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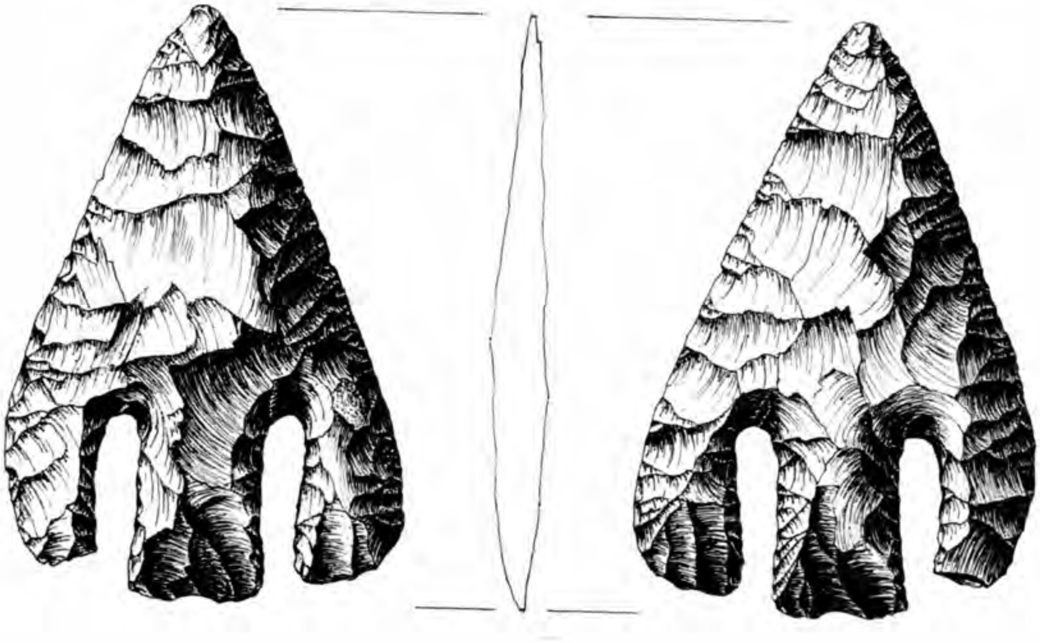

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QUARTERLY JOURNAL OF THE SOUTHERN TEXAS ARCHAEOLOGICAL ASSOCIATION

Volume 29, No.4
2002

Thomas R. Hester
Editor

DEE ANN STORY CONSERVATION AWARD for 2000: Terry Cullen. 1
ARCHAEOLOGICAL LIFETIME ACHIEVEMENT AWARD for 2000: Tommy Tomesal 1
OUTSTANDING AVOCATIONAL ARCHAEOLOGIST OF THE YEAR AWARD for 2000: Don Shirley . . 1
DEE ANN STORY CONSERVATION AWARD for 2001: Bette and Don Burris 2
PUBLIC SERVICE AWARD for 2001: Dr. Steve Black 2
OUTSTANDING ARCHAEOLOGIST OF THE YEAR AWARD for 2001: Rick Young 3
LIFETIME ACHIEVEMENT AWARD for 2001: Ellen Sue Turner 3
JIMMY MITCHELL AWARD for 2001–OUTSTANDING CONTRIBUTIONS TO SOUTH TEXAS ARCHAEOLOGY: Karen and Mike Fulghum 4
IN MEMORIAM: Dorothy Lee Hindes: 1926-2003 4
NOTES ON SOUTH TEXAS ARCHAEOLOGY: 2002-4
Problems in Typology in South Texas and Northeastern Mexico (Thomas R. Hester) 5
FIRE-CRACKED ROCK EXPERIMENTS: THE POTENTIAL OF THREE ANALYTICAL TECHNIQUES (Richard T. Stark) 12
PROJECTILE POINTS OF THE CALF CREEK HORIZON FROM FRIO, MEDINA, AND UVALDE COUNTIES, SOUTHERN TEXAS (David Calame, Sr., Carey Weber, Larry Banks, and Richard McReynolds) 29
CALF CREEK HORIZON POINTS FROM WILSON COUNTY, TEXAS (Richard McReynolds) 39
IDENTIFICATION OF HEAT-TREATED CHERT (Leland W. Patterson) 45
OBSERVATIONS ON THE USE OF BAKING SODA TO SOFTEN HARD CLAY AT FORT SAINT LOUIS, 41VT4 (Bryant Saner, Jr.) 49
AUTHORS 53
INFORMATION FOR CONTRIBUTORS 54
TEXAS SOUTHERN COUNTIES MAP and METRIC CONVERSION CHART 55
STAA SPECIAL PUBLICATIONS ORDER FORM 56

About the cover: A Calf Creek Horizon point. See Calame et al., p.35.

Information For Contributors:

Manuscripts for Vol. 30 should be sent to the Editor, Dr. Tim Perttula, 10101 Woodhaven, Austin, TX 78753-4346. Email him at tkp4747@aol.com . Dr. Perttula should also be contacted for production matters.. New authors are encouraged to contact the Editor for assistance in developing and submitting their papers. We greatly welcome papers on the archaeology of South Texas and surrounding areas, as well as from other parts of Texas.

Membership and publication information:

Request information on joining the STAA and send membership applications to Roy Banning, Memberships Chair, 11807 Broadwood, San Antonio, TX, 78249, 210-561-0244. Email: royb@swlegal.com. See STAA internet address below. Back issues of *La Tierra* and Special Publications can be ordered online or through Mr. Banning.

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THE DEE ANN STORY CONSERVATION AWARD
for 2000

TERRY CULLEN, Senior Vice President and Trust Manager of the First Victoria National Bank, accepts the award as Trust Manager for the Keeran estate, location of the site of Fort Saint Louis (41VT4), a major historical archaeological site in Texas.

THE ARCHAEOLOGICAL LIFETIME ACHIEVEMENT AWARD
for 2000

TOMMY TOMESAL has worked tirelessly heading up recruiting and outreach projects. He has been our telephone committee chairman for many years, interviewing all new members to help them become more acquainted with STAA. He was a diligent worker at the Dan Baker site, and again at the Onion House before his retirement from STAA Board.

THE OUTSTANDING AVOCATONAL ARCHAEOLOGIST OF THE YEAR AWARD
for 2000

DON SHIRLEY served as Field School Director for two sessions at the Stiver Ranch near Junction, Texas. Don could always be called upon to organize things, fix them and also to wake everyone up each morning. His good nature and steadfast dedication to the job made the field schools more enjoyable.

THE DEE ANN STORY ARCHAEOLOGICAL CONSERVATION AWARD
for 2001

Bette and Don Burris

This award was given to Bette and Don Burris of Victoria, Texas, owners of the Burris Bison site site (41VT66 and 41VT41), location of the STAA's 2001 Field School, and for all the previous excavations done in concert with Bill Birmingham, Jeff Huebner and Smitty Schmiedlin.

THE PUBLIC SERVICE AWARD
for 2001

Dr. Steve Black receives his award from Dr. Tom Hester (right).

Dr. Black is presented the Public Service Award for his work sponsored by the Texas Archeological Society and the University of Texas Archeological Research Lab in the creation of an educational website entitled "Texas Beyond History." This website will reach thousands of people throughout Texas and the world.

THE OUTSTANDING ARCHAEOLOGIST OF THE YEAR AWARD for 2001

Dr. Hester (left) presents the award to Rick Young

Rick has been an STAA member for five years. He is the laboratory director for our monthly lab and has been the host of our monthly fieldwork (Young site 41BX1428). He takes a lot of pride in serving STAA. He also works for Dr. Steve Tomka at the Center for Archaeological Research, UTSA.

LIFETIME ACHIEVEMENT AWARD for 2001

Ellen Sue Turner receives her award from Dr. Tom Hester

This award recognizes Ellen Sue Turner's contributions to the STAA during her 28 years as a member, officer, and frequent contributor to *La Tierra*. Sue has been extremely active in public outreach, working with persons interested in archaeology and encouraging the scientific documentation of collections. Whether at McFaddin Beach, San Antonio, Uvalde, Bandera or a host of other locales, Sue has always promoted the goals of STAA in her interaction with hobbyists and collectors. She is the senior author (with Thomas R. Hester) of *Field Guide to Stone Artifacts of Texas Indians* (now in its second edition), a contributor to the *New Handbook of Texas*, and author of papers in the *Bulletin of the Texas Archeological Society.*

THE JIMMY L. MITCHELL AWARD
OUTSTANDING CONTRIBUTIONS TO SOUTH TEXAS ARCHAEOLOGY
for 2001

Mike and Karen Fulghum, Dr. Tom Hester on right.

Karen and Mike have served STAA for many years–Karen as Chairman of STAA for 2000 and 2001, and other positions -- Vice Chair, and Secretary. Mike has served as Field School director and as a committee member for several field schools. The couple have been newsletter editors since 1996. Mike worked for many months on the Fort St. Louis Project in Victoria County. Both Karen and Mike have volunteered many hours to a number of other archaeological projects in South Texas.

* * *

Dorothy Lee Hindes: 1926-2003

In 1990, Dorothy Lee Hindes (Mrs. Bob Hindes) of Charlotte, Texas, was the recipient of the Dee Ann Story Archaeological Conservation Award, presented by the Southern Texas Archaeological Association. Since the late 1960s, she had been an active supporter of archaeological studies in south Texas. Her family's Green Branch Ranch in McMullen County was the source of a large documented collection of artifacts, a collection that she made available for research by a number of STAA members over the years. Mrs. Hindes passed away on February 14, 2003 and was buried in the Charlotte City Cemetery.

I first learned of Mrs. Hindes' interests in 1969, while a student employee at the Texas Archeological Research Laboratory. From 1969 through 1971, she provided a great deal of information to TARL on sites on Green Branch Ranch and recorded a number of them. She later played a key role in organizing a collections-identification meeting in Jourdanton in 1985, including a major display of her own artifacts. Jimmy Mitchell, C. K. Chandler, and others from STAA went down to this night-time event, While we hopefully provided information to the many folks who showed up, we were actually the ones on the "learning" end of the experience--completely astounded by what we had seen. C. K. and Jimmy published various materials they had documented., and I still have pages of notes that I took that serve as a source of information on that area. This "show and tell" event provided a model for other similar gatherings that the STAA has organized over the years. Mrs. Hindes' collection was documented in an excellent (but yet unpublished) paper by Kay Thompson Hindes and Teresa Eaton. Mrs. Hindes epitomized the south Texas rancher-collector, protective of their sites, but interested in the study of the cultural heritage of the region.

Thomas R. Hester

NOTES ON SOUTH TEXAS ARCHAEOLOGY: 2002-4

Problems in Typology in South Texas and Northeastern Mexico

Thomas R. Hester

This paper reviews several typological issues in southern Texas and northeastern Mexico. There are no "answers" in these observations, and as with all things typological, the objective to update, review, and open up for discussion some of the working models that we refer to as "types." For example, this issue of *La Tierra* contains two papers dealing with the occurrence of Andice and Bell points in south Texas. Indeed, this journal has been an important outlet for the last 20 years in the documentation and study of these distinctive basal-notched bifaces. The experimental studies and careful technological analyses by Carey Weber (cited elsewhere in this volume) have made major contributions; distributional studies by C. K. Chandler and several other authors have documented the widespread, and rather common, occurrence of Andice and Bell throughout south Texas and adjacent area. The work done by Don Wyckoff in Oklahoma since the late 1980s has clearly shown that these Texas "types" – Andice and Bell—are variations of a much broader pattern which he has termed the Calf Creek Horizon (these same "Texas" points are called Calf Creek in Oklahoma). A largely overlooked publication on the excavation and analysis of a site containing Calf Creek Horizon materials in Hays County, Texas (Ricklis and Collins 1994) should be consulted by *La Tierra* authors who write about these artifacts in the future. It also includes illustrations of "Andice" points from the Gault site. The two volumes in which the study is published are available from TARL and can be ordered on-line. Archaeologists in Texas continue to measure the depth of basal notches and other attributes of Andice and Bell, and fail to recognize that little of this matters—except for necessary description. The "Calf Creek" typological designation ought to replace Andice and Bell and, if nothing else, reduce the proliferation of unwieldy paper titles! It is clear that Calf Creek is a "horizon" representing the spread of these large basal notched bifaces in the Early Archaic (or if as some prefer, the redefined Middle Archaic) over a broad geographical region.

A poorly known type that is causing much confusion in the region is the "Charco" or Charcos point style found in western and southwestern Coahuila, Mexico. Turner and Hester (1993, as well as Hester 1990; Davis 1991) made a serious error by including the South Texas border in the area of distribution for this northeastern Mexico type. The confusion arose from some morphological similarities between Charcos and Shumla in southern Texas, and a few lateral-edge-notched points that had been found--but they are not Charcos. I know that I was influenced by a laterally-notched stemmed point found by A.E. Anderson at La Sal Vieja in Willacy County (collection at TARL) but a subsequent reexamination of that artifact shows that it is not Charcos (e.g., it is side notched, not basal notched). Despite repeated requests over the last decade, I am unable to get anyone to demonstrate the occurrence of Charcos points from known sites or documented collections from the middle and lower Rio Grande of Texas.

However, the "importers" of great numbers of Charcos points from northeastern Mexico are selling them (on commercial artifact-sales internet sites) across the United States as being from "Starr and Zapata counties" in southern Texas. Indeed, there may now be more Charcos points in North America than there are left in Mexico, given the scale of "importation" in past decades.

It is also difficult to track the definition of this "type." Arroyo de Anda et al. (1956) illustrated some of these artifacts (Figure 1) from the Bolson de Las Delicias (Torreon area, Coahuila). But, it appears that Neil S. Utberg, an artifact dealer in McAllen who collected extensively in the Torreon area prior to 1972 (the year of the US-Mexican treaty prohibiting import of Mexican artifacts), may have used the term first. In a curious, but highly useful, artifact catalog which Mr. Utberg published in 1969, *The Indian Artifacts of Mexico and South Texas* [McAllen, TX, 1968-1969 imprint], this distinctive point

Figure 1. Projectile Points from the Bolson de las Delicias, Coahuila. From Aveleyra Arroyo de Anda et al. (1967). These points have subsequently been described by others as Charcos.

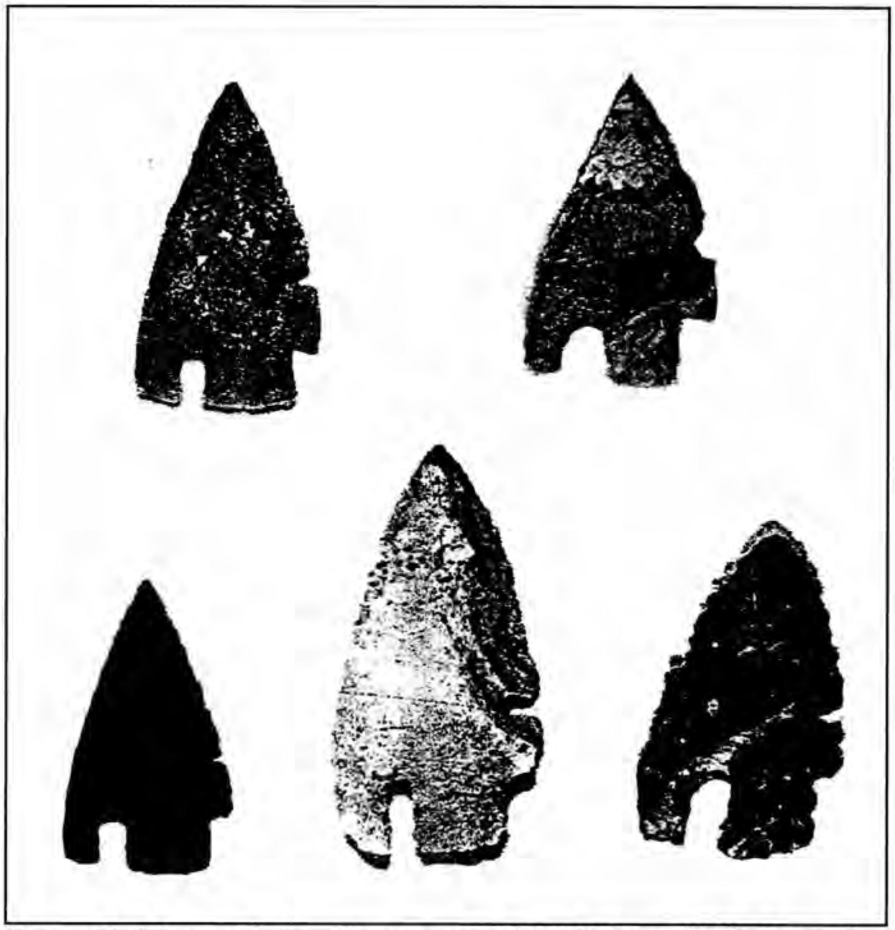

Figure 2. Charcos Points Illustrated by Neil Utberg, 1969. From the Laguna de Mayran Area.

"Charcos." About 100 specimens were illustrated in high quality photographic plates, and Utberg observed (ibid.), "... 'Charco' points were only made in Coahuila in the old Lake Mayran area" (see also Davila Aguirre 1967: plate following p. 86; Cardenas Villarreal 1978: 24). These distributional observations are confirmed by Heartfield (1975) in her survey of the Desierto de Charcos de Risas in southwestern Coahuila. She formally defined the Charcos type (see also Greene 1971) for this region between Saltillo and Torreon. A few Charcos points have apparently been found in the Cuatros Cienegas region not far to the northeast, based on limited collections that I have seen from that area. However, Taylor (1964), in reporting the chronology of Frightful and Fat Burro Caves and other shelters excavated at Cuatro Cienegas, does not illustrate or discuss any points that could be classified as Charcos. In Turner and Hester (1993), we also indicated that Charcos may occur in the Texas Big Bend, but again, this was based on "hearsay," and at present, I am unable to confirm such distribution at the present time.

The restricted distribution of Charcos is confirmed by publications of Archaic lithics from adjacent Zacatecas and Durango (Spence 1971 ; Silva and Hester 1973), from Nuevo Leon to the southwest (Nance 1992, as well as San Luis Potosi, Rodriguez 1983), and to the northeast by Taylor (1964). Dating of Charcos remains unclear, though Heartfield (1975) suggests that it is Late Archaic (and perhaps later). It appears to have dropped out of the scene in the southwestern Coahuila area by Late Prehistoric times, based on the data from Cueva de la Candelaria (Arroyo de Anda et al. 1956) and other sites (Hester et al. 1994).

Similar distributional confusion exists for Duran points (Figure 3), defined for the Cuatros Cienegas region by Taylor (1964). He was able to place it in the Middle Archaic portion of the Coahuila Complex (see also Heartfield 1975). Again, internet artifact-sales sites post these "Duran" points as being from "south Texas" or "west Texas," often made of distinctive white chalcedony material and multiple side notches. Avocational archaeologists and collectors who are knowledgeable of the Texas Big Bend report some similar points from that region, but the specimens I have seen would not fit into Duran as illustrated by Taylor. Complicating the issue is the presence of numerous multi-lateral notched, contracting stem points of yet-undefined types from other parts of northeastern Mexico that are not contemporary with Taylor's Duran type (e.g., Silva and Hester 1973).

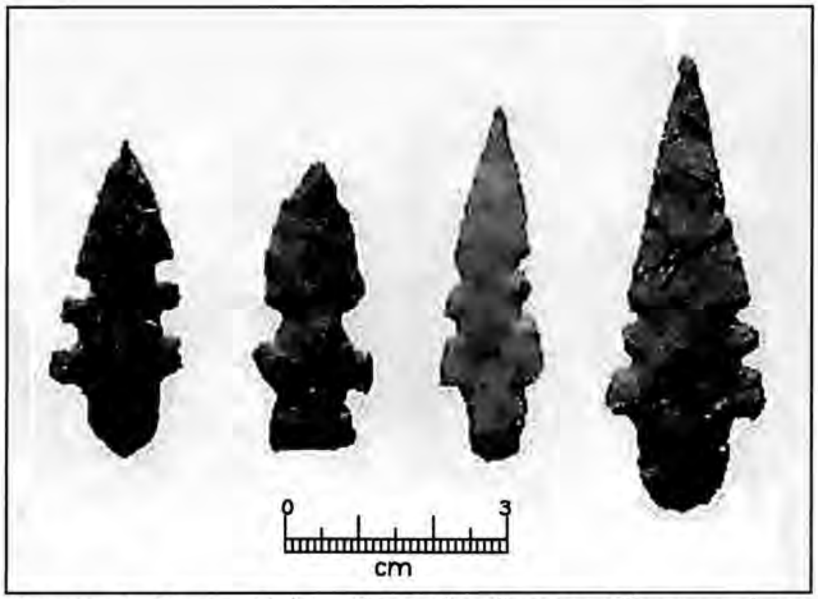

Figure 3. Duran Points from the Cuatros Cienegas Area, Coahuila. From Taylor (1964).

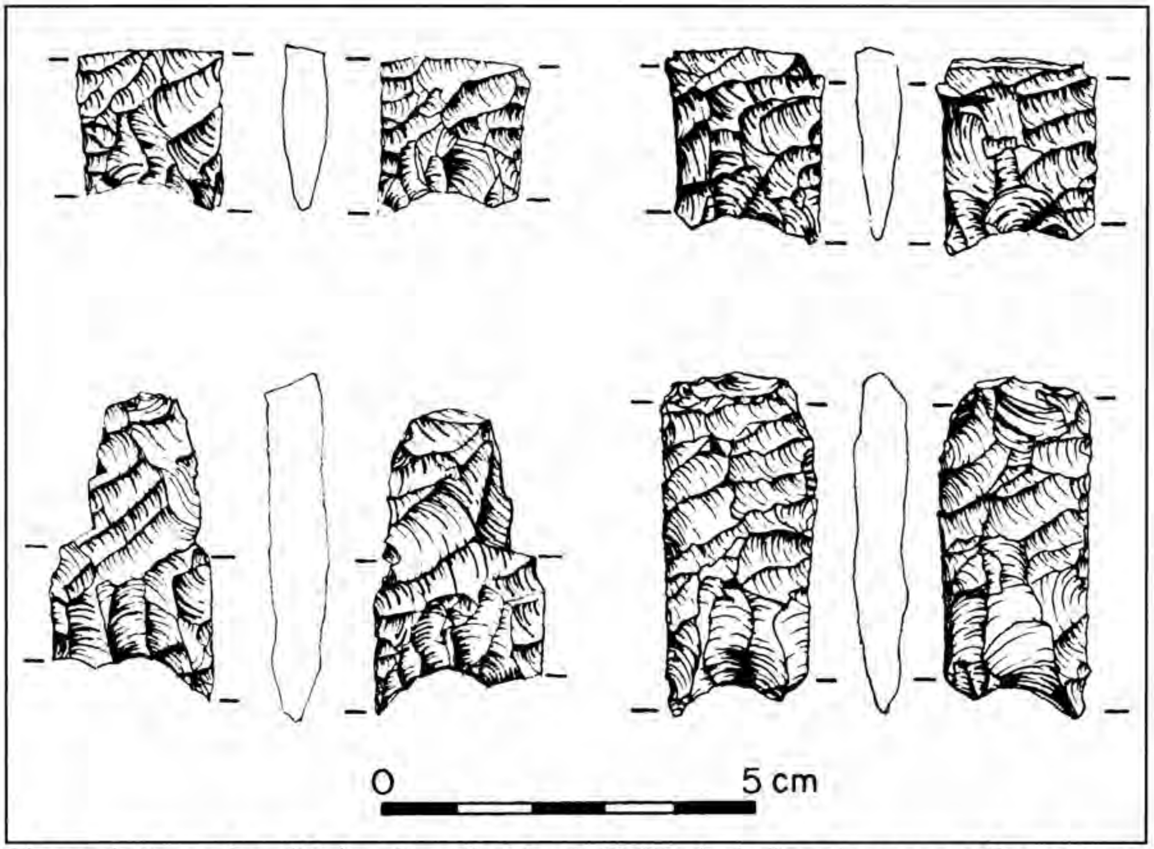

Figure 4. Examples of Points from St. Mary's Hall Paleoindian Component. From Hester (1991). Originally described as "Plainview" points.

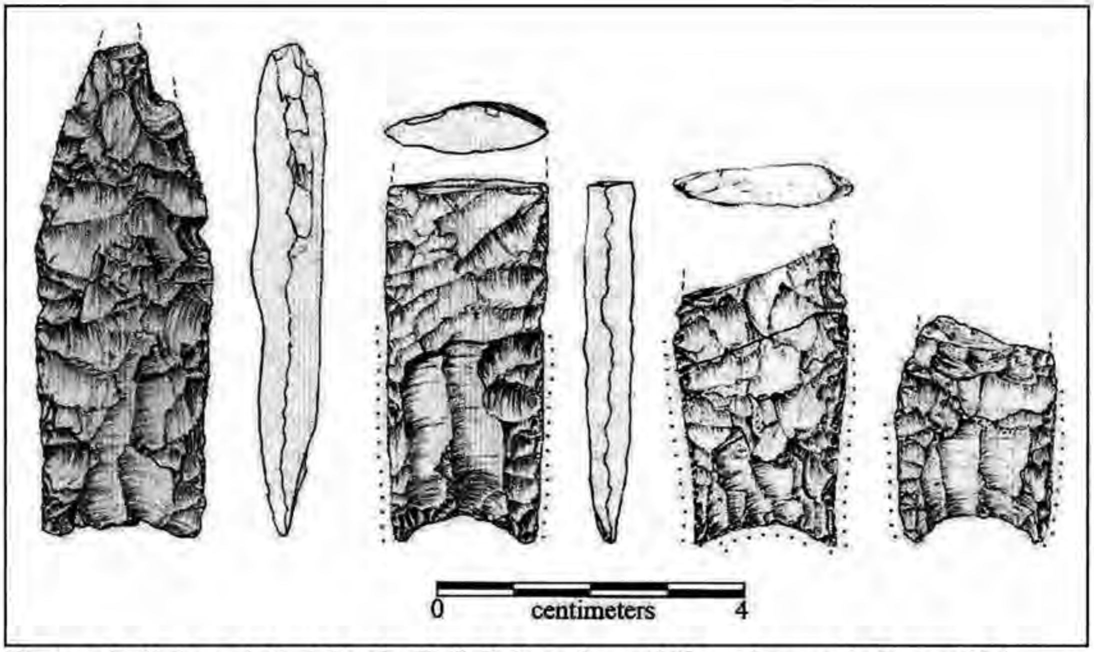

Figure 5. Selected St. Mary's Hall Points from Wilson-Leonard. From Dial et al. (1998)

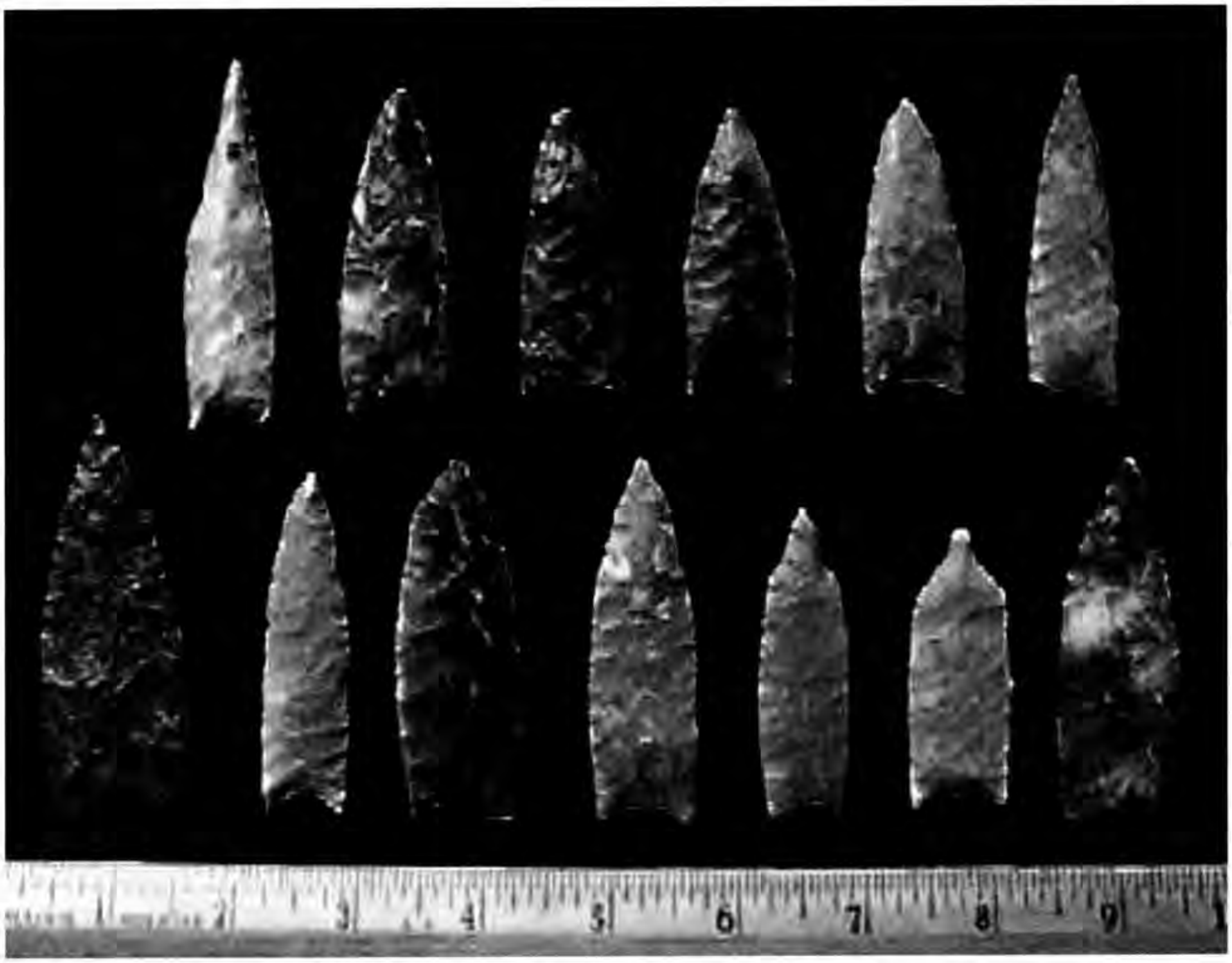

Figure 6. Examples of Paleoindian Points from the Cibolo Creek Site, Wilson County, Texas. From the Jay Roach collection. Photograph by David Calame, Sr.

Finally, there is the emerging and constantly changing typological framework for Paleoindian times in Texas and beyond. The landmark study at the Wilson-Leonard site (Collins 1998) provided a wealth of new data on chronological sequence and typological dimensions for Late Paleoindian points. Many points once labeled as "Plainview" in southern Texas are defined as "St. Mary's Hall," based on the specimens found at that site (41BX229) during STAA and UT-San Antonio excavations in the 1970s (see Hester 1991; Figure 4). The new type, proposed by Dial et al. (1998:324), termed "St. Mary's Hall," (Figure 5) has not yet been widely disseminated beyond the Wilson-Leonard report. It is defined as later than Plainview, and very broadly dated within a range of 9900-8700 years ago.

A major opportunity for typological research involving Paleoindian projectile points exists in the several very large collections from the Cibolo Creek Site (or Sand Pit), along Cibolo Creek in Wilson County (Pfeiffer 2001). A commercial gravel and sand-mining operation led to the recovery of many thousands of artifacts, collected during sand-sieving procedures and subsequently acquired by many collectors (see also

McReynolds, this volume). The sheer numbers of Paleoindian points (Figure 6), the morphological diversity, the range of "types" represented, etc., would provide tremendous resources for statistical and technological studies of existing and proposed Paleoindian types. There are no chronological controls, of course, but much new data can be had from the examination, for example, of hundreds of Plainview, St. Mary's Hall, Scottsbluff, Angostura, and other types (Clovis, Folsom, San Patrice, Midland, Dalton or other forms that may represent variants or even new types). Initial efforts at documentation have been made by STAA member David Calame, Sr. and son Bud., but much more remains to be done.

ACKNOWLEDGMENTS

The author wishes to thank Van Van der Veer for his work in producing the figures for this paper. Some had to be derived from photo copies and any problem with the image is the author's, not Mr. Van der Veer's! Thanks to David Calame, Sr. for the photograph used in Figure 6, and to Jay Roach, for his permission to study artifacts from the Cibolo Creek site, and to publish this illustration. Cindy Smyers of Midland, Texas has provided information on points from the Big Bend region that have lateral edge notching and may be related to Duran.

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FIRE-CRACKED ROCK EXPERIMENTS: THE POTENTIAL OF THREE ANALYTICAL TECHNIQUES

Richard T. Stark

ABSTRACT

A study of the physical nature of heated limestone rock was undertaken as an effort to understand the archaeological potential of three approaches to fire-cracked rock analysis: archaeomagnetism, x-ray diffraction, and thin-section analysis. Thirty limestone samples were cut into 4x4 inch cubes and subjected to various heating and cooling histories. Three distinct sources of limestone were used. The experiments were conducted in an electric kiln and monitored by thermocouples. One-inch cores were taken of the experimental cubes and submitted to archaeomagnetic, x-ray diffraction, and thin section analyses. Results: 1) Archaeomagnetic predictions of the maximum level of heat exposure to the rocks were 75% accurate. 2) The mineral portlandite was found to appear only in samples cooked for 8 hours at 800C. 3) The minearal vaterite appeared only in samples cooked for 24 hours at 800C. 4) The amount of portlandite significantly increases with the amount of time a sample was exposed above 800C. 5) Curvilinear micro-fissures appear only in thin-sections of samples that were water quenched (quick cooled). 6) Temperature profiles within various regions of a particular stone may exhibit great disparity.

By using reliable and repeatable techniques of analysis fire-cracked rocks surrender information related to human behavior. Archaeological sampling and curation of the fire-cracked rock artifact class is encouraged, as one-inch rock cores facilitate archaeomagnetic, x-ray diffraction, and thin-section analyses with minimal use of curatory space.

INTRODUCTION

The relevance of fire-cracked rock (FCR)[1] research, as one means to better understand the socio-economic structures of prehistoric foragers, cannot be overstated. FCR is the result of the use of rocks for heat storage and transfer to another medium, often food (Jackson 1998; Thoms 1986). FCR used in this manner may be referred to as cooking stone. Archaeological inquiry into the nature of FCR is both widespread (Barfield 1990; Black 1995a; Black et al. 1997; Bowsher 1990; Buckley 1990a, 1990b; Frison 1983; Larsson 1990; Movius 1966; Ramseyer 1991; Thoms 1986) and time deep. In Texas the study of burned rock middens and their associated FCR has a history approaching 100 years (Hester 1991:v). The goals of this paper are to discuss new findings about the nature of FCR and to report on the potential for new analytical techniques to better understand the fire-cracked rock artifact class. Specifically, by illustrating the potential of three analytical techniques, archaeomagnetism, x-ray diffraction, and thin section, this paper encourages thorough archaeological sampling of fire-cracked rock. Culturally constructed combustion features, such as earth ovens and hearths, are often social hubs of activity and therefore present archaeologists with unique opportunities to interpret prehistoric human behavior. Data gained from analyzing archaeologically recovered fire-cracked rock may be used to interpret maximum cooking temperatures, the duration of firing, and the geologic source of the stone thermal element. Therefore, in addition to understanding the cooking technique used for particular features, archaeologists may also infer fuel loads related to temperatures/duration of firing, and potential thermal element quarry locals. Ultimately, these data will help archaeologists to better understand prehistoric culinary environments, paleo-nutrition, and subsistence organization.

Archaeological evidence reveals that the first use of cooking stone in Texas coincides with the terminal Pleistocene, roughly 10,000 years ago (Thoms 2000, Black et al. 1997, Collins 1996). One of the earliest documented earth ovens in North America is a thermally altered rock-lined pit at the Wilson-Leonard site (dated to 8000 B.P) in central Texas (Guy 1998). Stratigraphically below this oven was a small rock-lined hearth[2] dated to 10,000 B.P. By 8,000 years ago Texas foragers were using cooking stones regularly, both in earth ovens[3] and boiling containers,[4] and these practices continued through the Archaic and into the Late Prehistoric period (Black et al. 1997). Cooking stones were an important tool in prehistoric Texas forager culinary regimes, and therefore much archaeological attention has been given to the fire-cracked rock artifact class (for example: Black 1985, 1989; Black et al. 1997; Collins 1991; Creel 1986, 1991; Gearhart 1987; Greer 1965; Hester 1970, 1971, 1973, 1981, 1991; Howard 1983, 1991; Jackson 1998; Peter 1982; Prewitt 1976, 1991; Ricklis and Collins 1994; Wier 1976, 1979).

Analytical techniques to interpret the heating and cooling histories of prehistoric cooking features have utilized the techniques of archaeomagnetism (Aitken 1990; Collins et al. 1990; Eighmy 1980; Gose 1994) to measure the maximum temperature of heating, the intactness of a combustion feature, and the number of heating episodes that a stone has experienced. This paper tests the ability of archaeomagnetism to make maximum temperature estimates of FCR, as well as discusses the value of two other analytical techniques for FRC: x-ray diffraction and thin-section analysis.

EXPERIMENTAL DESIGN

Outdoor cooking features and their associated thermal elements (typically rocks) have diagnostic heating and cooling histories (Jackson 1998). A particular rock's heating and cooling history is recorded in its mineralogy, remnant magnetism, and diagnostic micro-fissures. Earth ovens are typically subjected to intense heat (up to 900 degrees Celsius [900C]) for a relatively brief amount of time followed by a long cool-down period. This cool-down time begins after the oven is sealed and lasts until the rocks finally reach the ambient air temperature, often over 24 hours. Open-air hearths are subject to the same initial heat treatment, however their cooling time is shorter. Once the fire is out, the cooling history for an open-air limestone hearth is from 2-6 hours. For combustion features that involve water quenching, such as stone boiling and sweat baths, the heating history is one of reiteration while the cooling history is cut to a matter of seconds or minutes. Figure 1 is a thermodynamic model comparing the heating environment for a stone boiling feature versus an earth oven.

In Figure 1, the boiling stone line shows that the boiling stones are repeatedly exposed to high temperatures, with each heating episode followed by quick cooling. Boiling stone heat treatment only lasts for a matter of minutes, while for earth oven stones the heat treatment may last up to five hours. The line in Figure 1 modeling the thermodynamic processes of earth ovens shows that once the earth oven is closed, the rock temperatures drop to around 200C followed by gradual heat loss over the next 48 hours.

The experimental design for this project involved replicating the heating and cooling histories of earth oven and boiling stone thermal elements. Three limestone sources (X, Y, and Z) were used. Twelve samples were prepared from each geologic source,[5] and each sample was cut into a 4x4-inch cube and subjected to a unique heating/cooling history. Heat treatments ranged from 300C to 800C and from 1.5 hours to 24 hours in duration. Heat treatment was inside an electric kiln. Cooling treatments ranged from slow cooling inside of the kiln, to rapid cooling in a bucket of water. Table 1 reviews the heating and cooling histories for the experimental samples.

The 4x4 inch experimental stone cubes were then cored into one-inch samples for analysis. Rock cores not analyzed were curated. Rock cores were submitted for archaeomagnetic analysis to determine the accuracy of maximum temperature descriptions. X-ray diffraction analysis was used to determine the affect of duration of heating on rock mineralogy. Thin-section analysis was used to visually compare the mineralogy samples cooled rapidly in water with those cooled slowly at room temperature.

Table 1. Heating and cooling histories of laboratory samples.

Samples	**Max Temp**	**Duration**	**Cooled By**
X0,Y0,Z0	***********CONTROL GROUP—NO THERMAL ALTERATION***********		
X1,Y1,Z1	632 C	2 hours	air cooled
X2,Y2,Z2	729 C	2 hours	air cooled
X3,Y3,Z3	307 C	2 hours	air cooled
X4,Y4,Z4	307 C	2 hours	water quenched
X5,Y5,Z5	800 C	8 hours	air cooled
X6,Y6,Z6	600 C	8 hours	air cooled
X7,Y7,Z7	800 C	2 hours	air cooled
X8,Y8,Z8	600 C	1.5 hours	water quenched
X9,Y9,Z9	800 C	2 hours	water quenched
X10,Y10,Z10	600 C	24 hours	air cooled
X11,Y11,Z11	800 C	24 hours	air cooled
X12.Y12.Z12	600C	6 hours	air cooled

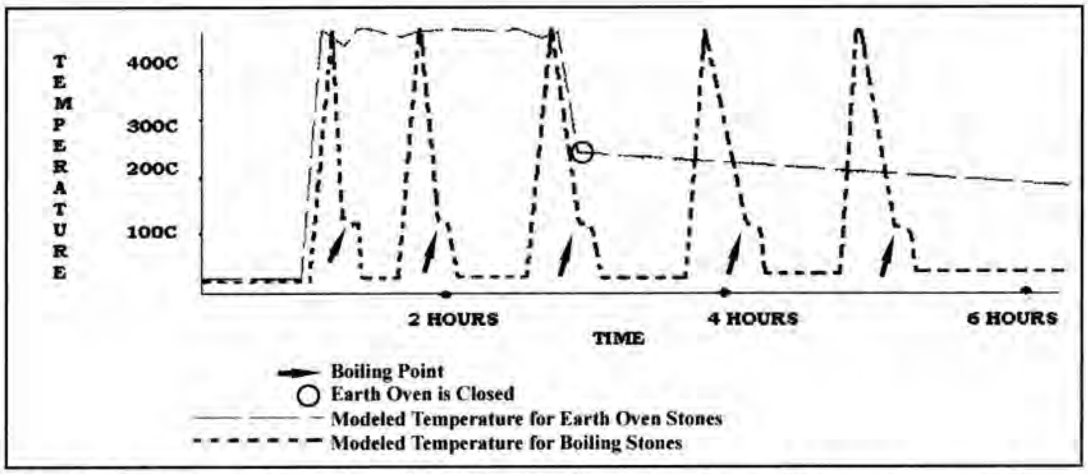
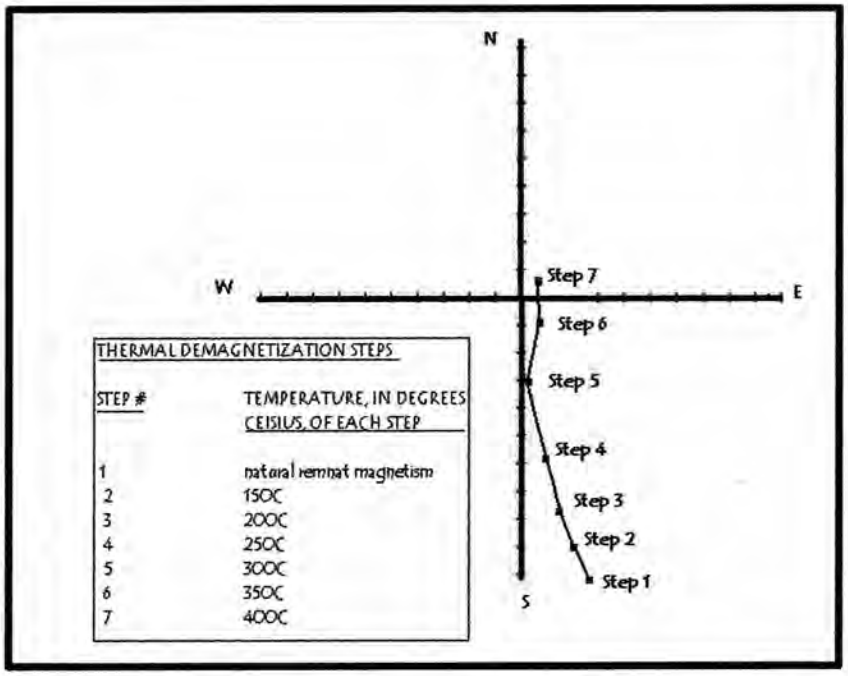


Figure 1. A comparison of modeled thermodynamics for earth oven stones and boiling stones (adapted from Jackson 1998:32 and Stark 1997).



THERMAL DEMAGNETIZATION STEPS

STEP #	TEMPERATURE, IN DEGREES CEISIUS, OF EACH STEP
1	natural remnat magnetism
2	150C
3	200C
4	250C
5	300C
6	350C
7	400C

Figure 2 Archaeomagnetism Sample Z3 originally was heated to 307C for two hours then cooled at room temperature During the thermal demagnetization steps the magnetic vector changed directions at Step 5, accurately interpreting the maximum experimental temperature at 300C.

ARCHAEOMAGNETISM

Archaeomagnetism,[6] or the application of paleomagnetic techniques to archaeological features, is often used in FCR research (Collins et al. 1990; Ramseyer 1991; Takac 1993). Archaeomagnetic data and analysis were provided with the assistance and direction of Dr. Wulf Gose of the University of Texas Department of Geology, and Paul Takac. Although archaeomagnetism has been used previously for fire-cracked rock research to infer maximum temperatures (Collins et al. 1990:69-78; Gose 1994:507-537), no experiments known by the author have been published which test the procedure.

Limestone contains the magnetic minerals hematite and magnetite. If limestone is heated above the Curie temperature for these minerals (680C for hematite and 580C for magnetite) their electrons are freed to rotate. Once the rocks are cooled the electrons become realigned with the current magnetic north.

> ...[W]hen materials containing magnetic minerals are heated above the Curie point (approximately 700C), the electrons of the magnetic minerals are thermally agitated and begin to rotate freely. As the material cools, the electron orbits tend to align with the earth's magnetic field and, with further cooling, are locked in place. Heating to temperatures below the Curie point usually results in partial thermoremnant magnetization, resulting in a less pronounced but often still detectable overall magnetization of the material (Abbott and Frederick 1994: 540).

Through a process called thermal demagnetization small samples of the rocks are heated in steps, typically in 50 degree (C) increments. After each step the magnetic alignment signal is recorded, ultimately producing a vector diagram. Theoretically, these vectors will travel in a straight line until the maximum temperature to which the rocks were heated is reached. At this point an abrupt change in the direction of the vector plot indicates the maximum temperature that the stone was exposed to.

> Careful thermal demagnetization will reveal the [maximum] temperature of heating. This information can be used to extract two different pieces of information from rocks utilized in a fireplace or midden: (1)...whether the rocks have remained undisturbed since their last use; (2)...the [maximum] temperature of heating provided that the temperature has not exceeded the Curie temperature (Gose 1994:507).

For instance, sample Z3 was heated to 307C. The archaeomagnetic vector reading records a dramatic shift in direction after the 300C thermal demagnetization step, thus accurately describing the maximum temperature for Z3 (Figure 2).

In this study, a majority of the archaeomagnetic vector plots indicated maximum temperatures similar to what the rocks experienced during their experimental kiln firing. There were, however, some notable exceptions. For example, sample Z2 was heated to 729C, however the archaeomagnetic vector plot interprets a 200 degree maximum temperature (Figure 3). The likely source of error in this instance is the fact that the maximum temperature exceeded that of the Curie temperature for the magnetic minerals of this sample (Gose 1994: 507).

Of the 20 archaeomagnetic studies carried out, 15 vector plots accurately predict the maximum experimental temperature, four produce inaccurate predictions, and one vector plot is inconclusive. The 75% accuracy rating indicates that other methods should be coupled with archaeomagnetism to confidently infer maximum temperature estimates of heated stones. Likely sources of error could be exposure of the sample to temperatures above its magnetic mineral's Curie temperature, lightning strikes, grass and tree fires, weak remnant magnetic signals, researcher error, and/or the thermal gradient inherent to heated stones. The nature of this thermal gradient will be discussed below.

X-RAY DIFFRACTION

"X-Rays Don't Lie"
Poster on the door of the X-ray Room,
Geology Department, UT/Austin

The minerals that make up a substance can be identified via a technique called x-ray diffraction. In this technique x-rays infiltrate between the atoms of crystals in the substance. The x-rays are reflected in angles diagnostic of each specific crystal giving a 'fingerprint' of a specific mineral (Plummer and McGeary 1979) (Figure 4).

X-ray diffraction analysis was performed by Dr. Leo Lynch of the University of Texas geologic x-ray laboratory. Three samples were submitted for x-ray analysis: X0, a control sample; X5 heated to 800C for 8 hours; and X11 heated to 800C for 24 hours. The x-ray analysis was undertaken to determine how duration of heating affects rock mineralogy.

The X5 sample contained portlandite[7], which was not present in the control, X0 (Figure 5).

The X11 sample, which was baked for 24 hours up to 800C, contained an even larger amount of portlandite, and vaterite (8) a mineral present in neither sample X0 or X5 (Figure 6).

While at this point there has not been enough experimental testing to claim that the appearance of specific minerals in archaeologically recovered limestone indicates a specific duration of heating above a specific temperature, these data do constitute a line of evidence which merits further investigation. At this point one could only say that heated limestone rocks, relative to unheated limestone rocks, have increasing amounts of portlandite and vaterite formed throughout the heating duration. Also, clays apparent in unheated limestone disappear in limestone heated to 800 degrees Celsius.

THIN SECTIONS

Thin-section analysis focused on the rate of cooling variable. The samples analyzed were either allowed to cool slowly at room temperature or were cooled rapidly in a bucket of water. The objective was to determine whether water-quenched rocks (simulating stone boilers) retain any morphological differences when compared with those cooled over a long period of time (like earth oven rocks).

There is a substantial amount of literature on the fracture patterns of FCR, however most of it involves macro-scale observations (Jackson 1998; Schalk and Meatte 1988; Thoms 1986; Zurel 1979). Rocks fracture as they heat up or cool down because of the disagreement between neighboring grains that are shrinking and swelling throughout the heating/cooling process (Allison and Goudie 1994; Homand-Etienne and Troalen 1984; Schalk and Meatte 1988; Taggart 1981). This process is known as thermal weathering. Expansion fractures set up during heating may be dramatically explosive and are typically reported to be curvilinear (spall, potlid-shaped) in outline. FCRs fractured during cooling/contraction typically exhibit a blocky outline (Jackson 1998:8; Schalk and Meatte 1988:8.6-8.7; Zurel 1979:10). The following thin sections illustrate that distinctive micro-curvilinear contraction fissures may also initiate during the cooling process of limestone.

Figure 7 is a thin section of sample Y7, which was heated to 800C for 2 hours and then cooled slowly at room temperature. Notice the blue hues indicating microporosity, but most importantly, notice the absence of micro-fissures.

Figure 8 is a thin section of X9, heated to 800C then cooled by water. In addition to the blue spots indicating porosity, the meandering and curvilinear crack filled with blue epoxy bisects a benthic foraminifera fossil.

Figure 9 is a thin section of sample Y9, which was heated to 800C, then cooled by water. The epoxy-filled, curvilinear micro-crack crosses a worm tube.

All samples cooled by water contained micro-cracks which typically transverse the entire thin section. These cracks were often dendritic and always curvilinear in nature. No

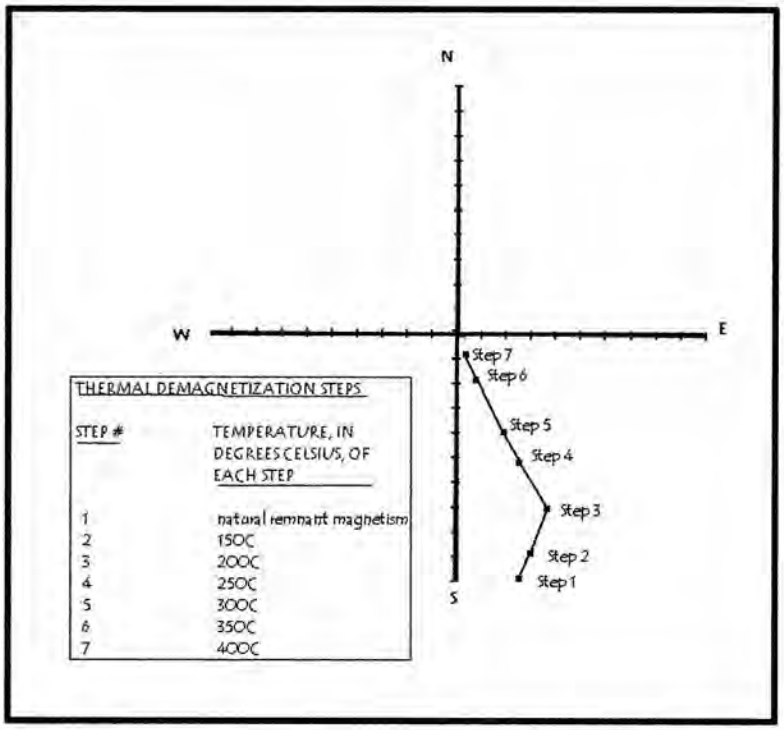


Figure 3. Archaeomagnetism Sample Z2, which had been heated to 729C for two hours then cooled at room temperature, was experimentally re-heated. During the thermal demagnetization steps, the magnetic vector changed direction at Step 3, erroneously suggesting a maximum experimental heating tem-perature of 200 degrees Celsius.

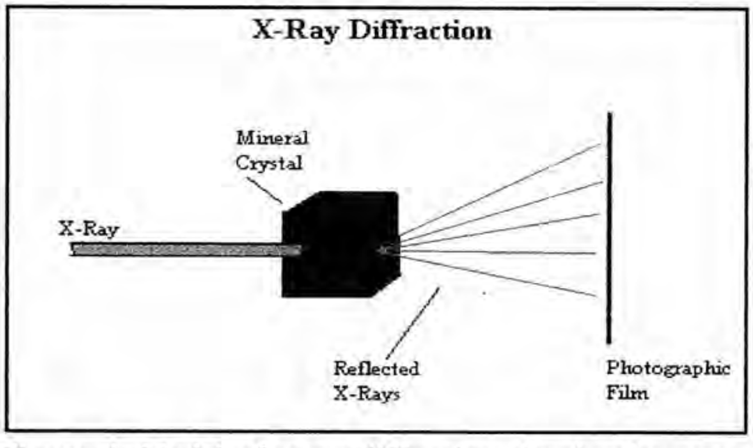


Figure 4. Model of x-ray diffraction showing how rays bombard the minerals and are diffracted at diagnostic angles (graphic modified from Plummer and McGeary 1979:Fig. 2.25).

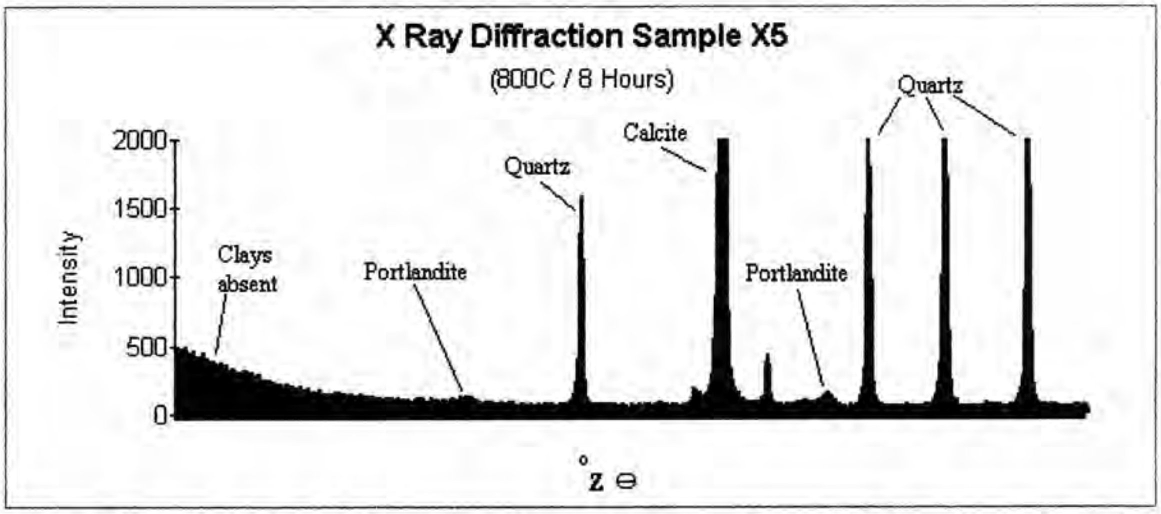


Figure 5. Results of x-ray diffraction analysis of limestone Sample X5, previously heated to 800 degrees Celsius for eight hours, then cooled at room temperature. The horizontal axis indicates diagnostic angles of diffraction for particular minerals. The vertical axis indicates the intensity or level of mineral presence for these minerals.

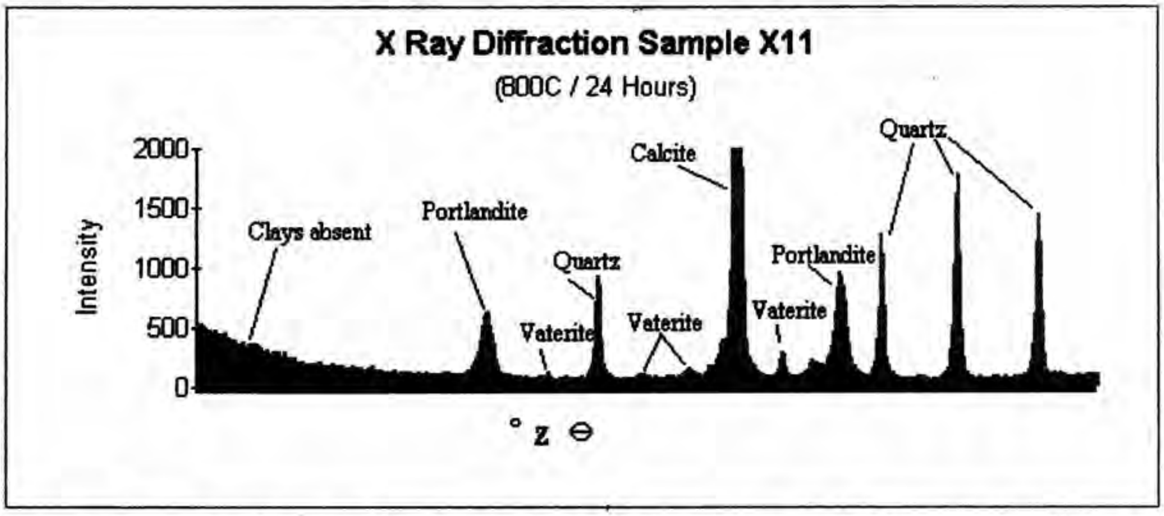


Figure 6. Results of x-ray diffraction analysis of limestone Sample X11, previously heated to 800 degrees Celsius for 24 hours, then cooled gradually inside of the electric kiln. The horizontal axis indicates diagnostic angles of diffraction for particular minerals. The vertical axis indicates the intensity, or level of mineral presence, for these minerals.

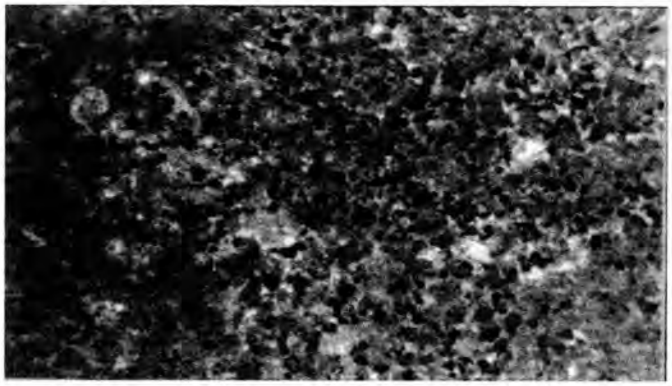


Figure 7. Magnified image (500x) of thin section Sample Y7, which was heated to 800 degrees Celsius for two hours and then cooled gradually at room temperature. Note the absence of any meandering curvilinear cracks.

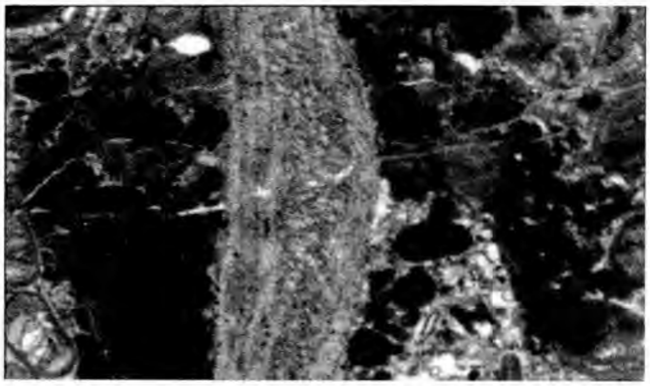


Figure 8. Magnified image (500x) of thin section Sample X9, which was heated to 800 degrees Celsius for two hours and then cooled rapidly in a basin of water. Note the meandering curvilinear micro-fissures.

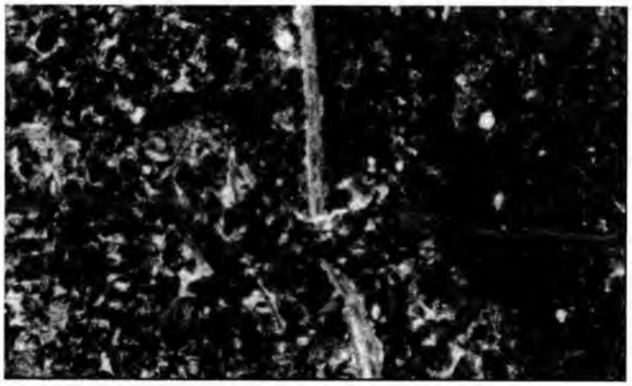


Figure 9. Magnified image (500x) of thin section Sample Y9, which was heated to 800 degrees Celsius for two hours and then cooled rapidly in a basin of water. Note the meandering curvilinear micro-fissure.

micro-fissures were observed in the samples cooled slowly. While it is premature to assert that micro-fissures are diagnostic of heated limestone that has been water-quenched, this line of evidence should be followed as one possible method of distinguishing stone boiling rocks from oven or hearth rocks.

Brink and Dawe (1989) have suggested that macroscopically observed crenellated, or angular and blocky cracks are associated with contraction due to rapid cooling of thermally charged sandstone and quartzite. The implication is that angular fissures should be associated with stone boiling or steam cooking activities, while curvilinear fissures are "...associated with expansion due to heating...[and should be found in] rocks used to line a dry roasting pit" (Brink and Dawe 1989:60). The differences between Brink and Dawe's findings and those reported in this paper are most likely the result of variance in rock type.

A NOTE ON THERMAL DISPARITY WITHIN A ROCK

During the course of analysis for this project a growing concern developed that within a thermally charged rock there may be multiple temperatures. In a hearth feature this would seem obvious: the side nearest the fire would absorb the most heat while the other side might be cold. This accords with the Laws of Thermodynamics, which describe the nature of energy transfer between two systems.

When a heated rock is placed in an environment of lower temperatures, say water or an earth oven, it transfers heat energy to the nearest medium, to the food for instance. This process is described by the First Law of Thermodynamics.[9] Likewise, when a rock is subjected to an ambient temperature higher than its own, the rock absorbs this energy until it reaches the same temperature. For instance, a rock in a fire (or an electric kiln) would be expected to eventually reach the same temperature as the fire or the ambient air in the kiln. This process is described by the Zeroth Law of Thermodynamics.[10] In order to determine how long it took for this process to be completed in the limestone samples, Experiment #12 was designed. After thermocouples were inserted into drilled holes into the core of the sample limestone cube, fire resistant fibers were inserted into each hole so that the recorded temperature would only be that of the rock interior and not the ambient kiln air. Three samples were exposed to 600C temperatures for six hours. The results illustrate a 200C disparity between the rock surface and rock exterior for the entire six hours (Figure 10).

Kiln Experiment #12 indicates that, for some stones there, is substantial lag time between when the ambient temperatures and thermal reservoir come into complete temperature equilibrium. For surfaces exposed directly to the ambient heat, this lag time is greatly reduced; however, for the center of even small stones the lag time may be longer than six hours. The implications for reconstructing the history of combustion activities related to cooking stones is noteworthy: for a substantial period of time during the combustion process, the thermal reservoirs (stones) may hold several temperature values. This is an important factor to consider when coring stones for archaeological sampling. In archaeomagnetic analysis a specific maximum heating temperature is designated at the point of vector change in the thermo-demagnetization sequence. Kiln Experiment #12 indicates that this specific temperature may be one of a range of temperatures maintained concurrently in a stone. The implication here is not that the Zeroth Law of Thermodynamics is invalid, but that there is a long lag time before the core of a stone comes into temperature equilibrium with the ambient air. In some combustion features with relatively short combustion episodes, such as open hearths, sweat baths, and boiling features, the FCR cores may never reach this temperature equilibrium. Further research is needed to determine lag time rates for total temperature equilibrium for various stone types.

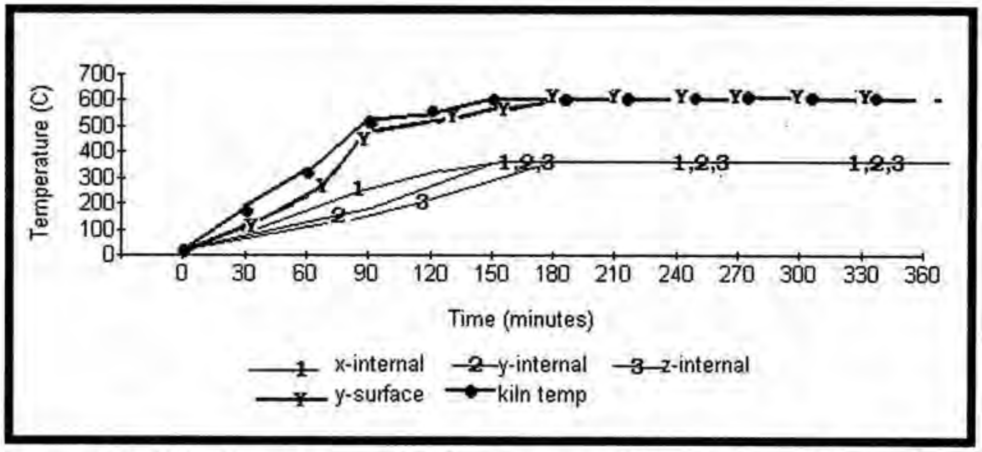


Figure 10. Kiln Experiment #12 demonstrates the variation of internal and external temperatures in three samples of limestone heated in an electric kiln at a maximum ambient temperature of 600 degrees Celsius. Note that 30 minutes after the ambient temperature inside the kiln reached 600C, the surface of the Y rock reached and maintained this temperature. The temperatures of the cores of the X, Y and Z rock samples (1, 2 and 3) reached steady state at about 400C.

CONCLUSIONS

A series of experiments on the nature of fire-cracked rock, using limestone samples measuring 1-cubic inch, indicate that archaeomagnetism, x-ray diffraction, and thin-section analysis may provide a wealth of archaeological data for interpreting the heating and cooling histories of combustion features. From the thermodynamic histories of specific stones, archaeologists may expand the domains of relevance to include the cultural behavior surrounding cooking features, and even broader evolutionary changes in paleo-cuisine, nutrition, and subsistence.

Archaeomagnetic descriptions of maximum temperature exposures for the 20 experimental samples in this study were 75% accurate. Maximum temperature estimates for cooking stones may be used to infer prehistoric cooking environments. When coupled with plant macro-fossil and tool wear analyses, knowledge of the cooking environment would help archaeologists understand prehistoric cuisine, nutrition, and subsistence strategies.

X-ray diffraction analysis indicates that the minerals portlandite and vaterite appear in increasing amounts through time in limestone heated above 800C. With more experimental work, archaeologists in the future may be able to use the presence and quantities of certain minerals as diagnostic of specific cook times for stones. This information could be used to understand how intensively stone thermal elements were used before being culturally re-deposited in burned rock middens.

Thin-section analysis illustrates micro-fissures in heated limestone samples experimentally quick-cooled with water. In terms of cooking environments, this information should be of assistance in distinguishing between stones used in hearths/earth ovens as opposed to those used in boiling features. As well, thin-section analysis aids in locating the exact geologic source of quarried cooking stones. By locating probable cooking stone quarry sites archaeologists increase their understanding of the parameters of resource catchment areas.

Finally, probing limestone samples during experimental heating indicates that FCR should be envisioned as a once hot dynamic system that held a range of temperatures. This serves as a cautionary note for those interested in fire-cracked rock studies, as the lag time for total temperature equilibrium between two systems could be considered in maximum temperature estimates. The slow movement of heat energy through stone, as indicated by this thermodynamic lag time, is precisely why traditional cooks use radiant heat stored in stone to cook food. Thermally charged cooking stones provide a slow, steady, and predictable exchange of heat to food, characteristics sought in even the most modern cooking systems.

Future archaeological sampling and curation of FCR is encouraged by the fact that the types of analyses described here utilize small rock samples, which require little curation space. Additionally, these analyses utilize standard geological techniques that are relatively inexpensive. Technological advances will no-doubt continue to improve our ability to extract culturally germane data from fire-cracked rock, making systematic archaeological sampling and curation of this artifact class imperative.

ACKNOWLEDGMENTS

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NOTES

(1) Fire-cracked rock, referred to in this paper as FCR is defined as any thermally altered stone used in a cultural context. FCR is not specific to any one type of feature and may be created in combustion features that are not related to cuisine.

(2) A hearth may be defined as an open combustion feature <2m in diameter. For combustion features larger than 2m in diameter a different set of behavior may be attributed and therefore the hearth designation is not appropriate. A hearth may or may not be in an excavated basin and may or may not contain FCR.

(3) An earth oven may be defined as a combustion feature used to cook materials (typically food) under a layer of earth. Earth ovens are typically subterranean features, but are not necessarily so. Earth oven forms vary, however they typically contain a pit hearth from 1-3m in diameter and from 30-60cm deep. Heating is via radiant energy from a thermal element (often rocks). Preferred rocks for thermal elements in earth ovens are limestone, porous basalt, sandstone (granites, quartzites, and gneiss are also used) (McDowell-Loudan 1983:26; Jackson 1998:7). The food is typically cooked in a steam-bake environment. Archaeological earth ovens may be recognized by demonstrating at least three of the following characteristics: a thermally altered excavated pit, thermally altered stone or some other thermal element (fired clay balls), a substantial accumulation of ash and charcoal (as the combustion environment is always initially open producing ash and then closed to an air reduced or starved situation which produces charcoal), a highly organic anthropogenized soil matrix (Waters 1992:33), an associated midden of shell or stone, or a mounded accumulation of the thermally altered stone, clay, ash, and charcoal.

(4) A stone boiling feature results from hot stones being dropped in a liquid, typically to cook or reconstitute meat, yet plants were stone boiled as well. Smaller rocks of fine-grained materials, such as quartzites, are preferred for stone boiling because they are more durable (Jackson 1998:7; Schalk and Meatte 1988:8.8; Taggart 1981:148-149). A stone boiling pit was often lined with a hide and used to hold a liquid. The rocks were heated in a nearby fire (Kennedy 1961:80; Kroeber 1964:50, 72; Tooker 1991:59; Turney-High 1969: 128) and introduced into the liquid container.

(5) Source X (hardest) was an Upper Glen Rose biomicrite, source Y (medium hardness relative to X & Z) a Jarrell biosparite, and source Z (softest) a

Fredericksburg chalky biomicrite.

(6) In addition to describing maximum temperature exposure, archaeomagnetism has also been used to reconstruct the number of heating episodes (Collins et al. 1990; Takac 1993:28) and the particular movements of rocks throughout a feature's use (Collins et al 1990:70; Takac 1995, 1998).

(7) Apparently, as the limestone ($CaCO_3$) sample was heated, carbon dioxide (CO_2) was driven off. The humidity or water (H_2O) in the air then bonded with the available calcium (Ca) to form $Ca(OH)_2$, or portlandite.

(8) Vaterite is still calcium carbonate ($CaCO_3$), however its crystalline structure, which is hexagonal, is slightly different than that of calcite, which is hexagonal/rhombohedral. Vaterite is the meta-stable phase polymorph of calcium carbonate.

(9) The First Law of Thermodynamics is a law of energy conservation, and states that since energy may be neither created or destroyed, the amount of energy (heat) transferred into a system must equal that was originally transferred. For example, when an object is brought into contact with a relatively warmer object, a process takes place that equalizes the temperatures of the two objects (see "Thermodynamics" in *Microsoft 96 Encyclopedia*).

(10) The Zeroth Law of Thermodynamics states that when two systems are in equilibrium and a third is introduced, the first two must become in equilibrium with the third. Their shared property is the temperature. If any of these systems (a rock) is placed in a thermal reservoir (a fire or kiln) the system will eventually reach the same temperature.

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PROJECTILE POINTS OF THE CALF CREEK HORIZON FROM FRIO, MEDINA, AND UVALDE COUNTIES, SOUTHERN TEXAS

David Calame, Sr., Carey Weber, Larry Banks, and Richard McReynolds

ABSTRACT

In this paper, a number of projectile points variously typed as Andice, Bell, and Calf Creek, from sites in Frio, Medina, and Uvalde Counties, are documented and illustrated. Descriptive data are supplemented by observations derived from technological analysis and examination of raw materials.

INTRODUCTION

Large, basal notched dart points, classified as Andice, Bell, and Calf Creek points, are distributed throughout Texas, Oklahoma, Arkansas, and Missouri. (Prewitt 1983; Justice 1987; Wyckoff et al, 1991; Turner and Hester 1993). The exact temporal and cultural relationships of these three point types remain unresolved. Overall, they appear to be linked through time and space. To prevent unwieldy references to all three type names used in this paper, we have followed Wyckoff (1991a,b) by including them in the Calf Creek Horizon.

Turner and Hester (1993:71-72) describe Andice points as large, broad, triangular points with convex lateral edges and long, essentially rectangular, stems. Prominent, massive barbs extend downward and are narrowest at the juncture with the body. They are closely related to Bell points morphologically, but are distinguishable by their greater size, stem length, and barb length. On the other hand, some of this variation may be related to resharpening, reworking, breakage patterns or other technological variables. The Bell point (Turner and Hester 1993: 80) is characterized as a wide, thin, triangular body and long, narrow barbs formed by basal notching.

Calf Creek points have the same overall attributes as Andice and Bell. Weber and Patterson (1985) and Weber (1986) offered quantitative and discriminant function analyses to try to distinguish quantitatively between Andice and Bell, and Weber (1986) found that the Bell-Andice spectrum likely represents a single type. Indeed, Wyckoff (1991a:3) considers the three types to be overlapping varieties of the same form and goes on to say that "Much of the more obvious variation results from different amounts of blade resharpening and reshaping."

THE STUDY SAMPLE

The artifacts reported in this paper were found on the surface of sites in the drainages of the San Miguel Creek in Frio and Medina Counties, and the Leona River in Uvalde County. The San Miguel Creek's headwaters, the Francisco de la Perez and Chacon Creeks, originate directly on the land form that divides the Medina River drainage from the Frio River drainage, between Castroville and the small community of Quihi. Both tributaries and the San Miguel itself drain areas of enormous lithic resources. The San Miguel empties into the Frio River in McMullen County.

The Leona River enters the coastal plain directly off the Balcones Escarpment in Uvalde County west of the Frio River. It also drains an area full of high quality lithics. The Leona River joins with the Frio River in Frio County just north of the Interstate 35 crossing of the Frio.

Lithic Resources of the Area

The lithic resources of the study area can be lumped into two groups, Edwards cherts (or flints) and Uvalde gravels. There are outcrops of Edwards all aong the Balcones Escarpment between Del Rio and Georgetown. In the area around Uvalde, the Nueces River contains high quality chert nodules, especially downstream from the 19-Mile Crossing on Highway 55 northwest of Uvalde. Two Edwards sub-types, Salmon Peak chert and tabular chert are found in the bed load of the river.

The chert or flint from the Salmon Peak formation occurs in fist to watermelon-sized, amoeba-shaped nodules. Cortex is smooth, thin, chalky, and usually tan in color. Microfractures beneath the cortex are very distinctive—thin, short, and curved black lines. The texture grades from fine and glassy to coarse. It is generally of high quality for knapping and the material color ranges from tan to light brown and lavender.

Tabular chert found in the Nueces River bed load is generally of very high quality, although it is usually fractured into smaller pieces. Cortex is thin, smooth, and light brown. Few microfractures occur beneath the cortex. Modern knappers compare the Nueces River tabular chert to that found in and around the Pedernales River. The local material is usually very high grade and glassy, ranging from tan to dark brown in color.

"Uvalde Gravels" is a term applied to highly variable lag gravels topping the uplands and eroding into stream beds in the study area (Turner and Hester 1993). Calame has collected examples for knapping experiments, and find the cobbles difficult to reduce because of large microfractures and interior stress fractures beneath the cortex. The small size of these "gravels" also precludes the manufacture of large bifaces.

The Francisco de la Perez and Chacon creeks both drain off extensive deposits of Uvalde gravels lying in a roughly triangular area between Castroville, Hondo and Devine. North of Highway 90 in this area, the gravels have a whitish cortex and is of a glassy dark brown chert known to knappers as "root beer flint." Calame observed deposits of this material at site 41ME100, near the community of Quihi, at the head of Francisco de la Perez creek. The fields in this locale are covered with these distinctive chalky white cobbles.

South of Highway 90, the Uvalde gravels change to cobbles with thin and hard orange to orange-brown cortex. The glassy cherts of the 4lME100 area drop off remarkably, replaced by cherts that are highly fossiliferous, and often with many inclusions. Colors of the chert include white and tan, dull brown, and brown with light red streaks These cobbles are hard, extremely well rounded, and very difficult to knap. Calame used heat treatment, up to 500 degrees F, to improve the chipping qualities of this material (see Hester and Collins 1974).

DESCRIPTION OF THE SITES

The sites were recorded by the senior author and are summarized below.

41FR34 -Upland site approximately one mile east of the San Miguel Creek and two miles south of the northern Frio County line. The site is on a high point for the area, at 610 feet above sea level, while the San Miguel Creek, one mile due west, is at 570 feet above sea level. The site has a commanding view of the San Miguel Creek valley.

A variety of Archaic and Late Prehistoric projectile points and stone tools have been surface collected from the site including Andice, Bulverde, Edwards, Frio, Montell, Palmillas, Perdernales, Perdiz, Scallorn, Tortugas, and one possible Midland. Seven Guadalupe and five Guadalupe-like bifaces have also been collected, along with two Clear Fork tools and one Nueces biface. In addition, one bison tooth, fragments of mussel shell and a mano have also been collected. Snail shells of the species Rabdotus are present, widely scattered. Small pieces of fine-grained red ochre are also present at this site. No knappable lithic material occurs naturally at this locale, so all lithics have been introduced by humans.

The site is now in coastal grass pastures. It should be noted that this site is on the senior author's property and therefore a much more thorough survey of this site has been conducted than of other sites in this report. In addition, the site being one mile from the San Miguel Creek and more than one and a half miles from the nearest paved road, it is believed the site was previously unknown and therefore collecting has been minimal.

41ME97 - Open campsite on the southern tip of the first terrace above the flood plain of the Francisco Creek in south central Medina County. Site is bisected by a county road and sits on the west side of the creek. Site actually sits on the southern tip of this terrace. Artifacts collected from this site include Andice, Edwards, Langtry, Perdiz, Guadalupe, Clear Fork, and various untyped scraping tools.

Field Site # 042 - This was an isolated find of an Andice or Calf Creek point (Larry Banks, personal communication). No evidence was apparent to the author of any cultural debris at this site. The site is an upland location approximately one mile east of the Francisco Creek in south central Medina County.

41UV351 - This site sits on a high spot on the northwest bank of the Leona River at the Two Mile Water Hole. This specimen was collected from the site after trenching for a fiber optic line passed through the site. This specimen represents a previously unknown buried component at this site. Previously the site was known to consist only of Late Prehistoric period artifacts. A Guadalupe biface was also salvaged from the trenching spoil dirt, as well as a Perdiz point, an untyped biface (knife?), some very large, high quality chert blades, and some faunal material (including a possible deer mandible). With these artifacts recovered, the time period for this site can now be linked to the Early Archaic as well as the Late Pehistoric.

DESCRIPTION OF THE ARTIFACTS
(Carey Weber)

Specimen #1, 41UV351, Figure 1, A, A'

The frequency of occurrence of this form is about 1 in 9 in terms of specimens that Weber has seen. This specimen was originally a fairly large, wide and thin biface. Face 2 was the flatter face, but both faces appear to have been well contoured. Even though the material is reddish, it does not appear to have been heat treated. A large pressure flake from the Face 2 left blade edge carried to the right edge, and it may have overshot slightly, removing a small portion of the right blade edge. The blade appears to have been damaged somewhat, and both barbs were likely lost concurrent with the blade damage. To repair the damage to the blade, Face 1 was reflaked from both edges using long pressure flakes, causing a moderate reduction in size. These flake scars intrude into and have reduced the terminal notching flake scars. Three long flake resharpening flake platforms from the Face 1 right edge were excessively strong for the very thin blade edge, and detachment of the flakes removed a significant part of the blade edge. The blade edges are very thin and sharp. Face 1 stem contouring is very good, with a wedge-shaped long section and precise, clean basal thinning and notching flake scars. Mean notching flake scar expansion is greatest from the right stem edge on Face 1 and is equal on Face 2. Notching flake scars show best alignment and spacing on the Face 1 left stem edge. The basal thinning scars on Face 1 were removed after notching had begun. On the Face 1 left stem edge basal thinning scars intrude into all adjoining notching flake scars, indicating that this notch was complete when the last basal thinning flake was removed. On the Face 1 right stem edge basal thinning scars intrude into notching flake scars half the way up, and the final notching flake scars intrude into the same basal thinning scar. This indicates that the Face 1 right/Face 2 left notch was half complete when the last basal thinning flakes were removed. Basal thinning on Face 2 of the stem failed, so the contour is not evenly tapered. This caused the stem to be the maximum thickness of the biface. The Face 1 right/ Face 2 left notching platform was crushed, and that notch is not as deep as the Face 1 left/Face 2 right notch. The stem shape is Variation 3, with incurvate, more or less parallel lateral edges tapering to a slightly expanding, convex base. Basal alignment is very good. Final microflakes were removed toward Face 2.

Specimen # 2, 41FR34, Figure 1, B

The frequency of occurrence of this form is about 1 in 8. The original point was fairly small and thin relative to width. The blade has been resharpened to a late stage of reduction. The final sequence of resharpening flake removals is typical of Andice/Bell points, with microflakes and short flakes from the right blade edges and long flakes from the left edges. The final microflake removal series is unifacial to Face 1. It is uncertain whether damage to the Face 1 left blade edge is incidental to use or the result of removing a resharpening flake from an excessively strong platform. Use of long flake resharpening and development of ridges, blade twisting and thinning was limited by the thinness of the original blade; however, these features are present to some degree on both faces. Original thinness also limited intrusion into terminal notching scars; however, the Face 2 left barb loss scar and terminal notching scar have been completely removed by resharpening. Notching flake scars on the Face 1 right/Face 2 left stem edge are classically excellent. Spacing and shape are very uniform, indicating precise

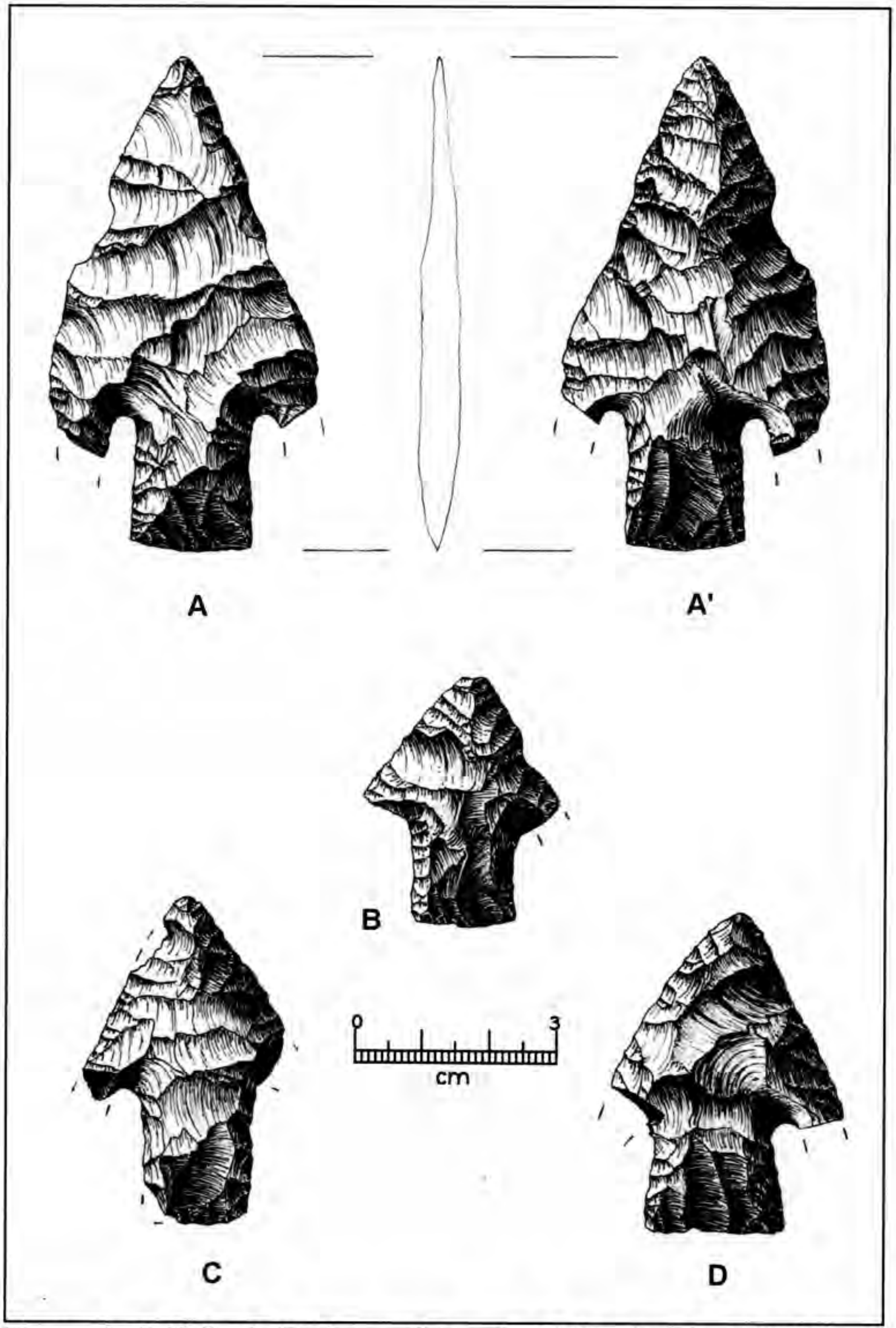

Figure 1. Calf Creek Horizon points. A, A' Specimen1, 41UV351; B, Specimen 2, 41FR34; C, Specimen 3, 41FR34; D, Specimen 4, 41ME97.

control of notching flake platforms and removals. These scars show almost no retouch. Those from the Face 1 right edge show classic slightly forward expansion and simple curvature, while those from the Face 2 left stem edge show classic lateral expansion and S-shaped curvature. The stem shape is Variation 3 with incurvate lateral stem edges and a slightly expanding, convex base. Stem thinning has produced only a somewhat wedge-shaped long section. This is because the original preform was thin relative to width and because of intrusion into the interior of the stem face by lateral scars without subsequent basal scars (the stem was already too thin). The basal edge is thin with good edge alignment, and it has been slightly dulled.

Specimen # 3, 41FR34, Figure 1, C

Per Weber's experience, the frequency of occurrence of this form is about 1 in 8. The specimen has been resharpened to a late stage of reduction, and it is covered almost entirely with manufacturing and resharpening pressure flake scars. Four edges of the point have sustained recent (post-patination) damage/reflaking. The blade is covered almost entirely with resharpening flake scars. On Face 1 limited thinning, twisting and ridges are present from the left edge, while the Face 2 blade face is not significantly different from the stem face. Remaining terminal notching flake scars have been reduced in size by blade resharpening. The Face 2 right terminal notching flake scar has been removed by a burin from the blade edge. The angle of the burin scar is acute in relation to the long axis of the point, indicating that the flake was detached after barb loss and after the blade had been considerably shortened, although the last series of resharpening scars intrude slightly into the burin scar. While notching flake scars expansion is limited, almost none of the classic notching flake scar attributes are present. Lateral stem scars are somewhat atypical of Andice or Bell points in irregularity of removal, and on the Face 2 left stem edge, beveling, nearness to Face 1 and reduction of notching flake scars by unifacial stem edge alignment scars are atypical. This indicates poor control of notching flake platforms and removals, and it suggests that the finished notches may have been somewhat wider than usual, especially the Face 1 right/ Face 2 left notch. The stem shape is typical of Variation 4, with more or less parallel lateral stem edges and a convex base. Basal thinning is typical post-lateral large pressure. Final basal edge alignment is poorer than usual, especially considering that edge damage (Face 1 left basal corner) that existed on the preform prior to finishing was not completely removed.

Specimen # 4, 41ME97, Figure 1, D

The frequency of occurrence of this form is about 1 in 9. The body of the point has been reduced moderately in size by microflake and short flake resharpening. The material is relatively coarse and appears to have a waxy luster, which may be evidence of heat-treating. If true, this would be the first evidence of heat treating that Weber has seen in Andice and Bell technology in Texas. However, it may also be an attribute of exposure. The material, overall shape and size and the manner in which the resharpening was performed give this point the look and feel of some Calf Creek points from Oklahoma. There is minor roll snap damage at the tip on Face 2 which has not been resharpened. Blade resharpening has produced slight asymmetry relative to the stem axis. Short flake resharpening scars have intruded into and reduced, but not greatly altered, original manufacturing scars. Only two possible long flake resharpening scars are present, one from Face 1 right and one from Face 2 right. The direction of these removals is upper right to lower left. The location and low number is atypical, but not unknown for Texas Andice or Bell points. The final microflake series is from right blade edges, which is typical for Andice or Bell points. Because long flake resharpening was limited, there is no blade thinning, twisting or ridges. The Face 1 left barb was removed by a lateral-in snap, and the Face 1 right barb was removed by a transverse snap. The Face 1 left barb loss scar shows minor intrusion by subsequent flakes; however, the lack of pronounced shoulders and lack of major intrusion and reduction in size of the barb loss scars indicate that barb loss occurred after the point reached its present size and shape. While the Face 1 left/Face 2 right terminal notching scars have been removed by the lateral-in barb snap, those on Face 1 right show intrusion, and those on Face 2 left show reduction by resharpening flakes. The stem shape is classic Variation 1, with an expanding stem and incurvate to fishtailed basal edge. Notching flake expansion is limited, and those from the left stem edges show some regularity; however, most other classic attributes, such as differential expansion and curvature, are not present. Pre-lateral percussion basal thinning produced a generally wedge-shaped stem long section, which was not greatly enhanced by subsequent pressure flaking. Basal edge alignment is good to very good, but not very thin and sharp. The final microflake alignment is unifacial toward Face 2. It is uncertain whether the flake that primarily formed the fish-tailed appearance was intentional or incidental. The Face 1 right half of the basal edge is dulled.

Specimen # 5, 41ME(042),Isolated Find, Figure 2, A, A'

The frequency of occurrence of this form is about 1 in 370. This specimen has been only slightly reduced from its original size by resharpening. It is essentially whole, with minor snap damage at the center of the base and transverse snap damage of the Face 1 right barb tip. Both of these fractures were contemporary with original manufacture and use of the point (pre-patination). About 2/3 of each blade face retains original manufacturing scars, which include lateral percussion thinning, lateral large pressure contouring and final pressure edge alignment scars from the left edges. Numerous serial microflakes and short flakes from right edges indicate early resharpening. Incipient shoulders are present on the blade edges where the last series of resharpening flakes stopped. The blade is slightly asymmetrical, partially because it was made that way and partially because the asymmetry has been accentuated by the resharpening. The faces are not well contoured, and Face 2 is more convex than Face 1. This is probably because the preform was not greatly larger than the size of the finished point (the maker wanted to get as large a piece he/she could out of the preform). The blade forward of the point of maximum thickness was manufactured to be thinner than the stem and slightly twisted. Notching flakes show some classic attributes; however, overall they are somewhat irregular. Mean notching flake scar expansion is greatest from left barb and stem edges, with the exception of two reversed scars on the Face 1 right edge of the left barb near the notch termination. The terminal notching scars show S-shaped curvature from left edges, and notch edges are irregularly zigzagged. Alignment and spacing of notching flake scars is irregular. The stem shape is typical Variation 3.

Specimen # 6, 41FR34, Figure 2, B

The frequency of occurrence of this form is about 1 in 93. This specimen was originally a relatively small, thin biface. It has been extensively resharpened to a late stage of reduction, when its apparent use as a projectile point caused roll snap impact fractures that reduced the blade size to the degree that the damage could not be repaired, and the point was discarded. Burins have removed both barb loss scars, and the Face 1 left scar was reflaked after the burin was removed. The burin removals and reflaking indicate that the barbs were likely missing prior to final use of the point as a projectile point. The stem shape is Variation 4, with more or less straight, parallel lateral stem edges and a straight to slightly convex base. Face 2 is the more convex and more well-contoured face. The stem is not evenly tapered (wedge-shaped) on Face 1, but it is classically excellent on Face 2. Notching flake scars show typically greater mean expansion from left stem edges. Notching flake scars from the Face 1 left/Face 2 right notch edge are classically excellent. The notching platforms were precisely controlled and the flakes were cleanly detached to produce uniform spacing, shape, alignment and zigzag notch edges. On the Face 2 right stem edge the notching flake scars show typical forward expansion and simple curvature, while those from the Face 2 left edge show typical lateral and reversed expansion with S-shaped curvature. Notching flake scars from the Face 1 left/Face 2 right notch edge are irregular.

Specimen #7, 41FR34, Figure 2, C

This is a barb fragment detached by transverse snap. It is a typical Andice or Bell barb in four ways: 1) it is wider at the base than near the notch termination; 2) it shows flake scars from the barb base; 3) it shows typical notching flake scar attributes; 4) it has been narrowed by delicate resharpening using microflakes and short flakes, primarily from the right edge. Notching flakes show greater mean expansion from the left edge, and the notch edge is closer to Face 1. The Face 1 right terminal notching scar shows reversed expansion.

Specimen # 8, 41FR34, Figure 2, D

This specimen is a Pedernales point, was

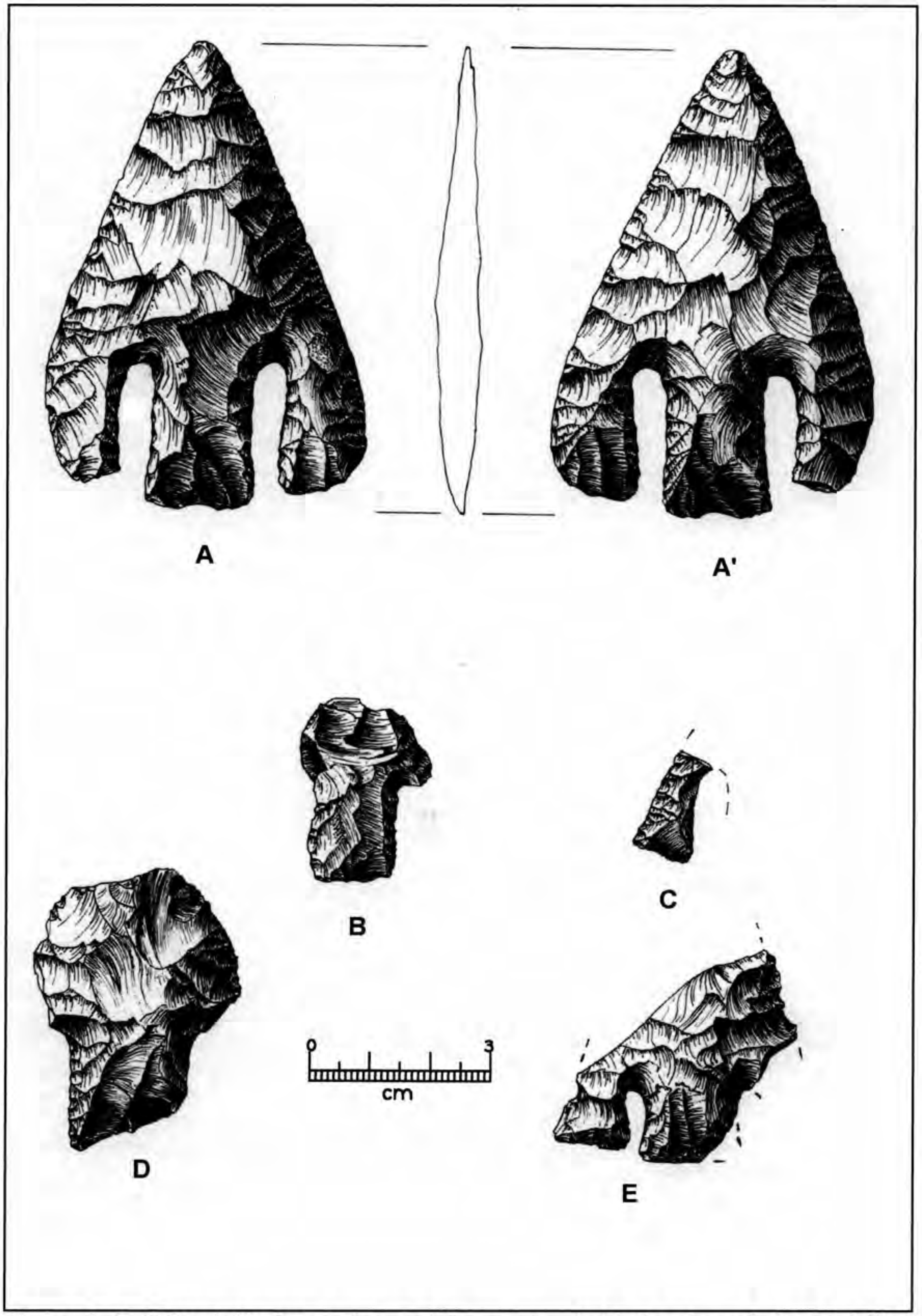

Figure 2. Calf Creek Horizon points and fragments. A,A', Specimen 5, Isolated Find (41ME042); B, Specimen 6, 41FR34; C, Specimen 7, 41FR34; D, Specimen 8, 41FR34; E, Specimen 9, 41FR34;

originally typed erroneously as Andice by the senior author. Weber's Andice expertise corrected this error. It is included in this paper because it is felt the senior author's mistake may help others in the future with the identification of this type artifact. The original size, shape and manufacturing scars remain except where removed by damage that was contemporary with alignment of blade edges. Large pressure flake scars, one of the hallmarks of Andice or Bell manufacturing, are not present on either face. There is no evidence of re-sharpening, indicating that this is the original size and shape of the artifact. The blade width and curvature do not suggest that this artifact ever had wide, long barbs. The stem is atypical of Andice or Bell points in several ways: 1) the shape is classic Pedernales; 2) the maximum notching flake expansion is high; 3) the depth of the basal concavity is high; 4) the lateral stem edge scars do not show any of the classic Andice or Bell attributes.

Specimen # 9, 41FR34, Figure 2 E

In Weber's view, the frequency of occurrence of this form is about 1 in 75. However, this is not the original form of the artifact at the time it was abandoned. This specimen was originally very thin and very well contoured by large pressure flakes. It was likely abandoned by its makers in an almost whole, unresharpened condition. While recent (post-patination) damage has altered most of the edges, there are no apparent resharpening scars on the interior of the faces. The stem shape has the narrow, more or less straight base of Variation 2; however, the base also expands slightly like Variation 3 and has been included in this category. The basal edge has been lightly ground or dulled. Notching scars on both left edges show classic S-shaped curvature. Those from the Face 2 left stem edge are classically excellent in spacing and alignment.

RAW MATERIAL ANALYSIS OF SPECIMEN #4, 41ME97, Figure 1D (Larry Banks)

At the request of Calame, an attempt to identify the raw material source for an Andice or Calf Creek dart point found in Medina County was done by the author. The dart point in question macroscopically resembled a variety of fossiliferous Edwards chert from the Georgetown, Texas vicinity. But, in comparison to microscopic analysis and ultra-violet light fluorescence, the artifact and the Edwards did not match at all, and in particular, the UV light fluorescence was dramatically different. While the use of UVL has not always been found to be a conclusive type of discrimination between some chert types, it has proven time and again to be quite reliable in distinguishing a variety of Edwards materials (Hoffman et al. 1991). In trying to match the chert type of the dart point with others in the comparative collection of Banks (cf. Banks 1990}, materials as far away as the Ozarks that shared superficial similarities also proved to be incompatible under careful examination. Gary White, a friend of Banks who often collected specimens of chert for him from any number of locations almost worldwide where he (White) was sent as a welder, had collected some chert materials from a creek and workshop area north of Brownwood, Texas in the late 1980s. In this collection of materials, several of the pieces of chert were similar to the Medina County dart point, but one chert sample exhibited all of the same physical characteristics, and the UVL fluorescence in both long and short wave radiation were an identical match. At the present time the author has yet to conclusively identify the geological source of the origin for the material collected from the creek north of Brownwood, Texas but the comparative macro and UVL analysis strongly suggest the two rock types are from the same source that contributes gravels to the aforementioned creek, and possibly the rock from which the dart point was manufactured came from that same creek. The descriptions of chert apply both to the dart point and the chert type that so closely matches the artifact. In the collection of chert from the creek reported by White, there is a variety of 10 slightly different materials occurring mostly in white and as light to medium dark grey and grayish brown. The only chert specimen described in detail in this report is the specimen which so closely matches the material of which the dart point from Medina County was manufactured. It must also be noted that in the absence of identification of the geologic source of origin there may be any number of other localities closer to the site from which the dart point was recovered, and that are simply unknown at present.

The subject chert type reflected in both the dart point and the raw material collected near Brownwood, Texas under natural light and dry condition, is a mottled white 10YR8/1, light grey 10YR7/2, and light greyish-brown 10YR6/2 with slightly darker gray splotching. Some tiny vugs contain slight degrees of iron oxide stainings around the open edges. It also exhibits early stages of patination that is reflected primarily in the whitish coloring. Under 17X hand lens and 40X microscope, the rock contains numerous small white blebs and clasts of unidentified paleozoic fossil foramanifera. The rock is opaque even on thin edges. It is not one of the more superlative knappable chert types, but the fracture patterns in both the raw material and the subject dart point are essentially identical.

The UVL fluorescence under long wave is a basic matrix of reddish brown and purplish tinged color with greenish yellow splotching. Under short wave the coloration is essentially reversed with background of greenish yellow and purplish red splotching. Under neither short or long wave does the fluorescence remotely resemble Edwards materials.

The suspected source of the rock is from an unnamed creek entrenched in the Strawn Group of Pennsylvanian age that is a westerly flowing tributary of Pecan Bayou. According to the *Brownwood Sheet of the Texas Geologic Atlas* most of the geological formations of the immediate area is the Strawn Group, and within that group the only chert-bearing formation is the Ricker Station Limestone. The chert in the limestone is defined in the *Brownwood Sheet* (above) as "locally subrounded chert, thin, discontinuous, grayish brown." It can also be noted that the Ricker Station Formation is fossiliferous. There are no Pennsylvanian-aged rocks anywhere near the Medina County location where the subject dart point was found, and at the present time, until more definitive and refined field work can be done to positively identify the geologic source of origin for the chert, the best and only candidate at this time is the Ricker Station chert from the general Brownwood, Texas vicinity.

SUMMARY

Locales with evidence of Calf Creek Horizon occupation have been described for three counties in southern Texas, supplementing the known distribution of Bell, Andice and Calf Creek points in Texas. The distribution of lithic resources used in the study area has been explored. The known cultural affiliation and stratigraphic picture at 41UV351 has been expanded. Qualitative analysis of flake scars and contouring done by Weber was carried out, and this analysis distinguished a Pedernales specimen that superficially resembled the Calf Creek Horizon artifacts. A detailed analysis of the raw material used in the manufacture of one artifact from south central Medina County suggests that the material originated at a distant source. This paper adds to the growing body of data on the manufacture, breakage and resharpening patterns for bifaces of the Calf Creek Horizon.

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The authors of this paper include Richard McReynolds, widely known for his fine illustrations. Thanks are also offered to Dr. Thomas Hester for his editing, enlightenment and encouragement, Shirley and Van Van der Veer for their assistance in production, and Dr. Harry Shafer for his opinions on fractures seen on some of the specimens. Last, but certainly not least, the senior author thanks his wife, Debbie Calame, for taking up the slack on home duties while he was working on this paper.

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CALF CREEK HORIZON POINTS FROM WILSON COUNTY, TEXAS

Richard McReynolds

ABSTRACT

Thirteen dart points of the Calf Creek Horizon are reported. Eleven are classified as Andice and two as Bell. All came from sand-quarrying operations at the "Cibolo Creek Sand Pit" in Wilson County, southern Texas.

BACKGROUND

Commercial sand quarrying and processing at a locality on Cibolo Creek in Wilson County, Texas, yielded the sample of Calf Creek Horizon bifaces or points documented in this paper. The "Sand Pit" has yielded thousands of projectile points of all time periods, but is particularly known for the hundreds of Paleoindian points found during the sand-screening activities (Pfeiffer 2001).

Large triangular bifacial dart points with deep basal notches and massive barbs characterize the Calf Creek Horizon, best represented in Texas by specimens typed as Andice (Prewitt 1983) and Bell (Sorrow et al. 1969). They are thought to date somewhere in the 3000-5000 B.C. time span of the Early Archaic, although recent realignments of the Central Texas Archaic sequence put them in the Middle Archaic, between 3000-4000 B.C. (Collins 1995:376). One of the key sites for the Andice type is the Gault Farm (41BL323). Specimens recovered from this site by Professor James E. Pearce (University of Texas) in 1929 were used by Prewitt (1983) in his definition of the type. In recent decades, commercial digging done at Gault has focused on the search for Andice specimens (Michael B. Collins, personal communication, May 2000).

This paper documents 13 specimens (Figures 1,2). Eleven are typed as Andice and two as Bell. Only one specimen can be considered complete and even it has been reduced from its original size by resharpening. All of the specimens are fragments or have been reworked. However, a few meaningful measurements were recorded (Table 1); maximum thickness and neck width are the only measurements that could be obtained from each example.

The Andice biface in Figure 1,f and the Bell specimen in Figure 2,g are unusual in that they do not exhibit extensive reworking. Whether they were broken during use or in manufacture cannot be determined (the reader should see Weber 2002 for recent studies of Andice breakage patterns). The notching process for Andice and Bell seem to lead to frequent breakage (Weber 1991), due to crushed platforms. The application of needed pressure to re-establish a platform can snap the biface if it is improperly stabilized by the flintknapper. Neither the Andice or Bell (Fig. 1,f; Fig. 2,g) clearly demonstrated crushed platforms but it should be noted that notch depth on either of them is not as great as other examples shown in Figures 1 and 2. The Bell point is very similar to specimens from Starr County (Chandler and Kumpe 1993), but it differs in that it was fashioned from a concave-base preform and consequently, the barbs extend beyond the line of the base.

The Andice illustrated in Figure 2,b, apparently had the deepest basal notches of any in the Wilson County sample. Figure 1,b and 1,e both reflect greater reworking of one lateral edge than the other. Figure 1,f and Figure 2,b, have convex stem bases. None of the examples have impact fractures. Finally, Figure 2,c and 2,d have been reworked down to the "nub."

None of the Andice or Bell artifacts in this paper have concave bases. Prewitt (1983), in defining the Andice type, noted that bases

Table 1. Measurements of illustrated points. (In millimeters)

	ANDICE											BELL	
Figures	1a	1b	1c	1d	1e	1f	2a	2b	2c	2d	2e	2f	2g
Maximum Width	51	37				60							62
Maximum Lengthm	64	63						66	42			52	
Maximum Thickness	7	7	6.5	7	7	7	6.5	6	7	6	7	6	6
Max. Stem Length	24	21		19		19		32	19	19		15	11.5
Min. Stem Length	24	21		18.5		16		29		18		14	11.5
Neck Width	19	16	19	15	19	18	17	18	15	17	15	16	19
Stem Width at Base		14		14		21.5		15	15.5	16		18	21

were usually straight but might vary from slightly concave (24%) to slightly convex (26%). There are no apparent concave bases on Calf Creek points from the type site in Arkansas (Dickson 1970; see also Perino 1968). There do seem to be a great many Calf Creek points with concave bases from sites in Oklahoma (Cestaro and Carrel 1991; Wyckoff 1993). I have recently drawn a nice Andice point from site 41VT6 that has a deeply concave base.

Although of differing colors, all of the lithic materials in the Wilson County sample are available within the margins of Central Texas. The specimen in Figure 2,d, is of translucent petrified palmwood. Both of the artifacts in Figure 1,c and Figure 2,a are different shades of gray Edwards chert. The point in Figure 2,b is a very light tan chert, more heavily patinated on the side illustrated than on the reverse. All of the other illustrated points are various shades of brown Edwards chert.

Both Andice and Bell bifaces probably served as points that were efficient killing tools, but at the end of the day they evidently served long and faithfully as butchering or cutting tools. Maintaining a sharp cutting edge required periodic resharpening, which reduced the lateral edges nearer to the juncture with the hafting notches. Eventual barb loss is the oft-seen result. It is remarkable that many barbs survive intact at all. The fragility of some of the surviving barbs (Figure 1,b,c) seems to indicate the need for firm support during resharpening as well as for varied cutting activities. Some specimens from the Calf Creek type site have undergone massive resharpening episodes, yet retain very fragile barbs (Dickson 1970; Perino 1968).

Figure 3 is an illustration of some ways that Calf Creek Horizon points could have been attached to wooden foreshafts while buttressing or stabilizing the barbs. All of the methods shown would have been more efficient with the use of a mastic in conjunction with binding (Carey Weber, personal communication, January 2001).

Figure 3, a, a' depicts the most obvious way to attach the biface to the haft securely and at the same time fill the voids between the barbs and stems. Its disadvantage is the amount of binding material necessary to fill those voids; this would produce bulk at the impact area and reduce efficiency as a projectile tip.

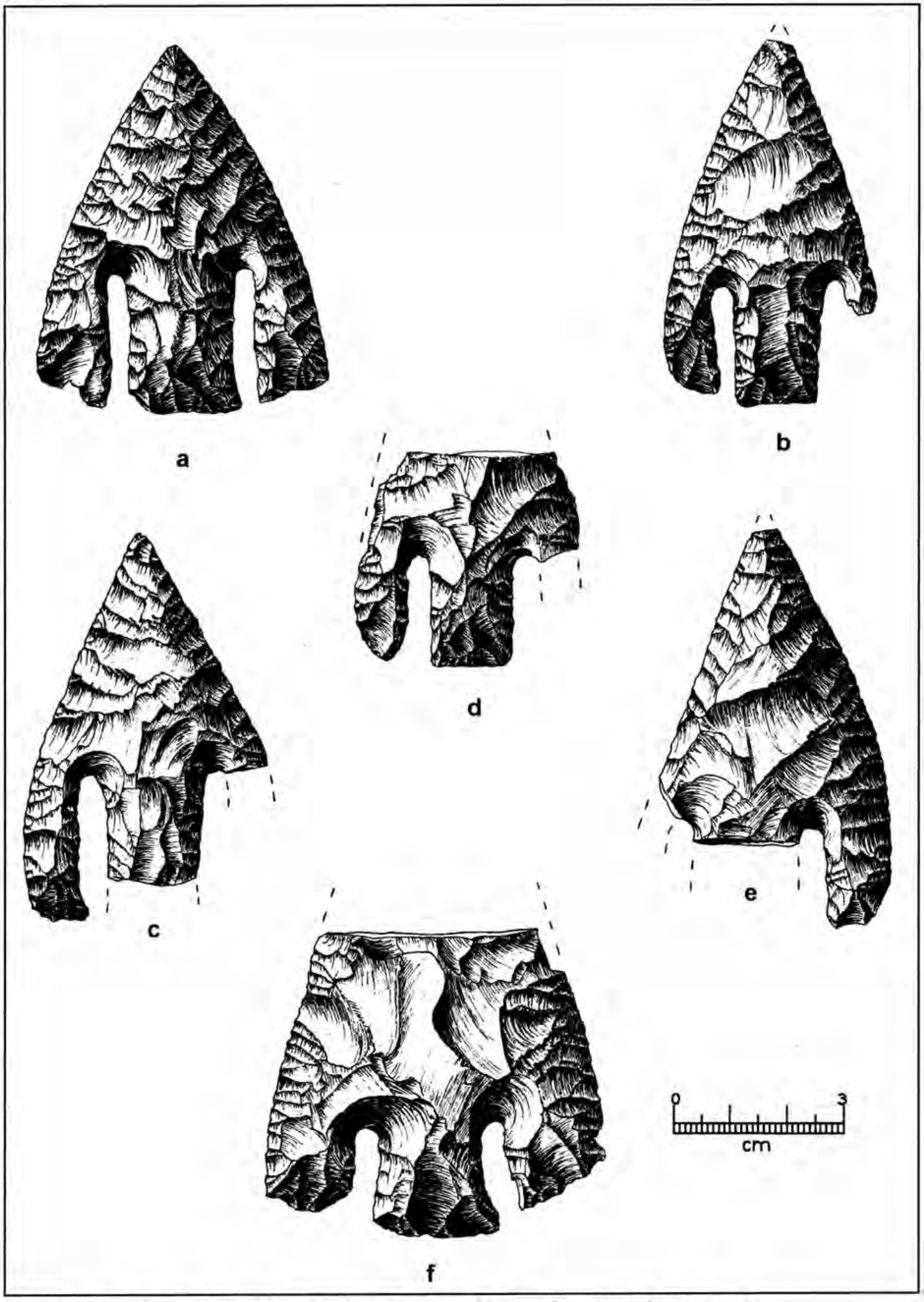

Figure 1. Andice Bifaces from Wilson County, Texas. Drawings by the author.

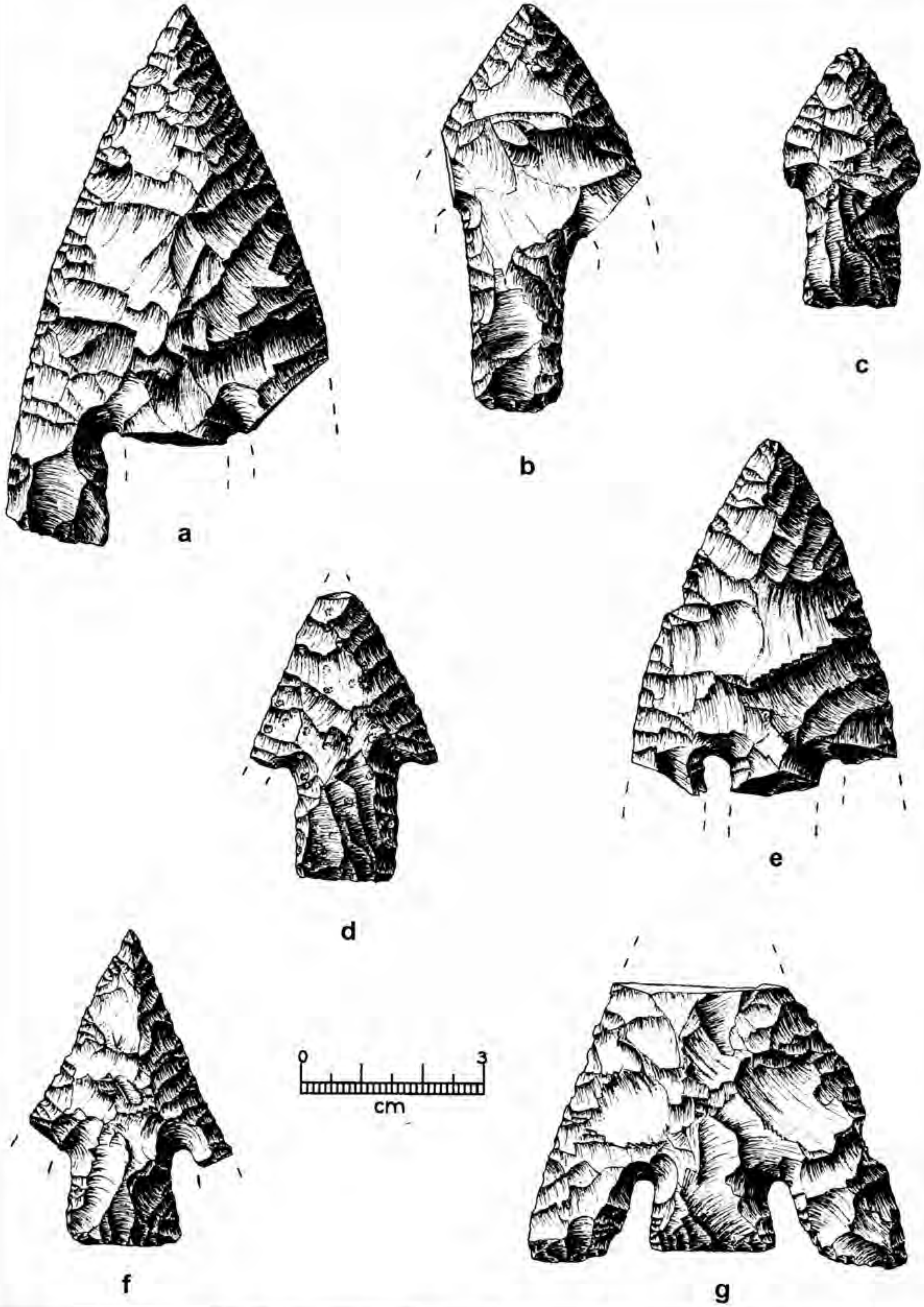

Figure 2. Andice and Bell Bifaces from Wilson County, Texas. a-e, Andice; f,g, Bell. Drawings by the author.

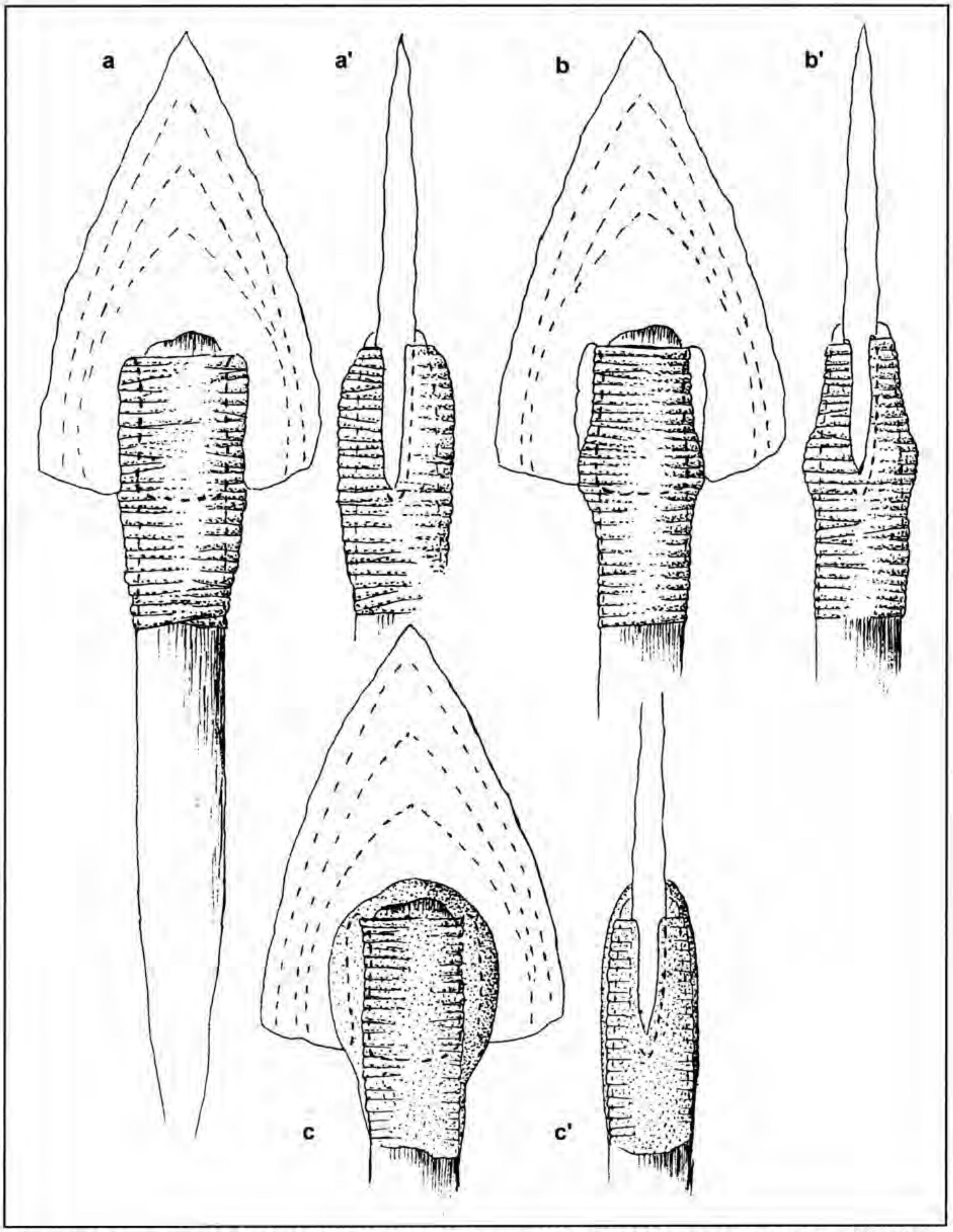

Figure 3. Suggested Methods for Hafting Bifaces of the Calf Creek Horizon. Dashed lines reflect hypothetical resharpening patterns. Drawings by the author.

Figure 3,b,b' illustrates a modification which would reduce the amount of binding material needed to buttress the barbs and at the same time improve the ability to penetrate on impact. I think this method would work very well when combined with Figure 3, c, c'.

Lastly, Figure 3, c,c' illustrates a technique that utilized the application of a resin or other mastic to cover the sinew-bound foreshaft. This would extend onto the interior surface of the barbs and fill the voids. Once the resin hardens it should protect the haft and barbs. I know of no evidence that resin, asphaltum or other mastics were used on Calf Creek Horizon bifaces, but adhesives were used in the Texas Archaic on other types of dart points, knives and scrapers (Turner and Hester 1993).

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IDENTIFICATION OF HEAT-TREATED CHERT

Leland W. Patterson

ABSTRACT

Observations are provided on analytical criteria used for the identification of heat-treated chert, including color, surface luster, and thermal damage. It is noted that not all chert types have uniform changes from heat treatment, and that identification of heat treatment for materials of finished bifaces may not always be possible.

INTRODUCTION

This paper comments on analytical criteria for the identification of heat-treated chert. Data used here are based mainly on the author's experience in experimental heat treatment of cherts of the Lower Cretaceous period from Central Texas, from the Edwards Plateau and adjacent Lampasas Cut Plain. There are a wide variety of chert types in Central Texas which can give a variety of results from heat treatment. A high proportion of chert types from Central Texas respond well to heat treatment for improvement of knapping quality. A low proportion of chert types from Central Texas exhibit little change in knapping characteristics from heat treatment or tend to suffer thermal damage at relatively low temperatures of 350-400° F (177-204° C).

Prehistoric use of heat treatment of chert was mainly for flake blanks that were used to produce bifacial artifacts, such as projectile points. Heat treatment can lower tensile strength (Purdy and Brooks 1971; Patterson 1981; Rick 1978) of chert for easier flaking and to allow the production of longer flakes (Flenniken and Garrison 1975:129; Rick 1978:47; Patterson 1979a). The author has seen unifacial tools made from selected flakes of bifacial reduction debitage from heat-treated flake blanks. However, purposeful heat treatment of flakes to make unifacial tools does not seem to be common.

In my personal experimental heat treatment of chert, a uniform procedure has been used with a home oven. Materials were heated with a temperature increase of 75° F (24° C) every 25 minutes until a temperature of 525° F (274° C) was reached. Heating was then continued at a constant temperature for three hours. The oven was then turned off without opening the door to allow slow cooling.

Changes in physical attributes of cherts from heat treatment are discussed below, and it is noted that identification of heat-treated cherts can be difficult for different varieties of chert. The author suggests that bifacial reduction debitage can often be more indicative of heat treatment than finished biface specimens. Some types of chert have little change in visual attributes from heat treatment even when knapping quality is improved.

COLOR CHANGE

Many types of chert show color changes from heat treatment, but some types of chert do not. A common color change is a reddish coloration due to oxidation of trace iron compounds (Schindler et al. 1982). Cherts from Flint Ridge, Ohio display a variety of color changes from heat treatment (Patterson 1979b). There can be problems in the use of color to identify heat treatment of chert. One problem is that color change can occur only on the surfaces of flake blanks. After removal of original surfaces by bifacial reduction, finished artifacts will not show any color change from heat treatment. Thus, color properties of debitage can be more indicative of heat treatment than finished bifaces. Examination of differences in colors of ventral and dorsal surfaces of flakes can often be used to judge whether or not heat treatment has been used. Surfaces of flake blanks made of Central Texas cherts often develop a dull brown color after heat treatment.

Another problem with the use of color to indicate heat treatment is that knowledge of the original color of a chert specimen is often needed to judge if a color change has taken place. For example, some types of chert from Central Texas are light tan before heat treatment and gray after heat treatment. However, natural gray cherts can be found in the same general source areas, so that indication of heat treatment by color change would not always be possible.

THERMAL DAMAGE

Thermal damage of chert can occur, ranging from slight to severe (Patterson 1995), depending on type of chert and conditions of exposure to heat. Varying degrees of thermal damage of chert at prehistoric sites in North America is common, and usually indicates accidental exposure to high temperature, such as in campfires. Historic Indians used controlled procedures for purposeful heat treatment of chert that resulted in slight or no thermal damage. Small potlid fracture scars about 1 mm in diameter are fairly common on surfaces of accidentally-burned flakes at prehistoric sites. As with color change of chert from heat treatment, it is usually necessary to analyze debitage rather than finished bifaces for indications that heat treatment has been used.

SURFACE LUSTER

Heat treatment of chert often gives a waxy surface luster (Whittaker 1994:73). This texture is sometimes best observed on fresh fracture scars, because dull luster can develop on older surfaces. It is not common in archaeological reports to see that a biface specimen, such as a projectile point, has been chipped by an analyst to reveal a fresh fracture scar. This analytical procedure is generally overlooked.

On bifaces newly made from heat-treated Central Texas cherts, the author has observed three types of surface lusters. Some specimens have generally waxy lusters on most surfaces, some specimens have waxy luster on only a few selected flake scars, and a significant proportion of specimens do not have any waxy luster on surfaces. Thus, the degree of waxy luster caused by heat treatment can be quite variable. This can be a problem in judging whether or not heat treatment has been used. Also, some of the finer grades of Central Texas cherts have a natural high luster before heat treatment.

HEAT TREATMENT OF CLOVIS POINT MATERIALS

Collins (1999:179) states that there is little evidence to suggest heat treatment of lithic raw materials by Clovis knappers. However, there are data on the use of heat treatment by Clovis knappers. Heat treatment of chert was used at the Anzick Clovis site in Montana (Wilke et al. 1991), at Clovis sites in Southern Idaho (Titmus and Woods 1991:129), and for a Clovis point from McFaddin Beach (41JF50) on the upper Texas coast (Story 1990:188).

There is a problem in judging whether or not some Clovis points made from Central Texas cherts have been made from heat-treated materials. Clovis points were usually made from finer grades of Central Texas cherts. Several fine grades of Central Texas cherts, such as Georgetown, have high natural lusters, and experiments show little change in luster or color from heat treatment. Therefore, visual attributes of some varieties of Central Texas cherts are not reliable indicators of heat treatment. Many modern knappers routinely heat-treat even the finest grades of Central Texas cherts to improve knapping quality. There is a possibility that heat treatment of chert was used by Clovis knappers more frequently than is generally recognized. Because attributes of debitage can be more diagnostic for heat treatment than finished bifaces, special attention should be given to debitage at Clovis sites to identify heat treatment. Thermoluminescence (TL) analysis of fine grain, high quality cherts could be used to detect heat treatment, but this technique is destructive of specimens and expensive. TL analysis could be used for debitage without sacrificing important specimens.

SUMMARY

A variety of personal observations have been given here on visual attributes of chert that can be used to identify heat treatment, including color, surface luster, and thermal damage. It has been noted that not all types of chert show the same changes in response to heat treatment, with some chert types showing little visual change from heat treatment. The author's experiments have shown that debitage is often more diagnostic for heat treatment than finished bifaces, where none of the original surface of the flake blank remains.

It is not always possible to judge whether or not an individual biface specimen has been made of heat-treated chert. However, in reviewing lithic assemblages as a whole, it is generally possible to ascertain whether or not heat treatment of chert was generally being used in a specific lithic system.

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OBSERVATIONS ON THE USE OF BAKING SODA TO SOFTEN HARD CLAY AT FORT SAINT LOUIS, 41VT4

Bryant Saner, Jr.

ABSTRACT

Sodium bicarbonate, baking soda, was used at the Fort Saint Louis Archeological Project to soften the very hard clay found on the site. Different amounts and lengths of time the soil was exposed to the baking soda were observed and recorded. The question of the effects of the baking soda on the artifacts is examined in this paper. The gain or loss of person hours and money to the project is explored. Conclusions are discussed and recommendations are made.

INTRODUCTION

Baking soda is a white crystalline compound, $NaHCO_3$, with a slightly alkaline taste. It is also known as bicarbonate of soda or, by it's proper name, sodium bicarbonate. It is used in making effervescent salts and beverages, artificial mineral water, pharmaceuticals, and fire extinguishers (Picket 2000). It is commonly used for cooking, deodorizing, and household cleaning. It has a critical use in the medical field. When a patient is in cardiac arrest, the blood becomes more acidic and the heart is harder to restart. Intravenous injections of sodium bicarbonate are given in an attempt to return the pH of the blood to within the normal range, 7.35-7.45(Cummins 1997).

The site of Fort Saint Louis and Presidio Nuestra Señora de Loreto, also know as La Bahía, is located in the southeast part of Victoria County. The nearly level soils at the site are Lake Charles clay and Telfner fine sandy clay loam. Dacosta-Contee sandy clay loam is found on the slope by the bluff. These soils are at the surface to 12 inches below the surface. The pH of these soils vary from slightly acidic to moderately alkaline (Miller 1982).

Roads built over the site by the landowner over the years and the operation of the backhoe on the site during the project has compacted the already hard clays. Excavation of the soil in some areas is very difficult. There are areas on the site where the soil is soft and the screening is easy.

All soils, hard and soft, were excavated and placed in a wheelbarrow which is then pushed from the excavation area to a staging area and filled with water, covering the soil completely. The soaking process usually lasts 18-24 hours. On occasions, the soaking may last 24-72 hours. If it is excavated on a Friday, it will soak over the weekend. Soaking the soil in water for this amount of time will rarely soften it enough to allow screening it rapidly. It may take up to 2 hours to water screen a full wheelbarrow of the very hard clay. The soft clay takes 20-30 minutes to screen.

METHODOLOGY

Two 50-lb. bags of baking soda were used for experimentation. It was purchased at a swimming pool supply company at a cost of approximately $1.00 per pound. Baking soda costing 46 cents per pound was later purchased for use at Fort Saint Louis. The baking soda was added to the wheelbarrows containing hard soil. It was added in 8 oz. (one cup, one-half pound, 227 gm) increments. One, two and ten cups were added to various wheelbarrows by placing it on top of the soil in the tub, adding water and stirring the soil. Some of the wheelbarrows had one cup placed in the bottom of the tub, the excavated soil added and one cup placed on top of the soil. Water was added and the contents stirred. All wheelbarrows were marked with flagging tape to identify how much baking soda was added and where it was placed. The wheelbarrows were allowed to soak for 18-24 hours. Records were kept as the wheelbarrows were screened with the amounts of baking soda added and time it took to screen the loads. The wheelbarrows without baking soda had the time it took to screen them recorded. The size of the chunks of soil, the ease or difficulty with screening and if baking soda remained undissolved in the tub were noted.

DISCUSSION

The soil with the baking soda added to it screened easier and faster than soil without it. The nearly full wheelbarrows with small chunks (fist size and smaller) screened in 20-25 minutes after 18-24 hours of soaking in the baking soda solution. The ones without baking soda took 50 minutes to 1 hour and 30 minutes to screen. The large chunks (hand size to 20 cm x 20 cm. and larger), soaked for 18-24 hours and took an hour or more to screen. These chunks were soft on the outer portion to about 3-4 cm. toward the center and hard in the inner portion. When these large chunks were soaked for 72 hours it took approximately 20-30 minutes to screen. The large chunks soaked in water took 1-2 hours to screen per wheelbarrow load.

The wheelbarrow with 10 cups of baking soda did make the hard soil soft in a shorter period of time. It took about the same amount of time to screen the loads with 10 cups as with those having two cups of baking soda.

The wheelbarrows that had one cup of baking soda placed on top of the soil and one in the tub under the soil and then stirred had some undissolved baking soda remaining in the bottom. The amount of undissolved baking soda varied from wheelbarrow to wheelbarrow.

It is important to determine if the baking soda has a detrimental effect on the artifacts. According to Steve Tomka (personal communication, 2001), Director of the Center for Archaeological Research at The University of Texas at San Antonio, it does not effect the C_{14} dating and it is not damaging to the prehistoric artifacts when used to dissolve hard soil. Donny L. Hamilton (personal communication, 2001), Director of the Conservation Research Laboratory at Texas A&M University in College Station, Texas, states that the iron, copper and copper alloy artifacts from damp terrestrial sites are stored in a mildly alkaline solution. Untarnished lead may be mildly affected by baking soda. However, the lead artifacts recovered at the site are coated with a whitish substance. This is probably lead carbonate and no more carbonate can accumulate on the artifact once the initial layer is in place. It is tannic and humic acid that usually damages lead in terrestrial sites. Tannic acid is an amorphous, strongly astringent substance most often found in oak galls. Oak trees are found at 41VT4. This acid is used in the preservation of leather. The word "tanning" is derived from the word "tannic" (Oxford 1980). Humic acid is a complex organic compound created by the decay of organic material (Evans 1978). The organic material is in the form of leaves and grass that is found across the site. It is likely that the baking soda will have beneficial effects by neutralizing the acids on the metal artifacts prior to arriving at the lab.

The reason that baking soda softens the clay is complicated. A condensed and simple explanation is offered by Wesley Miller (personal conversation, 2001), soil scientist with the Natural Resource Conservation Service in Victoria, Texas. The large clay particles have a negative charge, while the small sodium ions have a positive charge. When the baking soda is added to the soil and water mixture, the positively charged sodium ions attach to the negatively charged clay particles. When many positive sodium ions have attached to the clay particles, the ions will repulse one another because positive repels positive like a magnet. When the sodium ions repel one another, they pull at the clay particles breaking the bond and making the clay soft.

CONCLUSION

The most effective use of baking soda at 41VT4 is to place two cups on top of the soil in the wheelbarrows filled with the small and large chunks, add water and stir. Optimal softness is reached between 18-24 hours for the small chunks and 72 hours for the large chunks. Using 10 cups of baking soda per wheelbarrow did seem to speed up the time required to soften the soil for efficient screening. It did not decrease the screen time. Baking soda placed in the bottom of the wheelbarrows prior to placing the excavated soil in the tub is an inefficient method. There is undissolved baking soda in varying amounts found in the bottom of the tub when it is dumped into the screen. The baking soda that is undissolved is lost. It takes 0.33 to 0.5 hours to screen a wheelbarrow load of soil with two cups of baking soda added to it and soaked for 18-24 hours. This is 12-24 (average 18) wheelbarrows per day. It takes 0.8 to 1.5 hours to screen a wheelbarrow load soaked the same amount of time without baking soda in it. This is 4-10 (average 7) wheelbarrows per day. The use of baking soda saves 0.75 to 1.17 hours in screening time. The screening time is usually in between the worst and best case scenarios in both categories.

The cost of baking soda to the project is 23 cents per cup. One cup (8 oz.) of baking soda weighs half of a pound or about 227 grams. Each cup cost 23 cents per pound. At the Fort Saint Louis Archeological Project this equates to approximately 46 cents per wheelbarrow load of soil. The cost of the baking soda times the average wheelbarrows screened with baking soda is $8.28 per day. The savings per hour is 7.50 to $10.00. $10.00 per hour is used as the wage. This translates into a cost savings of $50.00 to $60.00 per day per screener less $8.28 for baking soda or $41.72 to $51.72 saving per screener. There are usually two screeners working. It is safe to say the savings is about $100.00 per day.

The amount of baking soda required to soften hard clay will vary. It appears that the more baking soda used the quicker the clay will soften. Using too little will not completely soften the soils. Using too much will soften the soil, but is wasteful and not cost efficient. It is recommended that each project that uses baking soda should do some preliminary testing to determine the amount of baking soda needed to create the desired effect and still be cost efficient.

The use of baking soda saves money on projects that have a limited budget such as cultural resource management (CRM) projects. The CRM companies contract to do a set amount of work at a set price. The addition of baking soda allows the screening to be completed quicker, therefore the job is completed in less time.

At the Fort Saint Louis Archeological Project, the gain is efficiency not money. This project is funded for a certain time period. At the end of this time period, the work in the field stops when there is no more funding for field work. Ironically, in the long term, it may actually cost more money! The less people required to water screen means more people excavating. The more people excavating will produce more artifacts. These artifacts will require cleaning, sorting, identification, cataloging, conservation and curation, all of which cost money.

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INFORMATION FOR CONTRIBUTORS
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We are now incorporating a small Texas map with the county represented in the lower right-hand corner of Page 1. This is not "Figure 1" and it may be all that you want in your paper. However, if you are being more precise as to your area of Texas, please submit a map showing the general region. This would be Figure 1. We prefer not to be too precise with locations of sites as some people will take advantage of this information to trespass, locate, and ravage archaeological sites.

Other figures can be line drawings or photographs; line drawings are preferred if they are good quality. Sharp black and white photos are preferred but color can be used. If you need assistance with illustrations, please let us know—there are several STAA members who have volunteered to help with illustrations. For examples of good artifact and map illustrations, see those by Richard McReynolds and Ken Brown in previous issues.

When drawings or sketches of artifacts are included in your manuscript, please give the name of the artist responsible for the illustration(s). All figures should contain an appropriate caption and, where necessary, identification of each specimen (a, b, etc. or 1, 2, etc.) to aid referencing individual specimens in the text. The suggested procedure is to photocopy your original drawing and write in captions and identification letters on the photocopy. This saves the original for our use in final preparation of camera-ready copy.

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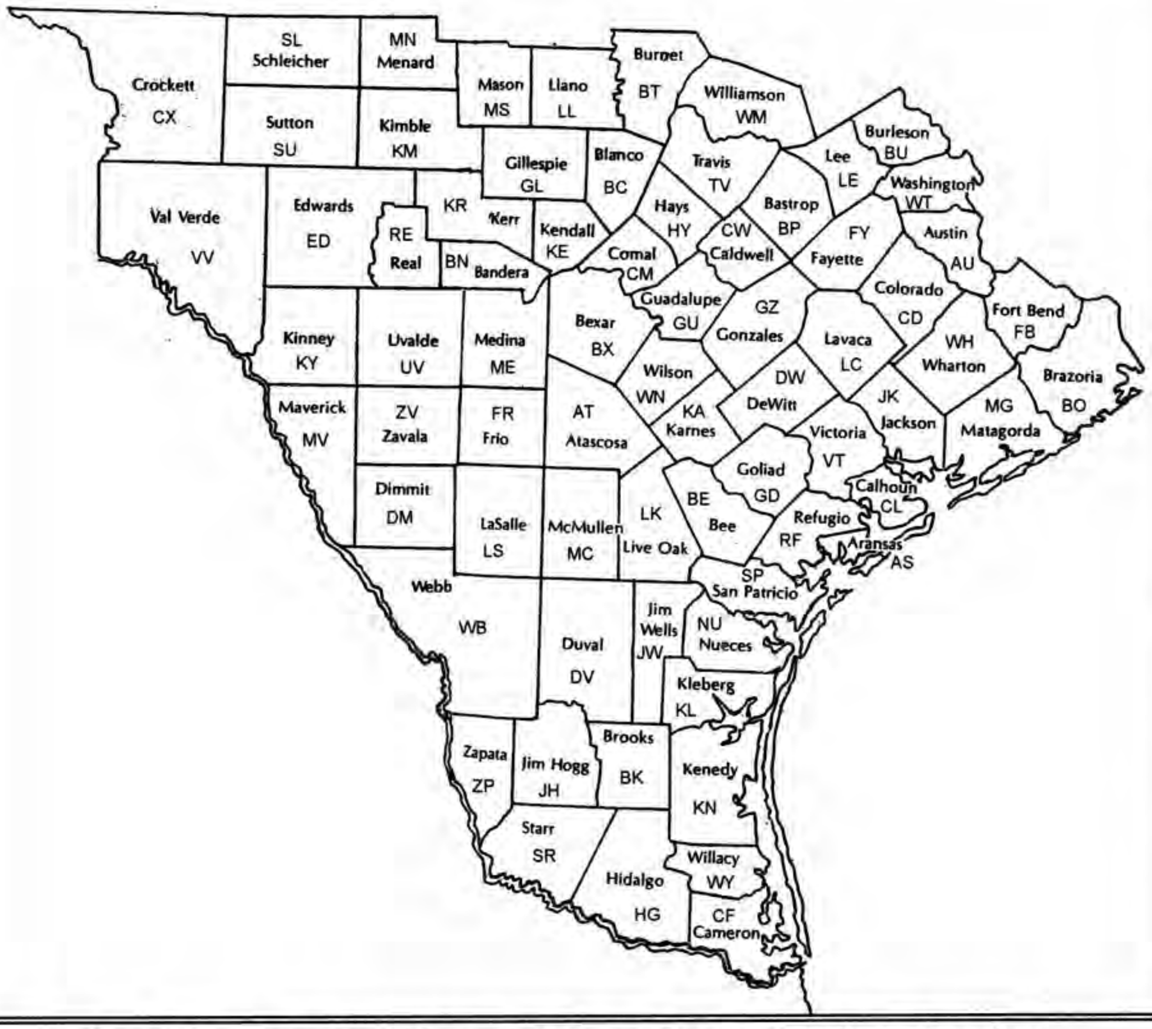

South Texas counties with symbols for archaeological site designations.

CONVERSION CHART

Multiply	By	To Get	Multiply	By	To Get
millimeters (mm)	0.0394	inches	inches	25.4	millimeters
centimeters (cm)	0.394	inches	inches	2.54	centimeters
centimeters	0.0328	feet	feet	30.48	centimeters
meters (m)	3.281	feet	feet	0.3048	meters
meters	1.094	yards	yards	0.9144	meters
kilometers (km)	0.621	mile	mile	1.609	kilometers
hectares (ha)	2.471	acres	acres	0.4047	hectares

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