuric acid which subsequently remobilized aluminum from the feldspars, phosphate from apatite (forming ortho-phosphoric acid, H_3PO_4), and iron from pyrite and biotite. The oxidation of pyrite and chalcopyrite by meteoric waters, with the generation of sulfuric acid, is believed to be essential to the leaching of phosphorus required for subsequent turquoise formation (Akwright 1979). The result of this groundwater event was a second series of mineralization in the Cerrillos district including the deposition of turquoise, limonite and kaolinite along fractures and bedding planes within the Espinosa Formation (Akright 1979; Klautz et al. 1981). This alteration was so significant that the igneous wall rocks have been altered between one and ten feet on either side of the supergene mineral zones which reach to a depth of 50-100 feet (Disbrow and Still 1957). Prehistoric miners also exploited these veins for associated ochres (limonite, hematite, malachite) as well as chert and jasper (Schroeder 1979; Warren and Weber 1979).

Turquoise seldom occurs as distinct crystals but more commonly is found as masses in veins and fracture fillings or as botryoidal masses coating the surface of rocks or in narrow fracture zones as thin veinlets. The mineralization at Los Cerrillos reached the surface where the turquoise was discovered by the Ancestral Puebloans. Mining began with small pits and extended deeper along fractures if the vein was worth following. The largest ancient mine working at Chalchihuitl Hill is a pit 61 meters (200 feet) across and 40 meters (130 feet) deep, all excavated by hand and stone tools. Current mine debris covers about 1 Ha (2.5 acres) and is believed to have once occupied as much as 8 Ha (20 acres) (Figure 3) (Milford 1994; 1995). While exploitation of turquoise in the 19th Century destroyed much of the evidence of ancient mining, other prehistoric workings can be seen at Mina del Tiro near Turquoise Hill where a single vein has been exploited for about 550 meters and at the Bathsheba Mine where a single pit reaches a depth of 8 meters (Warren and Weber 1979).

After the collapse of the Chaco Canyon culture, the primary users of the Cerrillos turquoise deposits were the inhabitants of San Marcos Pueblo located 4 kilometers (2.5 miles) to the east of the Cerrillos Hills. Seventy-five percent of the ceramic sherds found in and around the mine workings at Chalchihuitl Hill come from San Marcos Pueblo and nearly 95 percent of the sherds date from the period of ca. A.D. 1300-1680 (Rio Grande Glaze Wares) (Weigand et al. 1977). After the Puebloan revolt (ca. A.D. 1680), the mines were worked by the Spanish but their main focus was on the nearby occurrence of lead which also contained silver. There was a short revival of interest in the area's turquoise after the Civil War, primarily by the Tiffany Company of New York, but by the 1920's the mines had largely played out. Long since a favorite locality for mineral collectors, it is difficult to even find a specimen of turquoise today and where pockets are still present, they are being worked for jewelry by small local mining ventures (Disbrow and Stoll 1957; Snow 1973; Milford 1994; Magnus 2012).

Discussion

Several conclusions can be drawn from the results of the trace element analysis of the three Branch turquoise artifacts. First and foremost, the analysis has conclusively shown that all three artifacts are indeed constructed of turquoise and not another copper-bearing aluminum phosphate such as planerite or variscite. This fact alone largely rules out a source in the Ouachita Mountains.

Second, the analysis has shown a general geochemical similarity between the Branch artifacts and type Los Cerrillos, namely Chalchihuitl Hill turquoise; but the variation in chemistry between the artifacts and the type material sample coupled with the lack of an extensive turquoise source database makes it impossible to unambiguously identify Los Cerrillos, New Mexico as the source for the turquoise. However, given the close proximity of the Los Cerrillos mines to the Jemez Caldera where the majority of the Branch obsidian artifacts were sourced, it is likely that the Los Cerrillos mines are the probable source for the turquoise found at the Branch site.

The complexity of turquoise mineralogy, largely due to its wide variation in elemental substitution within the copper, aluminum and even phosphorus sites, makes source identification by XRF problematic. Color, long used by gemologists as a source indicator, is unreliable because very small changes in trace element chemistry can affect color, even across a single mineral specimen. Coupled with turquoise's known color changes with exposure to sunlight and heat, and color has to be relegated to only being a general indicator of source. To date, the spectrographic isotope analysis developed by Thibodeau et al. (2015) appears to the best methodology for sourcing turquoise. However, the methodology's main drawback is that even though it uses a minimal amount of sample material, the technique is destructive. In terms of a non-destructive methodology, careful, large multi-element analysis using X-Ray Fluorescence as shown here has promise, but the methodology will only potentially be effective if a much larger geologic database of turquoise samples from known locations is constructed. Until then, the best that can be determined is a probable sourcing based on the context of other artifacts such as ceramic sherds and obsidian as has been shown from the Branch site.

The presence of exotic materials in East Fork sites broaches the subject of interregional exchange and potentially provides insights into the social and economic relationships between groups (Baugh 1998). An established trade between the Ancestral Puebloan peoples in New Mexico and East Texas has long been recognized (Krieger 1946). Strategic resources in this exchange have been thought to be bison hides (robes), meat, turquoise and textiles from the Plains and bois d'arc bow wood and salt from East Texas (Creel 1991). Evidence of this trade has been recorded from several Caddo sites in East Texas and Arkansas (Housewright 1946; Hayes 1955; Early 1978; Prikryl 1990; Jurney and Young 1996) and from Toyah sites in Central Texas (Speth and Newlander 2012). These include items such as turquoise beads and pendants, worked flakes of obsidian, and various Puebloan ceramics. Turquoise has been recovered from five East Texas Caddo sites including Sanders (41LR2), Goss Farm (41FN12), Holderman (41RR11), Hatchel (41BW4), and Sam Kaufman (41RR16), but it always represents a very minor component of the site's total artifact assemblage, with usually only a few pieces reported per site (Housewright 1946; Early 1978; Jurney and Young 1996). In this regard, the East Fork sites and the Branch site in particular, are unique given the number and variety of Puebloan materials recovered to date (n = 90) (Crook 2013, 2015). Moreover, based on dates from the Puebloan ceramics found in East Fork sites, this exchange seems to have been over an extended timeframe but focused in two general periods (ca. A.D. 950 to 1200 and ca. A.D. 1300-1550). These time intervals correspond to the greatest periods of occupation along the East Fork (Crook and Hughston 2015) as well as the greatest periods of turquoise mining at Los Cerrillos (Snow 1973; Weigand et al. 1977; Milford 1994; 1995).

Among Prehistoric Americans, turquoise was so valued it became a metaphor for life in social and religious realms. Wisdom was likened to turquoise and the stone became a symbol of noble status (Harbottle and Weigand 1992). As such, turquoise trade was extensive; even hostile communities permitted turquoise traders to pass their borders. Turquoise trade appears to have begun about the same time as people in the American Southwest became more sedentary (Mathein and Olinger 1992; Mathein 2001).

It should be noted that none of the exotic items found in East Fork sites were really necessities for the aboriginal inhabitants of the East Fork. For example, the East Fork peoples did not need Puebloan ceramics, since they made their own serviceable shell- and sandy paste-tempered plain pottery. The same can be said for the obsidian artifacts as well as the shell and turquoise beads. Nor can it be said that the exotic items found in East Fork sites were associated with the exchange of food, at least not where exchange was a major source of subsistence. Instead there seems over time to have been an increasing desire to obtain more prestige items, of which clearly Puebloan ceramics, obsidian, shell and turquoise would have been near the top of the list (Perttula 2002; Crook and Hughston 2015).

Jurney (1995) postulates that one reason North Central and East Texas may have been a destination for trade with the Ancestral Puebloans is the presence of bois d'arc wood. Native bois d'arc stands are believed to have been present within the range of the Late Prehistoric of the East Fork and its tributaries, being widespread in the northern part of the region and gradually thinning toward the south (Bush 2014; Crook and Hughston 2015). The southernmost sites along the East Fork are near the southern end of the prehistoric bois d'arc occurrence, almost as if the presence of bois d'arc delineated the Late Prehistoric occupation (Jurney 1995; Crook and Hughston 2008, 2015).

Crook and Hughston (2007, 2008, 2015) have demonstrated that the inhabitants of the East Fork likely made extensive use of bois d'arc, even to the extent of crafting a specialized stone tool (the "East Fork Biface") for working the hard wood. It is entirely plausible that some of this bow wood production could have been used in periodic trade in addition to indigenous use. As such, given the presence of so many Ancestral Puebloan items, it is probable that the Branch site represents a major entrepot for trade into the region.

Acknowledgements

The author is indebted to the late R. K. "King" Harris who described in detail the location of the Branch site and its features to me during the summers of 1973-74. I am also grateful for the late Dr. R. L. Stephenson making available to me his unpublished field notes from his limited excavation the Branch site. I am also thankful to Dr. Alyson Thibodeau whose correspondence detailing her experiences in turquoise sourcing aided the author immensely. Lastly, I am extremely grateful to Dr. Thomas Williams of the Gault School of Archeological Research at Texas State University for assisting me in the X-Ray Fluorescence analysis of the three Branch site turquoise artifacts. Though we have completed literally thousands of XRF analyses on both geologic and prehistoric artifacts together, it never ceases to be both educational and fun to spend days in the XRF lab with Tom.

References Cited

Abdu, Y., S. Hull, M. Fayak and F. C. Hawthorn
2011 The Turquoise-Chalcosiderite Cu(Al, $Fe^{+3})_6(PO_4)_4(OH)_8 \cdot 4\ H_2O$ Solid Solution Series: a Mossbauer Spectroscopy, XRD, EMPA and FTIR Study. *American Mineralogist* 96:1433-1442.

Akright, R. L.
1979 Geology and Mineralogy of the Cerrillos Copper Deposit, Santa Fe County, New Mexico. In Ingersoll, R. V., L. A. Woodward and H. L. James, editors, *Guidebook of Santa Fe County: Santa Fe, New Mexico*, pp. 257-260. New Mexico Geological Society, 30th Annual Field Conference Guidebook.

Baugh, Timothy G.
1998 Regional Polities and Socioeconomic Exchange: Caddoan and Puebloan Interaction. In The Native History of the Caddo: Their Place in Southeastern Archeology and Ethnohistory pp. 145-158, Edited by Timothy K. Perttula and James E. Bruseth. *Studies in Archeology 30*, Texas Archeological Research Laboratory, The University of Texas at Austin.

Bush, Leslie L.
2014 Evidence for a Long-Distance Trade in Bois d'Arc Bows in 16th Century Texas (Maclura pomifera, Moraceae). *Journal of Texas Archeology and History* 1:51-69.

Creel, Darrell
1991 Bison Hides in Late Prehistoric Exchange in the Southern Plains. *American Antiquity* 56(1):40-49.

Crook, Wilson W. III
2007 The Branch Site (41COL9): A Large, Diagnostic Late Prehistoric Occupation in Collin County, Texas. *The Record* 55(2):30-44. Dallas Archeological Society, Dallas.

2013 Puebloan Intrusive Artifacts in Archeological Sites Along the East Fork. *Archeological Journal of the Texas Prairie Savannah* 3(1):36-43.

2015 An Occurrence of Turquoise and Obsidian at the Branch Site (41COL9), Collin County, Texas. *Archeological Journal of the Texas Prairie-Savannah* 5(1):46-58.

Crook, Wilson W., III and Mark D. Hughston
2007 The East Fork Biface: A New Distinctive Artifact From North Central Texas. *The Record* 55(2):58-64. Dallas Archeological Society, Dallas.

2008 The Late Prehistoric of the East Fork of the Trinity River: A Redefinition of the Wylie Focus. Paper presented at the Texas Archeological Society 79th Annual Meeting, October 24-25, Lubbock

2015 *The Late Prehistoric of the East Fork: A Redefinition of Cultural Concepts Along the East Fork of the Trinity River, North Central Texas*. CreateSpace, a DBA of On-Demand Publishing, LLC (an Amazon Company), Charleston, South Carolina.

Crook, Wilson W. III and Thomas J. Williams
2013 The Presence of Gault-Ft. Hood Chert at the Brushy Creek Clovis Site (41HU74), Hunt County, Texas. Paper presented at the Paleoamerican Odyssey Conference, October 17-19, Santa Fe.

Disbrow, Alan E. and Walter C. Stoll
1957 Geology of the Cerrillos Area, Santa Fe County, New Mexico. *New Mexico Bureau of Mines and Mineral Resources Bulletin 48*, Socorro, New Mexico, 66 pp.

Duff, Andrew I., Jeremy M. Moss, Thomas C. Windes, John Kantner and M. Steven Shackley
2012 Patterning in Procurement of Obsidian in Chaco Canyon and in Chaco-era Communities in New Mexico as Revealed by X-Ray Fluorescence. *Journal of Archeological Science* 39:2995-3007.

Early, A.
1978 Turquoise Beads from the Standridge Site, 3MN53. *Arkansas Archeologist*, 19:25-30.

Erd, Richard C., M. D. Foster and P. D. Proctor
1953 Faustite, a New Mineral, the Zinc Analogue of Turquoise. *American Mineralogist* 38:964-972.

Foord, Eugene E. and J. E. Taggart
1999 A Reexamination of the Turquoise Group: the Mineral Aheylite, Planerite (redefined), Turquoise and Coerulcolactite. *Mineralogical Magazine* 62(1):93-111.

Gardner, J. N., F. Goff, S. Garcia and R. C. Hagen
1986 Stratigraphic Relationships and Lithologic Variations in the Jemez Volcanic Field, New Mexico. *Journal of Geophysical Research* 91(B2):1763-1778.

Gautheir, Giles, Adrian L. Burke and Mathieu Leclerc
2012 Assessing XRF for the Geochemical Characterization of Radiolarian Chert Artifacts from Northeastern North America. *Journal of Archeological Science*, 39: 2436-2451.

Glascock, Michael D. and Jeffery R. Ferguson
2012 *Report on the Analysis of Obsidian Source Samples by Multiple Analytical Methods*. Archeometry Laboratory, University of Missouri Research Reactor, Columbia. (https://www.bruker.com/fileadmin/user_upload/8-PDF-Docs/X-RayDiffraction_ElementalAnalysis/HH-XRF/LabReports/Obsidian_Source_Samples.pdf), Accessed September 16, 2014.

Glascock, Michael D., R. Kunselman and D. Wolfman
1999 Intrasource Chemical Differentiation of Obsidian in the Jemez Mountains and Taos Plateau, New Mexico. *Journal of Archeological Science* 26:861-868.

Guthrie, G. D. and D. L. Bish
1991 Refinement of the Turquoise Structure and Determination of the Hydrogen Positions. *Geologic Society of America Abstracts with Programs* 23(5):A158.

Harbottle, Garman and Phil C. Weigand
1992 Turquoise in Pre-Columbian America. *Scientific American* 266(2):78-85.

Harris, R. K.,
1965 Club News, Editor's Note on Society's Excavation of the Branch Site in Collin County, Texas. *The Record* 21(1):4-18. Dallas Archeological Society, Dallas.

Hayes, E. W.
1955 Another Puebloan Trade Sherd in East Texas. *Bulletin of the Texas Archeological Society* 26:245-248.

Housewright, Rex
1946 A Turquoise Bead Necklace. *The Record* 5(2):9-10. Dallas Archeological Society, Dallas.

Hull, Sharon and Mostafa Fayek
2012 Cracking the Code of Pre-Columbian Turquoise Trade Networks and Procurement Strategies. In *Turquoise in Mexico and North America,* King, J. C. H., Max Carocci, Caro-

line Cartwright, Collin McEwan and Rebecca Stacey, editors, pp. 29-40. Archetype Publications in Association with the British Museum, London.

Hull, Sharon, Mostafa Fayek, F. Joan Mathein and Heidi Roberts
2014 Turquoise Trade of the Ancestral Puebloan: Chaco and Beyond. *Journal of Archeological Science* 45:187-195.

Jurney, David H.
1995 The Original Distribution of Bois d'Arc Part I: Texas. *Caddo Archeology Newsletter* 5(2):6-13.

Jurney, David H. and William Young
1996 Southwestern Pottery and Turquoise in Northeastern Texas. *Caddo Archeology Newsletter* 6(2):15-28.

Kendall, Heather
2010 To Measure or Not to Measure: Geochemical Analysis of Siliceous Materials in the Interior Plateau of British Columbia. *Exploration in Anthropology* 10(2):8-21.

Kim, J., A. W. Simon, V. Ripoche, J. W. Mayer and B. Wilkens
2003 Proton-Induced X-ray Emission Analysis of Turquoise Artefacts from Salado Platform Mound Sites in the Tonto Basin of Central Arizona. *Measurement Science and Technology* 14:1579-1589.

Klautz, P. F., R. V. Ingersoll, W. S. Baldridge, P. E. Damon and M. Shafiqullah
1981 Geology of the Espinosa Formation (Oligocene), North Central New Mexico. *Geological Society of America Bulletin* 92(12):2318-2400.

Kostov, Ivan
1968 *Mineralogy*. Oliver and Boyd, Edinburgh and London.

Krieger, Alex D.
1946 *Culture Complexes and Chronology in Northern Texas*. University of Texas Publication 4640, Austin.

Lisenbee, Alvis and Stephen R. Maynard
2002 *Geologic Map of the Captain Davis Mountain, 7.5-Minute Quadrangle, Santa Fe County, New Mexico*. New Mexico State Maps, Socorro.

Luedtke, B. E.
1978 Chert Sources and Trace-Element Analysis. *American Antiquity* 43:413-423.

1979 The Identification of Sources of Chert Artifacts. American Antiquity 44:744-757.

Magnus, Douglas
2012 The Turquoise Mines of the Cerrillos Hills Mining District, Gemstone Materials, and Their Usage: Ancient and Modern. In *Turquoise in Mexico and North America,* King, J. C. H., Max Carocci, Caroline Cartwright, Collin McEwan and Rebecca Stacey, editors, pp. 221-224. Archetype Publications in Association with the British Museum, London.

Mathein, F. J.
1981 Neutron Activation of Turquoise Artifacts from Chaco Canyon, New Mexico. *Current Anthropology* 22(3):293-294.

2001 Identifying Sources of Prehistoric Turquoise in North America: Problems and Implications for Interpreting Social Organization. *Journal of the Society of Bead Researchers* 12-13:17-37.

Mathein, F. J. and B. Olinger
1992 An Experiment with X-Ray Fluorescence to Determine Trace Element Variability in Turquoise Composition. In Duran, M. S. and D. T. Kirkpatrick, editors, *Archeology, Art, Anthropology: Papers in Honor of J. J. Brody*, pp. 123-134. Archeological Society of New Mexico, Albuquerque.

Milford, Homer E.
1994 History of the Los Cerrillos Mining District, New Mexico. *New Mexico Abandoned Mines Land Bureau Reports, Vol. 2*, Albuquerque.

1995 A Brief History of Turquoise Mining and Turquoise Hill. In Bauer, P. W., B. S. Kues, N. W. Dunbar, K. E. Karlstrom, and B. Harrison, editors, *Geology of the Santa Fe Region*, pp. 175-177. New Mexico Geological Society, 46th Annual Field Conference Guidebook.

National Weather Service
2014 Drought Information Service, synopsis of Current Reservoir Conditions, National Weather Service (NOAA), Dallas / Fort Worth Area.

Palache, Charles, Harry Berman and Clifford Frondel
1951 *The System of Mineralogy, 7th Edition, Volume II*. John Wiley and Sons, Inc., New York, 1124 pp.

Perttula, Timothy K.
2002 Archaeological Evidence for the Long-Distance Exchange of Caddo Indian Ceramics in the Southern Plains, Midwest, and Southeastern United States. In *Geochemical Evidence for Long-Distance Exchange*, edited by Michael D. Glascock, pp. 89-107. Bergin and Garvey, Westport, Connecticut.

Pogue, J. E.
1972 *The Turquoise: A Study of its History, Mineralogy, Geology, Ethnology, Archeology*, *Mythology, Folklore, and Technology*. The Rio Grande Press, Inc., Glorieta, New Mexico [originally published, 1915, Memoirs of the national Academy of Sciences, 20(2), Washington, D.C.]

Prikryl, Daniel J.
1990 *Lower Elm Fork Prehistory*. Office of the State Archeologist Report 37, Texas Historical Commission, Austin.

Qin, Y., Y. Y. Xu, H. M. Li, S. X. Li, and Q. F. Xi
2014 Turquoise Mine and Artefact Correlations for some Bronze Age Archaeological Sites in Hubei Province, China. *Archaeometry* doi: 10.1111/arcm.12126.

Ronzio, A. R. and M. L. Salmon
1967 Relation Between Source and Composition of Turquoise. *Journal of the Colorado-Wyoming Academy of Sciences* 5:30-31.

Ruppert, H.
1982 Zur verbreitung und Herkunft von Turkis und Sodalith in Prakolumbuschen der kordilleren. *Baessler-Archiv* 30:69-124.

Salmon, M. L. and A. R. Ronzio
1962 The X-Ray Fluorescence Analysis of Turquoise. *Journal of the Colorado-Wyoming Academy of Sciences* 5:19

Schoeder, A. H.
1979 The Cerrillos Mining Area. In *Archeology and History of Santa Fe County, Special Publication No. 8*, pp. 13-16, R. V. Ingersoll, editor. New Mexico Geological Society, Socorro.

Shackley, M. Steven
2005 *Obsidian: Geology and Archeology in the North American Southwest*. University of Arizona Press, Tucson, pp. 3-87.

2009 Some Provenance of Obsidian Artifacts from Six Ancestral Pueblo Villages in and around the Jemez Valley, Northern New Mexico. *Report Prepared for Matthew Liebmann*, Department of Anthropology, Harvard University.

2013 Catalogue of Sources of Archeological Obsidian in the Greater American Southwest: The Jemez Mountains and the Sierra de los Valles. Geoarcheological XRF Laboratory, www.swxrflab.net/jemez.html, accessed September 15, 2014.

Sigleo, A. M. C.
1970 Trace element Geochemistry of Southwestern Turquoise. *Unpublished Master's Thesis*, University of New Mexico, Albuquerque.

Smith, A. E. Jr.
1985 Aluminum Phosphate Minerals from Mauldin Mountain, Montgomery County, Arkansas. *Mineralogical Record* 16:291-295.

Snow, David H.
1973 Prehistoric Southwestern Turquoise Industry. In *Turquoise*, edited by S. A. Northrup, D. L. Neumann and D. H. Snow, Museum of New Mexico, Albuquerque.

Speer, Charles A.
2014 Experimental Sourcing of Edwards Plateau Chert using LA-ICP-MS. *Quaternary International* 342:199-213.

Speth, J. D. and K. Newlander
2012 Plains-Pueblo Interaction: A view from the Middle. In *The Toyah Phase of Central Texas: Late Prehistoric Economic and* Social *Processes* edited by Nancy A. Kenmotsu and D. K. Boyd, pp. 152-180. Texas A&M University Press, College Station.

Stephenson, Robert L.
1952 The Hogge Bridge Site and the Wylie Focus. *American Antiquity* 17(4):299-312.

Strunz, Hugo
1968 *Mineralogische Tabellen*. Akademische Verlagsgesellschaft, Gerst und Portig, K.G., Leipzig.

Thibodeau, Alyson M., John T. Chesley, Joaquin Ruiz, David J. Killick and Arthur Vokes
2012 An Alternative Approach to the Prehispanic Turquoise Trade. In *Turquoise in Mexico and North America,* King, J. C. H., Max Carocci, Caroline Cartwright, Collin McEwan and Rebecca Stacey, editors, pp. 65-74. Archetype Publications in Association with the British Museum, London.

Thibodeau, Alyson M., D. J. Killick, Saul L. Hedquist, J. T. Chesley and Joaquin Ruiz
2015 Isotopic Evidence for the Provenance of Turquoise in the Southwestern United States. *Geological Society of America Bulletin* 127(11-12:1617-1631.

Tykot, R. H.
2004 Scientific Methods and Applications to Archeological Provenance Studies. *Proceedings of the International School of Physics "Enrico Fermi"*, Course CLIV, M. Martini and M. Milazzo editors. IOS Press, Amsterdam.

Warren, A. H. and Robert H. Weber
1979 Indian and Spanish Mining in the Galisteo and Hagan Basins. In *Archeology and History of Santa Fe County*, Raymond V. Ingersol and Jonathan F. Callender, editors, pp. 7-11. New Mexico Geological Society, 30th Annual Field Conference, October 4-6, 1979. New Mexico Geological Society Special Publication No., 8.

Weigand, Phil C., Garman Harbottle and Edward V. Sayre
1977 Turquoise Sources and Source Analyses: Mesoamerica and the Southwestern U.S.A., in *Exchange Systems in Prehistory*, pp. 15-34. Academic Press, Inc., London.

Williams, Thomas J. and Wilson W. Crook, III
2013 Geochemical Analysis of Primary Chert Outcrops from the Edwards Plateau: A Methodological Approach for the Use of pXRF in Material Sourcing. Paper presented at the 84th Annual Meeting of the Texas Archeological Society, October 25-27, Del Rio.

Wiseman, Regge N. and J. Andrew Darling
1986 The Bronze Trail Site Group: More Evidence for a Cerritos-Chaco Turquoise Connection. In *By Hands Unknown: Papers on Rock Art and Archaeology in Honor of James G. Bain*, edited by Anne Poore, pp. 115-143. Papers of the Archaeological Society of New Mexico Vol. 12. Ancient City Press, Albuquerque.

APPENDIX I
XRF Results – Trace Element Geochemistry of Turquoise Geologic Samples, Southwest U.S. and Mexico (ppm)

Element	Cerrillos Chalchihuitl Hill #1	Cerrillos Chalchihuitl Hill #2	Cerrillos Chalchihuitl Hill #3	Cerrillos Chalchihuitl Hill #4	Cerrillos Little Chalchihuitl Mine	Cerrillos Little Chalchihuitl "Cerrillos Green"
Sodium	24	60	1	31	206	115
Magnesium	978	1,160	1,174	1,753	738	1,119
Silica	8,503	10,679	4,452	6,382	7,202	5,311
Potassium	737	210	0	889	0	194
Calcium	1,913	3,800	1,130	2,067	5,091	5,628
Titanium	86	258	64	100	41	1,714
Vanadium	36	25	28	17	36	119
Chromium	14	13	16	9	13	0
Manganese	69	79	72	671	36	0
Iron	20,806	42,671	12,476	2,862	15,166	0
Cobalt	21	13	20	13	12	16
Nickel	37	86	84	114	41	57
Zinc	0	0	0	0	0	0
Arsenic	70	96	142	81	164	13
Rubidium	6	12	10	10	26	6
Strontium	65	276	17	94	158	66
Yttrium	4	7	4	5	7	4
Zirconium	9	7	7	17	40	13
Niobium	1	3	1	2	3	2
Molybdenum	6	13	2	2	21	2
Barium	62	213	59	0	272	492
Lead	7	9	10	9	10	3
Thorium	3	5	3	2	4	1
Uranium	0	0	2	9	2	5
Mineral	Planerite	Turquoise	Turquoise	Turquoise	Planerite	Planerite

APPENDIX I
XRF Results – Trace Element Geochemistry of Turquoise Geologic Samples, Southwest U.S. and Mexico (ppm)

Element	Cerrillos Muniz Claim	Cerrillos Morning Star Claim	Cerrillos Blue Bell Claim	Cerrillos Little Blue Bell Mine	Cerrillos Tiffany Mine	Burro Mountain Grant Co., NM
Sodium	128	113	34	84	14	31
Magnesium	578	808	996	1,204	1,688	928
Silica	9,661	8,298	8,361	10,652	3,039	4,621
Potassium	516	885	36	255	47	423
Calcium	3,014	1,470	3,621	853	90	331
Titanium	61	168	44	44	38	840
Vanadium	30	47	33	24	26	64
Chromium	15	14	15	12	12	9
Manganese	62	20	69	70	235	0
Iron	9,634	19,087	17,480	5,389	3,269	0
Cobalt	13	18	19	11	17	36
Nickel	55	30	6	63	144	53
Zinc	0	0	0	0	0	0
Arsenic	344	369	310	84	60	10
Rubidium	15	19	13	20	5	10
Strontium	32	36	69	157	58	0
Yttrium	2	1	3	8	6	2
Zirconium	2	5	4	30	13	5
Niobium	0	0	1	3	3	1
Molybdenum	9	13	23	15	25	12
Barium	44	10	0	96	19	66
Lead	14	14	16	10	8	3
Thorium	4	5	5	2	2	1
Uranium	2	0	0	5	6	7
Mineral	Planerite	Planerite	Planerite	Turquoise	Turquoise	Planerite

APPENDIX I
XRF Results – Trace Element Geochemistry of Turquoise Geologic Samples, Southwest U.S. and Mexico (ppm)

Element	Morenci Arizona	Sleeping Beauty Mine Arizona*	Kingman Arizona #1	Kingman Arizona #2	Kingman Arizona #3	Cripple Creek Colorado
Sodium	64	165	35	334	112	103
Magnesium	1,142	1,157	1,482	1,359	1,182	1,289
Silica	3,161	4,579	3,021	3,426	2,584	4,496
Potassium	0	0	0	29	0	0
Calcium	0	42	1	0	0	110
Titanium	69	23	6	21	1	101
Vanadium	24	18	28	2	28	23
Chromium	13	11	13	9	15	14
Manganese	78	79	112	110	106	11
Iron	4,982	1,946	3,222	1,257	1,878	3,054
Cobalt	13	13	14	11	13	14
Nickel	9	125	117	107	109	11
Zinc	0	0	0	0	0	0
Arsenic	263	194	146	145	182	32
Rubidium	12	11	9	10	9	1
Strontium	8	1	9	10	4	15
Yttrium	3	4	5	4	6	12
Zirconium	6	10	1	1	11	12
Niobium	1	2	2	2	2	4
Molybdenum	26	24	21	61	22	27
Barium	0	0	0	0	0	224
Lead	14	10	11	10	15	5
Thorium	4	4	3	3	3	1
Uranium	1	4	1	2	2	1
Mineral	Turquoise	Turquoise	Turquoise	Turquoise	Turquoise	Turquoise

* Average of three analyses on small stream-rolled nuggets

APPENDIX I
XRF Results – Trace Element Geochemistry of Turquoise Geologic Samples, Southwest U.S. and Mexico (ppm)

Element	Royston Nevada	Pilot Mountain Nevada	Emerald Valley Nevada	Ajax Nevada	Fox Mine Nevada	Paiute Mine Nevada
Sodium	20	410	3,942	5,487	211	124
Magnesium	1,740	941	451	339	1,157	280
Silica	4,465	2,870	569	871	2,941	12,263
Potassium	238	0	171	218	0	8
Calcium	0	114	17	41	0	644
Titanium	24	23	339	739	55	44
Vanadium	31	25	21	13	36	30
Chromium	14	20	374	112	12	15
Manganese	95	58	273	151	118	47
Iron	2,839	16,207	12,003	19,999	2,044	21,119
Cobalt	12	20	15	27	17	21
Nickel	100	54	74	161	124	58
Zinc	0	0	1,788	1,655	3,463	0
Arsenic	179	78	6,393	6,163	380	83
Rubidium	11	5	182	168	11	3
Strontium	12	17	2,019	139	3	69
Yttrium	3	1	0	0	7	4
Zirconium	7	4	0	0	13	6
Niobium	1	0	0	0	3	1
Molybdenum	56	1	0	0	3	12
Barium	15	0	824	4,573	0	0
Lead	12	7	186	184	36	10
Thorium	3	2	60	57	3	1
Uranium	2	0	17	0	0	3
Mineral	Turquoise	Planerite	Turquoise	Turquoise	Turquoise	Planerite

APPENDIX I
XRF Results – Trace Element Geochemistry of Turquoise Geologic Samples, Southwest U.S. and Mexico (ppm)

Element	Blue Gem Mine Nevada	Tyrone Mine Grant Co., New Mexico	Hachita Grant Co., New Mexico	Campo Frio Sonora, Mexico	Campitos, Sonora Mexico	Nacozari Sonora Mexico #1	Nacozari Sonora Mexico #2
Sodium	115	183	133	0	64	135	157
Magnesium	1,248	830	1,159	1,159	1,029	948	1,042
Silica	2,243	6,076	6,173	5,095	2,527	2,577	3,400
Potassium	0	13	181	0	0	0	8
Calcium	0	104	39	38	13	10	644
Titanium	13	11	89	310	33	44	44
Vanadium	28	36	24	23	79	54	30
Chromium	17	13	15	16	13	19	15
Manganese	34	25	56	0	123	74	54
Iron	876	2,426	6,321	8,933	3,478	3,435	1,378
Cobalt	3	3	12	42	27	12	6
Nickel	31	22	54	88	117	73	47
Zinc	0	0	0	0	20,949	0	0
Arsenic	1,164	11	576	34	1,028	238	594
Rubidium	2	0	23	4	9	12	17
Strontium	10	8	31	13	15	4	4
Yttrium	0	0	6	6	6	4	65
Zirconium	0	0	12	12	11	8	0
Niobium	0	0	2	3	3	2	14
Molybdenum	0	0	16	26	27	19	6
Barium	0	318	67	22	0	0	0
Lead	25	3	23	5	10	12	18
Thorium	8	0	7	2	3	4	6
Uranium	0	0	0	0	1	2	3
Mineral	Planerite	Planerite	Planerite	Planerite	Faustite	Turquoise	Planerite

SOURCING TURQUOISE BEADS FROM THE GOSS FARM SITE (41FN12) USING X-RAY FLUORESCENCE

Wilson W. Crook, III

Introduction

After the end of the Second World War, Dallas Archeological Society (DAS) members Rex Housewright and Lester Wilson resumed their archeological explorations along the Red River in Lamar and Fannin Counties. At the Goss Farm site (41FN12) they encountered the burial of 5-6 year old juvenile in a shallow internment not associated with any of the prominent mound features in the area (Housewright, 1946). Around the head and shoulders of the juvenile were 260 small, tabular beads and two small rectangular pendants – all presumed to have been made from turquoise. Housewright noted the find in the DAS' journal, *The Record* (Housewright 1946) and the artifacts were curated in his personal collection.

Beginning in 2003, the author along with Mark D. Hughston initiated an extensive reassessment of the Late Prehistoric occupation along the East Fork of the Trinity River (Crook and Hughston 2008, 2015, 2016a). As part of this research, we let it be known that we would like the opportunity to study and record any artifact collections that could be verified as coming from sites along the East Fork. This led us to the discovery of the Rex Housewright-Lester Wilson-Bobby Vance collection (hereafter described as the "Housewright-Wilson-Vance" collection). These three Dallas Archeological Society members had made a pact to keep their archeological collections together for future research. The Housewright collection passed upon his death to Lester Wilson, who passed the combined collection on his death to Bobby Vance (Harris and Vance 1989). With the passing of Mr. Vance, the entire collection plus all its research maps and notes, was purchased by the author and Mark D. Hughston in order to keep this valuable set of data intact. While the collections were predominantly focused on the East Fork of the Trinity River, they also contained materials from the Red River region including the Goss Farm beads and pendant.

Elsewhere in this issue of *The Journal*, the author describes his efforts using X-Ray Fluorescence (XRF) to source two turquoise beads and a small pendant similar to those found at Goss Farm. Following a largely successful effort to source these three artifacts from the Branch site (41COL9) in Collin County (Crook 2013, 2015, 2016b), it was decided to use the same methodology and attempt to source the turquoise artifacts found by Housewright and Wilson at Goss Farm. This paper thus serves to record the results of this analysis.

Artifact Description

The Goss Farm site (41FN12) is located immediately west of the prolific Sanders site (41LR2), across Bois d'Arc Creek in eastern Fannin County and is believed to be of the same general age (Housewright 1946; Jurney and Young 1996). As noted above, Housewright and Wilson found a change of soil color which they believed was indicative of a shallow burial. Subsequent excavation revealed a single red-filmed ceramic sherd above a small oval area of gray clay. Within the clay they found the burial of a juvenile, tentatively aged approximately 5-6 years of age, flexed and facing east. A total of 260 very small, tabular turquoise-colored beads and two small rectangular pendants were recovered around the shoulders and neck of the individual in "short groups of 0.5-3 inches long" (Housewright 1946). Total length of the bead strand once restrung was 26 cm (10.25").

The turquoise beads are very small, ranging from 2.4-4.0 mm in diameter. Size of the two turquoise pendants, which appears to have been strung along with the beads, are as follows: 14.0 x 9.5 x 2.4 mm and 14.0 x 8.0 x 2.4 mm. Color of the turquoise ranged from bright blue to blue-green to almost white (Housewright 1946). The reconstructed turquoise bead necklace with the two small pendants is shown in Figure 1.

Two of the turquoise beads from the Goss Farm burial were selected for X-Ray Fluorescence analysis. As shown in Figure 1, both beads are extremely small, ranging from 3.2-3.5 mm in diameter. This is smaller than most of the shell beads from the area which are typically twice (or more) in size. Both are tabular and extremely thin (0.9-1.0 mm). Physical

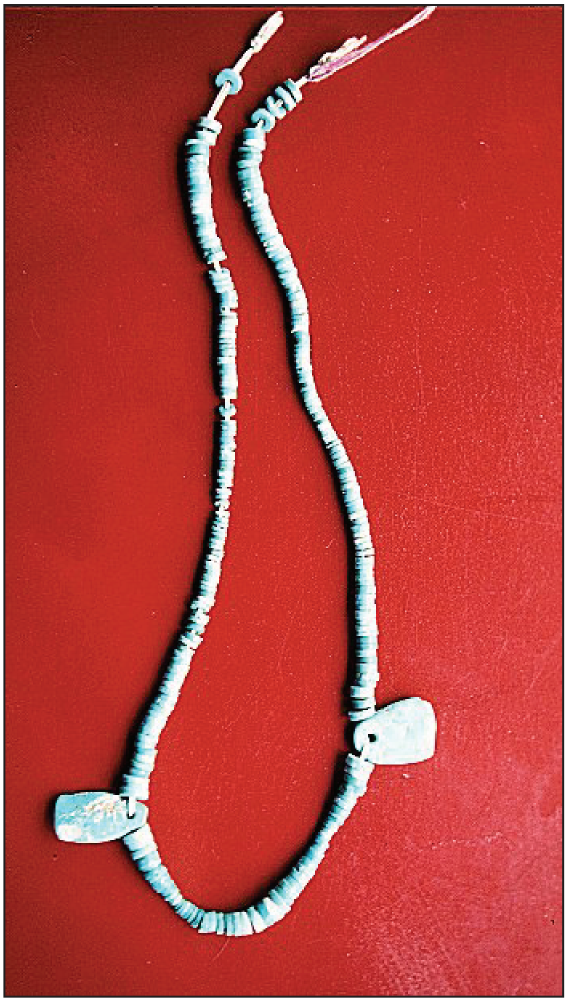

Figure 1. Reconstructed turquoise bead necklace from the Goss Farm site (41FN12), Fannin County, Texas (photo by Lester Wilson).

data including size and color of the two turquoise beads is shown in Table 1.

X-Ray Fluorescence Analysis

The two turquoise beads from the Goss Farm site 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 analysis was conducted using a Bruker Tracer III-SD handheld energy-dispersive X-Ray Fluorescence 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. Analyses were conducted on September 8, 2015 and then re-run for verification on November 10, 2015 at the

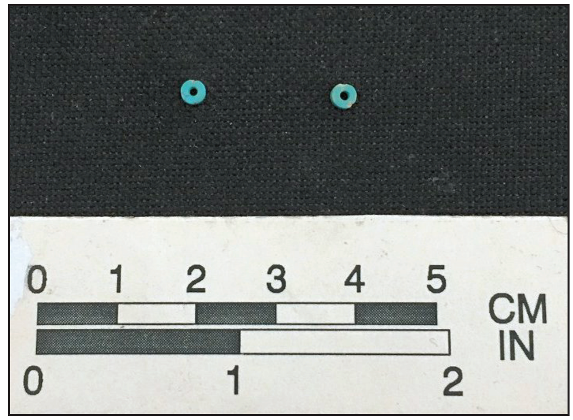

Figure 2. Two of the turquoise beads from the burial cache recovered by Rex Housewright and Lester Wilson from the Goss Farm site (41FN12), Fannin County, Texas.

laboratory of the Gault School of Archeological Research located at Texas State University in San Marcos, Texas. All samples were rinsed in Milli-Q ultra-pure water to remove all external contaminants prior to analysis.

Based on previous experience analyzing the turquoise artifacts from the Branch site (Crook 2017), the Goss Farms beads were measured at both low energy (15 keV, 23μA) and high energy (40 keV, 36.2μA), using no filter at the lower energy and a 0.3 mm aluminum / 0.02 titanium filter in the X-Ray path for the higher energy readings. In both analyses a 300 second live-count time was used and at least two measurements taken per sample and averaged. Peak intensities for Kα peaks of 22 elements were collected including sodium, magnesium, silicon, potassium, calcium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, rubidium, strontium, yttrium, zirconium, niobium, molybdenum, and barium, and the Lα peaks for lead, thorium, and uranium were calculated as ratios to the Compton peak of rhodium and converted to parts-per-million (ppm). With the exception of copper, this elemental analysis focused on the trace element spectrum.

One of the key findings in Tom Williams' and my work on sourcing complex minerals such as chert and turquoise using XRF technology is to adopt a large, multi-element approach based on the approach developed by Speer (2014) for Laser Ablation analysis. Even so, the technique was shown to only be as good as the geologic database the analysis was referenced to (Williams and Crook 2013; Crook and Williams 2013). Likewise, the analytical experience of Thibodeau (Thibodeau et al. 2015) and Weigand et al. (1977) demonstrated that a comprehensive geologic database is equally important in sourcing turquoise. In this regard, the author obtained a number of well-documented polished specimens from across both the U.S. and Mexican southwest to use as reference type specimens. This included geologic specimens from the Los Cerrillos, New Mexico area including individual locations from the district such as Chalchihuitl Hill, the Little Chalchihuitl Mine, the Muniz Mine (American Turquoise company, Turquoise Hill), the Castillian Mine (Blue Bell Claim), the Little Blue Bell Mine, and the Morning Star Claim. In addition to samples from the Los Cerrillos area, well-provenanced turquoise samples were obtained from elsewhere in New Mexico (Burro Mountain, Hachita and Tyrone mines), Colorado (Cripple Creek), Arizona (Morenci, Sleeping Beauty Mine and Kingman), Nevada (Royston, Pilot Mountain, Emerald Valley, Fox Mine, Ajax Mine, Blue Gem Mine and the Paiute Mine), and Mexico (Nacozari, Campo Frio, Campitos). Samples were specifically acquired to represent the broadest range of both color (bright green to turquoise blue) as well as locations which were known to have produced archeological turquoise artifacts.

The results of the XRF analysis of the Goss Farm beads are shown in Table 2 below. While copper was measured for in each analysis, the high amounts (sometimes in excess of 10% or 100,000 ppm) is really above the accuracy limits for X-Ray Fluorescence which is designed to focus on smaller trace elements rather than on major element analysis. As such, the copper contents have not been recorded in Table 2. However, it was easy to determine which specimens had significant copper present and thus were true turquoise versus those in which copper was absent to a major degree (planerite).

As can be seen in Table 2, both Goss Farm beads have very a similar trace element geochemistry which is characterized by relatively low iron (0.4-0.5%), anomalous silica (0.2-0.3%), and absolutely no zinc, no calcium, no barium and trace levels of arsenic (30-96 ppm) and trace strontium (12-18 ppm). Moreover, the presence of significant amounts of copper conclusively shows that the Goss Farm beads are made from turquoise and not some other copper-bearing aluminum phosphate such as planerite or variscite.

When compared to the 31 geologic samples, these characteristics most closely match either Morenci or Kingman, Arizona material. Note the analysis clearly does not match those taken from the southern end of the Los Cerrillos, New Mexico district, specifically the area in and around Chalchihuitl Hill. Chalchihuitl Hill turquoise is typically characterized by much higher levels of calcium, iron, silica as well as the consistent presence of trace barium.

Discussion

Several conclusions can be drawn from the results of the trace element analysis of the three Branch turquoise artifacts. First and foremost, the analysis has conclusively shown that the Goss Farm beads are made of turquoise and not another copper-bearing aluminum phosphate such as planerite or variscite. This fact alone largely rules out a source in the Ouachita Mountains.

Second, the analysis has shown that the two beads share the same trace element chemical composition and thus likely come from the same source. As the two beads were randomly selected from one end and the middle of the Goss Farm strand, it can be assumed that most if not all of the beads (as well as the two small pendants) share a similar trace element chemistry.

Lastly, the analysis has shown a general geochemical similarity between the Goss Farms beads and material from either Morenci or Kingman, Arizona, to the exclusion of all other Southwest U.S. and New Mexico sites including Los Cerrillos, New Mexico. While the composition of the beads most closely matches that of Morenci, Arizona material, the relative similarity of Kingman turquoise cannot be ruled out.

The presence of turquoise in Caddo sites along the Red River is well-documented provides strong evidence for interregional exchange and possible social and economic relationships between groups (Baugh 1998; Perttula 2002). An established trade between the Ancestral Puebloan peoples in New Mexico and East Texas has long been recognized (Krieger 1946). Strategic resources in this exchange have been thought to be bison hides (robes), meat, turquoise and textiles from the Plains and bois d'arc bow wood and salt from East Texas (Creel 1991).

Evidence of this trade has been recorded from several Caddo sites in East Texas and Arkansas (Housewright 1946; Hayes 1955; Early 1978; Prikryl 1990; Jurney and Young 1996) and from Toyah sites in Central Texas (Speth and Newlander 2012). These include items such as turquoise beads and pendants, worked flakes of obsidian, and various Puebloan ceramics. Specifically, in Burial 8 at the Sam Kaufman site (41RR16), two small turquoise pendants and five small beads "of the same type as those found by Housewright on Goss Farm" were recovered (Harris 1953a, 1953b). In Burial 17 of the same site, 30 turquoise beads were recovered (Skinner et al. 1969; Perttula et al. 2015; Perttula et al. 2016). Interestingly, the beads ranged from 3-5 mm in diameter and approximately 1 mm in thickness – almost identical to those found at Goss Farm (Skinner et al. 1969). Turquoise has also been recovered from three

Table 2.
XRF Results – Trace Element Geochemistry of Turquoise Beads from the Goss Farm Site (41FN12), Fannin County, Texas Compared to Analyses of Morenci and Kingman Turquoise as well as a Range of Analyses from the Chachihuitl Hill Area, Los Cerillos, New Mexico.

Element	Goss Farm Bead #1	Goss Farm Bead #2	Morenci, Arizona	Kingman, Arizona	Range Chalchihuitl Hill, Cerrillos, NM (5 analyses)
Sodium	613	626	64	35	1-206
Magnesium	1,708	1,744	1,142	1,482	738-1,753
Silica	2,337	2,924	3,161	3,021	4,452-10,679
Potassium	0	0	0	0	0-889
Calcium	0	0	0	1	1,130-5,091
Titanium	12	32	69	6	41-258
Vanadium	12	8	24	28	17-36
Chromium	5	5	13	13	9-16
Manganese	88	109	78	112	36-671
Iron	4,346	5,262	4,982	3,222	2,862-42,671
Cobalt	13	13	13	14	13-21
Nickel	96	102	9	117	37-114
Zinc	0	0	0	0	0
Arsenic	30	96	263	146	13-164
Rubidium	4	10	12	9	6-26
Strontium	12	18	8	9	17-158
Yttrium	5	6	3	5	4-7
Zirconium	11	12	6	1	7-40
Niobium	2	2	1	2	1-3
Molybdenum	21	22	26	21	2-21
Barium	0	0	0	0	59-272
Lead	5	9	14	11	7-10
Thorium	1	3	4	3	2-5
Uranium	1	1	1	1	0-9
Mineral	Turquoise	Turquoise	Turquoise	Turquoise	Planerite-Turquoise

other East Texas Caddo sites including Sanders (41LR2), Holderman (41RR11), and Hatchel (41BW4) (Early 1978; Jurney and Young 1996). Age of the Sanders site is estimated at ca. 1100-1300 AD or the Middle Caddo Period (Bruseth 1998). Given its extremely close location, Goss Farm is presumed to be more or less contemporaneous in age with Sanders.

Jurney (1995) postulates that one reason North Central and East Texas may have been a destination for trade with the Ancestral Puebloans is the presence of bois d'arc wood. Native bois d'arc stands are believed to have been present along Bois d'Arc Creek, the tributary of the Red River which separates the Goss Farm and Sanders sites (Bush 2014). Crook and Hughston (2007, 2008, 2015) have demonstrated that the inhabitants of the East Fork of the Trinity River likely made extensive use of bois d'arc, even to the extent of crafting a specialized stone tool (the "East Fork Biface") for working the hard wood. It is entirely plausible that similar bow wood production could have been used in periodic trade by the inhabitants of the Goss Farm, Sanders and Sam Kaufman sites.

Acknowledgements

The author is indebted is indebted to Dr. Thomas Williams of the Gault School of Archeological Research at Texas State University for assisting us in the X-Ray Fluorescence analysis of the two Goss Farm turquoise beads as well as the 31 geologic samples used in the analysis contained herein. I are also grateful to Dr. Alyson Thibodeau whose correspondence detailing her experiences in turquoise sourcing aided the author immensely. Lastly, I would like to thank Ms. Brenda Vance who made the Housewright-Wilson-Vance collection available to us allowing us to both preserve as well as analyze the Goss Farm turquoise.

References Cited

Bruseth, James. E.

1998 The Development of Caddoan Polities along the Middle Red River Valley of Eastern Texas and Oklahoma. In *The Native History of the Caddo: Their Place in Southeastern Archeology and Ethnohistory*, edited by T. K. Perttula and J. E. Bruseth, pp. 47-68. Studies in Archeology 30. Texas Archeological Research Laboratory, The University of Texas at Austin.

Bush, Leslie L.

2014 Evidence for a Long-Distance Trade in Bois d'Arc Bows in 16th Century Texas (Maclura pomifera, Moraceae). *Journal of Texas Archeology and History* 1:51-69.

Creel, Darrell

1991 Bison Hides in Late Prehistoric Exchange in the Southern Plains. *American Antiquity* 56(1):40-49.

Crook, Wilson W. III

2013 Puebloan Intrusive Artifacts in Archeological Sites Along the East Fork. *Archeological Journal of the Texas Prairie Savannah* 3(1):36-43.

2015 An Occurrence of Turquoise and Obsidian at the Branch Site (41COL9), Collin County, Texas. *Archeological Journal of the Texas Prairie-Savannah* 5(1):46-58.

2017 Difficulties in Sourcing Turquoise Artifacts Using X-Ray Fluorescence. *The Journal* 137:11. Houston Archeological Society, Houston.

Crook, Wilson W., III and Mark D. Hughston

2007 The East Fork Biface: A New Distinctive Artifact From North Central Texas. *The Record* 55(2):58-64. Dallas Archeological Society, Dallas.

2008 The Late Prehistoric of the East Fork of the Trinity River: A Redefinition of the Wylie Focus. Paper presented at the Texas Archeological Society 79th Annual Meeting, October 24-25, Lubbock

2015 *The Late Prehistoric of the East Fork: A Redefinition of Cultural Concepts Along the East Fork of the Trinity River, North Central Texas*. CreateSpace, a DBA of On-Demand Publishing, LLC (an Amazon Company), Charleston, South Carolina.

2016a The Late Prehistoric of the East Fork of the Trinity River. Center for Regional Heritage Research (CRHR) Research Reports, 2(1):1-16. DOI: http://dx.doi.org/10.5281.zenodo.44607. Available at: http://scholarworks.sfase.edu/crhr_research_reports/vol2/iss1.1.

Crook, Wilson W. III and Thomas J. Williams
2013 The Presence of Gault-Ft. Hood Chert at the Brushy Creek Clovis Site (41HU74), Hunt County, Texas. Paper presented at the Paleoamerican Odyssey Conference, October 17-19, Santa Fe.

Early, A.
1978 Turquoise Beads from the Standridge Site, 3MN53. *Arkansas Archeologist*, 19:25-30.

Harris, R. K.
1953a Two Recent Trips to Sites in Fannin and Lamar Counties. *The Record* 11(5):19-20. Dallas Archeological Society, Dallas.

1953b The Sam Kaufman Site, Red River County, Texas. *Bulletin of the Texas Archeological Society* 24:43-63.

Harris, Inus Marie and Bobby D. Vance
1989 Lester L. Wilson and Collin County Archeology. *The Record* 43(1):1-9, Dallas Archeological Society, Dallas.

Hayes, E. W.
1955 Another Puebloan Trade Sherd in East Texas. *Bulletin of the Texas Archeological Society* 26:245-248.

Housewright, Rex
1946 A Turquoise Bead Necklace. *The Record* 5(2):9-10. Dallas Archeological Society, Dallas.

Jurney, David H.
1995 The Original Distribution of Bois d'Arc Part I: Texas. *Caddo Archeology Newsletter* 5(2):6-13.

Jurney, David H. and William Young
1996 Southwestern Pottery and Turquoise in Northeastern Texas. *Caddo Archeology Newsletter* 6(2):15-28.

Krieger, Alex D.
1946 *Culture Complexes and Chronology in Northern Texas*. University of Texas Publication 4640, Austin.

Perttula, Timothy K.
2002 Archaeological Evidence for the Long-Distance Exchange of Caddo Indian Ceramics in the Southern Plains, Midwest, and Southeastern United States. In *Geochemical Evidence for Long-Distance Exchange*, edited by Michael D. Glascock, pp. 89-107. Bergin and Garvey, Westport, Connecticut.

Perttula, Timothy K., Bo Nelson, Mark Walters, and R. Z. Selden Jr.
2015 The Sanders Site (41LR2): A Middle to Historic Caddo Settlement and Mound Center on the Red River in Lamar County, Texas. *Journal of Northeast Texas Archaeology* 50:1-87.

Perrtula, Timothy K., Mark Walter and Bo Nelson
2016 *Caddo Ceramic Vessels from the T. M. Sanders Site (41LR2) on the Red River in Lamar County, Texas*. Special Publication No. 41. Friends of Northeast Texas Archeology, Austin and Pittsburgh

Prikryl, Daniel J.
1990 *Lower Elm Fork Prehistory*. Office of the State Archeologist Report 37, Texas Historical Commission, Austin.

Skinner, S. Alan, R. K. Harris and K. M. Anderson
1969 *Archeological Investigations at the Sam Kaufman Site, Red River County, Texas*. Contributions in Anthropology. Southern Methodist University, Dallas.

Speer, Charles A.
2014 Experimental Sourcing of Edwards Plateau Chert using LA-ICP-MS. *Quaternary International* 342:199-213.

Speth, J. D. and K. Newlander
2012 Plains-Pueblo Interaction: A view from the Middle. In *The Toyah Phase of Central Texas: Late Prehistoric Economic and* Social *Processes* edited by Nancy A. Kenmotsu and D. K. Boyd, pp. 152-180. Texas A&M University Press, College Station.

Thibodeau, Alyson M., D. J. Killick, Saul L. Hedquist, J. T. Chesley and Joaquin Ruiz
2015 Isotopic Evidence for the Provenance of Turquoise in the Southwestern United States. *Geological Society of America Bulletin* 127(11-12):1617-1631.

Weigand, Phil C., Garman Harbottle and Edward V. Sayre
1977 Turquoise Sources and Source Analyses: Mesoamerica and the Southwestern U.S.A., in *Exchange Systems in Prehistory*, pp. 15-34. Academic Press, Inc., London.

Williams, Thomas J. and Wilson W. Crook, III
2013 Geochemical Analysis of Primary Chert Outcrops from the Edwards Plateau: A Methodological Approach for the Use of pXRF in Material Sourcing. Paper presented at the 84th Annual Meeting of the Texas Archeological Society, October 25-27, Del Rio.

ANALYSIS OF A CERAMIC SHERD COLLECTION FROM A SITE ON THE LITTLE BRAZOS RIVER IN FALLS COUNTY, TEXAS

Timothy K. Perttula

Introduction

Frank Watt collected aboriginal ceramic vessel sherds from the Johnson site (40C8-2) on the Little Brazos River in the eastern part of Falls County, Texas. Falls County is in the Blackland Prairie Physiographic zone in east central Texas (Figure 1). These collections are in the holdings of the Mayborn Museum Complex at Baylor University, and the sherds in the collection were recently reexamined as part of a research project designed to identify the spatial and temporal distribution of ancestral Caddo vessels and vessel sherds outside of East Texas, especially in the general Central Texas area.

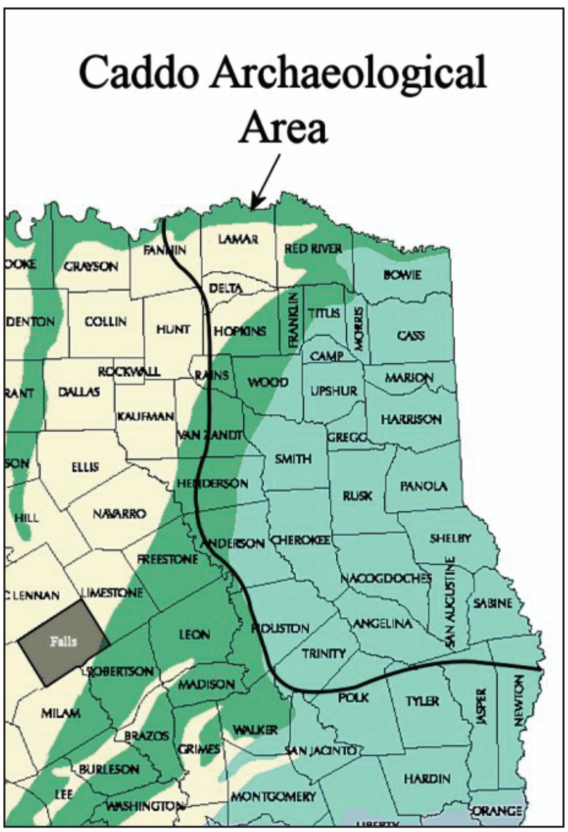

Figure 1. Falls County relative to the Caddo Archaeological Area and Natural Regions of Texas.

Johnson Site Ceramic Assemblage

The Johnson site collection has 70 sherds, including sherds from plain ware (46 percent) (Figure 2e), utility ware (41 percent), and fine ware (13 percent) vessels (Table 1). About 96 percent of the sherds are from vessels tempered with grog, either as the sole temper or in combination with burned bone. Approximately 27 percent of the sherds are from vessels with burned bone added as a temper, either as the sole temper (4.3 percent) or in combination with grog (23 percent) (Table 1).

About 76 percent of the decorated sherds (n=38) are from utility ware vessels, likely jars with everted rims. The engraved and engraved-punctated sherds in the collection are from carinated bowls and bottles.

The brushed and brushed-incised sherds comprise 24 percent of the utility wares, and 18 percent of all the decorated sherds from the Johnson site (see Table 1). They are from Bullard Brushed jars (Suhm and Jelks 1962:Plate 11) that have horizontal brushing marks on the rim, and vertical brushing marks and/or incised lines on the vessel body (see Figure 2c-d). The few punctated sherds (8 percent of the decorated sherd assemblage) have rows of fingernail punctations (a rim with grog temper and a sandy paste), tool punctated rows, and rows of small circular punctations (see Figure 2a-b, f), on rim and body sections of utility ware jars.

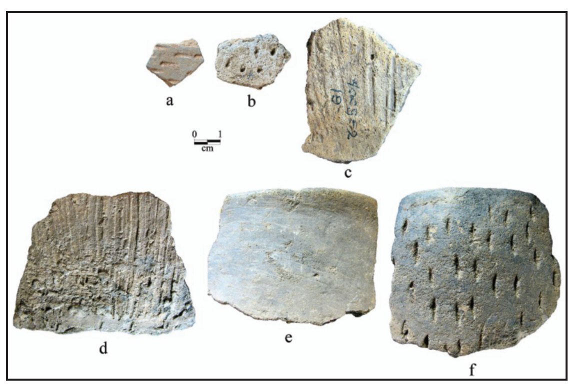

Figure 2. Plain, brushed, and punctated rim and body sherds from the Johnson site (40C8-2), Falls County, Texas.

Table 1. Ceramic sherds from the Johnson site (40C8-2).

Ware	Grog-tempered	Grog-bone tempered	Bone-tempered	N
Plain	21	9	2	32
Utility	22	6	1	29
Brushed	5	0	0	5
Brushed-Incised	1	1	0	2
Incised	10	5*	1	16
Incised-Punctated	3	0	0	3
Punctated	3	0	0	3
Fine	9	0	0	9
Engraved	7	0	0	7
Engraved-Punctated	2	0	0	2
Totals	52	15	3	70

**one of these sherds is from a San Jacinto Incised vessel*

The sherds with incised decorative elements are the most common in the assemblage, accounting for 42 percent of the decorated sherd sample (see Table 1). One grog-tempered rim sherd has at least three horizontal incised lines that encircle the vessel, another has cross-hatched incised lines (Figure 3b), and a third has diagonal opposed incised lines (Figure 3e). Body sherds have cross-hatched (n=1), diagonal opposed (n=1) (Figure 3a), horizontal and diagonal opposed (n=2) (Figure 4a), parallel (n=5), straight (n=1), and vertical (n=2) incised lines. The sherds with cross-hatched, diagonal opposed, and vertical incised lines are from Maydelle Incised vessels (see Suhm and Jelks 1962:Plate 52).

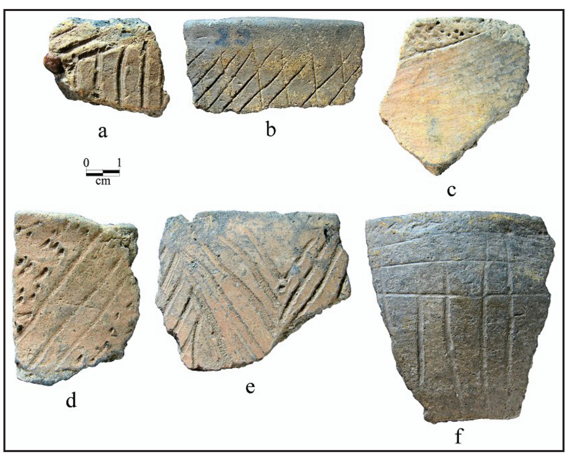

Figure 3. Incised and incised-punctated sherds from the Johnson site (40C8-2) in Falls County, Texas.

One of the grog-tempered incised rim sherds in the collection is from a San Jacinto Incised, *var. Spindletop* vessel (see Aten and Bollich 2002:50). This Southeastern Texas Gulf coastal ceramic vessel likely dates from 600-700 years ago. The rim has a series of vertical incised lines that extend from the rim down the vessel body, and these lines are intersected by three horizontal incised lines below the vessel lip (see Figure 3f).

There are three sherds in the Johnson site collection that have incised-punctated decorative elements.

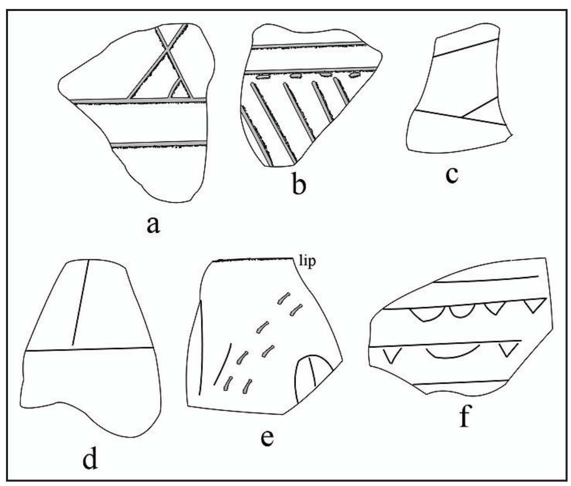

Figure 4. Decorative elements on selected incised and engraved sherds from the Johnson site (40C8-2) in Falls County, Texas: a, incised elements; b, incised-punctated elements; c-f, engraved elements.

The first, a grog-tempered rim, is from a Maydelle Incised vessel with incised triangular zones filled with rows of small tool punctations (see Figure 3d). A second grog-tempered rim has an incised triangle element pendant from the lip that has been filled with small circular punctations (see Figure 3c). The third incised-punctated grog-tempered sherd is a lower rim and body sherd with at least two horizontal incised lines on the lower rim, along with a row of tool punctations at the rim-body juncture, and diagonal incised lines on the vessel body (see Figure 4b).

The engraved and engraved-punctated fine ware sherds represent 24 percent of the decorated sherds from the Johnson site. Three of the engraved sherds are from bottles. The first has sets of narrow curvilinear engraved zones filled with hatched or cross hatched engraved lines, as well as curvilinear engraved lines, and horizontal engraved lines with small hatched pendant triangles (Figure 5d). The hatching and cross-hatching of narrow engraved zones is a regular feature on Caddo vessels dating from both Middle Caddo (ca. A.D. 1200-1400) and Late Caddo (ca. A.D. 1400-1680) period times in East Texas, including the post-A.D. 1500 Taylor Engraved type. The second grog-tempered bottle sherd has horizontal engraved lines on the vessel body, and two of the four lines have pendant triangles and semi-circles (see Figure 4f). The use of both elements is distinctive, but again such elements are present in Late Caddo period vessels in both the Late Caddo Titus phase and the Frankston phase in the upper Neches River basin. The third bottle sherd has diagonal and diagonal opposed engraved lines on the vessel body (see Figure 4c).

The Frankston phase connection in ceramics at the Johnson site is also apparent by the two grog-tempered Poynor Engraved carinated bowl sherds in the collection. The first of these, from a Poynor Engraved, *var. Blackburn* vessel (see Perttula 2011:Figure 6-64b'b'), with a vertical engraved panel and curvilinear hatched corners (see Figure 5c). The second Poynor Engraved rim sherd has a horizontal engraved line under the vessel lip and a portion of a set of curvilinear hatched engraved lines (see Figure 5a). This rim may be from a Poynor Engraved, *var. Cook* or *var. Lang* vessel (see Perttula 2011:Figure 6-64d, f-g'). In the upper Neches River basin (in Anderson and Henderson counties, Texas), these varieties of Poynor Engraved are thought to be most commonly made and used between ca. A.D. 1480-1560 (Perttula 2011:Table 6-37). Another grog-tempered body sherd from the site, probably also from a Poynor Engraved vessel, has horizontal and diagonal engraved lines (see Figure 4d).

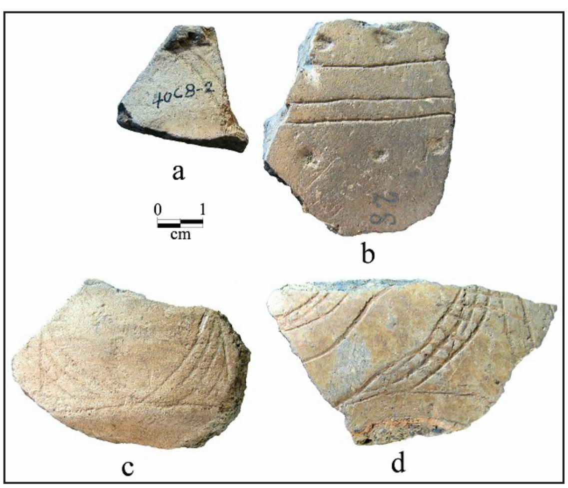

Figure 5. Engraved and engraved-punctated sherds from the Johnson site (40C8-2) in Falls County, Texas.

The first of the engraved-punctated sherds is from a post-A.D. 1500 Caddo vessel, likely from a Belcher Engraved carinated bowl; this vessel would have probably been made along the Red River in Northwestern Louisiana by Belcher phase Caddo groups (see Webb 1959; Kelley 2012), but such vessels have been found also in post-A.D. 1500 contexts along the Red River in East Texas and in Titus phase sites in the Big Cypress and Sabine River basins in East Texas. This grog-tempered sherd has three horizontal engraved lines that separate two horizontal rows of excised punctations (see Figure 5b). The second engraved-punctated sherd is a grog-tempered rim sherd (see Figure 4e). The decorative elements consist of a vertical engraved line, two diagonal rows of excised punctations, and an oval-shaped element with a single bisecting engraved line. The typological identification of this sherd is not known, but the rows of linear excised punctations are sometimes present on certain Belcher phase vessels.

There are also two Goose Creek Plain, *var. unspecified* body sherds and one base sherd in the collection (see Story 1990). These are indicative of a pre-A.D. 900 period use of the Little Brazos River basin by inland Mossy Grove groups (see Ellis 2013:Figure 1).

Summary and Conclusions

The Johnson site (40C8-2) on the Little Brazos River in Falls County has a small ceramic sherd assemblage collected by Frank Watt, a well-known avocational archaeologist that lived in Waco, Texas (see Bischof 2011). The collection is now held by the Mayborn Museum Complex at Baylor University.

The majority of the ceramic vessel sherds appear to be from ancestral Caddo vessels made in East Texas and Northwest Louisiana after ca. A.D. 1500, and traded/exchanged with the native occupants of the Falls County region of the Brazos River basin. These sherds are tempered with grog, grog-bone, and bone, and have decorative elements consistent with defined ceramic types belonging to the Frankston phase (Poynor Engraved, Maydelle Incised, and Bullard Brushed) and the Belcher phase (Belcher Engraved). In addition to the Caddo ceramic wares at the site are one sherd of Leon Plain and another sherd of San Jacinto Incised, indicating some use after ca. A.D. 1250, and three Goose Creek Plain, var. unspecified sherds from a pre-A.D. 900 Woodland period occupation.

Acknowledgments

I thank Anita Benedict and Sabrina Thomas of the Mayborn Museum Complex at Baylor University for access to their collections, in particular the Frank Watt collection. Thanks also to Dan Prikryl for his assistance during the documentation effort. Lance K. Trask prepared the figures in this Falls County manuscript.

References Cited

Aten, L. E. and C. N. Bollich
2002 *Late Holocene Settlement in the Taylor Bayou Drainage Basin: Test Excavations at the Gaulding Site (41JF27), Jefferson County, Texas*. Studies in Archeology 40, Texas Archeological Research Laboratory, The University of Texas at Austin, and Special Publication 4, Texas Archeological Society, Austin.

Bischof, R. E.
2011 Boxes and Boxes, Missing Context and an Avocational Archaeologist: Making Sense of the Frank Watt Collection at the Mayborn Museum Complex. Master's thesis, Master of Arts, Baylor University, Waco, Texas.

Ellis, L. W.
2013 Woodland Ceramics in East Texas and a Case Study of Mill Creek Culture Ceramics. *Bulletin of the Texas Archeological Society* 84:137-180.

Kelley, D. B.
2012 The Belcher Phase: Sixteenth- and Seventeenth-Century Caddo Occupation of the Red River Valley in Northwest Louisiana and Southwest Arkansas. In *The Archaeology of the Caddo*, edited by T. K. Perttula and C. P. Walker, pp. 411-430. University of Nebraska Press, Lincoln.

Perttula, T. K.
2011 The Ceramic Artifacts from the Lang Pasture Site (41AN38) and the Place of the Site within an Upper Neches River Basin Caddo Ceramic Tradition. In *Archeological Investigations at the Lang Pasture Site (41AN38) in the Upper Neches River Basin of East Texas*, assembled and edited by T. K. Perttula, D. B. Kelley, and R. A. Ricklis, pp. 145-320. Archeological Studies Program Report No. 129, Texas Department of Transportation, Environmental Affairs Division, Austin.

Story, D. A.
1990 Cultural History of the Native Americans. In *The Archeology and Bioarcheology of the Gulf Coastal Plain*, by D. A. Story, J. A Guy, B. A. Burnett, M. D. Freeman, J. C. Rose, D. G. Steele, B. W. Olive, and K. J. Reinhard, pp. 163-366. Research Series No. 38. 2 Vols. Arkansas Archeological Survey, Fayetteville.

Suhm, D. A. and E. B. Jelks (editors)
1962 *Handbook of Texas Archeology: Type Descriptions*. Special Publication No. 1, Texas Archeological Society, and Bulletin No. 4, Texas Memorial Museum, Austin.

Webb, C. H.
1959 *The Belcher Mound, a Stratified Caddoan Site in Caddo Parish, Louisiana*. Memoirs No. 16. Society for American Archaeology, Salt Lake City.

ABORIGINAL CERCAMIC SHERD COLLECTIONS FROM LIMESTONE COUNTY, TEXAS

Timothy K. Perttula

Introduction

The Moore Spring 18 Site, near Delia in northwestern Limestone County, in the headwaters of the Navasota River basin in the Blackland Prairie Physiographic zone (Figure 1), has ceramic vessel sherds collected by Frank Watt in October 1942. They are in the collections of the Mayborn Museum Complex at Baylor University, where I recently documented their holdings that appeared to have Caddo sherds from Central Texas contexts.

These Limestone County sherds may be from the Delia site (40A5-11) reported on by Watt (1953:81-82), but other sites with ceramics have been found in the Delia area, including sites 40A5-1 and 40A5-7, and a number of other sites reported by Bryan (1935:6, 1936:Map 7). Bryan indicated that over 1000 sherds had been collected from the Delia site, including at least two sherds with engraved elements. According to Watt (1953:82), the ceramics at the Delia site are Late Caddo period Frankston phase types, as are the ceramics reported by Bryan (1936), namely Poynor Engraved and Maydelle Incised types; Bryan recovered Perdiz arrow points in association with these ceramics. Watt goes on to say that "most of the sherds from the Delia site are crudely incised and brushed ware. Two sherds…show engraved circular designs, suggestive of sun symbols." He illustrates several Poynor Engraved vessel sherds (Watt 1953:Figures 24-25), as well as Early Caddo Weches Fingernail Impressed sherds from the Delia site (Watt 1953:Figures 24-25). At site 40A5-7, the 10 sherds are also from Frankston phase vessels (Watt 1953:84).

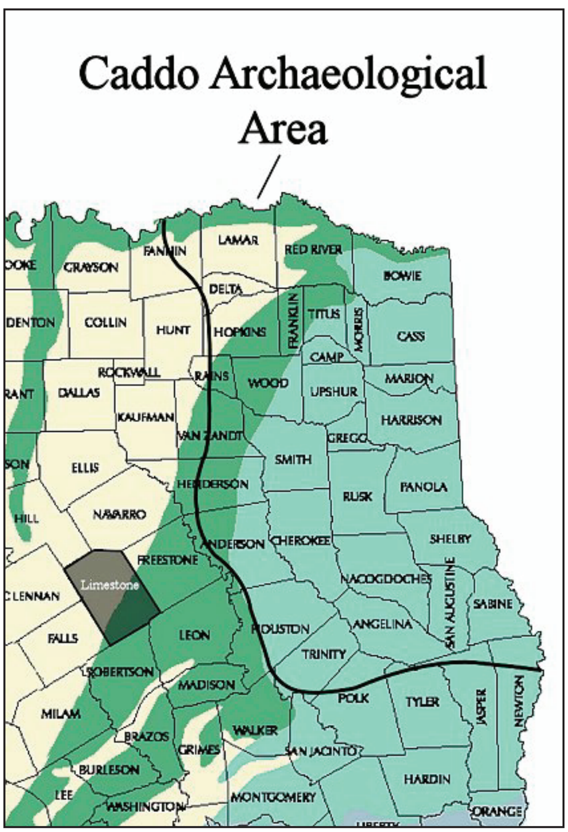

Figure 1. Limestone County relative to the Caddo Archaeological Area and Natural Regions of Texas.

Moore Spring 18

There are seven sherds from ancestral Caddo vessels in the Watt collection from the Moore Spring 18 site. Three sherds are plain grog-tempered body and base sherds, and three other body sherds (one with grog temper, one with bone temper, and the third with both grog and bone temper) have rows of fingernail punctations, a common decorative treatment on East Texas Caddo utility wares (Suhm and Jelks 1962:Plate 79). The last sherd, also a grog-tempered body sherd, has a straight incised zone (probably part of a triangle element) filled with rows of tool punctations (Figure 2). Such decorative elements occur on both Canton Incised and Maydelle Incised vessels (see Suhm and Jelks 1962: Plates 12 and 52), the latter dating after ca. A.D. 1300 in East Texas Caddo sites

Site 40A5-1

This site has one plain bone-tempered body sherd, probably from a Leon Plain vessel belonging to a post-A.D. 1250 Toyah phase encampment (see Kenmotsu and Boyd 2012).

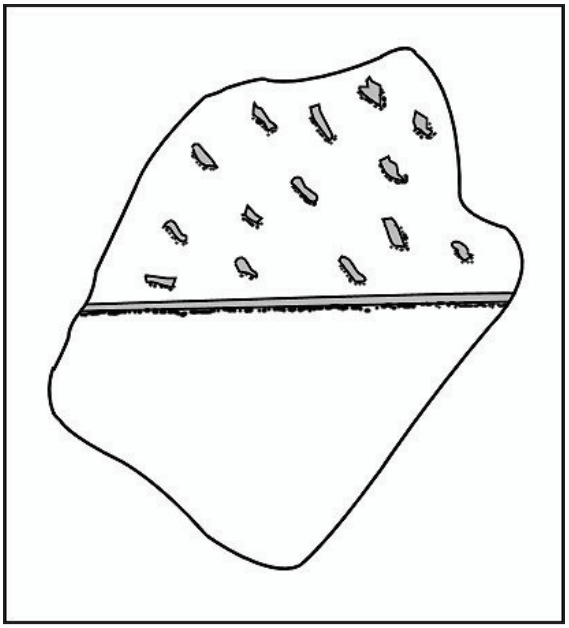

Figure 2. Incised-punctated body sherd from the Moore Spring 18 site in Limestone County, Texas.

Unnumbered site near Delia

The K. H. Aynesworth Collection at the Mayborn Museum Complex has a single grog-tempered plain body sherd from an unrecorded site near Delia on the Navasota River.

Summary

Watt (1953:Figure 26) had identified six pottery-bearing sites in the headwaters of the Navasota River in Limestone County, Texas, three with sherds of Late Caddo period age, primarily from Frankston phase (dating from ca. A.D. 1400-1680) contexts in the upper Neches River basin in East Texas. The Moore Spring 18 site is likely one of these identified sites. The collection documented has sherds from grog, grog-bone, and bone-tempered vessels with fingernail punctated and incised-punctated decorative elements. Site 40A5-1 has a single Leon Plain bone-tempered sherd from an apparent use of the site sometime during the Toyah phase (ca. A.D. 1250-1700), and an unnumbered site (41A5-1) has only a single plain grog-tempered body sherd from an ancestral Caddo vessel of unknown age. Bryan (1936) reports on similar ceramic sherds, including both plain and decorated (i.e., incised, incised-punctated, and engraved) sherds from eight sites in the Delia area.

Acknowledgments

I thank Anita Benedict and Sabrina Thomas of the Mayborn Museum Complex at Baylor University for access to their collections, in particular the Frank Watt collection. Thanks also to Dan Prikryl for his assistance during the documentation effort. Lance K. Trask prepared the figures in this manuscript.

References Cited

Bryan, F.
1935 A Resume of the Prehistoric Human Cultural Remains so far Discovered in Central Texas. *Bulletin of the Central Texas Archeological Society* 1:5-10.

1936 Preliminary Report on the Archeology of Western Limestone County. *Bulletin of the Central Texas Archeological Society* 2:81-92.

Kenmotsu, N. A. and D. K. Boyd
2012 The Toyah Phase in Texas: An Introduction and Retrospective. In *The Toyah Phase of Central Texas: Late Prehistoric Economic and Social Processes*, edited by N. A. Kenmotsu and D. K. Boyd, pp. 1-18. Texas A&M University Press, College Station.

Suhm, D. A. and E. B. Jelks (editors)
1962 *Handbook of Texas Archeology: Type Descriptions*. Special Publication No. 1, Texas Archeological Society, and Bulletin No. 4, Texas Memorial Museum.

Watt, F. H.
1953 Pottery Diffusions in the Central Brazos Valley. *Central Texas Archeologist* 6:57-85.

NAVARRO COUNTY, TEXAS, CERAMIC SHERD ASSEMBLAGES

Timothy K. Perttula

Introduction

The Mayborn Museum Complex at Baylor University in Waco, Texas has ceramic vessel sherds from two collections in Navarro County, namely the Frank Watt (see Bischof 2011) and Hawkins collections. Both collections come from sites in the Richland Creek drainage basin in the area of Dawson, Texas, in the western part of the county, which lies in the Blackland Prairie Physiographic zone (Figure 1).

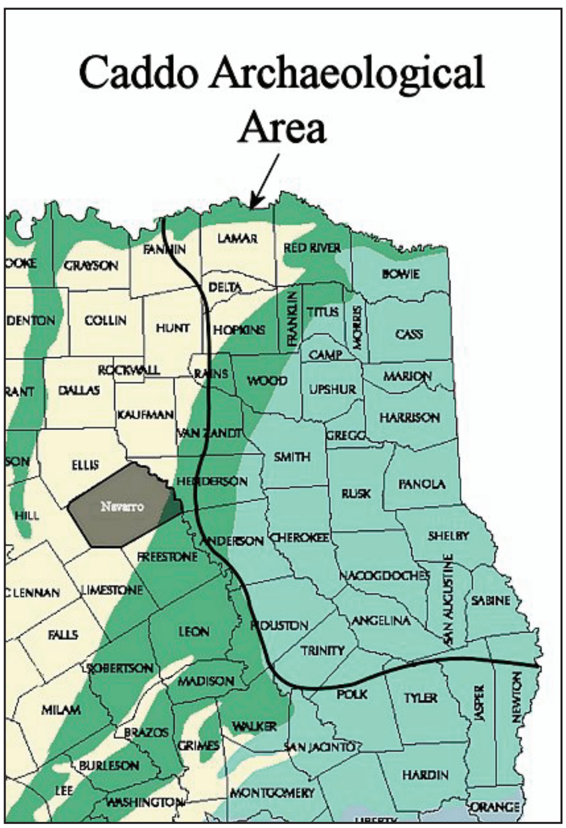

Figure 1. Navarro County relative to the Caddo Archaeological Area and Natural Regions of Texas.

Site 40B1-1

This site, collected by Frank Watt, is on a low hill by Richland Creek near Navarro Mills Lake, in the western part of Navarro County, in the Blackland Prairie (see Figure 1). The sample consists of 32 sherds from plain ware (n=14, 43.8 percent), utility ware (n=13, 40.6 percent), and fine ware (n=5, 15.6 percent) vessels (Table 1).

About 88 percent of the sherds are from vessels tempered with grog (i.e., crushed fired clay), either as the sole temper or in association with burned bone temper. More than 31 percent of the sherds from site 40B1-1 have burned bone temper, either as the sole temper (12.5 percent), or in combination with grog (18.8 percent).

The one brushed sherd with parallel brushing marks is from a grog-tempered Bullard Brushed vessel. The occurrence of a sherd with brushing marks indicates that the site was occupied sometime after ca. A.D. 1250, when brushing became a principal utility ware on ancestral Caddo sherds in the Neches River basin in East Texas (Perttula 2011, 2013). The incised sherds are from Maydelle Incised jars with diagonal incised line elements, diagonal opposed incised lines, and cross-hatched incised lines (Figure 2a-b, d, f). One incised-punctated rim sherd from a grog-tempered Maydelle Incised vessel has diagonal incised lines on one side of a zone (probably triangular-shaped) filled with linear tool punctations (Figure 2e). The other incised-punctated sherd is a grog-tempered body sherd with at least two rows of small circular punctations adjacent to a single straight incised lines. The punctated body sherds have either rows of fingernail punctations (Figure 2c) or tool punctations.

Engraved fine ware sherds from site 40B1-1 comprise 28 percent of the decorated sherds in the small sample in the Mayborn Museum Complex collections. One rim sherd has diagonal engraved lines, two have opposed engraved lines, and the other two have parallel engraved lines; one of these sherds is from a bottle.

Table 1. Ceramic sherds from Site 40B1-1.

Ware	Grog-tempered	Grog-bone-tempered	Bone-tempered	N
Plain	9	2	3	14
Utility	9	3	1	13
Brushed	1	0	0	1
Incised	4	3	1	8
Incised-Punctated	2	0	0	2
Punctated	2	0	0	2
Fine	4	1	0	5
Engraved	4	1	0	5
Totals	22	6	4	32

Rublau Creek Site

The J. Elmer and Maude Ellen Hawkins Collection at the Mayborn Museum Complex, Baylor University, has a small assemblage of ancestral Caddo vessel sherds from Rublau Creek, north of Dawson, Texas in the Richland Creek drainage basin. Bryan (1937:Map 2) indicates that there are several pottery-bearing sites in the Dawson area.

The assemblage has three plain body sherds (two with grog temper and one with bone temper) and two grog-tempered engraved sherds. One of these sherds has parallel engraved lines, while the other has cross-hatched engraved lines. The specific age when this site was occupied cannot be ascertained by the few decorated sherds, but it is suspected that this took place prior to ca. A.D. 1200.

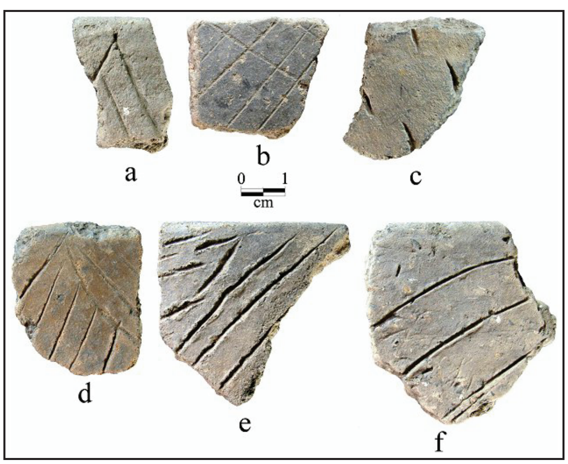

Figure 2. Selected decorated sherds in the assemblage from site 40B1-1 in Navarro County, Texas.

Conclusions

Two sites in the Richland Creek basin in the Blackland Prairie of western Navarro County have ancestral Caddo sherds from vessels likely manufactured after ca. A.D. 1250. These sherds have brushed, incised, incised-punctated, punctated, and engraved elements, including some identified to types made and used by Caddo peoples that lived in the upper Neches River basin in East Texas, including Bullard Brushed and Maydelle Incised. The absence of Poynor Engraved sherds in these assemblages suggests the occupations at the Richland Creek sites took place before ca. A.D. 1400.

Acknowledgments

I thank Anita Benedict and Sabrina Thomas of the Mayborn Museum Complex at Baylor University for access to their collections, in particular the Frank Watt collection. Thanks also to Dan Prikryl for his assistance during the documentation effort. Lance K. Trask prepared the figures in this manuscript.

References Cited

Bischof, R. E.
2011 Boxes and Boxes, Missing Context and an Avocational Archaeologist: Making Sense of the Frank Watt Collection at the Mayborn Museum Complex. Unpublished Master's Thesis, Master of Arts, Baylor University, Waco, Texas.

Bryan, F.
1937 A Preliminary Report on the Archeology of Western Navarro County and some Camp Sites in Hill and McLennan Counties. *Central Texas Archeologist* 3:70-79.

Perttula, T. K.
2011 The Ceramic Artifacts from the Lang Pasture Site (41AN38) and the Place of the Site within an Upper Neches River Basin Caddo Ceramic Tradition. In *Archeological Investigations at the Lang Pasture Site (41AN38) in the Upper Neches River Basin of East Texas*, assembled and edited by T. K. Perttula, D. B. Kelley, and R. A. Ricklis, pp. 145-320. Archeological Studies Program Report No. 129, Texas Department of Transportation, Environmental Affairs Division, Austin.

2013 Caddo Ceramics in East Texas. *Bulletin of the Texas Archeological Society* 84:181-212.

INTERPRETING ARROW POINT DAMAGE FROM LATE PREHISTORIC SITES ALONG THE EAST FORK OF THE TRINITY RIVER AND ITS TRIBUTARIES

Wilson W. Crook, III

Introduction

Numerous sites of the Late Prehistoric period occur along the East Fork of the Trinity River and its tributaries in a roughly north-south corridor from Collin County in the north to northwestern Kaufman County, some 70 km to the south. The area encompasses approximately 2,150 square miles including the eastern two-thirds of Collin County, virtually all of Rockwall County, northwestern Kaufman County and extreme northeastern Dallas County. Over 50 sites have been identified which share similar cultural materials (Figure 1). Of these, 20 have been arbitrarily designated as "major sites" based on their aerial size (>0.5Ha) and number of artifacts recovered (>100) with the others being smaller, seasonal campsites (see Figure 1). The observed artifact assemblage in all of these sites are very homogeneous and consistent with the with the Late Prehistoric period along the East Fork as initially characterized by Stephenson (1949b, 1952) and subsequently redefined by Lynott (1975a, 1975b), Crook (1987, 1989, 2007) and Crook and Hughston (2008, 2009, 2015a). Age of the Late Prehistoric along the East Fork has been radiocarbon dated from ca. A.D. 700 to A.D. 1600 (Valastro et al. 1967; Marmaduke 1975; Lynott 1975a, 1978; Crook and Hughston (2015a, 2015b, 2015c).

Arrow points are one of the key diagnostic features that initially defined the Late Prehistoric culture of the peoples that lived along the East Fork of the Trinity River and its tributaries (Stephenson, 1952; Crook and Hughston 2015a, 2016). Arrow points comprise 17 percent of the total East Fork artifact assemblage and 29 percent of all lithic artifacts in Late Prehistoric age sites (n = 5,414). Based on stratigraphic evidence at a number of East Fork sites, two distinct Late Prehistoric horizons are present. The initial phase ("Wylie Phase") appears to have developed in place from a preceding Late Woodlands Period occupation and is characterized by the introduction of the bow and arrow to the region. Stratigraphically, this occupation begins at a depth of 10-20 cm below the surface at most East Fork sites and extends to a depth of 30-40 cm or more. Arrow point types in this level consist predominately of Alba, Catahoula, and Scallorn types, with minor Steiner, Bonham and Young. Excavation at several East Fork sites has shown arrow points of these types coexist with dart points; the latter consisting almost exclusively of small to medium-sized Gary points (30-50 mm) with minor amounts of Kent, Godley and Dawson. It is uncertain how long this coexistence of the atlatl with bow and arrow persists but based on stratigraphic finds from undisturbed sections at several sites, it is estimated that the atlatl and dart point were maintained as part of the dual hunting weapon system well past ca. A.D. 1000 and possibly as late as ca. A.D. 1100+. Williams Plain, the primary ceramic of the underlying Late Woodland Period, continues as a major pottery type but there is an addition of Sanders Phase ceramics from East Texas (Sanders Plain, Sanders Engraved, Monkstown Fingernail Impressed and Canton Incised) with time. Dates for the Wylie Phase occupation are ca. A. D. 700-800 to approximately A. D. 1250.

On top of the first Late Prehistoric occupation is a second Late Prehistoric culture which has been given the name the "Farmersville Phase". This phase is characterized by a pure arrow point and ceramic occupation; dart points are completely absent by this time. Arrow point types consist of Perdiz coupled with Southern Great Plains types including Fresno, Washita and Harrell. Shell-tempered ceramics (Nocona Plain) largely replace sandy paste-, grog-tempered pottery. In addition, characteristic East Texas Caddo ceramics are present in small amounts (Maydelle Incised, Poynor Engraved, Killough Pinched, etc.). This occupation is relatively thin, typically found on the surface and to a depth of no more than 10-15 cm. Based on radiocarbon dates from the Upper Farmersville, Sister Grove Creek and Upper Rockwall sites, the Farmersville Phase is currently dated from approximately A. D. 1250 to A. D. 1600.

Recently, Engelbrecht (2015) has found that at the Eaton site in western New York State and elsewhere across the Eastern Woodlands there is a trend of decreasing arrow point width, weight and thick-

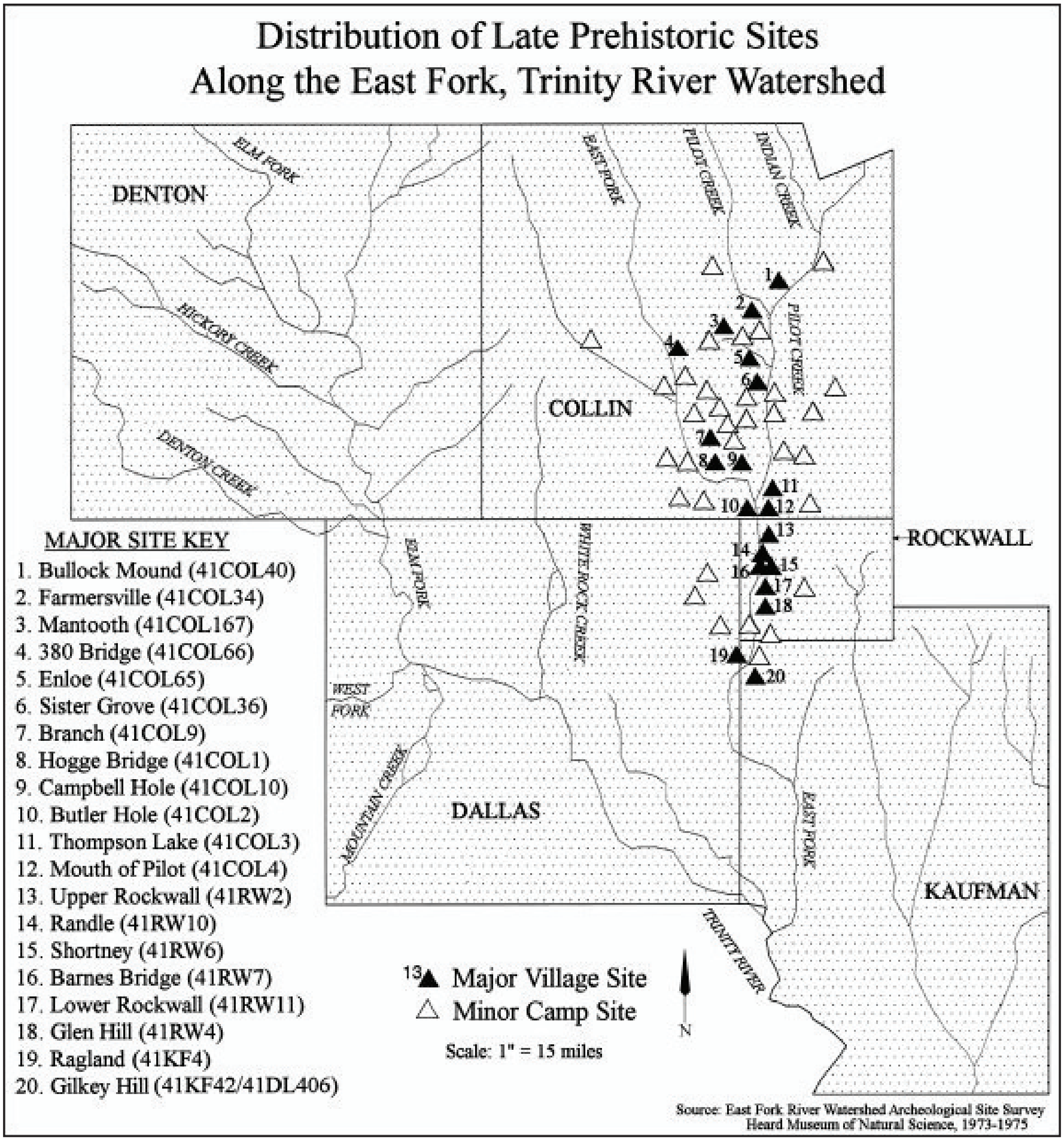

Figure 1. Distribution of the Late Prehistoric sites along the East Fork of the Trinity River and its tributaries. Major sites are identified by solid black triangles and identified by name; minor seasonal campsites are shown as unfilled triangles. (Figure by Mr. Lance K. Trask)

ness throughout the Late Prehistoric Period. This trend suggests arrow point types may have evolved to increasingly effective performance characteristics (Hughes 1998; Lyman et al. 2008; Blitz and Porth 2013). Engelbrecht (2015) observed that many of the arrow points recovered from the Eaton site had suffered some form of use-damage which he proposed was suggestive of the selective pressures influencing the evolution of arrow point design. To test this hypothesis, he measured 808 complete and broken arrow points for length, width, thickness and type of damage (if any) over time throughout the Eaton site. He found that the aboriginal inhabitants at Eaton had gradually shifted from principally using the Levanna point type to the Madison type which involved a switch to narrower, thinner and lighter points across the Late Prehistoric period (Engelbrecht 2015). The reason for the switch was assumed to be a desire to produce a single projectile point which was equally effective at killing both whitetail deer (the most common mammal remains at the site) and enemies (warfare).

Table 1: Summary of East Fork Arrow Point Measurements

Arrow Point Type	Average Length* (mm)	Average Width* (mm)	Average Thickness (mm)	Average L:W	Average T:L	Total Complete Points	Total Damaged Points
Wylie Phase							
Alba	21.1	13.9	3.5	1.52	0.16	222	167 (43%)
Catahoula	23.3	16.8	3.6	1.39	0.15	35	61 (64%)
Scallorn	22.6	14.7	3.5	1.54	0.15	55	50 (48%)
Total / Percent Breakage						312	278 (47%)
Farmersville Phase							
Perdiz	24.6	16.2	3.2	1.52	0.13	32	49 (60%)
Fresno	21.3	13	3.1	1.64	0.14	37	11 (23%)
Washita/Harrell	20.8	13.8	3	1.51	0.14	21	10 (32%)
Total / Percent Breakage						90	70 (44%)
Total Points (n = 750)						402 (54%)	348 (46%)

** Only includes complete points.*

Since arrow points types at East Fork sites change dramatically from the initial Wylie Phase Late Prehistoric occupation to the Farmersville Phase, it can be assumed that the change marked some evolution in the use of the bow and arrow and its efficiently as a hunting weapon. This change can also be seen in the loss of the atlatl – dart point weapon system over time. To test this hypothesis, a study similar to the one developed by Engelbrecht was carried out on 750 selected undamaged and damaged arrow points from 16 sites across the entire East Fork district. Arrow points were chosen for both diversity in typology, lithic material, site occurrence and use-damage. This paper thus serves to record the results of this analysis and its conclusions regarding changes in arrow point styles from the beginnings of the Late Prehistoric period (ca. A. D. 800) to its conclusion (ca. A. D. 1600)

Arrow Point Analysis

As mentioned above, a total of 750 arrow points from 16 sites along the East Fork of the Trinity River and its tributaries were selected for analysis. The study included artifacts from Hogge Bridge (41COL1), Thompson Lake (41COL3), Mouth of Pilot (41COL4), Branch (41COL9), Upper Farmersville (41COL 34), Sister Grove Creek (41COL36), 41COL38, Enloe (41COL65), 380 Bridge (41COL66), and Mantooth (41COL167) in Collin County; Lower Rockwall (41RW1), Upper Rockwall (41RW2), Glen Hill (41RW4), Barnes Bridge (41RW7), and Randle (41RW10) in Rockwall County; and Gilkey Hill (41KF42) in Kaufman County (see Figure 1). Both undamaged and damaged points were included in the analysis. Seven general arrow point types were noted including Alba, Catahoula and Scallorn from the Wylie Phase occupation, and Perdiz, Fresno, Washita and Harrell in the later Farmersville Phase. While other arrow point types have been found in East Fork sites, they are very minor with usually just a few recorded from any one site. As such, I have simplified the analysis by including only the major arrow point types. Typologies used follow those defined by Suhm and Krieger (1954) and Suhm and Jelks (1962).

Each arrow point selected for analysis was then measured for length, width and thickness; the ratios of length-to-width and thickness-to-length calculated, and any damage to the point recorded. Damage was described as either affecting the tip, one or both barbs, or the stem of the point. Measurement averages for all the arrow points used in this study are shown on Table 1 and the complete analysis for

Figure 2. Typical arrow points from the Wylie Phase of the East Fork Late Prehistoric period (Top Row – Alba: Upper Farmersville (2), Upper Rockwall, Thompson Lake; Middle Row – Catahoula: Lower Rockwall, Upper Farmersville (3); Bottom Row – Scallorn: Upper Farmersville, Mantooth Sister Grove Creek, Upper Farmersville).

every point is listed in the Appendix at the end of this paper. Due to damage, measurements for length and width only include those of complete points however thickness measurements were recorded for all artifacts. It should be noted that the Wylie Phase comprises about 80% of the total Late Prehistoric occupation along the East Fork, which is reflected in this study wherein 590 of the 750 arrow points measured (79%) are Wylie Phase types.

The initial Late Prehistoric occupation along the East Fork ("Wylie" Phase) is characterized by three predominant arrow points types: Alba, Catahoula and Scallorn (Figure 2). Alba points are by far the most common arrow point type in sites along the East Fork of the Trinity River, accounting for approximately 30% of all arrow points recovered (n = 1,546). As such, a total of 389 were selected for this study. As can be seen in Table 1, the average dimensions of the Alba point group are 21.1 mm x 13.9 mm x 3.5 mm. This results in a high length-to-width ratio of 1.52 as well as the highest thickness-to length ratio of 0.16. As you would predict from these ratios, Alba points have a high incidence of damage (178 or 43% of the study points), which occurs in order of decreasing frequency to one or both barbs (43%), the tip (34%), a combination of both the tip and at least one barb (13%), and to the stem (10%). End-use damage seems to occur regardless of lithic material. Two-thirds of the study sample were constructed of local quartzite, almost all of which show signs of heat treatment, with the remaining one-third constructed of chert imported from outside of the East Fork area (Central Texas, Oklahoma and Arkansas).

A total of 96 Catahoula points were included in the analysis, the overwhelming majority of which (85%) were made from local, heat-treated quartzite. Average point dimensions are 23.3 mm x 16.8 mm x 3.6 mm which yields a length-to-width ratio of 1.39 and a thickness-to-length ratio of 0.15. Given the larger width of Catahoula points (due to their characteristic thick barbs) you would expect to see a high rate of barb damage and this is the case for East Fork sites. Nearly two-thirds of the points show some form of use-damage with breakage in either one or both barbs (46%) and/or the tip in combination with a barb (18%) accounting for most of the observed breakage.

Of the 105 Scallorn points studied, 60% were constructed of chert and 40% from local quartzite. Average point dimensions are 22.6 mm x 14.7 mm x 3.5 mm; this yields a length-to-width ratio of 1.54 and a thickness-to-length ratio of 0.15, both very similar to that observed for Alba points (see Table 1). Breakage was also correspondingly similar with the majority of damage observed on one or both barbs (48%), the tip (30%), and/or the tip plus at least one barb (22%). As with Alba points, damage was observed in roughly half the Scallorn point sample.

Figure 3. Typical damage to arrow points from the Wylie Phase of the East Fork Late Prehistoric period (Top Row – Alba points; Middle Row – Catahoula points; Bottom Row – Scallorn points). Note damage to both the tips and barbs.

Examples of typical damage to Wylie Phase arrow points can be seen in Figure 3.

In the uppermost zones of many of the sites along the East Fork ("Farmersville" Phase) are a number of bi-pointed and triangular-shaped arrow points. The typology nomenclature adopted is Perdiz for all points with a pointed, contracting stem; Fresno for all simple un-notched triangles; Washita for all side-notched triangles; and Harrell for all tri-notched (side and base) triangular points. This is consistent with that developed by Suhm and Krieger (1954) and Suhm and Jelks (1962). Typical examples of these point types from the East Fork of the Trinity River are shown in Figure 4.

Of the Farmersville Phase arrow point types, the Perdiz type is the most abundant. A total of 81 have been included in this study (see Table 1), nearly 80% of which are constructed from fine-grain chert. Perdiz points are triangular in shape with straight to slightly convex sides. The shoulders are well-formed often with very prominent barbs. The stem is frequently one-third to one-half the overall length of the point, contracting to a point resulting in a pointed or needle-like appearance (Suhm and Krieger 1954; Suhm and Jelks 1962). Perdiz points are often very thin, frequently less than 3.0 mm. Average size of the Perdiz points measured herein are 24.6 mm x 16.2 mm x 3.2 mm. This yields a very high length-to-width ratio of 1.52 but a very low thickness-to-length ratio of only 0.13. As would be expected from long, wide and thin points, use-damage is high. Sixty percent of all Perdiz points show some type of damage with the highest incidence being in the breakage of the barbs (49%) and/or the barbs in conjunction with the point tip (22%). Damage to just to the tip alone accounts for the remainder of the observed breakage.

Figure 4. Typical arrow points from the Farmersville Phase of the East Fork Late Prehistoric period (Top Row – Washita: Mantooth (2), Upper Farmersville (2); Middle Row – Fresno: Upper Farmersville, Mantooth, Upper Farmersville (2); Bottom Row – Perdiz: Lower Rockwall, Glen Hill, Branch, Gilkey Hill).

Figure 5. Typical damage to arrow points from the Farmersville Phase of the East Fork Late Prehistoric period (Top Row – Perdiz points; Bottom Row – Fresno points (3), Washita points (3). Note tip and barb damage to Perdiz points and tip as well as corner damage to both Fresno and Washita points.

The other Farmersville Phase arrow points consist of triangular shapes, either un-notched triangles (Fresno) or various notched types (Washita, Harrell). Of the 48 Fresno points included in the study, almost all (90%) are constructed of a dark-colored chert which clearly originates outside of the East Fork area. Average dimensions of the points are 21.3 mm x 13.0 mm x 3.1 mm; these points have the highest length-to-width ratios (1.64) of any of the East Fork arrow points and one of the lowest thickness-to length ratios (0.14). Their very narrow average width (only 13.0 mm) coupled with their thinness results in the lowest breakage rate of all the studied point types (23%). Where damage is visible, it is confined either to impact damage to the tip of the point (55%) or minor damage to one of the corners (36%).

Similar dimensions are observed in the notched triangular-shaped arrow points. The 31 Washita and Harrell type points observed in this study have an average dimension of 20.8 mm x 13.8 mm x 3.0 mm, which yields a length-to-width ratio of 1.51 and a thickness-to-length ratio of 0.14. As was observed for the Fresno points, only 32% show any damage, which is restricted to impact damage to the tip of the point (60%) and/or to one of the corners (40%). Both arrow point types are almost exclusively made from chert (97%) as opposed to quartzite.

Examples of typical damage to Farmersville Phase arrow points can be seen in Figure 5.

Discussion

The primary game animal for the inhabitants of the East Fork of the Trinity River was the whitetail deer. This diet was supplemented by small game animals (raccoon, opossum, rabbit, squirrel, etc.), turkey and riverine fauna (turtle, fish, shellfish) (Crook and Hughston 2015a). During the Farmersville Phase, specifically within a window between ca. A. D. 1300-1420, bison migrated into the Southern Great Plains and the East Fork peoples also periodically exploited this animal resource as well (Lynott 1979; Prikryl 1990; Lohse et al. 2014).

Experimental evidence has shown that the best shot with a bow and arrow on a whitetail deer is one which penetrates the lungs causing hemorrhaging leading to death within 10 seconds (Friss-Hansen 1990). After impact the animal seldom travels more than 45 meters and leaves a prominent blood trail which is easy to track. The best shot for penetrating the lungs is either standing broadside or when the deer is quartering away (Friss-Hansen 1990). This gives the hunter the best opportunity to penetrate the lungs without encountered significant bone.

The distance between the ribs on a whitetail deer varies with age and sex but for an adult deer, the ribs are typically about 2.5-5.0 cm apart (Odell and Cowan 1986). Experiments on dead moose found that projectile points under 1.1 cm in thickness and width more often passed between the ribs and penetrated the lungs (Odell and Cowan 1986). In Wylie Phase arrow points, Alba and Scallorn points have similar length-to-width ratios (1.52 vs 1.54) and identical length-to-thickness ratios (0.15). This design is markedly different to that found in Catahoula points which are significantly wider (21% wider than Alba points and 14% wider than Scallorn points). The difference is manifested in the observed damage where both Alba and Scallorn points have a higher incidence of tip and/or tip plus stem damage relative to extensive barb damage seen in Catahoula points.

In the Farmersville Phase, there is a marked change to arrow points that are constructed longer and thinner. Perdiz, Fresno and Washita/Harrell points have length-to-width ratios between 1.51-1.64 with thickness-to-length ratios of only 0.13-0.14. Moreover, with the notable exception of Perdiz points, which typically have prominent flaring barbs, Fresno and Washita/Harrell points are considerably narrower than the types used in the preceding Wylie Phase. As such, observed damage is highest on the tips of Fresno and Washita/Harrell points but highest on the barbs of Perdiz points.

Experimental evidence has shown that many stone arrow points break after the first shot and almost all break after the second or third shot (Odell and Cowan 1986; Cheshier and Kelly 2006; Titmus and Woods 2006). So why make wider points, ones with prominent barbs such as the Catahoula and Perdiz? In both hunting and warfare there is a clear advantage to making a projectile point that will both penetrate and potentially shatter within the animal/enemy on impact (Milner 2005). Moreover, subsequent movement of the animal with the point embedded could also cause it to break and cause further damage (Flenniken 1985).

So why do arrow points get longer and thinner over the 800-900 years of their use along the East Fork of the Trinity River? While all projectile points have a finite life, points with a greater length-to-width ratio and/or a low thickness-to-length ratio are less durable and that could be an intentional design characteristic intended to cause both initial and subsequent damage to an animal after impact.

Experiments by Shott (1993) have shown that early bows were capable of inflicting a lethal wound on medium-sized prey (deer) at 45 meters. However, on larger game, such as bison, these early bows were only marginally effective, even at a distance of only 20 meters (Tomka 2013). Conversely, the effective range of the atlatl and dart has been found to be between 9 and 46 meters, but accuracy falls off after about 27 meters (Butler 1975; Fields 2005). However, despite its shorter range, Tomka (2013) has found that the dart thrown by an atlatl hits with significantly more energy (foot-pounds of energy) than the bow and arrow and thus would have been a more effective weapon on large game. Hrdlicka (2003) has conducted extensive experiments on atlatls and darts and found similar results regarding the hitting power of an atlatl-thrown dart. As a result, Tomka (2013) has suggested that societies that maintained a dual weapon system after the initial introduction of the bow and arrow maintained the familiar atlatl-dart for large and dangerous game (bison, bear, wolf, etc.) while they transitioned to the new bow and arrow system. This could explain why dart points and arrow points are found together in Wylie Phase horizons along the East Fork, at least until ca. A. D. 1000-1100 (Crook and Hughston 2015a).

The bow and arrow did provide some significant advantages, notably a flatter trajectory that made aiming easier; an important factor on smaller game like rabbits and turkey. Likewise, continued development of the bow and its power over time would have also facilitated the change to bow completely replacing the atlatl over time. A well preserved bois d'arc bow recovered from the Mounds Plantation site (16CD12) in northwest Louisiana shows the Red River Caddo were making sophisticated longs bows with recurved tips by ca. A.D. 1050 (Webb and McKinney 1975). The key to this development appears to lie in making the bows from bois d'arc wood.

Bois d'arc wood is a deep orange-yellow color, largely due to antifungal agents that make it very resistant to deterioration and decay (Hoadley, 1990; Coder 1999). The wood is also very dense with an extremely high strength under bending pressure. In fact, at a measured 261 kilojoules per cubic meter, bois d'arc has the highest strength of any wood that the USDA Forest Service provides data for; making it the perfect wood for bows (Bush 2014).

The qualities that make bois d'arc bows superior are its high elasticity and its speed of recovery when the bow is bent and released. The more durable wood results in arrows being shot farther, straighter and with more power (Hamilton 1982; Hamm 1989). Experimental evidence shows a bois d'arc bow could support a 70 pound pull (Hamilton 1982; Schambach 1995). Such a bow can shoot an arrow over 200 yards. Among modern archers, very few men can pull a 70 pound bow; most prefer a 55-65 pound pull; the point being that bois d'arc is such a superior bow wood that it can actually support a bow of greater strength than the average bowman can effectively use (Hamilton 1982). Ethnographic observations support the superiority of bois d'arc bows and their desirability by Native Americans. Flores (1984) noted that "Caddo bois d'arc bows could, with great ease, throw an arrow completely through a buffalo". As such, as late as A. D. 1810 a single bois d'arc bow was worth more than a horse in trade (Flores 1984).

Jurney (1995) and Bush (2014) both postulate that the counties encompassing the Late Prehistoric aboriginal inhabitants of the East Fork were among the 12 in North Central/Northeast Texas that originally had stands of native bois d'arc. More specifically, Jurney (1994) defines the aboriginal distribution of bois d'arc as including the areas along the East Fork of the Trinity River, Rowlett Creek, the North Fork of the Sulphur River and some of its tributaries, and Bois d'Arc Creek, a tributary of the Red River in Fannin and Lamar counties. As such, bois d'arc would have been a critical resource for the East Fork aboriginal inhabitants, not only as potential exchange material but for their own subsistence and use.

Use of bois d'arc bows would have provided substantial power for penetration of arrow points, especially into the lungs of large animals such as bison. The gradual development of longer and thinner arrow points must have thus been a critical design criteria; so much so that the aboriginal inhabitants of the East Fork went to great lengths to acquire high quality toolstone (chert and similar materials such as chalcedony), not native to the East Fork area, in order construct thinner points. Chert and related material comprises 84% of the Farmersville Phase arrow points as compared to only 34% of the points studied in the earlier Wylie Phase. This demonstrates an intentional development in arrow point design which necessitated higher quality toolstone in conjunction with strong, powerful bow wood.

Acknowledgements

I am grateful to Ms. Brenda Vance who agreed to the sale of the Rex Housewright-Lester Wilson-Bobby Vance artifact collection from the East Fork of the Trinity River to Mr. Mark D. Hughston and myself in order to preserve both the artifacts as a single collection and more importantly, all of their site maps and notes and papers. Many of these artifacts were included as part of this analysis. I would also like to thank Ms. Laura Nightengale, former (now retired) curator of the collections at the Texas Archeological Research Laboratory (TARL) in Austin, who took many superb photographs of our East Fork artifacts, some of which appears in this paper.

References Cited

Blitz, John H. and Erik S. Porth
2013 Social Complexity and the Bow in the Eastern Woodlands. *Evolutionary Anthropology* 22:89-95.

Bush, Leslie L.
2014 Evidence for a Long-Distance Trade in Bois d'Arc Bows in 16th Century Texas (Maclura pomifera, Moraceae). *Journal of Texas Archeology and History* 1:51-69.

Butler, William B.
1975 The Atlatl: The Physics of Function and Performance. *Plains Anthropologist* 20(68):105-110.

Cheshier, Joseph and Robert L. Kelly
2006 Projectile Point Shape and Durability: The Effect of Thickness:Length. *American Antiquity* 71:353-363.

Coder, K. D.
1999 *Osage-orange (Maclura pomifera): An American Traveler*. Publication FOR99-022.

University of Georgia School of Forest Resources Extension, Athens.

Crook, Wilson W. III
1987 380 Bridge Site (41COL66): A Small Wylie Focus Village in Collin County, Texas. *Texas Archeology* 31(4):7-8, Newsletter of the Texas Archeological Society.

1989 The Enloe Site (41COL65): A Diagnostic Wylie Occupation in Collin County, Texas. *Texas Archeology*, Newsletter of the Texas Archeological Society 33(1):10-11.

2007 The Branch Site (41COL9): A Large Diagnostic Late Prehistoric Occupation in Collin County, Texas. *The Record* 55(2):30-44, Dallas Archeological Society.

Crook, Wilson W. III and Mark D. Hughston
2008 The Late Prehistoric of the East Fork of the Trinity River: A Redefinition of the Wylie Focus. Paper presented at the Texas Archeological Society 79th Annual Meeting, October 24-25, Lubbock.

2009 The Upper Farmersville Site (41COL34): A Large Diagnostic Late Prehistoric Occupation in Collin County, Texas. *The Record* 56(1):25-46, Dallas Archeological Society.

2015a *The East Fork Late Prehistoric: A Redefinition of Cultural Concepts Along the East Fork of the Trinity River, North Central Texas*. CreateSpace, a DBA of On-Demand Publishing, LLC (an Amazon Company), Charleston, South Carolina.

2015b Two New Radiocarbon Dates from the Upper Farmersville Site (41COL34), Collin County, Texas. *Archeological Journal of the Texas Prairie Savannah* 5(1):7-20.

2015c Three New Radiocarbon Dates from the East Fork. *The Journal* 135:31-39. Houston Archeological Society, Houston.

2016 The Late Prehistoric of the East Fork of the Trinity River. Center for Regional Heritage Research (CRHR) Research Reports, 2(1):1-16. DOI: http://dx.doi.org/10.5281.zenodo.44607. Available at: http://scholarworks.sfase.edu/crhr_research_reports/vol2/iss1.1.

Engelbrecht, William
2015 Interpreting Broken Arrow Points. *American Antiquity* 80(4):760-766.

Fields, Ron
2005 New Mexico Atlatl Research Continues Sponsored by NMAC. Bluff Dweller Atlatls. http://www.scribd.com/doc/45902928/Bluff Dweller-Atlatls, Accessed 11/25/2013.

Flenniken, J. Jeffrey
1985 Stone Tool Reduction Techniques as Cultural Markers. In *Stone Tool Analysis: Essays in Honor of Don E. Crabtree*, edited by Mark G. Plew, Max G. Paresic and James C. Woods, pp. 265-275. University of New Mexico Press, Albuquerque.

Flores, Dan L. (editor)
1984 *Jefferson and Southwestern Exploration: The Freeman and Custis Accounts of the Red River Expedition of 1806*. University of Oklahoma Press, Norman.

Friss-Hansen, Jan
1990 Mesolithic Cutting Arrows: Functional Analysis of Arrows Used in Hunting of Large Game. *Antiquity* 64:494-504.

Hamilton, T. M.
1982 *Native American Bows*. 2nd edition. Special Publication No. 5. Missouri Archeological Society, Columbia.

Hamm, Jim
1989 *Bows and Arrows of the Native Americans: A Complete Step-by-Step Guide to Wooden Bows, Sinew-Backed Bows, Composite Bows, Strings, Arrows and Quivers.* Lyons & Buford, Publishers, in cooperation with Bois D'Arc Press.

Hoadley, R. B.
1990 *Identifying Wood: Accurate Results with Simple Tools*. The Taunton Press, Newton, Connecticut.

Hrdlicka, Daryl
2003 How Hard Does it Hit? A Revised Study of Atlatl and Dart Ballistics. *The Atlatl* 16(2):15-18.

Hughes, Susan S.
1998 Getting to the Point: Evolutionary Change in Prehistoric Weaponry. *Journal of Archeological Method and Theory* 5:345-408.

Jurney, David H.
1995 The Original Distribution of Bois d'Arc Part I: Texas. *Caddo Archeology Newsletter* 5(2):6-13.

Lohse, Jon C., Brendam J. Culleton, Stephen L. Black and Douglas J. Kennett
2014 A Precise Chronology of Middle to Late Holocene Bison Exploitation in the Far Southern Great Plains. *Journal of Texas Archeology and History*, 1:94-126.

Lyman, R. Lee, Todd L. VanPool and Michael J. O'Brien
2008 Variation in North American Dart Points and Arrow Points When One or Both Are Present. *Journal of Archeological Science* 35:2805 2812.

Lynott, Mark J.
1975a Archeological Investigations at Lake Lavon, 1974. *Archeology Research Program, Contributions in Anthropology 16*, Southern Methodist University, Dallas.

1975b Wylie Focus Pits in Light of Recent Investigations. *The Record* 31(2):1-4, Dallas Archeological Society.

1978 Radiocarbon Dating of the Wylie Focus in Northcentral Texas. *Plains Anthropologist* 22(77): 233-237.

1979 Prehistoric Bison Populations in Northcentral Texas. *Bulletin of the Texas Archeological Society* 50:89-101.

Marmaduke, W. S.
1975 The Wylie Focus: A Reassessment by the Analysis of Three Typical Sites. *Unpublished Master's Thesis*, University of Texas, Austin.

Milner, George R.
2005 Nineteenth-Century Arrow Wounds and Perceptions of Prehistoric Warfare. *American Antiquity* 70:144-156.

Odell, George H. and Frank Cowan
1986 Experiments with Spears and Arrows on Animal Targets. *Journal of Field Archeology* 13:195-212.

Prikryl, Daniel J.
1990 Lower Elm Fork Prehistory. *Office of the State Archeologist Report 37*, Texas Historical Commission.

Schambach, Frank F.
1995 A Probable Spiroan Entrepot in the Red River Valley in Northeast Texas. *Caddoan Archeology Newsletter* 6(1):9-25.

Shott, Michael J.
1993 Spears, Darts, and Arrows: Late Woodland Hunting Techniques in the Upper Ohio Valley. *American Antiquity* 58(3):425-443.

Stephenson, Robert L.
1949 A Note on Some Large Pits in Certain Sites near Dallas, Texas. *American Antiquity* 15:53-55.

1952 The Hogge Bridge Site and the Wylie Focus. *American Antiquity* 17(4): 299-312.

Suhm, Dee Ann and Alex D. Krieger, with collaboration of Edward B. Jelks
1954 An Introductory Handbook of Texas Archeology. *Bulletin of the Texas Archeological Society* 25:1-562.

Suhm, Dee Ann and Edward B. Jelks (editors)
1962 *Handbook of Texas Archeology: Type Descriptions*. Texas Archeological Society, Special Publications, No. 1, and the Texas Memorial Museum, Bulletin No. 4, Austin.

Titmus, Gene L. and James C. Woods
2006 An Experimental Study of Projectile Point Fracture Patterns. *Journal of California and Great Basin Anthropology* 8:37-49.

Tomka, Steve A.
2013 The Adoption of the Bow and Arrow: A Model Based on Experimental Performance Characteristics. *American Antiquity* 78(3):553-569.

Valastro, S., Jr., F. J. Pearson and E. Mott Davis
1967 University of Texas Radiocarbon Dates V. *Radiocarbon* 9:439-453.

Webb, Clarence H. and Ralph R. McKinney
1975 Mounds Plantation (16CD12), Caddo Parish, Louisiana. *Louisiana Archeology*, Bulletin of the Louisiana Archeological Society 2:39 127.

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL1	Alba	Quartzite	26	13	3.1	2	0.12	
41COL1	Alba	Quartzite	25	15	4	1.67	0.16	
41COL1	Alba	Quartzite	23.3	15	3.8	1.55	0.16	
41COL1	Alba	Quartzite	23	13.5	3	1.48	0.13	Barb
41COL1	Alba	Quartzite	23.9	15.7	3	1.52	0.12	Barb, Stem
41COL1	Alba	Quartzite	20	20	3.1	1	0.15	Tip, Stem
41COL1	Alba	Quartzite	17.5	15.3	4.4	1.14	0.25	Tip, Barb
41COL1	Alba	Quartzite	14	13	3.1	1.08	0.22	Tip
41COL1	Alba	Quartzite	18	15.8	3.2	1.14	0.18	
41COL3	Alba	Quartzite	30.5	13.8	3.5	2.2	0.11	
41COL3	Alba	Quartzite	25	16.5	4	1.51	0.16	
41COL3	Alba	Quartzite	27	14.5	5.2	1.86	0.19	Barb, Base
41COL3	Alba	Chert	33	18	3	1.78	0.09	
41COL3	Alba	Chert	29.1	19.3	4.9	1.5	0.17	
41COL3	Alba	Quartzite	33.1	17.3	5.3	1.91	0.16	
41COL3	Alba	Quartzite	20.6	15.3	4	1.35	0.19	
41COL3	Alba	Quartzite	16	15	3.1	1.07	0.19	
41COL3	Alba	Chert	24.3	18.2	4	1.33	0.16	Tip
41COL4	Alba	Quartzite	23	15.9	4.3	1.44	0.19	
41COL4	Alba	Quartzite	23	20	4	1.15	0.17	
41COL4	Alba	Quartzite	25.9	14.8	3.8	1.75	0.15	Barb
41COL9	Alba	Quartzite	24.9	14.1	3	1.58	0.12	
41COL9	Alba	Quartzite	24	14.8	3.3	1.58	0.14	Barb
41COL9	Alba	Quartzite	22.7	18.8	3	1.26	0.13	
41COL9	Alba	Quartzite	31.8	17.9	3.7	1.11	0.11	
41COL9	Alba	Quartzite	25	15.8	2.8	0.9	0.11	
41COL9	Alba	Chert	25.3	20	5.1	1.26	0.2	Barb
41COL9	Alba	Quartzite	23.8	21.5	5.3	1.11	0.22	
41COL9	Alba	Chert	19.2	21.3	5.1	0.9	0.26	
41COL9	Alba	Quartzite	21.8	17.2	3.3	1.26	0.15	
41COL9	Alba	Quartzite	21.5	13.1	3.7	1.64	0.17	
41COL9	Alba	Quartzite	24.1	14.1	4	1.71	0.16	Barb
41COL9	Alba	Quartzite	21.9	17	2.9	1.29	0.13	
41COL9	Alba	Quartzite	25.7	17	2.3	1.51	0.09	
41COL9	Alba	Quartzite	21.8	10.9	2.8	2	0.13	Barb
41COL9	Alba	Quartzite	22	13.5	4.1	1.63	0.18	Tip, Barb
41COL9	Alba	Quartzite	18.1	18.8	4.9	0.96	0.27	
41COL9	Alba	Quartzite	19.9	13.9	4	1.43	0.2	Tip, Barb
41COL9	Alba	Quartzite	19	11.8	3	1.81	0.16	Barb
41COL9	Alba	Quartzite	19.9	14.1	2.5	1.41	0.12	Barb
41COL9	Alba	Quartzite	20.9	13	3	1.61	0.14	Barb
41COL9	Alba	Quartzite	16.1	10	3	1.61	0.19	Both Barbs
41COL9	Alba	Quartzite	15	11	2.9	1.36	0.19	
41COL9	Alba	Chert	22	15.6	2.8	1.41	0.13	
41COL9	Alba	Chert	15.3	15	3.1	1.02	0.2	Tip

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Alba	Quartzite	15.9	13.7	2.5	1.16	0.16	
41COL34	Alba	Quartzite	15.5	11.5	2.3	1.35	0.15	
41COL34	Alba	Chert	17	13	2.1	1.31	0.12	
41COL34	Alba	Quartzite	13	12	3	1.08	0.23	Tip
41COL34	Alba	Quartzite	16.5	15	2.4	1.1	0.14	
41COL34	Alba	Quartzite	20	14.5	3	1.38	0.15	
41COL34	Alba	Quartzite	17.3	15	3.1	1.15	0.18	
41COL34	Alba	Quartzite	16.9	12	2.9	1.41	0.17	
41COL34	Alba	Chert	15.5	10	2.7	1.55	0.17	
41COL34	Alba	Quartzite	18	14	3.1	1.2	0.17	
41COL34	Alba	Quartzite	17	13	4.1	1.31	0.24	
41COL34	Alba	Quartzite	17	14.5	4	1.17	0.23	
41COL34	Alba	Quartzite	17.5	13.2	3	1.32	0.17	
41COL34	Alba	Quartzite	16	12	3	1.33	0.19	
41COL34	Alba	Quartzite	15.7	12.8	4	1.23	0.25	
41COL34	Alba	Quartzite	15.5	10.5	3	1.48	0.19	
41COL34	Alba	Quartzite	17	10.8	2.7	1.57	0.16	
41COL34	Alba	Chert	15.5	10.8	2.1	1.43	0.13	
41COL34	Alba	Quartzite	17.4	13	2.8	1.34	0.16	Tip
41COL34	Alba	Chert	17.3	11	3	1.45	0.17	
41COL34	Alba	Quartzite	15.1	11.1	2.7	1.36	0.18	
41COL34	Alba	Chert	20	10.5	3	1.9	0.15	
41COL34	Alba	Quartzite	18	12.4	3	1.45	0.17	
41COL34	Alba	Quartzite	15.5	11.7	2	1.32	0.13	
41COL34	Alba	Chert	18	16.1	2.6	1.12	0.14	
41COL34	Alba	Quartzite	22	13	3.3	1.69	0.15	
41COL34	Alba	Quartzite	20	16.1	4.3	1.24	0.21	Barb
41COL34	Alba	Quartzite	12	14.1	3.1	0.85	0.26	Tip, Barb
41COL34	Alba	Quartzite	14	16.1	2	0.87	0.21	Tip
41COL34	Alba	Quartzite	14	18.1	5	0.77	0.36	Tip
41COL34	Alba	Quartzite	16	15	4.1	1.07	0.26	Tip
41COL34	Alba	Quartzite	15.8	15.5	2.9	1.02	0.18	Tip
41COL34	Alba	Quartzite	17	15	3.6	1.13	0.21	
41COL34	Alba	Quartzite	19.2	11.1	2.6	1.73	0.14	Barb
41COL34	Alba	Quartzite	21.7	13	3	1.67	0.14	
41COL34	Alba	Chert	15.9	14.8	2.6	1.07	0.16	Tip, Barb
41COL34	Alba	Chert	17.5	12	2.4	1.46	0.14	Tip, Barb
41COL34	Alba	Quartzite	21	15	4.1	1.4	0.19	Barb
41COL34	Alba	Chert	17	16.1	3.6	1.06	0.21	Tip
41COL34	Alba	Quartzite	23	11.7	3	1.96	0.13	Barb
41COL34	Alba	Quartzite	19	13.3	3.8	1.43	0.2	
41COL34	Alba	Quartzite	20.9	11	3	1.9	0.14	
41COL34	Alba	Quartzite	22	12.8	3	1.72	0.14	
41COL34	Alba	Quartzite	21	15	3.4	1.4	0.16	
41COL34	Alba	Quartzite	20	16	4.2	1.25	0.21	Tip

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Alba	Quartzite	17.5	13.3	3.2	1.31	0.18	
41COL34	Alba	Quartzite	20	11.9	3.5	1.68	0.17	
41COL34	Alba	Quartzite	18.1	12	4.4	1.51	0.24	
41COL34	Alba	Quartzite	19.5	15	3.3	1.3	0.17	
41COL34	Alba	Quartzite	21	12	3.9	1.75	0.18	
41COL34	Alba	Quartzite	17.5	12	3	1.46	0.17	
41COL34	Alba	Quartzite	16.1	15.5	2.8	1.04	0.17	Barb
41COL34	Alba	Quartzite	24.8	10	2.5	2.48	0.1	
41COL34	Alba	Quartzite	23	10	4	2.3	0.17	Both Barbs
41COL34	Alba	Quartzite	20.9	11.8	3	1.77	0.14	
41COL34	Alba	Quartzite	22.4	10.7	3.1	2.09	0.14	
41COL34	Alba	Chert	28.5	12	3.1	2.37	0.11	
41COL34	Alba	Quartzite	22	14.8	4.8	1.49	0.22	
41COL34	Alba	Chert	22.8	18	3.3	1.27	0.14	Tip, Barb
41COL34	Alba	Chert	20	18	3	1.11	0.15	
41COL34	Alba	Quartzite	23.1	15.5	4.9	1.49	0.21	
41COL34	Alba	Quartzite	22	11.9	5	1.85	0.23	
41COL34	Alba	Quartzite	23	16.3	4.9	1.41	0.21	
41COL34	Alba	Quartzite	18.5	10.5	3	1.76	0.16	Barb
41COL34	Alba	Chert	25.5	15.3	5.1	1.67	0.2	
41COL34	Alba	Quartzite	22	10.8	3.1	2.03	0.11	
41COL34	Alba	Quartzite	14.5	11.1	2.8	1.31	0.19	Tip
41COL34	Alba	Quartzite	15.3	10.3	2.8	1.48	0.18	
41COL34	Alba	Quartzite	15	13	3.1	1.15	0.2	Tip
41COL34	Alba	Quartzite	20	13.2	3.7	1.16	0.18	Barb
41COL34	Alba	Quartzite	14.9	15	2.9	0.99	0.19	Tip, Barb
41COL34	Alba	Quartzite	18	12.3	3	1.46	0.17	Tip
41COL34	Alba	Quartzite	17	12.1	2.6	1.4	0.15	
41COL34	Alba	Chert	16	15.8	2	1.02	0.12	Tip
41COL34	Alba	Quartzite	15.3	11.8	2	1.3	0.13	
41COL34	Alba	Quartzite	20.1	14.2	2.3	1.41	0.11	Barb
41COL34	Alba	Chert	24	14.5	3	1.65	0.12	Barb
41COL34	Alba	Quartzite	17.5	14.4	3.4	1.21	0.19	Tip
41COL34	Alba	Quartzite	15	14.4	3.5	1.04	0.23	Tip, Barb
41COL34	Alba	Chert	16.1	15.1	2.6	1.07	0.16	
41COL34	Alba	Chert	20	14.7	2.7	1.36	0.13	
41COL34	Alba	Quartzite	19	17.5	4.1	1.09	0.21	
41COL34	Alba	Chert	21.1	12	3	1.76	0.14	
41COL34	Alba	Quartzite	24.7	14.9	3	1.66	0.12	
41COL34	Alba	Chert	22	13.4	3.3	1.64	0.15	
41COL34	Alba	Chert	23	11	3.4	2.09	0.15	
41COL34	Alba	Quartzite	23	13	2.2	1.77	0.1	
41COL34	Alba	Chert	24.9	12	4	2.08	0.16	
41COL34	Alba	Chert	29.7	17	3.5	1.45	0.12	
41COL34	Alba	Quartzite	25.8	17	2.9	1.51	0.11	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Alba	Chert	15.5	13.5	3.1	1.15	0.2	Tip
41COL34	Alba	Chert	18	9.9	2.9	1.81	0.16	
41COL34	Alba	Chert	20	12.1	3.1	1.65	0.15	
41COL34	Alba	Chert	16	12	3.9	1.33	0.24	
41COL34	Alba	Chert	20.7	15.7	3.5	1.32	0.17	
41COL34	Alba	Chert	20	13.5	4.9	1.32	0.24	
41COL34	Alba	Chert	16.8	11	2.9	1.53	0.17	
41COL34	Alba	Chert	20.5	12.5	3.1	1.64	0.15	
41COL34	Alba	Chert	19.2	13.1	3	1.46	0.15	
41COL34	Alba	Chert	21.7	10	3.9	2.17	0.18	Both Barbs
41COL34	Alba	Chert	20.8	12.1	3.6	1.72	0.17	
41COL34	Alba	Chert	19.9	14.5	1.8	1.37	0.09	
41COL34	Alba	Chert	14	9.9	1.8	1.41	0.13	
41COL34	Alba	Chert	17.3	12	2.8	1.44	0.16	
41COL34	Alba	Chert	20	12.3	2.8	1.63	0.14	
41COL34	Alba	Chert	29	14.7	3	1.97	0.1	
41COL34	Alba	Chert	27	16	3.3	1.69	0.12	
41COL34	Alba	Chert	19.9	14.1	4.6	1.41	0.23	
41COL34	Alba	Chert	19.3	14.9	2.8	1.29	0.14	
41COL34	Alba	Chert	15	10.1	2.8	1.48	0.19	
41COL34	Alba	Chert	24.2	12.2	4.2	1.98	0.17	Base
41COL34	Alba	Quartzite	29	12	4	2.41	0.14	
41COL34	Alba	Quartzite	23	13	5	1.77	0.21	
41COL34	Alba	Quartzite	28.5	17.9	4.9	1.59	0.17	
41COL34	Alba	Quartzite	29.9	13.5	5	2.21	0.17	
41COL34	Alba	Quartzite	29.9	18	5.5	1.66	0.18	
41COL34	Alba	Quartzite	18.7	14.4	5	1.3	0.27	Tip
41COL34	Alba	Quartzite	25.9	16	4.2	1.22	0.16	Barb
41COL34	Alba	Quartzite	25	12	5	2.08	0.2	
41COL34	Alba	Quartzite	20	13.1	3.3	1.53	0.16	Base
41COL34	Alba	Quartzite	21	16.5	3	1.27	0.14	
41COL34	Alba	Quartzite	25	15.1	5.3	1.65	0.21	
41COL34	Alba	Quartzite	21.7	15	4.4	1.44	0.2	
41COL34	Alba	Quartzite	22.7	15.3	3.1	1.48	0.14	
41COL34	Alba	Quartzite	24.8	17	3.8	1.45	0.15	Both Barbs
41COL34	Alba	Quartzite	30	17.3	6.5	1.73	0.22	Tip
41COL34	Alba	Quartzite	26.9	15	3.6	1.79	0.13	
41COL34	Alba	Quartzite	23	16.1	3.7	1.43	0.16	Barb
41COL34	Alba	Quartzite	28	17.4	3.8	1.61	0.13	
41COL34	Alba	Quartzite	21.2	14.8	2.9	1.43	0.14	Barb
41COL34	Alba	Quartzite	26.7	13.8	5	1.93	0.18	
41COL34	Alba	Quartzite	20.7	15.7	3	1.32	0.14	Base
41COL34	Alba	Quartzite	16	17	3.3	0.94	0.2	Tip
41COL34	Alba	Quartzite	22	10.2	2.5	2.16	0.11	Barb
41COL34	Alba	Quartzite	24.8	13.9	5	1.78	0.2	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Alba	Quartz	26	22.1	6	1.17	0.23	Tip
41COL34	Alba	Quartz	20	16.5	3	1.21	0.15	
41COL34	Alba	Chert	28	12	2.9	1.33	0.1	Base
41COL34	Alba	Chert	25	18.9	5.1	1.32	0.2	
41COL34	Alba	Chert	20.9	13.8	5.3	1.51	0.25	
41COL34	Alba	Chert	20	16	1.9	1.25	0.1	
41COL34	Alba	Chert	22.1	16.7	3.2	1.32	0.14	Base
41COL34	Alba	Chert	28.8	19	5.6	1.51	0.19	
41COL34	Alba	Chert	22.7	130	3.6	1.75	0.16	
41COL34	Alba	Chert	26	14	3.8	1.86	0.15	
41COL34	Alba	Chert	28	15	5	1.87	0.18	Barb
41COL34	Alba	Chert	23	19	3.1	1.21	0.13	Tip
41COL34	Alba	Chert	29	18	5	1.61	0.17	
41COL34	Alba	Chert	25.9	10.6	3.5	2.35	0.14	Both Barbs
41COL34	Alba	Chert	21	14	3.5	1.5	0.17	
41COL34	Alba	Chert	18	15.6	4.9	1.15	0.27	Base
41COL34	Alba	Chert	20	15	3	1.33	0.15	
41COL34	Alba	Chert	27.9	16	4.9	1.74	0.17	
41COL34	Alba	Chert	26.1	17.5	5	1.49	0.19	
41COL34	Alba	Chert	35.8	18	4.7	1.99	0.13	Tip
41COL34	Alba	Chert	26	14.8	3.8	1.76	0.15	Tip
41COL34	Alba	Chert	26.5	14	4.3	1.89	0.16	
41COL34	Alba	Chert	24	14.4	2.9	1.67	0.12	
41COL34	Alba	Chert	25	11	5	2.27	0.2	Both Barbs
41COL34	Alba	Chert	29.5	13	3.9	2.27	0.13	Barb
41COL34	Alba	Chert	24	15	2.9	1.6	0.12	
41COL34	Alba	Chert	19	13.1	3.1	1.45	0.16	
41COL34	Alba	Chert	16	11.1	3.1	1.44	0.19	
41COL34	Alba	Chert	20	13	2.2	1.54	0.11	
41COL34	Alba	Chert	16	10.5	2.2	1.52	0.14	
41COL34	Alba	Chert	23	14.4	3.4	1.6	0.15	
41COL34	Alba	Chert	21	14.2	3.5	1.48	0.17	Base
41COL34	Alba	Chert	14	13.8	3.1	1.01	0.22	
41COL34	Alba	Chert	21	14.5	3.9	1.45	0.18	
41COL34	Alba	Chert	25	12.5	2.5	2	0.1	
41COL34	Alba	Chert	30	14.6	3.6	2.05	0.12	Barb
41COL34	Alba	Chert	18	15.5	3.8	1.16	0.21	
41COL34	Alba	Chert	19.9	15.5	3.9	1.28	0.19	
41COL34	Alba	Chert	25	16.1	5	1.56	0.2	
41COL34	Alba	Chert	23	16	5	1.44	0.22	
41COL34	Alba	Chert	22.5	14.9	3.1	1.51	0.14	Base
41COL34	Alba	Chert	23	13.5	4.9	1.7	0.21	
41COL34	Alba	Chert	21	12.8	3.5	1.64	0.17	
41COL34	Alba	Chert	16	12	2.1	1.33	0.13	
41COL34	Alba	Chert	18	11.8	2.8	1.52	0.16	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Alba	Quartzite	16	14	3.8	1.14	0.24	
41COL34	Alba	Quartzite	20.9	14.9	4	1.4	0.19	
41COL34	Alba	Quartzite	19	12.2	1.9	1.56	0.1	
41COL34	Alba	Quartzite	23.5	13.5	4.2	1.74	0.18	
41COL34	Alba	Quartzite	15.1	14.9	2.7	1.01	0.18	Tip
41COL34	Alba	Quartzite	22.1	12.3	3.1	1.8	0.14	
41COL34	Alba	Quartzite	30	12.6	4.7	2.38	0.16	Barb
41COL34	Alba	Quartzite	32	14.4	4.3	2.22	0.12	
41COL34	Alba	Quartzite	20	13.5	3.1	1.48	0.15	
41COL34	Alba	Quartzite	23.5	12.5	3	1.88	0.13	Barb
41COL34	Alba	Quartzite	18	14.2	3.7	1.27	0.2	
41COL34	Alba	Quartzite	21	16.1	3.9	1.3	0.18	Base
41COL34	Alba	Quartzite	17	14.5	3.4	1.17	0.2	
41COL34	Alba	Quartzite	20	14.9	4.8	1.34	0.24	
41COL34	Alba	Quartzite	22	14.9	4.1	1.48	0.18	
41COL34	Alba	Quartzite	25	16	4.3	1.56	0.17	
41COL34	Alba	Quartzite	16	10.8	2.9	1.48	0.18	Barb
41COL34	Alba	Quartzite	21	11	3	1.9	0.14	
41COL34	Alba	Quartzite	13.5	14.5	2.9	0.93	0.21	Tip
41COL34	Alba	Quartzite	25	14.2	5	1.76	0.2	Barb
41COL34	Alba	Quartzite	24.5	16	3	1.53	0.12	Base
41COL34	Alba	Quartzite	26	15	4.8	1.73	0.18	
41COL34	Alba	Quartzite	21	18.4	5	1.14	0.24	Barb
41COL34	Alba	Quartzite	16	13.3	2.9	1.2	0.18	
41COL34	Alba	Quartzite	21	14	4.1	1.5	0.19	Tip
41COL34	Alba	Quartzite	21.3	10.2	3.4	2.08	0.16	Barb
41COL34	Alba	Quartzite	19.5	10.9	3.6	1.79	0.18	
41COL34	Alba	Quartzite	23.1	15.1	4.9	1.52	0.21	
41COL34	Alba	Quartzite	20	14.5	3.1	1.38	0.15	
41COL34	Alba	Quartzite	20.4	15	5	1.36	0.24	
41COL34	Alba	Quartzite	16.9	13	3.4	1.3	0.2	Tip
41COL34	Alba	Quartzite	20.5	11	3.2	1.86	0.16	
41COL34	Alba	Quartzite	15.3	11.2	2.3	1.08	0.15	
41COL34	Alba	Quartzite	15.5	14.2	4.4	1.09	0.28	Tip
41COL34	Alba	Quartzite	18	14.4	4.8	1.25	0.27	Tip
41COL34	Alba	Quartzite	19.2	13	3	1.48	0.16	
41COL34	Alba	Quartzite	25	11	3.1	2.27	0.12	
41COL34	Alba	Quartzite	25.5	15.5	5	1.64	0.2	Barb
41COL34	Alba	Quartzite	16.1	10	3.9	1.61	0.24	
41COL34	Alba	Quartzite	16	13.9	3	1.15	0.18	Tip
41COL34	Alba	Quartzite	29	14.9	4.8	1.95	0.16	Tip
41COL34	Alba	Quartzite	21.7	15	5	1.45	0.23	
41COL34	Alba	Quartzite	18.4	15	5	1.22	0.27	Tip
41COL34	Alba	Quartzite	26	15.1	2.9	1.72	0.11	Barb
41COL34	Alba	Quartzite	20.9	13	3.2	1.6	0.15	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Alba	Quartzite	20.7	14.7	3.9	1.41	0.19	Tip
41COL34	Alba	Quartzite	18	12.3	3	1.46	0.17	
41COL34	Alba	Quartzite	17	16	3.3	1.06	0.19	Base
41COL34	Alba	Quartzite	20.9	14	2.4	1.44	0.11	
41COL34	Alba	Quartzite	15	13.4	2.2	1.11	0.15	Barb
41COL34	Alba	Quartzite	20.4	14.2	2.4	1.44	0.12	
41COL34	Alba	Quartzite	23.7	14	2.9	1.69	0.12	Barb
41COL34	Alba	Quartzite	20	14	4.1	1.43	0.2	
41COL34	Alba	Quartzite	25.5	15	3.4	1.7	0.13	Barb
41COL34	Alba	Quartzite	20	14.7	4	1.36	0.2	Base
41COL34	Alba	Quartzite	20	13.9	2.9	1.44	0.14	Base
41COL34	Alba	Quartzite	18.2	15.1	4.1	1.17	0.22	
41COL34	Alba	Quartzite	15	12.1	2.5	1.24	0.17	Tip, Barb
41COL34	Alba	Quartzite	21.1	13.7	3.2	1.54	0.15	
41COL34	Alba	Quartzite	21	12.1	2.1	1.73	0.1	
41COL34	Alba	Quartzite	16	12.4	3.2	1.29	0.2	Barb
41COL34	Alba	Quartzite	21.5	14.8	2.9	1.45	0.13	
41COL34	Alba	Quartzite	21.6	14.8	4.8	1.45	0.22	
41COL34	Alba	Quartzite	16	16	3.9	1	0.24	Tip
41COL34	Alba	Quartzite	19.9	13.9	2	1.45	0.1	Base
41COL34	Alba	Quartzite	20	16.7	3.3	1.2	0.16	Base
41COL34	Alba	Quartzite	15.8	12.1	3.9	1.3	0.25	Barb
41COL34	Alba	Quartzite	18	11.2	4.2	1.61	0.23	
41COL34	Alba	Quartzite	16	11.1	2.9	1.44	0.18	Barb
41COL34	Alba	Chert	31.4	15	5.1	2.09	0.16	Tip
41COL36	Alba	Quartzite	31.8	13	3.2	2.44	0.1	Both Barbs
41COL36	Alba	Quartzite	27	12	5	2.25	0.18	
41COL36	Alba	Quartzite	26	12.8	4	2.03	0.15	
41COL36	Alba	Quartzite	21	15.5	4	1.35	0.19	Base
41COL36	Alba	Quartzite	20	12	2.8	1.67	0.14	
41COL36	Alba	Quartzite	23.5	13.5	2.9	1.74	0.12	
41COL36	Alba	Quartzite	21.8	13.8	3	1.58	0.14	
41COL36	Alba	Quartzite	15.3	13	3.3	1.18	0.21	Barb
41COL36	Alba	Quartzite	20	14.2	3	1.04	0.15	
41COL36	Alba	Quartzite	18	15.5	3	1.16	0.17	Base
41COL36	Alba	Chert	18	11	3	1.64	0.17	Barb
41COL36	Alba	Chert	21	14.8	2.5	1.42	0.12	
41COL36	Alba	Chert	20	11.8	2.8	1.69	0.14	
41COL36	Alba	Chert	23	15.1	2.4	1.39	0.11	
41COL38	Alba	Quartzite	19	12.5	4.4	1.52	0.23	Tip
41COL65	Alba	Quartzite	20	8.2	3.2	2.44	0.16	
41COL66	Alba	Quartzite	19	11.2	3.2	1.7	0.17	Barb
41COL66	Alba	Quartzite	21.3	11.8	4	1.8	0.19	Tip
41COL66	Alba	Quartzite	11.1	13.2	3	0.84	0.18	Tip
41COL66	Alba	Chert	18.5	16.5	5	1.12	0.27	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL167	Alba	Quartzite	19	11.1	2.9	1.71	0.15	Tip, Both Barbs
41COL167	Alba	Quartzite	20	15.4	3.5	1.3	0.18	Barb
41COL167	Alba	Quartzite	16	11	2.9	1.45	0.18	Both Barbs
41COL167	Alba	Quartzite	21.9	18	2.1	1.2	0.1	Tip, Barb
41COL167	Alba	Quartzite	23.1	17.9	2.9	1.29	0.12	Barb
41COL167	Alba	Quartzite	23	18	3.9	1.28	0.17	
41COL167	Alba	Quartzite	20	15	3	1.33	0.15	
41COL167	Alba	Quartzite	15.5	12	3.2	1.29	0.2	Tip
41COL167	Alba	Quartzite	14.8	13.8	2.9	1.07	0.19	Base, Barb
41COL167	Alba	Quartzite	19.7	14.7	3.2	1.34	0.16	
41COL167	Alba	Quartzite	20	14	4	1.42	0.2	Both Barbs
41COL167	Alba	Chert	16	15	2.9	1.07	0.18	
41COL167	Alba	Chert	27.1	14	3.2	1.93	0.11	
41COL167	Alba	Chert	22	14	5	1.57	0.22	Barb
41COL167	Alba	Chert	20	12	3	1.67	0.15	Barb
41COL167	Alba	Chert	28	20	4.8	1.4	0.16	Tip
41COL167	Alba	Chert	16.8	15.5	2.9	1.08	0.17	Tip
41COL167	Alba	Chert	17.1	15.8	3	1.08	0.17	
41COL167	Alba	Chert	15.5	15	2.8	1.03	0.2	Tip
41RW1	Alba	Quartzite	21.3	13.7	4.5	1.55	0.21	Both Barbs
41RW1	Alba	Quartzite	17	18.5	3.4	0.91	0.2	Tip
41RW1	Alba	Quartzite	19	13.5	2.9	1.41	0.15	
41RW1	Alba	Quartzite	21	19	3.9	1.1	0.18	Barb
41RW1	Alba	Quartzite	20	15	4	1.33	0.2	Tip
41RW1	Alba	Quartzite	24.1	14.9	3	1.62	0.12	Both Barbs
41RW1	Alba	Chert	17	13.3	2.3	1.28	0.13	Tip
41RW1	Alba	Chert	20	18	3	1.11	0.15	Barb
41RW1	Alba	Chert	19.1	18.1	2.8	1.06	0.15	
41RW1	Alba	Chert	20.9	15	5	1.39	0.24	Tip, Barb
41RW1	Alba	Chert	23	19.4	4.8	1.19	0.21	
41RW1	Alba	Chert	19.9	16.5	4.1	1.21	0.21	Tip
41RW1	Alba	Chert	19.7	13	3	1.51	0.15	Tip
41RW2	Alba	Quartzite	19.5	15.7	3.4	1.24	0.18	
41RW2	Alba	Quartzite	25.8	18.1	4	1.42	0.16	Barb
41RW2	Alba	Quartzite	31.9	16	4.3	1.99	0.13	
41RW2	Alba	Quartzite	22.7	13.1	2.9	1.73	0.13	Tip, Barb
41RW2	Alba	Quartzite	21	17.9	3	1.17	0.14	Tip
41RW2	Alba	Quartzite	21.7	14	3.1	1.55	0.14	Tip, Barb
41RW2	Alba	Quartzite	22.3	19	4.2	1.17	0.19	Tip, Barb
41RW2	Alba	Quartzite	17.1	14.9	3.8	1.15	0.22	Tip
41RW2	Alba	Quartzite	20	14.3	3.1	1.4	0.16	
41RW2	Alba	Quartzite	17	10	2.8	1.7	0.16	Both Barbs
41RW2	Alba	Chert	31.7	19	3.1	1.67	0.1	Barb
41RW2	Alba	Chert	20.3	15.8	3.1	1.28	0.15	Tip, Barb
41RW2	Alba	Chert	20.5	14.9	2.8	1.38	0.14	Barb

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41RW4	Alba	Quartzite	20	11.5	5.3	1.74	0.26	
41RW7	Alba	Quartzite	20.5	13.1	2.4	1.56	0.12	
41RW7	Alba	Quartzite	23	12.5	4	1.84	0.17	Tip
41RW7	Alba	Quartzite	15	13.5	3	1.11	0.17	Tip
41RW7	Alba	Chert	18	17.2	4	1.05	0.22	
41RW7	Alba	Chert	19.3	10.5	3.2	1.84	0.16	
41RW10	Alba	Quartzite	19.8	11.5	3	1.72	0.15	Both Barbs
41RW10	Alba	Quartzite	14.8	13	2.7	1.14	0.18	Tip
41RW10	Alba	Quartzite	18.4	19	4.8	0.97	0.26	
41RW10	Alba	Quartzite	20	20.1	2.9	1	0.14	
41RW10	Alba	Quartzite	19.4	18.5	3	1.05	0.15	
41RW10	Alba	Quartzite	18	17	4	1.06	0.22	
41RW10	Alba	Chert	26.9	20.9	2.9	1.29	0.11	Base, Barb
41KF42	Alba	Quartzite	19	17	3.8	1.12	0.2	
41KF42	Alba	Quartzite	25	15.5	3	1.61	0.12	Barb
41KF42	Alba	Quartzite	32	19.9	3.4	1.61	0.11	Barb
41KF42	Alba	Quartzite	31	17	3	1.82	0.1	Barb
41KF42	Alba	Quartzite	28	19.2	4.2	1.46	0.15	
41KF42	Alba	Quartzite	27	10.8	2.8	2.5	0.1	Both Barbs
41KF42	Alba	Quartzite	21.7	15.8	4	1.37	0.18	Tip
41KF42	Alba	Quartzite	20.1	15.5	4.2	1.3	0.21	
41KF42	Alba	Quartzite	23	15	3	1.53	0.13	Barb
41KF42	Alba	Quartzite	24	15.8	3.2	1.52	0.13	
41KF42	Alba	Chert	31	14.1	3.2	2.2	0.16	Barb
41KF42	Alba	Chert	17	14.7	2.8	1.16	0.14	Tip
41KF42	Alba	Chert	15	15.9	2.1	0.94	0.14	Tip
41KF42	Alba	Chert	25	13	3	1.92	0.12	
41KF42	Alba	Chert	24.1	15.8	3.2	1.52	0.13	Barb
41KF42	Alba	Chert	17	15	3.9	1.13	0.23	Barb
41COL1	Catahoula	Quartzite	28.9	19	5	1.52	0.17	
41COL1	Catahoula	Quartzite	26.8	16.9	3.7	1.58	0.14	
41COL1	Catahoula	Quartzite	25	16.4	4	1.52	0.16	
41COL1	Catahoula	Quartzite	27.2	19	4.9	1.43	0.18	Barb
41COL1	Catahoula	Quartzite	25	15	3.5	1.67	0.14	Barb
41COL1	Catahoula	Quartzite	23.7	14.8	4.1	1.93	0.17	Barb
41COL1	Catahoula	Quartzite	19.2	21.3	3.2	0.9	0.17	Tip
41COL1	Catahoula	Quartzite	18.5	14.7	2.8	1.26	0.15	Barb
41COL1	Catahoula	Quartzite	17	14.8	3.1	1.15	0.18	Tip, Barb
41COL3	Catahoula	Quartzite	20	14	4.1	1.43	0.14	
41COL3	Catahoula	Chert	29	18	3.6	1.61	0.14	Barb
41COL4	Catahoula	Quartzite	19.9	19	3	1.05	0.16	
41COL9	Catahoula	Quartzite	32.4	18.1	5	1.79	0.15	Barb
41COL9	Catahoula	Quartzite	33.1	21.4	5.9	1.55	0.18	Barb
41COL9	Catahoula	Quartzite	36.1	20.2	5.9	1.78	0.16	Both Barbs
41COL9	Catahoula	Quartzite	20	18.1	4.8	1.1	0.24	Tip, Barb

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL9	Catahoula	Quartzite	24	18	2.4	1.33	0.1	
41COL9	Catahoula	Quartzite	26	14.1	4.5	1.84	0.17	
41COL9	Catahoula	Quartzite	31.8	17	4.8	1.28	0.15	
41COL9	Catahoula	Quartzite	19.9	22	4.3	0.9	0.22	Tip
41COL9	Catahoula	Quartzite	19	15	3	1.27	0.16	
41COL9	Catahoula	Quartzite	17	14.4	2.6	1.18	0.15	Barb
41COL9	Catahoula	Chert	20.1	15.1	4	1.33	0.2	
41COL34	Catahoula	Quartzite	13	15.5	2.9	0.84	0.22	Tip, Barb
41COL34	Catahoula	Quartzite	23.2	15.7	5	1.46	0.22	Tip, Barb
41COL34	Catahoula	Quartzite	29.2	13.1	4.8	2.22	0.16	Both Barbs
41COL34	Catahoula	Quartzite	25.5	18.5	4.8	1.38	0.19	
41COL34	Catahoula	Quartzite	25	16.1	4.1	1.55	0.16	
41COL34	Catahoula	Quartzite	29	14.9	4.1	1.95	0.14	
41COL34	Catahoula	Quartzite	24	13	4	1.85	0.17	
41COL34	Catahoula	Quartzite	31	18	4.9	1.72	0.16	
41COL34	Catahoula	Quartzite	32	16.8	5	1.9	0.16	Barb
41COL34	Catahoula	Quartzite	26.5	20.3	4.3	1.32	0.17	
41COL34	Catahoula	Quartzite	29.9	14.9	4	1.4	0.19	Barb
41COL34	Catahoula	Quartzite	18	17.8	3.8	1.01	0.21	Tip
41COL34	Catahoula	Quartzite	19.1	20	2.8	0.96	0.15	Tip
41COL34	Catahoula	Quartzite	15	17.3	2.7	0.87	0.18	Tip
41COL34	Catahoula	Quartzite	23	17.2	3.2	1.34	0.14	
41COL34	Catahoula	Chert	35.5	26.1	4.2	1.36	0.12	
41COL34	Catahoula	Chert	23	14.9	3.5	1.54	0.15	Barb
41COL34	Catahoula	Chert	28	15.5	4	1.81	0.14	
41COL34	Catahoula	Chert	24.9	16.1	3.2	1.54	0.13	
41COL34	Catahoula	Chert	22	14.4	4.7	1.53	0.21	Barb
41COL34	Catahoula	Chert	22	16.1	4.9	1.37	0.22	Tip, Barb
41COL34	Catahoula	Chert	23	16.1	3	1.43	0.13	Barb
41COL34	Catahoula	Chert	16	21.7	4.7	0.74	0.29	
41COL34	Catahoula	Chert	15	13.5	3.1	1.11	0.21	
41COL34	Catahoula	Chert	14.7	13.7	2.9	1.07	0.2	
41COL34	Catahoula	Chert	15	15	3.1	1	0.2	Tip
41COL34	Catahoula	Quartzite	30	23.4	4	1.3	0.13	
41COL34	Catahoula	Quartzite	28	18	5.2	1.56	0.18	
41COL34	Catahoula	Quartzite	20.8	20	4	1.04	0.19	Barb
41COL34	Catahoula	Quartzite	22.5	21	3	1.07	0.13	
41COL34	Catahoula	Quartzite	22	19.8	3	1.11	0.14	
41COL34	Catahoula	Quartzite	24.8	15.8	5	1.57	0.2	Tip, Barb
41COL34	Catahoula	Quartzite	25	18	4.8	1.39	0.19	Barb
41COL34	Catahoula	Quartzite	20.7	15	5	1.38	0.2	Barb
41COL34	Catahoula	Quartzite	19.3	19.9	4.2	0.97	0.22	Tip
41COL34	Catahoula	Quartzite	18	15.8	4	1.14	0.22	Tip
41COL34	Catahoula	Quartzite	20	14.1	2.9	1.42	0.16	Barb
41COL34	Catahoula	Quartzite	15	18.3	2.2	0.82	0.15	Tip

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Catahoula	Quartzite	20	18	3	1.11	0.15	Barb
41COL34	Catahoula	Quartzite	14	15.1	3.2	0.93	0.23	Tip
41COL34	Catahoula	Quartzite	17	16.3	3	1.04	0.18	Tip
41COL34	Catahoula	Quartzite	18	14.5	3	1.24	0.17	Barb
41COL34	Catahoula	Quartzite	14.3	12.2	3	1.17	0.21	Barb
41COL34	Catahoula	Quartzite	20.9	15	3	1.39	0.14	
41COL34	Catahoula	Quartzite	19	12.3	3	1.54	0.16	Barb
41COL34	Catahoula	Quartzite	27	20	3.4	1.35	0.12	Barb
41COL34	Catahoula	Quartzite	22	18	3.1	1.22	0.14	
41COL34	Catahoula	Quartzite	20	14.5	3	1.38	0.15	
41COL34	Catahoula	Quartzite	20	17.1	4	1.17	0.2	
41COL34	Catahoula	Quartzite	20	19.8	3.3	1.01	0.16	Barb
41COL34	Catahoula	Quartzite	15.1	15.1	4	1	0.26	
41COL34	Catahoula	Quartzite	15.8	16	4	0.99	0.25	Tip, Barb
41COL34	Catahoula	Quartzite	23	14.7	3.1	1.56	0.13	Barb
41COL34	Catahoula	Quartzite	21	15.2	2.3	1.38	0.1	
41COL34	Catahoula	Quartzite	18	14.5	3.2	1.24	0.18	Tip
41COL36	Catahoula	Quartzite	17.3	18.1	2.9	0.96	0.16	
41COL36	Catahoula	Quartzite	17.5	15	2.3	1.13	0.13	Barb
41COL167	Catahoula	Quartzite	30.6	16.8	3.2	1.82	0.1	Tip, Barb
41COL167	Catahoula	Quartzite	20.8	22.1	3.5	0.94	0.17	Tip
41COL167	Catahoula	Quartzite	17	20	3	0.85	0.18	
41RW1	Catahoula	Quartzite	30.5	23.1	4.1	1.32	0.13	Tip
41RW1	Catahoula	Quartzite	28	17	3	1.65	0.11	Barb
41RW1	Catahoula	Quartzite	21.2	23.1	3.9	0.92	0.18	Tip
41RW1	Catahoula	Quartzite	18.2	14.3	3.5	1.27	0.19	Tip, Barb
41RW1	Catahoula	Quartzite	16.2	20.5	3	0.79	0.19	Tip
41RW2	Catahoula	Quartzite	20	17	3.6	1.18	0.18	Tip, Barb
41RW2	Catahoula	Quartzite	20.4	17	3.2	1.2	0.16	Tip
41RW2	Catahoula	Quartzite	15	19.9	3.4	0.75	0.23	Tip
41RW2	Catahoula	Quartzite	15	17.5	3	0.86	0.2	Tip
41RW7	Catahoula	Chert	17.5	18.1	3.1	0.97	0.18	Tip
41RW7	Catahoula	Chert	20.5	17.1	4.1	1.2	0.2	Tip
41KF42	Catahoula	Quartzite	29	14.3	2.3	2.03	0.08	Tip
41KF42	Catahoula	Quartzite	22.7	16.8	3.4	1.35	1.15	Tip, Barb
41COL1	Scallorn	Quartzite	23.4	15.5	3.2	1.44	0.14	Tip
41COL1	Scallorn	Quartzite	19	10.3	3	1.84	0.16	Both Barbs
41COL1	Scallorn	Quartzite	16.3	14.8	2.9	1.1	0.18	Tip
41COL1	Scallorn	Chert	20.2	14.2	3.7	1.42	0.18	Tip, Both Barbs
41COL1	Scallorn	Chert	13.9	17.5	4	0.79	0.29	Tip
41COL3	Scallorn	Chert	33	15	2.1	1.53	0.09	
41COL3	Scallorn	Quartzite	18.4	14.9	2.7	1.23	0.15	
41COL4	Scallorn	Quartzite	22.8	15	2.5	1.52	0.17	Barb
41COL4	Scallorn	Quartzite	19.3	15.9	2.1	1.09	0.14	
41COL9	Scallorn	Quartzite	34	15.6	3.1	2.5	0.09	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL9	Scallorn	Quartzite	30.2	19.9	3.2	1.52	0.11	
41COL9	Scallorn	Quartzite	21.5	15.5	3.5	1.39	0.16	Barb
41COL9	Scallorn	Chert	31.3	14	4.1	2.23	0.13	Barb
41COL9	Scallorn	Chert	23	19	2.5	1.21	0.11	
41COL9	Scallorn	Chert	21.7	13.1	2.3	1.66	0.11	Barb
41COL9	Scallorn	Quartzite	17	15.5	3.1	1.1	0.18	
41COL9	Scallorn	Chert	22	15.1	4.1	1.46	0.19	Barb
41COL9	Scallorn	Chert	16	10	2.4	1.6	0.15	
41COL9	Scallorn	Chert	14.7	11	2.3	1.34	0.16	Tip, Barb
41COL34	Scallorn	Chert	20.5	12.3	3	1.67	0.15	Tip
41COL34	Scallorn	Chert	19	14.7	2.9	1.29	0.15	
41COL34	Scallorn	Chert	23	11.5	3.2	2	0.14	
41COL34	Scallorn	Quartzite	29	15	4.9	1.93	0.17	
41COL34	Scallorn	Chert	23	16.5	3.2	1.39	0.13	
41COL34	Scallorn	Quartzite	20	16.9	4.9	1.18	0.15	
41COL34	Scallorn	Quartzite	26	20	3.1	1.3	0.12	
41COL34	Scallorn	Quartzite	23.1	15.5	3	1.49	0.21	
41COL34	Scallorn	Quartzite	22	11.9	3	1.85	0.22	
41COL34	Scallorn	Quartzite	26	12	4.9	2.17	0.17	
41COL34	Scallorn	Quartzite	16	18	5	0.89	0.25	Tip
41COL34	Scallorn	Chert	26	10	4.5	2.6	0.11	
41COL34	Scallorn	Chert	20	12.8	4	1.56	0.2	
41COL34	Scallorn	Chert	20	14.4	3	1.39	0.13	
41COL34	Scallorn	Chert	21	11.8	4.1	1.78	0.14	
41COL34	Scallorn	Chert	16.3	15	2.7	1.09	0.12	
41COL34	Scallorn	Quartzite	23.5	16	3	1.47	0.19	
41COL34	Scallorn	Chert	20.4	15.6	2	1.31	0.19	
41COL34	Scallorn	Chert	25	11.1	4.4	2.25	0.14	
41COL34	Scallorn	Chert	24	13	3.9	1.85	0.09	
41COL34	Scallorn	Chert	23	16.9	3.6	1.36	0.21	
41COL34	Scallorn	Chert	21	17.8	2.2	1.18	0.15	
41COL34	Scallorn	Chert	12	10.5	4.8	1.14	0.18	
41COL34	Scallorn	Chert	16.4	11	3.2	1.49	0.12	
41COL34	Scallorn	Chert	30	21.7	2.1	1.38	0.17	Tip, Barb
41COL34	Scallorn	Chert	32	15	2	2.13	0.13	
41COL34	Scallorn	Chert	34	21	5.2	1.62	0.1	Tip
41COL34	Scallorn	Chert	20	18	4.1	1.11	0.15	
41COL34	Scallorn	Chert	19.1	15.1	3.4	1.26	0.16	Both Barbs
41COL34	Scallorn	Chert	26.1	10	3	2.61	0.19	Tip, Barb
41COL34	Scallorn	Chert	19	14.7	3	1.29	0.13	
41COL34	Scallorn	Chert	22	15.5	5	1.42	0.22	
41COL34	Scallorn	Chert	17	11	2.5	1.54	0.16	Barb
41COL34	Scallorn	Chert	25.5	16.5	4.9	1.54	0.16	Barb
41COL34	Scallorn	Chert	24	15.9	2.8	1.51	0.13	
41COL34	Scallorn	Chert	22	13	4.2	1.6	0.14	Barb

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Scallorn	Chert	21	14	2.4	1.5	0.11	Barb
41COL34	Scallorn	Chert	29.7	14	3.2	2.12	0.11	Barb
41COL34	Scallorn	Chert	16	15	3	1.07	0.19	
41COL34	Scallorn	Chert	18	15	3.8	1.2	0.21	
41COL34	Scallorn	Chert	15	11	2.8	1.36	0.19	Tip, Barb
41COL34	Scallorn	Chert	18.4	13.2	3	1.39	0.16	
41COL34	Scallorn	Chert	18	11.2	3.1	1.61	0.17	Barb
41COL34	Scallorn	Chert	15	10.2	3.2	1.47	0.21	
41COL34	Scallorn	Chert	19	9.7	3.1	1.96	0.16	Both Barbs
41COL34	Scallorn	Chert	15	10	2.2	1.5	0.15	Barb
41COL34	Scallorn	Quartzite	26	19	4.2	1.37	0.16	
41COL34	Scallorn	Quartzite	26.2	15.8	4.6	1.66	0.18	
41COL34	Scallorn	Quartzite	23	14	4	1.64	0.17	Barb
41COL34	Scallorn	Quartzite	21	15.8	4.9	1.33	0.23	Tip
41COL34	Scallorn	Quartzite	23.3	18	5	1.29	0.21	
41COL34	Scallorn	Quartzite	22.4	13.6	4.9	1.65	0.22	
41COL34	Scallorn	Quartzite	30	14.8	4.8	2.03	0.16	Barb
41COL34	Scallorn	Quartzite	25.5	15	4.2	1.7	0.16	
41COL34	Scallorn	Quartzite	19.2	15	3.3	1.28	0.17	Barb
41COL34	Scallorn	Quartzite	20.8	11	3.4	1.89	0.16	Both Barbs
41COL34	Scallorn	Quartzite	20	13	3	1.54	0.15	
41COL34	Scallorn	Quartzite	20.9	14.3	3.1	1.46	0.15	
41COL34	Scallorn	Quartzite	21	10	3.1	2.1	0.15	Barb
41COL34	Scallorn	Quartzite	20.4	15	3.1	1.36	0.15	Tip, Barb
41COL34	Scallorn	Quartzite	18.1	10.8	3	1.67	0.16	Barb
41COL34	Scallorn	Quartzite	13	13.8	2.6	0.94	0.2	Tip
41COL36	Scallorn	Quartzite	28.1	18	4	1.56	0.14	Barb
41COL167	Scallorn	Quartzite	35.5	14.1	3.9	2.51	0.11	
41COL167	Scallorn	Chert	13.1	13	1.9	1.01	0.14	Tip, Barb
41COL167	Scallorn	Quartzite	14.8	12	3.1	1.23	0.21	Tip
41COL167	Scallorn	Quartzite	15	12.4	3	1.21	0.2	Tip, Barb
41COL167	Scallorn	Quartzite	25	15.5	4.9	1.52	0.2	
41RW1	Scallorn	Quartzite	17.3	15.2	3.2	1.14	0.18	Tip
41RW1	Scallorn	Quartzite	20.3	18	3.2	1.13	0.14	
41RW1	Scallorn	Chert	21.1	16	3	1.32	0.14	Tip, Barb
41RW1	Scallorn	Chert	17.1	14.2	3.1	1.2	0.18	Tip
41RW1	Scallorn	Chert	20.7	15.1	3.1	1.37	0.18	Tip
41RW1	Scallorn	Chert	23.4	13.1	2.9	1.79	0.12	
41RW1	Scallorn	Chert	24.9	15	3.1	1.66	0.12	Both Barbs
41RW1	Scallorn	Chert	17.1	12.3	3.5	1.39	0.2	Tip, Both Barbs
41RW2	Scallorn	Chert	25.8	15	3.1	1.72	0.12	
41RW2	Scallorn	Chert	24.2	15	5	1.61	0.2	
41RW2	Scallorn	Chert	19	17	4	1.15	0.2	Tip
41RW2	Scallorn	Quartzite	15	20	4.1	0.75	0.27	Tip, Barb
41RW2	Scallorn	Quartzite	18	16	3.6	1.12	0.2	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41RW7	Scallorn	Chert	15.5	12.2	3.5	1.27	0.22	Tip
41KF42	Scallorn	Quartzite	20.5	18.2	3.8	1.13	0.18	
41KF42	Scallorn	Quartzite	21.1	11.8	2.9	1.79	0.14	Barb
41KF42	Scallorn	Chert	21	19	4	1.1	0.19	
41KF42	Scallorn	Chert	18.2	14.7	3.9	1.24	0.21	Tip
41COL1	Perdiz	Chert	26.8	14.1	3.2	1.9	0.12	Barb
41COL1	Perdiz	Chert	25	15	2.9	1.67	0.12	Tip, Barb
41COL1	Perdiz	Chert	28.5	15.3	2.8	1.86	0.1	Tip, Barb
41COL1	Perdiz	Chert	23	21.5	3	1.07	0.13	Tip
41COL1	Perdiz	Chert	22.4	16	3	1.4	0.13	Tip
41COL1	Perdiz	Chert	16.2	13.8	2.8	1.17	0.17	Tip
41COL1	Perdiz	Chert	19.2	13.6	3.1	1.19	0.16	Tip
41COL1	Perdiz	Chert	17.8	16.5	2.3	1.08	0.17	Tip, Barb
41COL1	Perdiz	Chert	15	15	2.7	1	0.18	Tip, Barb
41COL3	Perdiz	Quartzite	31.6	16.9	3	1.87	0.09	Barb
41COL3	Perdiz	Chert	26	21.7	3.1	1.2	0.12	Tip, Barb
41COL3	Perdiz	Chert	21.2	15	2.9	1.41	0.14	Tip
41COL4	Perdiz	Quartzite	21.2	12.6	2.7	1.69	0.13	Barb
41COL4	Perdiz	Quartzite	26.8	15.8	3.7	1.7	0.14	
41COL9	Perdiz	Chert	30.1	19.1	4.8	1.58	0.16	
41COL9	Perdiz	Chert	30	17	2	1.76	0.07	
41COL9	Perdiz	Chert	30	16.3	3	1.84	0.1	
41COL9	Perdiz	Chert	25	18.1	3	1.38	0.12	Barb
41COL9	Perdiz	Chert	18.4	14.9	3.1	1.23	0.17	
41COL9	Perdiz	Chert	19.3	15	3.2	1.29	0.16	Tip
41COL34	Perdiz	Chert	27.2	15	3.3	1.81	0.12	
41COL34	Perdiz	Quartzite	26	18	3.1	1.44	0.12	
41COL34	Perdiz	Quartzite	22	15	3.5	1.47	0.16	
41COL34	Perdiz	Quartzite	17.3	13.5	3.1	1.28	0.18	Tip, Barb
41COL34	Perdiz	Chert	33.1	19.2	3	1.72	0.09	Tip
41COL34	Perdiz	Chert	36	19	3.5	1.89	0.1	Barb
41COL34	Perdiz	Chalcedony	21.3	12.3	3	1.73	0.14	Barb
41COL34	Perdiz	Chert	25.2	15	3	1.54	0.13	
41COL34	Perdiz	Chert	25.5	21.7	2.2	1.66	0.09	Barb
41COL34	Perdiz	Chert	25.4	20.2	2.8	1.26	0.11	
41COL34	Perdiz	Chert	34	13.5	2	1.88	0.08	
41COL34	Perdiz	Chert	30.7	19	2.9	1.79	0.08	
41COL34	Perdiz	Chert	30	17.8	2.9	1.72	0.09	Barb
41COL34	Perdiz	Chert	26	24.5	4.9	1.22	0.16	
41COL34	Perdiz	Quartz	27.2	20	5	1.3	0.19	Barb
41COL34	Perdiz	Chert	31.8	17	4	1.36	0.15	
41COL34	Perdiz	Chert	21.2	14.8	3.2	2.15	0.1	Barb
41COL34	Perdiz	Chert	25.5	16.1	1.9	1.32	0.09	Barb
41COL34	Perdiz	Chert	22.5	12.3	5	2.07	0.19	Barb
41COL34	Perdiz	Chert	18	15	2.6	1.5	0.11	Barb

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Perdiz	Chert	20	12.8	2.7	1.56	0.13	
41COL34	Perdiz	Chert	20	14.6	3.1	1.37	0.15	
41COL34	Perdiz	Chert	19.1	19.8	3	0.96	0.16	
41COL34	Perdiz	Chert	22.1	15	3.7	1.47	0.17	
41COL34	Perdiz	Chert	16.5	11.9	3	1.39	0.18	Tip, Both Barbs
41COL34	Perdiz	Chert	17.5	13	2.9	1.35	0.16	
41COL34	Perdiz	Quartzite	24.3	11	4.9	2.2	0.2	Both Barbs
41COL34	Perdiz	Quartzite	22	12.5	2.9	1.76	0.13	
41COL34	Perdiz	Quartzite	23.5	17	5	1.38	0.21	
41COL34	Perdiz	Quartzite	24.3	11	4	2.2	0.16	Both Barbs
41COL34	Perdiz	Quartzite	18	13.9	5	1.29	0.28	Tip, Barb
41COL34	Perdiz	Quartzite	20	12	2.4	1.67	0.12	
41COL34	Perdiz	Quartzite	23.7	12	2.2	1.87	0.09	Tip
41COL34	Perdiz	Quartzite	18	18	3.1	1	0.17	Tip
41COL34	Perdiz	Quartzite	20	15	5	1.33	0.25	
41COL34	Perdiz	Quartzite	20	14.3	3.1	1.4	0.16	Tip
41COL36	Perdiz	Chert	28	19.5	3.1	1.43	0.11	Barb
41COL36	Perdiz	Chert	26	17	3.5	1.53	0.13	
41COL36	Perdiz	Chert	30.1	17.5	3.1	1.72	0.1	Barb
41COL36	Perdiz	Chert	25	13	2.9	1.39	0.12	
41COL36	Perdiz	Chert	32.2	17	2.9	1.89	0.09	Barb
41COL36	Perdiz	Chert	20.8	13	3.5	1.6	0.17	
41COL36	Perdiz	Chert	26.5	13.5	3.8	1.96	0.14	Tip, Barb
41COL66	Perdiz	Quartzite	18	18.8	2.1	0.96	0.12	Tip
41COL167	Perdiz	Quartzite	24	14.5	4	1.66	0.17	
41COL167	Perdiz	Chert	20.5	17.8	3	1.15	0.15	Tip, Barb
41RW1	Perdiz	Quartzite	23	19	3.1	1.21	0.13	Tip, Barb
41RW1	Perdiz	Chert	24.8	19.9	3.5	1.25	0.14	Tip
41RW1	Perdiz	Chert	23	20	3	1.15	0.13	
41RW1	Perdiz	Chert	30.1	15.9	3	1.89	0.1	Barb
41RW1	Perdiz	Chert	25.8	20.2	2.6	1.28	0.1	
41RW1	Perdiz	Chert	24.1	18	3.5	1.34	0.14	Tip
41RW2	Perdiz	Chert	39.7	17	3.4	2.33	0.09	Barb
41RW2	Perdiz	Chert	30	13	3.1	2.31	0.1	Both Barbs
41RW2	Perdiz	Chert	23	11.9	3.1	1.93	0.13	Tip
41RW2	Perdiz	Chert	24.7	14.7	3	1.68	0.12	Barb
41RW10	Perdiz	Chert	25.8	20.8	4	1.24	0.16	Barb
41KF42	Perdiz	Chert	35	18	2.8	1.94	0.08	Barb
41KF42	Perdiz	Chert	26.1	17	3.8	1.53	0.14	
41KF42	Perdiz	Chert	21.7	15.7	3.6	1.38	0.17	
41KF42	Perdiz	Chert	26	15	2.2	1.73	0.08	
41COL3	Fresno	Chert	20	14	3	1.43	0.15	
41COL3	Fresno	Quartzite	20	14	2.5	1.06	0.17	Corner
41COL9	Fresno	Chert	17	15	3.8	1.13	0.22	Tip
41COL9	Fresno	Chert	20.1	15	3.8	1.34	0.19	Tip, Corner

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL9	Fresno	Chert	19.3	18.1	5	1.07	0.26	Tip
41COL9	Fresno	Chert	17	13	1.8	1.31	0.11	Corner
41COL9	Fresno	Chert	19.5	15.8	4	1.23	0.2	Tip
41COL9	Fresno	Chert	19	16.8	4	1.13	0.21	Corner
41COL9	Fresno	Chert	20	14.8	2	1.35	0.1	
41COL34	Fresno	Chert	24	13.9	2.2	1.73	0.12	
41COL34	Fresno	Chert	29	15	5	1.93	0.17	
41COL34	Fresno	Chert	31	15	5	2.07	0.16	
41COL34	Fresno	Chert	23	13	2	1.77	0.09	
41COL34	Fresno	Chert	19	13	2	1.46	0.1	
41COL34	Fresno	Chert	22	11.1	3.3	1.98	0.15	
41COL34	Fresno	Chert	17	16	3	1.06	0.18	
41COL34	Fresno	Chert	20.5	14.5	3.8	1.41	0.18	
41COL34	Fresno	Chert	15	12.1	3	1.24	0.2	
41COL34	Fresno	Chert	15.9	12.9	4	1.23	0.31	
41COL34	Fresno	Chert	15	14	2.5	1.07	0.17	
41COL34	Fresno	Chert	17	11.5	2.9	1.48	0.17	
41COL34	Fresno	Chert	15.9	10	1.9	1.59	0.16	
41COL34	Fresno	Quartzite	16	11.1	2.3	1.44	0.14	
41COL34	Fresno	Quartzite	14.7	13	2.8	1.13	0.19	
41COL34	Fresno	Chert	16.1	13.1	2.5	1.23	0.15	Tip
41COL34	Fresno	Obsidian	17.5	11.1	3.1	1.58	0.18	
41COL34	Fresno	Quartzite	20	15.5	3.2	1.29	0.16	
41COL34	Fresno	Quartzite	20	14.8	3	1.35	0.15	
41COL34	Fresno	Chert	16.1	11.1	3.5	1.45	0.21	Tip
41COL34	Fresno	Chert	19	13.5	2.5	1.41	0.13	
41COL34	Fresno	Chert	20	14.1	2.9	1.42	0.14	
41COL34	Fresno	Chert	18	15.3	3.2	1.18	0.18	
41COL34	Fresno	Chert	31.5	15	4	2.1	0.13	
41COL34	Fresno	Chert	32	16.1	5	1.99	0.15	
41COL34	Fresno	Chert	28	17.1	7	1.64	0.25	
41COL34	Fresno	Chert	23	15	3	1.53	0.13	
41COL34	Fresno	Chert	24	14.4	5	1.67	0.21	
41COL34	Fresno	Chert	18	10	2.8	1.8	0.15	
41COL34	Fresno	Chert	18	14.1	1.8	1.28	0.1	
41COL34	Fresno	Chert	17	11	2.5	1.54	0.15	
41COL34	Fresno	Chert	18.2	10	2	1.82	0.11	
41COL34	Fresno	Chert	15	14.1	2.1	1.06	0.14	
41COL34	Fresno	Chert	14.4	10.1	1.9	1.42	0.13	
41RW2	Fresno	Chert	15.8	14.9	3.2	1.06	0.2	Tip
41RW2	Fresno	Chert	18	10.8	3	1.67	0.17	
41RW2	Fresno	Chert	17	15.4	2	1.16	0.12	Corner
41RW10	Fresno	Chert	24.9	15	2	1.66	0.08	
41KF42	Fresno	Chert	19.2	15.4	3.4	1.25	0.18	
41COL9	Washita	Chert	19	14	3.1	1.36	0.16	

Appendix I: East Fork Arrow Point Measurements

Site	Arrow Point Type	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	L:W	T:L	Damage
41COL34	Washita	Chert	20.9	14	3	1.49	0.14	
41COL34	Washita	Chert	15	12	2	1.3	0.13	Tip
41COL34	Washita	Chert	16	10.5	2.5	1.52	0.16	
41COL34	Washita	Chert	15	10.9	3.8	1.38	0.25	
41COL34	Washita	Chert	35.9	16	5.1	2.24	0.14	
41COL34	Washita	Chert	29.5	15	3.1	1.97	0.11	
41COL34	Washita	Chert	19.2	13.1	2.3	1.46	0.12	Tip
41COL34	Washita	Obsidian	21	12.9	2.8	1.63	0.13	
41COL34	Washita	Chert	16.5	9.5	2.8	1.74	0.17	Corner
41COL34	Washita	Chalcedony	17	12	3	1.42	0.18	
41COL34	Washita	Chert	26.2	9.2	2.6	2.84	0.1	
41COL34	Washita	Chert	21.1	15	2.6	1.41	0.12	
41COL34	Washita	Chert	21.5	15	3.1	1.43	0.14	
41COL34	Washita	Chert	19.8	18	2.8	1.1	0.14	
41COL34	Washita	Chert	20	15.9	3	1.26	0.15	
41COL34	Washita	Chert	19	12.2	2.4	1.56	0.13	
41COL34	Washita	Chert	18	11.4	3	1.67	0.17	
41COL34	Washita	Chert	30	20.2	3.5	1.48	0.12	
41COL34	Washita	Chert	30.8	17.5	3.1	1.76	0.1	Corner
41COL34	Washita	Chert	18.1	15	3.2	1.21	0.18	
41COL66	Washita	Quartzite	15	10.5	3.4	1.63	0.23	Tip
41COL167	Washita	Chert	15	11.5	2	1.3	0.13	
41COL167	Washita	Chert	18.5	14.8	4	1.25	0.22	
41RW2	Washita	Chert	21.1	14.9	3.1	1.42	0.15	
41COL34	Harrell	Chalcedony	20.4	15	2.1	1.36	0.1	Tip
41COL34	Harrell	Chert	14.9	12	2.1	1.24	0.14	
41COL34	Harrell	Chert	22.1	14.5	2.3	1.52	0.1	Corner
41COL34	Harrell	Chert	20.9	15.1	2.4	1.38	0.12	Tip
41COL34	Harrell	Chert	19.7	17	2	1.16	0.1	Tip
41COL34	Harrell	Chert	23.1	14.7	2	1.57	0.09	Corner

EAST FORK LARGE PROJECTILE POINTS

Wilson W. Crook, III and Mark D. Hughston

Introduction

A rare but consistent component of the Late Prehistoric sites along the East Fork and its tributaries is the presence of very large (80-140 cm) projectile points, that may even possibly be spear points. The term "large" is used here to distinguish these points from other dart points found in East Fork sites; the latter typically being 60 mm or less in length. These large points are not common and have only been found at the largest sites with typically one or at the most three specimens from any single site (Harris 1936; Crook and Hughston 2008, 2015). They are generally well-made with rectangular stems and broad shoulders. The lateral edges of the blade are often very long and straight. If placed in a typology, they broadly fit into either Delhi, Pontchartrain or Pogo type points, but it is by no means certain that they actually are any of these types, just that they outwardly resemble them. Some of these points are made from local quartzite or petrified wood but most are made from high quality chert, typically Edwards chert. This paper serves to record these unusually large points and speculates on their use / function within the East Fork Late Prehistoric.

Description and Distribution

A total of nine very large projectile points / spear points have been recorded from six sites along the East Fork. These sites include Branch (41COL9) (three specimens), Upper Farmersville (421COL34) (two specimens), and Sister Grove Creek (41COL36) (one specimen) in Collin County; Lower Rockwall (41RW1) (one specimen) and Upper Rockwall (41RW2) (one specimen) in Rockwall County; and Gilkey Hill (41KF42/41DL406) (one specimen) in Dallas and Kaufman counties (the site is situated on either side of the Dallas-Kaufman county line and thus has two site numbers). In terms of both total artifacts recovered from the site as well as aerial extent of the occupation, these sites represent six of the largest sites along the East Fork (70% of the total known artifacts from the district) (Crook and Hughston 2015).

Of the nine large projectile point specimens, seven are complete; the remaining two specimens are broken at the junction of the stem with the blade. All nine points have large, leaf-shaped blades with edges that are generally straight to slightly convex. Shoulders are square to curved; well-defined barbs are absent. The stems are generally straight with straight bases. Basal grinding is completely absent. Total length varies from about 80 to 140 mm with the average being between 90-100 mm. Widths with one exception vary from 22-35 mm (average 30 mm) yielding a length to width ratio of about 3:1. Thickness varies from 5.5 to 12 mm with the average being about 9 mm (Table 1). Stem length and widths are typically near equidimensional with the average being approximately 15 x 15 mm. These characteristics are generally shared by Delhi, Pontchartrain and Pogo points as described by Suhm and Krieger (1954) and Suhm and Jelks (1962). Examples of

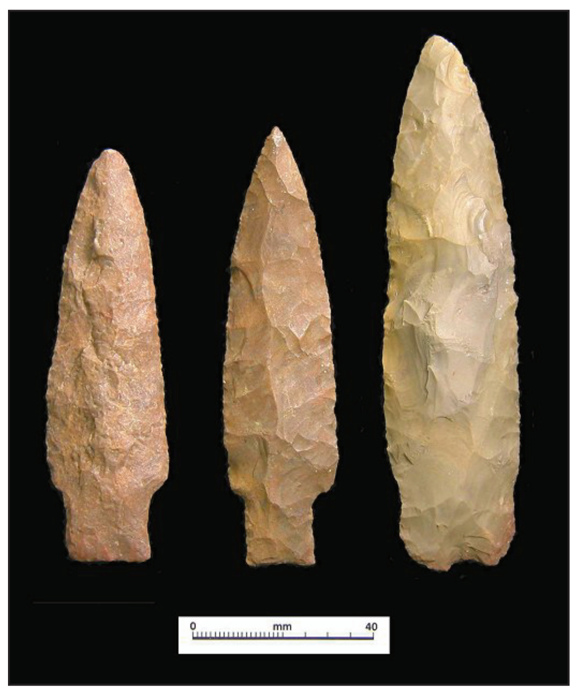

Figure 1. Large dart or spear points from various East Fork sites. L to R: Branch, Upper Farmersville, Lower Rockwall. (Photo by Laura Nightengale).

Table 1. East Fork Large Projectile Point Measurements

Site	Lithic Material	Length (mm)	Width (mm)	Thickness (mm)	Stem Length	Stem Width
41COL9	Chert	88.9	28	7.1	19.5	17.1
41COL9	Petrified Wood	90.2	26.1	10	16	18.1
41COL9	Quartzite	78.1*	34.9	8	0	0
41COL34	Chert	96.3	25	8.1	15.1	15
41COL34	Chert	98.9*	22.7	11.3	0	0
41COL36	Chert	79.8	26.9	5.5	10	13
41RW1	Chert	117	29.9	12.3	0	0
41RW2	Chert	90.2	21.7	10	15	11.9
41KF42	Chert	140	51.7	7.6	15.5	11.9
Average		100.3 (n = 7)	29.6 (n = 9)	8.9 (n = 9)	15.2 (n = 6)	15.2 (n = 6)

** Projectile point broken at stem; total length and stem length / width could not be measured.*

three of the large East Fork points are shown in Figure 1.

One of the projectile points which has a broken stem has been partially re-based into a square stemmed point (see Figure 1). The other large point which differs from the others described herein is the one recovered from the Gilkey Hill site (Harris 1942; Crook 2011) (Figure 2). This "point" is 140 mm in length with a width of nearly 52 mm. It has a relatively narrow stem (15.5 mm in length by 11.9 mm in width) for such a large point and may actually be a basal-tang knife as opposed to a projectile point.

The large projectile points appear to have been constructed primarily from percussion flaking techniques; only one point from Upper Farmersville and one from Sister Grove Creek show any significant retouch via pressure flaking. As mentioned above, seven of the nine specimens are constructed from a high quality chert which is not present along the East Fork or most of the North Central Texas area (Crook and Hughston 2015). All of these chert points fluoresce a bright lemon-yellow to orange color under both high and low energy UV radiation. This color and type of brilliant fluorescence is characteristic of cherts from the Edwards Plateau of Central Texas (Crook and Williams 2013; Williams and Crook 2013). Additionally, several of the points showed faint reddish coloration of the chert which is diagnostic of the lithic material having been heat treated.

A detailed examination of the nine large points under high magnification (80-200X) failed to demonstrate any conclusive wear patterns on any of the edges or tips. Minor polish characteristic of hafting was observed on the stems of several of the specimens but there was no visible polish or striations on any of the blades.

Conclusions

The presence of a few of these unusually large projectile points has been long known from Late Prehistoric sites along the East Fork and its tributaries (Harris 1936, 1942, 1948; Stephenson 1952; Harris and Suhm 1963; Crook 2011; Crook and Hughston 2009, 2015). They have generally been described as dart points, spear points or knives without any real study as to use-wear.

Figure 2. Large projectile point or basal-tanged knife from the Gilkey Hill site in Dallas / Kaufman County, Texas.

Seven of the nine known large points from the East Fork are constructed from a high quality chert; the other two from a heat-treated fine-grained quartzite and a highly-silicified petrified wood. Both the chert and the high quality petrified wood are not indigenous to the East Fork and represent importation either of the raw material or the completed artifact from outside the region. Edwards Plateau chert in particular was typically used and re-used in East Fork sites with virtually every flake turned into some functional tool (Crook and Hughston 2015). Thus to expend so much chert into a single artifact highlights their importance.

The lack of definite wear patterns on the blades of the artifacts suggests that they may have served a ceremonial as opposed to functional purpose. This suggestion is further underscored by their relative lack of abundance across the East Fork district. Of the nearly 19,000 lithic artifacts recorded from East Fork sites, only nine large projectile points have been recovered. It is significant to note that none of the large East Fork points was found in association with a burial.

Known distribution pattern of the points conforms directly to the larger Late Prehistoric sites of the East Fork. A similar large point, described as a Pogo point, was found in a burial at the Younger site in Marion County to the east of the East Fork (Perttula et al. 2012). This occurrence stands out as the point was found alongside a number of Caddo ceramics in the burial highlighting its importance. The occurrences in East Fork sites suggest they may have been symbols of power as opposed to functional tools. As such, they may represent significant artifacts.

Acknowledgements

The authors are indebted to a number of individuals and institutions who made their collections available as part of this analysis including Dr. James Krakker of the National Museum of Natural History, Anthropology Department, Archeology Division (R. K. Harris Collection), Laura Nightengale of the Texas Archeological Research Laboratory, Southern Methodist University, and Mr. John McCraw of McKinney, Texas. Laura Nightengale also took the photograph of the large points which is shown as Figure 1 above.

References Cited

Crook, Wilson W., III
2011 The Gilkey Hill Site (41KF42/41DL406): A Large Late Prehistoric Occupation in Dallas County, Texas. *Archeological Journal of the Texas Prairie-Savannah* 1(1):9-17.

Crook, Wilson W. III and Mark D. Hughston
2008 The Late Prehistoric of the East Fork of the Trinity River: A Redefinition of the Wylie Focus. Paper presented at the Texas Archeological Society 79th Annual Meeting, October 24-25, Lubbock.

2009 The Upper Farmersville Site (41COL34): A Large Diagnostic Late Prehistoric Occupation in Collin County, Texas. *The Record* 56(1):25-46, Dallas Archeological Society, Dallas.

2015 *The Late Prehistoric of the East Fork: A Redefinition of Cultural Concepts Along the East Fork of the Trinity River, North Central Texas*. CreateSpace, a DBA of On-Demand Publishing, LLC (an Amazon Company), Charleston, South Carolina.

Crook, Wilson W. III and Thomas J. Williams
2013 The Presence of Gault-Ft. Hood Chert at the Brushy Creek Clovis Site (41HU74), Hunt County, Texas. Paper presented at the Paleoamerican Odyssey Conference, October 17-19, Santa Fe.

Harris, R. K.
1936 Indian Campsites of the Upper Trinity River Drainage. *Bulletin of the Texas Archeological and Paleontological Society*, Vol. 8, pp. 112-133.

1942 The Gilkey Hill Pottery Site. *The Record* 3(9):48-53, Dallas Archeological Society, Dallas.

1948 A Pottery Site Near Farmersville, Texas. *The Record*, Dallas Archeological Society, Vol. 6, No. 10, pp. 38-45.

Harris, R. K. and Dee Ann Suhm (Appendices by Robert Hatzenbuehler, R. K. Harris, Mark E. Huff, Jr. and Norman Biggs)
1963 An Appraisal of the Archeological Resources of Forney Reservoir, Collin, Dallas, Kaufman and Rockwall Counties, Texas. *Report Submitted to the National Park Service* by the Archeological Salvage Project, University of Texas, Austin.

Perttula, Timothy K., Mark Walters and Bo Nelson

2012 The Younger Site (41MR6), Marion County, Texas. *Journal of Northeast Texas Archeology* 38:1-20.

Stephenson, Robert L.
1952 The Hogge Bridge Site and the Wylie Focus. *American Antiquity* 17(4): 299-312.

Suhm, Dee Ann and Alex D. Krieger, with collaboration of Edward B. Jelks
1954 An Introductory Handbook of Texas Archeology. *Bulletin of the Texas Archeological Society* 25:1-562.

Suhm, Dee Ann and Edward B. Jelks (editors)
1962 *Handbook of Texas Archeology: Type Descriptions*. Texas Archeological Society, Special Publications, No. 1, and the Texas Memorial Museum, Bulletin No. 4, Austin.

Williams, Thomas J. and Wilson W. Crook, III
2013 Geochemical Analysis of Primary Chert Outcrops from the Edwards Plateau: A Methodological Approach for the Use of pXRF in Material Sourcing. Paper presented at the 84th Annual Meeting of the Texas Archeological Society, October 25-27, Del Rio.

TUBULAR STONE BEADS FROM SITES 41JP96 AND 41JP135, JASPER COUNTY, TEXAS

Michael S. Woods

Introduction

The purpose of this paper is four-fold: (1) determine the distribution patterns of tubular stone beads in Texas, (2) attempt to determine the origins of the culture and or people who crafted these polished tubular stone beads, (3) look at the evidence for potential regional trade or exchange networks in the existing literature, and (4) consider a theory of local craft specialization or manufacture for at least one of the reported sites.

The two major sites which will be discussed, 41JP96 and 41JP135, have both been previously recorded with Texas Archeological Research Laboratory (TARL). However, when the author was working with his friend and archeological mentor, the late Mr. D.T. Kent, Jr., we discovered in his collection some interesting, potentially "exotic" artifacts for this East Texas area which needed to be investigated further. The author has since sent an addendum to TARL for each of the aforementioned sites to include items found by Kent at both of those sites, in addition to other sites Kent located in the adjacent areas. Each of the unique artifacts described herein was investigated in the literature as well as shown to various archeological friends in an attempt to learn if these tubular stone beads are the product of trade or technological exchange.

Discussion

Archeologically, the area of two sites in Jasper County is in the Eastern zone of the Southeast Texas Region (Patterson 1995). Both of the sites occur on the banks of the Neches River, approximately 1.8 km distance apart. During the time of their occupation, the area may have been one contiguous site which was occupied seasonally for a number of years. The artifacts included in this study from the D.T. Kent, Jr. surface collection are listed in Table 1.

The tubular stone beads from both 41JP96 and 41JP135 are shown in Figures 1-4 below. Physical measurements of the stone beads are shown in Table 2.

Distribution Patterns Across Texas

To determine the distribution pattern for tubular stone beads across Texas, I started by looking for reported occurrences in adjacent areas of Southeast Texas near the location of two sites in Jasper County. Additionally, I looked for similar artifacts at sites in some of the major counties on the western side of the Sabine River in an attempt to determine potential trade patterns or site manufacturing practices. This effort was achieved with the help of local Archeological Steward and friend Louis Aulbach (personal

Table 1. The artifacts from the D.T. Kent, Jr. surface collection.

Texas Site No.	Kent Artifact No.	Type Artifact
41JP96	12H-86	Tubular Stone Bead (TSB)
41JP96	12H-1972	TSB
41JP96	12H-1576	TSB
41JP96	12H-700	TSB
41JP96	12H-622	TSB
41JP96	12H-983	TSB (with defect)
41JP96	12H-703	Stone Bead "Preform"
41JP135	12B-70	TSB

Figure 1. Tubular Stone Beads from site 41JP96.

communications, 2016) as well as Jonathan Jarvis, Associate Director, Texas Archeological Research Laboratory (personal communications, 2016) who both ran queries in the Texas Archeological Site Atlas for the author. In addition, one other site (41JP65) was found in the literature to contain a "stone bead", which later was identified as a "tubular stone bead" similar to the ones of interest from the Kent collection (Kenmotsu and Perttula 1993). This site is located only 1.7 km from site 41JP96 and 1.5 km from site 41JP135.

The results of my initial query of sites from other Texas counties with sites containing tubular stone beads is shown below (Table 3). The counties were chosen randomly beginning with the counties of known tubular stone beads from the Kent surface collection north, adjacent to the Sabine River to counties in northeast Texas:

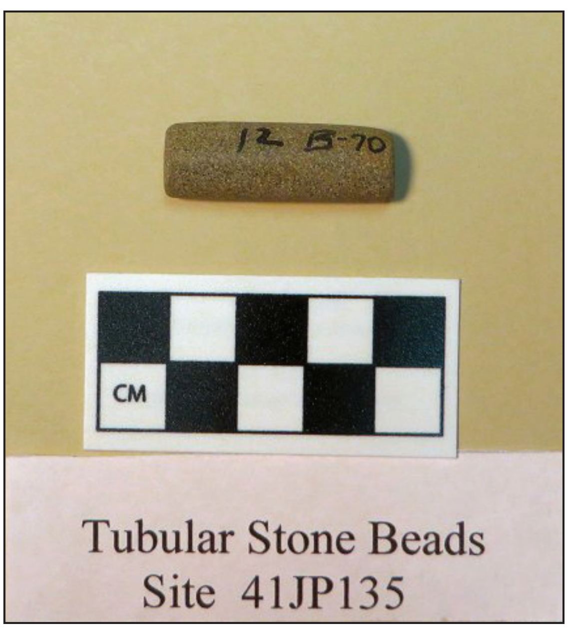

Figure 2. Tubular Stone Bead from site 41JP135.

Figure 3. Stone Bead with Defective Drill Angle, D. T. Kent, Jr. Artifact #12H-983, Site 41JP96.

The following Texas counties were also searched for sites containing tubular stone beads but were not found to have any ground stone beads reported:

Anderson
Henderson
Houston
Jefferson
Orange
Polk
Tyler
Smith
Trinity
Van Zandt

Figure 4. Stone Bead Preform (?) from Site 41JP96. Note Peck Marks on Surface.

Table 2. Physical Measurements of Tubular Stone Beads from Sites 41JP96 and 41JP135, Jasper County, Texas.

Site	Kent Artifact Number	Weight (gm)	Length (mm)	Left Side Diameter[1] (mm)	Right Side Diameter[1] (mm)	Middle Diameter (mm)	Left Inside Diameter[2] (mm)	Right Inside Diameter[2] (mm)	Lithic Material
41JP135	12B-70	6.5	32.97	10.8	10.86	10.91	4.46	4.28	Quartzite
41JP96	12H-1576	4.5	23.29	11.54	10.89	11.74	3.82	3.21	Limestone
41JP96	12H-700	8	45.4	10.97	10.75	11.12	4.21	4.57	Quartzite
41JP96	12H-86	12.7	33.48	14.71	13.64	14.16	3.61	4.03	Ironstone / Red Jasper
41JP96	12H-622	13	37.25	15.76	15.82	17.35	4.27	4.33	Quartzite
41JP96	12H-983	6.7	32.22	12.85	12.31	13.18	5.38	4.88	Sandstone
41JP96	12H-1972	11	31.6	14.53	14.13	14.66	3.79	4.59	Quartzite
41JP96	12H-703	14.8	38.31	16.29	16.35	16.28	N/A[3]	N/A[3]	Unknown

1 Left and Right Side Diameter denoted as looking at artifact and reading labeled artifact number from left to right.
2 Left and Right Side Inside Diameters determined in the same manner.
3 Complete dimensions unknown as artifact is an undrilled preform.

A second query on other sites in Texas where tubular stone beads were reported yielded two results:

Brewster	41BS758 - #1 – TSB (Kaolinite TSB)
Cameron	41CF2 - #1 – TSB

The author also checked some major sites reported from the early 1960’s when the Corps of Engineers was building Lake Sam Rayburn to determine if any of those sites contained tubular stone beads (TSBs) (Duffield 1963; Jelks 1965). Neither of those authors reported any TSBs in any site excavations or as inclusions as “exotic” grave goods during those major excavations which were in the near vicinity of the two sites in question.

To further determine the distribution pattern of TSBs across Texas, several other sources were checked. These included summaries of sites in Central Texas (Collins 2004), the Southern High Plains area (Johnson et al. 2004), and the Palo Duro Complex region (Boyd, 2004). No additional reported occurrences of TSBs was found.

Another source that was reviewed for potential TSBs was the mortuary practices from the Rio Grande Plains area to the Central Coastal Plains (Perttula, 2001). Again, there was no mention of tubular stone beads in any of the burials described by Perttula (2001).

Thus it appears from the literature that the distribution pattern of tubular stone beads is limited to a few counties in the central part of the eastern portion of the Southeast Texas area. However, the random East Texas county queries mentioned above may have been too “random” and missed distribution in some of the counties not queried. There may, potentially, be more of the eastern Texas counties containing sites which have contained TSBs and were missed when the author randomly selected the ones for query, and or there may be TSB’s which have been found at sites and not yet reported to TARL via site reports. Potentially, there may have been some sites with TSB’s documented in the Texas Site Atlas which were missed during the queries due to nomenclature of the artifact on the site report when reported to TARL.

Origins of the Cultures and or People Who Crafted Tubular Stone Beads

In an effort to find an origin for tubular stone bead technology, I questioned some friends and experts in Texas archeology including Tim Perttula, Tom Middlebrook and Wilson “Dub” Crook. They pointed the author in the direction of the Poverty Point site located in northeastern Louisiana as a possible starting point. The Poverty Point site is a major, late Archaic site, which was characterized by a significant “lapidary industry” (Webb, 1982a). In reviewing the literature and investigations about the

Table 3. Texas Counties Queried for Sites with Tubular Stone Beads

Texas Counties Queried	Sites with Results (Tubular Stone Bead)
	41JP65 - #1 Tubular Stone Bead(TSB)
Jasper	41JP96 - #6 TSB
	41JP135 - #1 TSB
Rusk	41RK254 - #1 (?) TSB
	41RK2 – Possible TSB
Harrison	41HS240 - #1 – Barrel-Shaped TSB
Bowie	41BW104 - #1 – Possible TSB
	41BW250 - #1 – Possible TSB
Cherokee	41CE20 - #1 –Unfinished TSB (Drilled from
	both ends but not completely through)
Newton	None
Sabine	None
San Augustine	None
Hardin	None
Tyler	None
Nacogdoches	None
Angelina	None
Shelby	None
Panola	None
Marion	None
Cass	None
Red River	None

Poverty Point people, I also reviewed potential precursors to the Poverty Point people and their genesis and technology development.

Some of the early radiocarbon dates which were published from the Poverty Point site in Louisiana and compared to the Upper Mississippi River Valley Adena culture placed these two cultures in "partial contemporaneity" (Webb, 1982b); therefore, it is possible that there was either a sharing of technology, sharing of thought processes, or migration of people from one culture to another resulting in a sharing of cultural ideology. Further, Gibson (1980) hypothesized that the Poverty Point site could have been a potential "gateway community" receiving certain raw materials from the northern region of the Mississippi River for distribution to other areas further south of the Poverty Point site. In discussing possible trade networks between the Upper Mississippi Valley and Poverty Point, Gibson (1979) noted:

> "Although demonstrative data are lacking in many cases, it also seems that these isolated localities have another environmental regularity in common. They appear to lie along or near a linked network of rivers and bayous which must have functioned as routes of transportation, communication, and trade."

I believe that Webb (1982) had the most succinct summary of the Poverty Point lapidary industry and origins stating:

> "The Late Archaic innovation of grinding stone tools enhanced their efficiency and va-

riety… Stone grinding, cutting, drilling, and polishing opened avenues of esoteric expression in ornaments: beads, pendants, zoomorphic and effigy forms were made by Archaic peoples. Centers for the manufacture of ornaments and esoteric objects, made of carefully selected materials, seem to have existed in the Yazoo Basin, around Catahoula Lake in central Louisiana, in southwestern Arkansas, on the Tennessee River, and in southern Alabama. Poverty Point people were heir to this tradition."

Thus it is relatively clear that there was an exchange of cultural ideas and or sharing of tool or craft ideas down the Mississippi River Valley area to the Poverty Point site in and around Louisiana. However, at this point it is difficult to say if there was any kind of cultural relationship or additional sharing of cultural ideology in tools or crafts from Poverty Point in a western direction to the Jasper county area of Southeast Texas.

Evidence of Potential Regional Trade or Exchange Networks

In order to better understand a plausible theory of how these TSBs were located where found, I explored the change in population dynamics and a change in climatic conditions from the Middle Archaic to the Late Archaic time period. It appears that beginning in the Middle Archaic period, there was a substantial increase in the indigenous population across Texas and Louisiana (Perttula and Bruseth 1990:94; Anderson et al. 2003:307; Patterson 1995:246). The increase in populations is believed to have been due to an overall change in climate to warmer summers and colder winters (Anderson et al. 2003:369) which, among other factors, contributed to the prior smaller groups of people beginning to have more "residential stability, sedentary in certain favorable environments" (Webb, 1982b, 3). This more sedentary, residential lifestyle with larger populations seems to have been somewhat similar from the southeastern portion of Texas through at least the eastern portion of Louisiana and probably further east.

Given a more sedentary lifestyle of the people of this time period, the author began to look for evidence of possible trade or exchange of goods in an attempt to determine if the tubular stone beads could have possibly been traded or exchanged for goods from the Poverty Point people or the areas where there is documented lapidary industrial sites near the Poverty Point peoples. Perttula and Bruseth (1990:93-121) discussed possible ideas of trade and exchange of goods in the eastern Texas area and into Louisiana, specifically the Poverty Point area of northeastern Louisiana. They indicate that there did not seem to be any evidence of direct trade or exchange from the Poverty Point area of Louisiana directly to East Texas during the Middle to Late Archaic. Perttula did propose an idea that some objects from the Poverty Point lapidary industrial areas may have ended up in East Texas due to an "intermittent, down-the-line exchange system" (Perttula and Bruseth 1990:101), which is different from a direct trade and or exchange system.

Conclusions

We are still left with the remaining question(s) of how and or possibly why did these tubular stone beads came to exist at these sites, 41JP96 and 41JP135, in Jasper, County Texas. Looking at the evidence we have from these two sites, several interesting observations can be made. At site 41JP96, one of the tubular stone beads had a drilling defect which came out of the side of the bead rather than being drilled to meet in the center of the bead (see Figure 3). In addition, there is one bead which appears to be a preform (see Figure 4). Both of these artifacts strongly support the concept that at least some of the tubular stone beads were being manufactured locally and were not the result of trade. In addition to these two beads, there is another site recorded by TARL, 41JP65, which is approximately 1.7 km north of site 41JP96 and approximately 1.5 km northwest of site 41JP135, where a tubular, red jasper, polished stone bead was excavated from a test pit at the same level as an "unfinished Palmillas" dart point (J. H. Jarvis, personal communication, 2016). The excavated tubular stone bead from 41JP65 found in association with the Palmillas dart point would place the tubular stone beads from this area in the Middle to Late Archaic according to the lithic chronology for the area (Patterson 1995:251; Turner and Hester 1999:167). Other reported sites in Texas with TSB's proceeding north from Jasper County, Texas are shown in Table 4.

The following are Louisiana and other sites of interest which contain similar tubular stone beads (other than Poverty Point Site and adjacent Poverty Point "satellite" sites):

1. 16IB63 (Allen Darby Collection – Surface Collection) (Louisiana Site)
   #1 – Red Jasper Bead Preform
   #2 – Red Jasper Tubular Beads
   #1 – Indeterminate Stone Tubular Bead (McGimsey 2006)

Table 4. Other reported sites in Texas with TSB's proceeding north from Jasper County, Texas.

Texas County	Site No.	Tubular Stone Bead
Jasper	41JP65	#1 – Tubular Stone Bead (TSB)
	41JP96	#6 – TSB
		#1 - Chert Stone Bead Preform
	41JP135	#1 – TSB
Cherokee	41CE20	#1 – Unfinished TSB (Drilled from both ends)
Rusk	41RK2	#1 – Possible TSB
	41RK254	#1 – (?) Possible TSB
Harrison	41HS240	#1 – Barrel Shaped TSB
Bowie	41BW104	#1 – Possible TSB
	41BW250	#1 – Possible TSB
"Outlier" Texas Counties		
Brewster	41BS758	#1 – TSB (Kaolinite)
Cameron	41CF2	#1 – TSB

2. Cad Mound: A Stone Bead Locus in East Central Louisiana (Gibson 1968)

3. Beads, Microdrills, Bifaces, and Blades From Watson Brake (Louisiana Site) (Johnson 2000)

4. Prehistoric Bead Manufacture: The Loosa Yokena Site, Warren Co, Mississippi (McGahey and Dockery 2004)

As the author was plotting the previously listed Texas counties with sites reporting TSB's from the Texas Archeological Site Atlas, there seemed to be a pattern developing with the counties listed. Observing the counties with reported occurrences of tubular stone beads, it is apparent that these counties are either adjacent to or very near the Neches River and or the headwaters of the Neches River. We already know from prior research at Poverty Point that the major rivers, creeks and other waterways offered an excellent mode of transportation, communication, and trade (Gibson, 1979). In light of this, the author proposes that the technology and information about the preparation of ground stone beads, adornments, and fetishes likely moved from the north down the Neches River Valley, much in the same manner as this technological information appears to be transferred from the north down the Mississippi River Valley to the Poverty Point area. The Neches River Valley begins to the north of Jasper County with the headwaters beginning in Van Zandt County and flowing southeast for approximately 416 miles to empty into the Gulf of Mexico (Texas Parks and Wildlife 2016). This is one of the major river valleys in East Texas and could have easily supported the transportation of both people and technology from the north to the East Texas area.

The author further proposes that the tubular stone beads located around the areas of the sites 41JP65, 41JP96, and 41JP135 were manufactured locally at these sites. To provide further support for the idea of local manufacture of these types of beads, I looked at two specific tubular stone bead production sites (Cad Mound in East Central Louisiana and Watson Brake in Louisiana) and compared the production attributes with those of sites in Jasper County. At the Cad Mound site in East Central Louisiana, Gibson (1968) gives a complete, in depth description of the bead production process which will only be summarized here to show a comparison to the evidence at the two Jasper county sites being investigated:

> "All the steps of the stone bead manufacturing process were found at Cad. The process involved an intimate knowledge of pecking, grinding, sawing, drilling, and polishing techniques. Materials utilized were vari-colored quartzites, predominately shades of red and purple, red jasper sometimes banded with

> black, and brown chert. Tan and green siltstones occasionally provided raw materials."
>
> "The initial step in processing the stone involved rough pecking and grinding of the edges of the selected pebble in order to achieve a rectanguloid shape."
>
> "The roughly shaped "block" was then cut by flake saws… Blanks were subjected to further grinding until tubular or barrel shapes were obtained ...Holes drilled in the tubular blanks were cylindrical ...Holes were drilled with a rotary motion of the drill for encircling striations etched into the bore wall of the bead were often visible… Subsequent grinding and polishing completed the beads and often gave a low lustrous finish. Finished beads ranged from 30 mm to 14 mm in length, and 13 mm to 7 mm in maximum diameter. Perforation diameter ranged from 6 mm to 2.5 mm and was usually slightly tapering. Tubular and barrel shapes were the only forms found" (Gibson, 1968:5-9).

The actual drill production and utilization at Cad Mound was not discussed by Gibson except to say that "These tools were not represented in collections from the site which may suggest that they were made of a perishable material" (Gibson 1968:11). The author's guess as to why the drills from the Cad Mound site were not found is due to their very small size rather than being made of perishable material. At the Watson Brake site in Louisiana, the excavators utilized a 1/8 inch screen to dry screen the soils specifically to capture small lithic artifacts (Johnson 2000:95). The microdrills recovered from the Watson Brake site were so small (average size: 9.2 x 2.7 x 2.1 mm) that they could easily have been lost or mistaken for very small debitage if one were not specifically looking for those artifacts (Johnson 2000:99). The lack of small, chert microdrill recovery at most sites is further supported by Hadley and Carr (2015:81) who stated that "due to the small size of microdrills, some form of fine screening is necessary for their recovery, but any form of fine screening is rare on lithic sites in the Southeast."

The stone bead production sequence was much more defined at the Watson Brake site (16OU175). This was a Middle Archaic mound group site in northeast Louisiana. The site is important from the standpoint that there was an entire tubular stone bead production sequence identified from the test excavations at this site which the author will attempt to compare to the sites in Jasper County, thus making the proposal that the beads at the Jasper county site were made at those sites as well.

The seven chert beads recovered during excavation of the Watson Brake site represent the entire spectrum of stone bead production including initial stage, intermediate stage, and final stages in the "production trajectory" (Johnson 2000:100). It is noted here that the beads excavated at the Watson Brake site were constructed of "chert" whereas and the beads from 41JP96 and 41JP135 are made from other lithic materials such as quartzite, sandstone and limestone. However, the author believes that the stone bead production sequence would have been the same or of a similar technological sequence for any lithic medium given the final production of the tubular stone beads from both Watson Brake and the Cad Mound Site are almost identical to the tubular stone beads at both 41JP96 and 41JP135 as well as 41JP65. The four steps in the production sequence identified from Watson Brake site are as follows (Johnson 2000:100):

> "Stage 1 commenced when a gravel was shaped into a roughly cylindrical form using bifacial or trifacial flaking. The apparent goal was to produce a blank as thick as it is wide, and the biface edge angles are very close to 90 degrees.
>
> Stage 2 represents the initial grinding that transformed the cross section from square or triangular to round or oval.
>
> Stage 3 is hypothetical; there are no examples in the collection (from Watson Brake). At this stage, grinding would have been completed.
>
> Stage 4 is the point at which the bead was drilled."

Evidence to substantiate that the drilling of these stone beads was indeed performed with chert microdrills has been documented from the Keenan Bead Cache in Jefferson Davis County, Mississippi, where a broken chert drill was found still inside a jasper bead (Connaway 1982:69).

Another site which shows a similar bead production sequence from the Middle to Late Archaic is the John Forrest (22CB623) site in Claiborne County, Mississippi (Hadley and Carr 2015). Hadley and Carr postulated the concept of "craft specialization", whereby the person or persons constructing the chert stone beads at this site may have been completely dedicated to the production of these chert beads while the other people with whom they lived were supporting them while they made the beads This site, again, has an identifiable production sequence for the chert bead production as follows:

> "The first step in bead manufacture was selection of appropriately sized gravels and knapping these into trifaces or quadfaces so that each face is roughly equal in size… The second stage involved grinding the chipped edges to transform the cross section from triangular/square to round and to smooth the ends. The final stage of manufacture was drilling…" (Hadley and Carr 2015:80)

In addition at this site, there was a subset of greenstone beads discovered and a possible production sequence was theorized for them as well which is:

> "The presumed first stage for greenstone bead production was grinding and cutting the pebbles into the desired shape… Drilling was the second and final stage of the ground bead manufacture." (Hadley and Carr 2015:80)

In conclusion, the author has presented several, well-known, documented archeological sites from the Middle to Late Archaic time period where tubular stone beads have been produced with a specific manufacturing sequences. I had begun this research in the hopes of answering several questions about how and why these particular tubular stone ground beads were at the sites 41JP96 and 41JP135 in Jasper County, Texas. After a somewhat lengthy review of as much pertinent archeological literature as possible, I propose several hypotheses about the genesis of these tubular stone beads at the Jasper County sites. These ideas must be prefaced with the facts that all of the artifacts, including the tubular stone beads, were surface collected from sites 41JP96 and 41JP135 over several years as opposed to the other sites mentioned above which were either from controlled excavations or controlled surface collections, both of which involved tighter or more control of time and spacial reference. That being said, I propose that the tubular stone beads at both 41JP96 and 41JP135 were crafted at those particular sites. I further propose that the technology for this bead making process was likely brought down the Neches River Valley from the north to these sites based on the distribution pattern of known up-river sites containing similar artifacts. To further substantiate the theory that these tubular stone beads were made at these sites, the recovered beads represent an almost entire sequence of manufacturing steps from preform to completed drilled bead. When combined with the manufacturing sequences observed at other Middle to Late Archaic sites in Louisiana and Mississippi, the proposed stone bead production sequence for the Jasper county beads is as follows:

- Step 1 – The selection of oblong/tear-drop shaped stones/pebbles to begin the production sequence
  Evidence: Kent's artifact #12H-703 Bead Preform (Site 41JP96)
  The rectangular stone has "peck marks" on all four sides of the stone to begin the reduction/shaping of the bead.

- Step 2 - The smoothing of the bead with some abrasive material (sandstone, sand, etc.) to shape the bead as desired.
  Evidence: Kent's artifact #12B-449 (Site 41JP135) – Circular Sandstone (5 cm x 1.9 cm) – Mano ?, or it could be utilized to grind/shape beads?

- Step 3 - Drilling the bi-directional hole in the bead from each end. To date there are no chert microdrills which were surface collected. This was probably due to the small size and similarity to the copious amounts of debitage in and around the sites.

  However, Kent's artifact #12H-983 (Site 41JP96) was found to have the holes from each end drilled at such an angle that hey did not meet in the middle of the bead, but rather they both came out the side of the bead.

Why would an "imperfectly" drilled bead be found at a site unless the manufacturer made a mistake during the production process? I further believe that with careful excavations and screening the soil with 1/16" hardware cloth, at or near 41JP96 and 41JP135, the very small microdrills similar to the ones utilized at the other major bead production sites (e.g. Watson Brake and John Forrest sites) would be recovered.

It is not my belief, at this time, that the present study can answer the question about "craft specialization" of stone bead manufacturing as proposed by Hadley and Carr (2015:71-98). This question would likely only be answered from a careful site excavation as opposed to a surface collection, such as is present from the Jasper County sites.

Lastly, the author finds it very difficult to believe that there have not been more of these tubular stone beads located and or reported in sites around Texas and more specifically in the eastern portion of Texas.

I would be very much interested in hearing from anyone with any information about these types of artifacts from any sites in Texas so that a better understanding of the originally posed questions could be answered.

Author Contact Information

The author would appreciate any information regarding sites where anyone has found similar tubular stone beads. The author can be reached by email: mikeswoods@aol.com

Acknowledgments

I would like to thank and remember my late brother, Paul Woods and his wife Becky, for their time helping me document some of D. T. Kent's sites and their encouragement to me to complete this report. I would also like to thank the members of the Houston Archeological Society who have encouraged and helped with this article, including Louis Aulbach, TAS Steward, who ran the queries in the Texas Archeological Site Atlas during my initial research, Linda Gorski, HAS President, and Wilson "Dub" Crook, Editor of the HAS Journal for his patience and gentle "nudging" for completion of, review and correction of this manuscript and for the identification of the stone material the pendants were made of. I would also like to thank Dr. Diana Greenlee, Poverty Point Archeologist who initially helped me with references about some important lapidary sites containing tubular stone beads in Louisiana. Also, Dr. Tim Pertulla and Tom Middlebrook for initial feedback about sites which may contain tubular stone beads in East Texas. Additionally, I am thankful to Dr. Jonathan Jarvis, Associate Director of TARL, who also ran queries of the Texas Archeological Site Atlas for me in my initial research of this paper.

I would also like to thank Elton Prewitt for his mentorship in East Texas archeological ideas and untold contributions to this and other projects. Last but not least by any means, I would like to remember my friend, the late Mr. D.T. Kent, Jr., for his mentorship in archeology thus promoting my interest in the field, the stories of East Texas which were always in abundance, and for his encouragement in archeology.

References

Anderson, David G. and Steven D. Smith
2003 *Archeology, History, and Predictive Modeling Research at Fort Polk 1972-2002*. The University of Alabama Press, Tuscaloosa.

Boyd, Douglas K.
2004 The Palo Duro Complex. In *The Prehistory of Texas*, edited by Timothy K. Perttula, pp. 296-330. Texas A&M University Anthropology Series No. 9. Texas A&M University Press, College Station.

Collins, Michael B.
2004 The Hunter-Gatherers of the Central and Southern Texas Prairies and Plains. In *The Prehistory of Texas*, edited by Timothy K. Perttula, pp. 101-126. Texas A&M University Anthropology Series No. 9. Texas A&M University Press, College Station.

Connaway, John
1982 The Keenan Bead Cache: Lawrence County, Mississippi. *Louisiana Archeology* 8:57-71.

Duffield, Lathel F.
1963 The Wolfshead Site: An Archaic-Neo-American Site in San Augustine County, Texas. *Bulletin of the Texas Archeological Society* 34:83-141. Texas Archeological Society, Austin.

Gibson, Jon L.
1968 Cad Mound: A Stone Bead Locus in East Central Louisiana. *Bulletin of the Texas Archeological Society* 38:1-17. Texas Archeological Society, Austin.

1979 Poverty Point Trade in South Central Louisiana: An Illustration from Beau Rivage. *Louisiana Archeology* 4:94.

1980 Speculations on the Origin and Development of Poverty Point Culture. In *Caddoan and Poverty Point Archeology: Essays in Honor of Clarence Hungerford Webb*, Edited by Jon L. Gibson. Louisiana Archeology 6.

Hadley, Alison M. and Phillip J. Carr
2015 Archaic Chert Beads and Craft Specialization: Application of an Organization of Technology Model. In *Exploring Southeastern Archeology*, edited by Patricia Galloway and Evan Peacock, pp. 71-98. University Press of Mississippi, Jackson.

Jelks, Edward B.
1963 The Archeology of McGee Bend Reservoir, Texas. *Unpublished Ph.D. Dissertation*. The Department of Anthropology, University of Texas at Austin.

Johnson, Eileen and Vance T. Holiday
2004 The Hunters and Farmers of the High Plains and Canyonlands. In *The Prehistory of Texas*, edited by Timothy K. Perttula, pp. 283-295. Texas A&M University Anthropology Series No. 9. Texas A&M University Press, College Station.

Johnson, Jay K.
2000 Beads, Microdrills, Bifaces, and Blades from Watson Brake. Southeastern Archeology 19(2):95-104.

Kenmotsu, Nancy A. and Timothy K. Perttula, Editors
1993 *Archeology in the Eastern Planning Region, Texas: A Planning Document*. Department of Antiquities Protection Cultural Resource Management Report 3, Texas Historical Commission, Austin.

McGahey, Samuel D. and David Dockery
2004 Prehistoric Bead manufacture: The Loosa Yokena Site, Warren County, Mississippi. *Mississippi Archeology* 40:3-29.

McGimsey, Chip
2006 The Allen Darby Collection from 16IB63. *Newsletter of the Louisiana Archeological Society* 34(3):15-18.

Patterson L. W.
1995 The Archeology of Southeast Texas. *Bulletin of the Texas Archeological Society* 66:239-264. Texas Archeological Society, Austin.

Perttula, Timothy K.
2001 Hunter-Gatherer Mortuary Practices in the Rio Grande Plains and Central Coastal Plains Archeological Regions of Texas. *La Tierra* 28(3&4):2-83.

Perttula, Timothy K. and James E. Bruseth
1990 Trade and Exchange in Eastern Texas, 1100 B.C. – A.D. 800. In *Exchange in the Lower Mississippi Valley and Contiguous Areas at 1100 B.C.*, edited by Jon L. Gibson, p. 101. Bulletin of the Louisiana Archeological Society 17:93-121.

Texas Parks and Wildlife
2016 An Analysis of Texas Waterways: A Report on the Physical Characteristics of Rivers, Streams, and Bayous in Texas. Major Waterways of East Texas. http://tpwd.texas.gov/publications/pwdpubs/pwd_rp_t3200_1047/07_e_tx_neches.phtml

Turner, Ellen S. and Thomas R. Hester
1999 *A Field Guide to Stone Artifacts of Texas Indians*. Gulf Publishing Book, Third Edition. Lanham, Maryland.

Webb, Clarence H.
1982 *The Poverty Point Culture*. Geoscience and Man, Vol. 17, 2nd Edition. Louisiana State University, Baton Rouge.

STONE PENDANTS FROM SITES 41JP66 AND 41JP96, JASPER COUNTY, TEXAS

Michael S. Woods

Introduction

The author examined two unique artifacts from two previously documented, adjacent sites in Jasper, County, Texas. The two artifacts were from the well-provenienced surface collection of the author's good friend and archeological mentor, the late Mr. D. T. Kent, Jr. Both of the sites, 41JP66 and 41JP96, have been previously recorded with the Texas Archeological Research Laboratory in Austin (TARL), but have since been updated by the author to include the artifacts which Mr. Kent collected at those sites.

Discussion

The area in which the sites are located, is archeologically defined by Patterson (1995:239-240), as the eastern zone of the Southeast Texas region of Texas.

The first artifact, with Kent's artifact number 12J-371, from site 41JP66, is a triangular, ground stone pendant (Figures 1 and 2). Unlike most pendants and or gorgets, the artifact has been "notched" rather than perforated in order to hold a string or cord (see Figures 1 and 2). The second artifact, with Kent's artifact number 12H-965, is from site 41JP96. While the artifact is incomplete, it has also been "notched" on the proximal (?) end and appears to also have been utilized as some sort of pendant as well (Figures 3 and 4). It is unclear if the artifact is a preform that broke during construction or was completed as a stone pendant and was broken at a later date during use. Physical measurements of both artifacts are presented in Table 1.

Ground stone artifacts in the eastern counties of Texas are somewhat rare and or are considered as exotic artifacts (see previous paper "Tubular Stone Beads From Sites 41JP96 and 41JP135, Jasper, County, Texas" in this HAS Journal issue) which one would expect to see as grave goods or mound inclusions (Perttula and Bruseth, 1990:101; Story et al. 1990). When ground stone artifacts are mentioned, one generally thinks of the Poverty Point site

Figure 1. Kent Collection Artifact #12J-371, Site 41JP66, obverse face.

Figure 2. Kent Collection Artifact #12J-371, Site 41JP66, reverse face.

Figure 3. Kent Collection Artifact #12H-965, Site 41JP96, obverse face.

Figure 4. Kent Collection Artifact #12H-965, Site 41JP96, reverse face.

in northeastern Louisiana in the Mississippi River Valley region (Webb 1982).

The author was interested in attempting to locate other sites in Texas in the same archeologically defined area which had reported stone pendants. My friend and Texas Historical Commission Archeological Steward, Louis Aulbach, (personal communication, March 20, 2016) ran queries for me in the Texas Archeological Site Atlas on several East Texas counties to identify the number of sites reported in those counties with pendants (see Table 2).

The author had hoped that this query of the Texas Archeological Site Atlas would produce more sites with pendants reported in order to obtain a better picture of distribution across this archeological area. However, the counties were just randomly selected from counties close to or adjacent to Jasper County. Another potential bias to the search may have been the way the author requested the query be performed utilizing the key search word "pendants" versus "ground stone pendant". Additionally, the way a site report was filled in by one researcher may have recorded "pendant" without the further description of "ground stone pendant" in the recording process.

It would be interesting and beneficial to attempt to place some sort of age range on these ground stone pendant artifacts from the Jasper county sites. It is generally accepted that throughout the South and Southeastern United States, during the Middle to late Archaic, there was a significant increase in population size (Perttula et al, 1990:94; Anderson et al. 2003:307; Patterson, 1995:246). Along with this increase in population size, there was also a change in social organization with the smaller groups of people transitioning to more "residential stability, sedentary in certain favorable environments" (Webb 1982:3). This more sedentary lifestyle had the potential for people to come together in certain adjacent areas for the sharing of ideas and exchange of technological and cultural information. Gibson (1979) has surmised that the exchange of information, communication and trade was facilitated in the Lower

Table 1. Physical Measurements of Stone Pendants from Sites 41JP66 and 41JP96, Jasper County, Texas

Site	Kent Artifact Number	Weight (gm)	Length (mm)	Top Width (mm)	Bottom Width (mm)	Lithic Material
41JP66	12J-371	5.5	40.41	8.41	33.13	Sandy Limestone
41JP96	12H-965	1.3	Unknown[1]	13.08	Unknown[1]	Sandstone

1 Complete dimensions unknown as artifact is broken.

Table 2. Sites Reported with Pendants

Texas County	Number of Sites Reported with Pendants
Jasper	2
Newton	0
Sabine	1
San Augustine	0
Hardin	0
Tyler	0
Nacogdoches	0
Angelina	0
Shelby	1

Mississippi Valley with the help of the vast waterways in that area. If so, a lapidary industrial technology could have been brought down the Neches River Valley from the north to the Jasper County area where these stone pendants were found. Other Mid-Archaic aged sites with established stone lapidary industries located east of Jasper County, such as the documented tubular stone bead production sites of the Watson Brake site (Johnson 2000), the John Forrest site (Hadley and Carr 2015) and others, give an approximate age range for the surface collected artifacts from the sites from Jasper County.

Quantifying and reviewing the identified diagnostic dart point types from each of the Jasper county sites where the pendants were found, helps to give a "rough" estimate of the surface collected artifacts from each of these sites. After reviewing the remaining identified dart point types from Kent's surface collection, they have been quantified as follows:

Site 41JP66 – 32.1% of the identified dart points were from the Middle to Late/Transitional Archaic utilizing Patterson's (1995c) projectile point chronologies for Southeast Texas. (Dart points comprise 57.1% of the total remaining projectile points in the collection from this site; this does not include the Neches River dart points in the collection which are presumed to also be Middle to Late Archaic in age).

Site 41JP96 - 77.8% of the identified dart point types were from Middle to Late/Transitional Archaic in age (Patterson, 1995c) (Dart points comprise 46.2% of the total remaining projectile points in the collection from this site; this does not include the Neches River or the Booker dart points in the collection which are presumed to be Middle to Late Archaic in age.)

With this quantification looking at percentage of identifiable dart point ages compared to total projectile points in the surface collection, it is reasonable to assume that both sites 41JP66 and site 41JP96, where the stone pendants were found, have a substantial Middle to Late Archaic component and, therefore, could be compared to the other major sites referenced above which have established stone lapidary industries of the same general age.

Conclusions

The author, after researching the tubular stone beads described elsewhere in this HAS Journal issue, proposes that the technological ideology for a ground stone lapidary industry likely came down the Neches River Valley from the north to not only sites 41JP66 and 41JP96 (where six tubular stone beads and a stone bead "perform" were also found) where the stone pendants were found, but also to site 41JP135 which contained a ground stone bead. All three sites are in close proximity to each other and possibly during the Middle to Late Archaic time period may have been one contiguous site along the Neches River. Based on the fact that several incomplete ground stone artifacts were recovered from these sites, the author would like to further propose that these stone pendants were made at these sites which had the technology for a lapidary stone industry in Jasper county, Texas similar to other ground stone industrial sites from Louisiana during the Middle to Late Archaic time periods.

Acknowledgments

I would like to thank and remember my late brother, Paul Woods and his wife Becky, for their time helping me document some of D. T. Kent's sites and their encouragement to me to complete this report. I would also like to the members of the Houston Archeological Society who have encouraged and helped with this article, including Louis Aulbach, THC Steward, who ran the queries in the Texas Archeological Site Atlas during my initial research, Linda Gorski, HAS President, and Wilson "Dub" Crook, Editor of the HAS Journal for his patience and gentle "nudging" for completion of, review and correction of this manuscript and for the identification of the stone material the pendants were made of. I would also like to thank Dr. Diana Greenlee, Poverty Point Archeologist, who initially helped me with references about some important stone lapidary sites in Louisiana. Additionally, thanks to Dr.

Jonathan Jarvis, Associate Director of TARL, who also ran queries of the Texas Archeological Site Atlas for me in my initial research of this paper.

I would also like to thank Elton Prewitt for his mentorship in East Texas archeological ideas and untold contributions to this and other projects. Last but not least by any means, I would like to remember my friend, the late Mr. D.T. Kent, Jr., for his mentorship in archeology thus promoting my interest in the field, the stories of East Texas which were always in abundance, and for his encouragement in archeology.

References

Anderson, David G. and Steven D. Smith
2003 *Archeology, History, and Predictive Modeling Research at Fort Polk 1972-2002*. The University of Alabama Press, Tuscaloosa.

Gibson, Jon L.
1979 Poverty Point Trade in South Central Louisiana: An Illustration from Beau Rivage. *Louisiana Archeology* 4:94.

Hadley, Alison M. and Phillip J. Carr
2015 Archaic Chert Beads and Craft Specialization: Application of an Organization of Technology Model. In *Exploring Southeastern Archeology*, edited by Patricia Galloway and Evan Peacock, pp. 71-98. University Press of Mississippi, Jackson.

Johnson, Jay K.
2000 Beads, Microdrills, Bifaces, and Blades from Watson Brake. Southeastern Archeology 19(2):95-104.

Patterson L. W.
1995 The Archeology of Southeast Texas. *Bulletin of the Texas Archeological Society* 66:239-264. Texas Archeological Society, Austin.

Perttula, Timothy K. and James E. Bruseth
1990 Trade and Exchange in Eastern Texas, 1100 B.C. – A.D. 800. In *Exchange in the Lower Mississippi Valley and Contiguous Areas at 1100 B.C.*, edited by Jon L. Gibson, p. 101. Bulletin of the Louisiana Archeological Society 17:93-121.

Story, Dee Ann, J. A. Guy, B. A. Burnett, M. D. Freeman, J. C. Rose, D. G. Steele, B. W. Olive and K. J. Reinhard
1990 *The Archeology and Bioarcheology of the Gulf Coastal Plain, Volume 1*. Research Series No. 38. Arkansas Archeological Society, Fayetteville.

Webb, Clarence H.
1982 *The Poverty Point Culture*. Geoscience and Man, Vol. 17, 2nd Edition. Louisiana State University, Baton Rouge.

AN UNUSUAL FISHTAIL-LIKE POINT FROM MACFADDIN BEACH (41JF50), JEFFERSON COUNTY, TEXAS

Wilson W. Crook, III

Introduction

"Fishtail" or Cola de Pescado points are key artifact indicators for one of the earliest Paleoamerican occupations in South and Central America (Bradley 2015; Collins and Ayala 2015; Suarez 2015). Just as Clovis marks a major early time horizon in North America, Fishtail points represent a similar marker horizon for occupations in South America and age dating has shown that they are nearly coeval with Clovis (Bradley 2015; Suarez 2015). Recently, Collins and Ayala (2015) have described two Fishtail-like points from collections in Texas. The first is from an Archaic burial at the Buckeye Knoll site (41VT98) in Victoria County and the second is from a surface find in 1938 near Attoyac Bayou in northeastern Nacogdoches County. Neither point displays the classic form of points from Argentina or Uruguay but both retain the characteristic flared stem that defines true Fishtail points. Moreover, both points are constructed of lithic material which appears to be of types not indigenous to Texas. Measurement of the stem characteristics of both points shows they fit well within the range of South American fishtail points, and as a result, Collins and Ayala (2015) have hypothesized that they are treasured heirlooms than made their way via exchange networks from Central America or northern South America to Texas.

Figure 1. Composite Photograph of a "Classic" Fishtail Point from the Lamanai Site, Belize (Photograph courtesy of Pete Bostrom, Lithics Casting Lab, www.lithiccastinglab.com).

Recently the author was made aware of an unusual Fishtail-like point from the McFaddin Beach site (41JF50) in Jefferson County, Texas. The point came from the collections of the late Mr. Herb Gsell, a noted avocational archeologist who passed away several years ago and his collection is being broken up and sold by his family. Given its unique shape, the point was acquired for study. This paper thus serves to record its occurrence and compares the point's morphology to the two points described by Collins and Ayala (2015) and to other South American Fishtail points.

Fishtail Points

As mentioned above, Fishtail points are the Clovis age equivalent for Central and South America. Originally described by Bird (1938, 1988) from Fell's Cave in Chile, they have a discontinuous distribution across South America. Fishtail points are known from as far north as Panama and Belize in Central America (Bird and Cooke 1978); from Ecuador and Peru (Bird 1969; Chauchat and Zevallos 1979; Nami 2000); to a more continuous distribution in the Southern Cone including central and southern Chile, the Pampas-Patagonia regions of Argentina, the Uruguayan Plains, and extreme southern Brazil (Politis 1991; Nami 1997; Flegenheimer et al. 2013). Fishtail points have not been found in either northern South America (Colombia, Venezuela) or the rest of the eastern coast of South America (Suarez 2003; Flegenheimer et al. 2013; Bradley 2015).

Fishtail points acquired their name due to their pear-shaped body coupled with their unique flared stem (Figure 1). However, there is considerable variability in the design, manufacturing technique and size of Fishtail points, with the major morphological differences being in the stems and shoulders (Suarez 2000, 2001; Suarez and Gillam 2008). Two major variants have been recognized including (1) the "classic" style with a marked stem and rounded shoulders (the shoulder-to-stem angle being 120

160°), and (2) a second variant that has more pronounced shoulders, with a shoulder-to-stem angle of 90-110° (Suarez 2001, 2006; Nami 2015). Manufacture is exclusively from percussion flaking, at least in the production of original unmodified points.

Many Fishtail points are made from large unifacial flake-blanks that may have stemmed from an earlier unifacial lithic technology that became fully bifacial over time (Bradley 2015). These points frequently have minor bifacial retouch on the lateral edges but retain the flake's unifacial character across one face. Other Fishtail points are manufactural from thin flake-blanks and thinned bifaces made from thicker blanks (Suarez 2015). Researchers in Uruguay have compiled an extensive database of Fishtail points (n = 90) (Suarez and Gillam 2008; Suarez 2015; Nami 2015). Fishtail points in their database range from 35-109 mm in length, 21-56.8 mm in maximum width, and 5-11 mm in thickness (Suarez 2015). Stem widths and the production of a stem "flare" (maximum base width minus minimum stem width) remain highly standardized, regardless of point size and/or alteration through resharpening (Bradly 2015). Thus measurements of the stem length, width and flare constitute a major defining characteristic of Fishtail points.

Fluting of the base is inconsistent with many points fluted on only one side or not at all. Suarez (2015) found in the Uruguay Fishtail database that 68% of the points have not been fluted, 24% have fluting on one face and only 8% have been fluted on two faces. Moreover, post-fluting retouch often erases the original channel flake scar (Bradley 2015).

Microwear analysis of Fishtail points shows intensive polish on both the stems as well as the basal shoulders from hafting (Nami and Castro 2014). Moreover, several points retained residue of a black adhesive material that was also used in binding the point to a dart or spear shaft (Nami and Castro 2014).

The broad tips of some Fishtail points have led researchers to question their suitability as projectile points (Suarez 2006, 2015; Nami 2007, 2015). Such variants are believed to have possibly been used as knives or some type of cutting tool. Recent work on points from northern Uruguay suggests that some Fishtail points were intentionally designed as hafted bifacial knives that could be easily modified into projectile points if hunting needs required them to be modified (Suarez 2015).

There are strong similarities between Fishtail and Clovis points. Both cultures went to extreme lengths to acquire high quality toolstone for projectile point manufacture. Many Fishtail and Clovis points display a waxy appearance characteristic of having been heat-treated. Both used a well-developed bifacial thinning technique including across-the-face and controlled overshot flaking (Bradley 2015; Suarez 2015). The manner in which platforms were prepared for the removal of bifacial thinning flakes and the wide spacing of flake removals is also similar. The lateral edges and bases of Clovis points and the stems and bases of Fishtail points were ground to

Table 1. Comparison of South American Fishtail Point Metrics with the McFaddin Beach (Gsell Collection) and other Texas Fishtail Points

Provenance	Maximum Length (mm)	Maximum Width (mm)	Maximum Thickness (mm)
McFaddin Beach (41JF50) Texas (Gsell Collection)	55.4	30	8
Buckeye Knoll (41VT98), Texas	276	84	10.6
Nacogdoches County, Texas	140	46	8.8
Fell's Cave, Chile	46	24	0
Fell's Cave, Chile	52	29	0
Lamanai, Belize	89	54	8
Range	*46-89*	*24-54*	*8*
Mean	*62.3*	*35.6*	*8*
Uruguay Fishtail Database (n = 90) Range	35-109	21-56.8	5-11

facilitate hafting. The major difference between the two points is Clovis points have fairly straight, slightly contracting lateral margins and Fishtail points are clearly stemmed with flaring basal ears. Given the large number of commonalities between the two points, researchers have speculated if there is a common cultural and technological source for both point types (Nami 1997; Suarez 2001, 2006; Bradley 2015).

The Gsell Collection Point

The Fishtail-like point from the Herb Gsell Collection is 55.4 mm in length and has a maximum width of 30.0 mm. Maximum thickness is 8.0 mm near the middle of the point. These measurements fit within the overall range of Central and South American Fishtail points, including the 90 specimens currently in the Uruguayan Fishtail database (Table 1) (Collins and Ayala 2015; Suarez and Gillam 2008; Suarez 2015; Nami 2015). There is extensive collateral flaking on the blade, especially toward the distal end of the point. Similar well-developed collateral flaking has been observed in some Fishtail points from Uruguay (Suarez 2001; Nami 2015; Nami and Castro 2014). The stem of the Gsell Collection point is strongly beveled with both the lateral edges of the stem and the base having been extensively ground. Of note, the stem is beveled through what appears to be two large flake removals. Examination of the stem under a binocular microscope (20-60x) shows that the construction of the stem appears to have been later than the rest of the blade suggesting that the point may have been broken and hurriedly rebased using a single, large flake removal from each face. The base has then been retouched to create a flare which is characteristic of South American Fishtail points.

As mentioned above, the single most diagnostic feature of Fishtail points is the consistent construction method used to make the characteristic "fishtail" stem. Researchers have shown that virtually all known Fishtail points can be identified as such by three stem measurements including the maximum width of the base, the minimum width of the stem, and the measurement of the "basal flare", which is simply the maximum base width minus the minimum stem width. Published metrics on the stems for 11 Fishtail points from Chile, 4 from Argentina, 11 from Uruguay and single points from Southern Brazil (Rio Grande do Sul) and Belize are shown in Table 2. Maximum basal width ranges from 13-26 mm with a mean of 17.5; minimum stem width ranges from 11-23.5 mm with a mean of 16.0. The basal flare ranges from 0 to 5 but averages near 2 (1.9) (see Table 2). As can be seen in Table 2, both the Buckeye Knoll and Nacogdoches Fishtail points described by Collins and Ayala (2015) as well the point from the Gsell Collection described herein fit within the known range of Fishtail points. Maximum basal with of the Gsell Collection point is 15.5 mm with a minimum stem width of 13.0 mm. This produces a "basal flare" of 2.5, close to the mean for the Fishtail points from Central and South America as shown in Table 2.

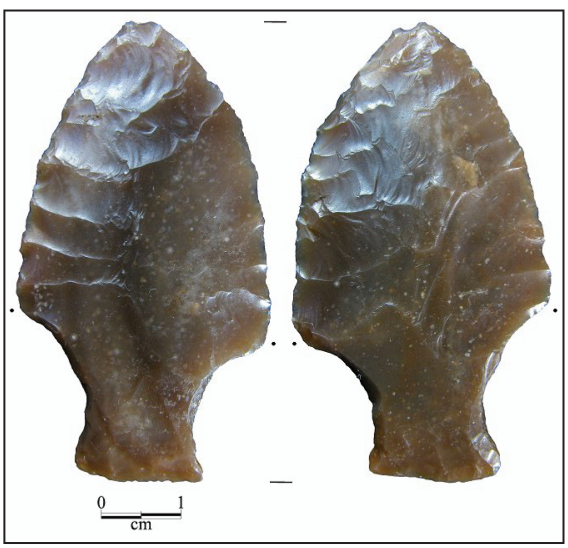

Figure 2. Composite Photograph of the Gsell Collection Fishtail-like Point from McFaddin Beach (41JF50), Jefferson County, Texas. Photograph by Lance K. Trask.

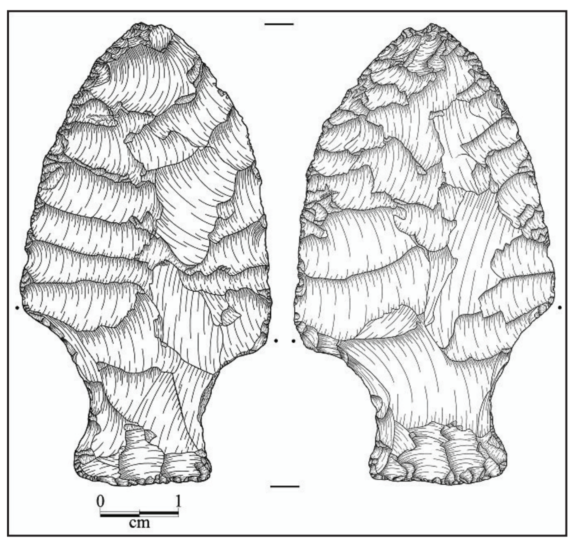

Figure 3. Illustration of both the Obverse and Reverse Faces of the Fishtail-like Point from McFaddin Beach (41JF50), Texas. Illustration by Lance K. Trask.

Table 2. Metric Comparison of Fishtail Point Stems from Central and South America to those from Texas Collections

Provenance / Specimen	Stem Length (mm)	Minimum Stem Width (mm)	Maximum Base Width (mm)	Basal Flare (Max. Base Width – Min. Stem Width)
Fell's Cave, Chile - 41.1a		17.6	18	0.5
Fell's Cave, Chile - 41.1b		16	17.5	1.5
Fell's Cave, Chile - 41.1c		12	13	1
Fell's Cave, Chile - 41.1d		14	15	1
Fell's Cave, Chile - 41.1e		17	17	0
Fell's Cave, Chile - 41.1f		12.5	14.5	2
Fell's Cave, Chile - 41.2 8303		17.3	19	1.7
Fell's Cave, Chile	14	11.5	13	1.5
Fell's Cave, Chile	18	15	16	1
Cueva del Medio, Chile – 1		11	13	2
Cueva del Medio, Chile - 2		19	20.5	1.5
Cerro la China, Argentina – 88		13	15	2
Cerro la China, Argentina - 455		13	14	1
San Cayetano, Argentina		16	18	2
Rio Sauce Chico, Argentina		17.5	19	1.5
Lobos, Uruguay		13	16.5	3.5
Alegre, Uruguay – 1		13	14	1
Alegre, Uruguay – 2		14	17	3
Rio Negro, Uruguay	27	17	21	4
Rio Negro, Uruguay	13	19	20	1
Uruguay – a		18.5	19.5	1
Uruguay - 1		23.5	26	2.5
Uruguay – 4		14	14.5	0.5
Uruguay – 8		19	21	2
Uruguay – 16		17	21	4
Uruguay - 19		15	20	5
Rio Grande do Sol, Brazil		12.5	15	2.5
Lamanai, Belize	25	20	22	2
Range	*13-27*	*11-23.5*	*13-26*	*0.0-5.0*
Mean	*19.4*	*16*	*17.5*	*1.9*
Buckeye Knoll, Texas	22	21	25	4
Nacogdoches, Texas	19	20	22	2
McFaddin Beach, Texas (Gsell Collection)	19.2	13	15.5	2.5

Color of the Gsell Collection point is olive gray (5Y 4/2) to olive (5Y 4/3-4/4) and the point has a dull sheen characteristic of so many artifacts recovered from McFaddin Beach (Long 1977). Under UV radiation, the point fluoresces a deep yellow-orange color, typical of Edwards chert. A composite photograph showing both the obverse and reverse faces of the point is presented in Figure 3. A detailed illustration of the point is shown in Figure 4. The collateral flaking on the left side of the point near the tip, the characteristic flare of the base, and the area of extensive stem grinding can be seen in both figures.

X-Ray Fluorescence Analysis

To further test if the chert used in the construction of the Gsell Collection Fishtail point did indeed come from the Edwards Plateau, the artifact was subjected to a source analysis utilizing X-Ray Fluorescence (XRF) techniques. In this regard, the large, multi-element approach developed by Williams and Crook (2013; Crook and Williams 2013) to analyze Texas Clovis chert artifacts was utilized.

All analyses were conducted using a Bruker Tracer III-SD portable (pXRF) energy-dispersive X-Ray Fluorescence spectrometer equipped with a rhodium target X-Ray tube and a silicon drift detector with a resolution of 145 eV FWHM for 5.9 keV x-rays at 200,000 counts per second over an area of 10 mm^2. Data was collected using a suite of Bruker pXRF software and processed using Bruker's empirical calibration software add-on. Sample area on each artifact was carefully selected to specifically avoid any inclusions within the chert and, where possible, on a flat surface (such as a flake scar) to reduce scattering effects due to artifact surface topography. Measurements were taken from both the obverse and reverse face and averaged.

Trace elements were measured using operating parameters of 15 keV, 55µA in order to detect major traced elements. Measurements were made on the sample using 300 second live-count time, which was then averaged. Intensities for the K-alpha peaks were recorded for a suite of 18 elements including sodium, magnesium, aluminum, silicon, phosphorus, sulfur, potassium, calcium, barium, titanium, vanadium, chromium, manganese, iron, cobalt, nickel, copper and zinc. Measured intensities in parts per million were then calculated as ratios to the Compton Peak of the rhodium target and converted to weight percent using Bruker's empirical calibration source. To further differentiate the chert sample, a second analysis was conducted on each specimen at a higher operating energy 40 keV, 55µA, using 0.3 mm copper and 0.02 mm titanium filters in the X-Ray path, and a 300 second live-count time. Peak intensities were measured for a second suite of 12 elements including arsenic, lead, thorium, rubidium, uranium, strontium, yttrium, zirconium, niobium, molybdenum, tin and antimony.

From this total suite of elements, 21 trace elements were used for the final statistical analysis. Elements within the chemical signature of chert that are subject to secondary chemical enrichment and/or depletion were removed for the purpose of the analysis. The final suite of trace elements, including calcium, titanium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, rubidium, strontium, yttrium, zirconium, niobium, molybdenum, tin, antimony, barium, lead, thorium, and uranium, were measured, calibrated, and converted to parts per million (ppm). Raw data was processed using a multivariate discriminant analysis (Fisher's Discriminant Analysis)

Table 3. XRF Results - Trace Element Geochemistry of McFaddin Beach Fishtail-Like Point (ppm).

Element	McFaddin Beach Fishtail-Like Point (Herb Gsell Collection)
Calcium	4,932
Titanium	102
Manganese	83
Iron	2,387
Cobalt	3
Nickel	13
Copper	27
Zinc	0
Arsenic	2
Rubidium	9
Strontium	26
Yttrium	21
Zirconium	34
Niobium	6
Molybdenum	46
Tin	1
Antimony	0
Barium	837
Lead	8
Thorium	5
Uranium	7

(Fisher 1936; Friedman 1989, Krzanowski 1977; Rencher 1992). Unlike principal component analysis, this statistical method allows data to be analyzed by region which means discrete variance in chemical signatures can be analyzed and compared. A geologic database of nearly 500 samples from known locations across the Edwards Plateau was constructed using the same analytical measurement methods (Williams and Crook 2013). Based on the processed results from the geologic samples, four source areas for the Edwards Plateau could be delineated including (1) the eastern part of the plateau in and around the Gault site (41BL323), (2) the eastern part of the Edwards Plateau encompassing the Fort Hood Military Reservation, (3) the southern and south-central parts of the plateau including the Leon Creek area in and around San Antonio in Bexar County plus Medina County, and (4) the Callahan Divide area (Coke, Taylor and Nolan counties) and Howard County in the northwestern part of the plateau.

Based on the trace element chemistry measured in the Gsell Collection Fishtail point, the specimen most closely corresponded to the area in and around the Gault site of the Edwards Plateau. However, as the match was only 70 percent (70 percent Gault, 30 percent Callahan Divide), the chert can only be sourced as "Edwards" with any certainty and not to a specific region within the Edwards Plateau. A listing of all the raw data measurements from the Gsell Collection point in parts per million is shown below in Table 3.

Conclusions

While the Gsell Collection point has many of the characteristics of known Fishtail points from Central and South America (see Tables 1 and 2), its construction from indigenous Texas Edwards Plateau chert makes its identification as a true Fishtail point problematical. The beveled stem is somewhat characteristic of a Nolan Archaic dart point from Central Texas (Suhm and Kreiger 1954; Suhm and Jelks 1962) but the flared base is much more akin to a Fishtail point than a Nolan. Moreover, the well-developed collateral flaking on the blade coupled with extensive lateral grinding on both the stem and the base are clearly more of a Paleoindian trait than that of the Middle to Late Archaic, the general time period for Nolan points. Other differences to true Fishtail points include (1) there's no hint of fluting (although some Fishtail points are not well-fluted), (2) the shoulders lack barbs, which also could be the product of damage, (3) the base is slightly convex as opposed to being concave (see Figure 1), and (4) the trimming along the margins of the stem is less orderly than usually seen on Fishtail type points. As mentioned above, it appears as though the point was damaged and has been subsequently re-based. The stem repair could have been done by someone familiar with the traits of a Fishtail point or perhaps it was just an accident. So while I believe the point is of Paleoindian to Early Archaic in origin, for now I will classify it as a "Fishtail-like" point and not a definitive Central/South American artifact.

References Cited

Bird, Junius

1938 Antiquity and Migration of the Earliest Inhabitants of Patagonia. *Geographical Review* 28(2):250-275, New York.

1969 A Comparison of South Chilean and Ecuatorial Fishtail Projectile Points. *The Kroeber Anthropological Society Papers* 40:52-71.

1988 *Travels and Archeology in South Chile*. University of Iowa Press, Iowa City, Iowa.

Bird, Junius and R. Cooke

1978 The Occurrence in Panama of Two Types of Paleoindian Projectile Points. In *Early Man in the Americas from a Circum-Pacific Perspective*, edited by A. L. Bryan, pp. 263-272. Occasional Papers No. 1, Department of Anthropology, University of Edmonton, Alberta, Canada.

Bradley, Bruce

2015 The Two C's: Cola de Pescado and Clovis. *PaleoAmerica* 1(2):127-130. Center for the Study of the First Americans, College Station, Texas.

Chauchat, C. and Q. Zevallos

1979 Una Punta Cola de Pescado Procedente de la Costa Norte de Peru. *Nawpa Pacha* 17:143-147.

Collins, Michael B. and Sergio Ayala

2015 South American Style Fishtail Points in Texas – What's Up with This? Paper presented at the 22nd East Texas Archeological Conference, February 14, 2015, University of Texas at Tyler, Tyler, Texas.

Crook, Wilson W. III and Thomas J. Williams

2013 The Presence of Gault-Ft. Hood Chert at the Brushy Creek Clovis Site (41HU74), Hunt County, Texas. Paper presented at the Paleoamerican Odyssey Conference, October 17-19, Santa Fe.

Fisher, R. A.
1936 The Use of Multiple Measurements in Taxonomic Problems. *Annals of Eugenics* 7: 179-188.

Flegemheimer, Nora, Laura Miotti and Nataila Mazzia
2013 Rethinking Early Objects and Landscapes in the Southern Cone: Fishtail-point Concentrations in the Pampas and Northern Patagonia. In *Paleoamerican Odyssey,* edited by Kelly Graf, C. V., Ketron and Michael Waters, pp. 359-376. Texas A&M University Press, College Station, Texas.

Friedman, J. H.
1989 Regularized Discriminant Analysis. *Journal of the American Statistical Association* 84: 165-175.

Krzanowski, W. J.
1977 The Performance of Fisher's Linear Discriminant Function Under Non-Optimal Conditions. *Technometrics* 19: 191-200.

Long, R. J.
1977 *McFadden Beach*. The Patillo Higgins Series of Natural History and Anthropology, Number 1. Spindletop Museum, Lamar University, Beaumont.

Nami, Hugo G.
1997 Investigaciones Actualisticas para Discutir Aspectos Tecnicos de los Cazadores Recoletores del Ttardiglacial: El Problema Clovis-Cueva Fell. *Anales del Instituto de la Patagonia, Serie Ciencias Sociales* 25:151-186.

2000 Technological Comments on Some Paleoindian Lithic Artifacts from Ilalo, Ecuador. *Current Research in the Pleistocene* 17:104-107.

2007 Research in the Middle Rio Negro Basin (Uruguay) and the Paleoindian Occupation of the Southern Cone. *Current Anthropology* 48(1):164-171.

2015 Paleoamerican Artifacts from Cerro Largo, Northeastern Uruguay. *PaleoAmerica* 1(3):288-292. Center for the Study of the First Americans, College Station, Texas.

Nami, Hugo G. and Alicia Castro
2014 Fishtail Points, Technology and Microwear Analysis from the Negro River Basin, Uruguay. *Archeological Discovery* 2:65-70.

Politis, G.
1991 Fishtail Projectile Points in the Southern Cone of South America: An Overview. In *Clovis Origins and Adaptations*, edited by R. Bonnichsen and K. Turnmire, pp. 287-301. Center for the Study of Early Man, Orono, Maine.

Rencher, A. C.
1992 Interpretation of Canonical Discriminant Functions, Canonical Variates, and Principal Components. *The American Statistician* 46: 217-225.

Suarez, Rafael
2000 Paleoindian Occupations in Uruguay. *Current Research in the Pleistocene* 17:78-80. Center for the Study of the First Americans, College Station, Texas.

2001 Technomorphological Observations on Fishtail Projectile Points and Bifacial Artifacts from Northern Uruguay. *Current Research in the Pleistocene* 18:56-58.

2003 Paleoindian Components of Northern Uruguay: New Data on Early Human Occupations of the Late Pleistocene and Early Holocene. In *Where the South Winds Blow*, edited by Laura Miotti, Monica Salemme and Nora Flegenheimer, pp. 29-36. Center for the Study of the First Americans, Texas A&M University, College Station, Texas.

2006 Comments on South American Fishtail Points: Design, Reduction Sequences and Function. *Current Research in the Pleistocene* 23:69-72.

2015 The Paleoamerican Occupation of the Plains of Uruguay: Technology, Adaptations, and Mobility. *PaleoAmerica* 1(1):88-104. Center for the Study of the First Americans, College Station, Texas.

Suarez, Rafael and Cristopher Gillam
2008 The Paleoindian Database of Uruguay: Collection Survey. *Current Research in the Pleistocene* 25:200-202.

Suhm, Dee Ann and Alex D. Krieger, with collaboration of Edward B. Jelks
1954 An Introductory Handbook of Texas Archeology. *Bulletin of the Texas Archeological Society* 25:1-562.

Suhm, Dee Ann and Edward B. Jelks (editors)
1962 *Handbook of Texas Archeology: Type Descriptions*. Texas Archeological Society, Special Publications, No. 1, and the Texas Memorial Museum, Bulletin No. 4, Austin.

Williams, Thomas J. and Wilson W. Crook, III
2013 Geochemical Analysis of Primary Chert Outcrops from the Edwards Plateau: A Methodological Approach for the Use of pXRF in Material Sourcing. Paper presented at the 84th Annual Meeting of the Texas Archeological Society, October 25-27, Del Rio.

TWO NEW ARTIFACTS FROM THE TIMBER FAWN CLOVIS SITE (41HR1165)

Wilson W. Crook, III

Introduction

As Houston Archeological Society members are aware, the Timber Fawn Clovis site (41HR1165) is the location in northeastern Harris County (Kingwood) where we discovered and salvaged 24 artifacts belonging to the Clovis culture (ca. 13,500-12,900 BP) in 2014-15. The discovery was published in a special report and distributed to the membership last year (Crook et al. 2016). With the completion of our salvage collection effort, the land owner, K. B. Homes, completed the housing development of the Rivergrove sub-division where the site is located. Over the past year, I have given a number of presentations on the site in an effort to raise public awareness on the potential for future discoveries in the Houston area. Recently, these efforts have paid their first dividends with the discovery of two new artifacts at the Timber Fawn site.

A local resident (who wished to remain anonymous), whose home is located over the area where a number of the Timber Fawn artifacts were recovered, found two new artifacts during the construction of a lawn sprinkler system. Both artifacts have been loaned to the author for study and inclusion in the Timber Fawn artifact database. This brief paper serves to record the artifacts, their physical properties, and the results of a trace element geochemical analysis using X-Ray Fluorescence in an attempt to determine their source.

Artifact Description and Analysis

The first artifact is the tip of a broken fluted projectile point. As can be seen in Figures 1 and 2, the remains of a central flute can be seen below the tip on both the obverse and reverse faces. Moreover, the tip of the point is relatively thick for a Clovis point and shows prominent beveling (see the left lateral edge in Figure 2). Both features are indicative of the point having been severely damaged and hurriedly re-sharpened. This would also account for the

Figure 1. Obverse face of Clovis point #3 from the Timber Fawn site, Harris County, Texas.

Figure 2. Reverse face of Clovis point #3 from the Timber Fawn site, Harris County, Texas. Note the presence of prominent beveling on the left lateral edge.

Table 1. Clovis Point #3 Measurements, Timber Fawn (41HR1165) Site Harris County, Texas.

Clovis Point	Measurements (mm)
Maximum Length	37.9[1]
Maximum Width	27.5[1]
Basal Width	n.d.
Distance from Maximum Width to Base	n.d.
Maximum Blade Thickness	6.5[1]
Distance from Maximum Thickness to Base	n.d.
Basal Depth	n.d
Thickness at Flute	5.2
Obverse Flute Length	18.2[1]
Obverse Flute Width	13.0[1]
Reverse Flute Length	15.0[1]
Reverse Flute Width	15.2[1]
Length of Grinding Left Lateral Edge	n.d.
Length of Grinding Right Lateral Edge	n.d.
Basal Grinding	n.d.
Weight (grams)	7.6 gm
Breaks	Tip with major break at about midpoint of the point due to impact fracture
UV Fluorescence	Lemon-Yellow to Yellow-Orange under both Short and Long-Wave Radiation
Material	Chert[2]

1 All measurements are affected by the major impact fracture; no basal measurements could be obtained.

2 X-Ray Fluorescence analysis confirms the source of the chert as the Leon Creek area of the Edwards Plateau.

proximity of the flute to the tip of the point. Remaining length of the point is 37.9 mm. Maximum width is 27.5 mm, which is at the break. Maximum thickness is 6.5 mm; 5.2 mm at the flute. As this is the third partial Clovis point recovered from the Timber Fawn site, it is referenced in the figures and tables as Clovis point #3. A compilation of the point's physical measurements is listed in Table 1.

The point is made from a light bluish-gray to bluish gray (GLEY2 8/1 – 6/1) colored chert which has white mottling from patination on both faces. The chert fluoresces a strong yellow-orange color under UV radiation which is seen as an indication of a possible Edwards Plateau source. UV fluorescence, both short-wave and long-wave, has historically been used to make some preliminary source 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).

The second artifact is a narrow bladelet which has fine retouch on both lateral edges (Figure 3). Examination of the bladelet shows that it has a relatively small bulb of percussion, typical of Clovis blade production. However, the bladelet is almost flat with little to no index of curvature. As such, it appears to be the product of basal thinning, possibly even a channel flake. Total length is 72.4 mm with a width of 17.8 mm. Thickness is only 4.0 mm. Exam-

Figure 3. Narrow bladelet with prominent retouch on both lateral edges from the Timber Fawn site, Harris County, Texas.

ination of the bladelet's bulb of percussion indicates that the original flake was probably considerably wider and has been narrowed with use and retouch. The artifact is made from 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-waver UV light. This is very similar to the so-called "Gray-Brown-Green Mottled" variety of Edwards chert as 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 3).

Both artifacts are either broken and/or at the end of their useful life and have been discarded. This is consistent with the rest of the Timber Fawn artifact assemblage which represents a seasonal hunting camp rather than a more permanent occupation (Crook et al. 2016).

X-Ray Fluorescence Analysis

Both 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 analysis was conducted using a Bruker Tracer III-SD handheld energy-dispersive X-Ray Fluorescence 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 analyses were conducted in December, 2016 at the laboratory of the Gault School of Archeological Research located at Texas State University in San Marcos.

Both artifacts were analyzed at 40keV, 55μA, using a 0.3 mm aluminum / 0.02 titanium filter in the X-Ray path, and a 300 second live-count time. Two measurements were taken on each side of the point and averaged. Peak intensities for Kα and Lα peaks of 22 trace elements were calculated as ratios to the Compton peak of rhodium and converted to parts-per-million (ppm). The complete raw data set of elemental data collected from the two artifacts is shown in Table 2.

Provenance analysis of the trace element data collected from the artifacts was conducted using a database of geologic samples from the Edwards Plateau obtained by the Gault School of Archeological Research. Geologic samples from 4 major geographic regions of the Edwards Plateau (Gault site area, Fort Hood, Callahan Divide, Leon Creek) were collected and analyzed in the past using the same method described above. A statistical analysis based on the methodology developed by Speer (2014) for Laser Ablation and later modified for XRF (Williams and Crook 2013; Crook and Williams 2013) was conducted on both the geologic database as well as the Timber Fawn artifacts. Statistical analysis of the trace element signature from the Clovis point indicates a probable match with the Leon Creek area of the southeastern part of the Edwards Plateau, with the re-worked channel flake matching the geochemistry of cherts in the Gault-Fort Hood region of the eastern part of the Edwards Plateau. This result confirms the visual and UV observation of the artifacts that had previously suggested an Edwards Plateau origin for the chert.

Conclusions

The discovery of another partial Clovis point brings the number found at the Timber Fawn site to

Table 2. X-Ray Fluorescence Analysis – Two New Artifacts From the Timber Fawn Clovis Site (41HR1165) (ppm)

Element	Broken Clovis Point Tip	Reworked Channel Flake
Calcium	4820	5476
Titanium	332	207
Chromium	0	0
Manganese	81	70
Iron	3126	2827
Cobalt	3	2
Nickel	12	9
Copper	0	0
Zinc	0	0
Arsenic	0	0
Rubidium	13	10
Strontium	64	36
Yttrium	22	21
Zirconium	36	36
Niobium	6	6
Molybdenum	49	46
Tin	1	2
Antimony	0	5
Barium	836	1073
Lead	7	7
Thorium	6	6
Uranium	6	5
Probable Source	Leon Creek	Gault/Fort Hood

three and the total reported from Harris County to 12 (Beaver and Meltzer 2007; Crook et al. 2016). The addition of a re-worked channel flake may indicate that new projectile points may have been produced at the site from flake cores carried by the inhabitants for the purpose of replenishing broken tools. Clovis people are known to have produced, carried and cached such prepared bifaces, one of which was found in the original assemblage from the Timber Fawn site (Collins 1990, 1998; Collins and Hemmings 1998; Bradley et al. 2010; Crook et al. 2016).

The composition of the two new artifacts shows a strong relationship to the other chert artifacts from the Timber Fawn site. Of the original 24 artifacts recovered from the site, 19 were made from chert. Of these, XRF analyses showed that 15 of the 19 (79 percent) had an Edwards Plateau source, with the largest number (10) coming from the eastern side of the Plateau in the Gault-Fort Hood region (Crook et al. 2016). People of the Clovis culture are well-documented to have traveled extensive distances to access unique and/or high quality lithic material (Bradley et al. 2010). In fact, long distances that separate the archeological site and the geologic provenance of the source of the lithic material is a salient characteristics of Clovis tool assemblages (Kilby 2008). The fact that the Clovis point described herein was damaged and considerably modified to re-use, demonstrates the value that its makers placed on high quality Edwards chert which was not available locally in Harris County.

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, and at McFaddin Beach in Jefferson County (Williams and Crook 2013). The southeastward movement from the Edwards Plateau is believed to possibly represent seasonal journeys to collect salt along the Gulf Coast while hunting large game animals along the way (Crook et al. 2016).

This study further shows the value of promoting a discovery such as the Timber Fawn site to the general public through informational presentations. The home owner who discovered the artifacts described herein attended one of these presentations and thus was made aware to look for new artifacts as well as to provide them for further study.

Acknowledgments

I would like to thank the Gault School of Archeological Research located at Texas State University for access to their portable X-Ray Fluorescence unit. Specifically, I would like to thank Dr. Thomas J. Williams for his expert XRF analysis and subsequent canonical discriminant analysis of the data that led to the provenance determination of the Timber Fawn artifacts described herein.

References Cited

Beaver, Michael R. and David J. Meltzer
2007 Exploring Variation in Paleoindian Life Ways: The Third Revised Edition of the Texas Clovis Fluted Point Survey. *Bulletin of the Texas Archeological Society* 78:65-100.

Bradley, Bruce A., Michael B. Collins and Andrew Hemmings
2010 *Clovis Technology*. International Monographs in Prehistory, Archeological Series 17, Ann Arbor.

Collins, Michael B.
1990 Observations on Clovis Lithic Technology. *Current Research in the Pleistocene* 7:73-74.

1998 Interpreting the Clovis Artifacts from the Gault Site. *TARL Rese*arch *Notes* 6(1): 4-12.

Collins, Michael B., and C. Andrew Hemmings
2005 Lesser-Known Clovis Diagnostic Artifacts: The Bifaces. *La Tierra* 32(2):9-20.

Crook, Wilson W., III, Lenore A. Psencik, Linda C. Gorski and Thomas L. Nuckols
2016 Timber Fawn (41HR1165): A Clovis Site in Harris County, Texas. *Report No. 26*, Houston Archeological Society, Houston.

Crook, Wilson W. III and Thomas J. Williams
2013 The Presence of Gault-Ft. Hood Chert at the Brushy Creek Clovis Site (41HU74), Hunt County, Texas. Paper presented at the Paleoamerican Odyssey Conference, October 17-19, Santa Fe.

Dickens, William A.
1995 Identification and Prehistoric exploration of Chert from Fort Hood, Bell and Coryell Counties, Texas. *Unpublished Master's Thesis*, Texas A&M University, College Station, Texas.

Hillsman, Mathew J.
1992 Evaluation of Visible and Ultraviolet Excited Attributes of Some Texas and Macroscopically Similar New Mexico Cherts. *Unpublished Masters' Thesis*, Eastern New Mexico University.

Hofman, Jack L., Lawrence C. Todd and Michael B. Collins
1991 Identification of Central Texas Edwards Chert at the Folsom and Lindenmeier Sites. *Plains Anthropologist* 36(137):281-395.

Kilby, J. David
2008 An Investigation of Clovis Caches: Content, Function and Technology Organization. *Unpublished Doctoral Dissertation*, University of New Mexico, Albuquerque.

Speer, Charles A.
2014 Experimental Sourcing of Edwards Plateau Chert using LA-ICP-MS. *Quaternary International* 342:199-213.

Waters, Michael R. and Thomas A. Jennings
2015 *The Hogeye Clovis Cache*. Texas A&M University Press, College Station.

Williams, Thomas J. and Wilson W. Crook, III
2013 Geochemical Analysis of Primary Chert Outcrops from the Edwards Plateau: A Methodological Approach for the Use of pXRF in Material Sourcing. Paper presented at the 84th Annual Meeting of the Texas Archeological Society, October 25-27, Del Rio.

A CLOVIS POINT FROM SOUTHERN CROSBY COUNTY, TEXAS

Wilson W. Crook, III

Introduction

In May of 2016, long-time Houston Archeological Society member, Marcel Frey, brought in a large collection of lithic artifacts for the society to help identify and organize.

Mr. Frey had been asked by the family of the late Mr. R. Don Patton of Crosbyton, Texas, to be custodian of the late Mr. Patton's artifact collection. In order to assess what the collection contained, Marcel brought it to the attention of HAS President, Linda Gorski. Linda asked several of the members to take a look at the collection and see if we could identify its major components.

The collection was found to have 184 total artifacts including 4 Paleoindian points (one Clovis, one San Patrice and two reworked Angostura points), 80 Archaic dart points ranging from Early to Transitional Archaic in age, 67 Late Prehistoric arrow points, 17 non-projectile point artifacts – mainly bifaces and preforms of probable Archaic age, 10 ceramic sherds, and 6 artifacts that are likely modern reproductions. While a large number of point types are present, unfortunately very little information was

Figure 1. Obverse face of Clovis point from the R. D. Patton Collection, Southern Crosby County, Texas.

Figure 2. Reverse face of Clovis point from the R. D. Patton Collection, Southern Crosby County, Texas. Note the major impact fracture at the distal end of the point and related damage which extends laterally across the reverse face.

retained about the provenance of any of the artifacts. Several of the reworked dart points had location information written on them (such as “Sandy Creek, Missouri”) and several of the pottery sherds were clearly Puebloan types; but outside of these examples, locational information was largely missing. However, from the typology of the dart and arrow points, most of the artifacts seem to come from West-Central to South Texas. Common Central Texas point types, such as Pedernales, are completely absent and common East Texas types (Yarbrough, Gary) are also absent.

In one of the boxes which the collection was originally housed was a distinctive Clovis point. A tiny scrap of paper was found below the point inside some cotton lining which simply stated “Southern Crosby County, Texas”. Given the paper’s location relative to the Clovis point, it is assumed that this is the point’s probable original location. As Clovis points are fairly rare and this point at least had some provenance data, it was decided to more fully study the point and record its physical measurements for the Texas Clovis Fluted Point Survey. This paper serves to further record the Crosby County Clovis point including the trace element geochemistry of the chert toolstone.

Artifact Description and Analysis

Outside of the small piece of paper that indicated the Clovis point described herein was found in “southern Crosby County, Texas” no other site location information or association is known. The late Mr. Don Patton lived in Crosbyton, Texas which is the county seat of Crosby County, so it is logical to assume he was the finder of the point.

As can be seen in Figures 1 and 2 below, the point is constructed of a bluish-gray (GLEY2 6/1-5/1) to light bluish-gray (GLEY2 7/1) chert which has a very pale brown (10YR 8/2) mottling on both faces. White spots from patination are also present on both faces. A minor amount of limestone cortex remains on the central part of the reverse face (see Figure 2).

Examination of the point shows that it has been damaged, probably twice. The original point was much longer than its current length of 71.9 mm; a noticeable change in the curvature of the lateral edges halfway up the point suggest it was re-tipped

Table 1. Clovis Point Measurements, Southern Crosby County, Texas

Clovis Point	Measurements (mm)
Maximum Length	71.9
Maximum Width	35
Basal Width	29
Distance from Maximum Width to Base	29.9
Maximum Blade Thickness	8.5
Distance from Maximum Thickness to Base	41.7
Basal Depth	2.8
Thickness at Flute	6
Obverse Flute Length	29.2
Obverse Flute Width	15.9
Reverse Flute Length	31.4
Reverse Flute Width	19.8
Length of Grinding Left Lateral Edge	30.9
Length of Grinding Right Lateral Edge	33.1
Basal Grinding	Strong
Weight (grams)	27.5 gm
Breaks	Tip with major impact fractures laterally across reverse face
UV Fluorescence	Lemon-Yellow to Yellow-Orange under both Short and Long-Wave Radiation
Material	Chert*

** Color and UV Fluorescence matches Edwards Chert; X-Ray Fluorescence analysis confirms the source as the Callahan Divide area of the Edwards Plateau.*

after probably suffering an impact fracture (see Figure 1). This re-sharpened point was then subsequently damaged by a second major impact fracture which resulted in both the loss of the new tip as well as causing two significant lateral fractures across the reverse face of the point (see Figure 2). Despite these fractures, the point is still longer than the state mean (65.0 mm) as reported in the Texas Clovis Fluted Point Survey of 408 specimens (Beaver and Meltzer 2007). Research at the Gault site, Pavo Real and other sites indicates that Clovis points are continually used, re-sharpened (and/or re-based) and then reused (Collins 1998; Bradley et al. 2010). However, once a Clovis point reaches a length of 50-70 mm it is frequently discarded (Michael B. Collins, personal communication, 2008).

Fluting is present on both the obverse and reverse faces of the point, the length of the flutes (29.2mm and 31.4 mm, respectively) suggesting the original length of the point was considerably longer. Similarly, lateral grinding (30.9 mm on left edge, 33.1 mm on right edge) is 42-46 percent the length of the point which is longer than a Clovis point of only 71.9 mm in length would typically have. Maximum thickness of the point if 8.5 mm; 6.0 mm between the flutes. Basal depth is 2.8 mm with strong edge grinding. The chert fluoresces a strong lemon-yellow to yellow-orange color under both short and long-wave UV radiation, characteristic of Edwards chert. A complete compilation of all the point's physical characteristics, as submitted to the Texas Clovis Fluted Point Survey, is listed in Table 1.

X-Ray Fluorescence Analysis

The point was subjected to a trace element geochemical analysis using a portable X-Ray Fluorescence spectrometer (pXRF) in order to attempt to determine its provenance. The analysis was conducted using a Bruker Tracer III-SD handheld energy-dispersive X-Ray Fluorescence 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. Analysis was conducted in December 2016 at the laboratory of the Gault School of Archeological Research located at Texas State University in San Marcos.

The Crosby County Clovis point was measured at 40keV, 55ìA, using a 0.3 mm aluminum / 0.02 titanium filter in the X-Ray path, and a 300 second live-count time. Two measurements were taken on each side of the point and averaged. Peak intensities for Kα and Lα peaks of 17 trace elements were calculated as ratios to the Compton peak of rhodium and converted to parts-per-million (ppm). The complete raw data set of elemental data collected from the Crosby County Clovis point is shown in Appendix I.

Provenance analysis of the trace element data collected from the artifact was conducted using a database of geologic samples from the Edwards Plateau obtained by the Gault School of Archeological Research. A total of 464 geologic samples from 4 major geographic regions of the Edwards Plateau (Gault site area, Fort Hood, Callahan Divide, Leon Creek) were collected and analyzed using the same method described above. A statistical analysis based on the methodology developed by Speer (2014) for Laser Ablation and later modified for XRF (Williams and Crook 2013; Crook and Williams 2013) was conducted on both the geologic database as well as the Crosby County Clovis point. Statistical analysis of the trace element signature from the Clovis point indicates a probable match with the Gault-Fort Hood region of the eastern part of the Edwards Plateau. This result confirms the visual and UV observation of the artifact that had previously suggested an Edwards Plateau origin for the chert. Southern Crosby County is approximately 450 km northwest of the Gault-Fort Hood region and demonstrates the great distances Clovis people moved in order to find both high quality toolstone as well as big game.

Conclusions

The composition of the Crosby County Clovis point shows a potential relationship to cherts that crop out in the eastern parts of the Edwards Plateau, an area well known for the Clovis age occupation at the Gault site (41BL323). Paleoindian hunters, especially people of the Clovis culture, are well-documented to have traveled extensive distances to access unique and/or high quality work material (Bradley et al. 2010). In fact, one of the salient characteristics of Clovis stone assemblages is the wide variation seen in the stone material used and the long distances that separate the archeological site and the geologic provenance of the source material (Kilby 2008). The fact that the Crosby County point described herein was damaged and considerably modified to re-use, demonstrates the value that its makers placed on high quality Edwards chert which was not available locally in Crosby County.

This study further shows the amount of the information that can be obtained from collections such as the R. Don Patton collection. Of course, if there had been more locational information, the value to science would be greater. But even without such information, there can still be important value obtained as a study collection for various point and artifact typologies.

Acknowledgments

I would like to thank the Gault School of Archeological Research located at Texas State University for access to their portable X-Ray Fluorescence unit. In particular, I would like to thank Dr. Thomas J. Williams for his expert XRF analysis and subsequent canonical discriminant analysis of the data that led to the determination of a Eastern Edwards Plateau provenance for the Crosby County Clovis point.

References Cited

Bradley, Bruce A., Michael B. Collins and Andy Hemmings
2010 *Clovis Technology*. International Monographs in Prehistory, Archeological Series 17, 220 pp, Ann Arbor, Michigan.

Beaver, Michael R. and David J. Meltzer
2007 Exploring Variation in Paleoindian Life Ways: The Third Revised Edition of the Texas Clovis Fluted Point Survey. *Bulletin of the Texas Archeological Society* 78:65-100.

Collins, Michael B.
1998 Interpreting the Clovis Artifacts from the Gault Site. *TARL Research Notes* 6(1): 4-12.

Crook, Wilson W. III and Thomas J. Williams
2013 The Presence of Gault-Ft. Hood Chert at the Brushy Creek Clovis Site (41HU74), Hunt County, Texas. Paper presented at the Paleoamerican Odyssey Conference, October 17-19, Santa Fe.

Kilby, J. David
2008 An Investigation of Clovis Caches: Content, Function and Technology Organization. *Unpublished Doctoral Dissertation*, University of New Mexico, Albuquerque.

Speer, Charles A.
2014 Experimental Sourcing of Edwards Plateau Chert using LA-ICP-MS. *Quaternary International* 342:199-213.

Williams, Thomas J. and Wilson W. Crook, III
2013 Geochemical Analysis of Primary Chert Outcrops from the Edwards Plateau: A Methodological Approach for the Use of pXRF in Material Sourcing. Paper presented at the 84th Annual Meeting of the Texas Archeological Society, October 25-27, Del Rio.

APPENDIX I
X-Ray Fluorescence Analysis – Clovis Point from the R. Don Patton Collection, Crosby County, Texas

Element	Clovis Point
Calcium	5361.88
Titanium	227.48
Chromium	0
Manganese	76.8
Iron	2506.22
Cobalt	3.17
Nickel	12.89
Copper	0
Zinc	0
Arsenic	0
Rubidium	9.89
Strontium	13.71
Yttrium	21.14
Zirconium	31.7
Niobium	5.91
Molybdenum	49.28
Tin	1.37
Antimony	0
Barium	1081.33
Lead	7.54
Thorium	5.85
Uranium	11.99
Probable Source	Gault-Fort Hood Region

MUNITIONS ANALYSIS BULLETS RECOVERED AT THE LEVI-JORDAN PLANTATION (41BO165)

Thomas L. Nuckols

Introduction

During the years 1855 to 1865, the Colt's Patent Fire-Arms Manufacturing Company produced a revolving cap and ball rifle called the Colt Model 1855 Full Stock Sporting Rifle. Calibers available for this rifle were .36, .40, .44, .50 and .56 (Flayderman 1998:77). On June 3, 1861, the Confederate States of America began manufacturing bullet molds designed to cast lead Minie balls in various calibers and styles for use in civilian owned muzzle-loading rifles. These rifles intended for military use were called "country" or "Kentucky" rifles (Thomas 2010:185). Two .50 caliber, three grooved conical cavity lead bullets, i.e., Minie balls, recovered at the Levi-Jordan Plantation (41BO165) while conducting the ADA Ramp Testing Project (17-09) by Moore Archaeological Consulting in March, 2017, are possibly examples of bullets intended to be used in one of the types of rifles mentioned above.

Bullet Analysis

ARTIFACT #: Lot 3
CONDITION: Unfired. Slightly oxidized.
DISTINGUISHING FEATURES: A sprue nib on the nose and two mold seams running down the length of the bullet 180° apart.
BODY PROFILE: Cylindro-ogival.
POINT TYPE: Sprue point (see COMMENT below).
WEIGHT: 344.0 grains
DIAMETER: 0.5"
LENGTH: 0.914"

BASE TYPE: Three groove (three rings @ 0.103" wide each & three grooves @ 0.074" wide each).
- LOWER GROOVE TYPE: Square.
- MIDDLE & UPPER GROOVE TYPE: Normal.
- OVERALL GROOVE HEIGHT (above base): 0.532"

CAVITY TYPE: Concentric ring, truncated cone.
- CONE WIDTH (at base): 0.375" (0.0625" skirt width).
- CONE DEPTH: 0.260"

COMMENT: A sprue point type indicates that a bullet was cast in a bullet mold with a cavity or sprue hole located at the top of the mold. Molds of this type are called nose cast molds. A bullet removed from this type of mold after casting is left with a sprue and two mold seams running down the length of the bullet at 180° apart. Often, a bullet mold was equipped with an integral sprue cutter. If not, the bullet was removed from the mold and the sprue was cut off by separate means which leaves a sprue nib on the bullet (Figure 1).

ARTIFACT #: Lot 4 (see Figure 1)
With the exception of weight and length, this bullet shares the same attributes as Artifact Lot #3 bullet described above.
WEIGHT: 347.4 grains
LENGTH: 0.915"

Conclusion

As the two bullets share the same attributes, they were probably cast in the same bullet mold. The bullet mold used to cast these bullets might have been equipped with an integral sprue cutter. However, the Lot 4 bullet has a pinch line bisecting the

Figure 1. 0.50 Caliber Minnie Balls, Lot #3 (left) and Lot #4 (right), from the Levi-Jordan Plantation (41BO165).

sprue located at the top of the bullet. This indicates one of two things:

1. Either the bullet mold was equipped with an integral sprue cutter that required additional trimming of the sprues by a separate tool, or

2. The bullet mold was unequipped with an integral sprue cutter and the sprues were cut off by a separate tool.

References Cited and Bibliography Used

Flayderman, Norm
1998 *Flayderman's Guide to Antique American Firearms and Their Values, 7th Edition*. Krause Publications, Iola, Wisconsin.

Thomas, Dean S.
1993 *Ready…Aim…Fire! Small Arms Ammunition in the Battle of Gettysburg*. Thomas Publications, Gettysburg, Pennsylvania.

2010 *Round Ball to Rimfire, A History of Civil War Small Arms Ammunition. Part 4, A Contribution to the History of the Confederate Ordinance Bureau*. Thomas Publications, Gettysburg, Pennsylvania.

Thomas, James E. and Dean S, Thomas
1996 *A Handbook of Civil War Bullets & Cartridges*. Thomas Publications, Gettysburg, Pennsylvania.

W. Reid McKee and M.E. Mason, Jr.
1980 *Civil War Projectiles II, Small Arms & Field Artillery With Supplement*. Rapidan Press, Mechanicsville, Virginia.