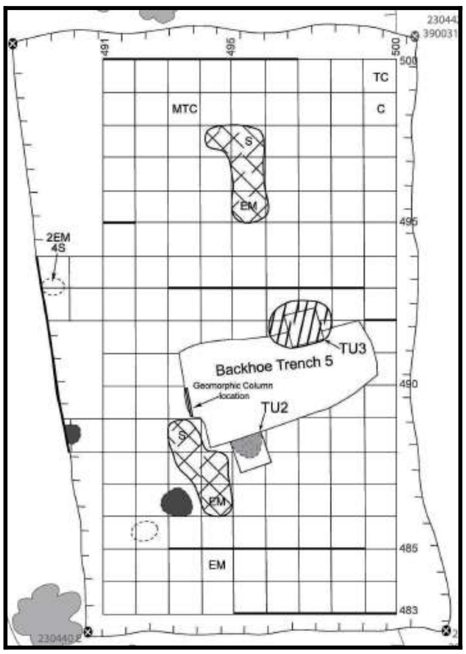
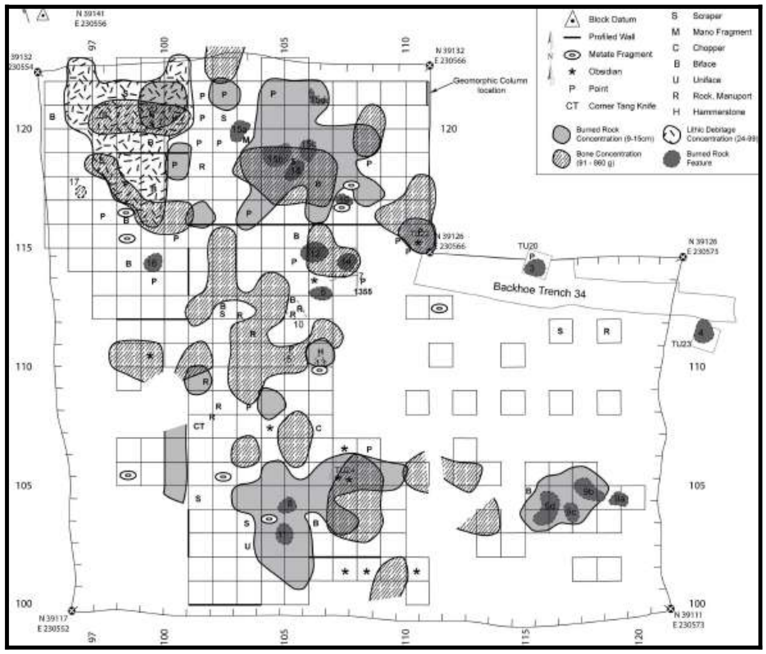
Landis Property: Data Recovery at Three Prehistoric Sites (41PT185, 41PT186, and 41PT245) in Potter County, Texas
Volume I

By:

J. Michael Quigg, Charles D. Frederick, Paul M. Matchen, and Kendra G. DuBois





Prepared for:

Bureau of Land Management

Amarillo Field Office
Amarillo, Texas

Prepared by:

TRC Environmental Corporation
Austin, Texas

TRC Report No. 150832

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EXECUTIVE SUMMARY

Cultural resource investigations were conducted by professional archeologists from the Cultural Resources Department TRC Environmental Corporation (TRC), Austin and Albuquerque offices. TRC was under contract with the BLM who transferred this federal property to the Girl Scouts of America. The cultural resource investigations were necessitated by the transfer of these federal lands to the private sector because of a requirement under Section 106 of the National Historic Preservation Act of 1966 and 36 CFR 800.

Data recovery investigations at three archeological sites (41PT185, 41PT186, and 41PT245) were conducted in two phases (Phase I and II) with fieldwork conducted during the fall of 2007 and in the fall of 2008. The three sites are within a ca. 1.6 km long, north to south section of upper West Amarillo Creek. They are on the Landis Property, previously managed by the Bureau of Land Management (BLM) in Potter County, just west of Amarillo, Texas.

Before this data recovery project, a cultural resource survey and initial site assessment investigations were conducted (in 1998 and 1999, respectively) by National Park Service archeologist Charles M. Haecker. That fieldwork identified four archeological sites (41PT184, 41PT185, 41PT186, and 41PT187) and 22 isolated finds, made site specific recommendations for future investigations and recommended the preparation of a data recovery/treatment plan. The BLM concurred with the overall recommendations and subsequently contracted with TRC for the preparation of the treatment plan. Following the preparation and acceptance of the treatment plan, the BLM made arrangements for the next phase of work, consisting of data recovery investigations at three of the five sites (41PT185, 41PT186, and newly identified 41PT245).

Data recovery was conducted in two separate phases (I and II) to allow for additional detailed site assessments and to facilitate an incrementally focused work effort. Phase I data recovery was conducted by TRC between September 24 and November 24, 2007. These field investigations included a geoarcheological component that was facilitated through the mechanical excavation of 47 backhoe trenches across the Landis Property. This was done to identify, document, and define the natural depositional processes in this part of West Amarillo Creek valley. This geoarcheological work contributed to the understanding of site formation processes and the sedimentary contexts of cultural materials in the three known sites. Twenty four trenches that totaled 262 linear meters (m) were within the three known archeological sites. Twenty three trenches were outside any previously identified archeological site boundaries and included 148 linear meters. A very complex Holocene alluvial history, represented by at least six allostratigraphic units (designated A through F), was documented. The alluvial fills were found to be upwards of 6 m thick. Thicknesses varied considerably, and fills were generally at least 4 m thick. About 60 percent of the Holocene record is represented in the project area. Specifically, a period of ca. 4000 years, (ca. 8200 B.P. to 4300 B.P.), was not represented in the depositional sequence.

During Phase I data recovery investigations, 46.9 m^3 of sediment from 41 test units were hand excavated and screened within the three sites. At site 41PT185, Locus A, the Pipeline site, seven trenches totaling 70 linear meters exposed all six units of Holocene fill. Eleven test units revealed cultural remains largely within the upper sandy, late Holocene deposits that had been partially mixed by turbation. Among the test units, two small burned rock features

were encountered. The excavations yielded only a few diagnostic artifacts and very few formal chipped stone tools. Within Locus A, four radiocarbon dates from bone collagen indicate a use period between 2130 and 2940 B.P., during the Late Archaic period. A broken beveled knife and a base of a possible Fresno point may reflect a second period of use during the Antelope Creek phase. No areas in Locus A were recommended for a Phase II data recovery.

At Locus B of site 41PT185, two backhoe trenches, with a total length of 14.5 m, revealed at least two buried cultural zones, one from ca. 35 to 45 cmbs and a second at about 70 to 80 cmbs. The most promising context for cultural materials lay under the Girl Scout cabins. Because of potential negative impacts to the Girl Scout camp grounds at the northern end of this site, no further excavations were conducted in that area during Phase I investigations. No areas in Locus B were recommended for a Phase II data recovery.

Locus C, at 41PT185 was newly identified during the Phase I investigations. Locus C was investigated with four trenches totaling 52 linear meters. The trenches exposed primarily Holocene fills dating to between ca. 1500 and 9600 B.P., with some very thin recent fills dating to the last ca. 500 years. Cultural materials were discovered primarily at the contact of the early and late Holocene deposits at varying depths. Thirteen test units exposed two intact burned rock features, two proximal sections of untyped Late Archaic dart points, bison bones, lithic debitage, scattered burned rocks, and three pieces of obsidian flaking debris. These cultural artifacts were in a mostly intact cultural component. This component was radiocarbon dated by three bison bone collagen dates to between ca. 2270 and 2420 B.P. Locus C was considered to have good potential to yield significant data for understanding the poorly defined Late Archaic cultural period in this region, and was recommended for Phase II data recovery investigations.

At 41PT186, the Corral site, Phase I investigations included the mechanical excavation of five trenches totaling 64 m. These trenches exposed very complex alluvial stratigraphy in multiple terraces. Cultural materials were detected in most late Holocene alluvial fills, but in relatively scattered and disturbed contexts. This contrasts with the most recent fill that is less than 430 B.P. in the vicinity of Trench 5. At Trench 5, an ash filled hearth and a cluster of butchered bison bones were discovered in one well defined and well sealed component at about 100 to 110 cmbs. This buried, intact cultural component was radiocarbon dated by both bison bone and wood charcoal to ca. 220 years ago, representing a rare component of the Protohistoric period. This low terrace at Trench 5 was recommended for Phase II data recovery in the form of a block excavation between 90 and 110 m^2 in area. The cultural materials identified under the T_1 surface across the majority of 41PT186, with the exception of the above area, appeared mixed and/or vertically dispersed. This disturbed context limits the potential of the cultural remains to contribute significant information to the prehistory of the region. Consequently, no other areas within 41PT186 were recommended for Phase II data recovery.

Phase I data recovery investigations at 41PT245, the Pavilion site, included six mechanical trenches totaling 62 m in length across two terrace surfaces (T_0 and T_1). The exposed trench profiles revealed all six identified Holocene alluvial units. The younger fills in the lower T_0 deposits again yielded additional significant and intact cultural deposits from 8 m^2. In the northern part of this site at least two sparse layers of bison bones, plus one well defined burned rock feature, were detected between 100 and 140 cmbs. One bison bone collagen date and one charcoal date documented site occupation between 1210 and 1390 B.P. for these layers, which also yielded scattered lithic debitage. This northern area was recommended for Phase II data recovery in the form of a large block excavation between 140 and 160 m^2 in area.

Following Phase I investigations three carefully selected target blocks, one at each of the three sites, was recommended for Phase II data recovery. The overall recommendations and approach for Phase II presented by TRC was subsequently approved by the BLM. Following an open bid competition for Phase II work, TRC was awarded the contract to conduct the Phase II investigations.

Phase II investigations were conducted in the fall of 2008. These hand excavations were initiated at the target block in 41PT245, but with very limited cultural remains encountered in the first 22 m^2, this work was halted. Efforts were then redirected to the targeted blocks at the other two sites. The target block at 41PT185/C, the Pipeline site, encompassed 285 m^2 and resulted in the recovery of significant cultural materials from the Late Archaic period. At 41PT186, the Corral site, a continuous block excavation of 144 m^2 targeted the Protohistoric component. The cultural materials are relatively limited in terms of quantity and diversity, but the horizontal distribution of the intact cultural features sheds considerable light on human behavior during this critical time period.

Thus, two of the three targeted blocks yielded significant data with which to address research questions concerning the Protohistoric and Late Archaic periods. In total, the Phase II investigations encompassed about 451 m^2 of hand excavations. Information from the two intact and well defined cultural components adds considerable knowledge to our understanding of the human populations that lived here. The data also contributes insights into the regional prehistory of the Southern High Plains.

The completion of the archeological field investigations at the Landis Property, followed by the thorough documentation of the recovered materials and the extensive analyses reported herein, all funded by the BLM, has completed the obligations of the federal government under Section 106 of the National Historic Preservation Act of 1966 and 36 CFR 800 in the transfer of the lands to the Girl Scouts of America.

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

ACKNOWLEDGMENTS

The Bureau of Land Management (BLM) sponsored and guided this three year archeological data recovery project. Many individuals and organizations worked together and contributed significant expertise in diverse ways to make this mitigation program a success. We thank all those individuals and institutions for their contributions in completing this project and helping preserve a part of Texas' prehistoric cultural heritage.

We would like to express our gratitude to the personnel in BLM for their support. Special thanks go to Dr. Signa Larralde, BLM State Archeologist for New Mexico in charge of this project, for her continued support, guidance, and interest in this project. Mr. John Littlefield of the BLM Amarillo Field Office was most helpful in providing gate keys and logistical support during project initiation.

The Landis Property was gifted to the Girl Scouts of America, with the property currently managed by Ms. Natalie Stephenson, Director of the Outdoor Program. Ms. Stephenson helped organize the Saturday open house for the Girl Scouts and their families in the region during the fall field seasons in 2007 and 2008. Thank you, Natalie, for your interest and efforts in organizing these multiple events. Mr. Dugan Holt, Facility Maintenance Supervisor, also contributed support in various capacities during our time on the property and helped with the open house events.

During the TRC Environmental, Inc. (TRC) Phase I efforts in the fall of 2007, the hard working field staff from the Cultural Resources Department of TRC's Austin and Albuquerque offices aided in to the timely and efficient completion of the fieldwork. The field crew was directed by Mike Quigg (Principal Investigator). Ms. Toni Goar served as Project Archeologist, with Kendra Luedecke and Courtney Wands serving Crew Chiefs who directed the crew of archeological technicians. These people included; Ms. Deidra Aery, Mr. Ardale Delena, Ms. Jennifer English, Mr. Owen Ford, Ms. Emily Hilley, Ms. Jalesa Johnson, Ms. Verity Robert, Ms. Beth Sain, and Ms. Tracy Steffgen. The project geoarcheologist was Dr. Charles Frederick who expertly identified, sampled, documented, and recorded depositional sequences, guided the archeologists to the prime contextual areas, and continually provided insightful comments and direction during his field time. Dr. Frederick was also kind enough to loan his diverse collection of projectile points, basketry, etc. for our open house displays. The excellent backhoe trenching and grading of the dirt road into the sites was conducted by Mr. Brian Mackey of Precision Excavation, Amarillo. He also lent a sharp eye for spotting cultural remains he carefully trenched and scraped with the backhoe.

TRCs Phase II data recovery investigations were again directed by Principal Investigator Mike Quigg with Paul Matchen serving as Project Archeologist and Kendra DuBois serving Crew Chief. The hard working 2008 field crew consisted of Ms. Erin Atkinson, Mr. Brennan Badjek, Mr. Jeffrey Brooks, Ms. Mindy Burkitt, Mr. Clay Cantrell, Mr. Michael Davis, Mr. Curtis Dusek, Mr. Owen Ford, Ms. Karen Jordan, Mr. Gabriel Kenton, Mr. Dale Lynch, Mr. Gregory Martino, Ms. Katherine Turner Pearson, Ms. Verity Robert, Ms. Shirley Shirley, and Mr. Gregory Sundborg. These archeologists are thanked for completing the field effort on time, with minimal errors and problems. They endured all types of weather including intense rain storms, strong gusty winds, cold temperatures, and sometimes combinations of these conditions.

Following the fieldwork, many individuals and institutions contributed their expertise in the forms of the special analyses and pertinent interpretations presented in the interim and final reports. Various TRC employees made substantial contributions to the completion of this project. Ms. Toni Goar oversaw the electronic site map production and facilitated the identification of several pottery sherds by Ms. Lori Reed following the Phase I fieldwork. Thank you, Lori, for your expertise, time, and comments concerning the few nonlocal sherds. Ms. Kendra G. Luedecke, presently Mrs. DuBois, TRC Austin Laboratory Supervisor, managed the collections throughout the process, which included sorting, washing, cataloging, creating and inputting data into the electronic database, and the preparation of all the various materials for curation. She also facilitated the handling of the volumes of samples sent to the various laboratories for the technical analyses, as well as conducted the drafting of all the figures used throughout this document. Mrs. DuBois was assisted at times in the laboratory with the washing and cataloging the collections by Ms. Debbie Blackburn, Mr. David Yelacic and Mr. Jeff Hall. Mr. Hall also conducted the flotation of the feature matrix samples and assisted in various aspects of the analyses including: documenting counts and weights of the faunal assemblage, lithic debitage, recording the artifact observations and measurements, data entry of the lithic debitage data, creating distribution maps of the various faunal remains and lithic debitage, the tabulation of faunal assemblage data and the burned rock data from the features, picking the heavy and light fractions from the flotation process, and the tracking down and correcting of labeling, and cataloging problems. Mr. Paul Matchen and Mr. Mike Quigg cooperated in photographing the various artifacts and other materials sent for analysis and used in the report. Mr. Matchen conducted the lithic debitage analyses with assistance from Jeff Hall. Mr. Matchen also contributed in several areas that included the establishment of the site block profile drawings for each site, sorting and selection of raw materials for Instrumental Neutron Activation Analysis submission, reviewing and editing the Phase I interim report and sections of this technical report, as well as managing and helping to conceptualize the artifact data entry interface from which the lithic analyses were based. Mr. Steve Miller, TRCs resident chemical and Microsoft Access expert, contributed his time and extensive knowledge to this project. Mr. Miller created various configurations to facilitate data entry and manipulations of the lithic debitage and stone tools. He also searched and addressed several highly unusual questions the archeologists raised concerning chemical properties and reactions. Thanks, Steve, for your extensive knowledge, chemical background, and willingness to help out the archeologists. We would also like to thank Mr. Peter Condon in the TRC El Paso office for supplying a few old, charred, corn cupule fragments to this project. These samples were used for comparison with our macrobotanical remains. Dr. Robert Ricklis conducted editing and content reviews on this report. Ms. Darija Clark performed the document production and compilation of the chapters and appendices for the drafts and the final. Thanks to all the TRC individuals for working together to complete this document.

Dr. Chet Walker of Archaeo Geophysical Associates, LLC, of Austin, expertly performed the intensive geophysical investigations at the three archeological sites at the start of Phase II data recovery. The geophysical work included the use of multiple instruments, including a magnetometer, an electromagnetic induction meter, a resistance meter, and ground penetrating radar. These electronic instruments were employed following the mechanical stripping of overburden at each of the three target locations. Thank you, Dr. Walker, for your excellent field strategies, working around our tight field schedule and timing, and preparation of the draft working report for our immediate use in the field.

Following both phases of fieldwork a group of scientists outside TRC contributed significantly to various aspects of this project with their technical knowledge that led to the success of this final report. Many private individuals contributed their time, energy, and samples for assembling and collecting natural source materials (clay and tool stone), specifically for Instrumental Neutron Activation (INA) analyses and comparisons in the petrographic analysis of the ceramic sherds and natural clays. We would especially like to thank Mr. Rolla Shaller, Texas Historical Commission (THC) Volunteer Archeological Steward and Adjunct Curator of Archeology at the Panhandle-Plains Historical Museum (PPHM) in Canyon, for facilitating the completion of paper work, and for mailing artifacts from the previous Landis Property investigations. Mr. Shaller also managed to relocate the Tecovas outcrop in West Amarillo Creek, obtain permission from the landowner to collect natural samples for our analysis, take photographs of the locality, document specific sample locations, and provide unpublished information from Jack Hughes's original field notes. He gave another day of his time and collected Tecovas source rocks from Palo Duro Canyon (M 122) south of the project and sent them to TRC for our use in the INA study. He also facilitated the release of Tecovas materials from the PPHM collections (M 114 and M 151) for use in our analyses. His dedication and interest in the local prehistory is much appreciated. Fellow archeologists will benefit from his efforts for years to come.

Mr. Alvin Lynn of Amarillo was also contacted concerning natural clay sources in the region. Alvin was a gracious host one evening and allowed Mike Quigg and Charles Frederick into his house to discuss various topics, and provided several personal clay samples he had acquired from the region. He provided an Ogallala clay sample from Government Canyon, a tributary to the Canadian River in Roberts County, which we ran for comparison purposes. He also provided Mr. Quigg with one of his own replicated Antelope Creek style pots to help in our analysis. Mr. Lynn participated with Rolla Shaller in collecting natural rock samples from many source localities in the Amarillo region. He contributed Tecovas jasper samples from the Blue Creek sources he had recorded. His time, thoughts, and samples are much appreciated and will definitely contribute to a greater body of information for the Texas Panhandle. Thanks, Alvin, for your hospitality and for sharing your in depth knowledge of the area.

On their own time, Mr. Shaller and Mr. Alvin Lynn, THC Volunteer Archeological Stewards for the region, reviewed PPHM documents, obtained land owner permission, and then proceeded to various known lithic source localities in the vicinity of Amarillo to collected natural source rocks Tecovas jasper samples from a quarry site (41PT276) in West Amarillo Creek valley north of our project area, from Coetas Creek (41PT434) north of the project, and Rotten Hill/South Basin (41OL284) west of the project, to be used in the INA analysis.

The PPHM in Canyon is also thanked for their cooperation in allowing samples of Tecovas jasper in their possession to be used in the destructive analysis for our sourcing project. Mr. Rolla Shaller again helped facilitate the filing of the proper paper work to allow the release of the materials from PPHM. He rounded up the samples and paper work concerning these various sources, and then he shipped the samples to Mr. Quigg at TRC. The Museum was also gracious enough to loan projectile points from Late Archaic kill sites in the Texas Panhandle to the Texas Archeological Research Laboratory (TARL) in Austin so that Mr. Quigg and others could view and document them first hand. This loan was facilitated under the direction of Dr. Jeff Indeck with the help of Dr. Matthew Taylor and Ms. Mary Moore. I would also like to especially thank Dr. Jeff Indeck at the PPHM in Canyon, for taking our crew on a guided tour of that facility on a moment's notice. The tour took us to some specific exhibits, and then into the archeological laboratory and curation areas to show us the inner workings of the museum. Dr. Indeck took time out of his busy day to educate our group and we are thankful for his time.

Ms. Arlene Wimer, Chief of Resource Management for the National Parks Service (NPS) at the Lake Meredith National Recreation Area, Alibates Flint Quarries National Monument (AFQNM) was instrumental in processing Mr. Quigg's Archeological Resource Protection Act (ARPA) permit for use of the collection of Alibates raw material from the National Monument. She also volunteered her time to collect many samples of Alibates, photo document the localities, and ship the samples to TRC for our use. She was accompanied by Mr. Shaller and Mr. Lynn during the collection of the Alibates materials.

Mr. Doug Wilkens, THC Volunteer Archeological Steward in Perryton, Texas was kind enough to collect several clay samples for our use. Not all the samples he collected for us could be run, though we did use one of his samples. Upon request Mr. Wilkens also supplied the unpublished drawing, and metric and nonmetric observations of a Late Archaic corner notched Marcos point from the M[c]Intyre bison kill site in Roberts County. Thanks, Doug, for your continued support in addressing questions concerning the prehistory of that region.

Dr. Paul Katz, Principal of Prehistoric Resource Identification, Assessment, and Management PRIAM, was kind enough to provide natural source samples of Alibates for use in our INA analysis. This material came from quarry pit A at 41PT1, excavated in the Alibates Flint Quarries National Monument for the National Parks Service. He provided a few hand samples and location maps. He also provided a power point presentation on the Alibates quarries from which were pictures that proved to be valuable. Thank you, Paul, for your help in facilitating this work and analysis.

Mr. Doug Boyd, Principal of Prewitt and Associates, Inc. also provided Alibates material he had previously received from Mr. Ed Day, who had obtained the material from private lands on the north side of the Canadian River opposite the Alibates Flint Quarries National Monument. Thank you, Doug, for your contributions and willingness to share rock samples, information, and exchange ideas.

Dr. Lee Bement of the Oklahoma Archeological Survey was kind enough to conduct the projectile point observations and measurements on the points recovered from the Certain site in Oklahoma. He also provided photographs of those points for our use here. Lee was also consulted on an unidentified hole in a bison bone for which he provided a medial explanation and educated this author. Thank you, Lee, for your willingness to conduct these analyses and share your data.

Dr. Chris Lintz, Wildlife Division of Texas Parks and Wildlife provided many clay samples he collected from the Texas Panhandle region and one natural rock sample from Green Belt Reservoir. Some of these samples were used in the instrumental neutron activation analysis. He also loaned Mr. Quigg many background documents concerning this region from his personal library. He shared his considerable and in depth knowledge of the region with Mr. Quigg and provided detailed comments and guidance for the background chapter and the overall document. Chris also collected numerous natural Tecovas samples from different Tecovas outcrops along the eastern margin of the escarpment near Quitaque, Texas and passed them on for our use in this study. Most samples arrived following the submission of materials for neutron activation analysis, but the samples will be used in the future to continue expand our understanding of this significant tool stone. Thank you, Chris, for your continued interest in the prehistory of the Texas Panhandle and your willingness to collect and share samples.

Dr. Scott Brosowske, Archeologist for the Courson Oil and Gas Company in Perryton, Texas, is thanked for his willingness to exchange ideas on various subjects. He also provided obsidian data in his possession. Thanks, Scott, for your continued support and interest in the prehistory of the Texas Panhandle.

Dr. K. C. Kraft of the United States Department of Agriculture in Oklahoma was kind enough to provide his master thesis and other manuscripts concerned with background data used in this report. The information was quite helpful and his willingness to share data was greatly appreciated.

Dr. Fred Schneider of Norman, Oklahoma was kind enough to supply the project with 13 modern Native American seed samples from his collections. These seeds were sent to Dr. Linda Perry, the project's starch grain specialist, so that she could extract starch grains from them and use in part for comparisons to our archeological samples that she was analyzing. The 13 Native seed samples included two types of beans (from the Cherokee and Arikara), four types of squash (from the Arikara, Wichita, Choctaw, and Mandan), and seven types of flour/corn kernels (from the Wichita, Pawnee, Quapaw, Cochoti, Osage, Cherokee, and Chickasaw). Thank you, Fred, for helping out in the name of science and his continued interest in native horticulture.

Dr. Steve Tomka, Director of the Center for Archaeological Research (CAR) at University of Texas at San Antonio, provided replicated gun flints and the associated debitage that he manufactured at our request. We used his modern replicas to compare with the lithic debitage from our Protohistoric component at 41PT186. I thank Steve for his willingness, time, and expertise in providing these useful comparative samples.

Chris Zier of Centennial Archaeology, Inc. of Fort Collins, Colorado was kind enough to provide the lead author with a compact disk that contained the final report on Recon John Rockshelter. The paper copies are no longer available.

Dr. Ernest Walker, professor at the University of Saskatchewan, Saskatoon, Saskatchewan, a forensic specialist was consulted on a strange hole in a bison tibia and provided a detail explanation of how that hole occurred. Thanks Erne for your insights and the education into forensic medicine.

We would also like to thank the many professional individuals and institutions whose outside technical expertise provided valuable contributions that allowed us to obtain in depth insights into the prehistoric peoples who occupied these sites. Dr. Mary Malainey of Winnipeg, Manitoba conducted the lipid residue extractions and analyses on a sample of burned rocks and ceramic sherds. Drs. Michael Glascock, Matthew Boulanger, and Jeff Ferguson of the Archaeometry Laboratory at the University of Missouri Research Reactor Center, conducted the instrumental neutron activation analysis on cultural and natural chert samples, and cultural and natural clay samples from these sites and the surrounding region. Dr. Steven Bozarth, Palynologist at the University of Kansas, conducted the opal phytolith and palynological analyses on dated sediment samples and column samples from the project area. Dr. David Robinson of Austin, Texas, performed the petrographic analyses of six ceramic sherds from these sites and 11 natural clay samples from the surrounding region. Dr. M. Steven Shackley, Director of the Berkeley Archaeological XRF Laboratory, conducted the source analysis on the obsidian samples. Geochron Laboratories, a Division of Krueger Enterprises, Inc., of Cambridge, Massachusetts, provided the stable carbon and nitrogen isotope data from the bison bone samples recovered from the sites. Dr. Linda Perry, of the Smithsonian Institute in Washington D.C., conducted the starch grain analysis on a few ceramic sherds, metate fragments, a small sample of selected stone tools, and many burned rock samples. We want to especially thank Linda for her continued communication and interest in working with me on this project and her willingness to conduct starch analysis on the burned rocks. Dr. Bruce Hardy, Professor in Department of Anthropology at Kenyon College, is thanked for his excellent identifications of microfossils and high powered use wear on the various artifacts. Dr. Manuel Palacios Fest of Terra Nostra – Earth Science Research, is thanked for the application of his broad knowledge and expertise in the analyses of gastropods and mollusks from BT 36 and his insightful interpretation of the paleoenvironment from his specific analyses. Dr. Barbara Winsborough of Austin conducted the diatom analysis on a limited suit of sediment samples from BT 36 in support of the environmental record. The scientists at Beta Analytic Inc., in Florida including Darden Hood, Ron Hatfield, Chris Patric, and Teresa Zilko Miller are thanked for their continued excellence in handling the many samples and subsequent results from the radiocarbon dating process. Dr. Phil Dering, of Shumla Consulting Service in Comstock, Texas, provided his extensive expertise in the identification of the macrobotanical materials and light fractions from the float samples submitted to him. Dr. Tom Maddox, director of the Institute of Ecology at the University of Georgia in Athens, provided the stable carbon and nitrogen isotope data on matrix samples used in this report. Dr. Linda Scott Cummings of PaleoResearch Institution, Inc. in Golden, Colorado directed the fourier transform infrared spectroscopy (FTIR) analysis. Ms. Melissa Logan of PaleoResearch Institute, Inc. preformed the FTIR on the samples and wrote the technical report. Thanks to the staff of PaleoResearch for their cooperation and support of this analysis.

As one can see that a wide ranging network of contributions and cooperation from many individuals and companies contributed data and expertise to this technical report. To all the above people and institutions, we are grateful, and appreciate all of the expert contributions to this project. Thanks to all. Any problems, omissions, or errors are the responsibility of the project director.

Mike Quigg,

Project Director and Principal Investigator

1.0 INTRODUCTION

J. Michael Quigg

1.1 INTRODUCTION

The information reported here is the end product of two phases (Phase I in 2007 and Phase II of 2008) of the fieldwork relating to the data recovery archeological investigations of the Landis Property in Potter County, Texas. This project was funded by the Bureau of Land Management (BLM). In 2007 the BLM transferred the Landis Property to the private sector (the Girl Scouts of America). This transfer of land required the implementation of the Section 106 of the National Historic Preservation Act of 1966 and 36 CFR 800, which calls for cultural resources survey, site assessment, and data recovery to be undertaken.

Volume I of this document begins by providing a brief discussion of the project location. This is followed by a discussion of the 1998 archeological investigation, which included pedestrian reconnaissance, followed by the 1999 site assessment at the Landis Property. Chapter 2.0 provides a general environmental background that presents the physiographic setting, geology, climate, economic resources, paleoenvironment, and paleoclimatic characteristics for the region. Chapter 3.0 provides the cultural historical regional cultural context for the three archeological sites investigated during this data recovery phase. The research design that framed and guided the field investigations and analyses is presented in Chapter 4.0. This latter chapter was part of the original treatment plan that was provided to the BLM in A.D. 2005, and provided the guidance to the data recovery program. Chapter 5.0 describes the field and laboratory methods, and the analytical techniques employed to obtain and analyze the cultural materials collected during the data recovery process. Broad, project wide geoarcheological investigation and stratigraphic interpretations are presented in Chapter 6.0. This chapter also provides the necessary context for understanding the different depositional deposits of these complex archeological sites and the materials they produced, plus the contextual reasoning behind the selection of the locations for the specific Phase II data recovery investigations. Chapter 7.0 briefly introduces the three archeological sites that were targeted for intensive data recovery. Chapter 8.0 presents comprehensive information concerning archeological site 41PT185 and its three distinct loci (A, B, and C). This includes discussion of the natural setting, previous Phase I investigations, site stratigraphy, Phase I results, and site integrity, followed by discussions of the Phase II data recovery investigations, the data recovered, analytical results, and major research issues and specific research questions. Chapters 9.0 and 10.0 present similar sections for archeological sites 41PT186 and 41PT245, respectively. Chapter 11.0 provides a summary of the Phase I and II results and interpretations. Chapter 12.0 provides brief recommendations for the cultural resources. Chapter 13.0 lists the references cited throughout the body of the report. A glossary of technical terms is provided in Chapter 14.0 to help the reader with selected technical terms used throughout this document. These 14 chapters are presented in Volume I.

Volume II contains 18 appendices, labeled A through R. The appendices provide various detailed data, technical analyses, and interpretations from a variety of sources, most from outside laboratories. These specific technical analyses begin with; Dr. Charles Frederick's detailed descriptions of the stratigraphy observed in each of the 47 backhoe trenches excavated across the property in Appendix A. Artifact frequencies from the Phase I investigations documenting the horizontal and vertical distributions of the recovered materials at the three sites which guided the recommendations for Phase II work are presented in Appendix B. The obsidian source analysis conducted by Dr. M. Steven Shackley is in Appendix C. The phytolith and pollen analyses by Dr. Steven Bozarth from dated samples and backhoe trench 36 at 41PT185/C are presented in Appendix D. Drs. Matthew T. Boulanger and Michael Glascock present the neutron activation analysis on chert in Appendix E. Starch grain analysis on a diverse suite of artifacts is presented by Dr. Linda Perry in Appendix F. Dr. Mary Malainey presents her lipid residue analysis in Appendix G. Stable carbon and nitrogen isotope analysis on bison bones by Geochron Laboratory is presented in Appendix H. Dr. David Robinson's petrographic analysis of aboriginal ceramics and natural source clays are presented in Appendix I. Instrumental neutron activation analysis (INAA) on ceramic sherds and natural clay by Drs. Jeff Ferguson and Michael Glascock is presented in Appendix J. Beta Analytic radiocarbon laboratory forms and results are presented in Appendix K. Dr. Bruce Hardy's results of high powered microscopic use wear and residue analyses on a selected and diverse artifact assemblage is presented in Appendix L. Paleoenvironment reconstruction from ostracods, mollusks, and isotope analysis from a column extracted from backhoe trench 36 at 41PT185/C is presented in Appendix M. Appendix N is the macrobotanical identifications of selected charcoal samples and feature light fractions by Dr. Phil Dering. Appendix O presents the geophysical investigations conducted by Dr. Chet Walker at the three proposed block excavations before the Phase II archeological investigations. Appendix P contains the diatom investigations, results, and interpretations from samples extracted from backhoe trench 36 at site 41PT185/C. Appendix Q contains individual tables with metric and nonmetric data for each stone tool by tool category from the three sites and various components. A compact disk – read only memory (CD ROM) is provided with the entire database for the Phase I and II data recovery investigations. Appendix R presents the technical report concerning the Fourier Transform Infrared Spectroscopy of organic residues performed by PaleoResearch in golden, Colorado.

1.2 PROJECT LOCATION

The Landis Property lies in the Texas Panhandle, within the Southern Plains region of the Great Plains physiographic province. This property is near the headwaters of West Amarillo Creek, a small south to north flowing tributary that enters the Canadian River valley from the south on the western side of Amarillo, Texas (Figure 1-1). The Landis Property consists of about one half of a section of land, 133.4 hectares (ha) or 331 acres, along the upper reaches of West Amarillo Creek, which drains through the middle of the property. Thus, the project area is centered on a small part of a much longer valley on the northern end of the Llano Estacado, in what is considered the Canadian Breaks, along the margin of the much broader and extensive Canadian River system.

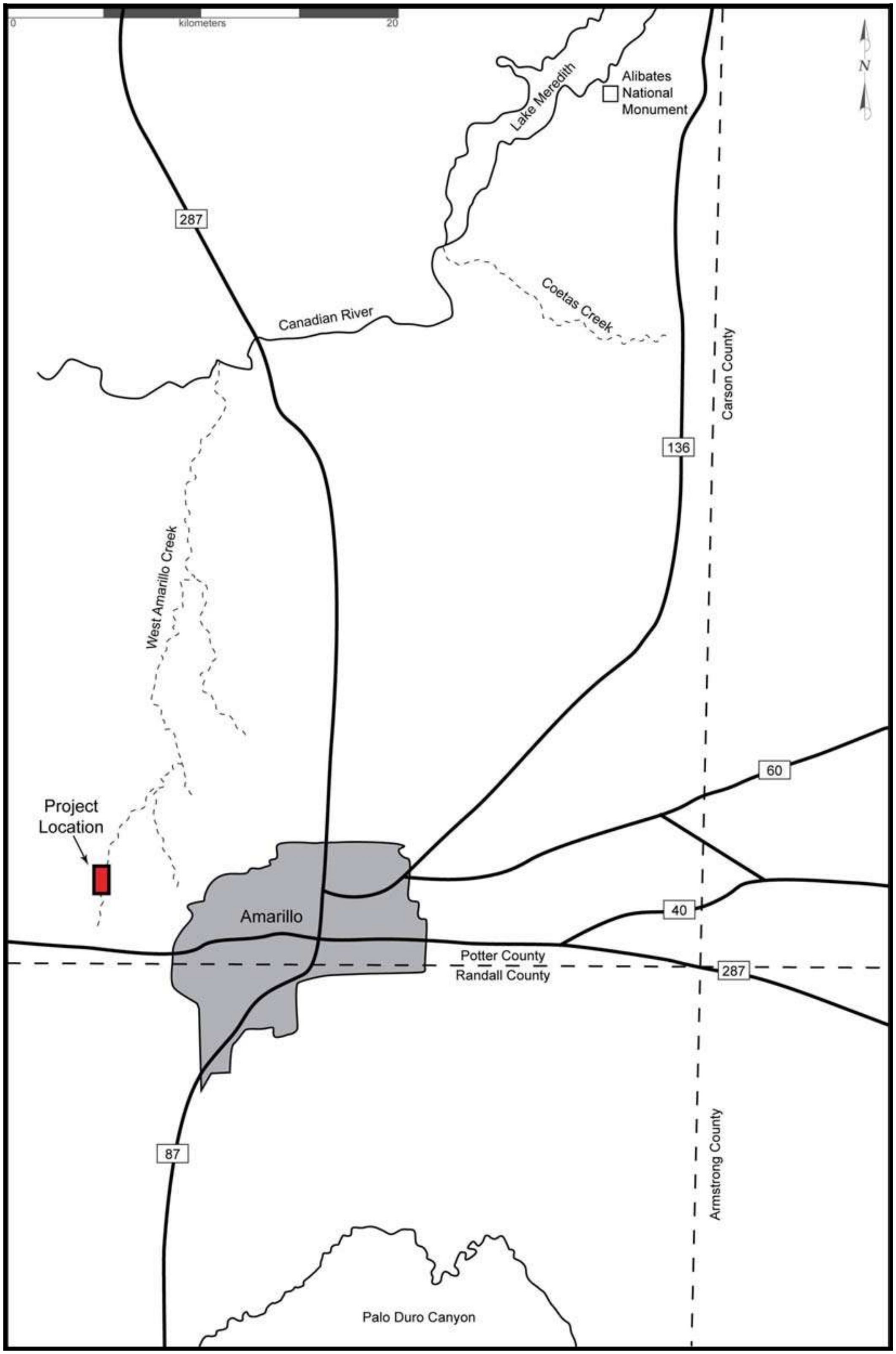

Figure 1-1. Location of Landis Property Along the Upper Reaches of West Amarillo Creek

1.3 PREVIOUS ARCHEOLOGICAL INVESTIGATIONS ON THE LANDIS PROPERTY

1.3.1 Project Survey and Site Assessment

In October 1998 an archeological surface survey, without the aid of shovel tests or backhoe trenches, was conducted by National Park Service archeologist Charles M. Haecker (Haecker 1999). The survey was conducted by a team of three persons who performed a systematic foot survey in lines 15 m apart with occasional deviations. When fewer than 20 cultural items and no cultural features were discovered in an area 20 by 20 m, any discovered material was considered an isolated occurrence (IO). Twenty two isolated cultural remains were encountered, which included five historic items, 15 prehistoric items, and two fossilized bone localities. Most prehistoric isolated pieces were from upland and/or colluvial slope settings. The team discovered and recorded four prehistoric sites (41PT184, 41PT185, 41PT186, and 41PT187), which, based on surface observations, were considered potentially eligible for listing on the National Register of Historic Places (NRHP: Haecker 1999). Three trowel dug test holes (size unstated) were conducted within each identified archeological site to determine if the observed cultural materials represented a surface scatter or signaled the presence of subsurface remains. A site datum, an aluminum capped steel bar driven flush with the ground, was placed in the approximate center of each archeological site. A Smithsonian trinomial site number (i.e., 41PT185) was then stamped on the site datum cap with the month and year of the survey (Haecker 1999). Following the field survey and subsequent data analyses of the recovered materials, Haecker (1999) submitted his findings and recommendations to the BLM.

Site 41PT184 consists of a small lithic scatter on the surface of a flat to slightly rolling upland setting overlooking West Amarillo Creek Valley. The scatter measured 20 by 30 m, with 12 flakes and four burned caliche cobbles found within a six square meter area. Three trowel tests did not reveal any subsurface cultural materials. The site was thought to be intact and was therefore considered eligible for listing on the NRHP (Haecker 1999).

Site 41PT185 (presently called the Pipeline site) originally consisted of two loci (A and B), one on each side of West Amarillo Creek. A spring emanates from the creek bank about 100 m south of Locus A. Locus A lies in sloping alluvial deposits on the eastern side of the creek and is bisected by a nonfunctioning helium gas pipeline. The gradually sloping terrace is covered in dense grasses with tall mature trees bordering the creek. A small cluster of quartzite cobbles was eroding from the sloping terrace edge on the southern side. Surface artifacts observed across the site included 34 unmodified flakes, two scrapers, two fragments of bifaces, a tip of a drill, a cluster of burned rocks, and a couple of large animal bones protruding from the eroding terrace wall. Haecker's site assessment involved the hand excavation of two contiguous 1 by 1 m units (TU's 1 and 2) to a depth of 40 cmbs, over part of the aforementioned concentration of quartzite cobbles (Feature 1), the mechanical excavation of one trench (TU 3) to a depth of 2 m, and the excavation of six shovel and auger tests spaced 10 m apart along a 50 m long baseline (Haecker 2000). The trench revealed no subsurface cultural artifacts or features. Test Units 1 and 2 exposed part of the scattered Feature 1 that yielded a few bone fragments, and a biface fragment, but no associated charcoal or basin. The shovel tests yielded a few bone fragments, a couple of chert flakes, and three fragments of plastic, all within the top 85 cmbs (Haecker 2000). The three bone fragments from ST 2 and 5 were identified as representing the right ischium and innominate of a cottontail (*Sylvilagus* spp.) and a tooth fragment of deer/pronghorn (*Odocoileus*/*Antilocapra*) (Duncan 2000). A fragment of a bison bone (FS 19.5) at 10 cmbs adjacent to Feature 1 yielded a radiocarbon date of 2130 ± 40 B.P. (Beta 135417). The fire cracked rock from this work included 19 cobbles of quartzite, one of basalt, one of chert, and one of schist (Ruscavage Barz and Haecker 2000). A one liter float sample (FS 53.1) from 10 cmbs in Feature 1 and another one liter float sample (FS 55.1) from 20 cmbs and below Feature 1 yielded no charred plant remains, but did yield a few flecks of charcoal. The light and heavy fractions from the float samples did yield some nonplant remains, including gastropods, mineralized bone fragments, mollusk shell fragments, insect body parts and eggs, and two tiny lithic flakes (Gish 2000).

Locus B lies on the western side of the creek is partially disturbed by the helium pipeline and access road that cross Locus A. A surface lithic scatter measuring ca. 50 by 120 m is visible across the area. The disturbed surface revealed scattered chert debitage and burned rocks. The spoil dirt of an animal burrow on the flat terrace in front of the Girl Scout cabins yielded a Late Archaic Ellis type projectile point (Figure 1-2; FS 69.1) an estimated 20+ m to the northeast of the cultural materials observed in the road area. The point was manufactured from an unclassified, dark colored chert (Ruscavage Barz and Haecker 2000). Five, 20 cm deep trowel tests did not yield any subsurface cultural materials. The indications of subsurface remains imply the site possesses integrity and the area was considered eligible for the NRHP (Haecker 1999). Locus B testing included a single 1 by 1 m test unit (TU 4) hand excavated to 15 cmbs, and five shovel and auger tests excavated along a 50 m long baseline through the site area in a southwest to northeast direction. Test Unit 4, depicted on the site map backhoe trench a few meters west of the cabins, yielded a core reduction flake and a bone fragment, whereas the shovel tests yielded a single flake, a wire nail, and roofing felt between 0 and 36 cmbs (Haecker 2000:24). The site map depicts a 1 by 2 m area of hand excavated units labeled TU 5 and 6 (Haecker 2000, Figure 5), just off to the northeastern side of the two track road, but the text does not mention these units.

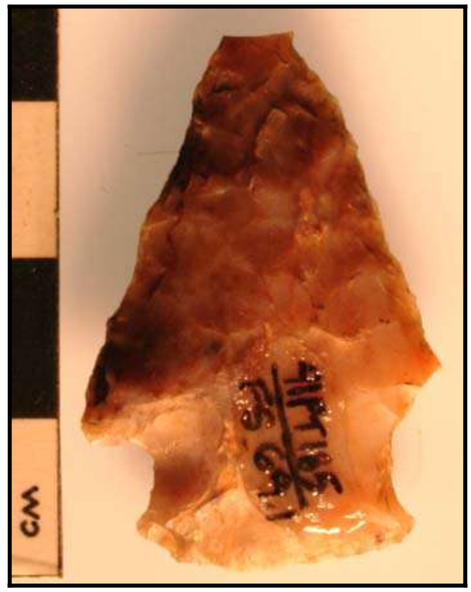

Figure 1-2. Late Archaic Corner-Notched Dart Point from Animal Burrow in 41PT185, Locus B.

The 16 pieces of lithic debitage from Loci A and B were identified according to type and frequency. Ten pieces were identified quartzite, 13 Alibates, one Niobrara chert, whereas two pieces were unidentifiable (Ruscavage Barz and Haecker 2000). The latter is definitely nonlocal and comes from a region further north in Kansas. A marginally retouched flake of Alibates was also identified (Ruscavage Barz and Haecker 2000). One Alibates core lacking cortex exhibits 13 flake scars and measures 3 cm long (Ruscavage Barz and Haecker 2000).

Pollen samples were collected and analyzed from 41PT185. The surface pollen record (FS 51.1) is dominated by Compositae (e.g., ragweed and sunflower) pollen with Cheno-am (e.g., goosefoot and amaranth) pollen about half abundant (Gish 2000). No grass pollen was in the assemblage which would reflect the current grassland conditions. The subsurface pollen records are also dominated by Low spine Compositae pollen with Cheno-am pollen a secondary aspect. No riparian arboreal taxa were observed (Gish 2000).

Site 41PT186 (presently referred tithe Corral site) lies across a gradually sloping alluvial terrace on the eastern side of the creek in a meander bend. A modern wooden corral, near the center of the site and measuring ca. 10.5 by 10.5 m, is constructed with wooden vertical posts and two horizontal cross members. The site measured about 30 by 30 m with at least 28 surface artifacts visible inside and around the corral. The surface artifacts include flakes, one piece of obsidian, a scraper, one Borger Cordmarked potsherd, and a fragment of an animal rib was exposed at 30 cmbs along the creek. Three trowel tests, each about 30 cm deep, failed to yield any subsurface cultural materials. Haecker (1999) determined this site to be eligible for listing on the NRHP. Haecker's subsequent site assessment included the hand excavation of one 1 by 1 m test unit (TU 1) to a depth of 50 cmbs just south of the southwestern corner of the corral near a concentration of surface artifacts, and the excavation of six shovel and auger tests, spaced 10 m apart along a 50 m long baseline. This baseline was orientated northeast to southwest and was west of the corral across a treeless sloping terrace. Test Unit 1 yielded a mixture of prehistoric and historic artifacts that included fragments of animal bone, one unifacial chipped stone tool, charcoal, fire cracked cobbles, and one obsidian flake (Haecker 2000). These were recovered from a dark brown silty loam with the occasional flecks of charcoal to about 25 cmbs. Most cultural materials were between 10 and 30 cmbs with historic trash to at least 20 cmbs. The forty four bone fragments recovered included a "hacked" deer tibia shaft (*Odocoileus* spp.), six fragments of bison/elk bone, a turtle (*Testudines*) carapace fragment, and other unidentifiable fragments of small, medium and large mammal bone (Duncan 2000). Two medium to large and five large mammal bone fragments were burned (Duncan 2000). The recovered fire cracked rock included six quartzite fragments, one basalt fragment, three chert and two pieces of unclassified stone (Ruscavage Barz and Haecker 2000). These investigations yielded 65 pieces of lithic debitage, including 26 pieces of Alibates, 10 unidentifiable chert pieces, five quartzite pieces, five rhyolite, and one piece each of Tecovas, Edwards, opalite, and obsidian (Ruscavage Barz and Haecker 2000). One stone tool, a broken retouched flake, was manufactured from Alibates (Ruscavage Barz and Haecker 2000). Protein residue analysis on this tool yielded negative results (Haecker 2000). A single Alibates core with five flake scars lacks cortex and measures 3 cm long (Ruscavage Barz and Haecker 2000). A one liter float sample (FS 58.1) from 20 to 25 cmbs in the east wall of TU 1 yielded no charred plant remains other than a flew flecks of charcoal. The light and heavy fractions did yield some nonplant remains, including gastropods, bone fragments, mollusk shell fragments, insect body parts, fecal pellets, a glass fragment, and two tiny lithic flakes (Gish 2000).

Two radiocarbon dates were obtained from samples derived from Test Unit 1. Haecker (2000:32) reports that a pocket of charcoal (FS 24.1) from 47 cmbs yielded a $\delta^{13}C$ corrected date of 340 ± 40 B.P. (Beta 138513). However, the Beta Analytic laboratory (Beta) form presented in Appendix B in Haecker's (2000) report concerning Beta 138513 indicates this sample actually dated bone collagen corrected for the $^{13}C/^{12}C$ ratio (Appendix K: sample Beta 138513). A fragment of a bison bone (FS 71.1) from 40 cmbs yielded a $\delta^{13}C$ corrected date of 80 ± 40 B.P. (Beta-135418). Obviously the two Field Specimen (FS) numbers on these two dated samples are reversed and the 80 B.P. date was obtained on the charcoal, whereas the bone date was derived from FS 24.1. The two radiocarbon ages are inverted according to their depths, apparently reflecting bioturbation within these shallow deposits. Assuming that the dated materials pertain to human occupations of the site, results represent Protohistoric to Historic period event(s).

Site 41PT187 is situated along the eroded midslope of the valley west of and considerably above the alluvial deposits of West Amarillo Creek. This elevation overlooks the pavilion across the creek. The site is marked by an artifact cluster measuring ca. 25 by 35 m and containing fragments of fire cracked quartzite cobbles, a chipped stone scraper, and a scatter of chert flakes. Three trowel tests, each about 20 cm deep, did not yield subsurface cultural items. It was determined that this site possessed integrity and was eligible for the NRHP (Haecker 1999). Follow up testing included the excavation of one mechanical trench (TU 1) to a depth of 2 m some 10+ m north of the material concentration. In the area of concentrated artifacts, three contiguous 1 by 1 m units (TU's 2 through 4) were hand excavated to about 5 cmbs. The three hand excavated units yielded 20 fire cracked rocks, three chert flakes, and one fragment of a mussel shell. The mussel shell (FS 43.2) yielded a $\delta^{13}C$ corrected radiocarbon date of 1920 ± 30 B.P. (Beta-135419). This age indicates an occupation during the Late Archaic period, if one accepts dates on mussel shells. During the mapping of this site two small concentrations of partially buried fire cracked rock, Features 1 and 2, were identified. Both features were completely excavated by means of 0.5 by 0.5 m units (TU's 5 and 6). No cultural artifacts or charcoal samples were recovered (Haecker 2000). The fire cracked rock encountered included 40 pieces of quartzite, three pieces of basalt, one piece of chert, three schist pieces, and one unclassified rock (Ruscavage Barz and Haecker 2000). Nine pieces of lithic debitage were recovered, including two pieces of quartzite, two Alibates, two unclassifiable cherts, one Potter chert, one Tecovas, and one possible Niobrara chert (Ruscavage Barz and Haecker 2000). A secondary flake with about 10 percent cortex was classified as a spokeshave and was manufactured of a dark gray, fine grained quartzite (Ruscavage Barz and Haecker 2000). This item was submitted for protein residue analysis, but yielded negative results (Haecker 2000). Site 41PT187 was quite shallow and determined to have no subsurface integrity; therefore no further work was recommended (Haecker 2000).

Site 41PT245 (the Pavilion site) is on a low terrace on the eastern side of West Amarillo Creek and is currently covered in dense grasses. A modern Girl Scout pavilion with a cement floor and adjacent metal storage shed with a cement foundation are present towards the middle of the upper terrace. The surface of this area did not reveal any prehistoric artifacts. Three small trowel tests were inconclusive in determining the presence or absence of buried cultural remains (Haecker 2000). Subsequent testing included the hand excavation of one 1 by 1 m unit (TU 2) on the southern margin of the terrace near the tree line, one mechanical trench (TU 1) 7 m east (the map shows it south) of the pavilion, and seven shovel and auger tests spaced 10 m apart along a 60 m baseline that oriented northeast to southwest, and positioned west and southwest of the pavilion. Test Unit 2 yielded 60 bone fragments, 10 flakes, and two burned rocks. The seven shovel tests yielded two bone fragments and one flake in the upper 30 cm (Haecker 2000). The recovered bones could not be identified to species and were placed into three general size classes that included one medium size mammal fragment, 14 medium to large mammal fragments, and 43 large mammal pieces (Duncan 2000). Only two pieces of fire cracked rock were encountered, one of quartzite and one of limestone (Ruscavage-Barz and Haecker 2000). Fourteen pieces of lithic debitage were recovered, including nine pieces of Alibates, two unclassifiable cherts, one quartzite, one opalite, and one limestone piece (Ruscavage Barz and Haecker 2000). A bone fragment (FS 36.2) from 30 to 40 cmbs in TU 2 yielded a $\delta^{13}C$ corrected radiocarbon date of 540 ± 40 B.P. (Beta-138512). This age indicates the bone represents the last part of the Late Prehistoric period, probably the Antelope Creek phase. The boundaries of the site could not be determined at that time (Haecker 2000).

Isolate 8 (IO 8), the locale of a mammoth molar plate, was tested by the hand excavation of one 1 by 1 m test unit to a depth of 25 cmbs. Additional tooth fragments (*N* = 41) were recovered from the surface (*N* = 31) and the top 10 cmbs, and fossilized bone fragments were recovered from between 13 and 18 cmbs. The soil at TU 1 was a redeposited brown loam on a 2 to 4 percent slope. Dr. Jeff Indeck at the Panhandle-Plains Historical Museum in Canyon, Texas indicated that the bones were not sufficiently massive to represent a mammoth, but no positive species determination was provided. Most bone fragments were submitted to Beta Analytic for radiocarbon dating, but insufficient collagen was present to obtain a date (Haecker 2000). A surface (0 to 2 cmbs) pollen sample (FS 14.1) was collected and processed. The identified pollen record is dominated by the Cheno-am pollen indicating a prairie grassland environment similar to that around this site at the time of excavation (Gish 2000). A second pollen sample (FS 13.1) from 18 to 21 cmbs and below the fragments of a mammoth tooth and mineralized bone exhibits a co-dominance of Cheno-am and Low spine Compositae. This sample had significant values of small pine and sagebrush/wormwood pollen, indicating a markedly cooler climate than today (Haecker 2000). It also yielded wind transported walnut (*Juglans* sp.) pollen indicating the presence of permanent watercourses in the region. A significant decrease in the pollen concentration was noted between the lower and the surface sample, indicating that this sample is significantly older than the surface pollen rain. The samples provide some information, and the results are possibly skewed, but in general terms the past appears cooler than the present (Gish 2000). Gish (2000) believes additional work is necessary to confirm this interpretation.

Haecker (2000) believed that fragmented bones and teeth from IO 8 represent at least two animals, a mammoth and a medium size mammal. He also stated these fragments were in redeposited post Pleistocene sediments. It was likely that the rest of the animal was eroded away.

Haecker (2000) believed that the testing data were sufficient for determining that 41PT185 and 41PT186, and possibly 41PT245, were eligible for listing on the NRHP. In the latter instance, the boundaries of the intact cultural remains were not determined (Haecker 2000). Haecker recommended the development of a data recovery plan for 41PT185 and 41PT186 and further testing of 41PT245 to determine site boundaries and eligibility for inclusion to NRHP.

Haecker's site specific recommendations were approved by BLM personnel. Subsequently, the BLM contracted with TRC to prepare a treatment plan for these three prehistoric sites. A treatment plan was prepared and submitted to BLM in January 2005 (Quigg 2005). BLM personnel accepted the treatment plan and proceeded to implement the plan. The subsequent data recovery program was conducted in two separate phases (I and II) and these two phases are presented below. This data recovery program was a stepwise process, with Phase II block excavations guided by recommendations based on the Phase I investigations at each of the three sites.

1.3.2 Data Recovery Investigations – Phase I (2007)

In the summer of 2007 TRC was awarded a contract by the BLM to conduct Phase I of the data recovery program at the three previously documented prehistoric sites in the Landis Property, namely, sites 41PT185 Locus A and B, 41PT186, and 41PT245. Phase I was viewed as a testing program with the goal of determining the nature and extent of 41PT185 and 41PT186, and the eligibility of 41PT245 for listing on the NRHP. Phase I was conducted between September 24 and November 24, 2007. To initiate this program, a prefield conference with representatives of the BLM and TRC was held at the BLM Field Office in Amarillo on September 24, 2007. Following this meeting, the geoarcheological program, including mechanical trenching, was initiated on September 25, 2007. The geoarcheological program was designed to evaluate the Late Pleistocene and Holocene alluvial history of the upper reaches of West Amarillo Creek basin within the project boundaries. This geoarcheological program was conducted by geoarcheologist Dr. Charles Frederick. He initially walked through the project area to visually inspect the existing creek cutbanks and terraces and thereby obtain initial impressions of the depositional sequence in this section of the valley and formulate his investigative strategies. The initial reconnaissance was followed by the mechanical excavation of 47 backhoe trenches (BT) throughout the lower elevations of the valley, targeting alluvial terrace deposits throughout the project area. Twenty four trenches were excavated within known cultural resource sites, totaling 262 linear meters (m). Twenty three trenches were excavated outside previously identified archeological sites, totaling and 148 linear m.

Dr. Frederick observed a very complex Holocene alluvial history that included at least six allostratigraphic units (designated Units A through F). These units were documented, sampled, radiocarbon dated, and related to the observed cultural materials in the archeological sites. The alluvial fills were found to be as much as 6 m thick and to vary considerably within this 1.6 km long section of the valley with most fills at least 4 m thick. About 60 percent of the Holocene record is represented in this part of the valley, with a 4000 year interval, from ca. 8200 B.P. to 4300 B.P., apparently missing. Chapter 6.0 provides the descriptions and details concerning the documented depositional sequences in the project area. Appendix A provides the individual trench descriptions from the geoarcheologist.

The Phase I archeological hand excavations at the three target sites began on October 15, 2007 and were completed on November 23, 2007. About 46.9 m^3 of sediment from 41 individual test units was hand excavated and screened within the three sites. The Phase I field investigations, analytical results, interpretations, and specific site recommendations were presented to the BLM in draft and final interim reports submitted to the BLM (Quigg et al. 2008). The archeological information derived from the Phase I investigations is elaborated upon within the site specific presentations in Chapters 8.0, 9.0, and 10.0.

The BLM reviewed and accepted TRCs recommendations concerning each site presented in the final interim report following the Phase I investigations (Quigg et al. 2008). In the spring of 2008 the BLM again requested bids on the recommended Phase II investigations to complete this program. In August 2008 TRC was awarded the Phase II data recovery investigation contract. After receiving notice to proceed, TRC initiated this program with a prefield meeting with representatives of the BLM and TRC held at the BLM Field Office in Amarillo on August 7, 2008.

1.4 PUBLIC OUTREACH

As part of the contracts with BLM, TRC conducted public outreach programs during the each of the fall field sessions. Open houses were held during both phases of this data recovery program. It was agreed that the Girl Scouts would advertise and work out the various logistics to enter and exit their property. During the fall of 2007, two open houses were planned, but one was cancelled due to poor weather.

The first open house was held on Saturday November 17, 2007 and directed primarily towards the Girl Scouts and their families who resided within the Texas Panhandle region. That program was designed to allow visitors to see archeology in action and see what it was like first hand and up close. Because of access limitations, and for safety concerns, the visitors met at the spacious pavilion, and proceeded together from there. At the Pavilion, Mike Quigg, together with Charles Frederick, our project geoarcheologist, provided verbal overviews of the project archeology (the why, what, and how) and what archeology was all about, with a brief overview of geoarcheology. TRC provided a variety of artifacts for the visitors to handle and become familiar with, which included projectile points, clay pots, woven baskets, bison bones, and burned rocks. A wide range of questions were asked and answered at this time. Then three groups of nearly 20 people each were given walking tours to the Pipeline site (41PT185) where the TRC archeological team was conducting hand excavations. The visitors were free to talk to the crew, see and handle recovered artifacts, and ask additional questions. An estimated 60 visitors were accommodated that day and Ms. Stevenson, Director of the Outdoor Program, was pleased with the turnout and with the information provided by TRC.

TRC also prepared a poster exhibit of the Phase I field investigations for the 2008 Society for Historic Archaeology public session held in Albuquerque, New Mexico on January 9 through 12, 2008. Highlights of the field findings were presented in text accompanied by many photographs to illustrate specific and exciting discoveries. The poster exhibit was subsequently presented to Ms. Natalie Stevenson of the Girl Scouts for display at their outdoor facilities at the Landis Property.

Following the Phase I field session TRC staff prepared an illustrated article for the local Amarillo Globe News. The article was submitted to the BLM for approval and then sent to that newspaper. Unfortunately, the article was never published, thereby preventing the local public from learning or hearing about the exciting and important archeological sites and investigations in their own area.

Two open house sessions were again scheduled for the field season in the fall of 2008. The first was held on Saturday November 8, 2008 and was open for the Girl Scouts and their moms. Some 90 individuals took part on that day (Figure 1 - 3). The visitors were treated to a viewing of a major ongoing excavation at the Pipeline site (41PT185/C) by a crew of 12 archeologists. Again, the visitors were given a brief introduction to the site and what was discovered. Then the groups were lead around the excavation block to various designated stations where hands on displays were available. The displayed materials included burned rocks used in the prehistoric cooking events, bones of bison that were killed and eaten, and a stone tool manufacturing kit with antler billets, chert flakes, cores, and formal stone tools. The visitors talked to the archeologists, asked questions of the Field Director, and many of the younger ones helped out with screening some of the excavated dirt. Following the tours, a luncheon was held in the Scouts' facilities where the archeological crew was welcomed and served by the Girl Scouts. The interactions were fun and exciting for all. It is hoped that this hands on experience will linger in the memories of those involved for a long time.

Figure 1-3. Paul Matchen, Field Director, Explaining to Visitors about the Excavations, Materials Recovered, and the Prehistory of the Pipeline Site.

The second open house, for the benefit of the general public and media, was held on Saturday November 22, 2009. This was led by Field Director Paul Matchen, and viewing and hands on exhibits were employed again. Approximately 55 individuals attended this event. After the second open house at the project area, a newspaper article accompanied by pictures entitled “Hidden Treasure at the Ranch” appeared in the Amarillo Globe News and on their web site (November 23, 2008).

In addition, the planned public outreach for this project will include a written and well illustrated exhibit of this data recovery program for the Texas Beyond History website http://www.texasbeyondhistory.net/) that has become a widely used resource for public education of archeological topics in Texas. It also presents an extensive variety of researched and investigated historic and prehistoric sites across Texas’ diverse geographic regions.

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2.0 ENVIRONMENTAL BACKGROUND

J. Michael Quigg

2.1 PHYSICAL ENVIRONMENT

The physical characteristics of this region provide a general backdrop in which the prehistoric populations conducted their every day lifeways. In some instances these physical characteristics created hardships for them, whereas other characteristics provided an easier lifeway. Regardless of which view you see the environment influencing the prehistoric peoples, they did adapt to and live in this region. Below, important aspects of the physical environment and some key natural resources the prehistoric peoples undoubtedly exploited are highlighted.

2.1.1 Physiography and Topography

The region is part of the Southern High Plains section of the Great Plains physiographic province (Fenneman 1931). The region is characterized by a flat, low relief surface dotted with small playa lake basins across the Llano Estacado, with the Canadian River valley creating a major topographic relief. The Caprock Escarpment creates relief around the margins of the Llano Estacado, which is an erosional margin of this high relief zone (Figure 2-1). The caprock is formed by calcretes and silicified zones of the Ogallala Formation and hard sandstones of the Dockum Group and Permian Quartermaster Formation. Amarillo lies on the northern end of the broad, flat Llano Estacado and on the southern edge of the Canadian breaks at an elevation of roughly 1220 m (4000 ft.) above mean sea level (Figure 2-2). West Amarillo Creek, just west of Amarillo, is one of many ephemeral streams that flow into the Canadian River, and is a relatively long, narrow tributary entering the much larger Canadian River from the southern side. The project lies in what is considered part of the upper end of the Canadian Breaks near the headwaters of West Amarillo Creek.

Figure 2-1. Edge of the Caprock Escarpment, Showing Major Relief. (photo by M. Quigg)

Figure 2-2. General Project Location Map Showing Major Relief. (map from Raisz 1957)

These breaks or erosional areas form along the edges of the Canadian River valley as the many spring fed tributaries cut through the very flat, adjacent uplands. In Potter County, the springs flow mainly from the Tertiary Ogallala sand and gravel, whereas some springs originate in the Triassic Dockum or Santa Rosa sandstone below the Ogallala (Brune 1981:365). Brune (1981) indicates that East and West Amarillo creeks are fed by many springs. The waters from these springs make their way northward into the Canadian River.

2.1.2 Hydrology

The Canadian River flows generally eastward and cuts across the Southern High Plains of Texas and into the Rolling Plains of Texas and Oklahoma and eventually into the Mississippi River. Its headwaters are in northeastern New Mexico near Raton, New Mexico south of the Trinidad Escarpment. There, the waters dissect plateaus and rolling plains east of the north south trending Sangre de Cristo Mountains. The initial segment of the Canadian River flows southward, paralleling the mountains, then bends sharply to the east and flows across northeastern New Mexico, eastward across the Texas Panhandle, and into Oklahoma. The Canadian River valley is the dividing line between the northern Texas Panhandle and the Llano Estacado to the south. The slightly higher ground just south of Amarillo is the drainage divide between the headwaters of the Red River system that also flows eastward and eventually forms the boundary between Texas and Oklahoma. The Canadian River valley varies in width from 0.8 to 1.6 km (0.5 to 1.0 mi.) and some 183 m (600 ft.) deep, with a water flow that varies seasonally. Natural springs contribute to the Canadian River. Currently, dams upstream in eastern New Mexico, like Conchas Dam and Ute Dam, regulate the flow down river. The Sanford Dam that created Lake Meredith lies roughly 60 km (37 mi.) north of Amarillo in Hutchinson County.

West Amarillo Creek is roughly 25 km (15.5 mi.) long with several smaller branches. It generally parallels East Amarillo Creek to the east and Tecovas Creek to the west. West Amarillo Creek valley is roughly 1 km (0.6 mi.) wide in the vicinity of the three archeological sites, with the creek bottom about 33.5 to 36.6 m (110 to 120 ft.) below the valley rim (Figure 2-3). Springs that originate in the Ogallala Formation are the primary source of the water flowing through this valley. Today, the water table has been lowered by man's actions, altering the original natural flow. Over the last decade portions of the Ogallala Aquifer across the Llano Estacado and High Plains have been lowered more than 8 m (Lewis cited in Etchieson and Couzzourt 1987). The creek bed gradually slopes northward into the Canadian River valley, whereas the water often seeps into the Tecovas Formation.

Figure 2-3. Overview of Upper End of West Amarillo Creek Valley, View Southwest.

This tributary valley, as with other tributary valleys of the Canadian River, forms a relative deep draw, with mostly steep sided valley walls and rock outcrops near the valley rim and 30 to 70 degree colluvial slopes below the rock outcrops. West Amarillo Creek valley can be subdivided into physiographic zones such as the valley bottom and the valley slopes, which join the valley rim and the adjoining uplands. The bottom zone includes the creek channel, the floodplain, the alluvial terraces and alluvial fans. The break between the valley bottom and slopes is generally not well defined, as the colluvial deposits continually move sediment down slope, forming the sloping transition between the steep valley walls and the flat alluvial terraces. In some parts of the valley, areas of exposed gravel deposits exist. One massive gravel deposit is just upslope of 41PT185.

2.1.3 Geology, Soils, Clay, and Tool Stone

2.1.3.1 Geology

The vast low relief surface dotted with small playa lake basins across the Llano Estacado that extends across a wide region is blanketed by Blackwater Draw Formation deposited during the recent Quaternary times. This relatively thin blanket covers the Ogallala Formation of the Tertiary (Figure 2-4). Below the Ogallala lies the Dockum Group of the Triassic that includes the Tecovas and Trujillo formations, which in tern overlies the Alibates/Quartermaster Formation and other divisions such as the Whitehourse of the upper Permian. Most deposits and formations are not flat but have considerable vertical changes in elevations below the surface. The overall trend is a gentle slope to the east where many of these outcrop along the eastern edge of the escarpment. Some thinner formations are not mapped or traceable across broad regions and probably pinch out before they are exposed again. These stratified and distinctive formations are briefly discussed below starting from the surface and going back through time. It is not our intention to go back to the beginning of time, but to inform the reader of the deposits and formations that are pertinent to the project area and to the prehistoric populations that roamed through the region.

Blackwater Draw Formation is the major surfacial deposit and consists of eolian and lacustrine sediments of Pleistocene age that occur all across the Llano Estacado (Reeves 1976; Gustavson 1996). Pleistocene lake deposits are interbedded with the eolian deposits. The thousands of playa lakes across the Llano Estacado are cut, collapsed, formed into this formation. In limited places the Blanco (late Pliocene) and Tule formations are present below the Blackwater Formation, but these are quite limited in aerial extent and generally buried. The Blackwater Draw Formation covers nearly all of the Llano Estacada and the Central High Plains north of the Canadian River valley (Gustavson 1996). The Blanco Formation is an extensive lacustrine layer of dolomite and deposited into the underlying Ogallala Formation.

The **Ogallala Formation** is Pliocene in age and occurs as a broad alluvial apron that covers older formations and extends over much of the High Plains region, northward and eastward (Seni 1980; Gustavson 1996). This broad alluvial deposit formed by coalescence of alluvial fans consists of a thick bed of undifferentiated sand, silt, gravel, conglomerate, and multiple layers of calcareous and siliceous caliche deposited by streams originating in the mountains to the west. The sandstone contains muscovite, and metamorphic rock fragments. The conglomerates contain quartzite, chert, and vein quartz classes. This is the major water bearing, aquifer system (High Plains aquifer) that extends all the way into South Dakota. It consists mainly of deposits derived from the Rocky Mountains to the west in New Mexico. Several calcretes including the indurated “caprock caliche” is a prominent ledge near the top of the escarpments bordering the plateau. This calcrete is believed to be pedogenic and formed in upper Ogallala fine sand and silt (Holliday 1995:11). A major time gap of millions of years creating an unconformity occurs between this and the lower Triassic deposits. The lower part is composed of reddish-brown, fine-to-medium grained sandstone that contrasts with the underlying red and green shales of the Trujillo Formation. The Ogallala outcrops throughout much of the Canadian River valley and along the eastern escarpments minimally into eastern Oklahoma and potentially to the eastern side of Oklahoma (Gustavson et al. 1980). Some limited areas within West Amarillo Creek valley also contain Ogallala gravels as do most of the east west stream valleys north and south of the Canadian River valley. In places the Ogallala sediments are 250 m thick (Seni 1980).

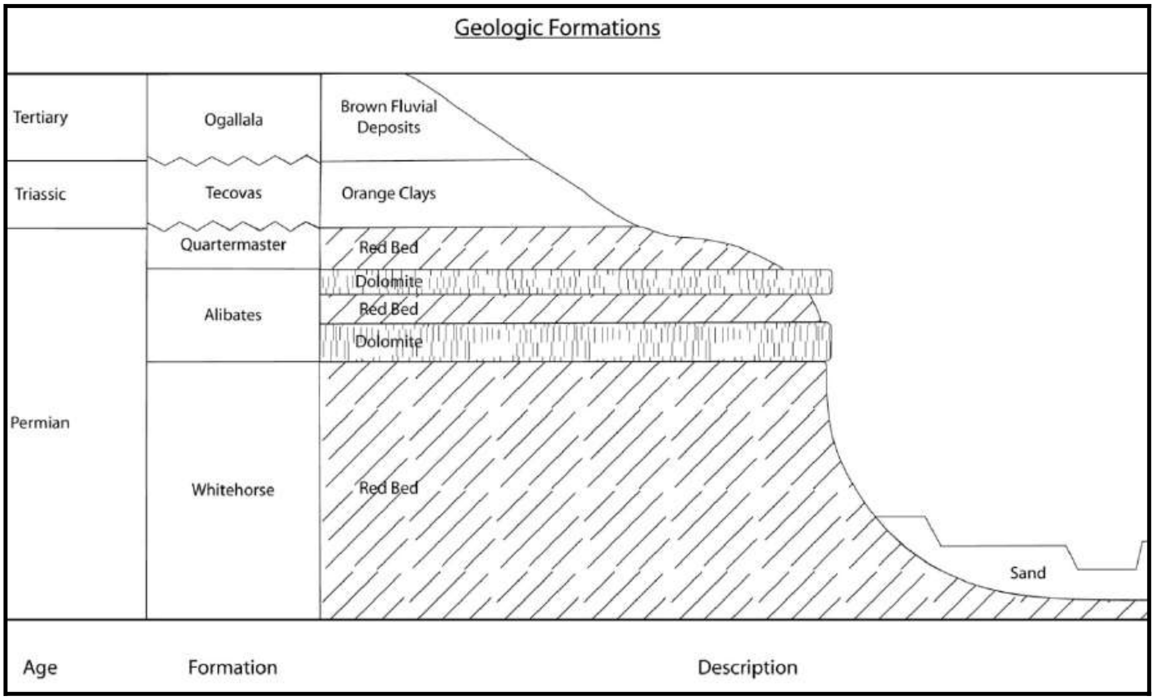


Figure 2-4. Schematic Drawing of Geologic Stratigraphy Across Panhandle of Texas.

The following Tecovas and Trujillo formations are part of the Dockum group of the Triassic, which overlie the redbeds of the Quartermaster Formation (Adkins 1958). Members of the Dockum Group outcrop in the Canadian River valley and along the Caprock Escarpment southwards to minimally Double Mountain Fork of the Brazos River, at Post, Texas (Baumgardner 1987). The Dockum Group underlies the entire Llano Estacado south of the Canadian River valley and potentially northward into the Cimarron and North Canadian valleys in the Oklahoma Panhandle (Adkins 1958). Much of the broader region is mapped as undifferentiated Dockum Group, but specific reports address the individual formations. Abundance of water, sands, mica, phosphate, limestone and calcareous shale and sandstone is indicative of the Triassic (Adkins 1958:246). East of the Caprock Escarpment the Dockum is 150 m thick, but buried by the Blackwater Draw and Ogallala formations.

Trujillo Formation: This formation overlies the Tecovas Formation and is the upper member of the Dockum Group. It contains coarse sandstone, cross bedded sandstone, conglomerates, petrified wood, pebbles of quartz, limestone, minor, and interbedded shales (Adkins 1958; Barnes 1969). It is roughly 30 m thick in areas. Trujillo sandstone is currently exposed in the creek bottom, but during most of the past this sandstone would have been generally buried (Figure 2-5).

Tecovas Formation: This formation lies above the Quartermaster and is some 38 m thick. It contains shale, siltstone, sandstone, clay, and petrified wood (Barnes 1969). These are generally a reddish brown, maroon, gray, greenish gray, yellow, and purple. The sandstone is micaceous and is fine-to-medium-fine grained in texture and composed of quartz. Locally large petrified logs are present. The Tecovas Formation outcrops within Palo Duro Canyon and all along the eastern Caprock Escarpment and vast areas along the Canadian River valley west of Amarillo. In places it is as much as 90 m thick.

Figure 2-5. Bedded Sandstone Exposed in Floor of West Amarillo Creek that is Part of the Trujillo Formation just North of 41PT185.

Quartermaster Formation of the Permian age is sedimentary and indicative of marine conditions that extended over most of Texas (Sellers et al. 1932). The term Quartermaster is used in the broad since for much of the Permian, and some geologists have divided this into smaller members or more restricted formations, such as the Alibates Formation. The Quartermaster Formation is characterized by the brick red coloration of the sandstones, shales, siltstones and mudstones. These are often interbedded and appear as lenes. White gypsum veins and dolomite have been observed interbedded in thin discontinuous veins of the mudstones. Uncolored, well rounded frosted quartz grains are common in the Permian (Adkins 1958:245). Often these deposits reveal folds, arches, troughs and cross bedding and sometimes ripple marks. One aspect of this formation is the various colors that are present. Some of the shales contain gray-green, circular spots called reduction halos, which in places give the red shales a distinctive polka dot appearance. These were produced as a result of chemical change of certain minerals in the shales (Matthews 1969:19). In addition to the major outcrop along the Canadian River at Late Meredith small localized areas of Quartermaster Formation with Alibates dolomite outcrop in small areas along the Eastern Escarpment. The formation is known to outcrop in limited areas (Baumgardner 1987), but it may not contain any chert that would be suitable for knapping.

Alibates Formation lies above the Whitehorse Formations. It is comprised of two dolomite layers separated by red shale. In comparison to other formations the Alibates Formation is a quite thin bed that reaches across a broad area of the panhandle. In places the dolomite becomes agatized and this is referred to as the "Alibates chert". The Alibates cherts exhibit a wide range of colors with similarly a range of textures. The usually banded or mottle red blue, purple, brown, cream and white are common colors (Barnes 1969; Banks 1990; see below for further discussions of Alibates).

2.1.3.2 Soils

Potter County exhibits minimally eight major soil classes, which reflect diverse land forms and topographic variation. The broad uplands with nearly flat level ground that surrounds West Amarillo Creek valley exhibit loamy Pullman soils. The Pullman series consists of deep, well drained, brown soils formed in heavy clayey eolian sediments. As the topography starts to change as one enters the Canadian River valley, the soils are part of the Acuff-Paloduro-Olton series. All three of these series are very similar with deep, dark brown, well drained soils that formed in loamy eolian deposits; however the Paloduro series formed in calcareous loamy sediments. The steep sloping ground surrounding the head of West Amarillo Creek is classified as Potter-Mobeetie series. The Potter series consists of well drained, very shallow, calcareous gravelly soils formed in a mixture of loamy sediment and caliche. The Mobeetie series are very similar to the Potter series, but are grayish brown in color and formed in loamy alluvial sediments. In the vicinity of West Amarillo Creek the rolling and undulating topography along and between these valleys exhibits the Weymouth-Vernon series. The Weymouth series consists of moderately deep, well drained, reddish brown soils formed in calcareous clayey and loamy redbed sediments. The Vernon series is quite similar but formed in calcareous marine clays and shales (Pringle 1980).

2.1.3.3 Clay

Following the Late Archaic cultural period, clay resources become more important over the last 1,500 years of the Early, Middle, and Late Ceramic period when pottery production was undertaken by various groups. Ceramic vessels were manufactured with clay from sources throughout this and adjacent regions. Clay is formed by the mechanical and chemical breakdown and weathering of rocks. The weathering products consist of mineral grains and rock particles of different sizes and different physical and chemical properties (Virta 1992). In addition to the clay or plastic portion, the additives to the clay are crushed rock fragments generally referred to as temper or grit, which often consists of quartz, micas, feldspar, iron oxides, and other minerals. Even crushed bone was sometimes added as a tempering agent. Clay deposits can be local and residual in nature, deposited in the same location in which they formed. Clays can also be secondary deposits laid down by fluvial processes, in valleys or along colluvial slopes. The water transported clays are subject to further alterations and mixing with other minerals (Virta 1992).

The geology of the Texas Panhandle region creates a setting that has abundant clay resources. Minimally three deposits of different ages contain clays that are suitable for pottery manufacture. The oldest, the Permian redbeds, which include many named formations, are exposed at the bottoms of some smaller tributary creeks and most lower margins along the Canadian River northeast of Amarillo and in Palo Duro Canyon to the southeast, with massive exposures further east in the Rolling Plains. These Permian exposures contain clay, sandy shales, fine sandstones, and white gypsum generally underlying a hard cap of Alibates dolomite. Uncolored, well rounded, frosted quartz grains are common in the Permian (Adkins 1958:245). This natural red clay is suitable for the production of pottery. However, gypsum within the clay is an undesirable ingredient for pottery manufacturing as it tends to cause spalling or pitting in the finished vessel (Lynn 1982).

Stratigraphically overlying the Permian redbeds is the Dockum group of upper Triassic age. The Dockum group is primarily exposed along the Caprock Canyonlands on the eastern margin of the Llano Estacado in eastern Potter and Moore counties. Subdivisions within the Dockum group include a basal shale labeled Tecovas, which is overlaid by sandstone and shale known as the Trujillo Formation (Adkins 1958). Both the Tecovas and Trujillo formations also contain layers of sandstone, mudstones, and shales, in a variety of colors including red, maroon, yellow, and variegated. The weathered clay is friable and dull in appearance. When wet, this clay exhibits brilliant colors and is plastic. One known source of this clay is north of the Canadian River near the confluence of Blue Creek. This source of the Triassic clays is assumed to be from around southcentral Colorado (Adkins 1958:245). The Triassic age material contains silicified wood, and abundant mica with colored, subrounded, partially frosted quartz grains (Adkins 1958:245).

The Ogallala Formation of late Tertiary age (Miocene and Pliocene) sits atop the eroded Triassic sediments. This formation is widespread across a broad region and contains a series of layered sands, silts, gravels, clays, and caliche in various shades of brown, gray and pink (Cepeda 1996). The many tributaries of the Canadian River have eroded through the Ogallala Formation exposing brown and buff-colored clay.

Most of the Texas Panhandle of the Southern High Plains is covered with the Blackwater Draw Formation. The thousands of shallow playa lakes that dot the panhandle region contain dark gray and blue clay. These playas are cut or collapsed into the Blackwater Draw Formations. Clays from these playas are also suitable for pottery manufacture (Lynn 1982).

Recent or Holocene alluvium from flood deposits is widespread along the bottoms of most creeks and rivers across the region. These secondary deposits contain quantities of sand, silt, gravels, and pockets of clay (see Holliday 1995 for details concerning the contents of draws across the Southern High Plains). Consequently, clays and clay mixtures are numerous, with a variety of colors dispersed across the region. The prehistoric population would have had relatively ready access to these clays for the manufacture of their pottery.

Limited research has focused on the source areas of clay for the production of pottery with no apparent clay distribution maps other than the general geological maps. This is likely the result of clay being widespread and readily available. Petrographic and instrumental neutron activation (INA) analyses of clays in association with archeological investigations are extremely rare. Recently, Meier (2007) included 15 modern clay samples from three general source areas along the Canadian River valley in the region in her INA analysis of Borger Cordmarked pottery of Antelope Creek phase sites. She included natural clay samples from near three selected archeological sites sampled in her investigations, which included three samples from the Cross Bar Ranch near 41PT109 at the mouth of West Amarillo Creek, five samples from further west along Alamosa Creek near Landergin Mesa in Oldham County, and five samples from near Alibates Ruin 28 along Alibates Creek in northeastern Potter County. The eight samples from Cross Bar Ranch and Alamosa Creek, and most likely all the samples from Alibates Creek are labeled as alluvial deposits. Alluvial deposits are considered secondary, potentially incorporating minerals from several local geological formations. Following INA analysis, six of the 15 clay samples plotted in or near the five INAA ceramic sherd groupings Meier (2007) identified. These data helped to determine where various Antelope Creek phase vessel groupings were potentially manufactured.

Phase I of the present BLM data recovery effort also analyzed natural clays from various sources across the Texas Panhandle region in our INA and petrographic investigations (Quigg et al. 2008). Those samples included six alluvial clays from West Amarillo Creek, natural clay from Blue Creek on the north side of Lake Meredith, Triassic clay from Wildcat Bluff Nature Center (WBNC) just north of West Amarillo Creek, and the Ogallala Formation. Eleven thin sections were created and used to compare with the petrographic analysis conducted on thin sectioned ceramic sherds recovered from the BLM Landis Property investigations. The petrographic comparisons indicated that four of five sherds analyzed were probably not manufactured locally (Robinson 2008).

Eight clay samples, seven local alluvial sediments and one natural clay sample from Blue Creek were included in the INA analysis to investigate potential source areas for the ceramic pastes. The INA results are presented in Appendix J. The INA data indicates that the local alluvial clay sources were very similar to the clay used for the manufacture of two or three of the five ceramic sherd groups identified by Meier (2007). Four of the five Phase I ceramic sherds appear unlike any of the five Antelope Creek phase ceramic sherd groups identified by Meier (2007). The Blue Creek clay (TRC380) and the Alvin Lynn replicated ceramic pot using the same Blue Creek clay with additives of sand and ash (TRC383) were quite unlike the local clay sources and unlike any of the Phase I sherds analyzed. Based on the INA data the later two samples (TRC380 and TRC383) were not as chemically close in comparison with Canonical Discriminate Function 1 and 2 as one might expect (Ferguson and Glascock 2008, Figure J-4). Consequently, the readily available natural clays in the region were important resources for the manufacture of ceramic vessels for some local groups, at least during the ceramic period of occupation in West Amarillo Creek valley.

2.1.3.4 Tool Stone Resources

The Texas Panhandle contains many sources and plentiful high quality tool stone across this broad region. However, much of the flat Southern High Plains/Llano Estacado to the south of this project area and the Central Plains are blanketed by sandy soils of the late Quaternary Blackwater Draw Formation (Gustavson 1996). Quantities of local tool stone are still available in specific geological settings and outcrops along the edges of the Blackwater Formation and in stream and river valleys. The known materials and sources are briefly discussed below.

Alibates Flint/Chert. First, this is not a true flint, but actually a silicified dolomite. References to this material in the literature varies, and includes; Alibates flint, Alibates agate, Alibates agatized dolomite, Alibates chert, and Alibates silicified dolomite (Bowers 1975; Holliday and Welty 1981; Banks 1990; Bowers and Reaser 1996; Holliday 1987). The principal component is silicon dioxide, with impurities producing the various colors and banding. Alibates dolomite is the upper cap of the Quartermaster Formation of Permian age, and outcrops at Lake Meredith in the Canadian River valley about 56 km north of Amarillo (Figures 2-6 through 2-8).

Figure 2-6. One Prehistoric Quarry Pit at Alibates Flint Quarries National Monument (41PT1) (photo by Paul Katz).

The outcrop occurs on both sides of the valley, with the Alibates Flint Quarries National Monument (41PT1) located on the southern side. The outcrop is nearly horizontal and is about 1.2 km long (Katz and Katz 2004 say 2 km long) and as much as 100 m wide in spots and exposed primarily along one ridge between two draws (Shaeffer 1958) with some subsurface and others in large boulder along the slopes. The Alibates Formation consists of two dolomite beds separated by one mudstone bed (Bowers 1975:21-22). No more than three percent of the dolomite is chert like. Chert occurs in most outcrops of Alibates, but it is more abundant in the upper member (Bower and Reaser 1996). The massive sheets, 20 to 60 cm thick and covering an area of some 1,000 m, have only been identified at Cactus Flats and the Alibates Flint Quarries National Monument (AFQNM).

Figure 2-7. Multiple Quarry Pits Exposed Following Fire at Alibates Flint Quarries National Monument (41PT1) (photo by Paul Katz).

Figure 2-8. Boulder with Alibates Exposed at Alibates Flint Quarries National Monument (41PT1) (photo by Paul Katz).

Alibates is a multicolored, fine grained microcrystalline material, occurring as large lenses and nodules, as a result of solidification of the dolomite (Gould 1907; Bowers and Reaser 1996; Holliday and Welty 1981). It is generally a grayish-blue with light colored banding or veins of grays, blues, reds, purples, and white. Red and white banding is the more common characteristic trait (Figure 2-9). The texture is dense and lacks flaws, with a dull opaque surface (Banks 1990:127-129).

The cortex on Alibates silicified dolomite is usually white and chalky, roughly 1 to 2 mm thick. Bower and Reaser (1996) studied the

Figure 2-9. Samples of Alibates from Alibates Flint Quarries National Monument (41PT1).

origin of the chert and their data support a replacement process. In their study they measured and studied 30 stratigraphic sections, including two on the Salt Fork, and collected samples from each sequence. They then examined more than one hundred thin sections with a petrographic microscope. Fifteen samples, including 13 dolomite and two chert (one from the upper member and one from the lower member) were analyzed chemically for major and trace elements. They presented the chemical composition for 10 elements on the two selected Alibates chert samples and 13 dolomite samples from studies conducted at the Minerals Studies Laboratory, Bureau of Economic Geology, The University of Texas at Austin.

The AFQNM contains minimally 731 prehistoric quarry pits (Katz and Katz 2004, 2005) in four to five clusters along a ca. 1,300 m long irregular shaped area of one primary ridge. The hundreds of quarry pits testify to the extensive extraction of the tool stone from subsurface deposits by prehistoric peoples. Outcrops of Alibates and many more quarry pits are known of on the northern side of the Canadian River on private lands. Published information is nearly nonexistent concerning the northern areas and the quantity of Alibates available. Those northern outcrops are reported to extend for 1.6 to 2.0 km (Shaeffer 1958).

The Canadian River cuts southwest to northeast through the Quartermaster Formation. Over time the river has transported pieces of Alibates down stream ca. 275 km into western Oklahoma (Wyckoff 1989, 1993). Alibates is definitely present in the various gravel or lag deposits along the Canadian River in western Oklahoma, and in sizes that that are suitable for the production of stone tools (Wyckoff 1989, 1993). Alibates transported down river as gravel or lag pieces will exhibit distinctive water worn and smoothed cortex, with battered corners. The Alibates material is often visually distinguishable, but some pieces look similar to Tecovas jasper. Alibates has been visually identified in sites dating to Folsom time, such as the Folsom and Lindenmeier sites in northern New Mexico and northern Colorado (Hofman et al. 1991), the Cooper site in northwestern Oklahoma (Bement 1999), to other Paleoindian sites such as Olsen-Chubbock (Wheat 1972) in eastern Colorado, and Blackwater Draw Locality No. 1 in eastcentral New Mexico (Boldurian 1991), to the Archaic and later periods in northeastern New Mexico along the Pecos River (Mobley 1978) and to between 1450 and 400 B.P. (A.D. 500 to 1500) at Caddoan sites in the Arkansas Basin of eastern Oklahoma (Wyckoff 2005). The presence of archeological Alibates from sites in the obsidian source areas in northeastern New Mexico, some 220 km west of the known Alibates quarries, also reveals the transportation of this high quality material across the landscape by prehistoric populations (Wiseman 1992). Caches of stone tools made of Alibates have been reported, and the cached artifacts consisted of flakes, unifaces, and bifaces (Lintz 1978c, 1981; Slesick 1978; Ballenger 1996; Flaigg 2002; Mercado-Allinger 2004), which indicates the prehistoric importance and transport of this valued resource.

Some early authors (Green and Kelley 1960) have observed visually similar materials in widely distributed places. As an example, Green and Kelley (1960) point to similarities in “flint” just south of Yeso, New Mexico that occurs in boulders that form part of the Permian beds. A thick deposit of the Dockum Group of Triassic age overlies the Permian deposits, indicating that the older Alibates Formation would be deeply buried, as is the case across the southern Llano Estacado (McGookey et al. 1988). However, Barnes (1968, 1969) maps Quartermaster Formation outcrops west of the project area along isolated parts of the Canadian River valley and some in the lateral tributaries in Oldham County. Most localities exhibit sandstone and dolomite, but minor amounts of chert may be present in some places.

Bowers and Reaser (1996) indicate that isolated outcrops of Alibates occur along the Salt Fork of the Red River systems some 65 km east of Amarillo and cite Barnes (1968). McGookey et al. (1988) also shows the Alibates Formation extending to (and possibly exposed along) the eastern Caprock Escarpment in northern Briscoe County and extending into the Rolling Plains in southern Hall County. Kraft (2008:13) expands on this point and indicates that the cherty Alibates dolomite deposits extend south Bowers and Reaser (1996) indicate that isolated outcrops of Alibates occur along the Salt Fork of the Red River systems some 65 km east of Amarillo and cite Barnes (1968). McGookey et al. (1988) also shows the Alibates Formation extending to (and possibly exposed along) the eastern Caprock Escarpment in northern Briscoe County and extending into the Rolling Plains in southern Hall County. Kraft (2008:13) expands on this point and indicates that the cherty Alibates dolomite deposits extend south along the Caprock Escarpment and cites the Texas Bureau of Economic Geology maps (Barnes 1968, 1969) as indicating an upper Permian in age for these deposits. He indicates that Alibates chert is exposed along the course of the North Fork of the Red River near Lake McClellan and the Salt Fork of the Red River near Greenbelt Reservoir (Figure 2-10). If these can be positively demonstrated as part of the same formation and identical to Alibates chert near Lake Meredith, it will cause many archeologists to rethink the distribution of this material. Kraft (2008) also indicates chert clasts collected along the Washita, Beaver, and Cimarron rivers in western Oklahoma emulate those in the Canadian River valley. However, analogous bedrock sources for those lookalike pieces have not been identified. Geologists have identified an Alibates Formation that extends from eastern New Mexico to central Oklahoma, but state the formation’s lithology is not the same as the formally designated stratotype

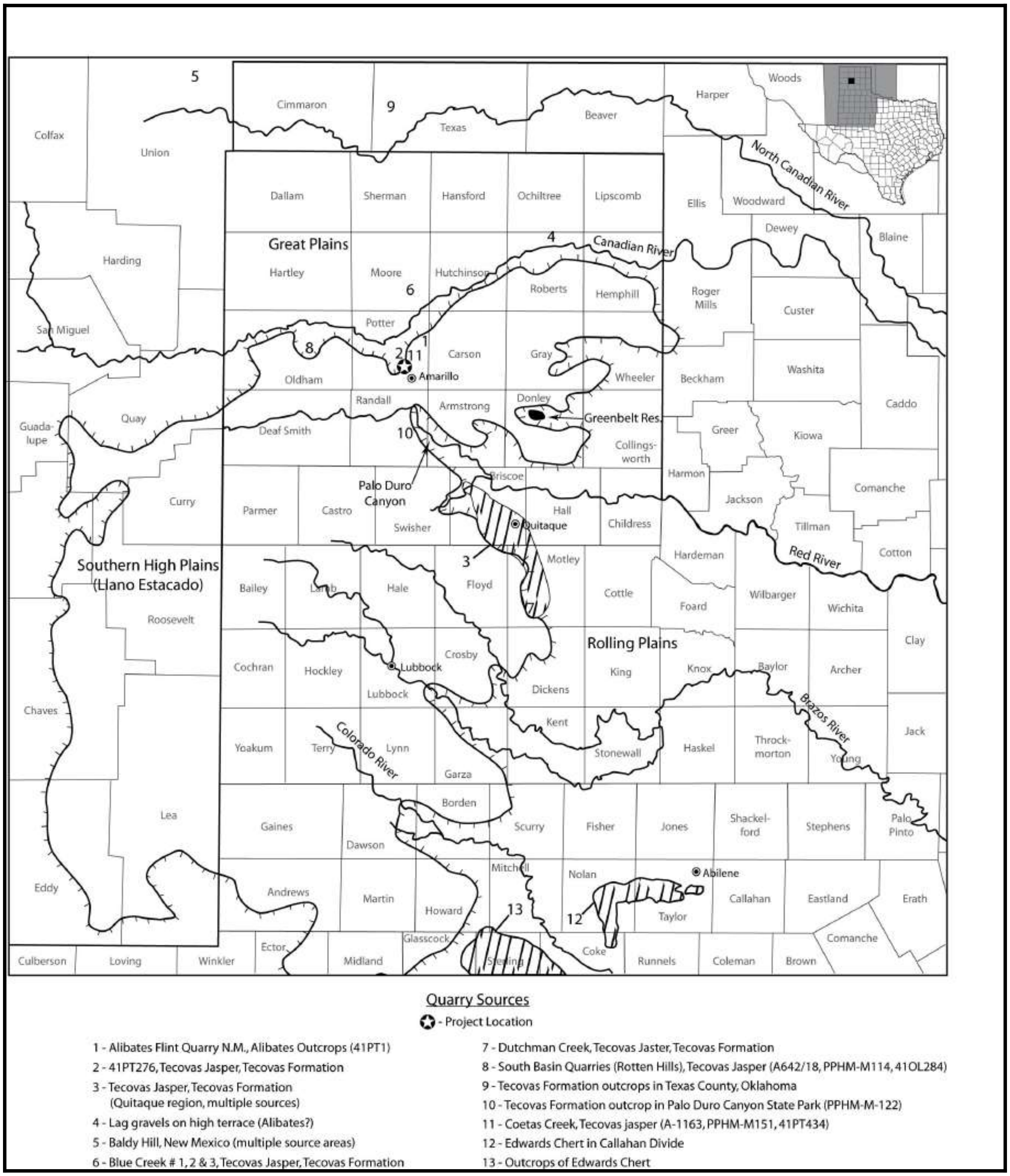


Figure 2-10. Map of the Quarry Source Areas across the Texas Panhandle

(McGookey et al. 1988). A chert bearing equivalent formation, the Day Creek Formation, is a lateral equivalent of the Alibates and is exposed in the North Canadian and Cimarron basins in northwestern Oklahoma and into southwest Kansas. Chert in these areas closely resembles Alibates in color, but is typically grainier, therefore not of the same quality (Banks 1984, 1990; Wyckoff 1989). Instrumental neutron activation (INA) analysis should help to clarify questions concerning materials of similar appearance in the different localities and/or the variations within one location/outcrop.

An initial INA analysis was conducted on natural Alibates material from the Quartermaster Formation as part of the Phase I mitigation at the BLM Landis Property (Quigg et al. 2008; Boulanger and Glascock 2008). A limited sample of 15 pieces of natural Alibates was analyzed. Those samples included six pieces from sources on private lands opposite the AFQNM, five pieces from Quarry pit 1 excavated at 41PT1, on the AFQNM in Potter County collected by Katz and Katz (2005), and four pieces from a single lag source exposed on a high terrace on the north side of the Canadian River in Roberts County some 90 to 100 km downstream of the main outcrop (Figure 2-10). The INA results indicate that all 15 Alibates samples were chemically indistinguishable (Boulanger and Glascock 2008). Importantly, the 15 natural Alibates pieces were chemically distinguishable from the 12 natural Tecovas jasper pieces analyzed (see below). Additional natural and cultural samples were analyzed during this phase. The results of the previous work have been incorporated into Appendix E.

Tecovas Jasper. Another high quality natural tool stone source is known to outcrop primarily 112 km southeast of Amarillo in the Quitaque area of Briscoe County (Figure 2-10) (Shaeffer 1958). This material originates in the Tecovas Formation (named by Gould 1907; mapped as part of the Dockum Group, Barnes 1969) of late Triassic age. In general, the Tecovas Formation in Potter County exhibits considerable variation in thickness with an average of about 61 m (200 ft.) and consists of various colored shales and soft gray unconsolidated, micaceous sandstone (Patton 1923). The type locality is just west of the project area at the head of Tecovas Creek in Potter County.

Tecovas jasper is widespread along the eastern Caprock Escarpment of the Llano Estacado (Green and Kelley 1960) and in the Canadian River valley west of Amarillo (Barnes 1968, 1969). Banks (1990) provides the best descriptions of the colors and most through discussions of Tecovas. He also provided a color plate of 11 Tecovas samples from three localities that include Weymonth Ranch (*N* = 4), Coetas Creek (*N* = 6), and West Amarillo Creek (*N* = 1).

A concentration of small outcrops of Tecovas lies between Quitaque and Palo Duro Canyon and this is the best known area for Tecovas jasper. Tecovas Formation outcrops are also all along the Canadian River valley in the western half of the Texas Panhandle (Barnes 1968, 1969). It is important to realize that simply because the Tecovas Formation is visible in a valley wall setting, this does not mean that a Tecovas jasper outcropping is necessarily present. The Tecovas Formation is also recorded in West Amarillo Creek valley including the nearby Wildcat Bluff Nature Preserve just north of the project area (Cepeda 1996). This formation also includes silicified wood (Barnes 1968, 1969). Other known Tecovas outcrops/source areas are scattered around the Amarillo region and include an outcrop at the South Basin quarries (Rotten Hills, quarries [41OL284 or PPHM-M114, A642/18, Banks 1990:92]) 24 km south of Landergin Mesa in eastern Oldham County (Figure 2-10, Mallouf 1989); an outcrop at Coetas Creek (41PT434 or PPHM-M151, Etchieson 1979b; Banks 1990; Raab 2005) at the southern end of Lake Meredith, several small outcrops along Blue Creek north of Lake Meredith in Moore County (Figure 2-10, Lynn 1986), and an outcrop in West Amarillo Creek at 41PT276 (Hughes 1969; R. Shaller personal communication Dec. 2007). The small outcrops in the Canadian Breaks are less well known and have not been systematically investigated or reported in the literature. Many other Tecovas source areas may be present, but as yet unrecorded. Multiple source areas are undoubtedly present and exposed within the mapped Tecovas Formation outcrops spread across the Canadian Breaks along the Canadian River valley west of Amarillo. A small Tecovas outcrop is also reported in the Oklahoma Panhandle along some of the small tributaries of the North Canadian River (Figure 2-10) (Banks 1984 citing an Oklahoma Water Resource report).

The best known and most widely cited source area for Tecovas is in the vicinity of Quitaque, Texas in Briscoe County (Figure 2-10). That region provides a vast range of colors of fine grained and variegated materials (Figure 2-11). The colors range from white through various shades of yellow, red, maroon, brown, with mottling (Holliday and Welty 1981; Banks 1990). Five pieces of the Quitaque materials on hand were used in our INA analysis that followed the 2007 fieldwork (presented in the interim report; Quigg et al. 2008) and are presented in Appendix E. One piece (#1-a) was a dark red (10R 3/4) with white mottles fading to pinkish to with red (10R 6/4) bands and white mottles. A second piece (#2-a) was a mottled dark tan (7.5YR 5/2) and red (10R 4/6) with white specks. A third piece (#3-a) was banded red (10R 6/4) and white (5YR 8/1) with a few orange (10R 5/8) mottles. The forth piece (#4-a) was gray (5YR 6/2) with pinkish orange specks. The fifth piece (#5-a) was yellowish tan (5YR 5/4) with cream to white (5YR 8/1) mottles.

Figure 2-11. Examples of Tecovas Jasper from Quitaque Area in Briscoe County.

Mallouf (1989) describes the South Basin quarry (41OL284) on the southern side of the Canadian River valley in an unnamed tributary of Sierrita de la Cruz Creek. He states that three exposures for Tecovas jasper have been located and recorded. The most extensive exposure of jasper (locality 1) occupies a roughly 250 by 300 m^2 area on the undulating floor of the basin a few hundred meters form the southern end of Rotten Hill. Here, the jasper occurs primarily as a tabular lens that is differentially eroding from the basin clays. The slabs of jasper vary from hat size to as large as 50 by 100 cm and range from 7 to 12 cm thick (Mallouf 1989:315). The cortex that surrounds the jasper varies thickness, but typically ranges from 2 to 20 mm. In many instances the cortex tends to be soft and rather crumbly. It is a very pale brown to pale brownish yellow (10YR 8/4 to 10YR 7/6). The jasper exhibits a wide range of textures and colors. The colors are in various combinations of red, green, caramel, yellow, tan, milky white, orange, pink, bluish-gray, and even purple (Mallouf 1989:317). These colors are typically mottled (roughly 56 percent) or banded (roughly 35 percent). In general, banding has often been considered an Alibates characteristic rather than associated with Tecovas pieces. All varieties observed are characterized by tiny chalcedonic or quartz spots and veins, and occasional crystal filled vugs. Specks of dark reddish-brown hematite are also fairly common. Occasionally specimens of the red and olive mottled variety will contain localized, variegated areas closely resembling agate. Five different samples were selected from the collections (Figure 2-12), analyzed, and the INAA results are presented in Appendix E.

Figure 2-12. Examples of Tecovas from South Basin Quarries, 41OL284.

North of the Landis Property, some 21 km farther down West Amarillo Creek valley is 41PT276 (A806), a small outcropping of Tecovas material (Figures 2-10 and 2-13). This outcrop was first recorded by Jack Hughes in 1969 (Hughes 1969). Hughes observed a ledge "of red to white jasper with yellow and other colors that occur in a lavender bed washing down into the alluvium of the gullies issuing from the bluff". The site appears to have been used, as evidenced by the amount of lithic flaking debris present. The outcrop occurs at an elevation of 961 m near the top of the bluff. Rolla Shaller visited this site in December 2007 and collected several reference samples for our use and took pictures of the locality and the jaspers. He observed that the jasper deposit was only about 30 cm thick. The collected specimens reveal diverse colors with pieces ranging from; maroon (10R 3/6) and yellowish tan with blue and white specks (#1-a), tan with white bands and dark reddish (5YR 4/6) orange spots (#2-a), reddish brown (2.5YR 4/6) with white spots (#3-a), creamy white and tan (7.5YR 6/4, #5-a), mottled white and tan (7.5YR 5/2, #6-a), and mottled reddish orange (2.5YR 4/6, #7-a) (Figure 2-14). A total of nine different samples were selected from Shaller's collections, analyzed, and the INAA results are presented in Appendix E.

In a distribution study of Tecovas jasper, Lynn (1986) recorded 20 locations with Tecovas jasper in a generally north south line across the Texas Panhandle, mostly along the eastern edge of the Llano Estacado, in the Caprock Escarpment. His study was not exhaustive, but he does describe two of the lesser known outcrops including the Blue Creek outcrop in the northern end of his study area just southeast of Dumas, Texas in Moore County, roughly

Figure 2-13. Outcrop of Tecovas at 41PT276 (A806) that Shows Mostly Patinated Materials. (photo by Rolla Shaller)

27 km north of the Landis Property (Figure 2-10). Three relatively small outcrops of Tecovas shale capped by Tecovas jasper (referenced as Blue Creek #1, #2, and #3) lie along the western side of the creek (Lynn 1986). Lynn (1986) describes each of these outcrops. The northern most outcrop (#1) is an eroded gully that exposes pinkish red shale and discontinuous lenses of jasper 4 to 15 cm in thickness within that shale. The jasper has a calcareous crust and calcite filled seams and fractures (Figure 2-15). The jasper is dark red to reddish brown (2.5YR 4/3) with a few tan (7.5YR 7/2) and white mottles (10YR 8/1) and specks, showing lighter colored pinkish and reddish gray (10R 5/1) with yellow (10YR 5/6) and orange (10YR 4/8) mottles and bands, deformed laminae within some of the lenses. Roughly 0.8 km south on the same side of the creek, Lynn (1986) describes a chimney-like structure (#2). The cap along the chimney exhibits an *in situ* layer of jasper 1 to 2 m thick and other thinner lenses 5 to 15 cm thick together with boulders on the slopes. The 1 to 2 m thick outcrop documented by Lynn (1986) at Blue Creek is in contrast to what Banks (1990:93) says about the generally available small size of Tecovas material in comparison to the larger size of available Alibates. Nearly 1.4 km further south are remnants of two additional small ridges (#3) that consist of pinkish-red shale capped by 4 to 20 cm of jasper (Lynn 1986). The jasper on both ridges is dull red, but some is vitreous and mottled red, yellow, and blue. Lynn (1986) states the vitreous jasper is of good quality but in small fragments. Two different samples, one from Blue Creek #1 and one from Blue Creek #2 were selected from Lynn's collections for analysis, and the INAA results are presented in Appendix E. The sample from Blue Creek #1 (#1-1a; TRC439) was a dark reddish brown (2.5YR 4/3) with few pinkish gray (7.5YR 7/2) and white (10YR 8/1) mottles and specks. The sample from Blue Creek #3 (#3-1a; TRC439) was dark reddish.

Figure 2-14. Examples of Tecovas Jasper from 41PT276.

Figure 2-15. Examples of Tecovas Jasper from Blue Creek Area.

Northeast of the Landis Property is the Coetas Creek outcrop (PPHM-M151, 41PT434, or LAMR 650) at the mouth of Coetas Creek in northeastern Potter County (Figure 2-10). This site was first discovered by Meeks Etchieson (Etchieson 1979a) and visited again by Jack Hughes, Etchieson, Billy Harrison, and others in 1983 (Harrison 1983; Hughes 1983). More recently a survey crew from 4G Consulting recoded this relatively large procurement site in detail, documented the materials, mapped, and photographed the location (Raab 2005). They recorded the site as extending over some 52,000 m^2 at an elevation of 952 m and divided up the site into eight intensive activity areas along the slopes below the Tecovas bedrock outcrops. The outcrop is roughly 10 m above the Permian age dolomite with large Tecovas jasper boulders below the outcrop. The procurement area includes large boulders that contain Tecovas jasper and show signs of having been tested and material extracted (Figure 2-16).

Figure 2-16. Boulder along Midslope with Tecovas Embedded in it at 41PT434. (photo by Rolla Shaller)

Minimally six quarry pits, ranging from 70 to 170 cm in diameter with depths of 30 cm, and associated clusters of artifacts and debitage concentrations of debitage, were observed. Artifacts include; tested cobbles, cores, bifaces, end scrapers, edge modified flakes, various stages of reduction flakes within recognized knapping localities, and a possible hearth feature (Raab 2005). Raab (2005) states that most of the bedrock lithic material is cherty, with some residual chalcedony in place on the rim surface. Some jasper specimens grade into orthoquartzite, but this is generally rare. Most of the jasper and chalcedony is heavily weathered and contains many crystal lined vugs. The Tecovas jasper is described as;

> "an iron-rich replacement chert with a variegated or randomly mottled appearance replete with lugs and druses filled with botryoidal surfaces, agate, or quartz crystals. Secondary crystal growths are common on frost-fractured surfaces. Flawless masses of Tecovas chert more than 15 cm in length are very rare. The color range includes: red (10R 5/6, 10R 4/6, 10R 4/8), dark red 10R 3/6), dusky red (10R 3/4), yellowish red (5YR 5/6, 5YR 5/8, 5YR 4/6), yellowish brown (10YR 5/6), white, light olive brown (2.5Y 5/4), and olive yellow (2.5Y 6/6)" (Raab 2005).

Raab (2005) goes on to describe the Tecovas chalcendonic chert/agate as;

> "fine homogenous texture, translucent with globular "bubble" features visible at <0.5 mm into the material, vitreous luster, in-filled veins of red (2.5YR 4/8) or dark yellowish-brown (10YR 4/6) jasper oriented along internal fracture planes, agate- or quartz-crystal lined cavities, some with botryoidal surfaces. The matrix has a frosted appearance, ranging in color from light greenish gray (Gley 1 7/1) to light bluish gray (Gley 2 7/1) to white".

The Tecovas orthoquartzite is described as;

> "homogeneous fine (1/8 to ¼ mm) to medium (1/4 to ½ mm) sand, rounded grain shape, white to colorless cement, opaque, sucrosic luster, jasper overgrowths are common, as are small vugs in-filled with jasp-agate. Color patterning ranges from homogeneous [weak red (2.5YR 4.5/2) or brown

> (7.5YR 5/4) to mottled weak red and brown with red jasper inclusions (10R 4/8). Tecovas orthoquartzite reported occurs in larger cohesive masses than Tecovas jasper (Banks 1990:93)."

Rolla Shaller, Alvin Lynn, and Arlene Wimer visited the site on February 17, 2009. They took pictures, recorded GPS points and collected natural Tecovas samples for use in this INA analysis (Figure 2-17; Shaller 2009). Five different samples were selected from their collections, analyzed, and the INAA results are presented in Appendix E.

Figure 2-17. Examples of Tecovas Jasper from Coetas Creek, 41PT434.

Some 40 km south of the Landis Property is the Palo Duro Canyon through which runs the Prairie Dog Town Fork of the Red River. Tecovas Formation outcrops in many locations in Palo Duro Canyon (Etchieson et al. 1978), and one specific outcrop (M-122) in the State Park has been briefly recorded (Figures 2-10 and 2-18). This outcrop is along the middle section of the valley wall above Prairie dog Town Fork of the Red River. Several large pieces of Tecovas under the talus, were recovered using a rock hammer. The specific location is Zone 14; 0256489N 3872583E. At this location the Tecovas layer was about 15 cm thick. The location that Billy Harrison sampled in 1972 was about 30 cm thick (Harrison 1972). The samples Rolla Shaller collected in 2008 were mostly dark blue, with some white stripping and a little with red coloration. This location was collected by Mr. Shaller; however Lynn (1986) reported at least another three localities with Tecovas jasper in Palo Duro Canyon. Four specimens were selected from the collections, analyzed, and the INAA results are presented in Appendix E. The four specimens analyzed (M-122-1a, M-122-2a, M-122-3a, and M-122-4a) are relatively similar in color (Figure 2-19). Specimen M-122-1a (TRC444) is a very dark bluish-gray (Gley 2 3/5B) with a few whitish (Gley 2 8/5B) areas. Specimen M-122-2a (TRC445) is a very dark gray (2.5Y 3/1) with white and gray bands and mottles. Specimen M-122-3a (TRC446) is again a light blueish gray with black and dark orange banding. Specimen M-122-4a (TRC447) is white (Gley 2 8/5B) and black (Gley 2 2.5/10B) mottled.

Figure 2-18. M-122 Outcrop near Top of Ridge in Palo Duro Canyon. (photo by Rolla Shaller)

Figure 2-19. Examples of Tecovas Jasper from M-122 in Palo Duro Canyon.

Farther south, Lynn (1986) also describes the Dutchman Creek outcrop just southwest of Matador, Texas in the southern end of his study area (Figure 2-10). The latter contains *in situ* materials as well as boulders and nodules below the outcrop. There are apparently only minor variations in the color, texture, and luster of the jasper from the Blue Creek and Dutchman outcrops (Lynn 1986). The few samples available exhibit primarily a reddish brown (2.5YR4/3), or reddish gray (10R 5/1) with tan (7.5YR 4/3), pinkish grays, yellowish brown (10YR 5/6), orangish (10YR4/8), and white (10YR 8/1) mottles. No samples from this locality were sent for INAA.

Tecovas jasper is a fine grained material similar to Alibates in texture and color. It is distinguishable by its often variegated or mottled appearance, with some exceptions. Most pieces are red, brown, cream, white, yellow, or green in colors. It is opaque, often with bluish white quartz vugs. It occurs in massive boulders as much as a meter in diameter that also contains tiny quartz filled vugs (Tunnell 2006). Both Alibates and Tecovas come in red, but the latter has a more even red, and is generally mottled or variegated often with tiny quartz vugs (Holliday and Welty 1981). The Tecovas material is often visually distinguishable, but some pieces may look quite similar to Alibates. It must also be stated that Alibates and Tecovas reveal very dark or purple/velvet ultraviolet light response (Hofman et al. 1991).

Tecovas has been visually identified in sites dating from Clovis and Folsom times, such as Blackwater Draw Locality No. 1 in eastcentral New Mexico (Boldurian 1991), the Folsom site in northeastern New Mexico (Hofman et al. 1991:302), and likely used throughout prehistory. The presence of archeologically derived Tecovas in eastcentral New Mexico, some 250 km southwest of Landis Property, also indicates the transport of this high quality material across the landscape by the prehistoric populations.

Caches of Tecovas jasper are in frequent, but a few, such as the Mackenzie (Willey et al. 1978:223), Palo Duro, and Crump Farm caches (Tunnell 1978) have been reported (Mercado-Allinger 2004). The Mackenzie cache (Feature 8 at 41BI46, Area I) is an isolated pit about 60 by 250 cm in size and about 45 cm deep. It contained minimally 666 noncortext flakes, the largest over 10 cm in length with most between 3 and 4 cm long. Willey et al. (1978:226) and Tunnell (1978:45) thought this cache pit represented a heat treatment of this raw material rather than a storage pit. Tunnell (1978:40) reports that one of the Witte (1942) caches near Palo Duro Canyon consisted of 608 unworked flakes of Tecovas, similar to the Weaver-Ramage cache. The Crump Farm cache in Motley County contained bifaces and flakes of Tecovas jasper (Tunnell 1978:45). These caches are all within the region, indicating that Tecovas materials were generally not widely distributed. The Turkey Creek cache contained “four oval bifaces pointed at one end measuring 11 to 13 cm long and 8 cm wide, four relatively long blades, two biface thinning flakes, and a large, oval bifacially shaped quarry blank weighing some 1.36 kg (3 lbs.)” (Tunnell 2006:742).

Lateral equivalents of Tecovas Formation or Dockum Group include the Chinle Formation of New Mexico (Dunbar and Waage 1969) and the Baldy Hill Formation (Foster 1966) of northeast New Mexico (Figure 2-10; Banks 1990:93). Banks (1990) reports that the Baldy Hill material closely resembles some Alibates and that it is often called “False Alibates”. Additional work is required to reveal the precise differences in these outcrops. Two pieces of Baldy Hill jasper from KUMA LCC #97-1 in Union County, New Mexico in Quigg’s reference collection exhibit diverse colors. Specimen #97-1a (TRC405) was tan (5YR 5/2) with red and dark brown (2.5YR 3/4) specks/banding and some orange areas. Specimen #97-2a (TRC406) was yellow tan (5YR 6/6) with dark red mottles (110R 3/3) and a few white/cream specks. These are generally of poor knapping quality, but it is not clear if these specimens are representative of all Baldy Hill materials. Both pieces of Baldy Hill jasper from the Dockum Group in Union County, New Mexico were subjected to INA analysis. The two Baldy Hill pieces were chemically distinguishable from the Tecovas jasper and the Quartermaster (Alibates) chert (Boulanger and Glascock 2008). See Appendix E for additional INA analysis results from additional source areas and cultural materials.

An initial INA analysis was conducted on selected natural Tecovas material from two different Tecovas Formation outcrops as part of the Phase I mitigation program at the BLM Landis Property (Quigg et al. 2008). A limited sample of 12 pieces of unmodified Tecovas were analyzed, which included six pieces collected by local archeologist Rolla Shaller from a Tecovas outcrop (41PT276) 27 km down stream from the Landis property, and six pieces from the general outcrops in the Quitaque area in Briscoe County on the eastern edge of the Llano Estacado (Figure 2-10). The INA results indicate that the 12 natural Tecovas samples show some similarity to materials from the two source areas sampled (Boulanger and Glascock 2008). However, plots of logged elemental concentrations also demonstrate the possibility of identifying differences between the two jasper sources. Jasper samples from 41PT276 exhibit slightly lower concentrations of rubidium, arsenic, tantalum, cesium, calcium, and slightly higher concentrations of chromium, uranium, and strontium (Boulanger and Glascock 2008). However, the few samples involved makes these preliminary interpretations open to revision as additional samples are analyzed. Neutron activation results on archeological specimens from the Phase I mitigations at the BLM Landis sites indicate that some of the Tecovas material from the Landis Property archeological sites originated from the local 41PT276 source, whereas other pieces were from unknown Tecovas source(s). No cultural pieces sampled were potentially from the Briscoe County in the Quitaque region, 112 km to the southeast along the eastern margin of the Llano Estacado. One cultural Tecovas piece was chemically unlike either of the two Tecovas sources analyzed, which indicates that material was collected from at least a third Tecovas source. As expected, additional source areas exist than we know about or that have been chemically sampled so far.

Opalite is another local raw material resource that occurs in the Ogallala Formation. The latter formation was named by Darton (1899) from outcrops near Ogallala, Nebraska. It extends from the Southern High Plains in western Texas northward across the plains east of the Rocky Mountains into western Nebraska and eastern Wyoming (Seni 1980). This generally structurally poor material, a caliche cemented sequence of gravel, sand, silt, and clay, occurs in horizontal beds of various thicknesses within the cemented caliche caprock of the Ogallala Formation, but also in some gravel beds (Gustavson 1996; Lintz 1998). Opalite is opaque cryptocrystalline silica, dull in luster, formed in clay matrix by a replacement process. The dominant colors are an off-white to pink-white (5YR 8/1.5), a light gray (5YR 7/1) to or a reddish brown (5YR 6/3). The quality of this material varies tremendously, but most pieces have many internal fractures and weather into blocky chunks. These characteristics create problems in knapping and therefore the usefulness of this material is limited to crafting small tools such as projectile points and scrapers, as Lintz (1998) points out for several assemblages. Some crude chopping and bifacial tools are also made of Opalite, and sometimes it was used as hearth stones. A chunk of opalite was recovered from one cache (Mercado-Allinger 2004), a rare occurrence.

Potter chert is another knappable material that occurs in the Ogallala Formation. It occurs in outwash Ogallala gravels and appears prominent in the Canadian River valley and across much of the Texas Panhandle. Potter chert is the most distinctive material in the gravels, which also include quartzite, jasper, siltstone, chalcedony, opalite, and silicified wood (Holliday and Welty 1981; Banks 1990). Potter chert is not a true chert, but rather, it is a fine grained silica cemented siltstone (Holliday and Welty 1981). It is primarily green or red; however, heat treating alters its true color. Quality ranges from extremely coarse grained to very fine grained. It has been flaked into a variety of objects, mostly larger chopping, cutting, and pounding tools or crude bifaces.

Ogallala quartzite, also is derived from the Ogallala Formation. It is very abundant in many places across the Southern Plains, primarily in the Canadian Breaks and along the Caprock Escarpments on each side of the Llano Estacado (Gustavson 1996). It appears throughout the region in dispersed outwash gravels and as isolated occurrences that resulted from tertiary outwash from the Rocky Mountains. Outcrops of Ogallala are found across southeastern Colorado and the Oklahoma Panhandle (Banks 1990). Typically Ogallala quartzite occurs as small fist-size cobbles in gravels on ridge tops, colluvial slopes, and high terraces. It is predominately gray to pink in color and ranges from cryptocrystalline to macrocryptalline in texture. This fine to medium grained silicified sandstone or siltstone is quite common and was often employed to make as large cutting, chopping, and pounding tools. The Ogallala deposits consist of sand, silt, clay, with some weakly developed caliche, and pebble to cobble sized gravels composed of quartz, quartzite, minor amounts of chert, petrified wood, schist, limestone, igneous rocks, metamorphic rocks and caliche nodules (Barnes 1969).

Silicified (petrified) wood is present in considerable quantities in both the Tecovas and Trujillo formations (Patton 1923; Barnes 1968, 1969). It is mineralized fossil wood that resembles chert. In some places, large logs have been documented. This is a local resource, but the pieces are not often easily worked into stone tools because linear fracture planes along the growth rings create difficulties during tool manufacturing. Colors vary considerably with reds and browns dominant. It has a dull luster and is opaque to slightly translucent along the edges. It is found in tertiary gravel deposits across a wide area.

Recognizable Nonlocal Stone Tool Resources. Tool stone is relatively plentiful in the Texas Panhandle region; however, some tools made of nonlocal stones tool resource have been detected in various cultural assemblages from this region. A couple of the more prominent and easily identifiable imported materials are discussed below.

Obsidian. All obsidian is considered nonlocal to this region, because the nearest source area is northcentral New Mexico. Obsidian is a volcanic glass that is brittle, but easily worked into stone tools. Given the long distance transport involved, it is often found only as small pieces of broken tools and small flakes.

Based on 88 obsidian artifacts from Oklahoma and Texas, Baugh and Nelson (1987) present a model of obsidian source use from Paleoindian to Protohistoric times for this one region. They suggest sporadic down the line exchange transactions. That is, one group near the source traded obsidian on to their neighbor and that group then traded it on to their neighbor. Distant populations were not going to the source areas and collecting the obsidian firsthand. The trade networks were most likely loosely structured, open systems with a general north to south orientation. This later directional movement was based on some 86 percent of the obsidian artifacts coming from sources in Idaho and Utah, with a much lower percentage originating in the Jemez Mountains in New Mexico (Baugh and Nelson 1987:325). More recent studies by Bement and Brosowske (2001) and Brosowske (2005) indicate that obsidian was from different source areas at different periods of prehistory. The Baugh and Nelson (1987) model was based mainly (92 %) on obsidian from Protohistoric sites (A.D. 1450 to 1650) that indicate obsidian at that particular time was primarily from Malad, Idaho. Bement and Brosowske (2001) indicate that during the Late Archaic period in the Oklahoma and Texas panhandle obsidian came from minimally two primary source areas, obsidian Cliff, in northwestern Wyoming and Valle Grande (i.e., Cerro del Medio) in northcentral New Mexico. The Plains Village period saw obsidian come primarily from Jemez Mountains in northcentral New Mexico. Brosowske (2005), studying the Plains Village period occupations in western Oklahoma and the Texas Panhandle, sourced 130 artifacts from 19 different Middle Ceramic period sites (A.D. 1200 to 1500), and found that nearly all the obsidian came from Cerro Toledo Rhyolite (sometimes call Obsidian Ridge obsidian) in the Jemez Mountains. Brosowske (2005) used the spatial distribution of obsidian to reconstruct the structure of Middle Ceramic period exchange networks on the Southern High Plains. Based on large quantities of obsidian at a few specific sites (i.e., Alibates Ruin 28, Chimney Rock Ruin 51, and Odessa Yates) Brosowske hypothesized that these communities served as regional trade centers.

Eight pieces of obsidian were recovered during the Phase I data recovery work and one piece came from the surface during the testing phase efforts (Haecker 2000:24) at the BLM Landis Property sites (Quigg et al. 2008). These nine pieces were subjected to elemental source analysis to determine their origins. Shackley (2008) demonstrated through x-ray florescence that eight pieces were from three separate source locations in the Jemez Mountains in northcentral New Mexico. One piece (41PT186-20.1) from the surface of the Corral site area (41PT186; Haecker 2000:24) was from an unknown source (R. Hughes 1999) and again by Shackley (2008). Shackley believes that the chemistry of this surface piece is similar to a mafic or intermediate volcanic rock. Two pieces of obsidian from the Late Archaic component at 41PT185/C were from El Rechuelos (Polvadera Group, not Polvadera Peak) in northcentral New Mexico.

Other nonlocal tool stone is sometimes recovered from archeological sites in the region. Permian age materials are present in southern Kansas and into western Oklahoma. Chert is present in seven of 16 limestone members and formations within the Council Grove and Chase Groups of the Lower Permian with Day Creek dolomite in the Upper Permian series (Banks 1990; Stein 2006). The most prominent general classes are Wreford and Florence cherts. The Wreford materials are exposed in the southern Flint Hills of Kansas and northcentral Oklahoma and come in a variety of colors including Wreford A, which is gray-buff or tan in color, Wreford B, blue-gray to gray in color and, mottled, and Wreford C, is brownish- or bluish-gray in color (Banks 1990; Stien 2006). Four varieties of Florence chert have been identified. Florence A, also known as Kay County chert or Maple City chert, is a buff to yellow-gray chert found in the southern Flint Hill that contains large fusilinid fossils appearing as fingerprints [“fingerprints”] with thin parallel lines. Florence B is mottled blue-gray and contains large fusilinid fragments. Florence C is uniform gray and contains fragments of unidentifiable fossils (Stein 2006). Florence D is gray to buff with translucent bands.

The Niobrara Formation, of Cretaceous age, is in northwestern Kansas. The silicified chalk found in the Smoky Hill chalk member was widely used throughout prehistoric times. It is referred to by a variety of names, including Smoky Hill jasper, Niobrara jasper, and silicified chalk. The material is typically opaque but may be translucent. Most of it is yellow to brown in solid colors or in bands. The texture is highly variable and generally lacks fossils (Stein 2006). Neutron activation analysis has been used to identify the raw material source of Smoky Hill jasper from the bluffs in the Saline River valley in Trego County (Banks 1990 cited in Stein 2006).

2.2 BIOLOGICAL RESOURCES

2.2.1 Floral Communities

A study of the native vegetation in the Canadian Breaks along Alamosa Creek in adjacent Oldham County provides data to help create an understanding of the past vegetation communities on the BLM Landis Property and in the surrounding region (Sikes and Smith 1975). In their study, Sikes and Smith identified three major plant communities, conducted transects across different land forms, and provided discussions of major communities represented and the percentage of ground cover occupied by each community. In a transect across a high mesa they documented a mesquite (*Prosopis glandulosa*)-Galleta (*Hilaria jamesii*) association. This is the primary floral community, which extends off the High Plains and into the creek valleys. Vegetation coverage was across 42 percent of the surface. Mesquite is considered an invader species, together with scattered pricklypear (*Opuntia* sp.) and cholla (*Opuntia imbricate*).

On an alluvial terrace next to a creek Sikes and Smith documented a mesquite-bristlegrass (*Setaria leucopoila*) association (Sikes and Smith 1975) covering about 41 percent of the ground in that locality. Scattered throughout the mesquite grassland, skunkbrush (*Rhus aromatica*) has replaced mesquite along the steep mesa slopes. Hackberry (*Celtis reticulata*) is often found with large cottonwood (*Populus deltoids*) along the streambeds. Near the Canadian River along an alluvial deposit below the crest of a mesa they encountered 57 percent ground cover dominated by hairy grama (*Bouteloua hirsuta*) and yucca (*Yucca* sp.). In one locality they identified a juniper (*Juniperus scopulorum*)-hairy grama association. In this one locality juniper, which is randomly interspersed within the mesquite grassland, composed 85 percent of the total cover. Along the margins of the Canadian River was found a concentration of salt cedar (*Tamarix gallica*) with some patches of dropseed (*Sporobolus cryptandrus*). The overall measured ground cover was 46 percent (Sikes and Smith 1975). These identified plant communities are assumed to be very similar to what the modern, undisturbed West Amarillo Creek communities would be like. However, these may not be similar to past vegetation communities, given possible responses to changes in climate and ground water availability.

Wes Philips conducted an inventory of the plant species in the project area (Philips 2000). He identified some 61 species of plants including ca. 16 different grasses and minimally eight species of trees. In general, he stated that the hillsides support shortgrass prairie and are dominated by various grama and little bluestem (*Schizachyrium scoparium*) grasses, plus mesquite (*Prosopis* sp.), sagebrush, halfshrub sundrop (*Calylophus* sp.), yucca (*Yucca* sp.), skunkbrush sumac (*Rhus aromatica*) and hackberry (*Celtis* sp.) (Figure 2-20). In the

Figure 2-20. Mesquite Grasslands with Scattered Yucca across Colluvial Slope below Bluff Tops.

more moist canyons, willows (*Salix* sp.) and cottonwoods (*Populus* sp.), grape (*Vitis* sp.), and goldenrod (*Solidago* sp.) prevail. In a study of modern pollen collected from three localities (two terraces and one colluvial slope) in the Landis Property that included site 41PT185 and 41PT186, Gish (2000) identified both arboreal taxa (N = 7) and nonarboreal taxa (N = 8). The arboreal taxa, all of which are wind pollinated, included spruce (*Picea*), pine (*Pinus*), juniper (*Juniper*), oak (*Quercus*), alder (*Alnus*), walnut (*Juglans*), and Willow (S*alix*). Interestingly, cottonwood was not identified even though it is growing along the creek today. The highest frequency in the three samples was juniper at 12, 8, and 4.5 percent. These taxa reflect regional or extra regional pollen influx from distant plant sources (Gish 2000).

The nonarboreal taxa include Compositae, sagebrush (*Artemisia*), Compositae tribe (Liguliflorae), goosefoot family and amaranth (cheno-am; Figures 2-21 and 2-22), grass family (gramineae), mustard family (Brassicaceae), plantain (*Plantago*), and cattail (*Typha*). The cheno-ams have the highest frequency, generally by a wide margin. Cheno-am pollen reflects the presence of shrub and herbaceous plants that are wind pollinated. The Compositae taxa includes ragweed (*Ambrosia*), sagebrush, also wind pollinated. The 8.5 percent representation of grass pollen may appear low, but for wind pollinated grasses this is a common value in grassland communities (Gish 2000). The unusual taxa would be the wind pollinated cattail pollen, given that cattails require permanent water.

2.2.1.1 Potential Food and Health Resources

The many grass species in the West Amarillo Creek valley and throughout the surrounding region provide tiny seeds that probably were used as food by humans, and that definitely provided food for the bison on which aboriginal human populations relied. Philips (2000) recorded 16 different grass species for this valley alone (Table 2-1). Thirteen (81 percent) of those are warm season C_4 species. The regional grassland community is classified as grama-buffalo grass (*Bouteloua-Buchloe*), reflecting the dominance of those two species (Kuchler 1975). These dominant species are classified within the Chloridoid group of grass subfamilies that produce primarily short cell saddle type phytoliths (Fredlund and Tieszen 1994). Other C_4 grasses recorded for this valley include Big bluestem (*Andropogon Gerardii*), Little bluestem (*Schizachyrium scoparium*), Sand bluestem (*Andropogon Hallii*), Sand Dropseed (*Sporobolus cryptandrus*), and Indiangrass (*Sorghastrum avenaceum*), all classified within the Panicoideae subfamily. These grasses produce various phytolith morphotypes including crosses, simple lobates, and panicoid types. In modern phytolith samples to the south in the Lubbock region, the C_4 short cell saddle type phytolith generally represents roughly 73 percent of the short cell phytolith assemblage (Fredlund and Tieszen 1994).

Figure 2-21. Maturing Amaranth Plant with Seed Spikes. (photo by M. Quigg)

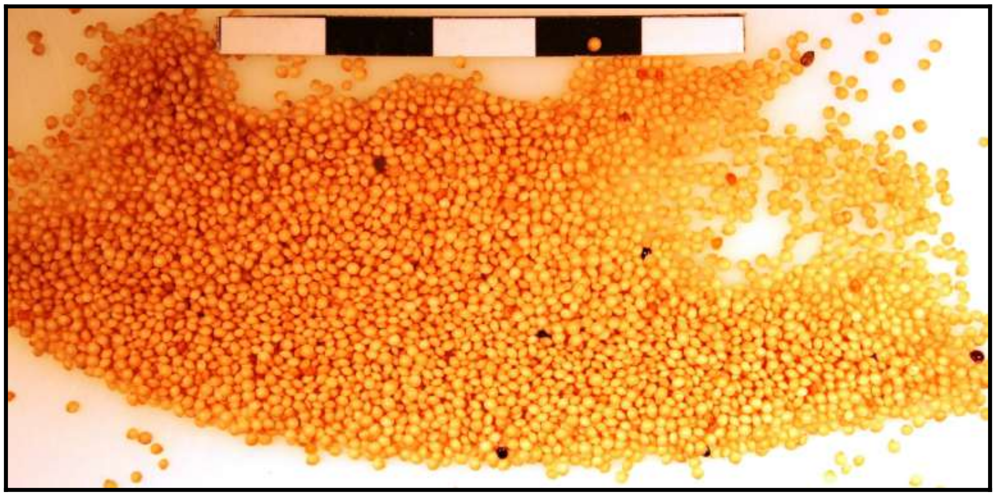


Figure 2-22. Modern Amaranth Seeds (scale in cm). (photo by M. Quigg)

Table 2-1. Local Plants that were Potentially Used for Food Resources.

Common Name	Scientific Name	Plant Part for Food	In Season
Annual Broomweed	*Xanthocephalum sphaerocephalum*	greens	summer, fall
Big Bluestem	*Andropogon Gerardii*	seeds	summer, fall
Blue grama	*Bouteloua gracilis*	seeds	summer, fall
Buffalo gourd	*Cucurbita foetidissima*	roots, seeds	summer, fall
Buffalo grass	*Buchloe dactyloides*	seeds	summer, fall
Bush Sandlily	*Mentzelia strictissima*	seeds	summer, fall
Canadian Wildrye	*Elymus canadensis*	seeds	summer, fall
Cat's Claw Mimosa	*Mimosa biuncifera*	seeds	late summer, fall
Chickasaw Plum	*Prunus angustifolia*	fruit	late summer
Gayfeather	*Liatris puntata*	root	spring
Hairy Grama	*Bouteloua hirsuta*	seeds	
Honey Mesquite	*Prosopis glandulosa*	seeds	late summer, fall
Indian Rush-pea,	*Hoffmanseggia glauca*	roots	fall
Indian Grass	*Sorghastrum avenaceum*	seeds	summer, fall
Little Bluestem	*Schizachyrium scoparium*	seeds	summer, fall
Missouri Goldenrod	*Solidago missouriensis*	leaves	late summer, fall
Net-leaved Hackberry	*celtis reticulata*	seeds	early fall
Panhandle Grape	*Vitis acerifolia*	fruit	late summer
Plains Cottonwood	*Populus sargentil*	seeds	spring
Purple Three-awn	*Aristida purpurea*	seeds	summer, fall
Sand Bluestem	*Andropogon hallii*	seeds	summer, fall
Sandbur	*Cenchrus incertus*	seeds	summer, fall
Sand Dropseed	*Sporobolus cryptandrus*	seeds	summer, fall
Sideoasts Grama	*Bouteloua curtipendula*	seeds	summer, fall
Silver Bluestem	*Bothriochloa saccaroides*	seeds	summer, fall
Silver-leaved Nightshade	*Solanum eleagnifolium*	roots	summer, fall
Small Soapweed Yucca	*Yucca angustifolia*	fruit, other parts	spring,summer
Slimleaf Goosefoot	*Chenopodium leptophyllum*	seeds	summer, fall
Skunkbrush, Fragrant Sumac	*Rhus aromatica*	fruit, roots	sping, summer, fall
Sunflower	*Helianthus annuus*	seeds	late summer, fall
Wavy-leaved Thistle	*Cirsium undulatum*	roots	all seasons
Western Wheatgrass	*Agropyron*	roots	summer, fall
Wild Onion	*Allium drummondii*	bulb	spring, fall
White Tridens	*Tridens albescens*	seeds	summer, fall
Wrightii Three-awn	*Aristida Wrightii*	seeds	summer, fall

The three cool season C_3 species identified by Philips (2000) in West Amarillo Creek valley include Canadian wildrye (*Elymus Canadensis*) (Figures 2-23), Western wheatgrass (*Agropyron Smithii*) and Crabgrass (*Digitaria sanguinalis*). The former two species are classified within the Pooideae subfamily and primarily produce short cell phytolith types that include keeled, conical, pryramidal, and crenate forms (Fredlund and Tieszen 1994). In modern phytolith samples from the Lubbock region the C_3 grass phytolith types generally represent roughly 26 percent of the short cell phytolith assemblage (Fredlund and Tieszen 1994).

Figure 2-23. Close up of Wildrye (*Elymus canadensis*) Grass Seed Head and Loose Seeds.

Most grasses produce many seeds that would potentially provide food resources for the prehistoric human populations (Stiger 1998). The grass seeds would require processing by cooking/heating to make them digestible. These seeds contain a high percentage of starch. Starch naturally occurs in plant cells in the form of small granules that are water insoluble at room temperature (Arons and Paschall 1975). For the nutrients to become available to humans the starch granules need to be broken down through cooking. Mechanical grinding or pounding does not rupture the starch granules. Heating as a means of breaking down the structure to release the nutrients is most often achieved through boiling. Upon heating, the granules absorb water and expand, causing the molecules to rupture and thereby making them digestible. Swelling of the starch granules in the heated water is known as gelatinization of the starch grains.

Starch analysis on a limited sample of selected prehistoric specimens obtained during the Phase I investigations yielded positive results (Perry 2008). Twenty analyzed samples included 16 prehistoric burned rocks from four features, two ceramic sherds, one natural rock, and one modern experimental rock. Plant tissues (mostly phytoliths, some fibers, and charcoal) were found on 90 percent of the samples analyzed. Starch fragments were found on 70 percent of the samples. Not only were starch grains detected, but gelatinized starch grains were present in 30 percent. This indicates direct contact of starch grains with heat and water and documents the cooking of starchy plants using these rocks from sampled features. Identifiable starch grains of wildrye (*Elymus* sp.) were found on two burned rocks from two separate cultural features of different ages. A second identified starch, pertaining to a Panicoid grass, was found on another burned rock, and Pooid grass starch grains were found on three samples. These positive results represent two different time periods, the Late Archaic and the Palo Duro/Woodland period.

A variety of other plants in the valley were potentially used in a variety of ways (i.e., food, medicine) include; Snow-on-the-mountain (Euphorbia *marginata*), Skunkbush (*Rhus aromatica*), Mexican hat

(*Ratibida columnarais*), and sunflower (*Helianthus annuus*). Other plants identified within West Amarillo Creek valley were potentially significant food resources for the early inhabitants. A few of the more important groups of food resources are discussed below.

2.2.1.2 Geophytes (Bulbs and Roots)

Recent archeological investigations in central Texas have identified many carbonized plant bulbs from prehistoric burned rock features. The identified bulbs include, but are not limited to; wild onion (*Allium canadense* var. *canadense*, *Allium drummondii*), false garlic (*Nothoscordum bivalve*), wild hyacinth (*Camassia scilloides*), and dog's tooth violet (*Erythronium albidum*) (Figure 2-24). Bulbs are often found in patches that would make collecting at specific times very easy (Figure 2-25). Farther north in the Wyoming plains, sego lily bulbs (*Calochortus nuttalli*) have also been linked to prehistoric pit oven baking (Smith and Martin 2001). Each of these plants has an underground storage organ that stores nutrients, making these perennials an excellent food source (Dering 1998:1610; Smith and Martin 2001). The wild onion or Canadian garlic has been identified in West Amarillo Creek valley (Philips 2000). These wild onions can be eaten raw or cooked. The bulbs have a brown net like (reticulated) fiber covering. The plant also has strong, onion like odor, and the bulbs taste like onion. The narrow, grass like leaves originate near the base of the stem and tend to be flat (not hollow). The stem is topped by a dome like cluster of star shaped, pink or white flowers that grow at the end of a specialized leaf called a scape. The flowers are hermaphroditic (having both male and female organs), and are pollinated by bees and other insects. Flowering typically occurs in the spring and early summer, from May to June. After pollinated, the flowers produce seeds. In terms of plant composition, the wild onion contains fructans (inulin form) with sucrose and fructose comprising roughly 55 percent of the dry weight. Starch is absent. (Wandsnider 1997, taken from Yanovsky and Kingsbury 1938). The ethnographic literature indicates these were most often eaten raw or were moist baked. Pit baking of inulin rich foods would have resulted in as much as a 100 percent increase in the energy obtained from these foods (Wandsnider 1997).

Figure 2-24. Bulbs (rain lily, false garlic, prairie pleatleaf) that Represent Potential Food Resources. (photo by M. Quigg, scale in cm)

Figure 2-25. Patch of False Garlic, Showing Blooms (light color) that Would Facilitate Collection. (photo by M. Quigg)

Gayfeather (*Liatris punctata*), with purple flowers in August and September, is common in the region (Figure 2-26). This C_3 plant produces a taproot that can reach a depth of 5 m. It is this taproot that was sought by native peoples in spring. It was often baked or boiled (Kirk 1970:293).

Figure 2-26. Gayfeather in Bloom in Fall. (photo by M. Quigg)

Another tuber with potential as a food resource is the buffalo gourd (*Cucurbita foetidissima*, Figure 2-27). The roots had many uses, the fruits were used in a variety ways, and the seeds were also edible. Roots of other plants such as wavy leaved thistle (*Cirsium undulatum*), common sunflower (*Helianthus annuus*), and silver leaved nightshade (*Solanum eleagnifolium*) potentially served in one way or another.

Figure 2-27. Buffalo Gourd Tuber (*Cucurbita* sp.) in Test Unit Profile Measured at Least 40 by 20 cm.

2.2.1.3 Beans

Honey mesquite (*Prosopis glandulosa*, a C_3 legume) is abundant through the region and occurs in west Amarillo Creek valley (Philips 2000). These thorny trees produce a long, narrow bean that was extensively used as a major food source in prehistoric times (Figure 2-28). The pods usually occur in late summer, but can persist throughout fall depending on rainfall. Cabeza de Vaca (1961:100) provided a detailed description of the use of mesquite when he camped on the upper Colorado River north of Big Springs, Texas in the early Sixteenth Century. In prehistoric times, the hard bean pods were processed by pounding in a mortar (wood being superior to stone for this purpose) during which the seeds were often separated from the pod meal and immediately discarded. The seed is edible if ground into meal, but it is very hard and is encased in a woody, inedible endocarp (Dering 2008). The whole pod was ground, or the seeds could be parched by shaking them together in a basket full of live coals. The ground seeds could have been stored as flour, or in the whole or partially ground dry pods (Bell and Castetter 1937:23-24. In terms of plant composition, mesquite contains high fructans (not inulin) with roughly 11 percent sucrose and fructose, no starch, and 22 percent hemicellulose by dry weight (Wandsnider 1997; taken from Yanovsky and Kingsbury 1938). Catclaw Mimosa (*Mimosa biuncifera*, a C_3 legume) is perennial shrub typically 1 to 4 m tall that occurs in West Amarillo Creek valley (Philips 2000). The stems, branches and leaves contain prickles or thorns which are slightly bent downwards. The flowers are in heads (puffballs) about 1 cm wide, with several pink stamens extending outwards. The fruits are small, flattened bean pods, hairy, and arranged in clusters. Individual one seeded sections of the pod break out at maturity, leaving the upper and lower margins intact like a frame. The seeds are gray-brown, about 6 mm long and 3 mm wide. The pods are known to have been used by prehistoric populations by drying and grinding into meal (Kirk 1970).

Figure 2-28. Mesquite Tree with Seed Pods Still on Tree. (photo by M. Quigg)

2.2.1.4 Other Resources

Another potential food source in this creek valley is the Chickasaw plum (*Prunus angustifolia*) (Figure 2-29). This shrub grows in clusters/thickets and yields a small, sweet fruit/drupe. Dense stands of plum are currently growing along the creek margins; one stand is next to 41PT186. The fruit ripens in June and July, and is elliptic or round with a large seed. The skin is thin, and the pulp soft and sweet (Medsger 1974).

Figure 2-29. A Single Small Wild Plum Tree Without Fruit. (photo by M. Quigg)

Specific cactus plants were not recorded in the valley, but many species are known to exist is the Canadian River breaks region. Sikes and Smith (1975) list cholla (*Opuntia imbricate*), tasajillo (*Opuntia leptocaulis*), pricklypear (*Opuntia* sp.), and yucca (*Yucca* sp.), in the region just to the west of West Amarillo Creek in Oldham County along the southern margin of the Canadian River. Pricklypear cacti produce red pear shaped fruits (tunas) 2 to 4 cm long that are fleshy, juicy, and full of seeds. These fruits generally ripen over a period of weeks and are red in late summer and may be eaten fresh or cooked. Philips (2000) recorded Soapweed Yucca (*Yucca angustifolia*), which is quite common. Much of this plant provides fibers and food for human use. The relative large fruit can be baked, the seeds eaten roasted (Kirk 1970), and the roots made into soap.

These above mentioned plants, and many others in the region, provide a wide range of potential food and medicinal resources that might have been procured and used by the early inhabitants. However, these organic resources are not well preserved in many archeological sites, especially open air sites. Better preservation of plant remains is in rock shelters. Plant parts are not often detected at the macroscopic level, either as charred beans or seeds in flotation analysis. This fact does not mean these plants were not used by groups in this region or even the people who occupied these sites. Charring is generally by accident; therefore most plants used become invisible in the archeological record at most sites. In the three flotation samples processed during the testing phase, none of the recovered plant materials were charred to indicate cultural use of plants (Gish 2000). This probably indicates the poor preservation or limited frequency of utilized plant materials in the sampled settings. In many cases, microscopic remains (i.e., phytoliths, lipids, and starch grains) may be preserved in the some form or another. The detection and identification of these tiny particles requires specific technical analysis of the cultural items and/or sediments collected form activities areas (see Chapter 3.0 Methods section).

2.2.2 Faunal Communities

The BLM Landis Property and the entire Texas Panhandle are within the Kansan Biotic Province (Blair 1950). This province reflects the transitional position between the more western Navahonian Province and the Texan Province to the east. Unlike Dice (1943) before him, Blair (1950) places the Permian red plains within the Kansan

Province. There is considerable overlap of fauna between these provinces. The Kansan is subdivided into three biotic districts based on the dominant vegetation and includes the Mixed-grass Plains to the east, the Mesquite Plains to the southeast, and the Shortgrass Plains district across the Llano Estacado and high plains. This project area lies within the Shortgrass Plains district.

In general, the mammalian fauna of the Kansan Province in Texas includes minimally 59 species, of which five are restricted to this province. The five restricted species include the Swift fox (*Vulpes velox*), a specific pocket gopher (*Geomys lutescens*), Plains pocket mouse (*Perognathus flavescens*), Texas Kangaroo rat (*Dipodomys elator*), and the Palo Duro mouse (*Peromyscus comanche*). The characteristic mammals include mink (*Mustela nigripes*), spotted skunk (*Spilogale interrupta*), stripped skunk (*Mephitis mepbitis*), badger (*Taxidea tanus*), coyote (*Canis latrans*), blacktailed prairie dog (*Cynomys ludovicianus*), yellow-faced pocket gopher (*Cratogeomys leucogaster*), jackrabbit (*Lepus californicus*), cottontail rabbit (*Sylvilgus andubonii*) and several species of mice (*Peromyscus* sp.) and rats (*neotoma* sp.). One land turtle is present in the western or Ornate box turtle (*Terrapene ornate*). Fourteen species of lizards are known also. Thirty one species of snakes and 14 species of frogs and toads are found in this province (Blair 1950).

However, the Canadian River and its tributaries cut east to west through the high plains region, creating a microenvironment that may not be typical of the broader Kansan Biotic Province. The broad Canadian River valley also creates a corridor allowing mammals to easily move from one region or province to another. In the nearby Canadian Breaks natural area on the south side of the Canadian River, just northwest of Amarillo in Oldham County, Scudday and Scudday (1975) conducted a ten day study in June of 1973. The species diversity was limited and they listed only four species of amphibians, and nine mammalian fauna. Davis (1960) includes opossum (*Didelphis marsupialis*) and Swift fox in Oldham County that were not observed by Scudday and Scudday (1975).

In the past, bison was an important resource for prehistoric peoples and was a prominent food source for the Plains Indians (Figure 2-30). The following is a general discussion that focuses on bison characteristics, as a background for understanding this very significant resource. A host of major

Figure 2-30. Young Bison Shedding Their Winter Coats. (photo by M. Quigg)

references, but not an exhaustive list, concerning early observations on bison (buffalo) behavior is cited, from which much of the information presented below has been drawn; Catlin (1851), Allen (1876), Haines (1970), Hornaday (1971), McHugh (1958, 1972), Dary (1974), and Roe (1972). Modern observations on bison handling and processing (Frison 1978a), calving patterns (Haugen 1974; Shaw and Carter (1989), bison size (Halloran 1961) bison ecology (Halloran 1968; Penden et al. 1974; Speth 1983;), carcass composition (Brink and Dawe 1989; Emerson 1990), classification and evolution (Wilson 1978; McDonald 1981); analytical techniques (i.e., Leechman 1951; Frison 1970, 1973, 1974; Frison and Reher 1970; Wheat 1972, 1979; Reher 1970, 1973, 1974; Bedford 1974; von den Driesch1976; Grayson 1978, 1979, 1984; Wilson 1974, 1978, 1980; Binford 1978, 1981 1984a; Reher and Frison 1980; Speth 1983; Lyman 1982, 1984, 1985, 1992; Klein and Cruz-Uribe 1984; Todd 1986, 1987a, 1987b; Todd and Rapson 1988; Morlan 1991). For a comprehensive review of historical records and early ethnographic accounts of communal buffalo hunting in the Northern Plains, the reader is referred to Verbicky-Todd (1984). Bamforth (1987) provides historical documents concerning bison ecology for the Great Plains.

Bison were quite abundant as the Europeans entered the plains beginning around 400 years ago (A.D. 1542), but the exact numbers are unknown. Estimates on the number of bison around A.D. 1830 range from 20 to 40 million (Roe 1972). In addition to their number, bison are the largest land mammals in North America during the Holocene. Adult bulls weigh as much as 815 kg (1,795 lbs). Adult cows are considerable smaller, weighing as much as 490 kg (1,075 lbs; Halloran 1968). Bulls continue to rapidly gain weight into about their eighth year, whereas cows generally stop gaining weight between 2 and 3 years of age (Halloran 1961). Beyond the age of three, cows and bulls should be distinguishable by weight and bone size. In addition to mass weight, male bison have proportionately larger humps and thicker necks than female bison (Speth 1983:87-88) citing Lott 1974:383). Speths's (1983) metric data on male and female bison bone elements documents a size sexual dimorphism and provides useful comparative information for archeological assemblages. Emerson (1990:76) using measurements on modern bison from Theodore Roosevelt National Park in western North Dakota, showing that some sexual dimorphism is evident in certain attributes as early as 1.5 years of age. The buffalo ranged across a broad array of habitats that exhibit a considerable variation in climate (Roe 1972:69). Despite climatic and topographic variations in habitats, the buffalo species is remarkably uniform.

Bison behavior is briefly discussed here, but McHugh (1958) provides great detail and discussions concerning behavior. Bison have excellent hearing and an acute sense of smell, but poor eyesight. They rely most on the acute sense of smell for detecting danger. They are also very curious and investigate new and strange objects, even investigating other killed animals. Herds can sustain speeds of 48 kilometers per hour (km/hr, 30 mi./hr) when chased and can increase speeds going downhill. They have the ability to cross up the face of a steep ridge, climb rocky hills, and go up steep places where they can barely stand (Roe 1972:149). Most observers thought they were stupid animals because they did not run at the noise or smoke of a rifle, falling and struggling animals did not convey a danger signal, they sometimes walk directly into quicksand, they would charge ahead regardless of the obstacles, and they often wandered away from good grazing conditions (Roe 1972:125). Wallowing was one of the most prominent summer activities of the buffalo. Water or rivers were not obstacles, because buffalo are swimmers and can cross rivers such as the mighty Missouri, the Mississippi, and the Yellowstone. Bamforth (1987) states that there are only three reasons that bison move around: to search for food and water, to search for other members of their species, and to escape dangerous or uncomfortable circumstances.

Bison are herd animals and generally move as groups. Norland (1984:46-47) and Marlow et al. (1984:23 cited in Fawcett, 1987), studying modern bison in Theodore Roosevelt National Park, indicate bison move in random directions about 2 to 3 km per day. They move independently of the location of water resources because they drink water only briefly every few days. No one animal is the sole leader; however, one animal can initiate herd movement in a particular direction, especially if distracted. Cows were generally the leaders (Hornaday 1971). Hornaday observed a single line of some 100 to 200 animals that stretched nearly 0.8 km. Buffalo were known to have made great pathways across the countryside. Some observers have remarked that they have hereditary paths and highways, worn deep on the landscape and making for the surest passes over mountains and best fords across rivers (Roe 1972:120). They appeared to choose the easiest routes and most direct course. Feeding and loafing behavior were the principle daily activities, which generally include minimally one trip to water. This contradicts the statement above, that bison “drink water only briefly every few days”. However, the early literature provides considerable discrepancy in the drinking habitats. Hornaday (1971) and others thought the buffalo had camel like capacity for enduring long periods without water (Roe 1972:106).

Haines (1970) reports that white buffalo hunters made observations and documented herd sizes. In the A.D. 1870’s one Frank Mayer recorded that a group of more than 60 animals was most unusual and he never saw a herd of over 200 animals. Groups of 15 were the most common. Cows with calves and an occasional 2 to 3 year old bull often formed one or several subgroups with about 25 animals per group within larger groups. Bull groups, often separated from the cow groups, contain mature males (greater than 4 years of age) in small groups as many as 12 animals. The cow calf and bull groups coalesced to form large groups during the rut. As an example, in July of A.D. 1853 in northern North Dakota, a particular herd was estimated at 200,000 (Haines 1970). In A.D. 1541, Coronado during his trek from east of the Pecos River in northern New Mexico into the Texas Panhandle, and then north to the Great Bend of the Arkansas River that lasted three months, stated that not a single day went by that he did not see buffalo, and that they were too many to count (Haines 1970). In general, one can expect a pattern of winter dispersal and summer aggregation (Bamforth 1987).

The life cycle of bison provides a context for interpreting the prehistoric remains. Bison calving and rut are two very important periods in the life cycle. Some variation in the time is noted in these events, generally from north to south across the Plains. In the south, documented behaviors among herds in the Wichita Mountains Wildlife Refuge in southwestern Oklahoma are applicable for the Amarillo region (Halloran 1961, 1968). Calves are born in early spring; however Haugen (1974) indicates a bimodal period of birthing. At the Wichita Mountains Wildlife Refuge the earliest recorded claves are born between March 10 and April 7 after an estimated gestation period of about 270 days (Halloran 1968 citing Mosby 1960); the peak calving period is around April 15. Roe (1972) and others use a 285 day gestation period, but it may last as much as 295 days. This places the initiation of effective breeding around June 5 (Halloran 1968) with peak breeding around July 15. Bulls are generally not effective sires as yearlings, but most become so at two years and all are productive sires by three years of age (Halloran 1968). Bison fetus growth is relatively slow over the first half of the gestation period with rapid growth during the last 40 percent of the period (Robbins and Robbins 1979). Most cows give birth to a single calf and twinning is extremely rare (Halloran 1968). Most cows (73 percent) have their first calves at three years of age, but some breed as yearlings and some (12 percent) give birth at two years of age (Halloran 1968:23; Shaw and Carter 1989). Calves weigh from 13 to 32 kg (30 to 70 lbs.) at birth and are known to nurse into their second year. Newborns normally stand within a few minutes after birth and can walk within 20 minutes. In terms of herd composition, calves constitute about 66 percent of a typical herd. In broad terms bison live as many as 17 years (Halloran 1968).

Bison are recognized as general grass consumers (opportunists) with intake of the dominant vegetation of the range. That is, bison consume vegetation in proportion to the abundance of grasses and other vegetation, while selecting for open expanses of prairie. Bison have greater digestive capabilities than many other ungulate species, which allow them to be less selective in their foraging preferences (Emerson 1990:101). The plains vegetation is composed of mosaics of mostly different types of warm (C_4) and cool season (C_3) grasses depending on slope and moisture conditions. Great diversity exists in the grassland communities throughout the plains. As an example, in the Pawnee National Grasslands of northeastern Colorado the warm season grasses constitute nearly 70 percent of the grass community, whereas cool season grasses constitute 3 to 5 percent of the grasses (Schwartz and Ellis 1981). In the Pawnee National Grasslands bison showed a greater preference for warm season grasses, specifically grama and buffalo, except in May when new spring growth of cool season grasses had commenced (Penden 1976). Penden (1976) observed that when the shortgrass prairie was heavily grazed the blue grama grass increased. An exception to the consumption of grass was found in the Arizona region where bison consume mostly salt brush (*Atriplex* sp.) a C_3 species, with minor amounts of grama grass (Martin et al. 1951). In the Wichita Mountains Wildlife Refuge in southwestern Oklahoma, bison consume mostly grama (*Bouteloua* sp.) a C_4 species and dropseed (*Sporobolis* sp.) grasses, also C_4 species (Martin et al. 1951). Detected dietary patterns of bison display seasonality that relate to the seasonal growth patterns of C_3 and C_4 photosynthetic systems, and dietary and growth patterns vary across time and space (Penden 1976; Tieszen et al. 1998). The C_3 species are dominant in early spring and early summer, whereas the C_4 species under go maximum growth in mid to late summer.

Bison bones were recovered during the 2007 Phase I data recovery of the Landis Property investigations (Quigg et al. 2008). Stable carbon and nitrogen isotope analyses on 20 selected bison bones that represent four specific time periods over the last 2,500 years provide information as to what individual bison consumed (Quigg et al. 2008). The results also provide proxy data as to the indication of what the regional grassland communities were like, proportional contributions of warm and cool season grasses, and significant changes that occurred to those grasslands communities over that period of time. In general, the carbon isotope values on analyzed bison bone from West Amarillo Creek valley range from -8.1 to -15.6‰, with the latter value as an outlier. If the latter is an outlier, the range minus this outlier, is much more restricted to 2.6‰ or from -8.1 to -10.7‰, with an overall average of -9.2‰. These new values are very similar to the range (-8.0 to -11.6‰) and mean (-9.5‰) obtained by Huebner (1991) on six bison bones dated to less than 750 B.P. for the Texas Panhandle region. These carbon isotope values are also very similar to the average -

9.0‰ for bison bones from the Garnsey site in eastern New Mexico dated to roughly 370 B.P. (Speth 1983). These values also indicate that bison consumed nearly all C_4 grasses (roughly 85 percent) throughout this time period. The four time periods investigated yielded carbon isotope values that indicate less than 1‰ differences in their averages. Consequently, this limited change in average carbon isotope value over time indicates very limited change in the bison grazing/consumption pattern occurred during the last 2,500 years. By proxy, the carbon isotope results also support very limited change in the regional grassland community during the last 2,500 years.

The nitrogen values obtained from the same bison bone samples from the Landis Property range from -7.6 to 6.9‰. The -7.6‰ value appears to be an anomaly and is currently rejected. Thus, the overall range is from 3.2 to 6.9‰ with an overall mean of 4.85‰. The difference between the four time periods is 1.24‰ with a slight change detected at the ca. 1200 to 1500 B.P. period, when the nitrogen values increased to an average of 5.84‰ and then deceased to 4.6‰ during the 500 to 800 year old period (Quigg et al. 2008).

Catlin (1851) stated that, in winter, buffalo paw through the snow to access the grasses below, and one observer witnessed buffalo using their noses like pigs to plough (root) snow. The distribution and quality of forage in a region are major determinants of migration. Consequently, bison aggregations tend to occur during seasons when forage productivity is highest (Bamforth 1987).

The nutritional status of bison is also assumed to vary largely depending upon the grassland conditions and the seasonal variation in those conditions. Speth (1983, 1991) postulates that by the end of the winter cows were undergoing a stressful period because they carried fetuses to term and the grass conditions were at their worst. He postulates that males were slightly better off because they lacked the stress of the pregnant cows. Hafez (1969:35), cited in Emerson (1990:94-95) notes that nutritionally the fetus is privileged, because it continues to grow despite some degree of maternal malnutrition. When an animal suffers from malnourishment, fat reserves stored in various parts of the body are mobilized. Male bison were in their best overall condition in late spring or early summer and at their poorest conditions during and immediately following the rut in late summer. Bulls have the toughest meat during rut (Wilson 1924:230). Wilson (1924:221 and 234) also notes the selection of male bison for their hides. Females were in their poorest condition during the calving season and in their best condition in the fall and early winter (Ewers 1958:76; Roe 1972:860-861; Wissler 1910:41). During spring these animals shed their winter coats, and Roe (1972:116) indicates they go through a "hairless condition" during early summer.

Bison were an excellent source of meat and supplied other nutritional parts and other products for human consumption. A buffalo will dress out about the same as modern cows, with a trimmed carcass nearly 50 percent of the live weight, on average about 363 kg (800 lbs.) per bull and 180 kg (400 lbs.) per cow (Haines 1970). However, the native populations consumed more than the just the meat. In addition to quantities of meat protein, their bones supply fatty acids, marrow, and various other nutrients (Table 2-2). Other buffalo parts considered delicacies by the Plains Indians include the fetus, tongue, nose, heart, liver, and hump. Their bones were also used for tools and the hides were used for clothing and shelters (Wissler 1910; Ewers 1955). Nearly every part of the bison was used in some way. In general terms, compilation of data from investigated prehistoric sites in Colorado and Texas provide a broad understanding of when bison were present in eastern Colorado (Butler 1992, 1997) and across Texas

(Dillehay 1974). Dillehay's (1974) Bison Presence period I included the Paleoindian period from ca. 12,000 to 7500 B.P. Paleoindian sites in eastern Colorado support this concept (Butler 1992). Following this was Dillehay's absence period from ca. 7500 to 4550 B.P. This included a major drying period across much of the Plains, the Altithermal, which some assume facilitated a general expansion of the grassland regions. Few sites in eastern Colorado have been investigated, so there is a lack of sites/data that would document their presence.

Table 2-2. Percentage of Fatty Acids, Dry Bone weight, Mean fat Weight, and Mean Weight of Marrow in Bison.

Elements	End	Mean % Fatty Acids 1	Mean Dry Bone Wt. (g)2	Mean Fat Wt. (g)2	Mean Wt. of Marrow (g)3
Front Leg =					**46%**
Humerus	proximal	40.5	809	324	
	distal	22	365	77	118
Radius/Ulna	proximal	33.5	353	116	
	distal	25.7	270	71	79
Metacarpal	proximal	8.9	84	7	
	distal	15.2	172	26	20
Hind Leg =					**54%**
Femur	proximal	31.4	352	111	
	distal	35.2	739	256	111
Tibia	proximal	33.5	376	129	
	distal	14.1	129	18	124
Metatarsal	proximal	12.4	73	9	
	distal	22.7	160	36	22

1. Brink and Dawe (1989:91), mean of three Northern Plains bison.
2. Brink (1995), mean of three Northern Plains bison.
3. Brink (personal communication 1996), mean of Brink (1995) and Emerson (1990) data.

However, this may be a function of poor preservation more than anything else. Beginning at ca. 4500 to 1450 B.P. is Dillehay's Bison Presence period II. The data from Colorado substantiates that bison were present throughout much of this period and that includes sites dated to the Middle and Late Archaic periods, and the Plains Woodland period (Butler 1992, 1997). It must be said that there are recorded sites during all these periods that also lack bison remains. Roughly 1450 to 750 B.P. was another period in Texas that Dillehay determined lacked bison. Since Dillehay's work, data from northern Texas, western Oklahoma, and eastern Colorado documents bison were present for most of this period. Four of the six Woodland components (ca. 1650 to 950 B.P.) investigated across Oklahoma yielded evidence of bison and this use pattern increases in the following Late Prehistoric period (S. Baugh 1986). The increased database since Dillehay's work has revealed that bison were present during his absence period. Dillehay's Bison Presence period III includes a period from ca. 750 to 400 B.P. Butler's (1992, 1997) data from eastern Colorado definitely supports the Texas and Oklahoma data that bison were present across most of the region. Prehistoric sites across all regions continue to yield bison remains right up to and into historic times. The Protohistoric component at the Corral site, 41PT186, dated to ca. 250 to 300 B.P. testifies to bison presence through that period.

The current information documents bison presence across the Southern Plains on a regular basis for minimally the last ca. 4,550 years and probably sporadically during Dillehay's absence period from ca. 7500 to 4550 B.P. as reflected by bison remains at Lubbock Lake during the middle Holocene/Middle Archaic (Johnson 1987). This means that the prehistoric populations in the region generally had access to this significant resource on a regular basis up until their near extinction around A.D. 1880 in the panhandle. However, it is not clear what the density of bison was or if all regions had equivalent distributions of bison, year round or seasonally.

2.3 CLIMATE

2.3.1 Modern Climate

The general region is classified as having a continental (steppe) semiarid to subhumid climate. Mean annual precipitation is 48 to 50 cm (19 to 20 in.) with a wide variation from year to year (Figure 2-31). Nearly 80 percent of the annual precipitation occurs between the beginning of March and the end of August (Larkin and Bomar 1983). Rain occurs most frequently as thunderstorms, which occur primarily in May and June. The three driest months are December, January, and February (Bomar 1983).

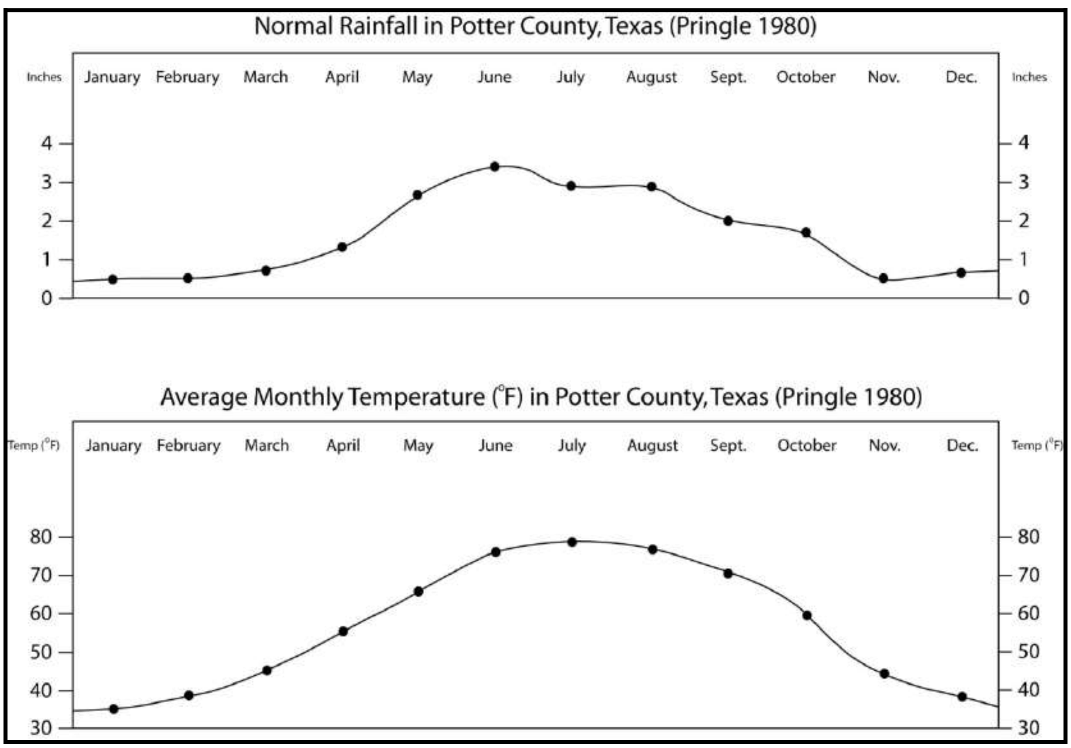


Figure 2-31. Monthly Average Rainfall and Temperature for Potter County, Texas.

The mean annual temperature in the Canadian River valley is 12º to 14ºC (54º to 58ºF), however temperatures are extremely variable with coldest every recorded at -26.7ºC (-16ºF) and the hottest at 42.2ºC (108ºF) (Bomar 1983). The average maximum temperature during the summer months is over 32ºC (90ºF). Amarillo only averages about five days a year with temperatures over 37.8ºC (100ºF) (Bomar 1983). During the winter months the average minimum temperature is below freezing from November to March. The mean date of the first frost is November 1, with the last frost on April 15 (Arbingast et al. 1973). The growing season averages 198 days (Pringle 1980). In winter, frequent surges of polar and artic air masses bring strong northerly winds and rapid drops in temperature (Pringle 1980). These cold spells are generally short, less then 48 hours. Generally winter is a dry season, with only light snowfall. Spring time is more variable with frequent changes in temperatures throughout March and April. These are also the windiest months. Wind speeds average about 22 km/hr (13.7 mi./hr) and prevail from the southwest from October through April and southerly from May through September (Pringle 1980). These winds often produce dust storms.

The climate is controlled by the air masses that move through the region. Continental tropical air masses from the southwest are hot and dry. Maritime tropical air masses from the Gulf of Mexico are commonly warm and moist. The continental polar air is typically cold and dry. Maritime polar air from the Pacific Northwest is also typically cold, but milder than the polar air (Larkin and Bomar 1983). These major climatic elements are driven by annual warming and cooling of oceans and continental and mountainous land masses.

2.3.2 Paleoenvironment and Indications of Paleoclimate Across the Southern Plains

2.3.2.1 Conditions After 3000 B.P.

The following discussion focuses on the specific time periods represented by the cultural deposits targeted during this data recovery in the BLM Landis Property. The cultural remains targeted primarily represent narrow points in time during the last 3,000 years. Detailed climatic and environmental studies have not been conducted across the Southern High Plains and especially in the Texas Panhandle. These investigations have also employed diverse means of extracting data to interpret the past environments and connecting to the climate. Research at Lubbock Lake, a large multicomponent camp site representing thousands of years was adjacent to a freshwater marsh in a narrow valley cutting into the Southern High Plains, some 190 km south of the Landis Property. This site has provided a wealth of diverse environmental data for that specific location, which may also be applicable to the broader Southern Plains region (Johnston 1987). It should be noted that the pollen record from Lubbock Lake remains in controversy and will not be addressed here. Suffice to say only three of the eight palynologists obtained sufficient pollen to interpret the record.

Holliday (1995) has done extensive research on stratigraphy and paleoenvironments of late Quaternary valley fills south of the Landis Property across the Llano Estacado incorporating primarily the headwaters of the Brazos and Colorado river systems south of the Canadian River valley. Holliday (2001) has also studied the stratigraphy and geochronology of the Quaternary eolian sand on the Southern High Plains of Texas and eastern New Mexico. North of the Canadian River valley Frederick (1993) has conducted stratigraphic and some paleoenvironmental investigations at one specific location some 175 km north of Amarillo at the northern edge of the Texas Panhandle along a small creek in Hansford County that drains into the North Canadian River. These few documents scattered over diverse areas across the region provide much of the following information, with more specific data coming from other studies across the broader region.

The local targeted archeological record in the Landis Property begins with the Late Archaic cultural period starting at ca. 3000 to 2800 B.P. and moving forward during the late Holocene period. The entire Late Archaic period (roughly estimated from 4500 to 1500 B.P.) is considered to have a more or less a modern climate with minor fluctuations of moisture and local variations. This is roughly equivalent to a climate period some have referred to as the Sub-Atlantic episode (ca. 2500 to 1700 B.P.) and is thought to have been somewhat moister than the preceding period (Hoffmann and Jones 1970; Wendland 1978). Across much of the Southern High Plains there is good geomorphologic data that indicate the region was largely stable from the end of the middle Holocene (ca. 4500 B.P.) to about 2000 B.P. (Holliday 2001). However, macrofossil records in the mountains of Colorado indicate a climatic deterioration from 4500 to 3100 B.P. followed by a rapid amelioration from 3000 to 2000 B.P. (Elias 1993). In eastern Colorado, pollen data from a sand dune in El Paso County at 5EP935 indicates the climate was dry between 2200 and 1800 B.P. (Wynn et al. 1993). This interpretation is based on higher Cheno-am frequencies relative to sagebrush (*Artemisia* sp.) and grasses (Gramineae).

At Lubbock Lake, the end of the Middle Archaic cultural period at roughly 4500 B.P. saw the available surface water decrease, with the resulting fauna, including modern bison, reflecting an open prairie. Eolian sedimentation indicative of periodic dry conditions and, probably, reduced vegetation cover across the uplands reflect a general decrease in moisture (Johnson 1987:95). Also, at Lubbock Lake a marsh existed in the valley axis of Yellow House Draw for most of the time after 4500 B.P., implying a return to moister conditions and stabilized upland vegetation. This stability probably involved denser vegetation across broad areas of the uplands. In turn, this implies more effective precipitation after ca. 4500 B.P. The sediments deposited at Lubbock Lake during this period are nearly 3 m thick (Stratum 4) and are characterized as sandy eolian. These deposits yielded bulrush (*Scirpus* sp.) and water-lily (*Nymphaea* sp.) seeds (Thompson 1987). A well developed soil, the Lubbock Lake Soil, formed in the top of this deposit and pedogenesis continued until around 1000 B.P. This soil is expressed by a well developed A horizon as much as a meter in thickness. The B horizon is moderately developed with good structure. The C horizon is variable. Pedogenic accumulations of secondary calcium carbonate are common in the Lubbock Lake Soil (Holliday and Allen 1987). The marsh continued to exist as the soil was forming, and periodically expanded/flooded across this stable surface. Limited direct data is available concerning the broad upland or open prairie. Bison were present during the Late Archaic period as reflected in several bison kill sites along the eastern escarpment of the Llano Estacado (D. Hughes 1977, 1989).

In the broader region from the Thurmond Ranch in Roger Mills County in far western Oklahoma, beginning and ending dates (N = 12) on many paleosols have established what Thurmond and Wyckoff (1999, 2008) refer to as a wet period, the Finch Canyon pluvial, that dates from ca. 2100 to 1900 B.P. (50 B.C. to A.D. 100). These authors indicate that this was the first of six identified pluvial events (wet periods) during the last two millennia, marked by 400 year regional rainfall cycles driven by a coeval cyclicity in solar output. If nothing else, their work indicates periods of change that reflect short stable periods (i.e., paleosols) alternating with periods of instability. Similar periods of landscape stability and soil formation have been detected in southwestern Kansas (Arbogast 1995 cited in Mandel 2006), but at slightly different times, such as roughly 2300 B.P.

2.3.2.2 Conditions Between 2000 and 1000 B.P.

The Early Ceramic cultural period (ca. 2000 to 1000 B.P.) at Lubbock Lake, saw a continuation of the spring fed stream and wet meadow marshland complex in the Yellow House Draw valley axis. At Lubbock Lake this period included bison, prairie dog, and thirteen lined ground squirrel (Johnson 1987:96). Some droughts in this period are revealed by substantial amounts of dune sand or sheet sand deposits after ca. 1500 B.P. (Holliday 2001). Minimally four different depositional events appear in the stratigraphic record farther south of Amarillo after ca. 2000 B.P. (Holliday 2001). Woodhouse and Overpeck (1998) identify two major droughts in the central United States between ca. 1200 and 1600 B.P. based primarily on dendrochronological records, however the records were not from northwest Texas. Holliday (2001) documented several eolian sand dune fields and sand sheets over the southern part of the Llano Estacado and into southeastern New Mexico. The most northern dune field, Muleshoe Dunes, is a long linear west to east belt of sand down valley of the Portales Valley, south of Clovis, New Mexico and along the upper reaches of Blackwater Draw or the headwaters of the Brazos River. He determined from buried soils and radiocarbon dates that the Muleshoe Dunes accumulated in several stages, probably in response to cyclical drought. The accumulations occurred primarily after ca. 1300 B.P., after ca. 750 B.P. and during the last 200 years. These extensive late Holocene deposits are typically 2 to 5 m thick (Holliday 2001). They also document cyclic patterns of deposition, erosion, and stability.

Higher in the Colorado Mountains, fossil insect data from Longs Peak Inn Bog indicates a climatic cooling ca. 1800 B.P. (Elias 1993). In eastern Colorado Wynn et al. (1993) also characterized the climate as somewhat mesic, but fluctuating between 1800 and 1400 B.P. based on pollen data from a dune. In southwestern Kansas, dune development was interrupted by an episode of stability and soil formation at 1500 B.P. and again around 1100 to 1000 B.P. (Arbogast 1995; Olson and Porter 2002 both cited in Mandel 2006).

In the northern reaches of the Texas Panhandle, an alluvial deposit radiocarbon dated to ca. 1700 B.P. along Palo Duro Creek yielded a phytolith assemblage that contained roughly 74 percent C_4 grass phytoliths (saddle shaped, indicating C_4 Chloridoid grasses) and indicates the sampled terrace was dominated by shortgrass vegetation (Quigg 1997, 1998; Jones 1997). Carbon isotope values from multiple bison mandibles from this same ca. 1700 B.P. event indicate that the bison were consuming a C_4 dominated grass assemblage.

Environmental data from western Oklahoma provide support for a broad regional climatic condition. There, Hall and Lintz (1984) use radiocarbon dated buried trees, buried soils, and pedogenic carbonate accumulations to show that the water table rose in elevation, indicating moister conditions between ca. 2000 and 1000 B.P. Also, in southwestern Oklahoma, the Caddo Paleosol, renamed the Copan Soil by S. Hall (1990a), is widespread and has been dated to between 1900 B.P. and 960 B.P. (Ferring 1982, 1986). This thick cumulic, organic rich, floodplain soil developed over nearly 1,000 years and it exists over a wide area of western Oklahoma, parts of the Texas Panhandle, and central Texas. This is likely the same cumulic deposit observed at Lubbock Lake in Stratum 4. Investigations at the Thurmond Ranch in Roger Mills County in far western Oklahoma and just south of the Canadian River have established the occurrence of a wet period (reflected by soil development), based on the dating paleosols. This period was named the Herring Creek pluvial. The beginning and ending dates (*N* = 32) of most paleosols indicate a period of stability from ca. 1550 to 1300 B.P. (A.D. 400 to 650) (Thurmond and Wyckoff 1999, 2008), corresponding closely with the soil formation detected in southwestern Kansas by Arbogast (1995) and Olson and Porter (2002) at ca. 1500 B.P. This period of stability is thought to be the second of six identified pluvial intervals during the last two millennia. These authors see these paleosols as the results of regional rainfall cycles driven by cyclicity in solar output. Further east, in the Cross Timbers of Oklahoma, pollen evidence indicates an increase in hickory (*Carya texana*) relative to oak (*Quercus* sp.) during this ca. 1,000 year period (S. Hall 1982, 1990a).

The currently available data indicate wide spread environmental conditions that are undoubtedly climate driven. Minimally one drought appears widespread across the region at ca. 1650 B.P (Woodhouse and Overpeck 1998). This drought falls into the time range of the Scandic episode (ca. 1700 to 1300 B.P.) defined by Bryson et al. (1970). The Scandic episode was postulate as warmer and perhaps dryer than today. However, these earlier interpretations are contradicted by more recent interpretations of data that reflect moist valley conditions like those documented at Lubbock Lake, Dempsey Divide, eastern Colorado, and here in West Amarillo Creek. As Kay (1998a:28) previously pointed out, the earlier interpretations are questionable in light of more precise dating and sophisticated analyses now in use.

South of our project area, near Plainview, Texas, some evidence exists for eolian deposits in Running Water Draw between ca. 2000 and 1000 B.P. (Holliday 1995:91). From minimally two archeological contexts south of the Canadian River the prairie vole (*Microtus ochrogaster*) existed during this period (Willey and Hughes 1978a; Schultz and Rawn 1978). This small grassland rodent is an indicator of moister conditions relative to today, in accord with other data sets from this region. The presence of the prairie vole 282 km west of its current range may be evidence of an isolate population or a slight climate change (Schultz and Rawn 1978).

2.3.2.3 Conditions Between 1000 and 500 B.P.

The cycle of wet and dry patterns continued through the Middle Ceramic period (ca. 1000 to 500 B.P.) and into historic times (i.e., Stratum 5 at Lubbock Lake, Dempsey Divide). Hoffmann and Jones (1970) view the Neo-Atlantic episode, ca. 1260 to 850 B.P. as having warm and moist conditions. More recent data from individual projects appears to contradict this earlier model. Further south on the Llano Estacado in Martin County, Frederick (1998) detected an apparent accelerated upland dune formation ca. 1000 B.P.

These wet and dry intervals probably did not significantly altered the regional faunal communities, but vegetation communities potentially were affected. The valley marsh deposit at Lubbock Lake yielded bulrush, devil’s claw (*Proboscidea* sp.), netleaf hackberry (*Celtus reticulata*), and prickly poppy (*Argemone* sp.) seeds (Thompson 1987). Carbon isotope evidence indicates a period of aridity for this short 500 year interval. During this episodic period, minimally two thin soils, the Apache and Singer Soils, formed along the valley margins at Lubbock Lake. The Apache Soil, weakly developed with a moderate B horizon formed during ca. 450 to 300 B.P. apparently coeval with the Delaware Canyon pluvial event. The Singer Soil, very weakly developed with a minimal B horizon, began forming ca. 100 B.P. (Holliday and Allen 1987). The local Lubbock Lake environs saw a mesquite savanna surrounding the marsh. The faunal remains at Lubbock Lake indicate a persistence of short grass plains, with forbs and other herbaceous plants (Johnson 1987:96). These conditions continued into the historic period without substantial changes. The open prairies across the uplands are postulated to have remained a shortgrass environment throughout the period in question, with the available moisture reflecting minor changes in the prairie grassland composition. Holliday and Allen (1987) state that, generally, the data from Lubbock Lake and the surrounding regions are representative of the entire region. The data from western Oklahoma indicates drying after ca. 1000 B.P. (Hall and Lintz 1984; S. Hall 1990a).

The extensive dating (*N* = 20 samples) of paleosols in the Dempsey Divide region of western Oklahoma have also documented the Higgins Creek pluvial (Thurmond and Wyckoff 1999, 2008) from ca. 1175 to 950 B.P. (A.D. 775 to 1000). This is followed closely in time by the postulated Brokenleg Canyon pluvial with beginning dates ca. 800 B.P. (A.D. 1150), and terminating at ca. 650 B.P. (A.D. 1300). The documentation of these multiple pluvial events (periods of soil development) supports the cyclic pattern in the regional climate of the Southern Plains. However, pollen data from 5EP935 in eastern Colorado have been interpreted as indicating a much drier episode after ca. 1400 B.P. (Wynn et al. 1993).

S. Hall (1990a) documented a major channel incision at ca. 1000 B.P. throughout the southern Great Plains, which is also apparent in valleys along the eastern margin of the Llano Estacado (Abbott 1990). Abbott (1990) speculates that this potentially caused more arid conditions. Boren Shelter No. 2 (41GR559) deposits at Lake Allen Henry, southeast of our project area, revealed a significant shift in depositional regimes ca. 900 to 700 B.P., which led Kibler (1998) to believe this was caused by a shift to more xeric conditions. This postulated xeric period would fall between the proposed Higgins Creek pluvial and the Brokenleg pluvial identified by Thurmond and Wyckoff (2008). A probable explanation for the different interpretations of the various data sets is that the climate was likely fluctuating or cycling and the different investigative strategies are generally identifying one of the changes, but not both the wet and dry episodes.

Carbon isotope data on sediments from across the Southern High Plains south of the project area indicate that the period from ca. 5000 to 500 B.P. reflects continued xeric vegetation in the uplands (i.e., dominance of C_4 plants; Holliday 1995:58). Over the last ca. 500 years there is a slight indication of increased C_3 plants in the region. The geomorphic data also demonstrates regionally synchronous episodes of alluviation and erosion during the late Holocene across the Southern Great Plains region.

Weakly (1965, cited in Woodhouse and Overpeck 1998) reported a 38 year long drought from ca. 675 to 637 B.P. (A.D. 1276 to 1313) in southwestern Nebraska based on treering chronology. This appeared to be a very widespread drought that included much of the Southern Plains, the Great Basin, and into California (Woodhouse and Overpeck 1998). This is the same drought that, in the Southwest, is associated with the abandonment of Anasazi settlements. Currently, it is difficult to determine if this drought directly impacted the northern Texas Panhandle.

2.3.2.4 After 500 B.P.

The data accumulated by Woodhouse and Overpeck (1998) demonstrate another widespread drought, based on treering data, at roughly 375 B.P. The last proposed pluvial event in western Oklahoma, referred to as the Delaware Canyon pluvial, is documented to have occurred from ca. 500 B.P. (A.D. 1450) to 300 B.P. (A.D. 1650) (Thurmond and Wyckoff 1999, 2008). This youngest proposed wet period may be linked to the Arapaho Peak glacial advance of the Little Ice Age that occurred slightly later in the Colorado Rockies. The period from ca. 500 to 100 B.P. (A.D. 1450 to 1850) is known as the “Little Ice Age” which had significantly greater precipitation and lower temperatures than modern conditions, minimally across the Rocky Mountains. The Longs Peak Inn Bog site yielded fossil insect assemblages that indicate climatic cooling between ca. 250 and 300 B.P. (A.D. 1700 to 1850; Elias 1993). However, Bamforth (1990) presents data to indicate that those climate conditions did not support increased precipitation throughout the entire Little Ice Age. Bamforth (1990 citing Landsberg 1980) suggests that there were no clear hemispheric temperature trends between ca. 371 and 70 B.P. (A.D. 1579 and 1880). Bamforth stresses that climate reconstruction for any specific region must be derived from data from within the region. It is clear that climate changes did occur, but the specifics of those changes are not yet well established. He goes on to point out that cultural changes which potentially occurred during that period cannot be explained as adaptations to increases in the carrying capacity of the Plains grasslands.

2.3.2.5 Discussion of Paleoclimatic Conditions

In summary, the current data indicate minimally four periods of widespread drought in or across the Southern Plains over the last ca. 2,000 years (Woodhouse and Overpeck 1998), which were intermixed with minimally seven periods of landscape stability indicated by soil development (Mandel 2006; Thurmond and Wyckoff 2008). The drought episodes potentially accompanied or were followed by periods of eolian activity. Consequently, sedimentation and soil development probably resulted from periods of increased and decreased available moisture and vegetation cover in sediment source areas. The timing of these events is generally defined on the basis of radiocarbon dates and tree ring data. However, it will be necessary to determine if these paleoenvironmental conditions existed in any given locality that is subject to investigation. It is also apparent that multiple lines of proxy evidence provide the greatest potential for interpreting the highly variable and often confusing records.

In going forward with regional environmental studies and paleoclimatic reconstructions, Holliday (1995:93) made two important and directive comments. First, he stated that “recovery of suitable pollen and insect samples has proven frustrating and disappointing”. That is not to say in some special circumstances pollen is not preserved. One such case was at Recon John Shelter in southeastern Colorado where 37 plant taxa were identified for a ca. 1,000 year period between ca. 2000 and 1000 B.P. (Zier and Kalasz 1991). Another case is the pollen obtained from the sand dune at 5EP935, also in eastern Colorado (Wynn et al. 1993). Second, Holliday (1995:93) stated that “phytolith and stable carbon isotope analyses, however, hold considerable promise as methods widely applicable for obtaining clues to regional paleoenvironments”. An example of preserved phytoliths is demonstrated in the ca. 6,800 year old record from Morgan Playa along the western margin of the Rolling Plains southeast of our project area (Fredlund et al. 1998). Phytoliths, and in some rare depositional environments, pollen, are preserved in West Amarillo Creek valley as demonstrated by TRCs Phase I investigations (Quigg et al. 2008; Bozarth 2008).

Past environmental investigations have revealed considerable disagreement on the specific timing and the record itself (Bousman and Brown 1998). Some of this inconsistency in the data and timing is presented above. A partial explanation for the disagreements is the nature of the diverse data sets combined with poor stratigraphic data and different or limited chronological control. More radiocarbon dates and better consistency in materials dated are certainly major factors that would help establish the more precise age of events, as demonstrated in the 95 radiocarbon dates obtained from the paleosols in Dempsey Divide (Thurmond and Wyckoff 2008). Caran (1998) reminds us that most reconstructions are quite complex and based on second, third, and higher order extrapolations from the database. He points out that correct interpretations of the regional paleoclimate requires recognition and differentiation of contrasting signals.

Not often addressed in the literature is the actual temperature change during identified warm or cool periods. Recently, Nordt et al. (2007) projected temperature differences from modern July temperatures based on the behavior of the stable carbon isotopic composition of buried soils across the plains. During the time of interest for this project, roughly the last ca. 2,600 years, they project a couple of periods of broad changes in the temperatures. Following a cool trend before ca. 2600 B.P. they postulate a warm interval from ca. 2600 to 1000 B.P. during which temperatures increased roughly +0.5ºC over modern July temperatures. Beginning by ca. 500 B.P. and continuing to the present was another cooler than average period compared to modern July temperatures. These projected temperature changes are very general and encompass a very broad region. These data may not provide the kind of precision that significantly contributes to our understanding of the local temperatures in West Amarillo Creek, but they do provide a broad indication of regional changes.

One important aspect to consider is the relationship between paleoenvironmental conditions and what effect those conditions had on the past plant and animal populations. As an example of the changes in the small mammal populations, the two year drought of A.D. 1933 and 1934 in western Kansas caused a threefold increase in the number of blacktailed jackrabbits (Wooster 1935). It also revealed a marked increase in the number of deer mice. In contrast, meadow mice decreased significantly. Thus, an understanding of the structure of the grasslands is important as well as the responses of those grasslands to the droughts and stable periods. Currently, and undoubtedly in the past, the plains experienced distinct wet and dry seasonal patterns. The amount of water strongly influences the above ground net primary production of grasslands (Sala et al. 1988). Sala et al. determined that when precipitation is less than 37 cm per year, sandy soils with low water holding capacity are more productive than loamy soils with high water holding capacity, where as the opposite occurs when precipitation is greater than 37 cm per year.

3.0 CULTURAL HISTORICAL BACKGROUND AND REGIONAL PREHISTORY

J. Michael Quigg

3.1 INTRODUCTION

This section presents an overview of the general historical sequence of cultural developments in the Southern High Plains, specifically, in the Texas Panhandle. Archeological investigations have been carried out in the Texas Panhandle for 100 years; however, most work was conducted long ago and focused on archeological sites that date greater than 7,000 years old or less than 1,000 years old. Many gaps exist in our knowledge of the region, including the basic cultural sequence for the Archaic period. Consequently, information from the surrounding archeological complexes/phases has been extrapolated to temporarily fill in existing gaps. Extrapolating archeological information from areas outside is not without its pitfalls. Such information should be considered and used with extreme caution because new data may radically change our perceptions of these cultures.

In comparison to many regions, the Texas Panhandle has received relatively limited systematic excavations and detailed reporting. The following summary emphasizes identified complexes and/or phases of the last 3,000 years that correspond to the general time periods specifically targeted during the Phase II data recovery efforts at the BLM Landis Property. Brief discussions characterize each of those complexes or phases.

Following Willey and Phillips (1958), the use of the term phase represents a cultural unit within a relatively limited period of time and space, and whose material expressions are sufficiently distinctive to indicate they represent a single society or group. In contrast, the term "complex" refers to a cultural manifestation that occupies a defined time and geographic area, but whose material composition is too poorly known to be formally defined as a formal phase. In some cases, a period is subdivided into subperiods when cultural changes temporally coincide, but the overall basic nature of the material culture assemblage is not marked by substantial technological change. In this section, the ages of the phases/complexes are reported as years before present (B.P., in the radiocarbon sense, as before A.D. 1950). Much of the following information is extracted from previous comprehensive summaries and/or detailed studies such as those of Baugh 1986; Hofman et al. 1989; J. Hughes 1991; Boyd 1995, 1997, 2004; Kay 1998b; Wood 1998; Zier and Kalasz 1999; Johnson and Holliday 1995, 2004, and Brooks 2004. Site specific information is derived from individual site reports.

The cultural chronology for the Southern Plains region is divided into five major periods; the Paleoindian (ca. 11,500+ to 8500 B.P.), Archaic (ca. 8500 to 2000 B.P.), Late Prehistoric or early and middle ceramic (ca. 2000 to 400 B.P.), Protohistoric or late ceramic (ca. 400 to 200 B.P.), and the Historic (ca. 200 B.P. to the present). The temporal boundaries for these periods do not necessarily indicate abrupt cultural changes, but merely provide general temporal guidelines for changes recognized in the archeological assemblages. Below a brief overview of major prehistoric periods is presented followed by more detail into the time periods pertinent to the Landis Property sites.

The Paleoindian period was a transition from the Late Pleistocene into the Holocene (ca. 12,000 to 7500 B.P.). Although recently, earlier occupations extending back 18,000 B.P. or earlier have been postulated for North and South America, none of the pertinent sites has yielded diagnostic tool forms that allow unequivocal identification of specific cultural patterns. The earliest recognizable culture of the Paleoindian period is Clovis. Populations of the Clovis culture hunted now extinct mammals (i.e., mammoth and mastodon), and were followed by Folsom peoples who hunted extinct species of bison between 11,000 and 10,000 B.P. (Bement et al. 2006). This detected hunting shift was probably linked to a habitat adjustment during the Younger Dryas, a relatively cold, dry interval (Bement et al. 2006). Hunting of large mammals was accomplished with the use of large dart points (i.e., Clovis, Folsom). Somewhat later Paleoindian point types include Plainview, Agate Basin, and Scottsbluff. All of these types are basically lanceolate in form and were hafted onto spears or onto darts that were propelled with atlatls, or spear throwers.

The Archaic period (ca. 8500 to 2000 B.P.) began during the early Holocene, continued through the middle Holocene (ca. 7500 to 4500 B.P.), and extended into late Holocene times (ca. 2000 B.P.). The cultures flourishing during this long period are characterized by groups that used notched and stemmed dart points (presumably propelled by the atlatl or spear/dart throwers) to hunt a wide variety of large and small modern game animals. The subsistence base was broadened to include greater emphasis on collecting and processing diverse plant resources. Peoples of the middle Holocene experienced warmer and drier climate conditions during the climatic interval known as the Hypsithermal episode in the eastern United States and the Altithermal in the western United States.

Cultural complexes of the Southern High Plains are undefined or poorly defined cultures (Kay 1998b) until sometime between 4000 to 2000 B.P. One of the few named complexes, the Little Sunday Complex is currently thought to be a late cultural complex for the general Archaic period in the Southern High Plains region of the Texas Panhandle.

The Late Prehistoric period is primarily marked by two significant technological changes: the appearances of the bow and arrow and ceramics. These technologies were not introduced simultaneously or by a single group. The entry of Europeans into the vast plains region, by means of various explorations, marked the beginning of the Protohistoric period. As material culture of the Europeans started to dominate Native American archeological assemblages, the Historic period began, only a relatively short time prior to white settlement of the region.

3.2 Archaic Period (ca. 8500 to 2000/1500 B.P.)

The environment during the six millennia of the Archaic was generally characterized by gradually warming and drying conditions (often referred to as the Altithermal or Hypsithermal) and more marked seasonality (Johnson and Holliday 1995, 2004). The temporal boundaries of climatic changes are not precise due to variations in the environmental proxies representing climate change. For the same reasons, the duration and intensity of the drying is also not clear. Undoubtedly, climatic variations extended across regions. Some evidence from central Texas and southeastern Colorado indicates that during this long, gradual drying interval two punctuated periods of intense droughts occurred within the Altithermal at ca. 6300 to 5500 B.P. and ca. 5000 and 4500 B.P. Between these two intensive drought periods a brief, but noticeable mesic interval occurred between ca. 5500 and 5000 B.P. that potentially lasted for less than a millennium (Johnson and Holliday 1986, 1995, 2004). The general dry conditions are estimated to have lasted until around 4000 B.P. This hypothesis is supported by alluvial geologic studies on the Southern High Plains, which indicate a long drying trend in the Southern High Plains of Texas from ca. 13,000 to 4000 B.P. (Stafford 1981) and an apparent absence of bison populations from the High Plains during the Early and Middle Archaic (ca. 8000 to 4500

B.P.), judging by an absence of bison bones from investigated sites in Texas (Dillehay 1974).

The Archaic is characterized by the appearance of diverse notched and stemmed dart points that replaced the earlier Paleoindian lanceolate forms. Other attributes typically include the use of stone for boiling along with other hot rock cooking technologies, chipped stone gouges, and an abundance of ground stone tools for processing wild plant seeds. It is assumed that the Archaic period is marked by greater regional adaptive specialization that included exploitation of local plant and animal resources. The Southern Plains also shows a greater regional diversity in projectile point forms.

Very little is known about Archaic sites in the Texas Panhandle and in the adjacent areas of the Plains due to the general lack of excavated sites dating earlier than 2000 B.P. (J. Hughes 1991; Blakeslee and Hughes 1997; Kay 1998b). The tripartite subdivision of the Archaic into Early, Middle, and Late subperiods that is often recognized outside the Southern High Plains has not been validated in the Texas Panhandle. In some cases, deposits dating to the Early and Middle Archaic intervals have been removed from local depositional sequences by severe erosion.

Intact and unmixed Archaic deposits have been exceedingly difficult to find in the Texas Panhandle and adjacent regions (Blakeslee and Hughes 1997). Even when these early deposits have been identified and investigated, as at Lubbock Lake, they have yielded only limited archeological remains (Johnson 1987; Johnson and Holliday 1986, 1995, 2004). In other instances, the excavated deposits that have yielded pre-3000 B.P. Archaic assemblages, such as at Chalk Hollow, have not been well reported (Wedel 1975; Lintz 2002). Various amateur collections contain large dart point forms with deep, basally notched and/or split stems that represent Middle Archaic period (cf. Ballenger 1999; White 1995; Rhoton 1995), but these are from mixed surface assemblages. The lack of intact buried sites and geological studies has caused some researchers to wonder if erosional conditions have destroyed deposits containing Early Archaic sites. As demonstrated by the Phase I mitigation investigations in West Amarillo Creek, the alluvial deposits dating from roughly 8200 to 4300 B.P. were absent from the upper section of the valley (Frederick 2008). Consequently, no Early Archaic sites were identified in the alluvial record of the upper section of the West Amarillo creek valley.

The best information concerning the Archaic period comes from alluvial deposits in the stream and river valleys on, or along the margins of, the Llano Estacado. Some of the earliest available Archaic dates are from the southern end of the Llano Estacado. One series of radiocarbon dates comes from several prehistoric water well sites in the floor of various draws near the southern margins of the Llano (Meltzer 1991; Meltzer and Collins 1987). The occurrence of hand dug prehistoric water wells at the Wingert Well site ($N = 3$), Mustang Springs ($N = 63$), Marks Beach ($N = 1$), Blackwater Draw ($N = 17$), and Rattlesnake Draw ($N = 1$), dating between 4000 and 7000 B.P. indicates that Early Archaic peoples were present in the Southern High Plains region (Quigg et al. 1994; Meltzer 1999; Figure 3-1). These water wells indicate that surface water was periodically scarce or nonexistent in the region. Human presence is also reflected in the recovery of a few Early Archaic style artifacts from surface collections. Importantly, no substantial excavations have been conducted on sites dating between 4500 and 7000 B.P. in the Canadian River valley.

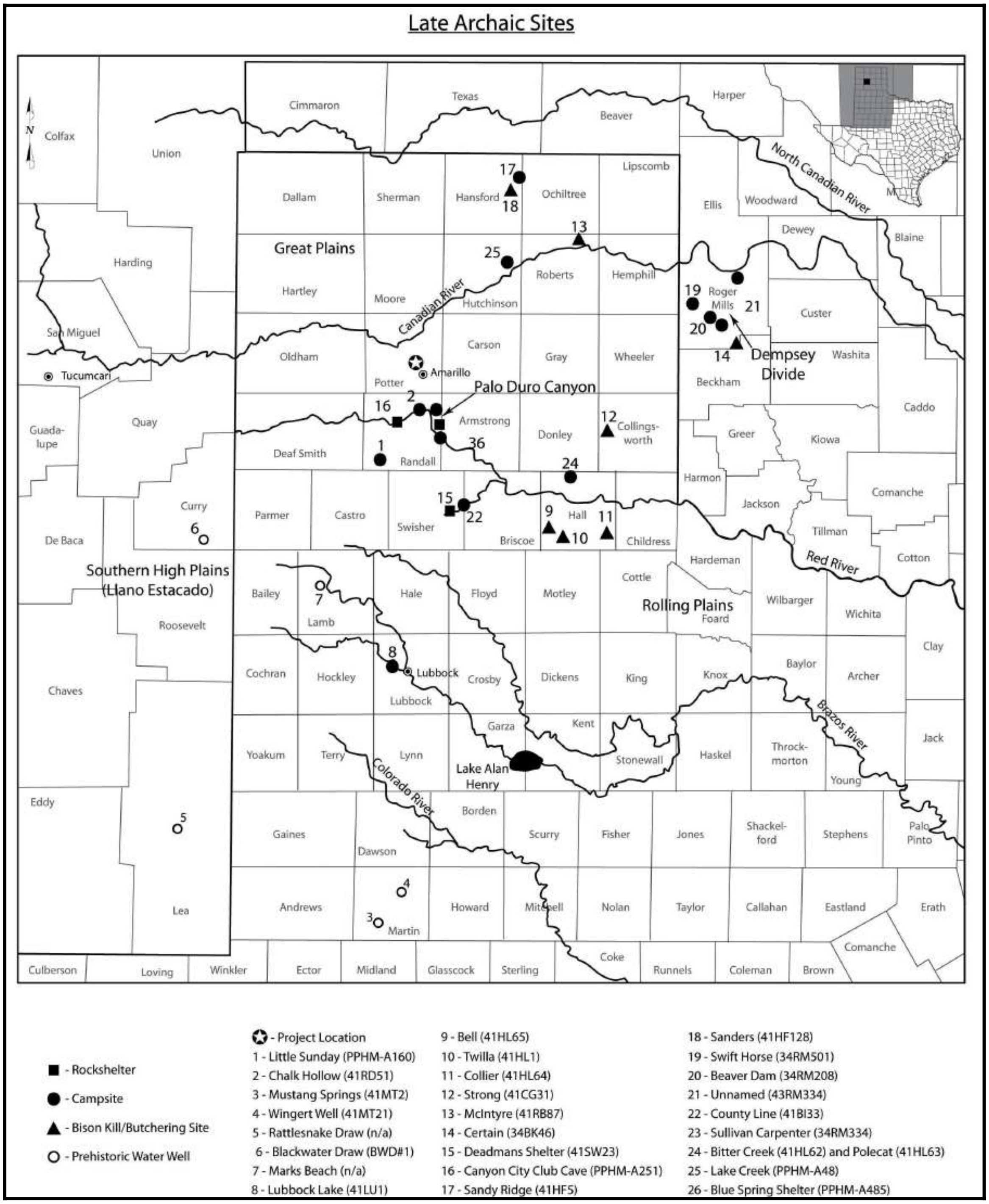


Figure 3-1. Location of Late Archaic Sites Mentioned in Text.

Chalk Hollow and Lubbock Lake are two excavated sites in the surrounding region that have yielded Archaic materials, and both merit further discussions. Chalk Hollow (41RD51) is just a few kilometers south of Amarillo along the headwaters of the Red River in Palo Duro Canyon (Figure 3-1). Excavations were sponsored by the

Smithsonian Institution in the early 1970s because the site is a 4.2 m deep stratified open campsite along a tributary to Palo Duro Canyon and yielded general stratigraphic and chronometric information associated with the Late Archaic and early ceramic period cultural assemblages (Wedel 1975; Lintz 2002). Twenty five radiocarbon assays on charcoal provide dates for at least two cultural occupations from a lower midden and one main occupation from the upper midden (Lintz 2002). The earliest Chalk Hollow radiocarbon date is 3395 ± 80 B.P. (SI-1293) on charcoal from around burned rocks. No detailed assemblage analysis has been completed on the Chalk Hollow materials. Based on the occurrence of arrow point styles and plain ceramic sherds, the upper midden zone appears to represent a relatively discrete Palo Duro complex assemblage dating to between ca. 975 and 1546 B.P. The lower midden zone contains multiple occupations represented by at least three clusters of radiocarbon dates and multiple dart point styles. This lower occupation appears to reflect mixed Late Archaic occupations that date from 2210 to 3820 B.P. The associated dart points from the lower midden zone include broad corner-notched points resembling the Marcos, Williams, Castroville, Ellis, and Palmillas types (Bell 1958, 1960; Turner and Hester 1999). These type names are adopted from regions further east in Oklahoma and central Texas. Until detailed analysis of the material assemblage and contextual information is conducted, data from Chalk Hollow should be used with caution.

Along the headwaters of the Brazos River system near the City of Lubbock is the well known Lubbock Lake site (Figure 3-1; Johnson 1987; Johnson and Holliday 1986, 1995, 2004). Although much has been recovered and published about this important site, occupations from the lengthy Archaic period are minimally represented. The Early Archaic period is represented by one feature (FA4-1) that consisted of a bison processing locale that lacked formal butchering tools. This locality is associated with substratum 2e and dates to between 8500 and 6400 B.P. The Middle Archaic period is represented at Lubbock Lake by six clusters of bone radiocarbon dated to between 6400 and 5000 B.P. in stratum 3. However, the bison and antelope bone clusters showed no evidence of human modifications and were not associated with formal tools. Stratum 4 dates to between 5000 and 1000 B.P. and contained some features assigned to the Middle and Late Archaic, and also to ceramic periods. No diagnostic projectile points were found in the Archaic deposits. One well defined rock covered baking oven (FA16-1) was excavated and radiocarbon dated to between 4700 and 4960 B.P. The lithic artifacts recovered from the Archaic deposits are minimal and consists mostly of a few small flakes with the occasional scraper and utilized flake. From various locations across this large, intensively investigated site, only three projectile points that represent three different forms were classified as Archaic (Johnson 1987; Johnson and Holliday 1986, 1995, 2004). The recovery of bison remains from Lubbock Lake indicates that Dillehay's (1974) model of bison absence between 8000 to 4500 B.P. is invalid for this part of the Southern High Plains. However, the relatively few individual bison represented indicates that the local bison population was potentially very limited.

Although not well dated, Late Archaic occupations are more numerous throughout the region. Two decades ago J. Hughes (1991) stated that "pitifully few of the Late Archaic components on the Southern High Plains have been radiocarbon dated". He places the terminal date of the Archaic about 1750 B.P. (A.D. 200) on the basis of dates associated with post-Archaic arrow points at Deadman's Shelter. Perhaps the most readily recognized kind of Late Archaic sites are bison kills. These are locations where many animals were apparently driven into narrow gullies, killed and processed (Figure

3-1; D. Hughes 1977, 1989). A few rock art carvings have also been attributed to the Late Archaic. Human remains have been sporadically reported with bodies generally buried in flexed positions, many in stone lined storage cist features, but rarely are mounds or quantities of burned rock found such as would reflect development of substantial rock ovens (J. Hughes 1991). Only a handful of Late Archaic sites have been intensively excavated and fully reported. The Late Archaic is mostly represented by surface sites with scattered lithic debris in diverse settings, and by the presence of large corner-notched dart points (Figure 3-2). Many Late Archaic sites in the region contain many different kinds of dart points, and over two dozen dart point types have been explicitly identified in Late Archaic contexts (J. Hughes 1991).

Figure 3-2. Late Archaic Dart Points from Twilla (41HL1; top two rows), Hoover (41HH12), Collier (41DY19), and Fritch (41DY19) Bison Kill Sites.

This diversity may indicate that many Late Archaic sites were either repeatedly occupied or reflect functionally specialized and morphologically distinct tools and implements used for hunting and butchering. The currently limited understanding of this period creates opportunities to make significant contributions when substantial Late Archaic components are investigated.

Most sites are attributed to the Late Archaic period based on the presence of a range of broad bladed, primarily corner-notched and barbed dart points (Figures 3-2) that resemble such central Texas types as Castroville, Palmillas, Ellis, Williams, and Marcos (see Turner and Hester 1999). Boyd (1997) reiterated that additional detailed studies are necessary to define specific types and determine the range of variations in these types. However, until larger point assemblages from single component sites are excavated, studied, and reported, resolution in our knowledge of Late Archaic use of the Southern Plains will remain poor.

Other Late Archaic artifacts include various forms of end and side scrapers, key shaped drills, bifacial knives, large chopping tools, spokeshaves, gravers, and denticulates (J. Hughes 1991). Grinding tools include sandstone metates, one handed manos, bedrock mortars, grooved sandstone awl sharpeners, and quartzite manos. Rare objects include painted pebbles, bone awls, as well as lunate stones, corner-tang knives, shell beads, shell pendants, and decorated bone gaming pieces (J. Hughes 1991). The basic stone tool manufacturing technology includes core reduction, tool production strategies, and resharpening techniques, all of which have received limited attention, with inadequate identification of tool forms (J. Hughes 1991).

Faunal remains from Late Archaic sites are dominated by bison bones, but a variety of other large and small game animals, birds, turtles, and mussels are represented in limited numbers (J. Hughes 1991). A few kill sites investigated in the Texas Panhandle reveal very limited numbers of bison, as reported by D. Hughes (1977), although much larger numbers are reported for these same kill sites by Fawcett (1987; see Table 3-1) who reanalyzed the bone assemblages. These arroyo trap kill sites received only minimal investigations from ca. 7 to 18.6 m^2 per site (D. Hughes 1977). The number of kill events represented at each locality is uncertain because most kill sites have been severely eroded. At least two kill events were present in the Twilla arroyo. Due to the limited extent of the site sample and the eroded nature of the arroyos, the numbers of animals identified at these kill sites may not accurately reflect the number of animals taken in a single kill event or how dense the bison populations were in the region (Table 3-1). The current data indicates that most kill events occurred in the fall. Possibly the hunting parties were acquiring surplus meat for use during the winter. These few kill sites show that bison was one of the primary resources exploited during the Late Archaic, at least during the fall in the Texas Panhandle. However, excavations of campsites will probably expand information on the Late Archaic subsistence base.

Across the eastern Plains of Colorado the ten Late Archaic sites Butler (1997) reviewed exhibited more deer than bison, although bison, antelope, and rabbits were all represented. Apparently, bison were less frequent or hunted less often in southeastern Colorado compared to northwestern Texas.

One of the first reports on a Late Archaic site in the Texas Panhandle was a location called Little Sunday (Figure 3-1). That site's name was also proposed for the Late Archaic type complex, Little Sunday complex, in the Texas Panhandle (J. Hughes 1955). Unfortunately, the artifact assemblage from this "type site" was not large or well defined, and the context is inadequately reported to assess whether the materials represented one or multiple occupations. Furthermore, no radiocarbon dates were obtained to chronometrically place the materials. For these reasons, the complex name is rarely regarded as a useful term. Boyd (1997) redefined the Little Sunday complex to refer to a series of selected sites concentrated in the Caprock Canyonlands of the eastern escarpment of the Llano Estacado in the Texas Panhandle that date from ca. 4000 to 1500 B.P. However, few new radiocarbon dates were available at the time Boyd (1997) redefined the complex.

Many sites have now been attributed to the generalized Late Archaic and/or the Little Sunday complex in the Texas Panhandle and adjacent areas (Figure 3-1; Boyd 1997). Most of our knowledge about the complex comes primarily through surface collections, limited or minor testing, and poorly reported sites. At least 10 bison kill/processing sites have been identified and include Bell, Twilla, Collier, Strong, (D. Hughes 1989; Lintz et al. 1991), McIntyre Kill (Wilkens 1997) in the Texas Panhandle and the Certain site in western Oklahoma (Bement and Buehler 1994; Buehler 1997). Table 3-1 provides a summary of information extracted from the various Texas bison kills sites. Twilla was the most extensively excavated locale with only 19 m^2, of bone bed exposed. This site provided the greatest variations in point types and also the greatest number of animals represented. Often the projectile points are the only attribute for assigning sites to the Late Archaic period. The projectile points however, show considerable variability in the hafting elements, with most assigned to the general broad, corner-notched style (Figures 3-2 and 3-3).

Unfortunately the assemblage samples from these kill sites are inadequate to reveal data on the procurement technology or the social complexity and lifeways of the people that conducted these bison kill activities. At least 25 campsites and rock shelters in Texas and Oklahoma are presently assigned to this complex by Boyd (1997). These include the lower midden at Chalk Hollow (Wedel 1975; Lintz 2002), lower deposits of Deadman's shelter (Willey and Hughes 1978a), lower deposits of Canyon City Club Cave (J. Hughes 1971), the Sandy Ridge site (Quigg et al. 1993), Sanders site (Quigg 1997), the Duncan Ranch site 1 (Gustafson 1994), and in western Oklahoma, lower deposits of Swift Horse (Briscoe 1989), the Beaver Dam site (34RM208) (Thurmond 1991b; Kraft 2005), and 34RM334 (Thurmond 1991a). The criteria for assignment of some campsites to the Late Archaic can be questioned. These are discussed below.

Both Boyd (1997) and J. Hughes (1991) attribute the lower component (stratum D) at Deadman's shelter to the Late Archaic period. But this stratum yielded both arrow points (N = 22) and dart points (N = 8), and contained 29 pottery sherds, but no bison bones. The mixture of pottery, arrow points and dart points indicates that stratum D may not be a discrete or intact Late Archaic component. However, two of the three radiocarbon dates on charcoal, uncorrected 1740 ± 40 B.P. (SI-1899) and uncorrected 1830 ± 60 B.P. (SI-1900) are in the appropriate time range for the Late Archaic period (Willey and Hughes 1978a). Even though Late Archaic dart points were recovered and dates were obtained, stratum D may not represent an unmixed Late Archaic assemblage that is useful for defining type assemblages or for building a reliable comparative foundation. The lower deposits (Level 5) of Canyon City Club Cave (J. Hughes 1971, 1991) have also been attributed to the Late Archaic (Boyd 1997). However, this lower deposit yielded only the occasional artifact, no formal tools or lithic debitage, some unburned bones, charcoal, and no cultural features. Level 5 was a relatively thin natural stratum in the central and back parts of the cave. Two of the three uncorrected radiocarbon dates on charcoal, 2830 ± 60 B.P. (WIS-430) and 2100 ± 60 B.P. (WIS-420) fall within the Late Archaic time frame.

Table 3-1. Data on Late Archaic Bison Kills Identified in the Texas Panhandle.

	41HL65, PPHM-A696	41HL64, PPHM-A373	41DY19, PPHM-A128	41HH12, PPHMP96	41DY20, PPHM-695	41DY18, PPHM-A127	41HL1, PPHM-A73	41CG31, PPHM-A694,	41RB87
	Bell	Collier	Finch	Hoover	R.O. Ranch	Sitter	Twilla	Strong	McIntyre Bison Kill
	Rolling Plains, Hall	Rolling Plains, Hall	Rolling Plains, Donley	Rolling Plains, Hemphill	Rolling Plains, Donley	Rolling Plains, Donley	Rolling Plains, Hall	Rolling Plains, Collingsworth	Southern High Plains, Roberts
	Arroyo head	Arroyo head	Arroyo margin	Arroyo margin	Arroyo head	Divide between two arroyos	Arroyo head	Arroyo head	In breaks on north side of Canadian River
	6.98	9.3	NA	NA	NA	was tested	18.6	4.65+	None, observations over time
	10 to 20 cm thick		15 m long	12 m long	3 to 6 m long	30 m long	6 m long, 15 to 30 cm thick	15 to 60	at least 6 m long
	1520 ± 110 [1726 ± 117]	1930 ± 110 [2136 ± 117]	NA	NA	NA	NA	1120 ± 100 [1326 ± 108]; 2335 ± 100; 2110 ± 85; 1550 ± 100	980 ± 100 [1186 ± 108]	1775 ± 115
	Darts, no type names, mostly corner-notched	untyped dart	2 dart point fragments, corner-notched	3 dart points,		2 corner-notched darts (Lang-like)	Darts, no type names, mostly corner-notched, 3 varieties	NA	1 Marcos
	Unknown,? Arroyo trap	Unknown,? Arroyo trap	Unknown,? Arroyo trap	NA	NA	? Arroyo trap	unknown,? Arroyo trap, 2 possible bone layers	Unknown,? Arroyo trap,	Arroyo trap, at least two layers
	limited, heavily weathered, 2 epiphysis charred, 4 vertebrae articulated	minimal, some cut marks, spiral fractures, some articulation	NA	NA	NA	NA	some cut marks on ribs, some spiral fractures, some articulation	minimal, 1 mandible with cut marks, some spiral fractures, vertebrae articulated	Mostly whole bones, some cut marks on ribs, articulated vertebrae and ribs,
	7 = 7 cows, 1 immature; Fawcett says 25	7 cows; Fawcett says 35	NA		NA	NA	23 = 19 cows, I bull, 3 immature; Fawcett says 50	10 = 7 cows, I immature bull, 1 fetus;	3+ based on size and fusion
	Unknown; Fawcett says Mar, Sept, Nov.	Fawcett says Aug-Sept	NA		NA	Fawcett shows Oct	Unknown; Fawcett says Oct	Unknown-fetus indicates winter; Fawcett says Oct	6 to 7 month old calf indicates fall = Oct-Nov
	3 points, 4 used flakes, 5 bifacial tools,4 choppers,	1 point,	NA	3 dart points,	2 cobble choppers	3 points, 4 used flakes, 2 scrapers	15 points, 2 chopper, 7 used flakes,	2 quartzite cobble tools, 4 used flakes,	None
	Hughes 1977, 1989; Fawcett 1987; Lintz et al. 1991	Hughes 1977, 1989; Fawcett 1987; Lintz et al. 1991	Hughes 1977, 1989;	Hughes 1977, 1989	Hughes 1977, 1989	Hughes 1977, 1989; Fawcett 1987	Tunnell and Hughes 1955; Hughes 1977, 1989; Fawcett 1987; Lintz et al. 1991	Hughes 1977, 1989, Fawcett 1987; Lintz et al. 1991	Wilkens 1997

1 = date on bone collagen
2 = adjusted age/dates within brackets are estimates for bone collagen dates for which no δ13C values were obtained

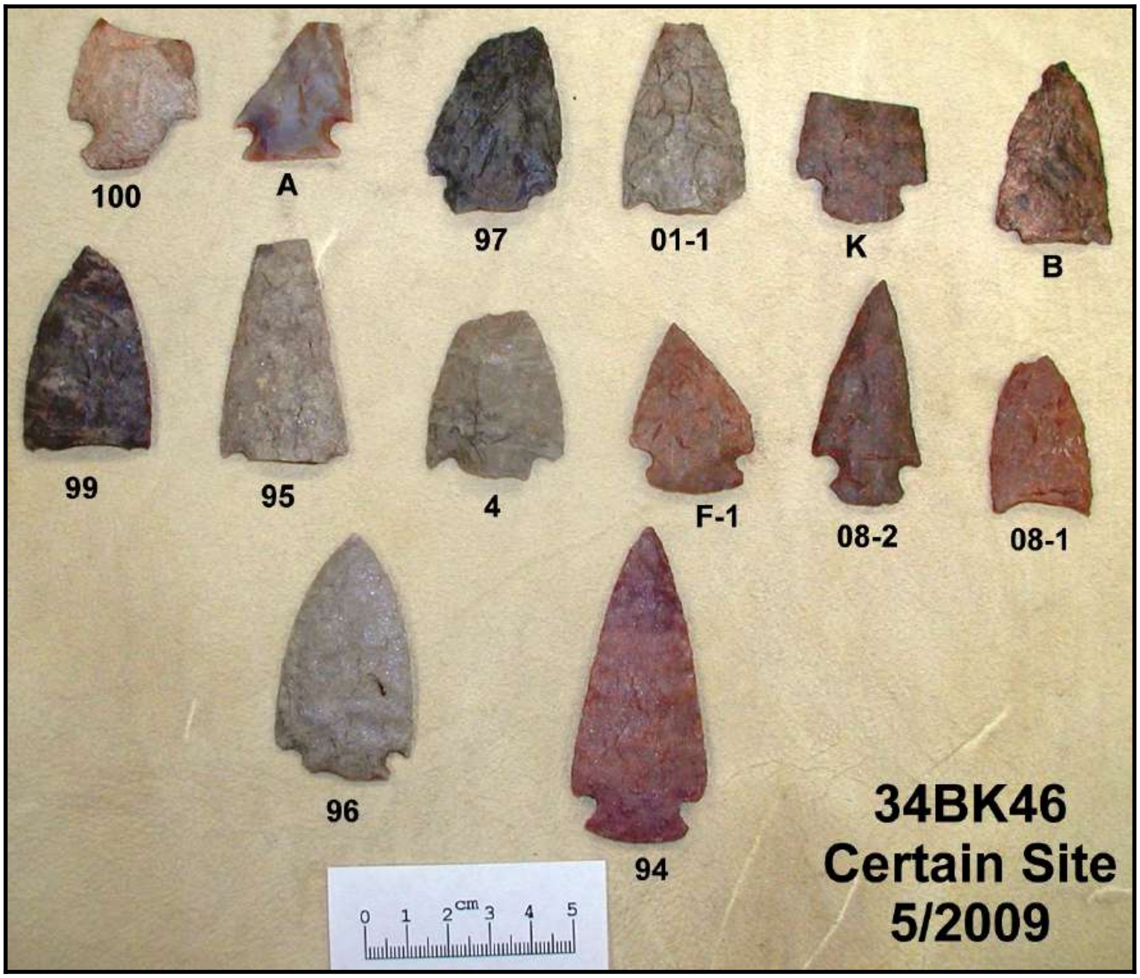


Figure 3-3. The Suite of Projectile Points Recovered from the Certain Site in Oklahoma. (photo courtesy of Dr. Lee Bement)

Mixed cave deposits are indicated by the vertically dispersed pottery sherds and at least two of the 11 radiocarbon dates from stratigraphic sequence. The few dart points recovered from the Cave came from Level 4 mixed with arrow points (J. Hughes 1971, 1991). Within this relatively thin deposit in Level 4 was minor rock fall and limited sand and sparse artifacts. Even Level 4 with its mixed arrow and dart points, resembles a Woodland complex more than a Late Archaic complex (J. Hughes 1971). Although the occasional Late Archaic dart point is present and Late Archaic dates were obtained from Canyon City Club Cave, a Late Archaic component is not readily apparent or well defined.

The Duncan Ranch site 1 was investigated through limited excavations that consisted of three widely spaced units (1 by 1 m squares) dug to depths of about 60 cmbs, seven shovel-test probes (20 cm in diameter) and possibly four trenches (1 by 0.5 m) (Gustafson 1994). The investigations lacked a professional geoarcheologist and details concerning the stratigraphy are limited. Diagnostic artifacts include 43 ceramic sherds from the surface, one Deadman's arrow point from level 2, one small basal-notched arrow point from level 4, one large corner-notched questionable dart point from Trench B, and one large corner-notched dart point from level 2 in Trench Y. A single radiocarbon date of 1000 ± 60 B.P. (Beta-71961) was obtained from 50 to 60 cmbs in

Trench I Unit X (Gustafson 1994). Although Gustafson argues that Duncan I represents a transitional occupation between the Archaic and Late Prehistoric periods, no analysis addressed the number of components present in the 60 cm thick deposits. The claim for a Late Archaic period component at Duncan Ranch I is questionable because the mere presence of a couple of dart points does not constitute an occupation. Indeed, one of the corner-notched points illustrated appears to be an arrow point rather than a dart point based on size and stem criteria.

The Sanders site (41HF128) in Hansford County at the extreme northern most end of the Texas Panhandle yielded one of the best dated Late Archaic assemblages reported in the Southern High Plains. The 115 m^2 mitigation area exposed a deeply buried, well defined Late Archaic component that yielded 25,000 pieces of cultural material from an intact, single camp event. This occupation dates to ca. 1863 B.P. based on three $\delta^{13}C$ adjusted charcoal radiocarbon dates (1880 ± 40 B.P. (Beta-91493), 1860 ± 80 B.P. (Beta-95636), and 1690 ± 70 B.P. (Beta-93287) and two $\delta^{13}C$ adjusted bison bone collagen dates (2115 ± 85 B.P (GX-16504-G) and 1770 ± 90 B.P (GX-16606-G; Quigg 1997, 1998). The lithic material assemblage included a very high percentage (76 percent) of nonlocal Alibates that was used to manufacture 119 stone tools that fall into six morphologically distinct artifact categories. They include 13 large, corner-notched dart points (Figure 3-4), end and side scrapers, bifaces, and edge-modified tools. Surprisingly, a single ceramic cordmarked sherd was also recovered from this Late Archaic component, indicating either the addition of a new cooking technology or the acquisition of a trade vessel. The sherd was manufactured from local clays with quartz sand and calcined bone temper additives. The subsistence base was focused on a bison cow calf herd, from a communal kill event in late March just before the calving season in April/May, judging by the presence of fetal bison remains. The bison bone was intensively processed for bone marrow and grease as it was highly fragmented. Bone tools include awls, punches, deer antler billets, and ulna choppers together with incised and painted bone gaming pieces. The horizontal patterning of the remains indicated that the excavated area represented the discard/disposal dump from cleaning/maintaining an adjacent living area. The living area was not identified and perhaps was closer to the creek in an area presently eroded away. Some 20 cultural features represented a diverse array of ash and burned bone dumps, multiple lithic debitage concentrations, bone discard piles, burned rock discard piles, and four dense refuse areas that contained multiple classes of cultural debris (Quigg 1997, 1998).

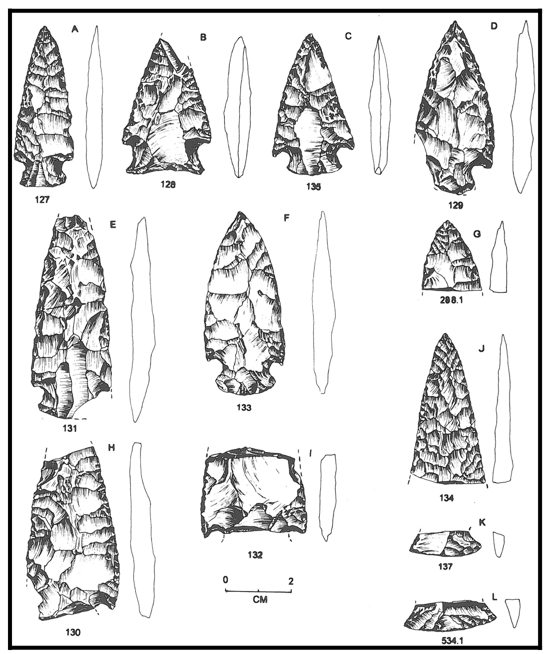


Figure 3-4. Late Archaic Corner-Notched Projectile Points from the Sanders Site (Quigg 1997).

In Roger Mills County in western Oklahoma, the Beaver Dam site (Figure 3-1; 34RM208) is the most intensively investigated Late Archaic site in western Oklahoma. It is a stratified site with multiple components from Late Archaic through Woodland times in 10 to 12 m thick alluvial deposits adjacent a spring (Kraft 2005). The Late Archaic component in Area A is within a paleosol with two charcoal radiocarbon dates of 1910 ± 50 B.P. (Beta 116185) and 1870 ± 50 B.P. (Beta-116182). The excavated area measured 2 by 24 m and exposed a sloping occupation zone. Three or four features (Features 1, 21, and 22 and possibly a fourth, Feature 10) are attributed to the Late Archaic. Feature 21 was a "kitchen area" whereas Features 1, 10 and 22 were fire hearths with associated cultural debris that included charcoal, milling stones, fire cracked rock, a core, flakes, a scraper made from a Plainview point base, corner-notched dart points of which one is of Alibates, a bone bead, a mussel shell scraper, a bone awl, and unidentified small animal bones together with deer and bison bones.

Charcoal samples form Feature 10 yielded one date of 1514 ± 80 B.P. (NZA-1388) and a second date of 1620 ± 50 B.P. (Beta-116181); these are of questionable association. A seven liter float sample from the center of Feature 10 yielded charred C*henopodium/Amaranthus* and purslane (*Portulaca*) seeds, barnyard grass (*Echinochloas*), bulrush (*Scripus* sp.), marshelder (*Iva* sp.), mustard (Cruciferae), and spikerush (*Eleocharis*) seeds, an acorn (*Quercus* sp.) and an unidentified nut shell fragment (Kraft 2005). Wood charcoal from this feature was identified as elm (*Ulmus americana*), hackberry (*Celtis* sp.), cottonwood (*Populus* sp.) and oak (*Quercus* sp.; Kraft 2005).

Also from the Beaver Dam site was a partial Late Archaic burial eroding from the creek bank at 75 cmbs. The four *in situ* human elements (tibia, humerus, and two scapulae) represent an adult male of middle age, projected to be 191 to 197 cm (ca. 6.3 to 6.5 ft.) tall and a robust individual (Thurmond 1991b; Kraft 2005). Associated artifacts include a rare lunate stone or atlatl weight with 21 notches along one edge, two complete bifaces below the *in situ* bones, and a corner-notched dart point (Marcos type) with a convex base (Figure 3-5). The latter was manufactured from silicified wood. One biface was manufactured from a medium gray Ogallala quartzite (Potter chert) and the other from silicified wood (Thurmond 1991b). This Late Archaic component and associated artifacts make a significant contribution to our knowledge of this cultural manifestation.

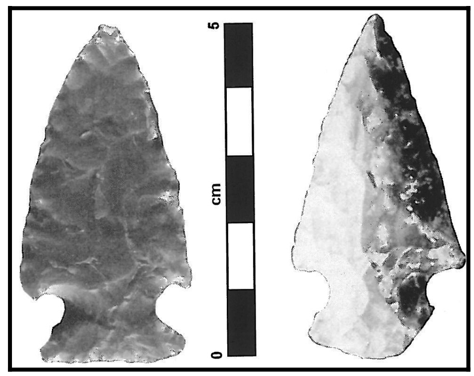


Figure 3-5. Two Late Archaic Corner-Notched Projectile Points from the Beaver Dam Site (34RM208).
(photo on right by Pete Thurmond in Kraft 2005).

Archaic burial sites are rare in the Texas Panhandle and none are reported from southeastern Colorado (Zier and Kalasz 1999:136). Summers' (1997) study of burials from the Texas Panhandle region reviewed 296 individuals from 145 burial sites. Only 29, roughly 10 percent, were attributed to the Archaic period. The recovered bodies represent primarily adults between the ages of 18 and 59 years old, with some children between three and 13 years old. Summers states that most bodies were in flexed positions with no apparent pattern to headward orientation. Some burials occurred under rock cairns and/or in small pits that contained either flexed, bundled, or cremated remains (Thurmond 1991b). Most burial sites tend to occur in the canyons south of the Canadian River.

A flexed infant burial from Potter County (PPHM-A769) yielded a small dart point, an obsidian pendant, 275 tabular bone beads, 38 hackberry seed beads, two mussel shell beads, and 11 modified prairie dog palates (Harrison and Griffin 1973). This burial was not radiocarbon dated. The few burials that have been radiocarbon dated fall in the range of 1500 to 1800 B.P. (Boyd 1997:257). Further east in the Canadian River valley of Oklahoma, Burial 2 at the Sullivan-Carpenter site contained three human bodies, associated with seven large corner-notched dart points, and two radiocarbon dates ranging between 1690 and 1370 B.P. (Gettys 1991; Oklahoma Archeological Survey 1993). The recovery of nonlocal marine shell pendants and green lunate stones from grave contexts indicates that the Late Archaic peoples were sharing in wider belief and/or trade systems (Redding and Parker 1991; Thurmond 1991b).

A few specific artifact types, such as the corner-tang knife (Figure 3-6) and lunate stones/boatstones or atlatl weights, have been attributed to the Late Archaic). Corner-tang knives are implements most frequently recovered from surface contexts (Patterson 1936, 1937Kraft 1993, 1994a, 1994b; Broehm and Lovata 2004).

Figure 3-6. Example of Corner-Tang Knife from 41PT185/C. (scale in cm)

Kraft (1994a) has identified at least 50 corner-tang specimens from 20 Texas Panhandle counties. However, similar specimens have been recovered throughout the Plains region extending as far north as Montana with an apparent concentration in central to south Texas (Kraft 1993, 1994b). The few specimens from excavated contexts come mostly from burials and cemeteries in south and southeastern Texas, including the Late Archaic cemetery at the Silo site in Karnes County (Broehm and Lovata 2004), the Rudy Haiduk site also in Karnes County (Mitchell et al. 1984), and the cemetery at Ernest Witte (G. Hall 1981) in Austin County. These corner-tang knives were probably intentional grave goods. At the Silo site, three corner-tang knives were buried with a five to six year old child (Broehm and Lovata 2004). At the Ernest Witte site, two corner-tang knives were buried with a female (G. Hall 1981). At the Rudy Haiduk site, five specimens were buried with an isolated body. The association of these tools with both male and female burials may either indicate some special attachment between the individual and these tools. However, they do not appear to be gender related. No high-powered use-wear analyses have been conducted, but these are generally considered to be a specific type of butchering tool.

The lunate stones/boatstones (called cariniform atlatl weights by Parsons et al. 1979) have also been linked to the Late Archaic through burial associations. Several burials, mostly along the headwaters of the Brazos River near Lubbock, have yielded lunate stones (Cockrum 1963, Parsons et al. 1979; Redding and Parker 1991; Thurmond 1991b), including the male interment at the Beaver Dam site discussed above (Figure 3-7). The lunate stone from Crosby County Texas was associated with as single Ensor dart point; a central Texas type dated to ca. 1600 to 1200 B.P. (ca. A.D. 250 to 750; Turner and Hester 1999; Collins 2004). However, this point appears to have been reworked and last functioned in some capacity other than as a projectile point (Redding and Parker 1991).

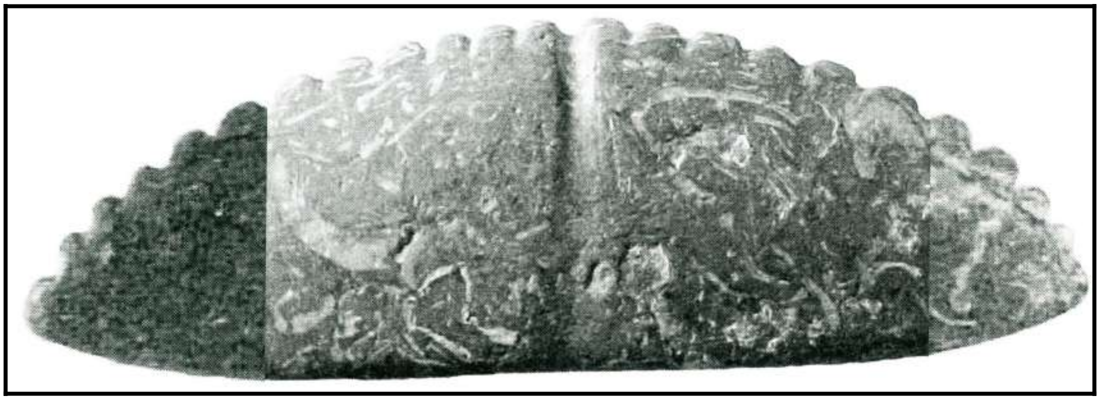


Figure 3-7. Atlatl Weight or Lunate Stone from Beaver Dam Site (34RM208). (photo from Kraft 2005, scale unknown).

Other lunate stones have been collected from the surface (Holden 1929). Based on their apparent associations with central Texas point types attributed to the Late Archaic (i.e., Ensor, Marcos, and Marshall types), these lunate stones are attributed to the Late Archaic groups. Only one lunate stone was manufactured from a local material. Most were manufactured from an igneous "greenstone", potentially a rhyolite. The scarcity of lunate stones and their rare occurrence with a few Late Archaic burials indicates that they have special significance. For the Late Archaic on the Texas coastal plain G. Hall (1981) suggested that a Late Archaic extensive exchange network existed that linked these populations to groups further north and east. Similarly the presence of bannerstones in western Oklahoma and gorgets in southeastern Colorado and southwestern Oklahoma are potential status symbols that are far removed from their general area of occurrence in the eastern United States (Neal and Drass 1998; Lintz 2000). Both items possibly are related to the far reaching Late Archaic exchange networks operating on the Texas coastal plain and points north and east.

The lithic resources used to manufacture chipped stone tools appear to reflect some regional availability, but further detailed studies are needed to affirm this impression. The lithic resources found at bison kill/processing sites indicate a slight reliance (58 percent) on local materials including Potter chert (48 percent), quartzites, and silicified wood (Table 3-2). The high quality Alibates and Tecovas cherts that outcrop along the Canadian River valley in the central Texas Panhandle were not intensively sought, as they constitute only 16 percent of the total. The one exception is the Sanders site where Alibates quarry materials dominated the assemblage (Quigg 1997, 1998). The Little Sunday site yielded a preponderance of local lithic resource materials including 50 percent Tecovas jasper, 22 percent Ogallala chert, 14 percent Alibates flint, eight percent nonlocal Edwards chert, and two percent local Dakota quartzite (J. Hughes 1955). Although research into other tool stone sources is limited, it is known that obsidian use had occurred at a surface site, 41BV171 in Beaver County Oklahoma, which is dominated by large corner-notched dart points (Bement and Brosowske 2001). Six pieces of obsidian from 41BV171 were sourced to Obsidian Cliff in northwestern Wyoming and six other pieces to Valle Grande in north central New Mexico (Bement and Brosowske 2001). Lang (1978; cited in Stuart and Gauthier 1984) reports that nearly 50 percent of the Late Archaic corner-notched points in the upper Canadian River area of northeastern New Mexico were manufactured of obsidian.

3.2.1 Summary and Regional Comparisons

The Little Sunday complex contains many generalized Late Archaic traits that cover a wide geographical area, an imprecise, but broad time period and a diverse suite of cultural materials. The radiocarbon dates from the bison kill/processing sites range from roughly 2500 to 1300 B.P. (Lintz et al. 1991). The dated campsites and rock shelters indicate an earlier beginning at ca. 4000 B.P. The bison kill sites reflect exploitation of one specific resource, but the plant gathering aspect is rarely documented (c.f., Beaver Dam site, Feature 10, Kraft 2005). Much is yet to be learned about Late Archaic adaptations in the Texas Panhandle including the beginning and ending dates, and a thorough understanding and description of the cultural assemblage(s) that reflect the various human activities.

The two burials mentioned above indicate that special care was given to at least some of the dead. These individuals were also associated with special objects like the lunate stones, projectile points, and *Olivella* shell beads, which indicate a particular social practice or honoring the dead or helping them in their afterlife. It also brings to light objects that are not normally found in campsites and broadens our understanding of the material aspects of these groups, and implies specific belief systems.

Based on the wide distribution of the broad bladed corner- to side-notched dart points, Boyd (1997) sees a much wider distribution of the Little Sunday complex than originally proposed (J. Hughes 1962). These point types appear concentrated in the Caprock Canyonlands and the western part of the Rolling Plains. The lack of excavated sites in the Canadian River valley and across most of the Llano Estacado, presumably accounts for the low frequency of recognized Late Archaic sites in the region. In general, the cultural patterns represented by the Little Sunday complex as defined for the Texas Panhandle are not well known.

In southeastern Colorado the Late Archaic is well represented through many excavated sites and in collections from large and small–scale surveys (Zier and Kalasz 1999:126). These sites are documented across the plains, foothills, and into the mountains. Zier and Kalasz (1999) believe there is evidence that population growth occurred during this period. With this apparent population growth came a florescence in the variability of projectile point styles. For example, Anderson (1989b) employs some 34 different categories that contain some 190 specimens of “large expanding stemmed points” with an acute angled tang for their work in the Piñon Canyon Maneuver site in southeastern Colorado. These projectile points generally represent larger corner-notched types. However, the general material culture, lithic industry, ground stone tools, bone and shell artifacts, plus the overall settlement pattern, does not change substantially from the previous Middle Archaic assemblages. Some 10 to 12 large expanding-stemmed dart point forms persisted throughout the Late Archaic (Anderson 1989a). Diagnostic projectile points include large corner-notched types with straight or concave blades and bases (types such as Ellis, Marcos, Shumla, Williams, and Palmillas), side-notched dart types (types such as Ensor and Edgewood), and other large triangular expanding stemmed types (such as Yarbrough; Anderson 1989a). A wide range of forms and sizes of hearth features is manifested, which includes a couple of examples of relatively large burned rock midden features (e.g., 5BA320) that are more prevalent across other areas of the Southern Plains. Use of arroyos to trap and kill bison is also documented during the Late Archaic period in northeastern Colorado, specifically at ca. 2715 B.P., (an average of one bone collagen and $\delta^{13}C$ adjusted dated of 2690 ± 60 B.P.

Table 3-2. Artifacts and Materials Types from the Late Archaic Texas Kill sites.

Site Name and No.	Total Counts	Alibates	Tecovas	Potter Chert	Silicified Wood	Quartzite	Unknown Chert	Kay County/ Florence	References
Bell, 41HL65, PPHM-A696									Hughes 1977, 1989; Fawcett 1987; Lintz et al. 1991
Corner-notched Points	3		3						
Bifaces	5								
Edge-modified Flakes	4	1		3					
Chopping Tools	4			4					
Coller, 41HL64, PPHM-A373									Hughes 1977, 1989; Fawcett 1987; Lintz et al. 1991
Point, ? Biface	1			1					
Utilized Flakes	3			2		1			
Finch, 41DY19, PPHM-A128									Hughes 1977, 1989;
Points	0								
Hoover, 41HH12, PPHM P96									Hughes 1977, 1989
Points	3	1		1			1		
R.O. Ranch, 41DY20, PPHM-695									Hughes 1977, 1989
Chopping Tools	2			2					
Retouched Flake	1			1					
Sitter, 41DY18, PPHM-A127									Hughes 1977, 1989; Fawcett 1987
Points	3		1						
Scrapers	2								
Utilized Flakes	4								
Core	1								
Twilla, 41HL1, PPHM-A73									Tunnell and Hughes 1955; Hughes 1977, 1989; Fawcett 1987; Lintz et al. 1991
Corner-notched Points	15	1	3	9	1			1	
Utilized Flakes	7	1	1	4			1		
Chopping Tools	8			5	1	2			
Strong, 41CG31, PPHM-A694,									Hughes 1977, 1989, Fawcett 1987; Lintz et al. 1991
Retouched Flake	4			2		1			
Chopping Tools	1					1			
Biface	1			1					
McIntyre, 41RB87									Wilkens 1997
Corner-notched Points	1								
Total by types	**73**	**4**	**8**	**35**	**2**	**5**	**2**	**1**	

[Beta-125434] and one charcoal $\delta^{13}C$ adjusted date of 2740 ± 40 B.P. [Beta-125435]) at the Kaplan-Hoover site (5LR3953; Todd et al. 2001). In the Foothills/Plains transition zone on the western edge of Denver, the Massey Draw site (5JF339) yielded a multicomponent and stratified Archaic site that included several Late Archaic bone and camp deposits (Anderson et al. 1994). The multiple Late Archaic events were radiocarbon dated to between 2930 and 1960 B.P. and yielded mostly bison bones and camp debris, as well as several basin hearths and corner-notched dart points.

In addition to the more typical campsites and rock shelters, petroglyph sites are documented and attributed to the Late Archaic period in southeastern Colorado (Zier and Kalasz 1999:135). Some 20 cation ratio dates obtained on petroglyphs from nine sites range from ca. 3000 to 1850 B.P. (Faris 1995). Missing from the current Late Archaic record in southeastern Colorado are bison kill sites. Rabbit bones dominate the recovered species at this time, with bison and deer poorly represented.

Corn is definitively documented in at least three different Late Archaic components (Medina Rock Shelter, Gooseberry Shelter, Recon John Shelter), and it is associated with radiocarbon dates (Zier and Kalasz 1999; Butler 1997). The oldest associated uncorrected radiocarbon date on charcoal is 2600 B.P. (Beta-40671) from Gooseberry Shelter followed by a detrital charcoal date of 1920 B.P. (Beta-24246) from Recon John Shelter, and dated charcoal from a fire pit of 1970 B.P. (GAK 672) from Medina Rock Shelter. Adair (2006) points out that cultivation and domestication practice, including corn, is documented on each side of the Central Plains region during the Late Archaic, although maize has not been identified from preceramic deposits in the Central Plains. There is widely scattered evidence that corn was introduced by ca. 1750 B.P., but did not become economically important until sometime after about 1150 B.P. (Adair 2006). Botanical inventories from the plains/foothills regions are diverse. Goosefoot seeds are dominant, but other seeds or fruit of pigweed, hackberry, purslane, prickly pear, hedgehog, compositae, and various grasses (particularly dropseed and Indian ricegrass) have been identified (Zier and Kalasz 1999:136).

In northeastern New Mexico the Late Archaic is poorly known from surveys and limited excavations mostly in the A.D. 1970s or earlier (e.g., Hammack 1965), with more recent investigations also documenting Late Archaic sites (Kramer et al. 1988; Lintz et al. 1988). Sebastian (1989) repeated that we known very little about the Archaic. For example, only 2.5 percent of the 199 sites recorded in the Canadian River valley were listed as Archaic, even though the period lasted some 6,000 to 7,000 years (Larralde 1989:133). Although prehistoric sites are numerous in this region, newly discovered sites are not easily assigned to time periods because of the lack of a solid and tight chronology of diagnostic artifacts for the region. Therefore, sites lacking ceramics have been generically assigned to the lengthy Archaic period (Stuart and Gauthier 1984). In general terms, the appearance of corn, pottery, and the bow and arrow took place around 1700 B.P. (A.D. 250) (Stuart and Gauthier 1984). The appearance of cordmarked pottery marks the beginning of the Plains Woodland period in this region, which is also poorly known.

3.3 Late Prehistoric Period (ca. 2200 to 400 B.P.)

The mechanisms for how the Late Archaic populations transitioned into what Southern Plains archeologists refer to as the Late Prehistoric period are unknown. Starting sometime around 2000 B.P., major technological changes began to occur in this region. These obvious changes might have been little more than the adoption of a new weaponry system by indigenous Archaic people in some places, and/or an intrusion of new people and technology in others. The recognized changes involved the adoption of the bow and arrow, and possibly a little later, the adoption of ceramic technology. These new technologies probably appeared at slightly different times in different areas. It is doubtful that the atlatl and associated darts were immediately and completely replaced and no longer used. Likely, there was a gradual experimentation with the new bow and arrow system. Possibly the two weapon systems served in different situations as indicated by the occurrence of large dart points at bison kills that date to periods when arrow points were in common use. Eventually, the bow and arrow system completely replaced the atlatl dart system. Several archeological sites and components reveal an apparent overlap of the use of arrow and dart points in radiocarbon dated contexts (J. Hughes 1969; Willey and Hughes 1978a; Thurmond 1989; Quigg et al. 1993). In several instances, the association is due to questionable context, but this is not so in all cases.

Surface sites with small arrow points and/or pottery are presumed to belong to the Late Prehistoric I period, whereas contemporaneous sites lacking arrow points and pottery are regarded as Archaic sites. Some researchers refer to this period as the Early Ceramic period (i.e., Gunnerson 1987; Zier and Kalasz 1991) to denote the first appearance of pottery. The use of the term "Early Ceramic" is rarely used in the Texas literature. Most researchers refer to this time as the Late Prehistoric I period. The timing of the adoption of ceramics and the bow and arrow technologies is not clearly established for the Southern High Plains (Boyd 1997). These new traits are recognized in the region by roughly 1850 B.P., but at least three sites; one in southeastern Colorado, one in the Texas Panhandle, and one in central Oklahoma, have yielded small corner-notched arrow points in limited quantities from contexts dating to between 2,500 and 2,200 years ago (Quigg et al. 1993:463).

There are also scattered instances of early ceramic sherds across the region. In one instance in the northern Texas Panhandle at the Sanders site, a single smoothed over cordmarked sherd tempered with crushed bone and quartz sand was recovered from a well defined, isolated Late Archaic bison processing/camp site radiocarbon dated to ca. 1870 B.P. (Quigg 1997, 1998). In addition, the Late Prehistoric period also involved an adaptive transition from highly mobile Late Archaic hunters and gatherers to the more semisedentary village and hamlet dwellers of the Late Prehistoric II, who relied on hunting and gathering and possibly limited practice of horticulture.

Differences in the shape of arrow point haft portions, as well as variations in ceramic vessel forms, surface treatment and manufacturing characteristics, together with variations in subsistence practices and architecture differences allow archeologists to delineate contemporaneous and sequential regional complexes during the Late Prehistoric I and Late Prehistoric II subperiods. Each complex has a reasonably well recognizable set of cultural traits, as discussed below. It is possible that the regional complexes of the Late Prehistoric I and II overlapped in time and space in the Texas Panhandle.

3.3.1 Late Prehistoric I Subperiod (ca. 2200/1800 to 1000/800 B.P.)

The affects of the environmental conditions during the Late Prehistoric I subperiod are not well understood. Remains of the prairie vole (*Microtus ochrogaster*) have been recovered from Palo Duro complex levels along the headwaters of the Red River at Canyon City Club, Blue Spring shelter, and Deadman's shelter (J. Hughes 1991). The presence of prairie vole remains in sites of this subperiod indicates somewhat cooler and more mesic conditions with increased rainfall. Furthermore, faunal remains recovered from the Late Prehistoric I sites reflect a significant decrease in reliance on bison, as compared to the Late Archaic, and an increased reliance on deer and a diversified suite of small animals. The reduced reliance on large herbivores is attributed to a decrease in bison populations, perhaps an exodus from the region between ca. 1800 and 800 B.P.

The Late Prehistoric I complexes are characterized by the presence of small, corner-notched or barbed arrow points and pottery. Two contemporaneous cultural complexes have been defined in the Southern High Plains and potentially across the Texas Panhandle based on different ceramic technologies and projectile point types. The Palo Duro complex dominates the southern parts of the Texas Panhandle south of the Canadian River and especially east of the high Plains escarpment in the Rolling Plains (Figure 3-8). The Lake Creek complex is more prominent north of the Canadian River with affinities to similar complexes found in northwestern New Mexico, eastern Colorado, Kansas, and

Oklahoma (J. Hughes 1991). The boundaries of these two Late Prehistoric I complexes in the Texas Panhandle are not known and quite likely their ranges may overlap and reflect gradual expansion of one complex over the other, or use of the region in a seasonally overlapping pattern. Each complex is discussed below beginning with the Palo Duro complex.

3.3.1.1 The Palo Duro Complex

Palo Duro complex sites are typically found in the broken canyon lands along the eastern escarpment of the Llano Estacado at the headwaters of the Red River, and the northern boundary extends along the breaks of the Canadian River (J. Hughes 1991; Boyd 1997). The Palo Duro complex was first recognized during excavations of the Deadman's shelter site in Mackenzie Reservoir in Tule Canyon, a major tributary of Palo Duro Canyon just south of Amarillo (Willey and Hughes 1978a).

Major components of the complex include the upper component at Chalk Hollow site (Wedel 1975; Lintz 2002), Deadman's shelter (Willey and Hughes 1978a), Kent Creek site (Cruse 1992), Cat Hollow, Gobbler Creek Bridge, Sam Wahl site (Boyd et al. 1994), Blue Spring shelter, and the Canyon City Club Cave (J. Hughes 1971; Boyd 1997). Only two sites, Kent Creek (Cruse 1992) and Sam Wahl (Boyd et al. 1994) are classified as residential base camps as they both contained pithouse structures. The tested South Ridge site (east end) near the dam at Lake Meredith (Etchieson 1979b), and the minimally tested Maintenance Barn site (Couzzourt 1982), both with undated, complex stratigraphy, are the best known Palo Duro complex sites in the Canadian River valley (Figure 3-8). These sites are currently the two most northern sites for this complex. Cultural assignment of some of these sites is based on, but one or two characteristics of the broader complex and their assignment to this complex can be questioned. As an example, the upper midden at Chalk Hollow yielded corner-notched Scallorn and Scallorn-like arrow points, occasional plain brownware sherds (Wedel 1975), but lacked pithouses and Deadman's points. Originally, Wedel (1975:273) attributed this material to the Lake Creek/Woodland complex, but this was before the Palo Duro complex was defined. Willey and Hughes (1978a:190) and J. Hughes (1991:26) have assigned this upper midden to the Palo Duro complex, but the material from Chalk Hollow has never been adequately described. Boyd (1997) believes the upper midden at Chalk Hollow is one of the most discrete Palo Duro components thus far identified.

Diagnostic artifacts of the Palo Duro complex include plain brown pottery, the distinctive "Deadman's arrow point" with the long stems formed by deep basal corner-notches, and occasionally shallow pithouses found at two sites. Boyd (1997) observes that ceramic materials are absent or rare in most Palo Duro sites. Few sites of this complex have been sufficiently excavated to define the frequency of pithouse usage. In the absence of these two principal characteristics, site/component recognition and assignment difficult at best. The assemblage variations of the same complex undoubtedly reflect different site types and functions. Most observed traits in the Palo Duro complex appear with no obvious local development, which implies the complex represents an infusion of new peoples into this area. The Deadman's arrow point is distinctive. They are deeply notched from the base creating a relatively long, slightly expanding stem and slender barbs, which has no known predecessor in the Late Archaic complexes of the region.

The Palo Duro complex has been redefined with the addition of more recent site excavations and additional sites have been assigned to this complex (Boyd 1997). This complex is presently viewed as representing semisedentary peoples who maintained mobility, subsisting on a variety of wild plants and small animals. Domestic crops

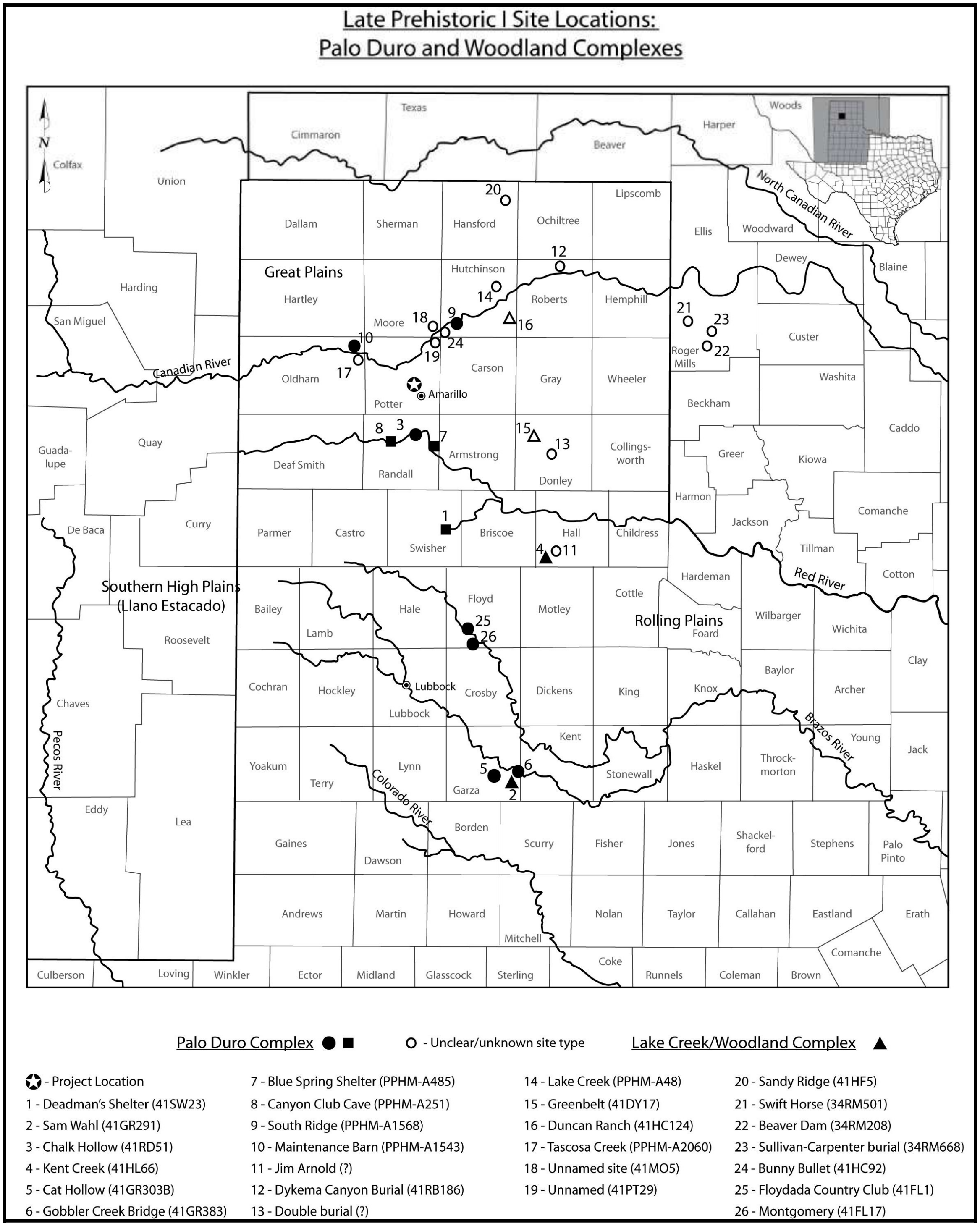


Figure 3-8. Late Prehistoric I Sites (Palo Duro and Woodland) Mentioned in Text.

have not yet been identified in the sites that represent this complex, although their use is implied by the identification of storage pits, Ovate and rectangular pithouses have been reported at only two Palo Duro complex sites: Kent Creek (Cruse 1992) and Sam Wahl (Boyd et al. 1994). These tend to be relatively shallow, rectangular structures ranging from 8 to 14 m^2 in size with or without rock lined fireplaces and extended ramp entryways. Although these structures are regarded as pithouses, they exhibit considerable variability in their sizes and shapes, and interior features. Storage pits, rock hearths, rock basin baking pits, and unlined hearths are present at these sites. The baking pits are assumed to have functioned as plant food cooking features (Boyd 1997). Storage pits are only well represented at the Sam Wahl site (Boyd et al. 1994). To complicate matters further, suites of radiocarbon dates from various features exposed at the Sam Wahl site indicate that multiple components existed during the general time span of Late Prehistoric I. Thus, the diversity of features of different ages at this site might reflect various occupational functions and an over printing of site patterns.

Helen A. W. Warren identified the 29 pottery sherds from Deadman's shelter to be Jornada Brownware with temper of rock, some sand, and andesite from the Sierra Blanca region of New Mexico (cited in Willey and Hughes 1978a). The pottery technologically resembles Alma plain, a smooth surface pottery type from the Mogollon region of southern New Mexico. The general consensus is that multiple varieties are represented, such as Jornada Brown, Roswell Brown, and Middle Pecos Micaceous Brown, implying multiple source areas. Petrographic analysis on less than two dozen sherds from five sites indicates considerable variation in composition, reflecting different sources (Etchieson et al. 1977; Robinson 1992, 1994). The plain brown ceramics are definitely nonlocal wares. Quartz, feldspar, biotite, and rock temper have been identified in these sherds.

At Deadman's shelter, the faunal assemblage from the lower occupation, (stratum D) was assigned to the Palo Duro complex, and had a faunal assemblage dominated by deer with some small mammals, but lacked bison bones and indeed bison appear rarely at nearly all Palo Duro sites. However, because only a few preserved faunal remains are present at most sites, a clear understanding of the full range of animal resources used is not yet available. Freshwater mussel shells are consistently present. Only a few sites have been sampled for macrobotanical remains. These studies indicate that mesquite beans, shin oak acorns, and possible Chenopodium were the primary exploited plants (Boyd 1997). Charred plant remains have been recovered from pithouse floors, baking pits, and nonfeature contexts. Grass seeds recovered from storage pits are interpreted as representing incidental materials for lining the pits rather than food (Dering 1994). Corn, beans, and squash or other domesticated plants have yet to be identified in any storage pits attributed to this complex, nor have agricultural tools been identified. Ground stone tools, including metates and manos, have been found and are thought to indicate the processing of wild plant foods. At present it is difficult to determine the relative importance of the various floral and faunal resources used.

Single human burials mostly in flexed positions have been found at Kent Creek, Deadman's shelter, the Jim Arnold site, and probably the Dykema Canyon Burial (Wilkens 2005), and attributed to this complex. No cemeteries have yet been found (Boyd 1997). The burial at Kent Creek was a female associated with bone and mussel shell artifacts (Cruse 1992). The body at Deadman's shelter was a male with bone and mussel shell grave goods (Willey and Hughes 1978a). Two burial pits, each with a primary interment, were investigated at Jim Arnold, but the age and cultural associations are not clearly established (Boyd 1997).

The Dykema burial was an adult male with eight small, stemmed arrow points in the chest. An AMS radiocarbon date on the human bone yielded a $\delta^{13}C$ adjusted age of 1290 ± 40 B.P. (CAMS-63198, Wilkens 2005). The stable isotope evidence from the body indicates this was probably a hunter gatherer. The occurrence of points in the body indicates that this might be a Lake Creek complex individual. Cut marks and trauma were observed on several bones. A few other human burials may be of this general time period, but the context and age of these remains makes specific cultural assignment questionable. The Double burial under a rock cairn excavated in 1938 in Donley County also appears to have Deadman's arrow points as the cause of death (Witte 1955). Both individuals were adults apparently killed during the Palo Duro complex period, but what group the individuals represent is not clear. These bodies indicate hostile interactions between groups.

Radiocarbon dates from these sites range from 1880 to 850 B.P. The current data reflect an intrusive Jornada Mogollon culture from eastern New Mexico, that moved out onto the plains region to the east side of the High Plains. It appears this population brought with them plain brownware ceramic vessels and ceramic technology, as well as a technology for building pithouses. These populations apparently did not bring horticulture with them. Reasons for the disappearance of this culture have yet to be determined. Their move eastward across the Llano Estacado to the Rolling Plains and possibly northward into the region of the Texas Panhandle potentially encountered Woodland groups from the north and east. Some have speculated the Palo Duro culture might have been the forerunners of Toyah phase, a Late Prehistoric II group that latter resided in central and western Texas (Shafer 1977; Johnson 1994; Boyd 1997). This speculation has yet to be tested and minimal evidence currently exists to rigorously test this idea.

3.3.1.2 The Lake Creek Complex

Archeologists working in the Plains have long used the term "Woodland" to refer to prehistoric sites characterized by elongate pottery vessels with conoidal bottoms, small corner-notched arrow points, and burial mounds recognized as diagnostics of the Woodland archeological period in the eastern United States. Since its earliest adoption in the area west of the Missouri River, the term "Woodland" has been prefixed by "Plains", in anticipation of the eventual demonstration of unique adaptive responses to the environmental constraints of a grassland gallery forest setting" (Johnson and Johnson 1998:201). The later authors go on to state for the Southern Plains that the Woodland manifestations are not well known. Also, the Woodland components may be difficult to identify, as few sites of this period have been systematically investigated and considerable diversity exists between regions (Johnson and Johnson 1998). For the Texas Panhandle, the second cultural complex identified for the Late Prehistoric I period is labeled the Lake Creek complex. The name is derived from limited test excavations conducted in A.D. 1952 into a small terrace at a site on Lake Creek, a tributary on the north side of the Canadian River (J. Hughes 1962). Even as late as A.D. 1991, few if any radiocarbon dates were available to document the age of the Lake Creek complex (J. Hughes 1991). Currently, few if any sites have been excavated and reported with well defined Plains Woodland components in good sealed context.

The A.D. 1952 investigations into the Lake Creek site yielded a very small sampling (51 items from subsurface context) of cultural materials from very limited excavations (ca.

6.9 m^2) in undated contexts. It should be pointed out that a 1.5 cm (0.5 in.) screen was used at this site and flakes and burned rock were not collected from the screen (J. Hughes 1962). The test excavations extended to about 75 cm deep and revealed an apparent single occupation zone about 25 to 35 cm thick (J. Hughes 1962). The recovered pottery was of two types, corded ware and plainware. The corded ware sherds (8 from subsurface and 36 from surface) included 42 body sherds and one rim sherd. These are rather thick (7 to 13 mm with an average of 11 mm). Their exterior surfaces were gray to black in color and reveal cord or fabric wrapped paddle impressions. The interiors are similar in color to the exteriors, with slightly uneven surfaces that exhibit temper particles, small cracks and pits. The clay was densely tempered with rounded quartz grains and angular limestone/caliche particles. The single rim reveals a slightly everted lip with a smooth exterior that had incised diagonal lines. The vessel shape was interpreted as having a shoulderless, slightly contracting upper part, with a hint of a pointed bottom (Hughes 1962). In A.D. 1962 J. Hughes thought this to be different from the Borger Cordmarked type characteristic of Antelope Creek and closely resembling vessels of the earlier Woodland tradition.

The plainware pieces (5 body sherds) were quite different. They had smooth exteriors ranging from light brown to dark gray in color. A compact paste exhibits abundant temper of fine angular particles of feldspar. Vessel walls were of moderate thickness (5 to 8 mm). Two sherds exhibit single drill holes, indicating possible repairs. These plainware sherds are similar in appearance to brownware sherds from the middle Pecos River valley in New Mexico (J. Hughes 1962; Jelinek 1967). The apparent presence of two very distinctive wares at this site indicates either a single component reflecting contact or exchange with the Middle Pecos valley, or two distinctive mixed components.

The 25 to 35 cm thick occupation zone at Lake Creek, was a relatively unconsolidated sandy matrix that yielded multiple kinds of projectile point types. These include small side (N = 1) and corner-notched (N = 1) arrow points, small unnotched triangular arrow points (N = 3), and one stem section, and two corner-notched dart points. The multiple point types indicate that at least two or more occupations were represented. Beveled, plain, and flake knives (N = 11), along with 21 unifacial scrapers, both side scrapers (N = 1), end scrapers (N = 6), and flake scrapers (N = 14) were recognized. Other stone tools included gravers (N = 3), a chopper (N = 1), a hammer, various shaped manos (N = 21), and grinding slabs (N = 10). A tubular bone bead cut at both ends was also recovered. The faunal assemblage includes bison, deer, turtle, jackrabbit, and mussel shells (J. Hughes 1962). Based on these remains, J. Hughes (1962) recognized the materials as representing something different from the later Antelope Creek Focus/phase.

Over the years, a few other sites have been assigned to the complex. Recently, Boyd (1997) discusses a transition from the Late Archaic into the Late Prehistoric period. He (1997) redefined the Lake Creek complex and as J. Hughes (1962, 1991) did earlier, equated this complex with the Plains Woodland. The diagnostic materials of the Lake Creek complex include small corner-notched (Scallorn) arrow points and thick, large, wide mouth conical vessels with boldly impressed cordmarked exteriors, tempered with liberal quantities of coarse crushed rock, added to an essentially Late Archaic assemblage of large corner-notched dart points (J. Hughes 1991; Boyd 1997). The similarity in dart point forms from the previous period indicates to some researchers that these materials represent indigenous peoples who had acquired pottery and bow/arrow technologies. Only a limited number of Woodland sherds have been recovered across the Texas Panhandle, and those few sherds reveal variability in temper with scoria, basalt, and bone all identified (Perttula and Lintz 1995). Diagonal incising is the only apparent decorative element represented in the Lake creek Complex in the Texas Panhandle (Perttula and Lintz 1995). Other cultural materials include disarticulated burned rock features and boiling stones, and abundant stone grinding implements. Not much is known about the nature of possible house structures, although it is generally assumed that structures of some kind were used.

The technology of making conical cordmarked pottery is a trait common to many complexes on the Central and Southern Plains (eastern Colorado through Kansas and western Oklahoma). It has its origins ultimately in the Mid-west (Missouri, Illinois, and Ohio valleys) where the tradition appears nearly a millennium earlier than on the Plains. It is not clear if the Lake Creek complex represents the more eastern orientated Plains Woodland here in the Texas Panhandle, or some variation that is not as well defined as yet. It is different from that of the contemporaneous Palo Duro complex.

Lake Creek sites are typically open campsites on terraces of the Canadian River and its tributaries. Some sites probably represent multiple or long-term occupations with extensive deposits of artifacts. Sites in the Texas Panhandle include Lake Creek (J. Hughes 1962, 1991), Harrison-Greenbelt (Campbell 1983), Duncan Ranch (Gustafson 1994), Tascosa Creek (Couzzourt 1985, 1988), 41MO5, 41PT29 (Green 1986), Indian Springs (41RB81; Cruse 2007), and Sandy Ridge (Quigg et al. 1993). In extreme western Oklahoma, sites include Swift Horse (Briscoe 1987, 1989), Beaver Dam (upper part of Area A, Thurmond 1988, 1991a; Kraft 2005), and potentially the Sullivan-Carpenter burial site (Gettys 1991). Only about a dozen radiocarbon dates from a half dozen sites are available. Most dates range from ca. 1200 to 2000 B.P. and very few dates occur in the span between 900 and 1200 B.P. (Boyd 1997). One exception is a circular slab lined cist with a central vertical slab (Feature 1) from the Bunny Bullet site (41HC92) at Lake Meredith (Etchieson and Couzzourt 1987:III-7), which yielded an uncorrected date of 1110 ± 140 B.P. (Beta-20868). Slab lined cists, identical to this dated example, have been assigned to the later Antelope Creek complex (Etchieson and Couzzourt 1987:III-7). So it is unclear if the date is incorrect or the assignment of these particular features is incorrect. Specific information on other features such as hearths is limited.

To the northeast, in Roberts County in the northern Texas Panhandle, Indian Springs (41RB81) has yielded an intensively occupied area with multiple components and several structures and other features. Structure 1, a large 10.5 by 8.2 m rectangular shallow pit structure with posts supported by rocks is currently attributed to the Late Woodland period (Cruse 2007). It apparently contains internal features such as storage and refuse pits, a rock lined hearth, and at least one roof support post. A wood charcoal date from a rock filled hearth (Feature 5) on the floor of structure 1 yielded a date of 1000 ± 40 B.P. (lab number not reported). Feature 6, a large circular pit, yielded a charcoal date of 1090 ± 40 B.P. (lab number not reported). The stratigraphy at the site is complex and other occupations are present in the immediate vicinity, which creates some difficulty in determining with what this unique structure is associated. Thick cordmarked ceramic sherds with bone and grit tempering combined with small corner-notched arrow points are part of the broader cultural assemblage found in the vicinity of this structure (Cruse 2007). The complete site report for this site has not yet been written.

Summers (1997) identified only 11 Woodland burials, or roughly four percent of her sample of prehistoric burials in the panhandle. She indicated that they were in various settings with no dominant pattern. Most were adults with some in flexed positions. The Dykema burial has relevance here, with a radiocarbon date of 1290 B.P. Based on the isotopic evidence from the human bones it appears the individual was a hunter gatherer with a low protein diet (Wilkens 2005). The bone chemistry evidence reveals a $\delta^{13}C$ value of -13.65‰ and a $\delta^{15}N$ value of 7.0‰ (Wilkens 2005). This indicates he had consumed a considerable amount of plants, as opposed to meat. Because the body appeared to have been killed with Deadman's arrow points he may represent a different group of people, possibly a Lake Creek individual. If this is a correct interpretation we gain a glimpse at a possible Plains Woodland/Lake Creek individual. The Dykema body was that of a male, 33 to 39 years old without decayed teeth. He had a low sloping forehead and relatively long and narrow vault and was 175 cm (5.8 ft.) tall. The body was placed on its left side, stomach down with one arm tightly flexed against the chest, with the skull on the west end, facing north. The analysts suggested that the position of the body indicated that this was not a formal interment. It is interesting to note that the Dykema individual, a possible member of a Plains Woodland/Lake Creek community, is nearly 20 cm shorter than the Late Archaic body at Beaver Dam site in western Oklahoma, though of course no firm conclusions can be drawn from a comparison of only two individuals.

The directly associated material cultural remains are very limited. The chipped stone artifacts are generally similar to those from other time periods and cultural complexes, except as discussed in the projectile points and ceramic vessels. Ground stone tools appear more common than in the Late Archaic. Faunal assemblages from Lake Creek sites are quite limited and/or poorly preserved. Therefore, subsistence information is limited at best though it can be noted that bison remains are generally scarce except at the early transitional sites. Ground stone tools indicate some plant processing activities, but no horticultural/cultivated crops have been identified as yet. Features are not well defined, but include burned rock clusters, charcoal and ash stains, hearths, and middens. J. Hughes (1991) thought the Lake Creek complex was primarily confined to the Canadian River valley, although Boyd (1997) has extended it to include all of the Texas Panhandle and into western Oklahoma.

Further north, in southeastern Colorado, the Early Ceramic/Plains Woodland populations were present from roughly 1900 to 950 B.P. (Cassells 1997; Zier and Kalasz 1999). Zier and Kalasz (1999) have proposed a new Late Prehistoric cultural taxonomy for the Arkansas River Basin that includes three temporally separate periods, namely, Developmental, Diversification, and Protohistoric. The Diversification period is divided into two phases, Apishapa and Sopris. The previously identified Early Ceramic or Plains Woodland period falls within their Developmental period. However, the first few centuries have also yielded a few Late Archaic traits such as the large corner-notched dart points, often in association with various small corner-notched arrow points. This period is often referred to as the transitional period. In general, the Plains Woodland complex in southeastern Colorado is marked by the earliest appearance of ceramics, small projectile points for use with the bow and arrow, dry laid masonry architecture, and the appearance of small scale maize horticulture (Anderson 1989a; Cassells 1997; Zier and Kalasz 1999).

As elsewhere, the Early Ceramic/Plains Woodland tradition is reflected by exterior cordmarking on the ceramic vessels. These vessels were built by piece molding or hand building with pointed bottoms and straight or incurving rims (Cassells 1997:195). Subsistence was based primarily on wild plants and animals. In a comprehensive study of faunal assemblages from sites across southeastern Colorado, Butler (1997) sees the mammal selection in the Woodland period being similar to the proceeding Late Archaic period. The only difference was that bison was the first ranked resource in the Late Archaic, whereas deer was the first ranked resource in the Woodland period (Butler 1997). Only limited information is available concerning plant use.

In southeastern Colorado, in addition to open campsites, petroglyph sites have also been attributed to this time period. In fact, 14 cation ratio dates from eight sites place glyphs in a period from ca. 1400 to 1100 B.P. (Faris 1995).

One significant discovery at the Belwood site in southeastern Colorado was the presence of two house structures dated to roughly 1200 to 1500 B.P. (Hunt 1975). House 2 was 3.5 m in diameter with a floor defined by six posts set in a shallow depression. House 1 was 8 m in diameter with low slab wall that circumscribes the floor area. Seven to eight postholes were arranged along the wall, but no central support posts were identified. There were a central hearth and a subfloor, and a bell shaped storage pit (Zier and Kalasz 1999). Two other houses with upright rock slabs for foundations were discovered at the Forgotten site (5LA3491). No pottery was recovered, although the radiocarbon dates range from 1100 ± 100 to 1300 ± 120 B.P., indicating a Woodland period occupation (Zier and Kalasz 1999). Single and multiple burials have also been recovered from southeastern Colorado and these generally have extensive grave goods (Black et al. 1991). Butler (1988) has assigned a limited group of sites along the Arkansas River to the Arkansas phase, defined a separate cultural taxon. The Arkansas phase is poorly defined and in need of substantial additional research (Butler 1988; Zier and Kalasz 1999).

The southwestern part of Kansas has received relatively limited investigations and thus far, no phases have been put forward for the Woodland period. The reader is referred to Bozell (2006) for a recent discussion of the Plains Woodland complexes in western Kansas and adjacent portions or Nebraska and Colorado. In southwestern Kansas, most Woodland occupation occurred from 1450 to 850 B.P. (A.D. 500 to 1100; Bozell 2006).

Overall, as additional investigations into the Woodland period sites are conducted, combined with the publication of additional detailed site reports, the recovered data will allow for a more comprehensive picture of regional Woodland cultures. Less is currently known about the western Woodland complexes, but the database increases significantly to the east. The Keith phase is currently identified in northwestern Kansas. Burial mounds, pottery, domesticated plants, and long distance trade are all recognized for this period in eastern Kansas.

3.3.2 Late Prehistoric II Subperiod (ca. 1000/800 to 400 B.P)

In contrast to the paucity of Late Prehistoric I sites investigated in the Texas Panhandle, a tremendous number of architectural sites that represent the broad Plains Village manifestation are known and many have been investigated to some extent. However, most investigations at Plains Village sites in the Texas Panhandle were conducted prior to the last 30 years. Many investigations were conducted by the Works Progress Administration (WPA) program with excavation techniques and reporting that were not at today's standards. If reports were published, they were not as comprehensive as today's reporting standards.

Most village sites tend to postdate 800 B.P. The two most obvious changes seen at these village sites are the presence of structures and the replacement of the corner-notched Scallorn arrow points with side-notched (Washita and Harrell types) and unnotched (Fresno) point forms. Also, wide mouth conical pottery vessels were supplanted by more globular, cordmarked jars with constricted orifices. The continuity of cord marking on vessel exteriors indicates to some that Late Prehistoric II complexes developed from the earlier Plains Woodland cultures. Apparently, no Palo Duro (Mogollon) complex characteristics carried over into this Late Prehistoric II subperiod, or at least not into the Antelope Creek phase of the upper Texas Panhandle, unless one assumes the occasional presence of pithouses reflect some continuity of that earlier intercultural relationship (D. Hughes 2001; Quigg et al. 2007; Boyd 2008).

During this interval, the regional environment apparently became warmer and dryer at roughly 1000 B.P., and bison herds returned to the region. Two cultural complexes are defined: The Buried City complex in the northeastern corner of the Texas Panhandle, centered along Wolf Creek, and the Antelope Creek phase centered around Lake Meredith (Antelope Creek "core area") just north of Amarillo (Figure 3-9). The latter phase extends across most of the Texas Panhandle during the Late Prehistoric II subperiod, whereas the Buried City complex appears to have been relatively restricted. These two complexes are generally divided/identified on differences in architecture and pottery styles.

In southeastern Colorado the Apishapa phase is documented for this period and is very similar to the Antelope Creek phase, in terms of its artifact assemblage and the use of the rock foundations for structures (Lintz 1986; Cassells 1997; Zier and Kalasz 1999). Lintz (1986) redefined the early work by Willey (1966:320) concerning "The Plains Village Tradition" and proposed the "Upper Canark Variant" of the Plains Village Tradition to include late prehistoric manifestations between the upper portions of the Canadian River and the southern tributaries of the Upper Arkansas River. He distinguished the Apishapa and the Antelope Creek phases within this variant. Given the location of the Landis Property along the Canadian River in the middle of the Texas Panhandle and near the core region of the Antelope Creek phase, the following discussion focuses only on the Antelope Creek phase.

3.3.2.1 The Antelope Creek Phase

The Antelope Creek phase, a regional variation of the broader Plains Village Tradition, existed on the Southern High Plains of the Texas Panhandle between 750 to 450 B.P. (A.D. 1200 to 1500). This phase and time period has received the greatest attention in the region. Many sites are recorded and discussed in survey reports, some have been targeted for, and these have received the most extensive radiocarbon dating (more than 60 assays) of any complex/phase in the Texas Panhandle. These sites have been investigated since the turn of the Twentieth Century. This phase is characterized by slab house architecture; triangular Fresno, Harrell and Washita arrow points, and Borger Cordmarked pottery among other traits (see summaries in Lintz 1986; J. Hughes 1991; Boyd 1997; Brooks 2004).

The Antelope Creek phase was first defined on the basis of materials recovered from WPA excavations on sites along Antelope Creek (e.g., Baker and Baker 2000), a southern tributary to the Canadian River near Lake Meredith (Lintz 1986). The apparent core area is centered along the Canadian River in the vicinity of Lake Meredith with some sites further north along the North Canadian River and its tributaries (see Figure 3-9). Antelope Creek phase sites exist as far south as the Red River and westward into extreme eastern New Mexico.

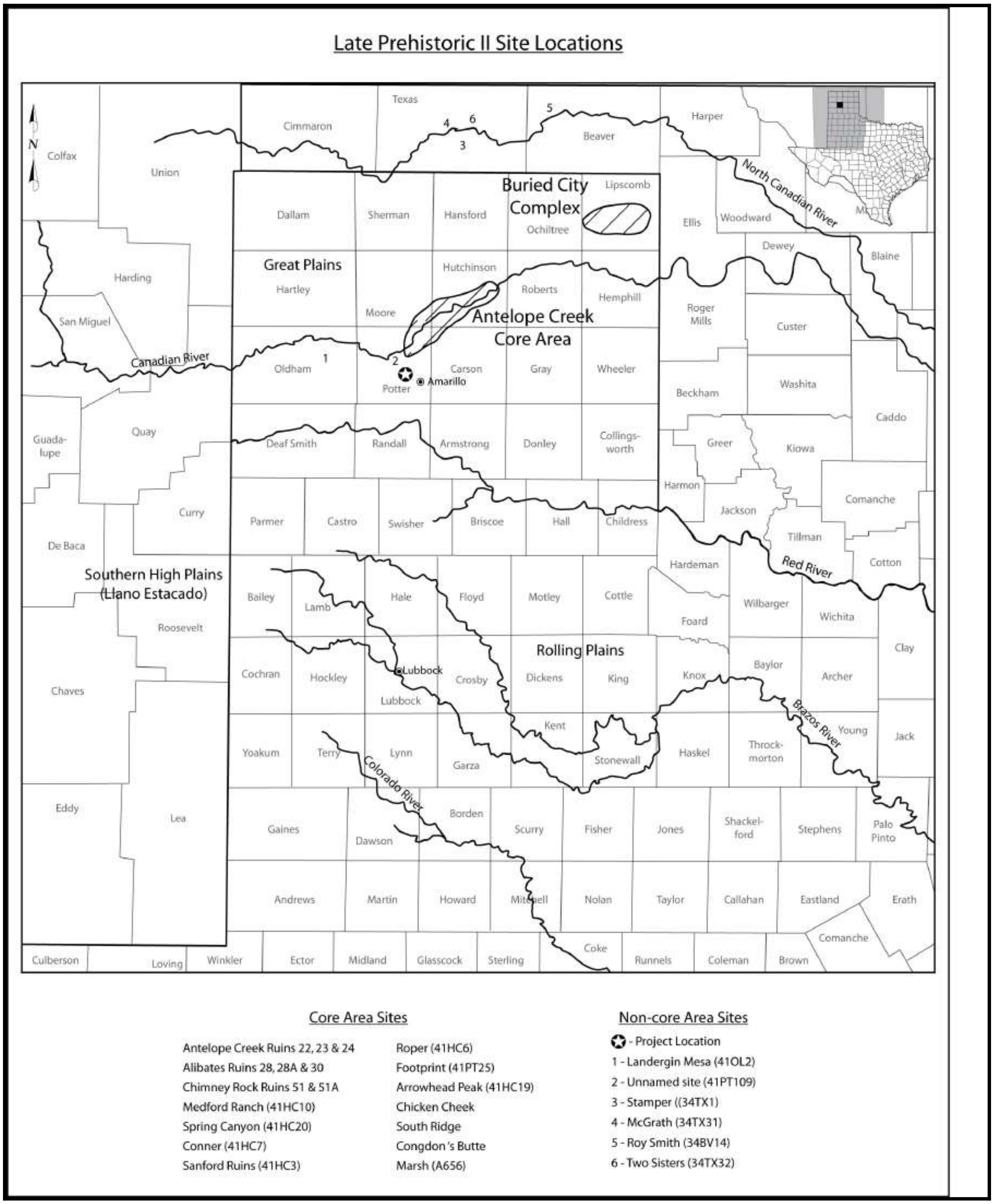


Figure 3-9. Late Prehistoric II Sites (Antelope Creek Core Area and Buried City) Discussed in Text.

Major sites attributed to the Antelope Creek phase in the "Core Area" along the Canadian River include Antelope Creek Ruins 22, 23, 24, Alibates Ruins 28, 28A, 30, Chimney Rock Ruin, Medford Ranch, Spring Canyon, Conner, Sanford Ruins, Roper, Pickett Ruins, Cottonwood Creek Ruins, Coetas Ruins, Saddleback Ruins, Footprint, Arrowhead Peak, Chicken Creek, the Blue Creek sites, South Ridge campsite, and Congdon's Butte (Duffield 1964; Lintz 1986, 1990, 1997; Schmidt-Couzzourt 1983; J. Hughes 1991; Couzzourt and Schmidt-Couzzourt 1996; Baker and Baker 2002). Along the North Canadian River in the Oklahoma Panhandle are the Roy Smith (Schneider 1969), McGrath, Stamper, and Two Sisters sites (Lintz 1976, 2003; Duncan 2002), as well as nearly a dozen other unexplored ruins. The use of masonry foundation architecture at these sites, along with cordmarked pottery, results in a superficial resemblance to the Apishapa phase sites in southeastern Colorado and sites Buried City complex. At least four Antelope Creek phase sites/structures have been excavated in the vicinity of West Amarillo Creek. During the WPA era of A.D. 1938 to 1941 Chimney Rock Ruins 51 and 51A were excavated under the direction of Floyd Studer. These two locations are on the northern side of the Canadian River along Corral Creek. A final report detailing the investigations was never completed (Lintz 1986). In A.D. 1967 J. Hughes directed students from West Texas State University (now West Texas A&M University) in the limited excavation of a partially vandalized slab line rectangular structure at the Marsh site near the mouth of Tecovas Creek (Lintz 1986:354-356, 2002). No analysis or report has been published on the Marsh site assemblage, but Lintz (1986) briefly describes the excavations that targeted a rectangular, double vertical slab wall structure. A third site (41PT109) was investigated by students from Texas State University in San Marcos under the direction of B. Bousman. The University field school excavated one Antelope structure near the mouth of West Amarillo Creek on the BLM Cross Bar Ranch property in A.D. 2004 and 2005 (Weinstein 2005; Meir 2007). Hand excavations of 31 m^2 targeted a single slab house structure and limited areas outside the structure walls. The structure's interior yielded few artifacts, which indicated a planned abandonment (Weinstein 2005). Further west in Oldham County a major excavation (2,225 m^2) was conducted at a large Antelope Creek village on top of Landergin Mesa by the Texas Historical Commission (Lintz 1990). Major excavations in this region have primarily been conducted at Antelope Creek phase sites in the Lake Meredith area north of Amarillo (i.e., Duffield 1964, 1970; Keller 1975; Lintz 1986; Couzzourt and Schmidt-Couzzourt 1996; Baker and Baker 2000; Brooks 2004).

The material remains of the Antelope Creek phase are extensive and varied. Settlement types include multifamily hamlets, single family homesteads with clearly defined houses, but few camp sites without structures. The distinctive slab house architecture exhibits a range of stylistic differences (Lintz 1986; J. Hughes 1991; Boyd 1997; Brooks 2004). The residential structures are often rectangular semisubterranean houses with vertical slab walls and a central east west depressed channel with a fire pit and four roof support posts. An entryway and an altar opposite the entryway are often present. Circular Antelope Creek structures of various sizes have also been identified. On hamlet sites, several residential structures may be contiguously aligned into apartment style structures, and these forms tend to be earlier (750 to 600 B.P.) than hamlets with isolated residential structures (600 to 450 B.P.). Pithouses are present at a few sites, although their contemporaneity and association with the Antelope Creek remains is questionable (Boyd 1997; 2008).

In addition to the slab lined houses, slab lined cists have been recorded at Antelope

Creek sites (Marmaduke and Witsett 1975; Lintz 1986; Green 1986; Etchieson and Couzzourt 1987). These have slight variations in that some have slabs on the floor others lack this attribute, whereas still others have a central vertical slab. The function of slab lined cists is still debated.

The Antelope Creek tool assemblage includes triangular, side-notched and unnotched arrow points, oval or lozenge shaped bifaces (sometimes alternately beveled), "guitar-pick" preforms, flake drills, large, thin end scrapers, flake tools, and, more rarely, chipped stone axes and stone hoes (Lintz 1986; J. Hughes 1991; Boyd 1997; Brooks 2004). Ground stone items include flat grinding slabs and deep oval basin metates, one handed manos, sandstone awl sharpeners, and straight and elbow pipes. Bison bone was fashioned into a range of tools that include tibia and scapula digging implements, squash knives, awls, pegs, beads, and bone whistles. Mussel shell scrapers, carved pendants, and shell disc (inlays?) are among the many implements reported from Antelope Creek sites.

The indigenous ceramics typical of the Antelope Creek phase are Borger Cordmarked vessels, usually large globular jars, as well as less common clay beads and miniature pots (Lintz 1986; J. Hughes 1991; Boyd 1997; Brooks 2004). The relatively large jars had round bottoms, relatively thin walls, cordmarked exteriors, and were tempered with crushed rock, sand, and limited amounts of mica, bone and other materials (Perttula and Lintz 1995). Noncollared vessels from Antelope Creek sites in the Canadian River valley are typically tempered with igneous materials (Lintz and Reese-Taylor 1997). Rim treatments are quite variable and include plain, cordmarked, diagonal puntations on the lip, pinched lip rim junctions, a single row of fingernail gouges, diagonal incised lines, and with collared and cambered rims (Lintz 1978b; Perttula and Lintz 1995). Petrographic analysis indicates that noncollared rim sherds from the Antelope Creek phase type localities of Antelope Creek-22, Alibates 28, and Cottonwood Creek Ruins were manufactured from igneous tempered pastes. This reflects the cultural norm within the Canadian River valley (Lintz and Reese-Taylor 1997). In contrast, collared rim sherds from these same Antelope Creek sites were mostly manufactured from sedimentary materials. The pastes from the plain collared sherds from the Roper site in the Oklahoma Panhandle, Cottonwood Creek Ruins site in the core area of the Texas Panhandle, and the Buried City complex sherds in the northeastern Texas Panhandle show similar composition. These similarities reflect similar geological origins of tempers and pastes and probably direct cultural interactions between peoples in the Canadian River valley and those living at Buried City (Lintz and Reese-Taylor 1997). Also the collared rim sherds from the sites in the Canadian River valley have stronger shared paste characteristics with the nearby Buried City complex than with the noncollared sherds from the same sites (Lintz and Reese-Taylor 1997).

Southwestern ceramic pottery has also been recovered from many sites. These include a variety of wares such as Black-on-White, Jeddito yellow ware, Lincoln Black-on-Red, St John's polychrome, and others (Lintz 1986; Brooks 2004). The presence of these various wares indicates trade with Southwestern groups. Lintz and Reese-Taylor (1997) see direct interactions between populations in the Canadian River valley and with those living along Wolf Creek at Buried City.

Instrumental neutron activation (INA) analysis on 75 Antelope Creek sherds from three sites (41PT109, Landergin Mesa, and Alibates Ruin 28), plus 15 natural clay samples, has provided interesting results (Meier 2007). All sherds were chemically very similar based on the Principle

Component analysis. One reason for the general overlap may be the similar nature of the sherd composition, clay and temper. However, the elemental analysis separated these sherds into five chemical groups (Group 1, 2, 3, 4, and 5, Meier 2007). The groups were generally associated with the natural clay samples analyzed from near the selected archeological sites. Four of the five chemical groups contained sherds from at least two of the three archeological sites sampled. Only chemical Group 3 contained sherds from a single site, Landergin Mesa indicating the homogeneity of that group. Apparently, the clay used to manufacture the vessels and/or the actual vessels from these three archeological sites, were transported throughout the region.

The Antelope Creek phase people had a mixed economy involving a combination of hunting, gathering, and cultivation (Duffield 1964, 1970). Charred remains of corn (*Zea mays*), beans (*Phaseolus vulgaris*), and squash (*Cucurbita* sp) have been found at Antelope Creek sites, though the degree of reliance on these crops has yet to be determined (Lintz 1986; J. Hughes 1991; Boyd 1997; Duncan 2002; Brooks 2004; Boyd 2008). Small plant remains have only been targeted for recovery in the last 10 years or so. Recent investigations at village sites that employed systematic flotation and macrobotanical analyses have yielded much more data on plants used by Antelope Creek communities. Charred corn, squash seeds, plus minor amounts of other seeds have been documented (Duncan 2002; Boyd 2008). Plains village sites in western Oklahoma have yielded similar evidence of cultivated crops, plus little barley (*Hordeum pusillum*), maygrass (*Phalaris caroliniana*), knotweed (*Polygonum erectus*), marshelder (*Iva annus*), sunflower (*Helianthus annuus*), and dropseed (*Sporobolus* sp.) (Drass 2008).

Faunal analyses at a few sites indicate that bison was the most important aspect of the meat diet, although a variety of other game animals are represented (Duffield 1964, 1970; Lintz 1986; Duncan 2002). The faunal remains often appear as small bone splinters of crushed and possibly boiled bison bones. It is not always clear if the splintering reflects a cultural or weathering process.

Chemical studies conducted on human bones indicate little change in diet over time for the Antelope Creek populations. However, a difference between the male and female diets has been detected (Levendosky 1987; Habicht-Mauche et al. 1994). Lewis (1998) revealed through paleopathological analysis and nutritional inferences that the individuals from the Footprint site appeared to have a nutritionally balanced diet and the subadults consumed a diet of soft, unprocessed foods. Lewis (1998) interprets that data to indicate an overall pattern more similar to hunter gatherers than to horticulturalists.

Nearly 60 percent of the skeletons investigated by Summers (1997) were reported as representing Plains Village peoples. The burial pattern or means of disposing of the dead varied, with bodies buried in rooms, outside rooms in midden areas, on or above abandoned rooms, under rock cairns, and in some cases, in cemeteries (i.e., Blue Creek or Big Blue Creek; Lintz 1986; Couzzourt and Schmidt-Couzzourt 1996; Summers 1997; Baker and Baker 2000). The four excavated individuals at Blue Creek (LMRA 242) in a cemetery included an infant, a toddler, and two adolescents (Couzzourt and Schmidt-Couzzourt 1996). Two of the four cairns that covered the four individual burials contained smashed Borger Cordmarked vessels. Two of the other burials contained grave offerings of arrows tipped with Washita points (Couzzourt and Schmidt-Couzzourt 1996). At Alibates Ruin 28, most bodies were shallowly buried (less then 60 cmbs) in pits and often covered with large rocks. Several bodies were covered by rock cairns (Lintz 1986; Baker and Baker 2000). The bodies were buried individually in primarily flexed or semiflexed positions (Lintz 1986). Roughly 60 percent of the individuals lacked any type of mortuary offering regardless of the individual's age or gender (Baker and Baker 2000). Lintz (1986) tabulates the different ages and sexes and discovered not everyone was accorded the same treatment. A few grave goods, made of locally manufactured items, were associated with all ages and both sexes, with a slightly higher frequency for adults over children. Lintz (1986) interprets the data to indicate a matri centered society with ascribed or inherited positions, but little or no major status ranking. He goes on to state that the mortuary offerings show parallels with the patterns recorded ethnographically for the Wichita Indians of western Oklahoma.

From the individual skeletons some general biological characteristics for the Antelope Creek populations are discernible, although not much specific data is published. Brooks (2004) presents a summary statement of the most recent interpretations of biological data as determined by D. Owsley's work (unpublished), which is presented here. These people were round headed with a moderate cranial vault. They were of moderate height with few distinguishing characteristics and did not exhibit characteristics of a group under severe nutritional stress (Owsley's comments in Brooks 2004). The biological characteristics studied by D. Owsley indicate little biological continuity between Antelope Creek and the earlier Woodland populations or even with other Southern Plains Village populations (Brooks 2004). Consequently, the Antelope Creek populations probably represent a distinctive group. Their origin is unknown and much additional research is required to answer this important question. The current data indicates that Southern Plains societies and the Central Plains societies were contemporaneous (Brooks 2004).

The Antelope Creek phase is thought to have developed from the earlier Lake Creek/Woodland complex, and represents the southwestern most extent of the Plains Village. However, direct evidence for this development from the Woodland period is lacking as Lintz (1986) pointed out flaws in each of the origin theories of immigration and acculturation. Petrographic studies of collared rim and uncollared rim sherds from six Plains Village sites indicate two separate ceramic paste technologies. This indicates that the cultural unit intrusion hypothesis into the Texas Panhandle is not warranted (Lintz and Reese-Taylor 1997). The Antelope Creek phase populations are relatively unique in the use of contiguous masonry structures that were local attempts to copy Puebloan architecture (Lintz 1986).

A regional variant of the Upper Canark variant, which "is composed for the Plains Village manifestations occurring along and between the upper portions of the Canadian River and the southern tributaries of the Upper Arkansas River" (Lintz 1986:25) is the Apishapa phase. The Apishapa phase is defined along the Apishapa Plateau in southeastern Colorado and also exhibits stone/slab enclosures ranging from single room sites to villages containing close to 60 rooms (Zier and Kalasz 1999). Some Apishapa sites exhibit stone slab walls that appear as fortification/defensive walls that enclose the smaller room or village sites. The chronological placement of the Apishapa phase is best reflected by a statement made by Lintz (1989): "chronological information about the Apishapa phase is hindered by the delineation of cultural attributes encompassing the phase and, until recently, by relatively few absolute dates". Roughly a dozen sites/components have now yielded some 29 radiocarbon dates that place the timing of this phase roughly between 1000 and 550 B.P. (Zier and Kalasz 1999). The apparent initiation of this phase then precedes that of the Antelope Creek complex to the southeast, but for the most part is contemporaneous with the Antelope Creek complex. Lintz (1978a) refuted the idea of an Apishapa to Antelope Creek development, with most researchers now seeing the Apishapa phase having developed *in situ* from indigenous hunter gatherer population (Zier and Kalasz 1999).

Trade relations, especially with Southwestern groups, were extensive, especially in the later half of the phase when climatic conditions had severely deteriorated (Lintz 1986, 1991). Exotic trade materials from the Anasazi populations include painted pottery, obsidian, stone pipes and possibly tobacco, marine shells, and turquoise jewelry that most likely accompanied food from trading partners in wider regions (Lintz 1986; J. Hughes 1991; Boyd 1997; Brooks 2004; Brosowske 2005). The majority of goods exported by the Antelope Creek people are thought to have included Alibates agate, and bison hides, bison meat, pemmican, and perhaps tobacco (Lintz 1990; Boyd 1997; Brosowske 2005). Most prehistoric quarry pits at the Alibates Flint Quarries National Monument in the core Antelope Creek area, are assumed to have been excavated during this period (Brosowske 2005), but direct evidence is lacking. Brosowske (2005) has investigated the development of the exchange between small scale societies in the Southern High Plains from 450 to 1400 B.P. (A.D. 500 to 1500). He indicates that it started with limited transfer of materials during the Early Ceramic period (A. D. 500 to 1200) and later the exchange increased dramatically during the Middle Ceramic period (Plains Village period, A. D. 1200 to 1500). Brosowske (2005) documented extensive use of obsidian during the Plains Village period with most of the obsidian (ca. 80 percent) sourced to the Cerro Toledo in the Jemez Mountains of northcentral New Mexico. The large quantities of obsidian at a few Plains Village sites (i.e., Alibates Ruin 28, Odessa Yates, and Chimney Rock Ruin 51) led Brosowske (2005) to suggest that regional trade centers had emerged and that obsidian from the Jemez Mountains was one of the commodities that was exploited and redistributed at this time. He believes the few sites with large quantities of obsidian are likely candidates for regional trade centers that participated in direct exchange with Puebloan communities (Brosowske 2005:336).

The Antelope Creek phase appears to come to a rather abrupt end around 450 B.P. (ca. A.D. 1500). It has been postulated that pressure from Apache groups (Athabascan speakers) moving into the area from the north, combined with uncertainty of horticulture during drought conditions caused the demise of this manifestation. Evidence of warfare is only evident at a few Antelope Creek sites. Piles of trophy skulls on the floor and human remains in bell shaped pits at the Footprint site, and skulls placed with some burials indicate conflict (Green 1986; Lintz 1986; Brooks 2004). However, none of the 44 burials studied by Lintz (1986) showed any sign of violent deaths. Some burned structures in the core area around Lake Meredith, and possible fortifications along the western margin of the Antelope Creek area (i.e., Landergin Mesa) are other indications of possible conflict. Lintz (1986) has suggested that one possible reason for conflict was the disruption of the well established relationship between the Puebloan societies in northcentral New Mexico and the Antelope Creek populations. Brooks (2004) suggests another possible reason was competition for access to the highly prized Alibates chert resources, like those at Alibates Flint Quarries National Monument, in the core Antelope Creek area. These various hypotheses have yet to be tested with sound archeological data.

3.4 THE PROTOHISTORIC PERIOD (CA. 400 TO 200 B.P.)

The Protohistoric period, sometimes referred to as the Late Ceramic period (Gunnerson 1987), is a relatively short period of considerable change across the Texas Panhandle Plains. It begins with the demise of the Antelope Creek phase. The beginning of this period is the entrance of European (Spanish and French) explorers through the region beginning with the Coronado expedition of 409 B.P. (A.D. 1541). However, throughout most of this period the region was still dominated by Native Americans who had only sporadic interactions with Europeans. As the Coronado expedition left Pecos Pueblo in northern New Mexico and headed east to find "Quivira" in western Kansas, through the Llano Estacado they encountered vast herds of buffalo and two different groups of Plains Indians (Hodge 1907; Bolton 1916, 1949; Hammond and Rey 1940; Schroeder 1962; Winship 1964). This group of Spanish explorers, accompanied by Pueblo Indians, crossed the Llano Estacado, though their exact route is debated (Hoyt 1992; Rhodes 1992). The documents associated with this expedition provide the most extensive and accurate accounts of the Native Americans living on the High Plains. The expedition did not record the existence of any settled group in the abandoned villages along the Canadian River (Gunnerson 1987). Recent discoveries of a Coronado's campsite in lower Blanco Canyon (near Lubbock) casts doubt that his expedition passed within 80 km (50 mi.) of the Landis Property (Boyd 2001).

At about that same time another Spanish expedition, the De Soto Moscoso expedition, entered the eastern part of the Southern Plains of Texas from the east in A.D. 1542 (Bruseth 1992). It is believed this expedition may have reached as far west as Fisher County, some 280 to 300 km to the southeast of the present project area, before heading back east (Stephens and Holmes 1989). Unfortunately, there are almost no first hand accounts available concerning the native populations of the Texas Panhandle from A.D. 1543 to 1750 (Newcomb 1993). As Spanish exploration and later colonization of the upper Rio Grande valley pushed northward from New Spain (now Mexico), there were ripple affects across surrounding areas. With the introduction of the horse, various Native groups became mounted raiders, such as the Apaches who, in the early A.D. 1600s, began to harass the sedentary Pueblo groups of present day New Mexico (Hammond and Rey 1953).

Two Southern Plains groups, the Querechos and the Teyas, are described in the chronicles of the Coronado expedition of A.D.1541 (Hammond and Rey 1940; Bolton 1949). Both groups are described as seminomadic bison hunters who lived in tipis and used dogs for transport. The Teyas were said to be painted or tattooed, whereas the Querechos were not. The chronicles also indicate that the two groups were enemies. Although there is disagreement over Coronado's route, the probable homeland of the Querechos was in the northern Texas Panhandle, in an area extending "from the Canadian River Breaks on the north through the upper drainages of the Red River to the southeast" (Habicht-Mauche 1992:249). The Teya rancherias were first encountered after about five days of travel to the south or southeast, indicating that their homeland was probably among the canyons of the upper Brazos drainage east of present day Lubbock. Habicht-Mauche (1992) equates the Tierra Blanca complex with the Querechos; and the Garza complex, with the Teyas. She argues that the Querechos were almost certainly Plains Apaches, whereas the Teyas were most likely Caddoan speakers. Schlesier (1994) also believes the Teyas were Caddoan peoples.

Following the Coronado expedition, other explorers, Spanish expeditions, and colonists penetrated northward into what is presently northern New Mexico. In 340 B.P. (A.D. 1610)–Spanish expeditions began moving caravans up the Rio Grande valley along the Camino Real, which connected central and northern Mexican settlements with the new Spanish capital at Santa Fe. These caravans brought wagonloads of goods and supplies, as well as livestock (Moorhead 1958). The Spanish came to know the more nomadic Plains Indians through various encounters at the Pueblos and that they resided to the west where the buffalo roam. By the A.D. 1620s the Spanish were well acquainted with the Apaches of northern New Mexico (Worcester 1979).

During this same general period from roughly 230 to 260 B.P. (A.D. 1690 to 1721) Spanish entradas penetrated into central and eastern Texas and began to establish missions. Mission San Francisco de los Tejas was one of the first missions in eastern Texas, established in 260 B.P. (A.D. 1690). Other missions were established, but no closer than Abilene, greater than 350 km to the southeast of the Landis Property.

During the 17th and 18th centuries the Spanish, mostly from the south and west, and French from the east conducted other expeditions onto the Southern Plains, including trips by Juan de Oñate (A.D. 1601; Bolton 1916; Scholes and Mera 1940; Weldel 1942, 1959; Hammond and Rey 1953; Schroeder 1962; Vehik 1986), Harpe (A.D. 1719), Pierre Mallet (A.D. 1739), Jose Mares (A.D. 1787-88) and Pedro Vial (A.D. 1786, 1788, 1792-3). Of these, it is possible that Oñate and Mallet passed through or near Potter County (Vehik 1986), but the others were further from the Landis Property area (Brune 1981; Johns 1975). Mallet's group did record an Indian village in northern Potter County (Brune 1981). The precise routes of these various travelers are uncertain. Their regional descriptions provide only general information about the peoples in the region.

The cultural changes that occurred as Europeans spread their influence into the native populations were quite gradual at first, but Europeans goods (guns, glass, metal, and horses) increased in quantities as time passed. Hofman (1989:91) summarized this period by stating, "The rapidity of economic and technological changes during the period between 400 to 150 B.P. (A.D. 1550 and 1800) has presented keen problems for interpreting the "traditions" of cultural groups via the archeological record during this period".

It is especially difficult to convincingly assign particular cultural assemblages of this age to specific Native groups, even though this is a problem that has received considerable archeological and ethnohistorical attention (e.g., Baugh and Sechrist 1999).

At least two Protohistoric and apparently different ethnic groups are currently identified for the Texas Panhandle region. The two identified archeological complexes, the Tierra Blanca and the Garza, have been tentatively linked to bands of the historic Apachean and possibly the Wichita (Caddoan) groups, respectively (Spielmann 1982, 1983, 1991a; Baugh 1986; Habicht-Mauche 1988, 1992; J. Hughes 1991). These two archeological complexes have not been thoroughly defined and their relationship to each other is yet to be clarified. Some of what has been learned about the Protohistoric period across the Southern Plains has been presented in a publication edited by Johnson (1992).

The Tierra Blanca complex, identified by J. Hughes (1991), is defined for a region just south of Amarillo along the headwaters of the Red River in Randall County (Figure 3-10). This archeological complex reflects a major settlement shift southward from the preceding Antelope Creek phase that apparently had a core area in the Lake Meredith area (Lintz 1991). A second and better defined archeological complex, the Garza complex, is identified even farther south from the Tierra Blanca complex and appears to be concentrated along the headwaters of the Brazos River system near Lubbock, Texas. The Garza complex dates to 295 to 540 B.P. (A.D. 1410 to 1655), roughly the same time as the Tierra Blanca complex and the Protohistoric Wheeler phase (200 to 550 B.P. or A.D. 1400 to 1750) farther east in Oklahoma (Baugh 1992).

It is highly unlikely that our present project location would produce evidence of the Garza Complex. Generally, assigning sites to the Garza complex is based primarily on the recovery of Garza and/or Lott arrow points with their distinctive basal notching. Because of the proximity to this project, only the Tierra Blanca complex is discussed below, which is generally thought to have occupied a region mainly south of the Canadian River.

3.4.1 Tierra Blanca Complex

The Tierra Blanca site (41DF3) in Deaf Smith County south of the Canadian River valley and immediately southwest of Potter County is the type site for this complex (Holden 1931; Spielmann 1982, 1983). This site was investigated at two different times (in A.D. 1930 and 1979 to 1980), but as yet no complete documentation of the findings, description of the recovered materials, or discussion of the stratigraphy has been published. Only cursory summaries have been published (Holden 1931; Spielmann 1982) with Habicht-Mauche (1987) focusing only on the site's ceramics. This important type site is difficult to work with in its present poorly reported state. The interpretations of the excavations indicate that at least two components, three structures and a roasting pit are represented (Spielmann 1982; Boyd 1997). Similar sites are known in Palo Duro Canyon and Tierra Blanca Creek south of Amarillo. Currently, no identified Tierra Blanca complex sites are recorded in the Canadian River valley (Figure 3-10). Although detailed information concerning the original site is lacking, that did not prevent the reporting author (Holden 1931) from designating the materials as a complex.

Boyd (1997) lists four major interpretive problems with this poorly defined concept. First, too few sites have been intensively investigated and reported in detail. Second, chronology is still in question. Third, the material culture has been minimally presented. Fourth, many of the identified components appear to be mixed. A fifth could be that no diagnostic artifacts exclusive to this complex have been defined. Therefore, the following information for this currently loosely define complex should be used with extreme caution. The chronology is based on cross dates of Southwestern trade pottery recovered from Tierra Blanca sites, which probably range from 500 to 300 B.P. (A.D. 1450 to 1650). It has been hypothesized the historic Querechos encountered by Coronado in 409 B.P. (A.D. 1541) and the Farones met by Oñate in 349 B.P. (A.D. 1601) were the peoples responsible for the Tierra Blanca complex (see Boyd 2001 for additional discussions). These groups in turn are currently known as Lipan Apache (J. Hughes 1991; Habicht-Mauche 1992; Boyd 1997, 2001).

Two types of Tierra Blanca sites have been described, large village sites like the Tierra Blanca Ruin and the Blackburn site (Spielmann 1982, 1983). Smaller campsites like Fifth Green (Kalokowski 1986), Tule Mouth (Katz and Katz 1976), Cita Mouth (Habicht-Mauche 1988), Palisades (J. Hughes field notes 1963; Boyd 1997), Fatheree (Hughes et al. 1978:146-153; Boyd 1997), and at least one rockshelter at Canyon City Club Cave (J. Hughes 1971; Boyd 1997), have all been assigned to this complex. Most sites linked to this complex by Boyd (1997) have received only limited excavation and cursory reporting.

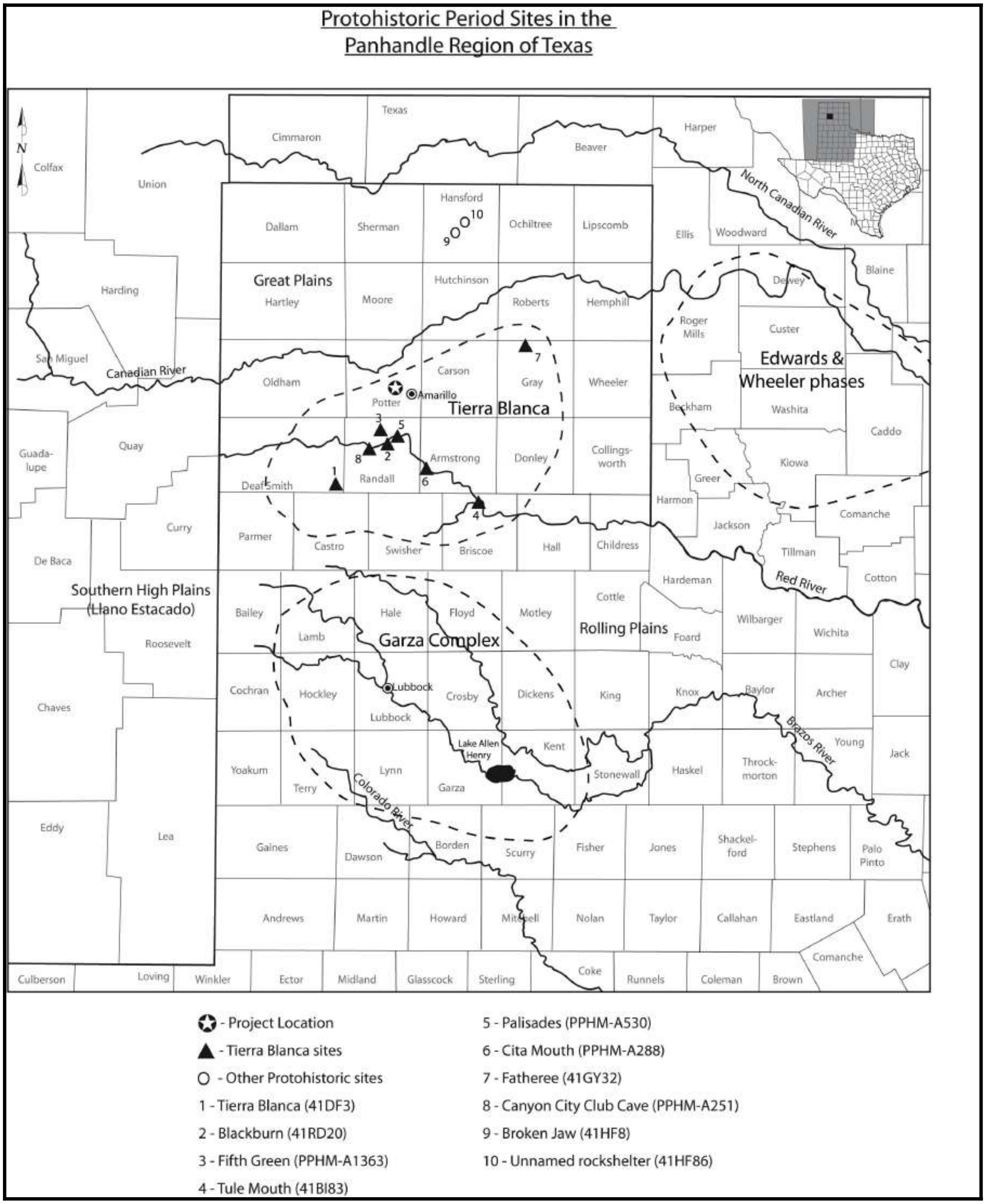


Figure 3-10. Protohistoric Sites Mentioned in Text.

Artifacts associated with the Tierra Blanca complex include side-notched (Washita and Harrell types), and unnotched triangular arrow points (Fresno, and Talco types), and micaceous tempered Perdido plain ceramics and/or Pueblo utility ware pottery. Other aspects of the indigenous assemblage are difficult to discern from the limited existing literature. Most sites typically have yielded abundant quantities of Southwestern trade wares, including Rio Grande glaze wares sherds such as Glaze C and D, and Pecos Glaze Polychromes (Glaze V), obsidian, and marine shell jewelry. The sites appear associated with circular stone alignments (tipi rings?) and roasting pits. Other structures present at the type site of Tierra Blanca may relate to Late Prehistoric II masonry dwellings of the Antelope Creek phase. At the Palisades site, a possible wattle and daub structure was encountered.

The tool assemblages, faunal remains, and accounts of early historic contacts imply the people of the Tierra Blanca complex employed a semisedentary lifeway that involved hunting bison and growing or trading for corn. The presence of Puebloan glazeware ceramics, obsidian, and turquoise reflects trade with or frequent visits to the Puebloan cultures to the west in New Mexico (J. Hughes 1991). This Eastern Puebloan contact around 550 B.P. (A.D. 1400) marks a shift from the previous Antelope Creek phase (Lintz 1991). Near this time, bison hunting again increased across the Southern Plains as did interactions with the Eastern Puebloan area, with bison products and pottery being some of the major items involved in the increased trading. Various authors (Speth 1983, 1991; Speth and Spielmann 1983; Spielmann 1982, 1991a, 1991b; Baugh 1991; Lintz 1991) have presented interesting ideas concerning possible reasons for this increased trade between these two areas.

The Tierra Blanca Plain ceramics were originally described as thin, dark sherds of Southwestern style striated utility ware (J. Hughes n.d. as cited by Habicht-Mauche 1987, 1991). Habicht-Mauche (1987, 1991) added that petrographic slides indicate a coil construction. The vessels were thinned by scraping, possibly with a dry corn cob, causing visible drag marks on both the interior and exterior surfaces. The exterior surfaces vary from well smoothed to fairly heavily striated. Decorations are rare. A few small sherds exhibit traces of two to three parallel rows of fingernail punctuations. The interior surfaces are glossy, coated with a dark film. The vessel walls are uniformly thin, with average sherd thicknesses ranging from 2 to 7 mm and most being 3 and 5 mm. Typically, vessels are less than 20 cm tall, and are squat and globular to slightly elongated jars with rounded bases and gently everted rims (Habicht-Mauche 1991). Paste has a silty appearance, and is tempered with medium to course particles of silica rich crushed rock with various amounts of mica. Since A.D. 1987 all of the striated culinary pottery from the Southern Plains has been assigned to a single type, Tierra Blanca Plain (Baugh and Eddy 1987). Habicht-Mauche (1987) even states that "it is virtually impossible to separate sherds of Tierra Blanca Plain from those of Rio Grande striated utility wares on the basis of stylistic and technological attributes alone". She goes on to state that these two wares are generically linked and part of a shared ceramic tradition (Habicht-Mauche 1987). Habicht-Mauche (1991) stated the striated ware from individual sites in the Rio Grande valley is internally quite uniform. In contrast, Tierra Blanca Plain ceramics from sites on the Southern Plains vary far more in terms of specific attribute categories. Habicht-Mauche (1991) conducted comparative petrographic analyses on a sample of striated sherds from the Southern Plains. Petrographic analysis of sherds from three Tierra Blanca complex sites (Tierra Blanca, Fifth Green, and Cita Mouth) indicates that 80 percent were manufactured from materials locally available on the southern High Plains (Habicht-Mauche 1991). The clays were tempered with subrounded to subangular grains of unconsolidated quartz feldspar sand. Therefore, she contends that hunter gatherer groups of Southern Plains were producing culinary pottery patterned after contemporaneous Pueblo vessels from north central New Mexico between 450 and 650 B.P. (A.D. 1500 and 1700). She sees this spread of the Puebloan ceramic technology into the Southern Plains as part of a highly integrated and complex system of economic specialization and regional interdependency (Habicht-Mauche 1991:52).

Boyd (1997) has many concerns over the ceramic assemblage reported by Spielmann (1983) and Habicht-Mauche (1987, 1991) and how it is interpreted. Boyd and Reese-Taylor (1993) believe that the majority of the striated plainware sherds from the Tierra Blanca site, which were typed as Tierra Blanca Plain by Habicht-Mauche (1987, 1988), are actually Puebloan plainwares. Boyd et al. (2002) obtained independent results from neutron activation analyses (*N* = 66) and petrographic (*N* = 53) analyses on sherds from the Protohistoric Longhorn and Headstream sites in Lake Allen Henry (formerly Justiceburg Reservoir) in Garza County, revealing that the majority of plainwares from those two sites are from pots that are similar in composition to the glaze wares and red wares of the Puebloan villages in northern New Mexico. Boyd et al. (2002) believe their findings support the idea that the plainwares were not made locally, but were imported. However, the geology of the two regions is very similar and care must be used in interpreting the composition of the sherds. Further research into the differences will require additional detailed petrographic and neutron activation analyses of large collection of sherds and clays from several sites that exhibit good context, in order to sort through the complexities of the pastes and temper used in the construction of these various plainware vessels.

At least two or three sites of similar age (Broken Jaw – 41HF8 and 41HF86) have been excavated and documented in the very northern reaches of the Texas Panhandle, but the ceramic sherds from those sites were not assigned to a specific archeological complex (Quigg et al. 1993). These more northerly ceramic assemblages are similar to the Tierra Blanca complex ceramic assemblages, but as discussed above, the latter are not presently that well defined.

In Garza County some 300 km southeast of the Landis Property are two of the rare excavated and well documented Protohistoric sites. Both are attributed to the Garza complex, but are presented here because of the wealth of the information they provide. These two sites (41KT51-Headstream and 41KT53 Longhorn) were part of the Lake Allen Henry (Justiceburg Reservoir) project (Boyd 1997). The data recovery at Headstream documented a multifunctional base camp of repeated Protohistoric occupations during the mid seventeenth century (ca. 300 B.P. or ca. A.D. 1636 to 1656). The hand excavations (86 m^2) yielded five cultural features including a midden, a disturbed rock lined hearth, two small unlined basin hearths and a baking pit. The excavations also yielded 4,499 specimens that included nearly 80 percent chipped stone artifacts and 20 percent ceramic artifacts. Only six of the 21 arrow points were classified into types, five were unnotched Fresno and one was Lott-like. Fifteen end scrapers were identified with 13 manufactured on large blades. The ceramic assemblage (*N* = 887) represents at least seven vessels and three pipes. One pipe was classified as a Pecos style pipe. The vessels are grouped into five categories and include plain utility, micaceous utility, redware, glazeware, and matte paint ware. Specific identified varieties include Tewa Polychrome, red slipped sherds of the Tewa tradition, unslipped and slipped redware sherds of Puebloan origin, and Pecos Glaze V polychrome (Boyd 1997). The source of the plain and micaceous wares was not positively identified, but the sherds appear similar to Puebloan made plain and striated utility wares, or to the Tierra Blanca Plain type. Petrographic study on selected sherds indicates that most of the plainware samples are similar in composition to decorated Puebloan made wares, indicating a Puebloan origin (Boyd 1997; Boyd et al. 2002). Other artifacts include three obsidian flakes sourced to the Cerro del Medio locality and two faceted cobalt blue glass beads, the only indication of European contact.

Extensive hand excavations (340 m^2) at the Longhorn site yielded a rich cultural assemblage (*N* = 9,028) that represents a multicomponent residential base camp with tipi rings dating between 550 and 200 B.P. (A.D. 1400 and 1700). Fifty cultural features were identified and include basin and ephemeral hearths, hearth dumps, ceramic clusters, post molds, and rock clusters, which indicate the presence of at least three tipi structures. The lithic debitage reflects nearly 76 percent use of nonlocal Edwards chert. The tool assemblage is dominated by unifacial end scrapers. The rare projectile points include six Fresnos, three Washitas or Harrell-like, and three Lott-like. The ceramic assemblage was fairly sizeable (2,595 sherds that represent a minimum of 24 vessels and 4 pipes) and variable, with Tewa Polychrome, Pecos Glaze V Polychrome, glaze painted wares, Salinas Redware, and various micaceous plainwares represented. The plainwares are similar to Puebloan made utility wares. Other artifacts include *Olivella* shell and turquoise beads. Historic artifacts include five sherds of blue-on-white majolica, an iron fragment, a lead ball, and four possible native made gun flints (Boyd 1997). At least two European animals, a longhorn cow and horse, were also represented. The site's occupants probably were regular participants in the Plains-Pueblo trade fairs.

The termination of the Tierra Blanca complex tends to coincide with the timing of the Comanche intrusion to the Southern Plains region by roughly 250 B.P. (ca. A.D. 1700). This change is an effective termination point for the Protohistoric period. Other indigenous people utilized the area, but they used an increasing amount of nonlocal goods obtained from Spanish, French, and American traders.

3.5 Historic Period (ca. post 200 B.P.)

Many Native American groups were drawn to the Southern Plains to gain access to Spanish domesticated horses from the New Mexican settlements. Throughout much of the seventeenth century the Apaches reigned throughout most of eastern New Mexico and western Texas. Sebastian and Levine (1989:98) point out that the first detailed account of the Apache settlement and subsistence did not occur until A.D. 1796 (Matson and Schroeder 1957).

Among the list of ethnographic groups that reportedly visited the "Dry Cimarron" part of northeastern New Mexico during the historic period were the Cheyenne, Arapahoe, Kiowa, Kiowa-Apaches, Comanches, with documented forays by the Utes, Shoshones, Pawnees, Blackfeet, Sioux, and Gros Ventres (Winter 1988:119). By the 224 B.P. (A.D. 1726), the Comanches replaced the Apaches as the resident Native American populations in the upper Texas Panhandle region. By the 150 to 125 B.P. (A.D. 1800 to 1825) the Kiowa moved into the region from the Black Hills region, and over the next 25 years, the Cheyenne and Arapahoe who moved south from western Wyoming joined them. By about 110 B.P. the (A.D. 1840s), the Kiowa, Kiowa-Apache, Comanche, Cheyenne and Arapahoe made peace with each other and unified their interests against the encroachment of nonIndian people into the region. For roughly 30 years between about A.D. 1848 to 1880 the American military conducted exploring expeditions and protection operations through this general region. The Comanches and other Southern Plains groups generally prevented settlement of the region by most EuroAmerican groups until the conclusion of the Indian Wars of 84 to 75 B.P. (A.D. 1866 to 1875, Nye 1968). The well preserved and extensive metal goods and assemblage from a well documented child burial less than 200 years old, about A.D. 1830 to 1850, such as the Canyon Creek site (41OC13), cannot be readily assigned to a specific known Plains Indian group (Shafer et al. 1994). This latter burial included many small metal tinkler cones attached to skin bags. Therefore, assigning older cultural assemblages to known/named Native groups is highly questionable.

The historic ethnicity of the original Native American people who occupied the Texas Panhandle during the Late Prehistoric II and into the Protohistoric period is not clear. Boyd (2001) addressed the issue regarding ethnic affiliation in the Texas Panhandle. It is likely Caddoan speakers such as bands of the Wichita or Pawnee were present since similarities exist in the material culture in these Late Prehistoric groups. Oral traditions among the Pawnee imply that they moved to central Nebraska from a southwestern direction where they lived in stone houses (Grinnell 1893:224). Shortly before the arrival of the first Spanish explorers such as Coronado in 409 B.P. (A.D. 1541), the local populations were displaced by Athabaskan speaking interlopers in groups we now recognize as Apaches. Generally, the Apaches are thought to have entered and occupied the southern Plains between 550 and 250 B.P. (A.D. 1400 and 1700; Gunnerson 1956; Schroeder 1974; Schaafsma 1981; Wilcox 1981). Gunnerson (1992) citing Hammond and Rey (1940) indicate the Apaches arrived in the southwest in 425 B.P. (A.D. 1525) shortly below the arrival of Coronado. In 350 B.P. (A.D. 1600) Ornate found these same peoples living in the same way (Hammond and Rey 1940). Gunnerson (1992) goes on to say that from south of Las Vegas, New Mexico to the northeastern corner of New Mexico that Apache sites dating from about 350 B.P. (1600s) until about 200 B.P. (mid-1700s) have been investigated archeologically with insights from the Spanish documents of Ulibarri and Valverde (Thomas 1935). The area he is discussing is in northeastern New Mexico and southeastern Colorado and definitely west of the Texas Panhandle.

Gunnerson (1969, 1987:114) suggests that the Jicarilla Apache had moved to the Rio Grande valley in New Mexico and settled near Ranchos de Taos, where they were reported in roughly 200 B.P. (mid-A.D. 1700s). It potentially was a past relationship that promoted or allowed the extensive trade networks that are envisioned for material coming from northcentral New Mexico to the plains. Gunnerson (1987) believes that a pottery type labeled as Cimarron Micaceous (currently a late type [post A.D. 1750] under the Mora Series of the Sangre De Cristo Micaceous Ware; (Baugh and Eddy 1987; Brunswig 1995) is linked to the Jicarilla Apache. He says this pottery is thicker than that of the earlier Ocate Micaceous (an early type under the Mora Series of the Sangre De Cristo Micaceous Ware) pottery and includes a marked thickening or splaying of the flattened lip of many ollas with striations from smoothing with corn cobs. The Cimarron Micaceous ware is thought to have been molded and finished using the paddle and anvil technique (Gunnerson 1969). The two types are generally thought to be distributed across northeastern New Mexico and southern Colorado, although Cimarron Micaceous types have not been identified in southern Colorado (Brunswig 1995). It has yet to be determined if these wares are present in the panhandles of Oklahoma and Texas. The Cimarron Micaceous wares are nearly always accompanied by metal, glass, and other items dating in the A.D. 1850's through 1870's (Gunnerson 1969:38).

For comparative purposes the Sangre de Cristo Ocate Micaceous type (postulated for pre A.D. 1750) is described as follows and is taken from Brunswig (1995:188-190). It was constructed by both hand forming and coil methods with paddle and anvil thinning, although the exterior surfaces were then scraped leaving vertical and horizontal striations from corn cobs. The paste is compact and has a fine texture. The temper includes moderate to heavy quantities of very fine to medium fine quartz sand, very abundant mica flakes. Vessel forms include globular pots with mostly out flaring to vertical rims, with bottoms that are flat to round. Vessels range from 12 to 35 cm in diameter, 20 to 45 cm tall, with thin walls ranging from 1.5 to 6 mm in whole vessels, with a mean thickness of around 3.5 mm. Rim lips are mostly tapered to rounded and uniform. No decorations are present, although the exterior surface exhibits corn cob scraping striations. In a rare instance or two sectioned rows of small punctations made with an elongated sharp tip tool are present.

Opler (1971) and others have indicated "that the making of pots was generally practiced among Jicarilla women, for the instruction in the craft was a normal part of the training of the girl". Earlier (1938) Opler (cited in Opler 1971) has shown that the supernatural instructed the woman in the manufacture of various pots and in a dream informs her how they are to be used and what names to give them. Opler (1971) makes a very noteworthy statement and indicates that "clay for pots and pipes was obtained by the Jicarilla from a spot in the mountains about 29 km (18 mi.) southeast of Taos". Members of both bands were free to gather their supplies of clay from the same place, which had the status of one of the important Jicarilla holy spots". The clay there contains natural mica and is referred to as micaceous clay. This is a very critical statement in that there is a close resemblance of Jicarilla pottery to that made at Taos and Picuris.

Just a short distance north of this Landis Property and crossing West Amarillo Creek in an east west direction, is an apparent historic trail that Lintz (2002) refers to as the Fort Bascom – Elliot Trail. Fort Bascom was near Tucomcari, New Mexico on the southern side of the Canadian River. The Fort was established in A.D. 1863 during the Civil War to police the region and control the Native Americans. Colonel "Kit" Carson was once station there and led a group of soldiers in the Battle of Adobe Walls of A.D. 1864 in the Texas Panhandle.

4.0 RESEARCH DESIGN

J. Michael Quigg

This archeological research design established an explicit framework for conducting the subsequent field investigations, analysis, and presenting interpretations of recovered and documented remains (Quigg 2005). This provides a theoretical orientation drawn from general concepts and models, and relates those to region specific problems in a way that both enriches general theory and, at the same time, places regional issues in a broader, comparative light. From this theoretical point of departure, the research design identifies how the anticipated findings of the specific project may be used to address explicit issues and questions, and thus guides and justifies the various methods employed. The end result synthesis and maximizes the interpretive information recovered from the investigated sites. It also provides a substantial contribution to an understanding of how general behavioral processes are expressed on the region's historically unique stage.

4.1 General Theoretical Orientation

This project deals with archeological remains that occur within a specific environmental region – the Southern Plains -- and that represent human occupation over the last 3000 years and significant cultural variation along an historical evolutionary trajectory. Accordingly, the theoretical orientation employed here makes use of concepts drawn from a broad range of theoretical approaches, including cultural ecology and cultural evolutionary theory.

One essential tenet of this synthetic approach is that humans adapt to specific environments, and cultural ecology provides one useful framework for interpreting the archeological findings. Cultural ecology assumes that the way a group adapts to its environment influences its overall cultural configuration (Steward 1955). Steward distinguishes cultural ecology from environmental or economic determinism. Unlike deterministic approaches, cultural ecology asks "whether the adjustments of human societies to their environments require particular modes of behavior or whether they permit latitude for a certain range of possible behavior patterns" (Steward 1955:36). Deterministic approaches already have the answer to this question and proceed from there.

Early work in cultural ecology may have had a deterministic tendency, assuming that specific cultural features were determined by ecological factors, but later studies moved away from this. Later writings examine complex and variable relationships people have with their natural and cultural settings (e.g., Anderson 1973; Helm 1962; Vayda and Rappaport 1968). The study documented in the present report does not presume that any specific feature of culture is determined by environment. As with other schools of thought in anthropological theory, cultural ecology takes a holistic view of culture. It assumes that "all aspects of culture are functionally interdependent upon one another," but recognizes that there are different degrees and kinds of interrelationships among features of a culture. The features that are most interdependent are part of what Steward calls the "cultural core": the constellation of features, which are most closely related to subsistence activities and economic arrangements. The core includes such social, political, and religious patterns as are empirically determined to be closely connected with these arrangements (Steward 1955:37).

Cultural ecology gives primary attention to these features, which are involved in adapting to the environment. Alterations in a group's adaptation to its environment should be reflected in changes in demography, relationships to natural habitats, technology, and strategies for resource procurement and processing. Archeology provides the time depth necessary for tracking long term changes in cultural adaptive patterns, and the ways in which people responded to changing opportunities and constraints in their environments.

The Southern Plains is particularly well suited for cultural ecological studies. For one thing, it is a marginal environment, and data suggest that people may have occupied the Canadian River valley during different seasons and/or during periods of environmental change (Dean et al. 1985; Euler et al. 1979; Gumerman 1988; Schoenwetter and Dittert 1968). Furthermore, researchers, such as Cordell (1980) and Anschuetz (1984), have developed models based on a cultural ecological approach.

Human culture, however, has evolved to satisfy not only bare subsistence needs in particular environmental settings, but also to provide cognitive "maps" that allow human groups to carry on and reproduce their social structure and ideological systems within complex webs of interaction. Importantly for archeologists, the cognitive map of culture involves the use of material traits which serve as visual cues that help channel and structure culturally embedded perceptions of the world (see Boyd and Richerson 1987; Wobst 1977). The potential variation of cultural behaviors and associated marker traits is such that a broad range of evolutionary outcomes may be possible from any given "starting point."

These evolutionary possibilities are conditioned as much by essentially random historical circumstances and mutation-like variation in human behavioral patterns as they are by the economic exigencies of wresting a living from a particular environment, hence the profound diversity in human cultures. At the same time, the nature of cultural learning is such that, once a particular set of culturally instilled patterns of behaviors and marker traits is established, such patterns will constrain and channel the direction of subsequent change by providing a unique, culture specific pool of variation upon which evolutionary forces can act (Gould and Lewontin 1979). As a result of evolutionary processes and particular historical conditions, minor cultural variation between two groups at one point can lead to wide differences over time, with each group following its own divergent evolutionary course (Boyd and Richerson 1985). Thus, archeologists and historians can recognize both diversity between different areas and regions, and long term continuity within particular regions. For archeologists, these patterns typically are characterized as cultural traditions that, in turn, can be subdivided into spatial temporal units such as periods and phases.

Cultural learning processes evolved to provide humans with an efficient mode of reproducing themselves socially, politically, and ideologically. As a result, humans are constrained by these culturally informed behavioral patterns, many of which recur cross culturally. Such recurrences include social organizational patterns such as those characterized within evolutionary typologies (e.g., Fred 1967; Service 1962; Johnson and Earle 1987), or organizational modes, simultaneous hierarchies versus sequential hierarchies (see also Braun 1991) and corporate versus network hierarchies (see Feinman et al. 2000). Other human behavioral convergences have been discussed in terms of interactional models such as Wobst's (1977) information exchange theory, the peer polity interaction model (Renfrew and Cherry 1986), or world systems theory (see Chase-Dunn and Hall 1991). Recurrent forms of architecture—and evolutionary trends in architectural forms—may reflect cross cultural behavioral patterns variously associated with similarly recurrent environmental conditions, economic patterns, and social organizational structures. Parallel developments in domestication and agriculture in different regions of the world provide another example of cross cultural convergence. Thus, despite the great diversity of human cultures, there are many behavioral convergences that reflect humanity's common evolutionary heritage and are relevant to an understanding of the archeological record in any particular cultural historical context.

Using this theoretical orientation as a point of departure, the anticipated findings at the three investigated sites can be considered from a comparatively broad and informed perspective. The occupations at these sites represent highly localized and chronologically momentary residues of human activities conditioned by specific cultural historical contexts. At the same time, patterned behaviors are expected to derive from human cognitive structures and learning processes. This dual perspective is offered as a means of enriching an approach to region and site specific research problems.

4.2 RESEARCH ISSUES

In general, research issues for the Southern High Plains region are poorly developed because of the scarcity of comprehensive excavation data sets from across the Texas Panhandle. Early excavations conducted at numerous Antelope Creek sites in conjunction with a few reservoir specific investigations have not been thoroughly analyzed or reported, and no large scale excavations have been conducted in the region in the last 30 years. A few general regional or culturally focused summaries provide broad directions for identifying data gaps (Baugh 1986; Boyd 1997; Hofman et al. 1989; Hughes 1991; Lintz 1986). However, much of the data in the summaries are derived from very broad regions.

Due to the paucity of known information, the important research issues, research questions, and data sets for the Southern High Plains region are very generalized. Since no substantial historic corollary is known for these sites, the research issues pertain to the period before European settlement of the area and inferences about culture prehistory cannot benefit from the direct historical approach. Key research issues consist of the following areas of inquiry (Table 4-1).

4.2.1 Chronology and Cultural Affiliation Issues

General research questions center on the age of the identified or recognized components and cultural patterns represented within each site. Discerning the age of the occupational components is critical for comparing the assemblage to other sites in the region and for discussing the rate of culture change.

The age of the component(s) can be derived from several chronometric procedures. Charcoal, the most reliable material for radiocarbon dating, is usually present in buried feature contexts. Charcoal is present in most site components during the last 3,000 years. If charcoal is not present in abundance, but occurs only as very small pieces, it is necessary to employ the more expensive Accelerator Mass Spectrometry (AMS) method. Recently, AMS dates have been obtained using organic residues extracted from burned sandstone cooking rocks. The results are in general agreement with standard radiocarbon dates on wood charcoal from the same features (Quigg and Cordova 2000; Quigg et al. 2001; Quigg et al. 2002a). Thus, in situations where charcoal is not associated with specific features, it is now possible to date specific behavioral events where sandstone has been employed in cooking features.

The antiquity of occupation zones can also be derived from radiocarbon dating of animal bones, snail shells, and mussel shells, which may be directly, associated with buried occupation surfaces.

Table 4-1. Potential Research Issues

Features	Yes		Yes	Yes	Yes	Yes	Yes
Tool assemblages	Relative		Yes	Yes	Yes	Yes	
Projectile points	Relative		Yes	Yes	Yes	Yes	
Burned rock	Possible	Residue	Residue	Yes	Yes	Yes	
Ground stone			Yes	Yes	Yes	Yes	
Bone	Date	Yes	Yes		Yes	Yes	
Mussel shells	Date	Yes	Yes		Yes	Yes	
Lithic debitage				Yes	Yes	Yes	
Ceramic sherds	Date		Yes	Yes	Yes	Yes	Yes
Charcoal	Date	Possible					Yes
Matrix	Date	Isotopes					
Macrobotanical	Date	Possible	Yes		Yes		Yes
Cultural stratigraphy	Relative		Yes	Yes	Yes	Yes	
Natural stratigraphy	Yes	Yes					
Phytoliths		Yes	Possible		Possible		Yes

Ceramic sherds used in cooking can contain residues that can be dated by the AMS technique (Quigg et al. 2002b). Aggressive chronological studies in stratified sites are lacking across much of the region and every possible means must be employed to date these components and their associated archeological assemblages.

The cultural affiliation of specific components is usually defined on the basis of associated "diagnostic" tool forms, especially projectile points or ceramic pottery types. Although there is no necessary correlation between a single diagnostic tool form and a single cultural group, the occurrence beyond a single site of a basic form (e.g., side-notched point tradition) often denotes contemporaneity and shared cultural interactions. The diagnostic points and ceramic sherds from the various components will allow comparisons between contemporaneous assemblages.

Substantial diversity of diagnostic tool forms on a single occupation surface might represent contemporaneous or near contemporaneous use of the site by a) groups participating in different manufacturing traditions, b) trade/exchange of tools between groups, c) artifact recycling, or reuse of tools from older occupations, or perhaps d) diversity in technological strategies used by a single group. Some of these possibilities may be delineated provided that the samples are of sufficient size.

Research Questions

What are the ages of specific cultural occupations at each of the sites investigated? Can a meaningful temporal framework from the stratified deposits at these sites be constructed? Can the chronology of the morphological diagnostic materials be refined? What is the timing of the natural depositional events here and how do they contribute to understanding the cultural assemblages contained within the pertinent sediments?

Data Needs

Materials that can be radiocarbon dated include charcoal, bone, shell, burned rocks, pottery, burned clay, and bulk sediments (organic fractions). Other techniques of dating are not yet regarded as viable for this region given that the prerequisite data are not regionally available (e.g., archaeomagnetic dating), the resulting margins of error are unacceptably large for meaningful interpretation (optical luminescent dating), the required materials are not apt to be present (dendrochronology), or the age estimates of the methods exceeds the expected antiquity of people in the region.

Analytical Methods and Approaches

Obtain multiple radiocarbon assays on cultural materials from each recognized component. Identify diagnostic artifacts (projectile points and pottery) from each component. Conduct radiocarbon dating of identified sediment packages from the various depositional units encapsulating the cultural components at each site and throughout the West Amarillo Creek valley.

4.2.2 Subsistence and Resource Variability Issues

The economic resources exploited by prehistoric people provide important insights into the way people organized themselves and moved about the region. Select kinds of subsistence data inform us as to whether the people practiced a specialized or generalized economy.

Although the prehistory and cultural sequence of the Texas Panhandle is in a formative stage of development, there is general agreement that many of the prehistoric groups throughout the region were hunter-gatherers, with the probable exceptions of the Palo Duro, Buried City, and Antelope Creek complexes. In either case, clarification of subsistence practices and mobility patterns are key research issues in the region for the relevant time periods. The diachronic investigations of subsistence remains from single stratified sites or multiple sites of different ages in the same area are ideal for examining changes in the environment and/or in subsistence practices, since the geographical variables are controlled. Differences in subsistence remains (bones, mussel shells, and charred plant remains), residues (lipids), phytoliths, and cultural implements between identifiable components may reflect variations in group size, duration of occupation, season of occupation, size and configuration of resource catchment area around the site, and the focused (specialized) or diffuse (generalized) resource exploitation strategies employed by the people who utilized the site.

Preservation of faunal remains is generally poor in open-air sites scattered across the uplands, but better preservation is expected in alluvial deposits along small streams, as indicated by bone (deer/pronghorn, bison, and rabbit) recovered from all three sites in the present project area. Some marked seasonal differentiation is expected in the faunal and floral assemblages based on temperature variability between seasons that might provide insight into subsistence practices. Butchered bones were documented in the target sites. These remains may significantly contribute insights into the subsistence patterns and seasonal variability for the various components. Mussel shells and macrobotanical remains were also recovered from these sites, indicative of the variety of species exploited. The recovery of robust data on component/site subsistence must rely on both direct and indirect data. Deer and bison tooth eruption and wear pattern studies, which are predicated on a relatively brief yearly calving season necessitated by short growing periods, may also contribute to identification of seasonal hunting patterns. The general birthing seasons for deer/pronghorn and bison may contribute to understanding seasonal procurement of these species through identification of age groups represented by bone samples. Many plant remains may have lengthy storage life and thus tend to be poor indicators of seasonal use. Species identifications (e.g., deer/pronghorn, bison, rodents, etc.) may reveal exploitation of specific habitats, ranging from the immediate creek area or the more distant Canadian River, or points beyond.

Research Questions

What specific resources were prehistoric people utilizing at each component in these three sites? Did they alternate between hunting and gathering on a seasonal basis? Were domestic crops being grown along this creek valley? Did the resources exploited here provide a nutritionally complete diet, or did they comprise only a set of supplemental resources used during times of stress? Were relatively sedentary groups exploiting the West Amarillo Creek valley on a seasonal basis to supplement their horticultural economy? How were raw subsistence materials being extracted and processed for consumption? Did Protohistoric groups employing the horse rely on the same subsistence resources as did their prehistoric forebears prior? Can the transition from hunter-gatherer to horticulturalist be identified in this valley?

Data Needs

Critical data needs for addressing subsistence issues include the recovery of; identifiable macrofloral remains, identifiable terrestrial and aquatic faunal remains, identification of phytoliths from feature matrices, documentation of carbon and nitrogen isotopes values from residues on/in burned rock, interpreting lipid residues from burned rock and stone tools, and using high-powered use-wear analyses of stone tools to ascertain the relative frequency of tools used on plants, wood, bone, or hides. Seasonality data can be obtained from ecofacts such as fish otoliths, deer and bison teeth, and complete mussel shells. Resource use can also be inferred on the basis of selected blood residue and pollen washes from stone tools.

Analytical Methods and Approaches

Taxa identification (genus and species level) of the faunal assemblages from each of the components. Conduct taxon identification on recovered macrobotanical plant material. Conduct stable carbon and nitrogen isotope analysis on residues from burned rocks and pottery sherds from various contexts in each component. Perform lipid residue analysis on selected burned rocks and pottery sherds from various contexts. Undertake phytolith analysis from selected features. Conduct detailed analyses on seasonally sensitive items such as bison teeth.

4.2.3 Settlement and Community Pattern Issues

These research issues relate to the frequency and scheduling of peoples' movements across the landscape. The duration of occupation is reflected in the kinds of habitation structures used as well as seasonal indicators. The ethnohistoric characterization of the indigenous historic groups suggests that the people were relatively nomadic hunter-gatherers with a generalized and limited artifact assemblage suited for a mobile existence. However, this adaptation might reflect breakdown of traditional patterns as populations were impacted by introduced Old World diseases, which preceded most European/EuroAmerican explorations of the region. Presumably, the introduction of diseases and the horse had notable effects on indigenous demography and lifeways and influenced patterns of mobility and settlement.

Research Questions

What kinds of structures and small features were built and used in each of the components and did these changes occur during the last 3000 years? Does the tool assemblages and other cultural debris represent permanent year around occupations, short-term campsites, or resource extraction localities in each component and were there identifiable changes in these patterns through time? How large were the populations? What kinds of activities occurred in these small creek valleys in this upland setting? What was the duration of each occupation? In what season did each occupation occur?

Data Needs

Recognizable features (structures, storage pits, campfires, etc.) and horizontal patterning of cultural debris. Measures of tool diversity as a proxy for generalized or specialized adaptive patterns. Floral or faunal remains indicative of seasonal use. Artifact density measured against rates of landform deposition/stability. Horizontal patterns in the material distributions within identifiable components.

Analytical Methods and Approaches

Collection of metric and nonmetric data on features to categorize feature function. Conduct lipid and isotope analyses on burned rocks and pottery to help in identifying feature/vessel function and component use. Analyze the horizontal patterning of cultural materials and features in the various components to identify habitation intensity and related functions.

4.2.4 Exchange and Regional Interaction Patterns

The prehistoric populations of our study area did not reside in complete isolation from one another. Artifacts held in private collections, indicate that the peoples previously living in the Amarillo region may have had considerable contact with adjacent groups, as reflected by the nonlocal cherts from the north, pottery from adjacent regions, obsidian from the west, lunate stones from burials, and tubular stone pipes (Boyd 1997). In the late Holocene, some hunter-gatherer groups were occupying much of the Southern Plains with neighbors on either side practicing more sedentary lifeways involving horticulture. Those horticultural groups (Antelope Creek and Palo Duro complexes) also moved into the plains region and may have had contacts with more distant groups.

Research Questions

What is the direction and intensity of contacts with other groups? What is the material being imported and or exported from/to the adjacent groups? What is the relative degree of isolation and self sufficiency of groups during the Late Holocene? How dependent were the local inhabitants on nonlocal resources from adjacent areas? Group interactions conducted seasonally or year round?

Data Needs

Exotic/nonlocal artifacts, including such materials as marine shells, obsidian, or other exotic tool stone, nonlocal pottery types, or other ornamental stones. Specific identifiable food resources need to be present. Knowledge of the various source localities for the identified lithic resources and ceramic sherds recovered.

Analytical Methods and Approaches

Macroscopically identify the lithic materials (tools, debitage, etc.) as to the material type. Identify the pottery types present and determine the original clay source through petrographic and instrumental neutron activation analysis (INAA). Conduct sourcing analysis on the obsidian recovered. Determine the frequency of the nonlocal material versus the local materials to address the intensity of interactions and degree of reliance on other sources.

4.2.5 Geomorphological and Paleoenvironmental Issues

Paleoenvironmental data establishes the past environmental context that created opportunities and constraints on prehistoric peoples in the area and supplies baseline information for identifying human adaptations and adaptive change. Holliday (1995) has provided significant new information on the stratigraphy and paleoenvironments of late Quaternary valley fills on the Southern High Plains, but that work focused on the Brazos and Colorado River drainages just to the south and not the Canadian River system. The paleoenvironmental conditions are broadly postulated for this part of the Texas Panhandle. Baerreis and Bryson (1965) proposed that the Canadian River valley received greater precipitation between 700 and 500 B.P. Few site specific proxy data have been gathered to define the nature of the prehistoric environment in the local region. Present data indicates dramatic changes in the late Holocene climate of the Southern Plains. The Llano Estacado has been grassland for at least the last 20,000 years (Holliday 1995). Identifying the fluvial dynamics of West Amarillo Creek can aid in reconstructing paleoenvironmental conditions. Documenting channel migrations, periods of alluvial and colluvial deposition, rates of deposition and erosion, and ponding, will contribute to modeling past conditions.

Research Questions

Did the alluvial deposits in West Amarillo Creek provide long periods of stable landforms for prehistoric occupations? At what specific points in time did the climate create depositional changes that might cause vegetation changes necessitating adaptive response by the peoples in the area? If environmental change has occurred, how rapid were the changes and did they affect the human population? Was the timing of environmental change synchronous with changes in the valley dynamics and alterations in material culture so that a causal relationship can be postulated? If climate change is detected, what influence did it have a peoples practicing a horticultural way of life in the West Amarillo Creek valley? Was West Amarillo Creek valley mostly covered in warm dry grasses over the last 4,000 years, creating a stable vegetation pattern?

Data Needs

Geomorphological data, including detailed documentation and understanding of the different depositional packages and periods of stability and erosion, are needed to infer climatic trends and changes. This includes a dated sequence of various depositional units from different settings and a clear understanding of the sediment units themselves. Other paleoenvironmental proxy data including phytoliths, stable isotopes on sediments and bison bones, macrobotanical remains, and faunal remains, will all contribute to modeling the broader paleoenvironment. The research should also clarify what kinds of materials are preserved in the open-air sites in the Texas Panhandle. Suitable pollen recovery has been difficult to obtain, but phytolith and stable carbon isotope analyses hold considerable promise as methods widely applicable for obtaining clues to regional paleoenvironments (Holliday 1995:93).

Analytical Methods and Approaches

Detailed descriptions of the sediment packages at each of the sites and along the West Amarillo Creek valley through the excavation of backhoe trenches, cutbank inspections, or extraction of sediment cores. Conduct soil chemistry and grain size analyses on closely spaced vertical sediment samples from each deposition package in each site to document the details concerning sediment types and nature of depositional changes. Conduct stable carbon and nitrogen isotope analyses on dated sediment columns through each site to detect shifts in vegetations communities. Conduct phytolith analysis on vertical and dated columns of sediment samples from each site and other locations in the valley. Identification of the macrobotanical remains from the various cultural components at each site to detect changes in use and availability of the plant resources. Identify (to genus and species level) faunal assemblages from each of the components to help to inferentially reconstruct vegetation communities. Carry out stable carbon and nitrogen isotope analysis on a suite of bison bones from the different time periods to detect changes in available vegetation.

4.2.6 Component Function/Intrasite Patterning Issues

Component structure and organization relates to the patterning of activities as represented by the distribution of artifacts, debitage, and features on each living surface (component), and the changes in organization of space through time as represented on multiple living surfaces. It is critical to first identify the location and number components present in the deposits and then to recognize the geometry of each living surface. The structural integrity of the archeological record is a function of the stability of the landform, duration of surface utilization and the degree of activity overprinting occurring on each surface. Short term occupations have the clearest expressions with material/functional classes of cultural debris generally horizontally separated, whereas those of occupations of longer duration tend to result in overprinting of different activities, complicating interpretation. It is critical to locate and recognize primary contexts of materials as evidenced through vertical zonation of features and artifacts. Primary *in situ* cooking features and horizontal distribution of debris reflect intrasite activity areas such as cooking areas, animal processing areas, and tool manufacturing areas, etc. In contrast, site maintenance areas are reflected by secondary dumping events of various material classes. The extent to which materials are abandoned in place or discarded in formal areas is informative of site function, structure, and duration (Quigg and Peck 1995, Quigg 1997).

Postdepositional factors play an important part in the vertical and horizontal patterning of cultural materials. Translocation of artifacts after site abandonment by the processes of deflation, water movement through the matrix, and plant/animal bioturbation must be evaluated from the context and associated patterns of materials on the occupation surfaces. Parts of each site may be disturbed through one or more processes, but some areas within each site should contain mostly intact deposits that will reflect human behaviors.

The identification of the nature of activity areas depends upon the recovery of logically consistent artifact associations (e.g., tools, preforms, features, burned rocks, pottery, bones, and stone tool manufacturing debris, etc.) and relatively discrete patterns of artifact distribution. This identification is most readily accomplished in situations involving briefly utilized and subsequently abandoned activity areas. The limits of various activity areas are sometimes detectable from refit analysis of broken implements or bone fragments, or the delineation of debitage reduced from specific cobbles identifiable on the bases of distinctive colors or other material characteristics. The spatial patterning of activity areas can be defined on the basis of the densities and distributions of artifacts and various classes of debris.

Research Questions

How many living surfaces or discrete occupational components are represented at each of the sites? For each component identified what specific activity areas are represented by the various data sets such as the faunal remains, the lithic debitage, formal and informal tools, and the primary and secondary features? Does the cultural material represent one specific activity or a broad range of diverse activities across each component? Does the West Amarillo Creek valley represent similar uses or functions by the various groups through time? Are hunting-gathering occupations reflected by different debris patterning than horticultural groups?

Data Needs

Horizontal and vertical control of the various data sets such as the burned rocks, lithic debitage, faunal assemblage, the formal tools, the pottery, and the features. Documentation of vertical positions of the cultural materials through 10 cm levels and/or piece plotting of larger pieces such as burned rocks. Sort the various cultural data sets into functional subcategories. Define feature centered artifact distribution patterns.

Analytical Methods and Approaches

Excavations conducted in large blocks using 1 by 1 m units for horizontal control and maintenance of vertical control in 10 cm levels. Basal depths of the larger pieces of cultural materials such as burned rocks, large bones, diagnostics, and features were recorded for elevation control. Piece plotting allowed for documentation of the horizontal distribution of the entire cultural assemblage in each component. Individual components were assessed by vertical measurements taken on the various the cultural materials. Spatial analyses employing horizontal distribution of the various data sets in each of the components.

4.2.7 Technological Issues

Technology represents the relationship between tools/tool production and the resources exploited by prehistoric groups. Three components of any technology are: 1) the techniques, procedures, and knowledge shared to conduct exploitation; 2) the raw materials and supporting implements (artifacts and features) needed to achieve the exploitation; and 3) the organization and social arrangements of task groups to achieve exploitation (Ellis 1992). Changes in technology or tool production are presumed to reflect changes in these components, usually in response to changes in environmental conditions or changes in populations/ethnic composition.

Technology is extremely important because the products of technological behavior tend to be the most easily recognizable and best preserved data in the archeological record. The best preserved materials include burned rocks, lithic tools and the debris from tool manufacture, pottery, and rock features.

Burned rocks constitute one of the more abundant data sets present in hunter-gatherer sites and are generally easily recognized. The degree of rock dispersal/clustering, size, and position relative to the occupation surface is informative about how those rocks were used, the kinds of intrasite activity areas, and the vertical extent of each component. This is especially true where microturbation may have moved small cultural objects such as small flakes and charcoal flecks, but not the larger pieces of the cultural assemblage such as burned rocks.

Clusters of burned rock, generally regarded as features, reflect various behaviors relating to heating, cooking, and discard practices. The spatial distribution of the rocks on the living surface, the degree of clustering, presence of ash, associated charred materials, and oxidized surfaces are attributes helpful in distinguishing feature types and functions and whether they represent *in situ* burning episodes or secondary dump localities. A diverse data set can contribute information toward better interpretation of the function of burned rock features. Useful data include the burned rock characteristics of size, shape and material type, the horizontal and vertical distribution of burned rock in features, and the results from various technical analyses including lipid residues and stable isotope data.

The reuse of rocks in cooking generally results in size reduction of cobbles to smaller pieces that no longer are useful for heat storage. Therefore, the average burned rock size/weight can be a measure of reuse, and perhaps a measure of heat intensity or function. Different kinds of rocks also obtain, retain, and disperse heat differentially. Some rock types and shapes may have been better suited for certain cooking procedures such as boiling as opposed to grilling. It may be possible to separate stone boiling cobbles from roasting pit rocks on the basis of fracture patterns.

Stone tools and manufacturing debris are also prominent classes of artifacts in open-air sites and contribute considerable information for interpreting human behavior. The importance of stone tool manufacture relative to other activities involving less permanent materials may be difficult to assess, due to the sampling biases inherent in differential preservation. Hunter-gatherer groups carried finished implements and sometimes implements in need of repair to sites, then spent time resharpening and/or replacing tools, and perhaps engaging in "gearing-up" activities involving the manufacture of other tool forms for either anticipated tasks at subsequent camping locales, or caching implements for use on subsequent returns to the site. This issue of monitoring tool transport and reuse assumes that recognizable differences in material type, color, texture, or inclusions exist within raw tool stones of the region, and an adequate sample of activity areas has been sampled. If consistent material variability is present between components at that locality, then comparisons of raw materials present in the debitage and complete and/or broken tools can provide insights into which kinds of tools were manufactured on site for replacement (e.g., proximal broken points/knives), which kinds of tools were made and abandoned on site, and which stages and forms of implements were removed from the manufacturing areas.

Ceramics are often present in late prehistoric or later components and may reflect differences in group composition, group movements, regional interactions, and group ancestry. Understanding the manufacturing processes and stylistic elaborations are keys to understanding and interpreting these various aspects of the group.

Research Questions

What lithic resources were exploited through time? What are the patterns of manufacture and tool use during the last 3,000 years in the panhandle? What technological changes are evident between specific time periods? Do any of the perceived technological changes correlate with paleoenvironmental or resource shift changes? Do the technological and/or stylistic changes (introduction of the bow and arrow, pottery, etc.) have antecedents in this or other regions at an earlier date? Does the cultural record reflect wholesale replacement of the technological patterns (local populations are displaced by new people), or are small segments of the total material culture assemblage piecemeal (reflecting refinements and readjustments to changing conditions)? Are the technological records sufficiently complete to for reconstructing behavioral patterns and social arrangements? What is the relationship between feature morphology and food processing? What ceramic technology and stylistic expressions were in use and were they consistent over time? Do the hunter-gatherer groups made more use of expedient tools than sedentary groups? What affect did the introduction of the horse have on the various technological aspects of the broader cultural assemblage?

Data Needs

Need assemblages of formal and informal tools and manufacturing debris from specific time periods. Need detailed documentation of individual features from temporally discrete components. High-powered microscopic use-wear analysis and residue analysis on implements to help understand the function of tools and the types and nature of the resources exploited. Baseline comparative technological data are required from several discrete points in time. Require a suite of ceramic sherds from one or more specific time periods with which to define ceramic technologies and stylistic expressions. Metric and nonmetric data on burned rocks from individual features associated with occupational surfaces.

Analytical Methods and Approaches

Conduct systematic use-wear analysis of artifact assemblages from various time periods to identify specific tool use. A broad range of data is required on all formal tools from each component including typology designations for diagnostic items, metric and nonmetric observations, and proportional representations different tool forms. Document feature characteristics including metric and nonmetric observations on size, form, and contents in order to identify functions. Systematic recording of burned rock sizes, material types, and frequencies from individual features and those scattered across each component. Document attributes of potsherds sherds through macroscopic analyses using metric and nonmetric data to sort and classify the sample. Petrographic analysis of ceramic sherds of various types from identified components to address questions of clay sources and related issues concerning the origin, transport, and exchange ceramics. Identification of lithic material types and source those materials represented in each of the component/time periods. Analysis of sample of lithic debitage in order to identify the types of tools or cores from which debitage was derived. Classify bifaces into stages of reduction and identification of breakage types. Identify all informal tools for each component.

5.0 INVESTIGATIVE METHODS

J. Michael Quigg and Paul M. Matchen

5.1 INTRODUCTION

Data recovery excavations at the Landis Property were undertaken in two separate phases (Phases I and II). Phase I fieldwork included a geoarcheological investigation that included mechanical excavations of backhoe trenches throughout the property to locate, identify, record, and sample the natural depositional deposits. Also during Phase I, small 1 by 1 meter (m) hand excavation units were conducted at each of the three previously identified archeological sites to identify and sample the nature and extent of the cultural deposits across the multiple terraces. Upon completion of Phase I fieldwork, TRC submitted draft and final interim reports to the BLM that summarized the archeological and geoarcheological investigations undertaken. The reports presented preliminary tabulations and limited assessment of artifacts, feature data and analytical techniques that provided positive results (Quigg et al. 2008). The final interim report documented significant research potential for specific areas within each site and made recommendations for major block excavations at each of the three sites during Phase II data recovery investigations. Following the BLM approval of TRCs recommendations, the Phase II fieldwork was initiated in the fall of 2008. Phase II targeted three specific locations, one at each identified site, to undergo hand excavations within large horizontal blocks. The following section presents the field methods employed during Phases I and II. This is followed by descriptions of laboratory methods employed during the final analyses of the findings from both phases. Last, each analytical technique employed (as directed in the treatment plan; Quigg 2005) is discussed in general terms under the section entitled Analytical Techniques below.

5.2 PHASE I DATA RECOVERY INVESTIGATIONS

5.2.1 Introduction

At the outset of Phase I, it was necessary to evaluate the Late Pleistocene and Holocene alluvial history of West Amarillo Creek the basin. Initially, the project geoarcheologist walked much of the project area along the creek channel to inspect the existing cutbanks and terraces. This visual reconnaissance was followed by backhoe trenching (BT) throughout the project area targeting the different alluvial terraces (Figure 5-1). A total of 47 trenches were excavated. Nearly every trench had at least one side wall cleaned and described, and where significant lateral stratigraphic variation occurred within a trench, a drawing of one wall was made using a string line, line level, and measuring tape to record the profile. The trench numbering began with 1 and continued sequentially throughout the project area through 46, although there is a 17a and 17b. The numbering sequence was independent of whether a given trench was on or off a known archeological site. Detailed descriptions of the trench deposits are provided in Appendix A.

Within the bounds of archeological sites, trenches were placed at locations in which cultural materials were believed to rest within intact contexts, as assessed by archeologist Mike Quigg. Area coverage across the three sites was important in confirming the locations of intact prehistoric deposits and activity areas. Twenty four trenches were excavated into the three targeted archeological sites. Seven trenches were excavated in 41PT185, Locus A, with a total length of about 70 m. Two trenches were excavated in 41PT185, Locus B, with a total length of 14.5 m. Four trenches were excavated in 41PT185, Locus C, with a total length of 52 m. Five were excavated in 41PT186 with a total length of 64 m. Finally, six trenches were excavated in 41PT245, with a total length of nearly 62 m. Mr. Quigg and geoarcheologist Charles Frederick inspected each trench to identify cultural materials and the depositional sequences in which they were contained.

Figure 5-1. Example of Excavated Backhoe Trench (BT 6 east wall) with Safety Benches on Right Side.

Subsequently, the project archeologist was able use the information obtained from trench excavations and inspections to plan the placement of the hand excavation units. The hand excavated units, labeled as test units (TU), served to sample the various identified cultural zones, materials and deposits. Test units were numbered sequentially at each archeological site. In those instances where Haecker (2000) had previously excavated test units, our investigation units began with the next number in the sequence. Haecker's units generally were the first and second test units, whereas TRCs units followed with the next number in sequence so as not to duplicate numbers at that site. No block excavations were conducted during Phase I data recovery. Test units were 1 by 1 m in size with an occasional minor deviation because of trench conditions. A total of 41 individual 1 by 1 m units, totaling 46.9 m3, were hand excavated in 10 centimeter (cm) arbitrary levels across the three targeted sites. In most instances these units were excavated off the sides of the trenches to facilitate access to deeper deposits (Figure 5-2). These units often targeted materials or cultural zones exposed in the trench walls. To assess and sample other areas, test units were also excavated away from trenches. The hand excavations generally began at the surface, and extended to depths that varied from 60 to 200 cmbs. Individual 10 cm arbitrary levels were excavated by hand with a combination of pick, shovel, and/or trowel. The excavated matrix was screened through 6.4 millimeter (mm) (1/4 in.) mesh. Depths were measured and recorded in centimeters below surface (cmbs) and termination depths were based on abundances of cultural materials. When sizable pieces of cultural material were encountered in situ, these items were most often piece plotted on the excavation level record and the bottom elevation was recorded. Each hand excavated level was recorded on a TRC level record containing pertinent information concerning how the excavations were accomplished, what types and quantities of cultural materials were encountered, and the nature of the sediment matrix. When clusters of cultural materials were encountered, they were designated as features.

Figure 5-2. Excavation of TU 16 off BT 31 at 41PT185 Locus A.

Once features were recognized, the excavation and recording methods were changed in order to record more observations and extract more data to facilitate analyses and interpretations. The feature was then isolated from the rest of the level for more precise excavation and documentation, keeping feature materials separate from the nonfeature materials (Figure

5-3). In most instances, a sample of the internal matrix was removed and bagged without screening for more refined screening/flotation in the laboratory. The features were cross sectioned at least once to expose a profile and examined for basins, and to determine vertical extent. The feature was drawn in plan view and a profile was drawn if necessary. Photographs were taken and a separate feature form was completed. The feature form provides information on size, shape, various construction elements, and contents. Contents of the features (i.e., burned rocks, mussel shells, lithic materials, and matrix) were bagged and labeled separately and returned to the laboratory.

Figure 5-3. Clustered Feature Rocks Isolated from Surrounding Burned Rocks (Feature 8 at 41PT185/C).

One wall of selected units at each site was recorded in profile (Figure 5-4). In some instances, small sediment samples were collected from selected proveniences. Potentially, these matrix samples would be used for a variety of analyses, including, but not limited to, phytolith or isotope analyses.

Figure 5-4. Profile of Unit Wall at 41PT185 Locus A.

Artifacts classified as burned rock were generally counted and weighed for each excavation level and then discarded. However, selected samples of burned rocks from various levels and/or features were collected and returned to the laboratory for possible analysis and assessment. Bulk sediments for fine screening and/or flotation in the laboratory were collected from selected features and other contexts. Macrobotanical, charcoal, and other samples were collected from recognized features and other contexts during hand excavations, as well as from trench walls.

Once in the TRC Austin laboratory, the recovered materials and samples were sorted into material classes, washed, labeled, bagged, accessioned with catalogue numbers assigned to each level and subcategory, and recorded in an electronic database. When possible, recognized formal and informal tools were handled with gloves and not washed. On these unwashed tools, a small spot on one surface was cleaned so that a permanent label could be placed on the artifact. These unwashed artifacts were set aside for use-wear and/or residue analyses. A preliminary count of the various material classes was compiled from the information recorded on the individual level records and generally checked against bag contents. These initial counts and categories were used in the interim reports submitted to the BLM.

5.2.2 Geoarcheological Investigations

In addition to backhoe trenching at the three targeted archeological sites, the project geoarcheologist investigated areas across the broader upper West Amarillo Creek valley within the Landis Property. At the initiation of this project, the geoarcheologist walked the creek channel and inspected cutbanks, examined terrace depositional sequences, and then proceeded with mechanical excavation of backhoe trenches in selected alluvial deposits. Trench locations were generally selected on the basis of local topography and in light of a preliminary stratigraphic model that was conceptualized during the initial reconnaissance.

The stratigraphic model was modified as new exposures were examined. Alluvial terrace deposits along the upper reaches of West Amarillo Creek were the primary targets. These geoarcheological investigations, including the field documentation of deposits and samples collected (over 197 sediment samples, plus three sediment columns for diatom analysis, and at least eight 50 cm long monoliths – Figure 5-5), were carried out in order to obtain insight into the contexts of cultural materials. Samples for radiocarbon dating and paleoenvironmental analysis were collected as trenching progressed, but most of the sampling was performed late in the trenching operations after the stratigraphic model was relatively well refined.

Forty seven backhoe trenches (BTs 1 through 46 with two BT 17s [17a and 17b]) were excavated and documented along both sides of upper West Amarillo Creek within the Landis Property (Figures 5-6 and 5-7). The trenches were excavated by a backhoe employing roughly a 100 cm wide bucket that generally cut a 110 to 120 cm wide trench. The length and depth of the individual trenches varied considerably (Table 5-1). The longest trench was nearly 30-m-long, whereas the deepest was 450 cmbs. The average trench length was 9.1 m long by 2.8 m deep. Most trenches required a safety step/bench at roughly 100 cmbs on one side of the deeper section resulting in most trenches being roughly 2+ m wide.

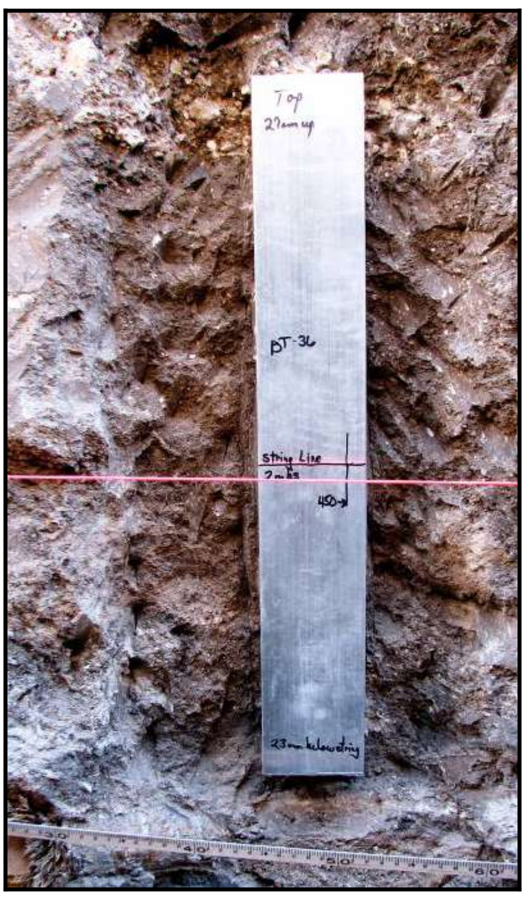


Figure 5-5. Monolith Sample Extraction Procedure from BT 36, 41PT185/C.

Figure 5-6. Project Geoarcheologist Dr. Charles Frederick Documenting Sediments from BT 40 Profile.

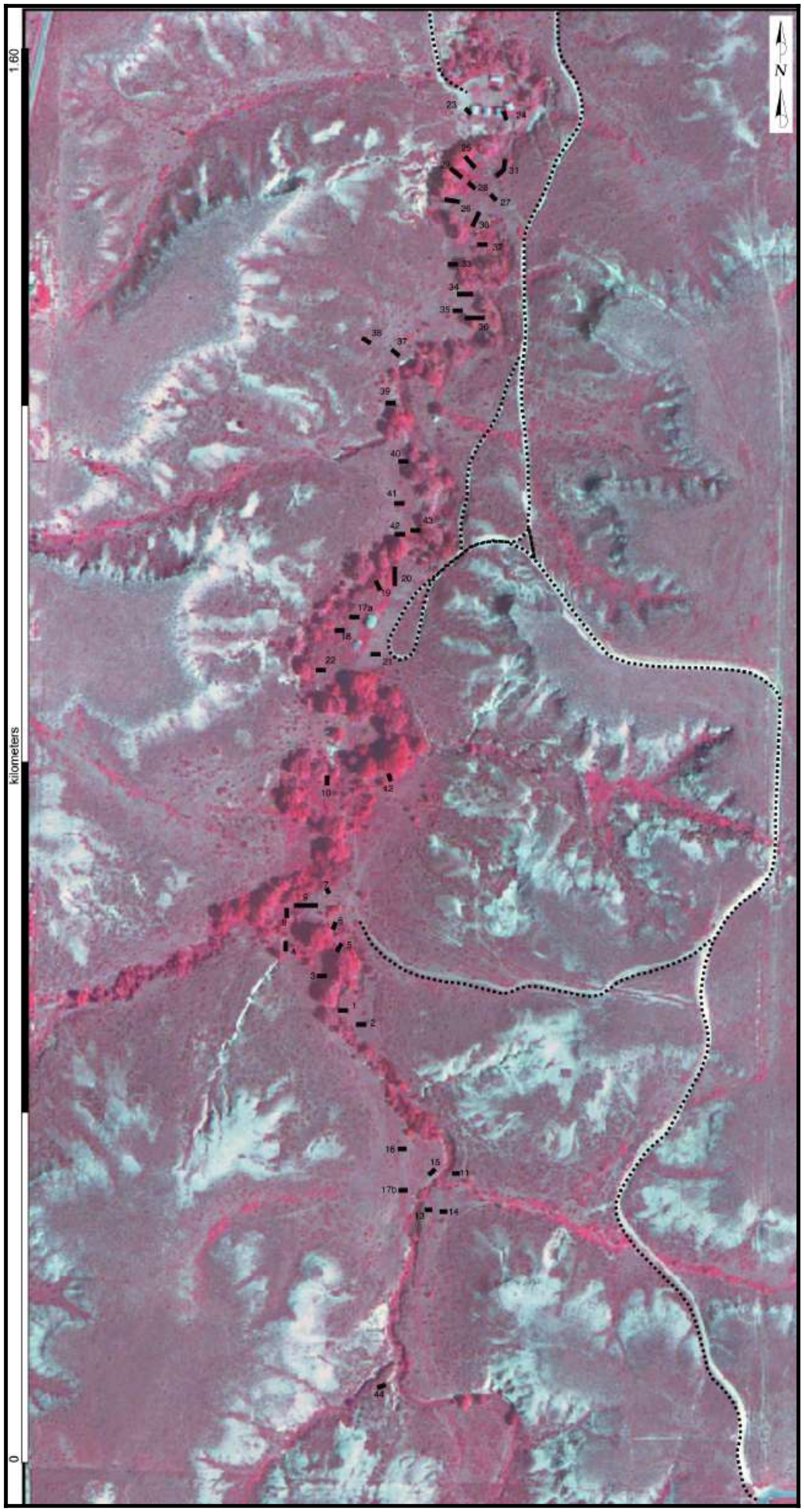


Figure 5-7. Infrared Air Photograph Showing the Location of 47 Backhoe Trenches across Upper West Amarillo Creek Valley in the Landis Property. (white areas lack vegetation)

Table 5-1. List of Trenches Excavated During 2002 Fieldwork.

All UTM Coordinates Employed the NAD 27 Datum.

Trench No.	UTM Easting	UTM Northing	Length (m)	Width (m)	Depth (m)	Orientation
1	0230420	3900247	4	2	3.5	N70W
2	0230459	3900214	10	3	3.4	N90E
3	0230399	3900278	9	3	2.8	S80E
4	0230361	3900323	7	3	3.0	N25W
5	0230420	3900314	7	3	3.0	N40E
6	0230417	3900341	7	3	3.4	N25E
7	0230409	3900381	8.5	2.7	2.7	N30W
8	0230361	3900347	9	2	2.2	N10E
9			28	1	3.0	N80W
10	0230410	3900485	11	2	1.8	N30E
11	0230459	3900092	9	2	2.9	N60E
12	0230469	3900503	10	2	2.6	N18W
13	0230509	3900009	9	3	2.9	N90E
14	0230525	3900000	9	2	2.5	N89E
15	0230522	3900075	12	2	2.7	N50E
16	0230488	3900091	8.3	2	3.0	N70E
17a	0230437	3900678	6	2	3.1	N65W
17b	0230483	3900031	8	2	2.8	N75E
18	0230426	3900666	11	3	2.5	N75W
19	0230466	3900711	9.5	1-2.8	2.6	N60W
20	0230488	3900718	19	2	2.7	N25W
21	0230450	3900629	8	2	2.9	N80W
22	0230407	3900614	8.5	2	2.9	N77E
23	0230563	3901216	5.5	1	2.0	N65W
24	0230600	3901219	9	1	3.0	N30W
25	0230566	3901163	10	2	2.9	N45W
26	0230550	3901127	11	2	1.9	N65W
27	0230584	3901129	8	2	2.6	N72W
28	0230566	3901142	11	2	2.4	N65W
29	0230546	3901158	10	2	2.7	N65W
30	0230572	3901113	8	1	1.9	N20W
31	0230598	3901167	12	1	1.5	N10W, N25E
32	0230571	3901073	6	2	2.3	N70W
33	0230546	3901062	7.5	2	2.3	--
34	0230552	3901031	18	2	2.0	N87E
35	0230549	3901001	9	2	3.1	N70E
36	0230567	3900999	13	2	4.5	N85E
37	0230474	3900957	8	2	2.9	N78W
38	0230425	3900964	8	2	2.4	N75W
39	0230468	3900900	6	2	2.6	N75W
40	0230484	3900851	7	3	4.8	N70E
41	0230482	3900810	7	1	3.0	N90E
42	0230494	3900771	7	3	4.5	N80E
43	0230503	3900766	7	2	2.8	N80W
44	0230471	3899821	8	2	2.0	N32E
45	0230478	390071	14	2	3.8	N75E
46	0230484	3900851	13	2	2.5	N70E

Trench walls were most often troweled, in the search for cultural materials and to facilitate recording and documentation. Following wall inspection, the different depositional units were identified and then recorded on standardized exposure description forms by the project geoarcheologist. Recorded observations of the different deposits included; depth, texture, consistency, type of boundary, structure, reaction to dilute acid, color, identification of soil horizon, and general comments. A sketch of the trench wall profile was generally made. A photograph was generally taken of each backhoe trench, showing at least one of the exposed walls. Detailed descriptions of the individual trenches are provided in Appendix A.

The 23 trenches excavated outside the known site boundaries explored the subsurface deposits. In at least four instances (BTs 3, 10, 12, and 16) cultural materials were encountered within these trenches. No attempt was made to define additional site boundaries or to sample the cultural materials observed in these trenches.

In general, many samples (i.e., sediment, charcoal, bones, and some cultural materials) were collected from selected trenches to facilitate analyses that would be directed towards clarifying the nature of the deposits and reconstructing paleoenvironmental conditions. Collected samples allowed for 1) radiocarbon dating of selected deposits; 2) addressing of questions concerning the paleoenvironment through phytolith and pollen analyses; and 3) more precision in defining or refining the nature of the deposits through particle size analysis and/or chemical characterization (total carbonate, pH, percent organic matter, etc.).

The stratigraphic model compiled in the field identified allostratigraphic units, which are deposits that are defined by their geomorphic/stratigraphic position and by the unconformities that border them. The modern ground surface and buried erosional surfaces are the most common bounding surfaces identified here. Although the initial stratigraphic model was defined on the basis of allostratigraphy, most deposits can now be recognized on the basis of lithology (composition and appearance), as well. In the field, the age of different depositional units was estimated using a combination of characteristics such as the relative stratigraphic position, the degree of soil development (cf. Birkeland 1999; Holliday 1995), and identification of sedimentary features that are generally thought to be temporally correlative on the Southern High Plains. The most notable case of the latter was a freshwater marl, which on the Southern High Plains typically dates to the first quarter of the Holocene (Holliday 1995), although radiocarbon dating of this deposits here proved this provisional correlation to be significantly misleading (discussed in more detail below).

5.2.3 Sediment Characterization Analyses

A continuous column of bulk sediment was collected from each major allostratigraphic unit, except for the very recent Unit F. Table 5-2 lists which trench the samples were collected from, the depositional unit they represent, and the approximate number of samples collected from each location. Following completion of the Phase I fieldwork, column samples collected from allostratigraphic Units B, C, D and E were analyzed in the laboratory in order to document their physical properties and supplement general impressions formed during the fieldwork.

Multiple analyses including particle size, calcium carbonate, magnetic susceptibility, organic carbon, and stable carbon isotopes, were conducted by Dr. Frederick on these various samples (see more details in the geoarcheological section below). The isotope analysis was conducted by Dr. Tom Maddox at the Institute of Ecology, University of Georgia in Athens.

Table 5-2. Trench Profiles Sampled for Use in Characterization of Deposits

Backhoe Trench No.	Depositional Unit Designations	Number of Bulk Samples
5	E	~30
11	A	20
21	A & B	~27
36	D	40
40	C	48
42	B	32

The combination of analyses of these various samples allows for: 1) detailed assessments of the age and position of geomorphologic deposits; 2) addressing questions concerning the paleoenvironment through isotopic measures, phytoliths, and pollen analyses; and 3) analysis of the samples for particle size, calcium carbonate, organic carbon and stable carbon isotopes to provide a solid descriptive baseline for the major alluvial deposits identified. The methods used in these analyses are described below and the data resulting from these analyses are listed on Table 5-3. The results of the various analyses are integrated into the discussions of each major allostratigraphic unit, below.

A total of 113 bulk sediment samples were analyzed from four profiles (BT 5 [Unit E], BT 36 [Unit D], BT 40 [Unit C] and BT 42 [Unit B]). For each sample the texture, organic carbon content, calcium carbonate content, magnetic susceptibility, and stable carbon isotopic composition were determined. The details of the analytical methods employed are presented below.

The particle size (texture) analysis was performed using the hydrometer sieve method (cf. ASTM 1985; Gee and Bauder 1986; Bouyoucos 1962). For this analysis the total sample was air dried and weighed, then crushed with a rubber pestle and mortar, and subsequently passed through a 2 mm sieve. Material caught on the 2 mm sieve, if detrital material, was then sieved at a one phi interval and the mass on each sieve recorded. A fraction of the less than 2 mm size material (roughly 40 grams [g]) was then soaked 50 milliliters [ml] of a 5 percent sodium hexametaphosphate solution overnight, and then mixed in a mechanical mixer for 5 minutes before being diluted to one liter with distilled water. This mixture was placed in a one liter settling jar, mechanically agitated for one minute, and then set on a table, after which point hydrometer readings were made a different time intervals (specifically 1, 3.5, 15, 45, 300, and 1,440 minutes). A control hydrometer and temperature reading on an empty jar with nothing but distilled water and the sodium hexametaphosphate solution was made at intervals throughout the analysis to permit calibration of the hydrometer. A small split of the less than 2 mm sediment was also oven dried to determine the moisture content and correct the sample mass used in the hydrometer analysis (hygroscopic moisture correction). After 24 hours, the contents of the hydrometer jar were wet sieved through 37 micron sieve, and the sand retained on the sieve was transferred to a beaker and oven dried at 105˚Cecius (C). This sand was subsequently sieved at 0.5 phi intervals once dry and the mass retained on each sieve recorded. From these data the percentage of gravel, sand, silt and clay, as well as various descriptive statistics were calculated for the grain size distribution using a spreadsheet written by Paul Lehman.

The calcium carbonate content (C.C.E) was determined by employing a 1.7 g split of the ground less than 2 mm fraction of each soil sample by means of a Chittick apparatus (Dreimanis 1962; Machette 1986). This sample was finely ground (to pass a 0.075 mm sieve), then weighed, and placed into a small (250 ml) Erlenmeyer flask. Once attached to the Chittick apparatus, the liquid level in the measuring burette was set to -10 ml, then the stopcock was closed so no gas could leave the system, and the leveling bulb was dropped in order to establish a vacuum inside the sample chamber. At this point the barometric pressure and temperature in the room were recorded. Then 10 ml of 50 percent hydrochloric acid (ca. 6 N HCl) was delivered to the sample flask, which was agitated intermittently until the reaction had ceased (usually 1 to 2 minutes). At this point, the leveling bulb was raised to the point that the liquid level inside of it was equal in elevation to the liquid in the burette, and the volume of gas evolved was then measured and the calcium carbonate equivalent calculated.

In order to determine the organic carbon content of each sample, splits of the less than 2 mm size fraction were submitted to the Analytical Chemistry Laboratory at Institute of Ecology, University of Georgia. The carbon content was determined on a on a Micro-Dumas NA1500

Combustion Elemental (C/H/N) Analyzer (Carlo Erba Strumentazione, Milan). Details of the procedures used in the procedure may be found on the institute's web page (http://www.uga.edu/~sisbl/soilerb.html) and

Table 5-3. Analytical Results from Individual Samples Analyzed from Backhoe Trenches.

BT5															
number	depth	% ?63µ	% ?2µ	% gravel	%sand	% silt	% clay	mean	sd	skew	kurt	%water	Organic C (%)	□^{13}C (PDB)	%CCE	□
1	5	57.98	85.73	0.16	57.82	27.75	14.27	5.25	2.91	0.54	0.81	8.97	1.13	-18.33	9.44	38.28
2	15	54.78	84.68	0.06	54.72	29.90	15.32	5.56	3.16	0.56	0.67	10.62	1.05	-18.55	14.31	38.48
3	25	62.38	87.20	0.21	62.17	24.82	12.80	5.11	3.01	0.56	0.72	8.63	0.90	-18.55	12.79	30.90
4	35	72.17	89.51	2.43	69.74	17.34	10.49	4.23	2.40	0.53	1.20	5.76	0.42	-18.27	12.19	23.50
5	45	71.62	88.62	0.22	71.4	17.00	11.38	4.41	2.12	0.64	1.19	5.77	0.37	-17.52	10.67	22.22
6	52	74.8	90.36	11.13	63.67	15.56	9.64	3.25	1.97	0.27	2.72	4.92	0.32	-17.81	10.98	21.72
7	57	71.28	88.87	0.81	70.47	17.59	11.13	4.13	2.27	0.50	1.31	4.86	0.30	-17.16	11.89	22.05
8	65	68.04	89.25	0	68.04	21.21	10.75	4.39	2.59	0.47	1.00	5.18	0.40	-17.69	11.28	24.68
9	75	49.82	83.20	0.16	49.66	33.38	16.80	5.81	3.38	0.53	0.60	8.37	0.86	-17.49	13.71	35.31
10	85	45.36	83.54	0.02	45.34	38.18	16.46	5.89	3.15	0.54	0.63	7.41	0.87	-17.00	14.62	39.23
11	95	53.55	82.43	0.04	53.51	28.88	17.57	5.87	3.51	0.57	0.54	6.36	0.68	-16.72	14.01	33.28
12	105	68.34	87.88	0.01	68.33	19.54	12.12	4.80	2.87	0.63	0.82	4.02	0.37	-16.59	11.27	24.67
13	115	49.75	82.57	0.33	49.42	32.82	17.43	5.93	3.50	0.55	0.54	6.95	0.64	-16.66	13.99	36.38
14	125	58.8	85.56	0	58.8	26.76	14.44	5.27	3.03	0.55	0.75	5.93	0.40	-16.89	12.18	29.33
15	135	64.06	84.95	0	64.06	20.89	15.05	5.27	3.17	0.61	0.61	5.09	0.27	-16.55	12.18	25.53
16	145	68.48	87.49	0.25	68.23	19.01	12.51	4.66	2.75	0.61	0.93	5.15	0.23	-17.81	11.39	23.28
17	155	56.82	83.02	0.05	56.77	26.20	16.98	5.82	3.52	0.61	0.53	7.17	0.36	-17.44	11.57	31.87
18	165	58.84	82.20	0	58.84	23.36	17.80	5.97	3.58	0.67	0.48	8.23	0.30	-16.04	12.79	30.04
19	175	57.77	82.46	0.00	57.77	24.69	17.54	6.01	3.73	0.64	0.46	9.29	0.29	-15.86	12.79	28.73
20	185	57.94	83.24	0.00	57.94	25.30	16.76	5.84	3.53	0.62	0.53	10.35	0.32	-16.95	13.40	29.12
21	195	69.01	87.30	0.08	68.93	18.29	12.70	4.77	2.80	0.59	0.91	8.57	0.19	-15.99	10.96	22.43
22	205	73.92	89.21	0.08	73.84	15.29	10.79	4.24	2.44	0.61	1.14	7.37	0.18	-16.95	9.13	20.75
23	215	53.76	81.35	0.30	53.46	27.59	18.65	6.18	3.72	0.64	0.36	11.22	0.25	-17.64	10.65	25.45
24	225	49.44	80.17	0.00	49.44	30.73	19.83	6.18	3.86	0.56	0.42	12.01	0.27	-17.68	10.96	27.97
25	235	58.45	84.85	4.54	53.91	26.40	15.15	5.25	3.50	0.52	0.77	11.50	0.26	-18.52	13.39	22.65
26	245	41.40	78.87	2.07	39.33	37.47	21.13	6.24	3.93	0.39	0.46	13.26	0.31	-18.81	11.56	23.37

BT36																
number	**depth**	**% ?63µ**	**% ?2µ**	**% gravel**	**%sand**	**% silt**	**% clay**	**mean**	**sd**	**skew**	**kurt**	**%water**	**Organic C (%)**	**□^{13}C (PDB)**	**%CCE**	**□**
BT36-1	0-7	73.6	89.1	34.1	39.5	15.5	10.9	1.71	4.89	-0.03	0.63	1.68	0.29	-18.41	29.7	9.0
2	7-20	58.7	82.6	2.1	56.6	24.0	17.4	5.59	3.76	0.57	0.53	1.88	0.32	-18.51	18.5	10.5
3	20-32	60.6	83.2	0.7	59.9	22.6	16.8	5.53	3.62	0.60	0.53	1.97	0.29	-18.28	18.0	9.0
4	32-41	71.4	87.3	0.8	70.6	15.9	12.7	4.62	2.77	0.61	0.91	1.37	0.20	-17.20	13.4	8.1
5	41-44	55.4	80.1	0.5	54.8	24.7	19.9	6.07	3.75	0.66	0.25	2.08	0.54	-17.84	22.8	8.1
6	45-48	26.7	70.7	0.4	26.3	44.0	29.3	7.07	4.07	0.16	0.39	2.81	0.99	-18.23	51.1	6.7
7	50-58	44.0	76.7	2.1	41.9	32.7	23.3	6.27	4.05	0.46	0.44	3.01	na	na	26.8	10.1
8	62-74	36.2	72.6	0.1	36.1	36.4	27.4	6.93	4.02	0.45	0.37	3.99	0.77	-18.22	20.6	12.0
9	72-75	32.9	71.3	0.4	32.5	38.4	28.7	7.08	4.01	0.44	0.36	4.12	0.81	-18.70	20.0	12.8
10	80-90	29.6	71.8	0.2	29.4	42.1	28.2	7.17	4.08	0.32	0.35	4.81	1.04	-18.83	22.1	13.4
11	100-110	26.8	68.7	0.8	26.0	41.9	31.3	7.32	4.17	0.25	0.34	4.74	1.29	-18.55	25.5	14.0
12	110-120	18.0	65.3	0.1	17.9	47.3	34.7	7.74	3.94	0.16	0.38	5.68	1.49	-16.80	27.9	14.9
13	120-128	20.9	69.3	1.7	19.2	48.3	30.7	7.40	3.86	0.21	0.44	5.99	1.46	-16.92	31.9	12.8
14	128-134	44.0	79.3	11.1	32.9	35.3	20.7	5.51	4.54	0.26	0.71	4.80	0.97	-18.23	32.5	9.1
15	134-142	17.8	63.4	0.0	17.8	45.6	36.6	7.80	3.95	0.09	0.16	6.90	1.50	-18.49	28.2	11.4
16	150-159	12.0	64.4	0.3	11.7	52.4	35.6	8.01	3.65	0.12	0.40	5.33	2.15	-17.78	30.9	10.9
17	160-168	7.8	57.3	0.0	7.8	49.5	42.7	8.45	3.63	0.05	0.39	8.25	2.18	-18.16	25.7	10.4
18	169-174	4.0	46.9	0.0	4.0	42.9	53.1	9.26	3.18	0.02	0.47	10.11	2.64	-19.48	37.5	8.6
19	174-179	89.1	95.0	74.2	14.9	6.0	5.0	-1.06	3.36	0.65	1.05	na	na	na	na	4.0
20	179-180	21.7	66.2	0.0	21.7	44.4	33.8	7.50	4.04	0.15	0.39	5.13	1.57	-18.82	25.7	6.9
21	200-205	76.1	89.9	0.6	75.5	13.8	10.1	3.39	1.70	0.39	2.06	0.87	0.31	-22.36	8.1	2.2
22	205-215	63.4	85.2	0.7	62.6	21.8	14.8	5.35	3.27	0.61	0.65	1.56	0.48	-21.39	13.0	4.0
23	225-235	55.4	84.2	1.1	54.4	28.7	15.8	5.84	3.07	0.67	0.44	1.69	0.68	-21.24	13.9	6.8
24	254-260	67.0	88.8	0.5	66.6	21.8	11.2	4.57	2.55	0.54	0.98	2.68	0.46	-22.14	12.4	5.9
25	266-272	57.5	84.6	0.0	57.5	27.1	15.4	5.47	3.36	0.57	0.59	4.99	0.62	-20.92	18.4	4.0
26	281-284	18.5	72.4	0.0	18.5	53.9	27.6	7.35	3.55	0.24	0.47	13.07	1.63	-21.47	41.3	4.1
27	284-288	4.8	60.4	0.0	4.8	55.6	39.6	8.73	3.04	0.16	0.51	18.56	1.85	-21.15	56.7	6.0
28	288-292	13.5	65.0	0.0	13.5	51.5	35.0	7.84	3.53	-0.03	0.62	14.43	1.74	-22.06	49.1	3.3
29	292-300	85.1	94.0	0.0	85.1	8.9	6.0	2.63	1.19	0.53	2.28	0.61	na	na	6.9	1.2

BT40															
number	**depth**	**% ≥63μ**	**% ≥2μ**	**% gravel**	**%sand**	**% silt**	**% clay**	**mean**	**sd**	**skew**	**kurt**	**%water**	**Organic C (%)**	**δ^{13}C (PDB)**	**%CCE**	**χ**
BT40-1	10-20	45.8	84.3	0.1	45.7	38.5	15.7	5.77	3.13	0.51	0.67	2.77	1.36	-17.81	10.5	37.8
2	30-40	45.3	82.9	0.1	45.2	37.7	17.1	5.97	3.35	0.53	0.59	3.23	1.19	-17.12	13.2	37.8
3	50-60	38.4	80.2	0.5	37.9	41.8	19.8	6.46	3.51	0.50	0.51	2.92	1.23	-17.61	16.6	41.8
4	70-80	33.3	78.3	0.0	33.2	45.1	21.7	6.72	3.55	0.49	0.48	3.26	1.00	-17.42	19.1	39.7
5	90-100	38.7	75.9	0.0	38.7	37.2	24.1	7.12	3.64	0.64	0.24	3.48	0.95	-17.63	18.5	31.0
6	100-110	39.3	76.5	0.0	39.3	37.2	23.5	6.60	3.69	0.51	0.45	3.29	0.77	-17.57	17.9	31.0
7	120-130	43.0	75.7	0.0	43.0	32.7	24.3	6.74	3.97	0.61	0.37	4.41	0.67	-18.02	19.1	25.7
8	140-150	43.6	77.3	0.2	43.4	33.7	22.7	6.47	3.84	0.56	0.43	3.56	0.57	-18.95	20.0	25.0
9	160-170	43.1	75.9	0.0	43.1	32.8	24.1	6.64	4.03	0.56	0.37	3.17	0.63	-19.25	20.9	21.3
10	180-190	50.0	76.3	0.0	50.0	26.3	23.7	6.36	4.07	0.58	0.38	3.27	0.39	-19.24	25.2	12.8
11	190-200	54.7	79.8	0.1	54.6	25.1	20.2	5.94	3.80	0.58	0.46	2.97	0.41	-20.35	26.8	9.2
12	200-210	56.0	80.1	0.5	55.5	24.0	19.9	5.98	3.91	0.60	0.43	2.71	0.34	-19.72	25.9	7.9
13	210-220	62.2	83.2	0.6	61.6	21.0	16.8	5.59	3.58	0.63	0.54	2.14	0.286	-19.71	16.0	7.5
14	220-230	63.0	82.8	0.2	62.8	19.8	17.2	5.66	3.63	0.64	0.52	2.04	0.197	-20.22	18.8	6.5
15	240-250	66.2	85.1	0.1	66.1	18.9	14.9	5.37	3.29	0.63	0.54	1.88	0.093	-20.84	16.9	5.8
16	250-260	66.3	84.3	0.1	66.3	18.0	15.7	5.43	3.45	0.64	0.58	1.85	0.092	-20.40	14.8	8.2
17	260-270	64.4	83.9	0.1	64.3	19.6	16.1	5.49	3.49	0.63	0.57	1.56	0.097	-19.23	15.1	7.8
18	280-290	67.2	86.3	0.1	67.1	19.1	13.7	5.17	3.06	0.62	0.72	1.85	0.070	-19.72	12.9	7.2
19	300-310	66.5	87.0	0.1	66.5	20.4	13.0	4.96	2.72	0.60	0.92	1.67	0.084	-20.28	11.1	6.9
20	320-330	57.7	85.0	0.1	57.6	27.3	15.0	5.41	3.19	0.54	0.69	2.54	0.144	-19.86	11.7	11.9
21	330-340	51.3	82.5	0.2	51.1	31.2	17.5	5.96	3.69	0.55	0.50	2.76	0.193	-19.30	12.9	10.4
22	340-350	50.0	80.6	0.0	50.0	30.6	19.4	6.16	3.72	0.58	0.48	3.24	0.184	-19.40	13.2	10.4
23	360-370	63.0	85.6	7.9	55.1	22.6	14.4	5.26	2.95	0.69	0.53	2.38	0.118	-19.17	20.9	7.9
24	380-390	54.9	81.8	0.0	54.9	26.9	18.2	6.14	3.57	0.65	0.49	2.77	0.106	-19.41	9.2	14.8
25	400-410	53.2	83.1	0.0	53.2	29.9	16.9	5.97	3.35	0.62	0.58	2.40	0.137	-17.30	10.4	12.0
26	430-445	85.9	94.7	0.4	85.5	8.8	5.3	2.49	1.17	0.35	2.57	0.74	na	na	14.7	1.8
27	445-458	70.6	88.4	0.3	70.3	17.8	11.6	4.61	2.57	0.58	0.99	1.87	0.101	-19.31	12.6	4.5
28	458-470	87.7	96.5	10.9	76.8	8.8	3.5	1.93	1.30	0.16	2.78	0.65	na	na	20.3	1.3
29	480-490	71.1	90.4	0.3	70.8	19.3	9.6	4.00	1.80	0.43	1.69	7.06	0.178	-19.84	12.3	3.7

BT42																
number	**depth**	**% ≥63μ**	**% ≥2μ**	**% gravel**	**%sand**	**% silt**	**% clay**	**mean**	**sd**	**skew**	**kurt**	**%water**	**Organic C (%)**	**δ13C (PDB)**	**%CCE**	**χ**
BT42-1	0-10	56.9	86.3	1.1	55.8	29.4	13.7	5.06	2.87	0.47	0.87	8.62	0.91	-17.30	6.9	33.2
2	10-20	60.0	86.6	2.2	57.8	26.6	13.4	4.85	2.79	0.46	0.97	9.36	0.82	-15.52	9.3	30.8
3	20-30	55.9	83.9	0.7	55.2	28.0	16.1	5.57	3.43	0.54	0.61	9.85	0.73	-15.29	10.2	32.9
4	30-40	51.4	81.9	1.2	50.2	30.5	18.1	5.96	3.68	0.55	0.51	10.09	0.84	-15.20	10.6	39.9
5	40-45	49.4	81.3	0.6	48.8	31.9	18.7	6.41	3.47	0.68	0.34	8.61	0.71	-15.87	8.1	44.2
6	54-60	48.3	78.7	1.4	46.9	30.4	21.3	6.46	4.08	0.58	0.40	5.49	0.60	-16.21	10.8	42.6
7	60-70	44.1	75.8	0.9	43.1	31.7	24.2	6.69	4.13	0.59	0.38	5.45	0.42	-16.83	15.7	43.2
8	70-80	41.6	73.6	0.6	40.9	32.0	26.4	6.89	4.22	0.59	0.34	5.93	0.37	-17.38	16.0	44.3
9	80-90	39.3	73.7	0.7	38.6	34.4	26.3	6.92	4.15	0.54	0.34	6.64	0.27	-19.35	16.0	46.6
10	90-100	31.2	71.2	0.0	31.2	40.0	28.8	7.22	4.03	0.51	0.35	7.40	0.34	-17.17	16.3	52.1
11	100-110	30.2	71.1	0.0	30.2	41.0	28.9	7.27	4.04	0.54	0.35	7.23	0.32	-17.41	16.0	51.9
12	110-120	27.7	70.6	0.0	27.7	43.0	29.4	7.35	3.97	0.53	0.35	7.55	0.30	-17.82	14.8	56.2
13	120-130	29.2	71.2	0.4	28.9	42.0	28.8	7.25	3.98	0.50	0.36	8.02	0.31	-17.83	13.9	56.2
14	130-140	29.5	71.2	0.0	29.5	41.7	28.8	7.25	4.04	0.50	0.35	8.02	0.29	-18.21	13.8	53.7
15	140-150	31.6	73.4	0.0	31.6	41.8	26.6	7.10	3.93	0.49	0.20	8.23	0.29	-18.05	12.9	54.0
16	150-160	22.0	69.4	0.0	22.0	47.5	30.6	7.53	3.87	0.34	0.36	9.32	0.32	-18.07	14.1	59.9
17	160-170	17.8	62.4	0.0	17.8	44.5	37.6	7.88	4.00	0.15	0.31	12.96	0.41	-18.10	14.4	64.0
18	170-185	21.3	67.9	0.0	21.3	46.6	32.1	7.60	3.95	0.35	0.37	10.81	0.37	-18.23	13.8	60.1
19	185-200	31.8	75.0	4.0	27.7	43.2	25.0	6.73	3.94	0.41	0.52	10.01	0.26	-17.61	14.7	53.4
20	200-220	35.1	78.6	2.0	33.1	43.5	21.4	6.53	3.65	0.44	0.52	9.34	0.22	-18.58	13.5	47.7
21	220-240	40.1	82.4	0.0	40.1	42.3	17.6	6.08	3.23	0.47	0.62	8.00	0.15	-18.43	12.9	43.3
22	240-260	34.3	82.0	0.0	34.3	47.6	18.0	6.31	3.01	0.52	0.65	8.00	0.17	-18.42	12.9	47.0
23	260-280	27.7	81.9	0.0	27.7	54.3	18.1	6.73	2.58	0.66	0.50	8.25	0.17	-18.42	13.8	48.9
24	280-295	38.7	82.5	0.0	38.7	43.8	17.5	6.00	3.27	0.41	0.60	8.61	0.14	-18.69	15.9	41.0
25	295-310	66.3	88.5	0.0	66.3	22.3	11.5	4.85	2.60	0.62	0.89	5.94	0.07	-18.58	12.0	25.0
26	310-320	61.3	89.0	0.0	61.3	27.7	11.0	5.15	2.69	0.61	0.73	6.97	0.10	-15.77	12.0	28.9
27	320-340	58.1	87.9	0.0	58.1	29.8	12.1	5.27	2.81	0.57	0.72	6.91	0.08	-16.08	10.5	31.5
28	340-360	39.8	84.0	0.0	39.8	44.2	16.0	6.03	2.93	0.57	0.70	9.09	0.10	-17.32	12.9	40.0
29	360-380	44.9	85.2	0.0	44.9	40.4	14.8	5.87	2.86	0.59	0.73	9.02	0.09	-17.47	12.6	36.8

general aspects of the method are discussed by Schulte and Hopkins (1996). Organic carbon content was determined from a 2 g split of the less than 2 mm size sediment treated with 6 N HCl to remove calcium carbonate, then rinsed repeatedly, subsequently dried at 105˚C, and then finely ground.

The stable carbon isotopic value of the organic carbon for each sample was determined at the Stable Isotope/Soil Biology Laboratory at Institute of Ecology, University of Georgia. These values were determined from the carbonate free less than 2 mm sediment used to determine the organic carbon content and were measured by a stable isotope ratio mass spectrometer by converting the organic carbon to a gaseous state by extremely rapid and complete flash combustion of the sample material.

The reversible, low frequency mass magnetic susceptibility (MS) of the samples was determined by filling a 2.54 mm (1 in.) plastic cube with air dried less than 2 mm size material from each sample. The samples were weighed and then the low frequency magnetic susceptibility was measured on a Bartington MS2 meter and MS2B sensor. Each value was measured twice and the average values were used to calculate the reversible, low frequency mass susceptibility (X_{lf}), which are reported in standard international units ($10^{-8}m^3kg^{-1}$). The precise methods and equations used may be found in Gale and Hoare (1991:222-226).

5.3 Phase II Data Recovery Investigations

5.3.1 Archeological Field Procedures

The field strategies employed during Phase II data recovery emphasized opening up large continuous block excavations at specific targets at each of the three sites (Figure 5-8). The excavation blocks enabled us to expose large portions of each occupation zone, thereby revealing the horizontal spatial patterning of features and artifacts.

Figure 5-8. Large Block Excavation in Progress at 41PT185/C.

The initial step of Phase II was the mechanical (backhoe) stripping of the overburden from above the target depths that were determined during Phase I data recovery investigations. The stripping was directed by a three person archeological crew, which continuously monitored and guided the depth of the stripping and inspected the exposed surfaces for cultural materials (Figure 5-9).

A total mapping station was used to determine and monitor the depths of the block stripping. The relative elevation at ground surface was checked at regular intervals to gauge how deep to mechanically excavate from the surface to reach the target zone. In addition, stripped surfaces were also regularly checked to control digging depth. Block coordinate datums (i.e., control points) were established at locations on the ground surface adjacent to each excavation block for subsequent transit set-up.

Figure 5-9. Crew Monitoring Stripping Process at 41PT245.

The shape and size of each block was determined by a combination of factors including topographic characteristics and horizontal extents of artifact concentrations based on Phase I data recovery findings. The orientation of grid north was arbitrary for each excavation block and was established so that it was parallel to the bank of West Amarillo Creek.

Following the stripping, horizontal control across each large block was maintained through the creation of a 1 by 1 m grid system. Each unit was designated by the northern and eastern coordinates of its southwest corner (e.g., N109 E53). All 1 by 1 m units were hand excavated using primarily shovels and picks, with trowels and brushes used and excavate around and expose larger artifacts and features.

Vertical control was conducted through the excavation of arbitrary 10 cm levels. Vertical elevations were determined using level lines strung from block subdatums established in the vicinity of each excavation unit and scattered across each block as needed. All elevations were recorded in centimeters below the original ground surface (cmbs). This was especially important since the hand excavations began at arbitrary elevations following mechanical stripping of over burden. These subdatum elevations were marked by the use of a transit that established the cmbs, which was established from the primary block datum.

On occasion, the first hand excavated level of some units was less than 10 cm thick (i.e., because of the unevenness of the mechanical stripping process, the first level would have been a partial level). In these cases, the first two hand excavated levels were sometimes excavated together. Also, individual 10 cm levels were occasionally subdivided into two separate 5 cm levels to more clearly demarcate transitions between major stratigraphic zones or to provide tighter vertical control within features.

All hand excavated sediments were screened through 6.4 mm (1/4 in.) hardware cloth during both Phase I and II excavations. During Phase II a number of units at 41PT186 were selected for fine screening. This was deemed appropriate as an area of dense lithic debitage was encountered. In these instances stacked screens with 6.4 and 3.2 mm mesh (1/8 in.) were used to first capture the objects greater than 6.4 mm and then the pieces larger than 3.2 mm (Figure 5-10).

Excavation Level Records were completed following the completion of each hand excavation level. Burned rocks, bones, tools,

and other materials found in situ were plotted on the level forms and bottom elevations were recorded for in situ items. As a rule, systematic attempts to document artifact elevations applied only to those artifacts that were larger than a golf ball, since it was presumed that the larger items were subjected to less vertical translocation than smaller artifacts.

Consequently, these larger artifacts served as indicators of the buried occupation surfaces. Any diagnostic artifact found in situ was also plotted on the level sketch map along with a notation of its bottom elevation.

Figure 5-10. Nested Screens Used to Collect Tiny Microdebitage at 41PT186.

Burned rocks were counted, weighed, and recorded on the level records by predetermined size classes (less than 4 cm, 4.1 to 9 cm, 9.1 to 15 cm, and greater than 15 cm in diameter). After being counted and weighed, most burned rocks recovered from nonfeature contexts, as well as some of the burned rocks from feature contexts, were discarded. However, random samples of nonfeature burned rocks, in addition to large samples of burned rocks from features, were bagged, tagged, and collected for future analyses. Sampling of burned rocks focused on rocks that might be used in various analyses. Also, rock samples were collected for identification of rocks types and the ways in which they were used.

Upon completing each excavation level, field personnel counted and/or weighed the material collected and recorded preliminary tabulations on the excavation level forms. These field counts served as the basis for the preliminary assemblage tabulations. All collected lithic debris, bone, ceramic sherds, burned clay, mussel shells, charcoal, tools, and other artifacts and ecofacts (i.e., matrix samples and odd rocks) were placed in clear seal top plastic bags. A provenience tag with all pertinent information was completed for each bag of material/artifacts, then placed into a small bag, which was subsequently placed within the appropriate artifact bag. Other discarded materials included the occasional snail shells and natural pebbles and gravels. In some instances, these materials were also counted and/or weighed, as appropriate. That information was recorded on excavation level forms, and then the materials were discarded in backfill piles.

Whenever stone tools were identified in the field, whether found in situ or recovered from screens, they were most often collected using a trowel and not handled with bare hands. They were then placed in individual plastic bags so as not to contaminate or alter their surfaces. Once in the laboratory, most tools (chipped and ground stone items) were neither handled with bare hands nor washed. A sample of these untouched tools was submitted for use-wear analyses.

The criteria for recognizing and designating cultural features during field operations were based on the judgment of the Field Director or Principal Investigator. Features were required to exhibit clear patterning beyond a nebulous clustering of artifacts or burned rocks. In practice, the criteria for designating features varied somewhat among the components, but generally included clear clustering of rocks and/or artifacts, the presence of charcoal, soil color and/or texture that contrasted with surrounding matrix, vertical internal feature structure, and/or a relatively dense clustering of artifacts. Features were numbered consecutively at each site no matter when the feature was identified or recorded.

After a feature was identified and designated as such, its surface was carefully exposed using small hand tools (e.g., trowels and brushes) and a detailed plan map was drawn. Next, the feature was sectioned along one axis and half of it was excavated with hand tools to expose the vertical cross section of the feature. Profiles of these cross sections were drawn for those features that exhibited vertical structure. Observations about the form, construction, content, context, integrity, and associations of burned rocks, bone, charcoal, or other artifact classes were recorded on individual feature forms. In some cases, scatters of burned rock and artifacts lacked clear, recognizable boundaries. The Principal Investigator and/or Project Archeologist used their judgment to decide on the boundaries of such ambiguous features. Artifacts associated with features and sediment matrix samples were collected, bagged, and labeled separately for each feature. Feature fill was collected for subsequent flotation, fine screening and/or water screening, and possible laboratory analyses (e.g., phytoliths, stable carbon and nitrogen isotopes). Matrix samples were collected from the blocks for potential detailed analyses of soil texture, grain size, stable carbon and nitrogen isotopes, radiocarbon dating of humates, and pollen and phytoliths.

Various rare and anomalous objects (manuports and unidentified substances) encountered during excavations were collected for further examination in the laboratory. While the question of whether these objects were of cultural or natural origin was allowed to remain open until tested by analyses. Such items were collected based on their potential to provide insights into site stratigraphy, site formation processes, and/or cultural activity. Items in this category include mineral deposits (e.g., red and yellow ochre), exotic (i.e., nonlocal) gravels, and natural calcium carbonate concretions (believed to be mineralized root casts).

5.3.2 Laboratory Methods

All materials collected during Phase I and II data recovery excavations were transported back to TRC's laboratory facilities in Austin, Texas, for processing, cataloging, analysis, and temporary curation.

In general, artifact processing entailed washing and labeling most of the cultural material recovered including lithic debitage, stone tools, and bones. Washing involved scrubbing the dirt from artifact surfaces using tap water and soft bristled toothbrushes, arranging wet artifacts to dry on fine mesh screen lined drying trays. Fragile materials such as burned clay, ochre, mussel shells, and charcoal were not washed. In addition, stone tools identified in the field and bagged without handling were not washed. A subset of these tools was submitted for use-wear analysis and others were set aside for long term curation with only minimal handling by laboratory and analytical personnel. All personnel wore nitrile gloves when handling these unwashed tools.

Individual artifacts and artifact lots from within single provenience units were assigned unique catalog numbers. TRC's cataloging system assigns strings of numbers to artifacts that encode information on provenience, artifact class, a unique identifier, and samples taken from the artifact or lot for specialized analyses. Unique provenience numbers (PNUMs) were assigned to lithic debitage, stone tools, burned rocks, sediment, burned clay, faunal bones, ceramic sherds, historic artifacts, and mussel shells. PNUMs are sequential integers that designate the overall provenience unit (i.e., excavation unit, backhoe trench, modern ground surface) and level, or depth, within that provenience unit by reference to a master list of PNUMs. All of the cultural material recovered from a single excavation level within an excavation unit was assigned a unique PNUM designation (e.g., #1261). Within each PNUM, the various artifact classes were assigned a secondary designation (i.e., lithic debitage [001], faunal bone [002], burned rock [003], soil [004], feature [005], shell [006], macrobotanical remains [007], ceramic sherds [008], and historic material [009]) referred to as the artifact class number. Individual tools and other unique items were assigned individual artifact numbers starting with the number 10 within the same unit and level designated by the PNUM. Thus, individual tools, and other unique objects were assigned a PNUM and an individual unique number appended to the PNUM (e.g., #1261-010, #1261-011, and #1261-012).

In many cases, individual samples were removed from larger bags or objects of sample material for specialized analyses (e.g., radiocarbon dating, wood identifications, and instrumental neutron activation analysis). For example, if a single burned rock was extracted from the collection of burned rocks designated as #1261-003 for lipid residue analysis, then that burned rock would be designated as #1261-003-001 to indicate it constituted the first sample from that provenience. In another words, a catalogue number such as #1261-003-1 would identify that specific burned rock as the first sample (1) taken from the burned rock class of artifacts (003) within a specific provenience unit (#1261). If burned rock #1261-003-1 was subdivided into two pieces for different types of analyses, such as lipid residue and starch grain analyses, then lower case letter designations (i.e., a and b) would be added following the last number in the sequence (i.e., #1261-003-1a and #1261-003-1b) to signify that two parts (part a and b) were taken from burned rock #1261-003-1. The complete two or three part number sequence assigned to each object or class of objects constitutes the catalog number. This process allows individual pieces of large collections of various materials to be individually handled and tracked.

Approximately one in 10 artifacts (10 percent) occurring in bulk classes (e.g., chert debitage, faunal bones) within specific provenience units (e.g., a level) were labeled. Size of the object was also a major consideration for labeling purposes. Artifact labeling consisted of inscribing the State of Texas Archeological Site Trinomial for each site (41PT185, 41PT186, or 41PT245) and the catalog number on designated artifacts using black indelible ink. After the ink was dry, the artifact labels were coated with clear acetone to preserve the inscriptions.

Permanent paper bag tags were included with each individual artifact or class of artifacts collected from a single provenience. These tags include the site trinomial, provenience information, the class or type of artifact(s), the date of excavation, the excavator's initials, and the quantity of items in the bag. These permanent tags were printed on acid free, 30.4 kg (67 lb.) card stock and filled out using No. 2 pencils.

All stone tools, samples of lithic debitage, samples of matrix from features, samples of burned rocks, all field records, and photographs from both phases will be permanently curated. Two to three burned rocks from selected burned rock features are also to be curated. Individual artifacts and artifact lots, including all stone tools, ceramic sherds, lithic debitage, burned rocks, faunal bones, and mussel shells, are in clear line seal top plastic bags according to provenience. Small samples of sediment from various proveniences are stored in a similar fashion. Each polyethylene bag contains an archival quality, acid free curation tag that lists the site number, provenience data, date of excavation, excavator(s) initials, artifact type, and quantity. Digital photographs printed out on a color printer were placed in curation approved, acid free plastic preservers for curation. All original field records are on acid free paper and placed in acid free reinforced file folders for curation.

Cultural materials were labeled according to the 2008 curation standards of the Texas Archeological Research Laboratory (TARL) of The University of Texas at Austin. The destination of the collected materials is anticipated to be the Panhandle-Plains Historical Museum (PPHM) at Canyon, Texas.

5.3.2.1 Flotation

Sixty three bags of sediment totaling 135.8 liters, including matrix samples from 16 feature proveniences and two nonfeature proveniences from the combined three sites were floated at the TRC Austin offices using a Dousman flotation system (Figure 5-11). The light and heavy fractions were collected separately and dried. The light fraction was then macroscopically scanned for cultural materials, in particular tiny burned organic remains such as seeds and charcoal. Those light fractions with observed charred organic remains were selected and submitted to Dr. Phil Dering for identification. Dr. Dering's analytical procedures, results, and interpretations are presented in Appendix N. The heavy fractions were spread out on clean white paper and sorted into flakes, snail shell, burned rock fragments, charcoal, bone, seeds, etc., with the aid of magnification. Results were incorporated into each of the feature discussions.

Figure 5-11. Flotation of Matrix Samples Using Dousman Flotation System.

5.3.3 Analytical Methods

Artifacts were subjected to different metric, nonmetric, typological, and other special analyses, including use-wear and neutron activation analyses. In some instances, artifact quantities within specific classes were so high that only a sample of the class could be subjected to more detailed analyses. A set of predefined attributes for each material class was first encoded on paper, and then entered into TRC's electronic database management system based on Microsoft's (MS) Access 2000 software. This MS Access 2000 database constitutes the master database for the Phase I and II data recovery investigations at the Landis Property. A copy of this database is provided on the CD-ROM attached to the back cover of Volume II of this report. The specific data recorded for each class of artifacts are presented below. Analytical methods pertinent to each data class and the various secondary suites of software used for specialized analyses are discussed in detail in the appropriate parts of this report. The materials from Phases I and II were integrated into a single database.

5.3.4 Chipped Stone Artifact Analysis

Data entry forms were created to record qualitative and quantitative attributes of chipped stone tool for analytical and interpretive insight. A morphological typology (based on Andrefsky and Bender (1988) and Andrefsky et al. 1994) was used that allowed lithic analysts to classify and sort chipped stone artifacts first into debitage versus tools then into more specific categories (Figure 5-12). The edges and surfaces of each piece of chert were macroscopically examined for signs of use as a

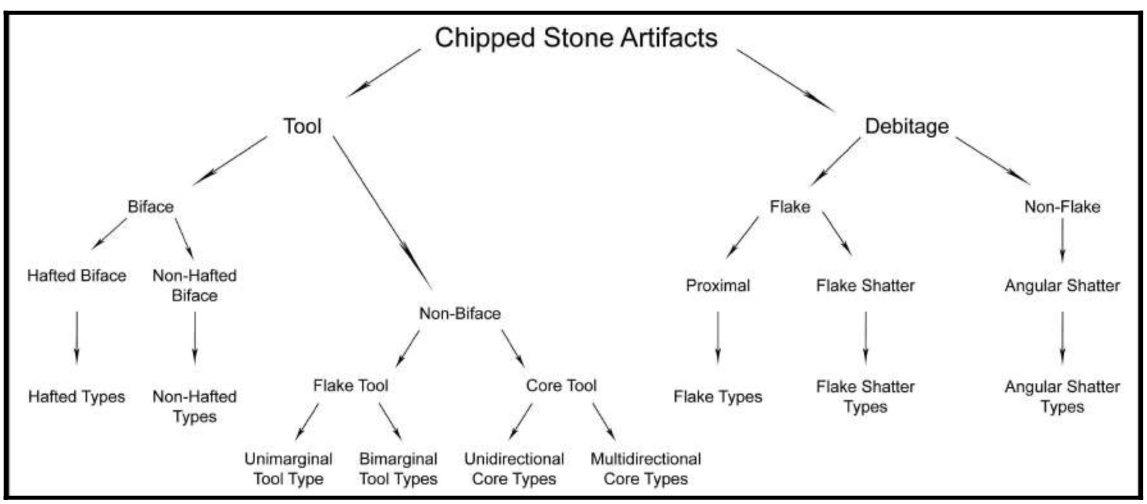


Figure 5-12. Chipped Stone Artifact Analysis Flowchart.

tool. If worked areas were identified, the artifact was assigned to a morphological and/or technological category based on general form and inferred function. Sets of observations were recorded for all tool classes recovered. The following subsections provide definitions of major tool classes.

5.3.4.1 Tools - Bifacial

5.3.4.1.1 Bifaces

Bifacial tools are those worked pieces, whether finely or crudely produced, in which the manufacturing process has apparently been brought to completion, as evidenced by secondary retouch, edge straightening, hafting preparation, notching, and similar characteristics. Bifaces are defined based predominantly on morphological characteristics, but they may also have functional associations (e.g., cutting, piercing, chopping, drilling). Bifacial tools exhibit purposeful, usually patterned flake removals on both faces of the object. Most or all of each face may be covered with flake scars, and in some cases one face may be completely modified, whereas the opposite face exhibits only partial modification. Bifaces may be fashioned either from large bifacial cores or from flakes. However, if only the margin of a specimen exhibits modification rather than most or all of at least one face, then the tool was classified as an edge-modified flake tool. Included within this overall morphological category are diverse functional groups such as projectile points and drills (see below). Data on 25 distinct dimensions of variability were recorded for bifaces. Attributes included nonmetric observations concerning the completeness of the specimen, overall morphology, manufacturing characteristics, and manufacturing stage based on morphological classes adapted from Callahan (1979). Metric measurements of length, width, thickness, and weight also were recorded for each specimen even if it was broken.

5.3.4.1.2 Projectile Points

Projectile points are a functional subset of the biface class specifically designed to be hafted to the distal end of a shaft used in stabbing, throwing, or shooting to penetrate animal hides and flesh. Projectile points are bifacial tools formed by fine secondary retouch, usually with basal modification in the form of notching, stemming, or thinning of the proximal end for purposes of hafting. Dart points, arrow points, and indeterminate dart/arrow points are all classes of projectile points. Dart points are those employed to tip hand held darts or spears; arrow points are used to tip arrows; and indeterminate points are, as the name implies, of uncertain usage. Whereas dart points are usually manufactured from bifacial preforms, arrow points are often manufactured on thin flakes.

Projectile points were assigned to recognized types whenever possible. In traditional archeological literature, projectile points are normally referred to by their typological designation, which are usually based on a set of morphological characteristics (that generally focus on the hafting modification) shared in common by groups of similar points. Initial point classifications were attempted by TRC's personnel in reference to established point typologies in use in Texas archeology (Suhm et al. 1954; Prewitt 1985; D. Davis 1995; Turner and Hester 1999). However, the recovered dart points from 41PT185/C did not exhibit characteristics similar to those published types that allowed their assignment into previously named central Texas types. Therefore, the dart points recovered from the Late Archaic component at 41PT185/C were not assigned to existing types and form a recognizable group on the basis of characteristic corner-notches.

A comprehensive suite of 44 metric and nonmetric observations was recorded for all projectile points recovered from the Landis Property. Nonmetric attributes recorded include descriptors of overall morphology and manufacturing and reworking characteristics. Numerous metric measurements also were recorded (Figure 5-13). Metric measurements of

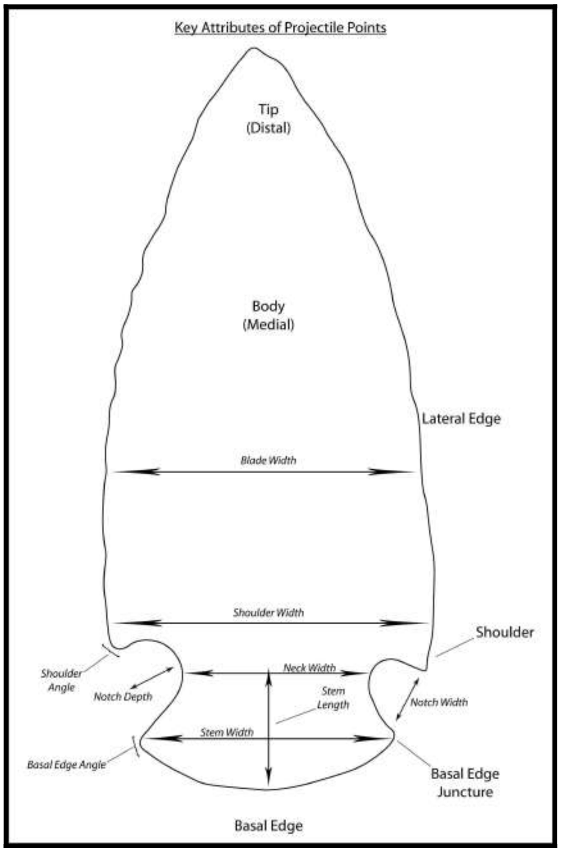


Figure 5-13. Projectile Point Terms and Metric Measurement Locations.

length, width, thickness, and weight were recorded for each specimen even if it was broken.

5.3.4.1.3 Drills

Drills are another function specific subset of the biface class. Drills generally consist of two sections—the distal bit (or working edge) and the stem or proximal end section. Distal bits are typically long, tapered, and bifacially flaked, resulting in a diamond shaped cross section that distinguishes this type of tool. The bit is usually relatively thick and is designed to produce a stable base for rotary motion. Drills are usually presumed to have been used on hard substances, such as wood, shell, or bone, and spun in a rotating fashion to penetrate the material; therefore, drill tips usually exhibit heavy rounding and/or polishing of bit edges.

Drills are often subdivided into specific types, such as T-butt, irregular, or notched, but this typology was not employed in this analysis. Twenty five metric and nonmetric observations were recorded for drills. Metric measurements of length, width, thickness, and weight were recorded for each specimen even if it was broken.

5.3.4.1.4 Cores

A core is a cobble, pebble, or other mass of lithic raw material that exhibits one or more platforms and flake scars resulting from the systematic removal of flakes by flint knappers. Technically, any chipped stone tool may properly be classified as a core as it is the object created through the removal of flakes from the exterior surface of the original mass of lithic material. In common terms, however, cores are generally considered to be those masses of material from which one or more flakes were removed. In other words, cores do not exhibit any intentional or use-related flake scarring along any of their edges, though scars resulting from platform preparation may be evident, and a core might be expediently used as a tool (e.g., extensive crushing damage along one or more thick edges of a core would probably result in classification of the object as a chopper).

Various types of cores are recognized according to the degree of knapping and the flake removal strategy. Four basic types of cores are unifacial, bifacial, multidirectional, and blade core. The last named type often has a distinctive conical polyhedral shape, the result of the repeated, parallel removal of long, narrow flakes known as prismatic blades.

Tested cobbles are natural clasts of tool stone that exhibit only a very limited number of flake scars, often just one or two, removed by hard hammer percussion. Generally, these flakes removed the exterior, cortical surface of the cobble, exposing the interior structure of the cobble. The edges of the flake scars do not exhibit any further alteration, such as edge grinding, dulling, or crushing that may be indicative of additional modification or use.

Tested cobbles most likely represent intentional exposure of the interior of the stone for the purpose of evaluating its quality and suitability for manufacturing stone tools.

A unifacial core is one that exhibits flake scars removed from only one face. The flake removals may be in various directions and exhibits no pattern or structure to the removals. There are usually only one or two platforms.

A bifacial core exhibits flake removals from both faces and again these may be in multiple directions. The parent or objective rock is generally a cobble that exhibits two detectable faces. The flakes were driven from the lateral edges, thus the platforms are along the edges.

The multidirectional core is generally a chunk of raw material that does not necessarily exhibit two obvious faces. Generally there are a number of platforms from which flakes were removed. Most often the flakes are removed in different directions.

Blade cores are chunks of raw material intentionally prepared to facilitate the removal of a specific kind of desired flake. These generally exhibit two or more parallel scars driven from the same platform in the same direction with the same overall shape.

Twenty metric and nonmetric observations were recorded for cores. Metric measurements of length, width, thickness, and weight were recorded for each specimen even if it was broken.

5.3.4.2 Tools--NonBifacial

5.3.4.2.1 Unifaces

Unifaces are those tools that exhibit flake scars on one face only. Like bifaces, unifaces are defined based predominantly on morphological characteristics, but they also tend to have functional associations (e.g., scraping, planing, cutting, engraving). Unifacial tools exhibit purposeful flaking across most or all of one face, whereas the opposite face most often remains flat and unmodified. Unifaces may be fashioned from cobbles or flakes. This category includes such functionally diverse groups as scrapers, gouges, edge-modified flakes, gravers, and spokeshaves. One or more edges of a unifacial tool may exhibit manufacture and/or use related flake removals that may be patterned or unpatterned. To some degree, unifacial tools form a continuum from formal tools exhibiting intentional, patterned, manufacture related edge flaking to informal, ephemeral tools that show only use related edge scarring. The former tend to fall within the scraper and gouge categories, whereas the latter are generally classified as edge-modified flakes.

5.3.4.2.2 Scrapers

Scrapers are a specific type of unifacial tool that have at least one intentionally modified working edge. In some instances, bifacial modification may be present, but in such cases the intentional retouch tends to be located on the dorsal flake surface whereas the ventral surface tends to exhibit primarily use related flake scars. Based upon the location of the primary working edge, scrapers are subdivided into end, side, or combination types. End scrapers are pieces with retouch restricted to either the distal or proximal end of the flake blank, generally producing a convex working edge. The opposing end of the piece may bear some minimal retouch, presumably to facilitate hafting the piece. Side scrapers are pieces with retouch present on one or both lateral edges of the flake blank. Working edges may be convex, straight, or concave. On combination scrapers, marginal retouch may appear along the end as well as along one or more lateral edges of the blank. As implied by the name of this tool, the primary function of scrapers is presumed to relate to scraping relatively soft materials such as animal hides or vegetable matter, or slightly harder materials, such as wood or possibly antler or bone.

Twenty eight metric and nonmetric attributes were recorded for scrapers. Many measurements relate to the number, location, and characteristics of the various working edges on the tool. Metric measurements of length, width, thickness, and weight were recorded for each specimen even if it was broken.

5.3.4.2.3 Edge-Modified Flakes

Edge-modified flakes are minimally modified flakes, flake fragments, or pieces of angular debris that are characterized by one or more areas of flake scarring along margins. The edge flaking may be patterned or unpatterned, continuous or discontinuous, and may result from intentional pressure retouching to prepare an edge for use or may result exclusively from use related activities. Many edge-modified flake tools exhibit combinations of these characteristics, and most have more than one working edge. The modifications, however, usually are restricted to the edges of the piece and do not significantly alter the original flake form. Edge modifications may be either unifacial or bifacial. Edge-modified flakes are usually considered to be “expedient” tools, or pieces of raw material that are picked up, utilized for a short time with or without first being minimally modified, and subsequently discarded at the location of use, or soon after use.

Twenty one metric and nonmetric attributes were recorded for edge-modified flakes. Metric measurements of length, width, thickness, and weight were recorded for each specimen even if it was broken.

5.3.4.2.4 Gravers and Spokeshaves

Various types of specialized working edges are often found on tools otherwise identified as scrapers or edge-modified flakes. While it is possible that only one such specialized bit may exist on a tool, these types of tools are considered to primarily fall within the appropriate scraper or edge-modified flake category, while the specialized working edge would be classified as one of the working edges. Types of specialized working edges that are often recognized include perforators or borers, graver spurs, spokeshaves or notches, and burins. For purposes of this analysis, graver spurs and borers are combined into a single category, as are spokeshaves and notches.

Graver spurs, or gravers, are additional carefully flaked, prominent, sharp protrusions formed on scrapers or edge-modified flake tools by the creation of adjacent shallow concavities or notches. Graver spurs may be quite short, only a millimeter or two in length, or rather prominent, in which case they grade into the category of tools often referred to as borers or perforators. Graver spurs may exhibit alternating edge retouch, but this is usually present only on longer specimens. The function of graver spurs is assumed to be engraving relatively hard substances such as wood, bone, and antler.

Spokeshaves, or notches, are working edges on scrapers or edge-modified flakes formed by the removal of numerous small flakes in a limited area along the lateral edge of a piece to form a single, relatively deep, concave area. Such notches may be relatively small or quite large, shallow or deep. The function of spokeshaves is assumed to relate to scraping or planing relatively hard substances, such as wood, bone, and antler, that are either tubular in shape or for which a convex outer surface is a desired result (e.g., dart or arrow shafts).

By definition, graver spurs, spokeshaves, and burins are considered to be specialized tools made on objects that may otherwise be classified as scrapers or edge-modified flake tools. As such, the metric and nonmetric data encoded regarding that working edge would follow the procedures used for scrapers or edge-modified flakes, as appropriate.

5.3.5 Ground Stone Tool Analyses

This broad artifact class includes pieces of natural rock that have been modified by grinding, pecking, or battering, either to intentionally shape an implement or as a by product of use. Ground stone tools are recognized by the presence of nonnatural abrasions, grooves, and striations and/or smoothing. Significant rounding, flattening, and/or pitting of utilized surfaces can also be identified. Categories of ground stone tools include hammerstones, manos, and metates (milling stones).

The edges and surfaces of each piece of rock were macroscopically examined for signs of use as a tool. If battered, smoothed, unnaturally flattened, pitted, ground, striated, incised, or pecked areas were identified, then the artifact was assigned to a morphological and/or functional category based on general form and inferred function. Sets of observations were recorded for the tool classes recovered. The following subsections provide definitions of major tool classes.

5.3.5.1 Manos and Metates

Manos and metates are generally used together to grind friable materials (nuts, seeds, other vegetal matter, pigments) into powder. A mano is a hand held grinding stone, generally characterized by a round to ovate shape, usually of a hard, dense siliceous rock such as quartzite or sandstone. One or more surfaces exhibit a smooth or polished, and/or possibly flattened area caused by grinding against another hard surface (the metate). In some instances the edges exhibit crushed or pitted areas indicating possible use as hammerstones as well. Generally, these are water worn cobbles that exhibit no other alterations to the natural cobble.

A metate is often a large slab of a dense siliceous rock such as sandstone, which has functioned as the base on which the mano is used to grind materials. The grinding action most often creates a shallow concave face that is smoothed and/or polished. Extensive and continued use creates a deeper concave surface and in some instances both faces may have functioned as a base for grinding. The deep oval basin-like or elliptical grinding surfaces on metates from the Great Basin region, or the long, rectangular trough characteristic of metates of agricultural cultures of the United States Southwest are not recovered from the Plains hunter-gatherer sites. Occasionally the edges of Plains metates are artificially shaped. Metric and nonmetric observations were recorded for manos and metates. Measurements of dimensions were recorded only when the dimension in question was completely represented and/or could be reasonably estimated.

5.3.5.2 Hammerstones

A hammerstone is a hard nodule of lithic material, usually dense siliceous rock such as quartzite, used for direct percussion fracturing of tool stone during lithic reduction. These pieces usually exhibit limited or extensive areas of battering, crushing, and/or pitting on one or more surfaces of the natural cobble. In some cases, small flake scars may form as the result of hard hammer percussion, creating an appearance similar to a tested cobble core. Metric and nonmetric observations were recorded for hammerstones. Measurements of dimensions were taken only when the dimension in question was completely represented and/or could be reasonably estimated.

5.3.6 Lithic Debitage Analyses

Chipped stone debitage is the unmodified debris that results from lithic reduction activities associated with the manufacture and maintenance of stone tools. Lithic debitage lacks any macroscopic indications of use or modification. Pieces that exhibit any sign of use-wear or intentional modification are placed in the appropriate tool category. All debitage was counted and weighed. The debitage collection from each excavation block was subjected to detailed analysis, with individual pieces sorted into the reduction classes listed below.

Besides the total count, the pieces were classified by completeness/type of debitage represented, (whole, proximal fragments, distal fragment, shatter/blocky debris), size grade into 6.4, 12.8, 19.2, and 25.6 mm groups, cortex percentage (0, 1 to 25, 26 to 50, 51 to 75, and 76 to 100 percent), platform type (indeterminate, cortical, flat, complex, abraded, faceted, multifaceted, and rejuvenated after Andrefsky [1998:93-96]), observed purposeful thermal alteration, technique used in reduction (indeterminate, hard hammer, soft hammer, indirect, pressure, and bipolar), and raw material type.

5.3.6.1 Core Reduction Flakes

This category includes flakes, flake fragments, and pieces of angular debris associated with initial core preparation activities, such as test flakes that were removed to determine the quality of raw material within a cobble as well as to decorticate a cobble for further reduction. Items in this category tend to have cortex covering more than 50 percent of their dorsal surfaces. By definition, most of these items tend to be relatively large (smaller flakes with dorsal cortex often fall within other categories, such as early and late stage biface flakes or indeterminate flakes, depending on their diagnostic characteristics). Core preparation flakes may or may not exhibit pronounced platforms, bulbs of percussion, or ventral concussion rings, though most do have one or more of these characteristics.

5.3.6.2 Biface Thinning Flakes

Biface manufacture flakes were classified based on the presence of multifaceted striking platforms, multidirectional dorsal flake scars, parallel to slightly expanding flake margins, and slight to moderate longitudinal curvatures. This category was subdivided into early and late stage biface manufacture flakes. Early stage biface flakes tend to be somewhat larger than late stage biface flakes, have fewer and larger dorsal flake scars, and may retain a considerable amount of cortex on their dorsal surfaces. As employed in this analysis, early stage biface flakes correlate roughly with Callahan's (cf. 1979) revised Stage 1, 2, and 3 bifaces ("blank," "rough out," and "primary preform" stages) while late stage biface flakes correlate with Callahan's revised Stage 4 and 5 bifaces ("secondary preform" and "final preform" stages). In practice, Stage 1 ("blank") flakes are more likely to fall within the core preparation flake category due to the lack of clear diagnostic characteristics on many such specimens. Final percussion thinning, pressure thinning, and retouch flakes that do not clearly exhibit biface manufacture characteristics due to their small size would likely be included in the tertiary thinning/retouch flakes category. The early and late stage biface flake categories may contain complete flakes, proximal and distal flake fragments, and/or small pieces of angular debris that exhibit clear characteristics of the biface manufacturing process (in practice, the latter type of debitage—angular debris bearing bifacial traits—is rare in the biface manufacture flake categories).

5.3.6.3 Tertiary Thinning/Retouch Flakes

This category includes flakes and proximal and dorsal flake fragments resulting from the final stages of tool manufacture, including final percussion thinning and any subsequent pressure retouch. By definition, flakes in this category tend to be quite small, and it is difficult to distinguish whether they result from biface manufacture, uniface manufacture, or resharpening.

5.3.6.4 Angular Debris

Angular debris, or "shatter," includes angular pieces of lithic raw material that break away from the core as flakes are struck. In contrast to flakes, angular debris does not generally retain any diagnostic characteristics of the flint knapping process (i.e., platforms, bulbs of percussion, concussion rings, and definable dorsal or ventral surfaces). In this analysis, those few pieces of angular debris that exhibit characteristics diagnostic of biface manufacture were included in the appropriate biface manufacturing category (i.e., early versus late stage biface flakes).

5.3.6.5 Indeterminate Flakes

This category includes flakes and flake fragments that lack diagnostic traits that would permit their placement into one of the other categories. Generally, these flakes are small fragments of flakes and/or thin pieces of angular debris that do not display clear evidence of a platform, concussion rings, or flake scar patterning on their dorsal surfaces. This category also includes a small number of potlid flakes and fractured heat spalls resulting from thermal alteration of raw materials.

5.3.7 Ceramic Analysis

Very few ceramic sherds were recovered from each site. The sherds were first visibly inspected for obvious signs of residues. If no residues were observed then each sherd was lightly washed, except in a few instances, and labeled with ink. Once cleaned and labeled with the appropriate PNUM each sherd was described and subjected to a combination of metric and nonmetric analyses. Sherd attributes such as interior, exterior and core colors (Munsell), type of interior and exterior surface treatments, temper, and range of sherd size and thickness, were recorded on the form. Sherd descriptions included observations on construction techniques, sherd/vessel form, and summary of the recorded attributes. Since sherds were generally recovered from multiple sites and scattered test units, vessels reconstruction was not attempted. However, one group of sherds recovered from the top 20 cm of TU 3 at 41PT245 was determined to represent a single vessel.

Nine sherds were selected for petrographic analysis (see details below) to determine the types and quantities of additives to the natural clays, in order to determine whether or not clays were locally derived. Six were prepared through standard thin sections and three had to be wet mounted as they were too small for thin sectioning. For purposes of comparison, 11 natural clay samples from the broad region of the Texas Panhandle were also subjected to petrographic analysis (see the petrographic section, below, for details). The methods, results, and interpretations of the petrographic analyses are presented in Appendix I.

Six sherds were also selected for Instrumental Neutron Activation Analysis (INAA) at the Archaeometry Laboratory, Research Reactor Center at the University of Missouri (Columbia). Three specimens were pieces of sherds subjected to petrographic analysis. See the section on INAA, below, for details. The sample preparation steps, the actual analytical procedures, and the interpretations of the chemical data, are presented in Appendix J.

Pieces of two sherds (41PT245 #341-008-1a and #401-008-1a) were also sent for lipid residue analysis. Pieces of these same sherds also were sent for INAA, with a piece of #401-008-1e also sent for petrographic analysis. These were submitted to Dr. Mary Malainey in Winnipeg, Manitoba. See the lipid residue analysis section, below, for more details. The lipid residue results are presented in Appendix G.

The information concerning each individual sherd is presented in the appropriate artifact description section of each site. Results from the various technical analyses are also presented.

5.3.8 Mussel Shell Analysis

Freshwater mussel shell fragments were rare occurrences in these alluvial terrace deposits and those that were recovered consist predominantly of small, unidentifiable fragments. Whenever possible, shell fragments were compared to TRC's mussel shell comparative collection in an attempt to identify the species. Fragments of valves were counted, weighed, and examined for signs of human modification.

5.3.9 Faunal Bone Analyses

The entire recovered vertebrate faunal assemblage was examined to identify specific taxa, anatomical elements, element symmetry, element part, size, weight, skeletal maturity, presence or absence of burning, and type of human modification (cuts, impacts, and/or use as a tool). If bone tools were identified, the pertinent specimen was set aside for detailed observation as an artifact. Such items are discussed in the text under heading, "Bone Tools".

The faunal remains from each site and each component were divided into major taxon groups based on the size and type of animal represented. The various groups identified include dog/coyote (*Canis*), deer (*Odocoileus* sp.) bison (*Bison bison*), turtles (Testudines), snakes (Serpentes), and small rodents, and fish (Osteichthyes). The assignment of a bone fragment to a specific taxon was based primarily on cortical wall thickness, bone shape and structure, and other specific observed attributes. If these attributes were not sufficient to confidently assign a bone to a specific taxon the fragment was assigned to an unknown category. Bones were identified as to element and symmetry where possible, but many pieces are small long bone fragments (LBF) that could not be identified to a specific taxon. The counts and weights of each group or taxon were recorded and are listed by taxon.

The bones were also recorded according to predetermined fragment size categories. The categories range from 0 to 3 cm, 3.1 to 6.0 cm, 6.1 to 9.0 cm, 9.1 to 12.0 cm, and greater than 12.1 cm. Knowing the size bone fragments provides an indication how the bones may have been processed (e.g., highly fragmented bones may reflect bone grease rendering).

Each bone was inspected for various alterations, including burning, scrape marks, chop marks, blunt impacts, cut marks and other possible cultural modifications (Fisher 1995). The cut marks include various types such as thin and thick cut lines from stone tools made during skinning, defleshing, and disarticulation. Cut mark morphology reflects the shape of the tool's edge, the angle at which the tools was held, and the force behind the tool. Broad chop marks or percussion pits are often linear depressions that generally have a V-shaped cross section caused by larger and heavier stone tools, often during disarticulation. Impact locations are characterized by conchoidal flake scars and bone flakes created by heavy hammerstones that indicate the point of impact where the element was struck to break the bone, as in marrow extraction.

Burning may result in a variety of observed colors that are generally related to the temperatures (degrees Celsius [°C]) that the bone was subjected too. This includes bones burned to a solid black, a solid brown, a mixture of brown and black, a calcined white, and a mixture of black and white. Generally speaking, the bones of an ungulate turn to a brown color in the temperature range around 200°C, black in the 300°C range, gray in the 300 to 400°C range, and white above about 700°C range (Nicholson 1993).

General weathering of the bones were observed, but no details concerning this process were recorded beyond its presence or absence. It should be pointed out that bone weathering is not just a direct result of time. It also reflects a combination of physical and chemical processes that result in cracking, splitting, exfoliation, disintegration and decomposition.

Root etching is a separate process that causes narrow, shallow lines and pits etched into the surface of bones by acids associated with plant roots (Fisher 1995). These lines are sinuous or wavy, have U-shaped cross sections, and are easily identified.

Following initial identifications, weighing, and documentation, the more intact and mature long bone articular ends that represent mature bison elements were selected for measuring to determine what gender they represent. Gender was determined from a variety of metric measurements, as presented by Lorrain (1967), Driesch (1976:88-90), Speth (1983), and Morlan (1991). The specific measurements were taken with electronic calipers at designated locations on the various bones. The recorded measurements were then compared to known sexed bison data presented in Speth (1983). Measurements on astragali were compared to those outlined by Morlan (1991) and graphed to separate bones of the two sexes.

Age estimates of individual mandibles are based on tooth eruption and wear patterns in the mandibular teeth of bison. Bison molars erupt at known ages and are worn down at relatively constant rates (Frison and Reher 1970; Reher 1973:89-105). This fact allows for an age estimate of mandibles that contain molar teeth and, by extension, the age of the individual animal. Beyond the age of five years, all the molars have erupted and tooth wear becomes less consistent and is, therefore, less reliable as an indicator of age or season of death. The age of the animal at death is also used to infer the season of death and the season of human hunting activity.

Element maturity estimates (i.e., element not fully developed) are based on the degree of fusion of long bone articular surfaces to the main bone shaft. Different bone elements are known to fuse at different times in an animal's life. However, very little is known about the exact timing of bone fusion rates in North American *Bison bison*. Previously most researchers used Koch's (1935) study of European bison (*Bison bonasus*) to approximate the general trends in the timing of various epiphyseal fusions in North American bison. In 1950 Sisson and Grossman (1950) provided fusion rates based on modern cow (*Bos Taurus*), which may or may not be similar to fusion rates in *Bison bison*. From the 10,000 to 11,000 year old Cooper site faunal assemblage in Oklahoma, Bement and Basmajim (1996) created a fusion rate chart for *Bison antiquus* using the numerous articulated skeletons they discovered. The Bement and Basmajim (1996) chart provides yearly age determinations from birth to five years old. These fusion rates may not be appropriate for our ca. less than 3000 year old *Bison bison* assemblage. For the *Bison antiquus* from the Cooper site, all epiphyses of the appendicular skeleton were fused by the age of 5.3 years (Bement 1999). Here, we followed the Bement and Basmajim (1996) fusion rates, with a caution to the reader that this may not be a completely correct timing for *Bison bison*.

A fetal age category, which represents an unborn animal, and a new born category were also incorporated into the maturity system. This general age category is relatively easily determined based on the size of the element coupled with the development of the bone's cortical wall tissue. Uncertainty enters the picture if the animal was killed just prior to birth or just after birth, as the tissue development is quite similar. Once the animal begins to walk, the periosteum layers begin to solidify.

The minimum number of individuals (MNI) by species was derived from the maximum number of recognized elements coupled with size, age, and sex estimates also taken into consideration.

The faunal identifications were conducted by Mike Quigg using his personal comparative collection. At times he was assisted by Jeff Hall who helped in various steps throughout the analyses, especially in production of tabulations and distribution maps. The results are incorporated into the body of the text for each site and component.

5.4 ANALYTICAL TECHNIQUES

The following analytical techniques were conducted in order to better understand the diverse materials recovered, and to generate data for interpretation. Many of the following techniques were applied to samples of materials following the 2007 Phase I data recovery effort. When these specific technical analyses yielded positive and interpretable results, they also contributed towards addressing specific research questions developed in the initial research design (Quigg 2005). The Phase I results provided guidelines for the data collection strategies employed during Phase II. These same technical analyses were again implemented to selected data sets in the subsequent Phase II data analyses. The Phase I results have been incorporated into each of the various appendices were appropriate, and integrated into the body of this document.

The various technical analyses were conducted by highly skilled individuals who have applied their expertise and offered interpretations based upon the obtained results. Their specific reports are attached as appendices in Volume II that provide the details of their methods, studies, analytical results, and interpretations. The results of these diverse technical studies, coupled with analyses of cultural materials obtained during both Phase I and II mitigation investigations, are incorporated throughout the body of this report. The combined results are used to address the various research questions presented in the Treatment Plan for the Landis Property (Quigg 2005).

5.4.1 Radiocarbon Analysis

Charcoal, the preferred material for radiocarbon analysis was scarce, except in the case of the Protohistoric component at 41PT186. Thus, in order to establish a chronological age for a specific cultural and/or natural event required the use of other kinds of organic materials. Fifty one samples (includes four from survey and testing) of four different material types (charcoal, bison bone, sediment, and two types of shell) were selected and submitted to Beta Analytic Inc. (Beta) for radiocarbon dating. These samples were collected from a variety of cultural and natural deposits.

At the Beta laboratory each sample was pretreated prior dating. The bone collagen was extracted with the use of alkali, whereas the organic rich sediments were washed with acids. The dates are reported as radiocarbon years before present (B.P.), with present being A.D. 1950 using the Libby ^{14}C half life of 5,568 years (Figure 5-14). Each sample was measured for carbon 13 verses carbon 12 ratios ($^{13}C/^{12}C$) expressed as the delta 13 carbon ($\delta^{13}C$) and calculated relative to the internationally standard Cretaceous belemnite formation at Peedee, South Carolina (PDB or VPDB).

The individual and combined results provide the foundation for determining the ages of the natural deposits throughout the investigated area of upper end of West Amarillo Creek valley and provide absolute ages of cultural events sampled at these three archeological sites. Beta's Laboratory reports for individual samples with specific details per individual sample are presented in Appendix K. Individual sample results are presented throughout the text.

Figure 5-14. Beta Laboratory, Showing the Gas Extraction Process.
(photo provided by Beta Analytic)

5.4.2 Use-Wear Analyses

The chipped stone tool assemblages were not extensive from any of the investigated sites within the Landis Property. Chipped stone tools from both Phase II excavation blocks, with a Protohistoric component at 41PT186 and a Late Archaic component at 41PT185/C, were selected for high-power, microscopic use-wear analysis. A total of 42 unwashed artifacts, 11 Protohistoric and 31 Late Archaic were sent to Dr. Bruce Hardy at Kenyon Collage (Gambier, Ohio) for use-wear analyses. Most tools selected were minimally handled in the field and not washed in the laboratory. In order to track individual items, a small spot on one face of the artifact was cleaned and a label applied in ink. All chipped stone tool classes represented in the recovered assemblage were sampled and submitted for analysis. This included four dart points, 13 end and side scrapers, nine bifaces, one drill base, one corner-tang knife, two choppers, nine edge-modified flakes, and two flakes. Edge-modified flakes were intensively sampled as they presumably functioned in a variety of tasks and on a variety of materials. Therefore, it was thought that the greatest functional diversity would be apparent in the edge-modified flake tool class. The edge-modified flake tools included a variety of edge shapes and sizes in hopes of identifying a wide range of functions such as cutting, graving, shaving, scraping, and whittling. The analytical methods and individual results of Dr. Hardy's findings are presented in Appendix L.

5.4.3 Starch Grain Analysis

Starch grains are microscopic granules that serve as the principal food storage mechanism of plants. These grains are found mainly in roots, tubers (e.g., crow poison, rain lilies, false garlic, wine cup, and spring beauty), seeds of legumes, and grasses, where they are often produced in abundant numbers (Perry personal communication 2008). Starch grains from different plants possess a large variety of forms that have been recognized for some time. Distinctive features of starch grains are genetically controlled and when carefully observed, can be used to identify plant taxa. At least 300 species and varieties of important economic plants from around the world have been described and there is widespread recognition that these materials can be preserved in archeological contexts (Piperno and Holst 1998); Piperno et al. 2000). Researchers around the world (particularly in the neotropics and in Australia) have been using these techniques with excellent results (Perry personal communication 2007). Specifically, starch grain remains have significantly increased the knowledge of plant domestication and crop-plant dispersal in various regions (Perry et al. 2006:76-77). Researchers have employed starch grain analyses to study diet, plant processing, plant domestication and cultivation, tool use, and uses of ceramic vessels. Starch grains have been extracted from soil samples, ceramics, and chipped and ground stone tools to address questions of resource procurement and preparation of foods. Intact starch grains have been extracted from formal and informal chipped stone tools, both washed and unwashed (Perry personal communication 2007). Heat alone does not destroy starches as they are found in vessels, thus burned rocks have the potential to also yield starch grains.

A total of 55 samples that include 37 burned rocks from 14 different cultural features, six metate fragments, six chipped stone tools, two manos, two ceramic sherds, one rock from under a bison skull, and one of Quigg's experimental burned limestone rock with known starch residues were selected and sent for starch grain analysis. These went to Dr. Linda Perry, affiliated with the Smithsonian Institution, to determine the presence/absence, and taxa of starch grains. Dr. Perry's extraction methods, results, and interpretations are presented in Appendix F.

5.4.4 Burned Rock Analyses

Burned rocks often account for a high percentage of the artifacts recovered from hunter-gatherer camp sites. These have been heated and often rapidly cooled as the result of use in cooking or other heating activities. While it is occasionally difficult to distinguish burned from unburned rocks in the field, many burned rocks exhibit cracks, discoloration, crazing, reddening, and angular fragmented edges.

During excavation, burned rocks were treated as cultural artifacts. The larger pieces were often mapped in situ and all burned rock pieces from each hand excavated level were collected and recorded. The collected burned rocks were then sorted into four previously established size categories (i.e., 0 to 4 cm, 4.1 to 9 cm, 9.1 to 15 cm, and greater than 15 cm) based on maximum dimensions, and then counted and weighed by size class. Most burned rocks from feature contexts and a sample of burned rocks from nonfeature contexts were collected, bagged, and returned to the laboratory for processing, cataloging, and analysis. Some burned rocks from features and most burned rocks from nonfeature contexts were discarded in the field after being counted and weighed. While the entire volume of burned rock encountered during the hand excavations is known, only a small sample was retained for possible further analysis and curation.

Fifty eight burned rocks were selected for lipid residue analysis. These samples represented a total of 15 features including two from 41PT245, one from 41PT185/A, and 12 from 41PT185/C. Three major time periods were represented by the 58 burned rocks. Two burned rocks were from the Protohistoric component at 41PT186, four represent a probable Protohistoric component at 41PT245, four rocks represent the Late Prehistoric Palo Duro or Woodland component at 41PT245, one rock represents a probable Antelope Creek period, whereas 47 represent the Late Archaic period components at 41PT185/A and C. These 58 samples were sent to Dr. Mary Malainey in Winnipeg, Manitoba for analyses. The detailed sample preparation and extraction methods, individual rock analyses, and interpretations of the lipid residues are presented in Appendix G.

Another 55 burned rocks were subjected to starch grain analysis. In most instances these are parts of the same 58 rocks that were subjected to the lipid residue analysis. These include two samples from the Protohistoric occupation at 41PT186, three from the probable Protohistoric component at 41PT245, five from the Palo Duro or Woodland component at 41PT245, one representing a probable Antelope Creek period, and 44 burned rocks from 16 features representing Late Archaic components at 41PT185/A and C. As a cross check Mike Quigg prepared a modern experimental burned rock with known residues on it, and submitted it blind along with the prehistoric burned rock samples. These burned rocks were submitted to Dr. Linda Perry of the Smithsonian National Museum of Natural History for analysis. Her detailed sample preparation, analysis, and interpretations of the starch grain analysis are presented in Appendix F.

5.4.5 Macrobotanical Analyses

The Phase I and II hand excavations yielded very few chunks of charcoal or other macrobotanical remains. Bulk sediment samples from identified cultural features were also collected for potential analysis.

In the laboratory, selected feature samples with the potential to yield macrobotanical remains were subjected to an initial fine screening to assess their potential to yielded macrobotanical remains. These initial samples yielded very tiny flecks and limited charcoal pieces that potentially could be identified. The tiny size of the charcoal recovered prevents positive identifications in most instances.

Subsequently, bulk matrix samples from features were subjected to flotation at the Austin facilities. Selected samples were floated using a Dousman flotation system that allowed for the collection of separate light and heavy fractions. The collected heavy and light fractions were subjected to specific analyses.

Fifteen light fractions were selected for macrobotanical analysis. These samples were from various proveniences that were radiocarbon dated to within the last 3,000 years. Fifteen light fraction samples from the flotation process were sent to Dr. Phil Dering of Shumla Archeobotanical Services in Comstock, Texas for sorting and identification of organic materials. Dr. Dering's detailed technical report is presented in Appendix N.

The heavy fractions were carefully examined and sorted for charcoal, burned seeds, bone, lithic debitage, burned rock fragments, and snail shells. These materials were then counted and weighed by material class and the results are presented in the appropriate feature discussions within the rest of the report.

5.4.6 Charcoal Analyses

A total of 40 macrobotanical and/or charcoal samples, 25 from 41PT185/C and 15 from 41PT186, were submitted to Dr. Dering for identification. The charcoal pieces used in radiocarbon analysis were generally too small for species identification and therefore, these dated pieces were generally not identified prior to dating. Dr. Dering presents the detailed methods, macrobotanical identifications, and interpretations in Appendix N.

5.4.7 Ceramic Petrographic Analyses

Microscopic thin section analysis has been around for over 50 years and provides a means of quantifying the details concerning potsherds through point counts of materials for interpreting and addressing questions concerning manufacturing, production techniques, and cultural differences.

Six of the 20 sherds collected from the Landis Property were selected for petrographic analysis. Unfortunately, the individual sherds recovered were generally too small to subdivide and send for all the different types of analyses under consideration. Only a couple of shreds were of sufficient size to subdivide into two or more pieces in order to conduct other technical analyses. Besides these six sherds, 11 natural sediment/clay samples were selected to use for comparison to the sherd pastes. Once the sherds were selected, the first step was to create microscopic thin sections. The thin sections were prepared by National Petrographic Service, Inc., Houston, Texas. Slide preparation entailed cutting each sherd and mounting a thin slice on a glass slide for examination under a microscope. The thin sections were stained for carbonates, and the finished thin sections were not covered. The sediment/clay samples were impregnated with a blue resin, then sliced and ground, and mounted on slides. Three tiny sherds (41PT185/C-#850-008-1 and 41PT185-#915-008-1, and 41PT186-#443-008-1) were too small for standard mounting through thin sectioning. These three sherds had tiny sections crushed with the resulting matrix submerged in water and placed on a slide. Then these sherds were observed under a Nikon stereoscopic microscope. All the slides were then submitted to Dr. David Robinson, Austin, for petrographic analysis of the ceramic and natural sediment fabrics (Figure 5-15). Dr. Robinson's detailed methods, analysis, individual results, and interpretations are presented in Appendix I. His specific information is incorporated into the body of this text.

Figure 5-15. Instruments Used in Petrographic Analysis.
(photo furnished by Dr. Robinson)

These data, coupled with the INA analysis on the same or similar sherds, provides powerful evidence as to where these vessels may have been manufactured and what materials were used in their manufacture.

5.4.8 Obsidian Sourcing

Although obsidian was not a lithic material commonly recoveredduring the Landis Property investigations, a few pieces were discovered. Nine of ten pieces of black glass recovered from various contexts, including one from Haecker's (2000) previous investigations (FS 20.1), were sent to Berkeley Archaeological XRF Lab under the direction of Dr. Steven Shackley to determine their origins. Dr. Shackley's detailed report is presented in Appendix C. In general, eight pieces were sourced to three different locations in the Jemez Mountains in northern New Mexico. One piece (FS 20.1) yielded chemistry similar to intermediate volcanic rock and is from an unknown source. Another piece (41PT185/C-#857-001-1) yielded a chemical signature similar to modern glass. Individual specimens and sources are discussed within the text.

5.4.9 Pollen Analysis

In general, pollen in alluvial sediments in Texas can be poorly preserved. Therefore; the marsh deposits identified in various backhoe trenches across the Landis Property, which often provide good pollen preservation, presented a relatively good opportunity to explore this fragile record.

Pollen analysis was pursued primarily from a noncultural setting that focused on the identified late Holocene marsh (Unit D) revealed in BT 36. Unit D, roughly dated here from 1900 B.P. to sometime after 800 B.P. and no later than 400 B.P. was encountered across much of this upper section of West Amarillo Creek valley. Initially, following the Phase I data recovery, four noncultural sediment samples from dated contexts were selected from BT 36 deposits and submitted to Dr. Steven Bozarth in Lawrence, Kansas for analyses. He determined pollen was well-preserved (concentration ranged from ca. 3500 to 25,000 grains/cm^3), relatively diverse with some 27 species represented. He also provided pollen interpretations along with phytolith analyses (Bozarth 2008).

Based on Bozarth's initial positive results, a more extensive sampling of noncultural sediments from this same BT 36 context was conducted during Phase II data recovery. Sixteen samples from a vertical column through Unit D at BT 36 were sent to Dr. Bozarth for analysis. Dr. Bozarth's methods of extraction, sample counts, identifications and interpretations are presented in Appendix D together with the phytolith interpretations (see below).

5.4.10 Phytolith Analyses

Phytolith studies are important in reconstructing an approximate profile of grassland flora in this plains setting and tracking possible changes through time. Opal silicate bodies comprise the phytoliths entities form within plant cells. The distinctiveness of various types of bodies varies according to cellulose structure. In grasses, phytoliths exhibit diversity and are distinct for grass species. The presence of certain phytoliths (e.g., panicoid, festucoid, and chloridoid) in the paleoenvironmental record provides a record of general vegetative conditions, such as forested versus open grassland prairie, and the type of grasslands. Phytolith analysis was conducted to provide data for reconstructing the broad grassland vegetation communities in this region through the Holocene period.

Following the Phase I fieldwork, 13 sediment samples from various scattered deposits, all directly linked to radiocarbon dates, were submitted to Dr. Steven Bozarth for initial analysis. He determined that these initial samples all contained well preserved phytoliths and presented his results (Bozarth 2008).

Continuing with a more through sampling strategy, a suite of 16 more samples from a single dated column in BT 36 were sent to Dr. Bozarth for analysis, selected along with three samples from three cultural features at 41PT185/C. Dr. Bozarth's methods of extraction, sample counts, identifications, and his interpretations are presented in Appendix D.

5.4.11 Lipid Residue Analysis

Previous research in Texas since about 2000 (Quigg and Cordova 2000; Malainey 2000) and other areas using this chemical approach has successfully demonstrated that organic residues are present and can be extracted and generally interpreted from burned rocks used by prehistoric peoples to process foodstuffs (cf. Quigg et al. 2000; Malainey and Malisza 2003, 2008). The interpretations provide only a general indication of what is chemically represented and not precise species or taxa. This proxy line of investigation is critical when environmental conditions are not conducive to the preservation of primary organic data, such as macrobotanical and faunal remains. The fatty acid analysis provides chemical results to help identify the types of general food groups or types of resources (mostly plants versus animals) may have been cooked by burned rocks. This allows some general understanding of the function of the features and what the rocks were used to cook.

Chunks of the burned rocks, weighing from 14 to 345 g, were broken from the parent rock for submission. The parent rock was retained and is curated for future reference. The selected burned rocks were mostly from burned rock features that are radiocarbon dated or otherwise chronologically placed.

A total of 64 artifacts were submitted to Dr. Mary Malainey in Winnipeg, Manitoba, for lipid residue analysis. These included 58 burned rock pieces from 16 features from the three sites investigated, three metate fragments from 41PT185/C, two ceramic sherds from 41PT245, plus one rock that was under the bison skull at TU 8, 41PT186. The lipid analysis was conducted to identify the cultural lipids within the organic residues that remain inside the burned rock or ceramic sherd, which may indicate the kinds of foods that were cooked (Figure 5-16). These data potentially reflect changes in subsistence practices or species

Figure 5-16. Dr. Malainey's Lipid Data Laboratory.
(photo furnished by Dr. Malainey)

available over the nearly 3000 years of prehistory represented. Dr. Malainey presents the background to identification of fatty acids, her detailed methods, results obtained on individual artifacts and interpretations of the samples in Appendix G. Her results have been incorporated into the appropriate sections within the body of the text.

5.4.12 Instrumental Neutron Activation Analysis

Instrumental neutron activation (INA) analysis provides a chemical fingerprint for a variety of different materials, such as ceramic sherds, tool stones, and clays. The chemical fingerprint aids in tracing that material to a general region or sometimes a specific locale. This analytical technique allows inquiry into origins of ceramic manufacture, lithic procurement areas, and population movements. It is possible that actual quarry sources used in the manufacturing of artifacts (clay for the production of pottery and tool stone used in tool manufacturing) can be identified. If so, this would significantly contribute to our understanding resource procurement strategies, and movement of products through trade and/or population movements.

Meier (2007) initiated INA analysis on local natural clays from three source areas in the general region and submitted her samples to Dr. Michael Glascock at the Missouri University Research Reactor (MURR) for INA analyses. Her 15 natural clay samples were derived from three alluvial sources near 41PT109 at the mouth of West Amarillo Creek, four alluvial sources near Landergin Mesa (41OL2) at the mouth of Alamosa Creek to the west, one alluvial source along the Canadian River, and seven sources to the north in the Antelope Creek phase core area near Alibates Ruin 28 on the southern side of Lake Meredith. She also ran INA analysis on 75 Antelope Creek phase ceramic sherds from three Late Prehistoric village sites that include Landergin Mesa, 41PT109, and Alibates Ruin 28 (Meier 2007).

Figure 5-17. MURR Laboratory Assistant Compiling Data.
(photo furnished by Dr. Glascock)

TRC expanded upon Meier's initial sampling of clay sources by submitting clays from nine more sources and six ceramic sherds from the Landis Property investigations in West Amarillo Creek (Table 5-4; Figure 5-17). This was done to evaluate and determine the similarities and differences with Meier's (2007) local and regional clays and her Antelope Creek sherds. These results allow us to identify the sources of the clays employed in the manufacture of pottery and potentially the movement of those vessels across space. Appendix J provides the INA analyses on the ceramic sherds and natural clays.

With the goal of identifying the specific types of tool stone and their original source or sources, 71 lithic artifacts were selected from the three investigated sites and submitted to Dr. Michael Glascock at the MURR. These included 49 pieces from the Late Archaic component at 41PT185/C (comprised of 23 chipped stone tools, [TRC449 through 471] and 19 pieces of debitage [TRC412 through 418, and TRC491 through 509], 17 pieces from the Protohistoric component at 41PT186 (comprised of five chipped stone tools, [TRC419 and 476 through 479] and 12 pieces of debitage [TRC420 through 423, 472 through 475, and 480 through 483]), and five items from 41PT245 comprised of one chipped stone tool (TRC427) and four pieces of debitage (TRC424 through 426, and 428) (Table 5-4).

Table 5-4. Cultural and Natural Samples Selected for INAA.

Quartermaster Formation Chert/Dolomite				
41PT1, Alibates Flint QNM	Potter County, TX	Agatized Dolomite, Quartermaster	13	TRC 407-411, 448, 520-526
Greenbelt Reservoir	Conley County, TX	Day Creek Chert, Quartermaster	1	TRC 438
Pleistocene Gravel Terrace	Roberts County, TX	Agatized Dolomite, Quartermaster	4	TRC 390-393
North Side of AFQNM	Potter County, TX	Agatized Dolomite, Quartermaster	8	TRC 399-404, 414-442
Tecovas Formation Jasper				
Blue Creek 1 & 3	Moore County, TX	Jasper, Tecovas	2	TRC 439-440
41PT434, Coetas Creek	Potter County, TX	Jasper, Tecovas	5	TRC 510-514
41OL284, South Basin	Oldham County, TX	Jasper, Tecovas	5	TRC 515-519
41PT276	Potter County, TX	Jasper, Tecovas	9	TRC 384-389, 487-490
M-122, Palo Duro Canyon	Briscoe County, TX	Jasper, Tecovas	5	TRC 394-398
Quitaque Region,	Randall County, TX	Jasper, Tecovas	4	TRC 444-447
Other Chert Sources				
Baldy Hill	Union County, NM	Chert, Dockum	2	TRC 405-406
Analyzed Chert and Jasper Artifacts				
41PT185/C, Pipeline	Potter County, TX	—	49	TRC 412-418, 449-471, 491-509
41PT186, Corral	Potter County, TX	—	17	TRC 419-423, 472-483
41PT245, Pavilion	Potter County, TX	—	5	TRC 424-428
Neutron Analysis Clay & Ceramics				
41PT185/C, Pipeline	Potter County, TX	Clay	1	TRC 379
Big Blue Creek	Moore County, TX	Clay	1	TRC 380
Neutron Analysis Clay & Ceramics continued				
41PT185/C, Pipeline	Potter County, TX	Clay	1	TRC 381
Wildcat Bluff, NC, TX	—	Clay	1	TRC 382
Big Blue Creek Pot	—	Clay and sand	1	TRC 383

Quartermaster Formation Chert/Dolomite				
Site/Name	Location	Formation	Number of Samples	MURR Lab Numbers
41PT245, Pavilion	Potter County, TX	Redware sherd	1	TRC 429
41PT245, Pavilion	Potter County, TX	Plain sherd	1	TRC 430
41PT186, Corral	Potter County, TX	Corrugated sherd	1	TRC 431
41PT186, Corral	Potter County, TX	Cordmarked sherd	1	TRC 432
41PT245, Pavilion	Potter County, TX	Plain sherd	1	TRC 433
41PT186, Corral	Potter County, TX	Silty clay	1	TRC 434
Holocene Alluvium, BT 11, Zone 6	Potter County, TX	Sandy loam	1	TRC 435
41PT245, Pavilion	Potter County, TX	Clay	1	TRC 436
Holocene Alluvium, BT 46, Lower Channel	Potter County, TX	Clay	1	TRC 437

As far as can be determined, no previous INA studies have been published on two prominent, local tool stone resources, Alibates or Tecovas, which outcrop across the broader northwestern Texas region, and possibly beyond. To aid in the identification of the tool stone used by the prehistoric populations in the Landis Property for the last ca. 2800 years it was necessary to first identify the chemical signatures of these two important natural resources. It was not known if all Alibates or all Tecovas sources/outcrops have similar chemical signatures. Therefore, it was important to establish individual chemical signatures for specific sources/outcrops. The first step was to establish chemical signatures for Alibates and Tecovas from known sources/outcrops.

Once those chemical signatures were established the results would provide other researchers with a comparative database against which to compare their prehistoric materials. To this end, natural tool stone of different colors and textures was collected from 10 known local source outcrops/locations, six from Tecovas outcrops, three known source areas for Alibates, plus one source locality at the eastern end of Greenbelt Reservoir (TRC438) of unknown type. A total of 25 natural samples of Alibates from three locations was selected and submitted for INA analysis (Table 5-4). A total of 30 natural samples of Tecovas jasper from six source outcrops/locations was selected and submitted (Table 5-4). Two samples (TRC405 and TRC406) from Baldy Hill in the Dockum Formation in northeastern New Mexico were also submitted as some may mistake this material with either Tecovas or Alibates.

The various source/outcrops for the Tecovas material include the following: The closest to the Landis project is a small Tecovas outcrop – site 41PT276 farther down West Amarillo Creek (J. Hughes 1969; R. Shaller personal communication Dec. 2007) from which nine pieces were submitted. The most distant and poorly known source area is Baldy Hill (KUMA LCC #97-1 in Union County, in northeastern New Mexico (Foster 1966; Banks 1990:93). Two pieces of Baldy Hill materials were submitted. A couple of creek valleys to the west of the Landis Property is the large South Basin/Rotten Hills quarry (41OL284), along Alamosa Creek valley in eastern Oldham County (Banks 1990:92; Mallouf 1989). Five pieces from South Basin were submitted from this outcrop. To the north are at least two small outcrops along Blue Creek that drains into the Canadian River (Lynn 1986). Two pieces from Blue Creek outcrops were submitted for analysis Also north is the Coetas Creek quarry (41PT434) at the southeastern end of Lake Meredith (Etchieson 1979; Banks 1990; Raab 2005). Five pieces from Coetas Creek were submitted for analysis. Some 27 km to the south of this project is the M-122 outcrop in Palo Duro Canyon in Randall County (R. Shaller personal communication Dec. 2008). Five pieces from M-122 were submitted for analysis. The last area sampled is the broad regional source area near Quitaque, in Brisco County southeast of the Landis project (Green and Kelley 1960; Holliday and Welty 1981; Banks 1990). Five pieces from the Quitaque region were submitted

Natural stone of different colors and color combinations of Alibates were also selected (Table 5-4). Source locations include the main quarry source area (41PT1) on the southeastern side of Lake Meredith (*N* = 13), the Alibates outcrops on private lands opposite 41PT1 on the northwestern side of Lake Meredith (*N* = 8), and a single Pleistocene lag gravel outcrop on a high terrace downstream along the Canadian River (*N* = 4) near State Highway 70. These 25 specimens from these three locations were used to determine the range of chemical variation of Alibates and for comparisons with the INA data obtained on submitted cultural artifacts materials. Appendix E provides the details of the natural and cultural lithic INA analyses.

An isolated source of a grainy, white orthoquartzite (TRC438) lies at the eastern end of Greenbelt Reservoir in Donley County. The reservoir is some 100 km east of the Landis Property along State Highway 70. The material, as well as Alibates, was thought to have come from the Quartermaster Formation.

Now that some source/outcrop locations are known and some chemical fingerprints are established, future researchers can potentially discuss movements of materials across the landscape. The results presented here significantly contribute to a broader understanding of tool stone selection processes, the chemical variability in stone from these source locales, and the distances humans have moved material around the region.

5.4.13 Diatom Analysis

Diatoms are single-celled algae with a siliceous cell wall. They grow in a wide range of aerophilous habitats, including damp soils, wet plants and rocks, marshes, wetlands and mudlands, as well as in all types of aquatic habitats. Their silica cells are often preserved in sedimentary deposits. Because individual taxa have specific requirements and preferences with respect to water chemistry, hydrologic conditions, and substrate characteristics, the presence of diatoms in natural and/or archeological contexts can provide information about the nature of the local environments. Diatoms, when present, provide a proxy measure of water quality/degree of pollution and ultimately certain aspects of the paleoenvironment.

Thirteen matrix samples from the natural sediment column through Unit D in BT 36, plus a single sediment sample from under one burned rock from Feature 8 at 41PT185/C, were selected and sent to Dr. Barbara Winsborough of Austin, for diatom analysis. Her detailed methods, individual sample results, and interpretations concerning the past environment as represented in Unit D at BT 36 are presented in Appendix P.

5.4.14 Stable Carbon and Nitrogen Isotope Analyses on Bison Bones

Stable carbon and nitrogen isotope analyses were conducted on individual bison bones representing four general time periods within this Landis Property. Twenty bone samples, which ranged from 6 to 25 g each, each assumed to represent an individual bison, were selected. Five bones representing each time period were submitted to Geochron Laboratories (Geochron) for these analyses. The reported carbon isotope results, minus the fractionation affect, provide an indication of the amount of C4 grass consumed by each bison. These combined figures also provide proxy data for interpreting the regional grassland that the animal grazed in. The isotope data, in diachronic perspective, may also reveal changes in the regional grassland conditions over the last ca. 2,800 years. Because prehistoric populations relied heavily on bison throughout much of this time, the bison bone isotope values will also contribute to interpretations of the isotopic values obtained from human bones from the same time periods, if such are analyzed in the future. The individual carbon and nitrogen isotope values obtained from the analyses are presented in Appendix H. The interpretations of the isotope results are discussed under the Environmental Issues section in the Summary Section of Chapter 11.4.2.

5.4.15 Fossil Insect Analysis

Five bulk matrix samples (#263-004-1 through 5) were collected from five locations on the south wall of BT 36 to specifically look for, and if present, analyze, the insect parts to extract paleoenvironmental information. These samples were small, one to three liters in size. Each sample was measured in volume, and then processed in the following manner. A No. 8 U.S.A. Standard Testing Sieve (2.36 mm) was placed on an ordinary five gallon plastic bucket for support. Inside the sieve was placed a fine mesh nylon screen (0.33 mm). The matrix was poured into the fine mesh screen. Using a garden hose with an adjustable spray nozzle the matrix was sprayed lightly until saturated and left momentarily, to soften and loosen the dry, compact clumps. Then the spray nozzle was used to gently hose down the matrix separating the sediment from the particulates within. If necessary the matrix was left to soak a while longer, and then sprayed until all the sediment had passed through the fine mesh into the bucket below. The fine mesh screen with the sampled particulates was then removed and set out to dry on a table. This process was repeated for each sample.

Close inspection of the collected fraction under a magnifying glass revealed only one or two possible insect parts. At this stage it appeared that insufficient insect parts were present in these small samples to pursue any detailed analysis, as the small sample size was not sufficient to provide a suitable sample of insect parts to allow for meaningful interpretations. Each sample yielded many tiny snail shells, tiny chunks and/or flecks of charcoal, with many tiny hair rootlets in sample #263-004-95a from 478 to 488 cmbs. This sample also yielded tiny pieces of possible insect casings that are shinny black, very thin, and appear to lack any diagnostic characteristics. It also yielded the largest pieces of charcoal and this was the location of the charcoal that yielded the radiocarbon date of 1890 B.P. Three samples (#263-004-95, #263-004-96, and #263-004-98) yielded very tiny black seed-like objects with a hard outer white coating of similar shape. No samples were sent for technical analysis.

5.4.15.1 Fourier Transform infrared Spectroscopy

In the last few years this technique has been applied to archeological materials in the surrounding regions, as at least one commercial laboratory is now providing this service. This is the study of organic residues through the use of infrared light passed through organic residues extracted from samples. Fourier transformation is a data processing technique used to improve the quality of the infrared spectrum (M. Malainey personal communication January 6, 2010). This technique provides vary accurate wave length measurements simultaneously, which then produces an infrared spectrum of the sample. The spectrum is divided into two primary regions revealed by wave numbers. From this, it is possible to identify different types of organic compounds. These compounds are then compared to commercial or laboratory created analytical standards or compounds reflective of plant and animal products. It is then up to the analysts to attempt to match the unknown spectrums to a known.

This technical analysis was directed at ten carefully selected artifacts to obtain specific information concerning what organic residues were associated with the individual specimens to better understand the cultural activities. Five different artifact classes were subjected to this analysis and include; four burned rocks (#899-003-5, #901-003-2, #1337-003-2, and CE 14), two sandstone metate fragments (#405-010 and #1129-010), one quartzite mano (#1175-010), one Alibates side scraper (#452-010), one Potter chert chopper (#467-010), and one Edwards chert chopper (#627-010). The laboratory report with the specific methods, technical background, discussion of substances, ethnographic review of selected plants, and artifact results are presented in Appendix R.

5.5 CURATION

The current land owners, the Girl Scouts of America, are in discussions with the Panhandle-Plains Historical Museum (PPHM) in Canyon, to have the all the cultural materials and associated documents from the cultural resource investigations at the Landis Property curated at that facility. Currently, the parties are working to formalize the agreement and complete the formal paperwork to complete this process. The material will then be curated and available for future research.

6.0 STRATIGRAPHIC OVERVIEW OF UPPER WEST AMARILLO CREEK VALLEY

Charles D. Frederick

6.1 INTRODUCTION

The results of the geoarcheological fieldwork revealed a considerably more complex Holocene alluvial history than was envisioned by Haecker (1999). In fact, this work demonstrates that the Holocene alluvial deposits of upper West Amarillo Creek are upwards of 6 m thick in places and most fills are at least 4 m thick.

Following completion of the trenching and the incorporation of the initial results of radiocarbon dating, the stratigraphic model was reevaluated and a total of six allostratigraphic units are now recognized in the upper reaches of West Amarillo Creek within the Landis Tract. For sake of simplicity, these units are here referred to as Units A through F. Figure 6-1 depicts the relative stratigraphic position of each alluvial fill within the valley, but it is important to keep in mind that this figure is hypothetical, and this complete sequence was not observed at any single locality in the valley. As will become clear through examination of the stratigraphic cross sections for each site, the presence and three dimensional arrangement (often referred to as the alluvial architecture) of a specific fill varies considerably within the valley. Complete descriptions of each unit are presented below. Table 6-1 provides a key to where each allostratigraphic depositional unit was observed and radiocarbon dated.

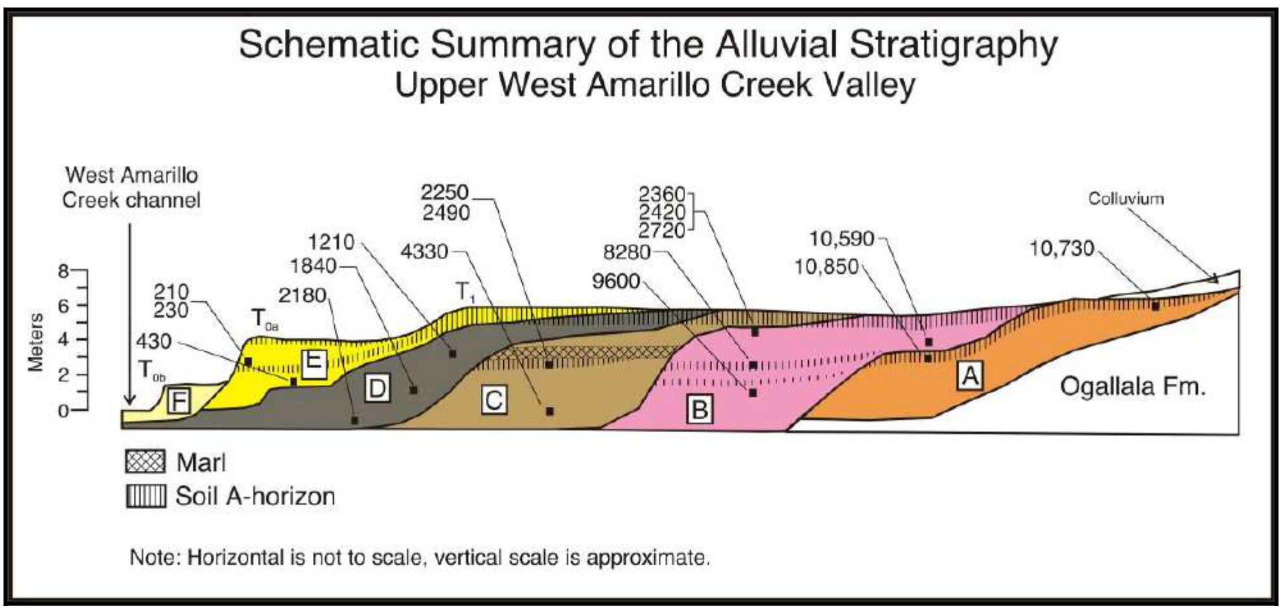


Figure 6-1. Schematic Summary Illustrating Projected Alluvial Stratigraphy of the Upper West Amarillo Creek Valley.

Table 6-1. Location of Depositional Units and Where Radiocarbon Dated.

Depositional Unit	Trenches Where Units Were Observed	Trenches Where Units were Radiocarbon Dated
Unit A	11, 21, 24?, 44	11, 21
Unit B	3, 6, 7, 9, 12, 13, 14, 15, 16, 17a, 17b, 21, 23, 24, 27, 30, 31, 33, 34, 35, 37, 42, 45	6, 9, 21
Unit C	9, 18, 28?, 33, 40	9, 40
Unit D	1, 4, 5, 8, 9, 10, 13, 15, 19, 20, 22, 26, 32, 36, 39, 40	1, 19, 20, 36
Unit E	1, 4, 5, 8, 15, 18, 22, 25, 28, 29, 36, 39, 43	5
Unit E veneer (<1 m thick)	3, 6, 7, 9, 10, 12, 13, 16, 17a, 17b, 19, 23, 24, 26, 27, 30, 31, 32, 33, 34, 35, 40, 42, 45	9, 27, 35
F	2, 11, 14, 37, 44	

6.2 UNIT A

The oldest deposit recognized in the sequence, Unit A was observed in only a few places in the valley, often beneath a slightly higher surface (T_2) than the main terrace (T_1). It was exposed in cut banks adjacent to BTs 11 and 44, but in both localities, only the uppermost portion of the fill was preserved. At BT 11 this deposit was seen to thicken considerably toward the valley axis with its base lying about 2 m above the modern channel floor. In the cutbank exposure near BT 11 Unit A appears to be more than 3 m thick, but the actual thickness of this deposit is presently unknown. In BT 11 the A horizon of this deposit, buried by almost 1.5 m of colluvium, yielded an age of 10,730 ± 70 B.P. (Beta-238309). At the Pavilion site (41PT245), the A horizon formed in the top of this fill was radiocarbon dated 10,770 ± 50 B.P. (Beta-238319) where it was buried by approximately 1.85 m of Unit B.

The soil formed within Unit A is the most advanced of any unit in this alluvial sequence, and is characterized by a black A horizon, typically with strongly developed prismatic structure, and underlain by a Btk horizon, which also exhibited well developed structure. Secondary calcium carbonate in the form of thick filaments and films on ped faces was common. When Unit A began to aggrade is unknown given that only fragments of this deposit have been observed, and most of those from the top of the fill. A better idea of the antiquity of this deposit could be obtained by cleaning and sampling the cutbank profile near BT 11, which is the thickest exposure of this deposit that was observed in the valley.

6.3 UNIT B

This deposit is located beneath the first terrace of West Amarillo Creek, generally towards the valley margin, and appears to be the best preserved and most significant (volumetrically speaking) deposit in the valley. It is easily identified on the basis of its rubified (reddened) color, generally fine texture, and the presence of two faint buried A horizons within the upper 3 m of the fill. Although numerous trenches revealed the top 3 m of this deposit, backhoe trenching was unable to reach its base. The thickest exposure documented was BT 42, which was 4.7 m deep, and the total thickness of this deposit probably approaches 6 m. The top of this unit is nearly everywhere draped by a younger sandy alluvial deposit, which may be Unit C, Unit E or a combination of the two. Three radiocarbon ages have been obtained from this deposit. The base of the unit was dated in BT 21 at the Pavilion site, where it yielded an age of 10,590 ± 40 B.P. (Beta-238320). The middle and upper parts of this fill were dated to the early Holocene in BT 6 at the Corral site (41PT186). A bulk sediment sample from beneath the lower of the two buried soils yielded an age of 9610 ± 50 B.P. (Beta-235484) and a bulk soil sample from the upper buried soil yielded an age of 8280 ± 550 B.P. (Beta-235483). Together, these samples suggest that deposition of Unit B started around the end of the Pleistocene (about 10,700 B.P.) ended sometime soon after 8,000 B.P. Between 8,000

B.P. and before approximately 4,400 B.P., the creek channel cut deeply into the Unit B deposits (ca. 5 to 6 m) and eroded a broad notch in the center of the valley.

The soil formed in Unit B was surprisingly variable. In coarser textured deposits it exhibited an A-Bw-Bk profile with a stage I (filamentous) calcic horizon, whereas in BT 21, where a thin (ca. 2 m) veneer of Unit B rests upon Unit A, the soil formed in this clayey floodplain sediment exhibited a prominent stage II (nodular) calcic horizon more typical of a much older deposit. A column of samples was collected from Unit B in BT 42 for characterization and the results of this work are plotted on Figure 6-2.

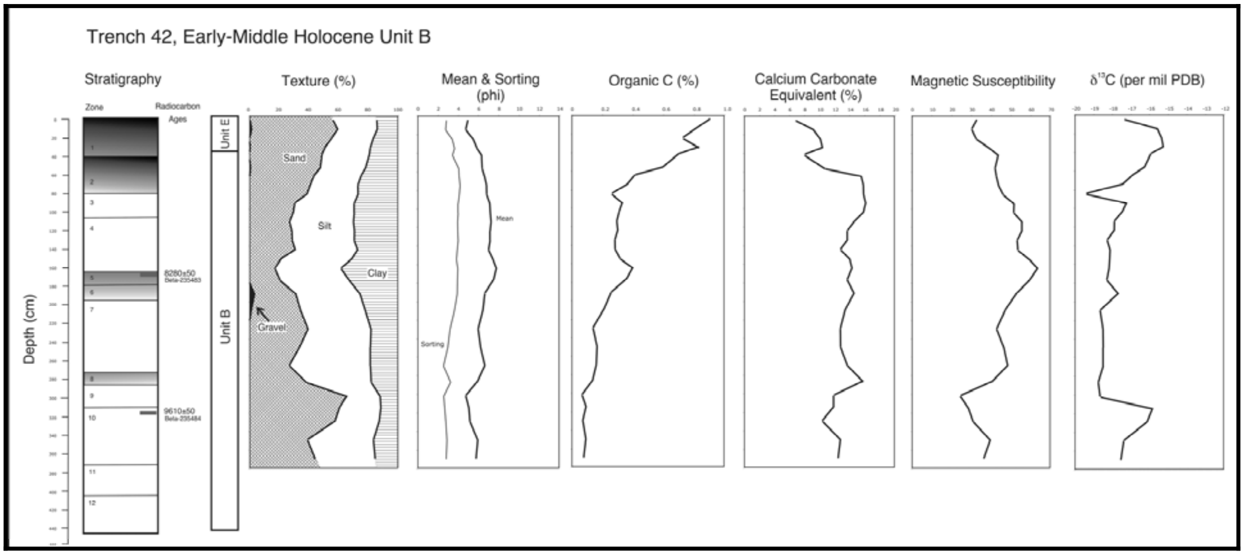


Figure 6-2. Sediment Characterization of Unit B at BT 42.

Note: Radiocarbon ages shown here were obtained from BT 6 at the Corral site and are shown in their approximate inferred stratigraphic position in order to provide a chronological correlation. No radiocarbon ages were obtained from BT 42.

Examination of this figure shows that Unit B fines upward from its base (which was not exposed in this trench) through the upper of the two buried soils, and then gradually coarsens upwards from there. The top of Unit B is clearly leached of calcium carbonate, and a slight increase in calcium carbonate is present in the upper Bk horizon just below the A horizon. The organic carbon content, calcium carbonate content, and the granulometry all support the field interpretation that this deposit is buried by a younger drape of sandy alluvium.

6.4 UNIT C

This deposit was one of the most elusive in this sequence and has largely been removed from the valley by erosion. Unit C is inset into Unit B beneath the first terrace (T_1) of Amarillo Creek and it may drape Unit B in some places. Fragments of this deposit were observed in BT 9 at the Corral site (41PT186), in BT 18 at the Pavilion site (41PT245), and in BT 24 and BT 28 at the Pipeline site (41PT185). Only one complete section was observed in the field, in BT 40 (Figures 6-3 and 6-4), and this deposit was more than 4 m thick. It was sampled for laboratory characterization.

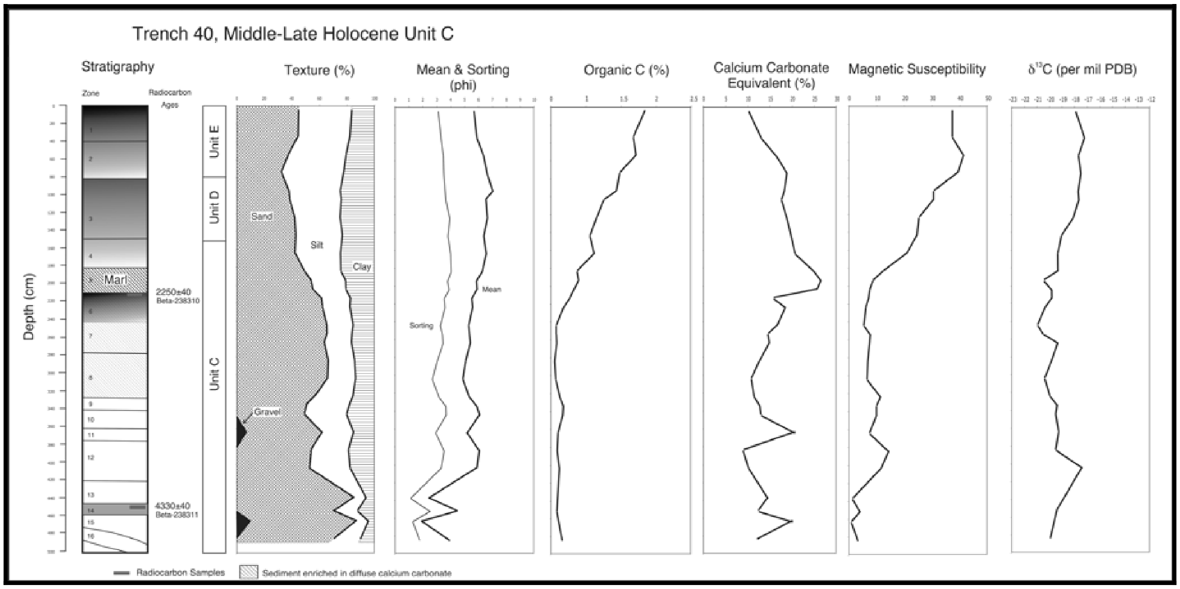


Figure 6-3. Chart Showing the Results of Laboratory Analysis of Samples Collected from BT 40.
(Note: They consists of a core of Unit C and thin drapes of Units D and E. The marl (zone 5) and the distinctly elevated calcium carbonate content in this zone.)

Figure 6-4. BT 40 Profile Showing Sampling in Progress, Core is Unit C, with Units D and E on Top.

In general terms, Unit C is quite sandy, and contains prominent marl (freshwater chemical sediment) near the top of the unit that was quite distinctive in the field and was originally thought to be of early or middle Holocene age on the basis of correlation with marls identified elsewhere on the Southern High Plains by Vance Holliday (1995). To our surprise, multiple radiocarbon samples of a paleosol (buried A horizon) situated directly beneath the marl yielded consistent late Holocene ages.

In BT 40 a bulk soil sample from the buried soil at a depth of 2.1 m yielded an age of 2250 ± 40 B.P. (Beta-238310), and a bulk sediment sample from 4.45 m depth yielded an age of 4330 ± 40 B.P. (Beta-238311). At the Corral site (41PT186) a bulk soil sample from the buried soil below the marl yielded an age of 2150 ± 40 B.P. (Beta-235486) and a piece of charcoal from this deposit yielded an age of 2490 ± 40 B.P. (Beta-237021). Hence, it appears that the deposition of Unit C follows upon a period of erosion and may have begun to accumulate as early as 5,000 B.P. A pause in sedimentation appears to have occurred around 2,150 to 2,250 B.P., and was followed immediately by the deposition of marl. Abandonment of Unit C by

West Amarillo Creek appears to have occurred soon after that, possibly around 2,100 B.P. On Figure 5, Unit C is clearly draped by thin veneers of sediment associated with Units D and E.

6.5 UNIT D

The deposit that follows Unit C is very distinctive in appearance, and is a considerable departure from the coarse textured sandy sediment that comprises Unit C. Unit D is inset into Unit C beneath the upper floodplain or T_{0a} surface, and consists of more than 4.5 m of fine-grained dark colored mud which appears to represent a period of presumably more humid climate when small ponds and marshes dominated the floor of the West Amarillo Creek valley (Figures 6-5 and 6-6). Amazingly, this period seems to last slightly more than 1,000 years, from roughly 1,900 B.P. to sometime after 800 years B.P. Between the end of Unit C deposition and the beginning of Unit D, the channel of West Amarillo Creek cut down 3 to 4 m and scoured out a modest size notch in the center of the valley.

The most detailed record of Unit D was obtained from BT 36 which exposed a series of superimposed channels associated with Unit D. The base of Unit D in this trench was more than 5 m below the surface and was not uncovered by the trench. A series of four radiocarbon ages was obtained from this exposure, dating the earliest phase of sedimentation to sometime before 1890 ± 40 B.P. (Beta-210070). During this early phase at least one thin marl bed that contained more than 50 percent calcium carbonate was deposited on the valley floor. The middle of the unit was radiocarbon dated to 1430 ± 40 B.P. (Beta-239651), and after this point in time the deposit gradually begins to coarsen as more gravel entered into the system. A second thin marl bed was found in the upper meter of the Unit D sediments. The top of Unit D sedimentation is not represented in the BT 36 sample profile, and probably post dates 750 ± 40 B.P. (Beta-239652) but given a date reversal near the top of the sequence, the precise end of this phase of alluviation is unclear. It undoubtedly terminates before 430 ± 40 B.P., which is a radiocarbon age obtained from cultural material buried at the base of Unit E at 41PT245.

Floodplain facies of Unit D appear to be massive cumulic soils in excess of 3 m thick which exhibit little lithologic variation until fairly late in the history of this deposit, when coarse material, specifically gravel, appears to become more common.

6.6 UNIT E

Toward the end of Unit D deposition, West Amarillo Creek appears to have experienced more and larger floods, which resulted in an increase in the size of the stream deposits, and eventually prompted a period of channel incision. Sometime at or after ca. 800 B.P., the creek channel incised about 4 m, and our existing radiocarbon dates suggest that it only began filling this cut sometime around 430 B.P. The resulting deposit, Unit E, remains part of the modern floodplain, but appears to be flooded infrequently today. Unit E forms the leading edge of the higher of the two modern floodplain surfaces (T_{0a}) and is more than 3 m thick adjacent to the modern channel.

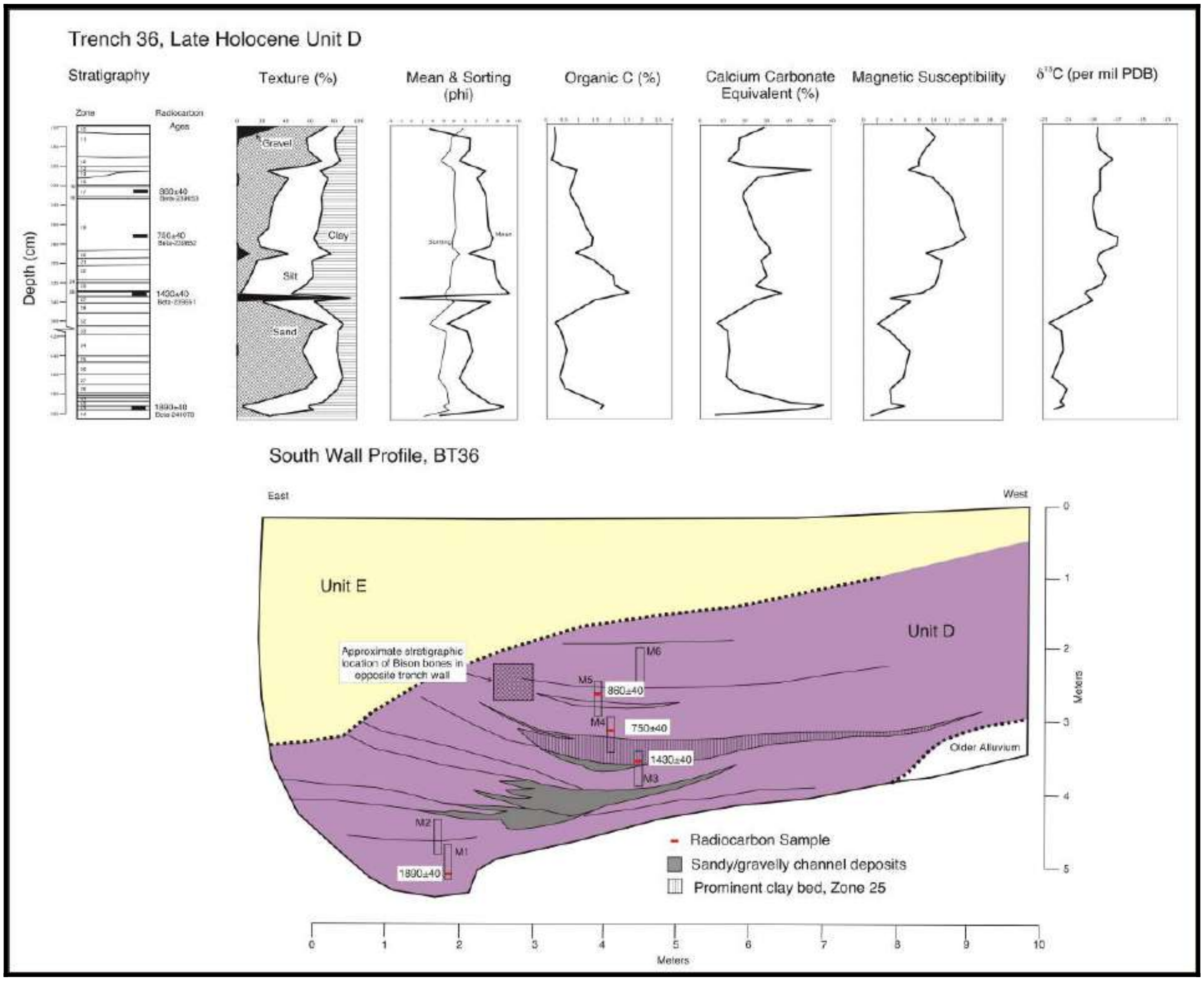


Figure 6-5. Plot of the Analytical Data for a Column of Samples Collected from BT 36.

Note: Most of these samples were collected from a series of monoliths because the sediments in this trench were quite stratified and we decided we could do a better job sampling in the lab. Bottom shows sketch of the stratigraphy revealed on the South wall of BT 36, and the location of the monoliths used in sampling the deposits. No stratigraphic details are shown for Unit E or the older deposit that cropped out beneath Unit D at the west end of the trench.

Figure 6-6. Profile of Central Core of BT 36 at 41PT185/C Showing Unit E (lighter) over Unit D (darker).

It also occurs as a thin drape or veneer across the first terrace throughout most of the valley (see discussion of Unit E veneer, below). Although there is a very weak soil formed at the top of Unit E in most exposures, the most prominent soil within Unit E is a buried soil or paleosol that occurs towards the top of this deposit, and can be traced throughout the Landis property (Figure 6-7). At the Corral site (41PT186) a prehistoric/Protohistoric occupation was found resting directly upon this soil and charcoal collected from ash yielded an age of 230 ± 40 B.P.

(Beta-235482) and a bone from the same occupation yielded an age of 210 ± 40 B.P. (Beta-238317) (Figure 6-8). Along the leading edge of the Unit E deposit a meter or more of sediment has been deposited on top of this soil in the last 200 years. The deposits associated with Unit E are generally quite sandy and contain some gravel, and the soils formed within this deposit are relatively weakly developed, and exhibit A-C profiles. As can be seen on Figure 6-8 the soils formed in Unit E do not exhibit significant leaching of carbonate in the A horizons, and the variation of calcium carbonate in these sediments is largely attributable to differences in texture rather than pedogenic reorganization.

6.7 UNIT E VENEER FACIES

As noted earlier, a thin deposit of sandy sediment drapes the first terrace throughout the Landis property (Figure 6-9). In the field it was apparent that this veneer of sandier sediment was of Late Holocene age, and it was generally associated with Unit E. But as fieldwork progressed it became apparent that most of the Late Holocene deposits (Units C, D and E) lapped up onto the edge of and possibly draped the first terrace. There were only a few trench exposures where there was stratigraphic evidence indicative of this process (specifically BTs 15, 33, and 40).

This was perhaps most clear in the field in BT 15, which was excavated across the T_{0a} to T_1 scarp (Figure 6-10). This trench revealed three Holocene depositional units (B, D and E) and

Figure 6-7. Profile of Unit E Deposits in BT 5, 41PT186.

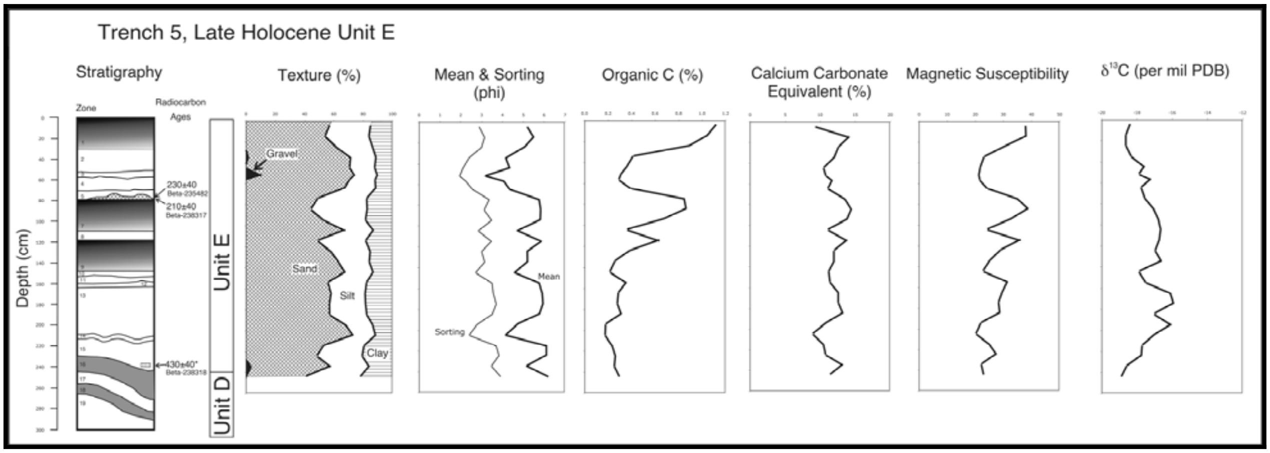


Figure 6-8. Plot of Laboratory Data Obtained from the Analysis of Unit E as Exposed in BT 5, at the Corral Site (41PT186).

Note: The lowest radiocarbon date was not obtained from this trench, but rather was obtained from BT 18 at the Pavilion site (41PT245), and is projected into its approximate stratigraphic position in order to show the best available age for the base of Unit E.

both of the recent deposits formed a thin drape across the eroded top of Unit B, which forms the core of the first terrace. Although this relationship was clear in BT 15, in most places, postdepositional disturbance of the veneer effectively destroyed sedimentary evidence of more than one phase of deposition (see Figure 6-11 for a clear example of the magnitude of this disturbance in one exposure).

Postdepositional disturbance is one factor that clearly complicates understanding the depositional heritage of the veneer, but the other factor involved is that in most places, the flood events that contributed to the formation of the veneer left only very thin deposits that were easily incorporated into the existing soil by fauna and flora. This process of relatively slow deposition of small amounts of sediment over a long period of time led to the creation of a cumulic soil. It is generally only the leading edge of the T_1 surface where sedimentation was rapid and thick enough during any given phase of late Holocene sedimentation that stratigraphic evidence of this process is preserved.

In addition to visible stratigraphic evidence, radiocarbon dates obtained from cultural material within the veneer suggests that this sediment was deposited within the last 2,200 years. For instance, at 41PT185 a prehistoric occupation in Area A buried by the veneer dated to the Late Archaic ca. 2640 B.P. in BT 27, and

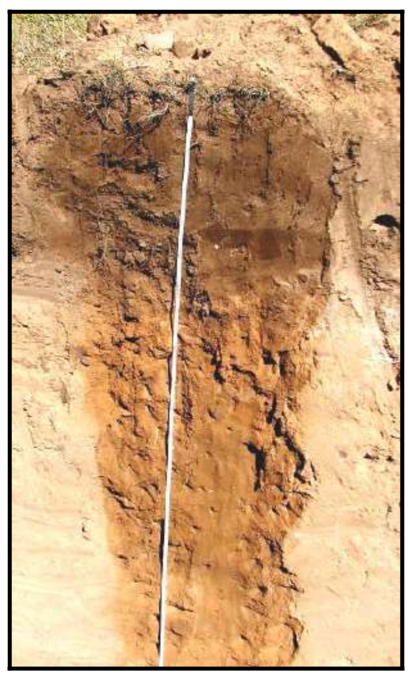


Figure 6-9. Thin Veneer of Unit E with Dark A Horizon on Top of Much Older Unit B.

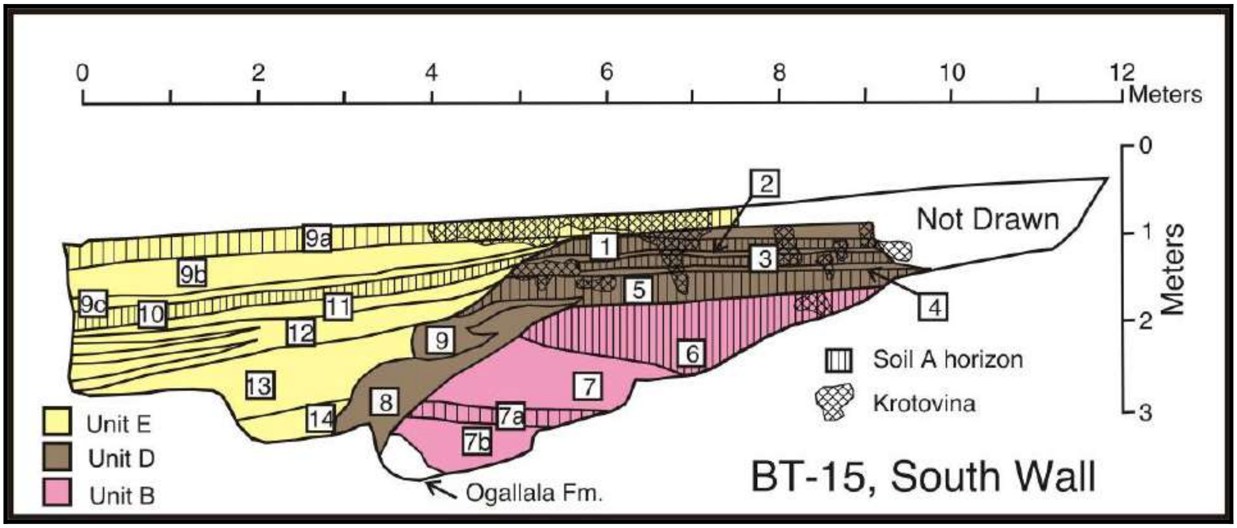


Figure 6-10. Stratigraphy of BT 15 Clearly Showing Unit E Overlapping Units D and B.

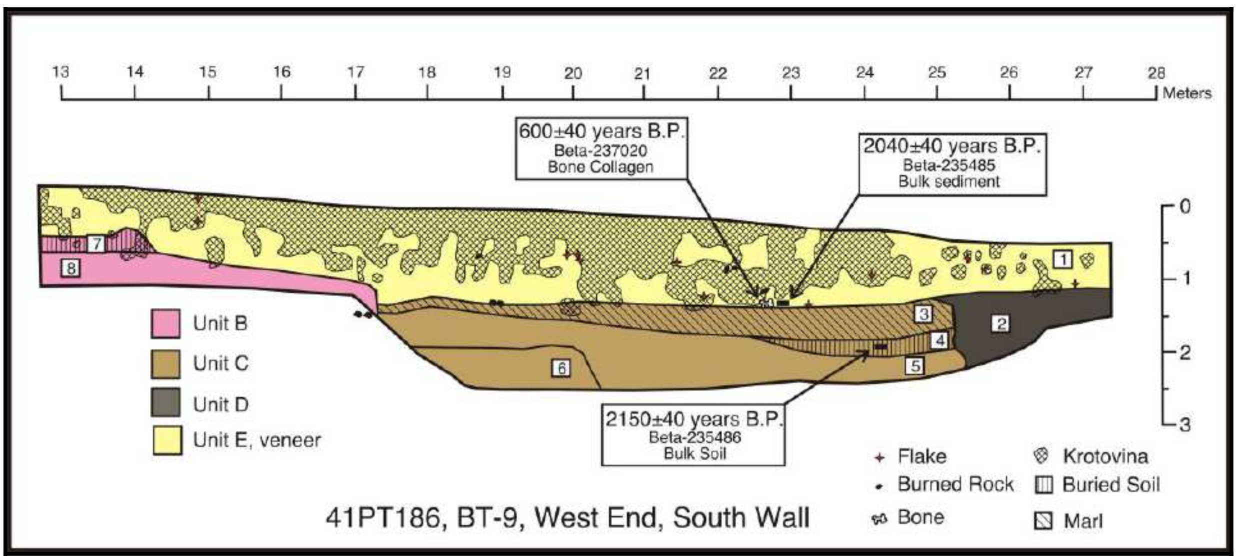


Figure 6-11. Stratigraphy of BT 9 Showing Extensive Disturbance in Upper Profile, Unit E.

in Area C the prehistoric occupation buried by the veneer yielded radiocarbon ages between 2360 B.P. and 2270 B.P.

6.8 UNIT F

The youngest unit in this alluvial sequence is present beneath the low floodplain (T_{0b}) of West Amarillo Creek. It was not examined systematically because it was judged to be too young to contain prehistoric cultural material in primary context. But examination of this deposit in BT 46, adjacent to BT 40, revealed that it is approximately 1.5 to 2 m thick and consists largely of coarse textured lateral accretion deposits of the modern stream. It is likely that the age of this deposit overlaps with Unit E.

6.9 PALEOENVIRONMENTAL SUMMARY

Although it is clear that the character of the alluvial deposits in West Amarillo Creek varies through time in response to changing climatic conditions, tracking these changes is rather subjective. An alternative approach is to examine the variation in the stable isotopic composition of the soil organic carbon preserved in the alluvial deposits through time, which in the late Holocene, provides a nearly continuous proxy record of changing vegetation within the West Amarillo Creek catchment.

The stable carbon isotopic composition of soil organic matter can be used as a proxy for the relative productivity of plants using C_3 and C_4 photosynthetic pathways that contributed organic matter to a deposit. Plants using these two photosynthetic pathways fractionate ^{13}C differently resulting in significantly divergent $^{13}C/^{12}C$ ratios in their tissues. Specifically, C_3 plants discriminate more against $^{13}CO2$ than plants using the C_4 pathway, resulting in more depleted (negative) $\delta^{13}C$ values. In general terms, C_3 plants have mean $\delta^{13}C$ values of -27‰, as opposed to C_4 plants, which yield mean values of -13‰ (Nordt et al. 1994). Long term trends and shifts in the $\delta^{13}C$ values of soil organic matter should reflect long term vegetation dynamics that reflect vegetation response to climatic variation (cf. Nordt et al. 2002; Nordt et al. 1994; Humphrey and Ferring 1994).

The West Amarillo Creek valley in the project area is a small stream with a limited catchment area, and the sediment transported by the stream has two basic sources: 1) water running off the ground surface, and 2) erosion of older sediment in storage. Although some mixing of modern (runoff) and ancient (stored sediment) sources has undoubtedly occurred, it is probable that much of the time the carbon isotopic record of the alluvial sediment reflects the vegetation growing in the local environment.

In order to examine a time series of stable carbon isotopic values we used the soil column samples collected for characterizing the different alluvial fills. In order to plot changes through time it was necessary to calculate an age for each sample, and this was done using radiocarbon ages obtained from each sample column, and then inferring a linear sedimentation rate. Because the assumption of a linear sedimentation rate is clearly unrealistic (alluvial sedimentation is usually episodic) care must be taken to avoid over interpreting the results. Most of the sample columns are reasonably well dated and in only one instance was a radiocarbon age imported from another trench for the purpose of this analysis (specifically the age for the base of Unit E). The results are plotted on Figure 6-12 and the right hand scale permits estimation of the approximate proportion of the carbon in each sample that was contributed by C_4 vegetation.

Within the West Amarillo Creek alluvial sequence, the best data are available for the late Holocene (ca. 4,000 to present), and during this period we have nearly continuous sedimentation within the valley. The Late Pleistocene and early to middle Holocene periods represented by Units A and B are considerably more problematic. The sampled column for Unit B, BT 42, is undated and the only radiocarbon dates for this deposit are available for BT 6. In the latter trench we dated the main paleosol, which serves well as a stratigraphic marker and can be traced throughout the project area, but the second date is less easily placed stratigraphically. Perhaps more problematic is the absence of a clear bracketing dates for the start and end of Unit B deposition. Unit A suffers similar problems, but in addition, we were unable to sample a long sedimentary record from this deposit. Hence, for this analysis only the late Holocene record is examined in detail, although the results from Unit B are briefly examined.

6.9.1 Stable Carbon Isotopic Results

The results of the stable carbon isotopic analysis for the late Holocene deposits are plotted on Figure 6-12 and the results for the early Holocene Unit B are plotted on Figure 6-2. Figure 6-12 clearly demonstrates a gradual change in soil organic carbon composition through time and some of these changes are often directly correlated with changes in the alluvial deposits.

Part of Unit C is comprised of sandy alluvium, but toward the end of Unit C sedimentation, marl (palustrine carbonate) appears to prevail on the valley floor. This is probably the earliest expression of the more mesic conditions that were to predominate during the deposition of Unit D.

6.9.1.1 Unit B

The stable carbon isotopes from BT 42 suggest that the vegetation in the basin during deposition of Unit B sometime around 9,600 B.P. was initially fairly xeric with values around -15.7 to -16.1‰, which equates to slightly more than 80 percent C_4 vegetation and is climatically comparable to the period between 400 to 500 B.P. After that the $\delta^{13}C$ values become gradually more depleted, suggesting that the basin vegetation shifted slightly in favor of C_3 plants through the end of Unit B deposition. Owing to incremental sedimentation on the top of Unit B in the latter half of the Holocene, the top of the BT 42 profile appears to record a compressed version of the late Holocene carbon isotopic record.

6.9.1.2 Unit C

Following a prolonged period of erosion in the middle Holocene, West Amarillo Creek resumed deposition around 4,500 B.P. The stable carbon isotopic trend preserved in Unit C is one of progressively more depleted (negative) $\delta^{13}C$ values, although a number of small scale cyclical changes appear to be present. This suggests that a gradual change towards more humid/mesic conditions prevailed in this interval, which ends around 2000 B.P. Substantiation of this can be found in the lithologic record. The basal part of Unit C is comprised of sandy alluvium, but toward the end of Unit C sedimentation, marl (palustrine carbonate) appears to prevail on the valley floor. This is probably the earliest expression of the more mesic conditions that will dominate during the deposition of Unit D.

6.9.1.3 Unit D

The stable carbon isotopic values obtained for the lower half of Unit D are the most depleted in the entire late Holocene and reflect a significantly decreased contribution of C_4 organic matter between 1,500 and 2,000 B.P. During this period, C_4 plants contributed only about 40 percent of the organic carbon, but by approximately 1,400 B.P. the proportion of C_4 organic matter increased significantly, thereafter oscillating between 60 and 70 percent. The sediments associated with Unit D are very fine-grained (Figure 6-13) and reflect low magnitude flooding and intermittent ponding on the valley floor, especially in the early stages of deposition when at least one marl bed was deposited. After 1,500 B.P. the deposits of Unit D become gradually coarser textured at the same time the carbon isotopic ratio suggests that the vegetation was shifting to a more xeric assemblage. Indeed, the coarsest textured deposits associated with Unit D occurred immediately before the channel incised sometime between 850 and 450 B.P., effectively ending Unit D deposition and marking the onset of Unit E sedimentation.

6.9.1.4 Unit E

As sedimentation resumed around 430 B.P., the carbon isotopic values suggest that the surrounding vegetation was around 80 percent C_4 and shifted gradually to include a slightly more C_3 rich assemblage up to the present day. The coarser sediments associated with Unit E suggest a return to less effective vegetation cover during this period.

6.9.1.5 Discussion

In examining Figure 6-12 it is clear that the broad pattern of vegetation change in the West Amarillo Creek valley is consistent with previous work performed in this region. In particular, it nicely parallels the summary Boyd (1997) presented for the region around Lake Alan Henry at the edge of the Southern High Plains southeast of Lubbock. The main differences between our results and Boyd's record are the specifics of timing of the maximum period of mesic conditions, with the West Amarillo Creek record suggesting that these conditions were a bit earlier than suggested by Boyd.

In comparison with the isotopic record obtained by Humphrey and Ferring (1994) at the Aubrey site, the West Amarillo Creek record exhibits a similar trend, but the timing of the late Holocene

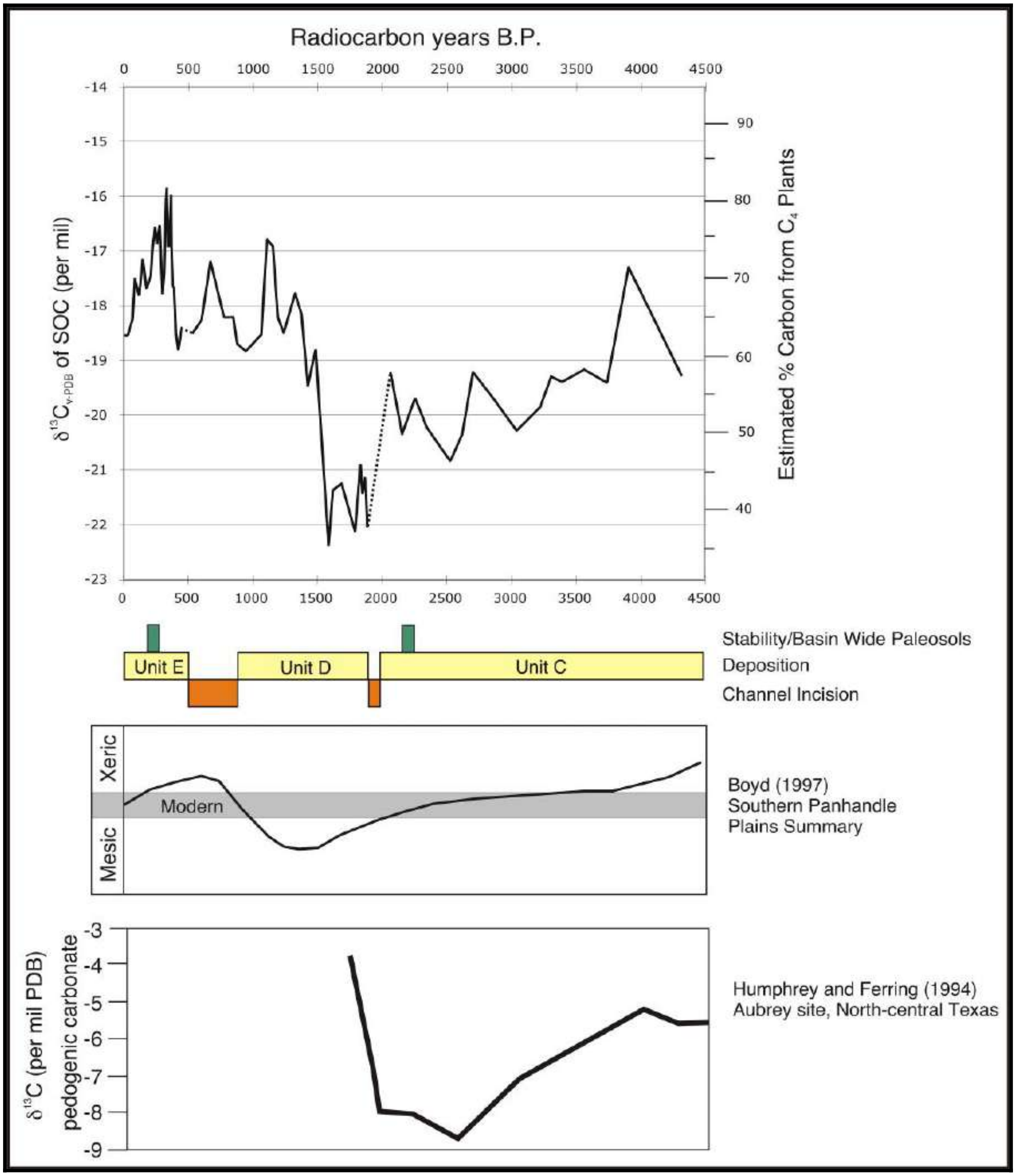


Figure 6-12. Summary of Soil Organic Carbon Changes through Time in Upper End of West Amarillo Creek Valley Compared to Two Other Records from Northern Texas.

Note: Top panel plots the change in soil organic matter stable carbon isotopic composition through time, with the solid lines denoting changes within a single alluvial fill, and the depositional hiatus between each alluvial fill shown as a dotted line. The period of time represented by each alluvial fill is shown below this plot. Middle panel is a summary figure produced by Boyd (1997) for the southern Panhandle Plains around Lake Alan Henry. Bottom panel is the results of carbon isotopic analysis of pedogenic calcium carbonate at the Aubrey site, near Denton, Texas (Humphrey and Ferring 1994). The results of the work from West Amarillo Creek compare favorably with Boyd's summary, and provide a more detailed record than Humphrey and Ferring (1994).

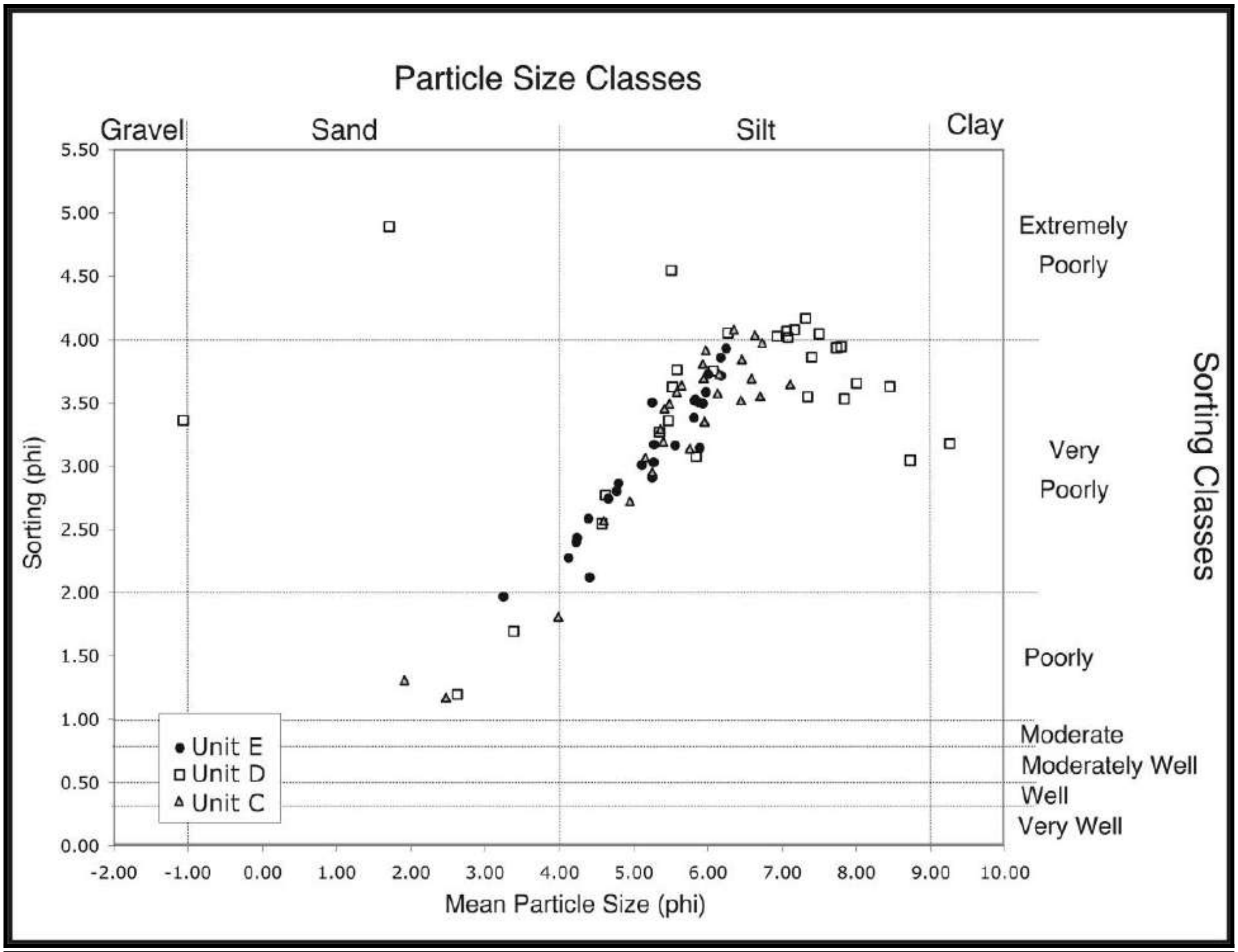


Figure 6-13. Plot of the Mean Particle Size Versus the Sorting (standard deviation) for Alluvial Units C, D and E.

Note: That if the few clearly coarse channel beds are excluded, Unit D is considerably finer textured than either Unit C or Unit E.

Mesic phase is later and it is likely that the nature of the sedimentation in West Amarillo Creek has yielded a more precise record for the last 3,000 years. Strong similarities are also apparent between our work here and work done mesic phase is later and it is likely that the nature of the sedimentation in West Amarillo Creek has yielded a more precise record for the previously in the Palo Duro Creek valley in Hansford County, Texas, north of here, which also dated a mesic phase between approximately 3,880 B.P. and 1,400 B.P. (Quigg et al. 1993).

7.0 THE TARGETED ARCHEOLOGICAL SITES

J. Michael Quigg

7.1 INTRODUCTION

The Phase I and II data recovery investigations targeted three previously identified prehistoric sites; 41PT185, 41PT186, and 41PT245. The Pipeline site (41PT185) is contained within three different meanders of West Amarillo Creek. During the initial 1998 survey the Pipeline site was divided into two Loci (A and B; Haecker 1999) and subsequently during the Phase I data recovery investigations in 2007, a third Locus (C) was identified. Locus A is defined as the middle meander and lies on the right bank of the creek. Locus B is located on the left bank of the creek at the point where the helium pipeline crosses the creek. It is situated on the northernmost of the three meanders in direct proximity to the Girl Scout cabins. Locus C lies south of Locus A on the left bank of West Amarillo Creek. Site 41PT185 and each loci is presented and discussed in Chapter 8.0. Chapter 8.0 presents the natural setting, summary of the 2007 Phase I investigations, the site stratigraphy, results from Phase I, and recommendations for Phase II data recovery. This is followed by the Phase II investigations. This begins with the geophysical investigations conducted before the archeological hand excavations, followed by the descriptions with analytical results of the cultural features and artifacts classes. Interpretations of the data recovered from the block excavations are presented under various research issues topics and questions at the end of this chapter. Information concerning Corral site (41PT186) is presented in Chapter 9.0. This site is farther upstream within a meander of the creek as well. Data presentation follows that of 41PT185 with the Phase I investigations presented first, followed by site stratigraphy, excavation results, site integrity discussion, and recommendations for Phase II investigations. The phase II investigations conducted are then presented beginning with the geophysical investigations before presenting the archeological feature and artifact descriptions and analytical results. Again, the interpretations of the block excavations conducted are presented in a similar manner to 41PT185/C.

The third site, the Pavilion site (41PT245) is presented in Chapter 10.0. It lies between the first two sites and occupies two low terraces on the eastern side of the creek. The data presentation follows the first two sites. However, the recommended and approved block excavation was terminated early and the very limited results from Phase II provide no quality data to address the research issues and questions proposed.

8.0 SITE 41PT185 - THE PIPELINE SITE

J. Michael Quigg and Paul M. Matchen

8.1 INTRODUCTION

The Pipeline site (41PT185) is the northern most site with three Loci separated by the meandering stream (Figure 8-1). Each locus is separately presented and discussed below as they were investigated as individual sites with individual recommendations.

8.2 SITE 41PT185 – PIPELINE SITE, LOCUS A

8.2.1 Natural Setting

The surface of Locus A appears as one large gently sloping terrace with colluvial deposits encroaching from the eastern side and interfinguring with alluvial deposits that are more prominent to the west, next to the creek. The higher elevation is to the east, whereas the lower elevation is next to the creek along the western margin (Figure 8-2). West Amarillo Creek borders on three sides of this landform. A well defined boundary between the different alluvial fills was not apparent at the surface. A gentle scarp separates the upper floodplain from the first terrace in the northwestern portion, which rises about 4 m above the stream channel. Several short erosional gullies have cut headward from the creek channel onto the first terrace and upper floodplain. One 16 m long gully is along the southern part of Locus A, just east of TUs 1 and 2 excavated by Haecker (2000) and TU 4, which TRC excavated. A second smaller gully is along the western side of Locus A, and cuts eastward into the upper floodplain. A third gully is present at the northeast corner of Locus A, in an area where the old pipeline crosses the creek. Minimally one helium pipeline (currently not in use) crosses through the northern side of Locus A in a southeast to northwest direction. The site is in a grassland environment. Currently, most of this alluvial dominated landform is covered with ragweed and various species of grasses. Large cottonwood trees line the margins of the creek. A few small mesquite bushes/trees dot Locus A. The modern surface pollen is dominated by Low spine Compositae (41 percent) followed by Cheno-am (22 percent), with grass at a low four percent (Gish 2000).

8.2.2 Summary of 2007 Phase I Mitigation Investigations at Locus A

Seven backhoe trenches (BTs 25 through 31) were excavated across this broad Locus, encompassing a total length of 70 m (Figures 8-3). Two trenches (BTs 25 and 29) were excavated into the lower floodplain deposits (T_{0b}, Unit F) along the western margin near the creek to a depth of between 280 and 290 cmbs. These trenches did not reach Pleistocene deposits. Creek channel deposits were exposed in the bottom of the trenches. At roughly midslope, BTs 26 and 28 were excavated to depths of between 240 and 280 cmbs, and revealed relatively thin (roughly 60 cm thick), late Holocene deposits over much thicker early to middle Holocene deposits in the sloping transitional area. Very limited if any, cultural materials were observed in these trenches. Moving further upslope, BTs 27, 30, and 31 were excavated to a maximum depth of 260 cmbs, into the T1a surface. These three trenches exhibited relatively thin (roughly 100 cm or less) late Holocene deposits overlying older Pleistocene deposits (Figure 8-1).

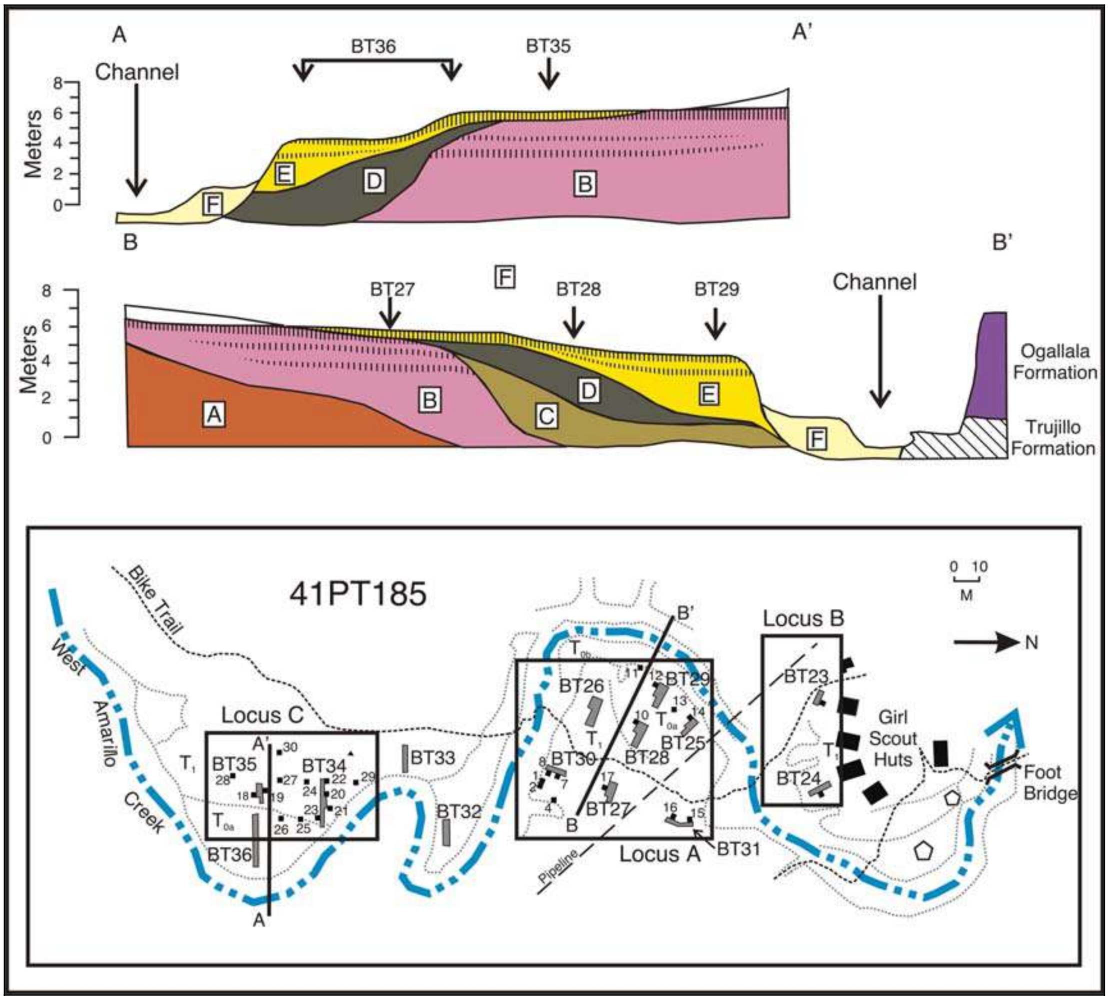


Figure 8-1. Profile of Stratigraphy and Plan Map of the Pipeline Site, 41PT185.

Figure 8-2. Overview of 41PT185, Locus A on Far Side of West Amarillo Creek. (View is North).

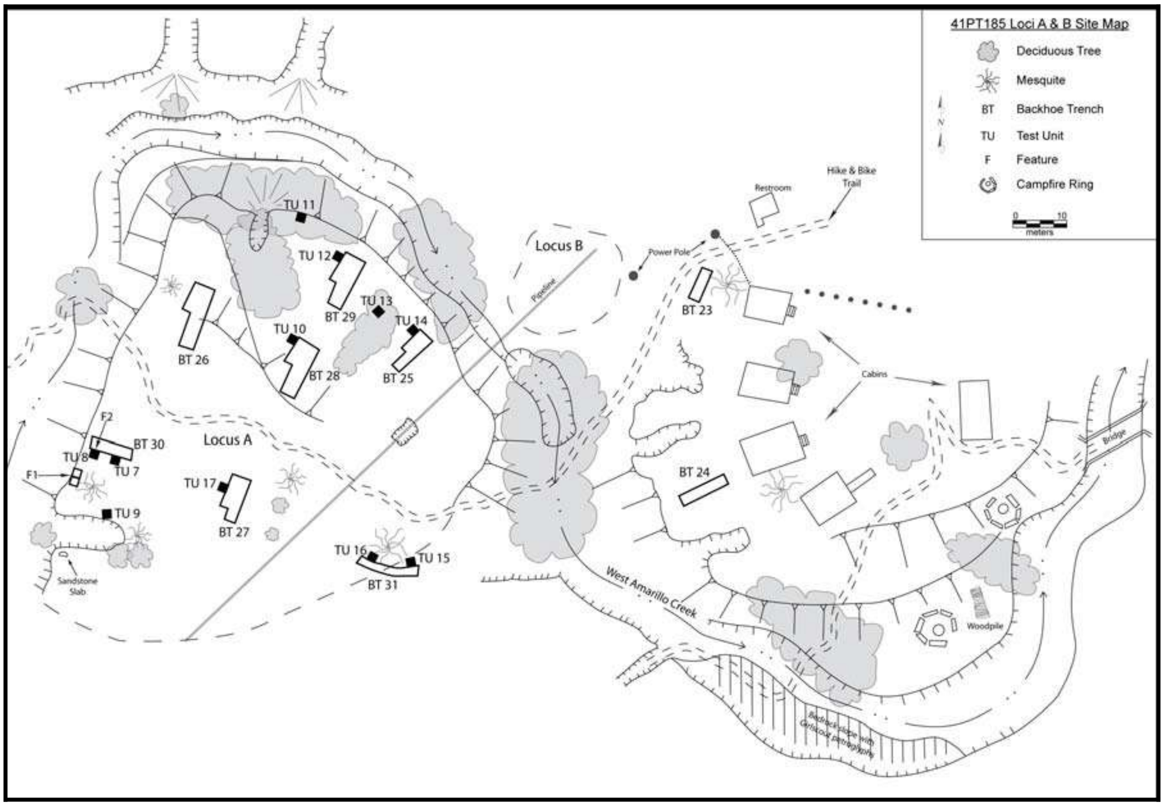


Figure 8-3. Plan Map of 41PT185 Locus A (left) and B (top middle) Depicting Excavation Areas.

Eleven units (TUs 7 through 17) were hand excavated across Locus A (Figure 8-3). These units varied in depth from 80 cm deep in TU 7 to 140 cm deep in TU 14, with a total of 12.0 m^2 excavated and screened. Six units (TUs 7 through 9, and 15 through 17) were placed from the sides of BTs 27, 30, and 31 across the midslope of T_{1a}. Test Units 10 through 14 were excavated to depths between 100 and 140 cmbs along the western side of Locus A and closer to the creek.

8.2.3 Stratigraphy

A complex suite of alluvial deposits is present within Locus A (Figure 8-1). The eastern part of Locus A is underlain by Unit B (dated to ca. 10,700 to 8000 B.P.). A thin veneer of younger sandy sediment drapes across the top of Unit B, and this is probably Unit E (ca. 800 to after 430 B.P.) and/or Unit C (ca. 5000 to 2100 B.P.). Most prehistoric cultural material was observed within the top of Unit B or in the younger overlying sandy veneer. Minimally three alluvial deposits lay inset against one another east of the first terrace. Trench 26 revealed a greater than 2 m thick wedge of Unit D (ca. 1900 to after 800 B.P.) overlain by a veneer of Unit E that was about 1 m thick at the western end, and 0.5 m thick at the eastern end. The thinner Unit E deposits were extensively disturbed by rodent burrowing (Figure 8-1). Trenches 25, 28 and 29 revealed a fragment of Unit C at depth, which was in turn overlain by Unit D, and was subsequently truncated and overlain by Unit E, which was nearly 3 m thick in BT 25. A thin wedge of Unit F borders the stream around most of the meander.

8.2.4 Archeological Results at Locus A

Occupational debris within Locus A was present at the rear of the first terrace in the middle of the meander, and to the south where the first terrace directly abuts the creek channel. In the lowest (western) part of Locus A, BTs 25, 26, 28, and 29 revealed sparse animal bones within the upper 100 cm of deposits. Multiple bison bones that ranged in condition from very fragmented to complete elements were observed in the upper portions of the walls of BTs 25 and 29. A small bison mandible fragment (#267-002, 26.7 g) was collected from 62 cmbs in BT 25. In this same general area, TUs 10 through 14 yielded only 19 pieces of chert debitage from about 5.3 m^2 (Appendix B). No cultural features and very few burned rocks were recovered from these five test units. This low frequency reflects limited human activity in these areas. The animal bones recovered from these deposits could not be confirmed as reflecting human activity, as they lacked signs of burning, spiral fractures, or cut marks. However, bison bones which include fragments of long bones a distal vertebrae spine (#145-002) were recovered from TUs 10, 11, 12 and 14. Most fragments reveal root etched surfaces that are partially covered with calcium carbonate. These very late Holocene deposits adjacent to the creek probably lack significant cultural remains in good context such as would warrant any further investigations in those specific areas. TRC recommended no further excavations in this lower (western) section of Locus A (Quigg et al. 2008).

Upslope, in the vicinity of BTs 27, 30, and 31, cultural materials were more frequent and more visible in the trench walls. Backhoe Trench 27 revealed a small unidentifiable bone fragment (#266-002-1a) from 68 cmbs, a rib fragment (#266-002), and a navicular cuboid (#266-002-2a). The most productive hand excavated units in Locus A were TUs 7 through 9 and 15 through 17 (Appendix B). Units 7 through 9 yielded 71 pieces of lithic debitage, 21 pieces of nonfeature burned rock, some 125 burned rocks as part of Feature 2, together with minimally one Tecovas edge-modified flake (#115-010) from 20 to 30 cmbs and one small unnotched, Alibates point base (#117-010) with potlids. The latter base was from 50 to 60 cmbs in TU 9. Bison remains from TU 7 include tooth enamel (#104-002), whereas TU 8 yielded a left distal tibia (#157-002) of a female. All three test units yielded small unidentifiable bone fragments. Test Units 15, 16, and 17 also yielded a few specimens identified as bison that include tooth enamel (#167-002 and #169-002) and a badly weathered and root etched medial tibia fragment (#176-002). These elements were often associated with small unidentifiable bone fragments scattered throughout the profile.

Two cultural features (Features 1 and 2) were identified in the vicinity of BTs 27, 30, and 31. Feature 1 was mostly exposed on the surface along the partially eroded southern edge of the T_1 surface (Figure 8-3). It consisted of a concentration of minimally 37 mostly whole quartzite cobbles in the ca. 8 to 15 cm size range within no obvious arrangement. None of the cobbles appeared to be fire cracked or show signs of intensive heat alterations. Haecker (2000) tested Feature 1 through hand excavations of a 1 by 2 m unit (TUs 1 and 2). The well rounded quartzite cobbles were between 0 and 10 cm deep, mostly complete, and did not rest within a visible basin. No charcoal or other organic staining was observed around the cobbles. Several small bone fragments were within the feature matrix (Haecker 2000). One unspecified bone fragment (FS 19.5 or 16.1) from 10 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon age of 2130 ± 40 B.P. (Beta-135417; Haecker 2000). Although not identified as such by Haecker (2000), the $\delta^{13}C$ value obtained (-10.1‰) during the dating process is indicative of a C_4 consumer, most likely a bison. This date, so close to the surface, raises some doubt that this bone fragment was in its original context and that the date reliably represents the true age of Feature 1. If, on the other hand, this is in fact the age of Feature 1, it must be inferred that considerable erosion has occurred to account for the near surface position of the feature. However, the deposits in the immediate vicinity of Feature 1 pertain to Units D or E, which are younger than 2,100 years old, implying that the bone fragments were found in disturbed deposits.

Feature 2 was discovered less than 10 m west of Feature 1 (Figure 8-3). It initially appeared as a loose concentration of small burned and unburned rocks at roughly 74 cmbs in TU 8 on the eastern edge of BT 8. At this level the sediment was generally a brown (7.5YR 5/4) very sandy clay loam mixed with limited cultural materials. As excavations proceeded downward, the burned rocks became concentrated into a tight cluster that was present between about 83 and 87 cmbs (Figure 8-4). The thin gravelly lens was above the concentrated burned rocks and appeared to rest atop a brown (7.5YR 5/6) matrix. The top part of Feature 2 appeared disturbed, making it difficult to identify a clear shape or pattern. This upper section includes a gravelly matrix with a high frequency of caliche pebbles less than 1 cm in diameter. Cultural lithic flakes were found throughout the small gravels, with a few bone fragments near the top. No soil color contrast was detected between the inside and outside of the burned rock concentration. No charcoal was observed amongst the burned rocks. Two arbitrary levels (70 to 90 cmbs) yielded 122 small burned rocks with an average weight of about 6 g each (Table 8-1), 31 pieces of lithic debitage, and a few small, bone fragments of a medium size ungulate. The context of Feature 2 is in doubt with possible disturbance of the upper part caused by high energy flood deposits, whereas the lower part may be the remnant of a basin filled with burned rocks. The presence of unquestionable burned rocks and lithic debitage associated with what appears to be small pieces of caliche gravels creates some uncertainty as to what this cluster represents and how it functioned.

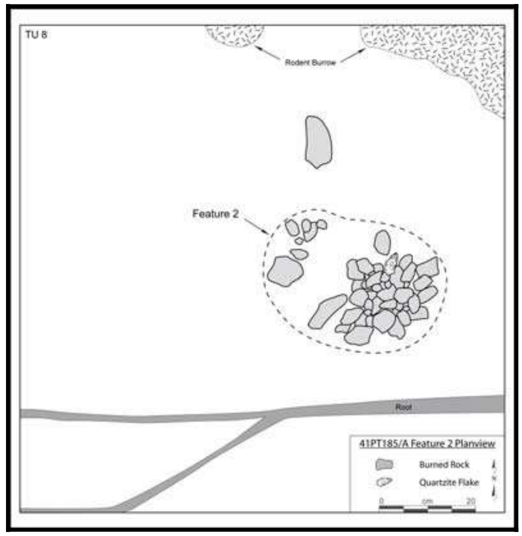


Figure 8-4. Bottom Part of Burned Rock Cluster, Feature 2 at 41PT185/A.

Four burned rocks (#112-003) from the lower, and relatively intact, part of Feature 2 (81 to 87 cmbs) were randomly selected for technical analyses. These consisted of three quartzite pieces and one dolomite piece. Lipid residue and starch grain analyses were conducted in anticipation that the results would contribute to understanding the function of Feature 2 and what food resources might have been cooked by these burned rocks. Interpretable lipid residues were extracted from only one (#112-003-1a) of the four rocks. This burned rock yielded fatty acids that are interpreted to indicate the presence of large herbivore meat and traces of plant products (Appendix G). Starch analysis was conducted on two pieces of these same burned rocks (#112-003-1b and #112-003-2b). Burned rock #112-003-1b yielded one unidentifiable starch grain, which positively supports the lipid residue findings above. Burned rock #112-003-2b yielded grass starch grains and gelatinized grains (Appendix F). The latter gelatinized starch grain definitely indicates that starchy Panicoid grass seeds were exposed to heat and water. These data indicate that Feature 2 was part of a cooking apparatus where minimally grass seeds were probably boiled with large herbivore (bison or deer) meat.

Table 8-1. Burned Rock Characteristics from Feature 2, 41PT185/A

Unit	Depth		Size (cm) and Weight (g)						Material Type [1]			Total	Total
	(cmbs)	Cat. No.	0-4	Wt.	4.1-9	Wt.	9.1-15	Wt.	LS	SS	Qtz	Count	Wt. (g)
TU 8	70-80	110-003	73	177	5	170			71		7	**78**	**347**
TU 8	80-90	112-003	41	262	3	121			24	1	19	**44**	**383**
Totals			**114**	**439**	**8**	**291**	**0**	**0**	**95**	**1**	**26**	**122**	**730**

1. LS = limestone, SS = sandstone, Qtz = qauartzite

A five liter sediment sample (#112-004) from beneath and around the clustered burned rocks in Feature 2 was collected and subsequently floated. This yielded 610.8 g of heavy fraction. The latter includes 28 tiny pieces of burned rocks, eight tiny pieces of lithic debitage, nine tiny bone fragments, and one burned hackberry seed. The light fraction weighed 3.8 g and consisted mostly of tiny hair rootlets with a few tiny snail shells, but no visible burned seeds or charcoal.

To obtain approximate ages of the natural deposits and the cultural activities in this area two bones extracted from 68 and 145 cmbs from the side walls of BT 27 were radiocarbon dated. The upper and unidentified bone (#266-002-1a), from late Holocene dark brown (10YR 3/3) loam (AB horizon), yielded a $\delta^{13}C$ adjusted radiocarbon age of 2640 ± 40 B.P. (Beta-238312). The lower bone was a right bison navicular cuboid (#266-002-1b) from 145 cmbs in a brown (7.5YR 4/3) loam, Abk soil horizon, and yielded a $\delta^{13}C$ adjusted radiocarbon age of 2940 ± 40 B.P. (Beta-238313). These two bone dates are in stratigraphic order and provide an indication of when bison were present in the area. However, the age obtained on the lower element appears too young for the early deposits it was recovered from, indicating that disturbance had displaced this cuboid downward into older deposits. A second scenario would be that the bone was exposed on an old surface for considerable time, which allowed older sediments to encase the bone through turbation processes.

Just north and in the same horizontal context, TUs 15 through 17 were relatively productive in terms of yielding cultural materials. These three units yielded at least two broken bifaces (one a distal section of a beveled biface made of Alibates [#156-011] and one proximal section of Potter chert [#159-010]), one flake of nonlocal obsidian (#156-001), many burned rocks, and butchered bison bones. The most productive unit was TU 16, which yielded roughly 70 pieces of lithic debitage, 18 bone fragments, and some 54 burned rocks. However, the relatively abundant cultural materials did not appear highly concentrated, as they were vertically dispersed over the 100 cm of hand excavated deposits (Appendix A). Units 15 and 17 exhibited a similar vertical dispersal of cultural materials. Lithic debitage and burned rocks were relatively abundant in a roughly 30 cm thick zone between 60 and 90 cmbs in TU 15, whereas TU 17 yielded greater concentrations in top 50 cmbs. No obvious living surface was detected as the cultural materials appeared to have been vertically displaced. A bison distal tibia fragment (#157-002) from 75 cmbs in TU 15 yielded a $\delta^{13}C$ adjusted radiocarbon age of 2720 ± 40 B.P. (Beta-238314), between the two other bones radiocarbon dated from BT 27. The four bison bone dates from Locus A support the presence of bison and undoubtedly their exploitation by humans during a ca. 800 to 900 year interval during the Late Archaic cultural period, and provide a general age for the cultural remains found at these levels.

8.2.5 Artifacts Recovered

A small proximal end of an unnotched triangular Fresno arrow point (#117-010) was recovered from 50 to 60 cmbs in TU 9. Most of one face of this point has a large heat spalled or "pot-lidded" surface. The opposite face has two small potlids. The basal edge is slightly convex and retouched along both faces. The right lateral edge and distal end are missing, whereas the left lateral edge shows small flake scars on one face. This point was manufactured from cream colored Alibates. This small fragment of an unnotched point may be associated with the Late Prehistoric period, possibly Antelope Creek. It remains unwashed for possible future analysis.

One end of an alternately two beveled knife (#156-011), made of dark-red banded Alibates, was recovered from 68 to 71 cmbs in TU 14 (Figure 8-5). Beveled knifes are quite common in Antelope Creek phase tool assemblages and this knife may represent that Late Prehistoric cultural pattern. This piece remains unwashed for potential residue analyses.

Figure 8-5. Half of a Beveled Knife #156-011.

A proximal biface fragment (#159-010) of Potter chert was recovered from 90 to 110 cmbs in TU 15. The end is rounded indicating a possible ovate shape for the complete piece. Both faces are extensively worked and are completely covered with flake scars. Two small fresh nicks are along the base. This piece remains unwashed for possible future analysis.

A light colored quartzite tested cobble or large chopping tool (#174-010) was found at 42 to 48 cmbs in TU 17. This water worn and rounded cobble weighs 1,236 g and measures 139.7 mm long, 115.2 mm wide, by 55.2 mm thick. Only one edge and one face exhibits flake scars with minimally four major scars. A few very short, small flake scars are along the worked edges with a small scar or two on the ventral side. It is unclear if these small scars were created through use.

Two obsidian flakes were recovered in close proximity to one another. Specimen #156-010 is a resharpening flake from 60 to 70 cmbs in TU 15. Specimen #167-001 is a biface thinning flake from 60 to 70 cmbs in TU 16. Both flakes were submitted for XRF analysis to determine their original source. Both were determined to have originated from the Jemez Mountains, specifically the Valles Rhyolite outcrop (i.e., Valle Grande), in northern New Mexico (Appendix C). These nonlocal pieces were either brought in by the occupants or traded for from their source area. Based on the three radiocarbon dates on bison bones from nearby, these two obsidian pieces are believed to have been used during Late Archaic times ca. 2720 ± 40 B.P.

In summary, Locus A yielded no intact charcoal laden features, no diagnostic projectile points or ceramic sherds, and the deposits appeared to be disturbed. The two features identified represent burned rock cooking related features, and both potentially have been disturbed. The limited tool assemblage potentially reflects the Late Prehistoric Antelope Creek period, whereas the two radiocarbon dates on bison bones probably reflect Late Archaic occupations/components. The scattered units did reflect some horizontal differences across this area, with some areas of concentrated artifacts. However, our current understanding of the relatively sparse and vertically scattered materials over some 90 cm is that there has been significant mixing of cultural occupations through turbation, and that more than one component is represented.

8.2.6 Locus A Integrity

The geoarcheological interpretation of the upper 65 to 75 cm of this deposit is that it represents sediments that are less than 500 years-old (Depositional Unit E). The bison bone (FS 16.1) radiocarbon date of 2130 ± 40 B.P. (Beta-135417) from Feature 1, at 10 cmbs, does not correlate with the geoarcheological interpretation for the deposits at this depth. Either the geoarcheological interpretation is incorrect, or the bone was displaced upward from older deposits. If this dated bone was displaced, it would indicate that these upper sediments in the late Holocene context have been disturbed. Disturbance through turbation is one mechanism that also creates the relatively homogeneous vertical distribution pattern detected in the cultural materials from TUs 15 and 16. The eroding slope of the southern terrace edge in the location of Feature 1 may be a partial explanation for the apparent shallow depth of the older bone. The bone (#157-002) radiocarbon dated to 2720 B.P. from 75 cmbs in TU 15 provides a general age for the cultural remains in the zone from 50 to 80 cmbs. The roughly 2940 B.P. bison navicular cuboid (#266-002-1b) at 145 cmbs in an early Holocene Abk soil horizon appears significantly too young for the matrix that surrounded it. Again, it is likely that the dated bone had been displaced downward by turbation. Alternatively, this younger bone was buried by older deposits through the actions of ants and/or worms. The dated bison bones indicate minimally one period of site occupation during the Late Archaic, although some turbation appears to have influenced their vertical positions.

Currently, the upper 50 cm or so are interpreted to have suffered from considerable turbation and intermixed cultural materials of differing ages within that zone, if more than one occupation/component is represented. It is possible that the 20 to 30 cm thick zone from roughly 60 to 90 cmbs contains the remains left by one or more Late Archaic occupations, based on the three bison bone dates. This is also the approximate depth of Feature 2, the two obsidian flakes, and a relatively high density of other cultural materials. The lack of diagnostic projectile points hinders the assignment of the cultural materials to a particular cultural expression or phase. The apparently older deposits below ca. 90 cmbs may contain scattered cultural materials displaced from overlying cultural occupation. The most promising areas in Locus A probably lie between BTs 30, 27, and 31 and were a potential target zone under consideration for a Phase II data recovery block. This potential target zone appears roughly 30 cm thick between roughly 60 and 90 cmbs. The cultural materials above this depth appeared too disturbed to justify further work (Figure 8-6). This lower zone, although not extremely rich in artifacts, may represent one or more Late Archaic occupations. It also seems to have a high potential for mixed cultural materials. Because better defined Late Archaic deposits exist in Locus C (see below), Locus A was not recommended for further investigations during Phase II data recovery (Quigg et al. 2008).

8.3 Site 41PT185 – Pipeline Site, Locus B

8.3.1 Natural Setting

Locus B lies on the opposite side of West Amarillo Creek from Locus A. As mapped by Haecker (2000), the site appears to occupy part of a colluvial slope in the area disturbed by the helium pipeline and adjacent two-track road. The area to the north of the road is the southwestern margin of a broader alluvial terrace that contains Girl Scout cabins, whereas the southern side is comprised mostly of colluvial deposits and the pipeline. Currently, the vegetation in the undisturbed areas is dominated by various grasses and small mesquite bushes/trees. The immediate margins of the creek exhibit large cottonwood trees.

Figure 8-6. Profile of TU 9 that Reveals Rodent Disturbance and the Different Depositional Units.

The geomorphic setting of Locus B is somewhat complex, as it lies near the intersection of the midslope of western valley wall near where it articulates with the first terrace. The cultural material observed was exposed across the disturbed surface of the two-track road along the pipeline, presently part of the hike-and-bike trail, immediately south of the Girl Scout cabins (Figure 8-3). It is postulated that the occupation exposed along the pipeline and roadway extends into the alluvial meander core north of this location. This projected extension of the occupation area is probably valid, given that Haecker (1999) reported finding a Late Archaic corner-notched dart point (Figure 8-7, FS 69.1) on a spoil pile from a rodent burrow adjacent to one of the Girl Scout cabins. Haecker (1999) also surmised that the broad terrace in front of the cabins also contained subsurface cultural remains.

Our work in Locus B was restricted to the small area south of the Girl Scout cabins, most of which is part of the first terrace. As in Locus A, several gullies have cut headword into the first terrace along the southern margins of this meander from the creek. It is not clear at this time whether or not the terrace surface was significantly altered when the cabins were built. Haecker (1999) states that this first terrace was leveled to accommodate the six Girl Scout cabins.

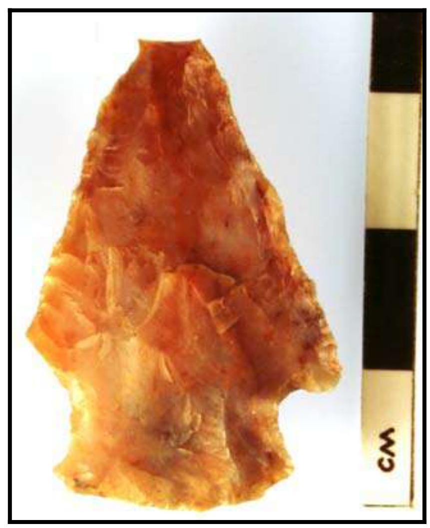


Figure 8-7. Corner-Notched Projectile Point (FS 69-1) Manufactured of Alibates, Recovered from Surface of 41PT185/B.

8.3.2 Summary of 2007 Phase I Investigations at Locus B

Two backhoe trenches, BTs 23 and 24, were excavated along the very southern margin of the broader terrace, which contain parts of Locus B (Figure 8-3). Backhoe trench 23, roughly 6 m long and 2 m deep, was excavated in the vicinity of the plotted artifacts on Haecker's (2000) sketch map. This trench was on the northern edge of the disturbed pipeline right-of-way. Trench 24, roughly 9 m long by 3 m deep, was excavated just north of the creek and some 37 m east of BT 23 along the southern terrace margin behind the Girl Scouts cabins (Figure 8-8). The Haecker (2000) sketch map showed a site area of roughly 375 m^2 that did not reflect what was truly represented on the ground. The Girl Scout cabins are on the southern side of a broad alluvial terrace, whereas the pipeline and adjacent road are towards the extreme southwestern corner of the terrace and part of the adjacent colluvial slope. The artifacts exposed in the pipeline and road, plus those discovered in BTs 23 and 24, combined with the one Late Archaic projectile from the rodent borrow in front of the cabins, indicate that the cultural deposits undoubtedly extend northward within the alluvial deposits that are under the cabins and across a much larger area in the middle of the Girl Scout use area. This broader terrace is projected to encompass minimally 1,140 m^2, with the actual extent of cultural occupation not precisely defined.

Figure 8-8. View of Southern Terrace Margin of Area B that Shows BT 24 During Excavation with BT 23 Backdirt in Foreground.

Following the excavation of BTs 23 and 24 and the documentation of cultural materials observed in their walls, TRC personnel became concerned with excavating additional exploratory backhoe trenches across the northern part of this broad terrace in front of the cabins. This terrace is a major use area around the Girl Scout cabins. Further trenching and potential hand excavations were postponed until a meeting with Dr. Signa Larralde of the BLM could be convened. In a field meeting with Dr. Larralde, the parties discussed the options. It was decided that if at all possible, it was best not to excavate additional trenches or hand units across this broader terrace in front of the cabins at Locus B and disrupt the manicured use area. Subsequently, Dr. Larralde instructed TRC to investigate newly encountered Locus C, rather than to conduct further work at Locus B. The testing effort planned for Locus B was shifted over to Locus C.

8.3.3 Stratigraphy at Locus B

Trench 23 revealed a roughly 55 cm thick veneer of very dark grayish brown (10YR 3/2) sandy loam late Holocene sediment (possibly Unit C or D, dated to last ca. 2,500 years) resting upon a buried soil formed at the top of Unit B (dated to ca. 10,700 to

8000 B.P., Appendix A). Prehistoric cultural materials were observed within the sandy veneer as well as within the fine-textured buried soil (55 to 100 cmbs) at the top of Unit B. The matrix in the top of Unit B was a dark grayish brown to very dark grayish brown (10YR 3.5/2) silty clay loam. The 2Bw zone was a brown (7.5YR 5/4) loam that gradually lightened with depth. Trench 24 revealed the top ca. 60 cm of sandy loam was probably Unit E, overlying deposits probably related to Unit B (ca. 10,700 to 8000 B.P.) and very similar to BT 23. Below about 115 cmbs was an apparent older Unit A that extended to at least 180 cmbs.

8.3.4 Archeological Results at Locus B

The absence of hand excavations in Locus B limited data recovery from this area and hence the interpretation of cultural activities in this location. Trench 23 yielded some historic items to about 30 cmbs mixed with a few burned rocks fragments. Scattered burned rocks were also found between 30 and 42 cmbs and all items appeared within the thin veneer of very sandy loam to about 55 cmbs (probably Unit E). A rabbit pelvis fragment (#257-002, acetabulum, 0.3 g) from one end of the trench was in the very dark grayish brown (10YR 3.5/2), very old buried A horizon (Unit B). The rabbit fragment was burned to a black and white state and is considered culturally modified. A few scattered burned rocks were found between 75 and 80 cmbs. The latter group of burned rock was close together in the wall, whereas two other burned rock fragments were at roughly the same elevation not to far away at the southeastern end of the trench. Below that was a brown (10YR 5/4) loam to about 200 cmbs. Minimally 10 pieces of burned rocks, one bone fragment, and a couple of tiny charcoal pieces were all observed in the trench walls. The bone was from hard, compacted clay at 83 cmbs and one piece of charcoal from 62 cmbs also in hard compact clay were collected.

Backhoe trench 24 revealed six burned rock pieces, which varied in depth from 65 to 88cmbs. Four articulated thoracic vertebrae of a bison were uncovered at ca. 70 cmbs in the trench. A bison first phalanx (#268-002, 3.5 g) was observed and collected from 130 cmbs in the trench wall during cleaning. No occupation floor, cultural features, or dense accumulation of debris representing a cultural component was observed.

Trenches 23 and 24 revealed the presence of scattered cultural materials at roughly two different elevations. The scattered burned rocks and small bone fragments represent general camp debris. This indicates that the much broader alluvial terrace deposits under and in front of the cabins potentially contain similar camp debris and probably in much better context. The Late Archaic dart point from a rodent backdirt pile indicates minimally one Late Archaic cultural component, and others are probably present in that area.

8.3.5 Locus B Integrity

The cultural artifacts observed on the surface along the buried pipeline and adjacent road probably were displaced or disturbed and lacked good contextual integrity. These materials were probably displaced when the pipeline was installed and testify to the presence of buried materials in this general area. Much of what was observed in the two trenches appeared in to be in secure contexts. The materials from BT 23 appeared primarily in very old and very hard clays with what appeared as potentially compressed context. The presence of an articulated section of bison vertebral column and burned rock pieces in BT 24 combined with the projectile point from in front of the Girl Scout cabins indicate the cultural materials are widely distributed across this alluvial terrace. Although hand investigations were not conducted toward the middle of this broad alluvial terrace, the current evidence implies that cultural materials are buried in this terrace. Similar alluvial terrace deposits generally provide good context, but it is currently unknown if this particular terrace surface was stripped or altered during the preparation for the installation of the cabins. It is also possible that rodent and other disturbances have affected the buried cultural materials in this area.

8.4 SITE 41PT185– PIPELINE SITE, LOCUS C

8.4.1 Natural Setting

Locus C is south of Locus A, on the opposite side of the creek (Figure 8-1). The surface of Locus C is covered with ragweed and mixed grasses, with the occasional small mesquite bush. Large cottonwood trees are scattered along the bottom of the creek, which was dry at the time of our fieldwork. The creek lies along the eastern margin of Locus C (Figure 8-9). The T_1 surface that dominates Locus C gradually slopes down to the east to the lower T_0 surface along the creek.

The elevation change between the two terraces is gradual rather than well defined. The gently sloping T_1 surface rises about 2 to 4 m above the creek channel. The western side gradually rises up a colluvial slope to the western valley wall, and is underlain in part by gravelly Holocene colluvium.

Figure 8-9. General Overview of 41PT185/C Looking Southeast with West Amarillo Creek along the Tree line.

8.4.2 Summary of 2007 Phase I Investigations at Locus C

Four backhoe trenches (BTs 33 through 36) totaling 52 m in length were excavated north to south across Locus C (Figure 8-1). Trenches 33, 34, and 35 were excavated east to west across the broader T_1 surface, with BT 36 excavated east to west in the lower and narrow T_{0a} surface next to the current creek channel. Trench 33 was towards the very northern end of the site adjacent to a bend in the creek channel. A few pieces of cultural materials were observed in Unit D, zone 3 and 4. Trench 34, some 30 m south of BT 33, was excavated 18 m long by 2 m deep, towards the northern side of the creek's meander bend. Trench 35 was excavated about 26 m south of BT 34 and was 9 m long by 3 m deep. Trench 36 was excavated roughly 6 m east of BT 35 into the lower terrace to a depth of nearly 5 mbs. This latter trench was targeted for paleoenvironmental investigations.

Thirteen hand-dug units (TUs 18 through 30) totaling of 13.4 m^2 were excavated across Locus C. All units began at the surface and were excavated to depths of between 80 and 150 cmbs to assess the Holocene deposit for cultural materials and their contexts. The relatively dense cultural materials detected in BTs 34 and 35 were targeted by six hand excavation units (TUs 18 through 23). Units 20 and 23 were laid out above burned rocks observed in walls of BT 34. Test Units 18 and 19 were placed adjacent to BT 35 and over or near exposed bison bones in the trench walls (Figure 8-10). Test Units 24 through 30 were away from trenches, but excavated primarily between BTs 34 and 35 to further define the horizontal and vertical extent of the encountered cultural deposits. Trench 36 did not reveal any cultural materials in the trench walls, although part of an unbutchered bison skeleton appeared in a pond deposit. A small sample of bison bone from this skeleton was collected. Many matrix samples were collected from BT 36 for potential analyses to extract data to address environmental questions.

8.4.2.1 Stratigraphy at Locus C

The stratigraphy of Locus C is relatively straight forward, with the exception of one confusing aspect to be discussed below. The core of the first terrace (T_1) is underlain by the very old Unit B (ca. 10,700 to 8000 B.P.) a brown (7.5YR 4/4) loam, and like most places in the valley, the upper ca. 50 to 70 cm or so appears to be a drape of a younger, sandier alluvial fill (Figure 8-11). This upper 70 cm or so is a very dark brown (10YR 2/2) sandy loam. This may represent a mixture of younger deposits associated with the top part of Unit C, and Units D or E (ca. less than 3,000 years old).

Figure 8-10. Completed TU 18 off North Side of BT 35, that Shows Natural Stratigraphy with Younger Darker Deposits Overlying Light Colored Very Old Unit B Deposits.

The cultural material in this part of the site appears primarily towards the bottom of the dark, sander and younger drape, but some materials are also within the lighter, extreme upper part of Unit B. This is where it is confusing as radiocarbon dates on multiple bison bones from this cultural zone in the extreme upper part of Unit B indicate that the bones are much younger (specifically ca. 2360 to 2720 B.P.) than the radiocarbon ages obtained for Unit B (ca. 10,700 to 8000 B.P.). This poses a bit of a paradox, as the bone dates are contemporaneous with Unit C deposition, but none of the deposits associated with Unit C exhibit this degree of weathering, specifically reddening, which is only associated with the Unit B deposits. The most likely explanation for the younger bone dates from older deposits is that the short-term burial of the prehistoric component was probably caused by pedoturbation, specifically exhumation of sediment from depth by insects and worms. If large animals were responsible for this burial there would be considerably more vertical variation in the distribution of the

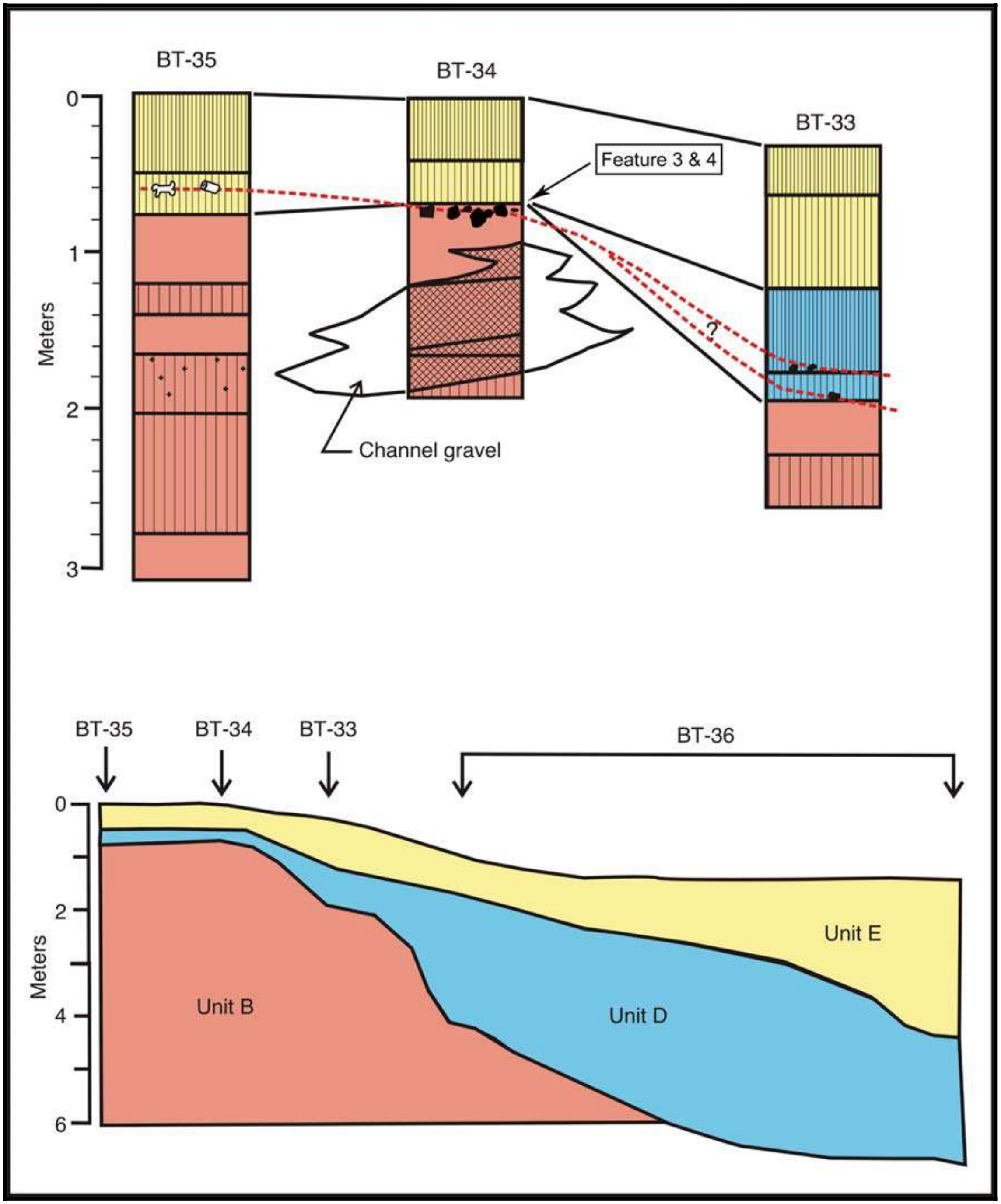


Figure 8-11. Schematic Depiction of Depositional Units and Stratigraphy of Locus C as Detected in BTs 33, 34, and 35.

cultural material. The dense nature of the fine-grained sediment most likely discouraged burrowing mammals much like it does today. Elsewhere it is apparent that the sandy sediments they are attracted to were extensively disturbed during the same time frame. Supporting this hypothesis, however, would be challenging. Radiocarbon dating the sediment would yield a young age owing to downward contamination from the immediately overlying A-horizon, and such a date would not reflect the time of deposition.

Beneath the T_{0a} BT 36 revealed a tapering 290 cm thick wedge of Unit D (ca. 1900 to 800 B.P.) inset against a ca. 80 cm thick wedge of the older Unit B that forms the core of T_1 (Figure 8-12). Dark brown (10YR 4/3) sandy loam (sample ”N”) from 510 cmbs, just above the Triassic Trujillo sandstone bedrock, and the tilted edge of older Unit B yielded a $\delta^{13}C$ adjusted radiocarbon date of 4330 ± 40 B.P. (Beta-253238). This wedge of Unit D includes a series of superimposed 485 to 490 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon dated on sediment of 1890 B.P. for the base of Unit D, whereas a date of 4330 ± 40 B.P. (Beta-241070) was obtained to the west side in Unit B. At about 200 to 220 cmbs a partial bison skeleton was exposed in the northern wall. This Unit D deposit had been truncated and overlain by a tapering 3 m thick wedge of the younger Unit E (less than 500 B.P.). It was from this trench profile that sediment and charcoal samples, plus six 50 cm long monolith columns were collected and analyzed during Phase I investigations to assess their potential for paleoenvironmental reconstruction (Figure 8-12). Subsequently, matrixes from these monoliths were sampled in the laboratory for charcoal, pollen, phytolith, and texture analysis.

A gradual slope of the natural deposits is apparent, with a general thickening of the alluvial deposits towards the creek. On the western side of Locus C the colluvial deposits are thicker, with thin stringers of fine pebbles interfinguring with the alluvial deposits. The late Holocene and the underlying middle Holocene fills thicken towards the creek channel. The nearly 3 m thick Unit D deposit in BT 36 was targeted for paleoenvironmental interpretation for this roughly 1,500 year long period.

8.4.2.2 2007 Phase I Archeological Results at Locus C

The cultural component identified in Locus C is situated toward the leading edge of the first terrace, near the point at which it abuts the upper floodplain. Trench 33 yielded sparse burned rocks at the interface of the younger sandy loam (possible a mix of Unit D and E or the last 2,000 years) and the older Unit B (ca. 10,700 to 8000 B.P.) at roughly 140 cmbs, with and one burned rock at 155 cmbs. No hand units were excavated next to or adjacent this trench.

At BT 34 quantities of burned rocks were present along both side walls and with two possible burned rock features identified (Features 3 and 4). Feature 3 was partially exposed near the middle of the trench on the basis of two closely spaced burned rocks just below the base of the safety trench. Many individual burned rocks were scattered along the western half of the trench with a number appearing to represent the same occupation as they are close in elevation at roughly 70 cmbs.

Feature 4 was isolated towards the eastern end of the trench and was evidenced by 5 to 6 large burned caliche rocks tightly clustered between roughly 80 and 110 cmbs on the southern wall Rodent burrows were present under the rocks and no charcoal was visible. The natural deposits appeared to thicken eastward, toward the creek. These two recognized clusters of burned rocks were then targeted with individual test units. No bones or lithic debitage were observed in this trench.

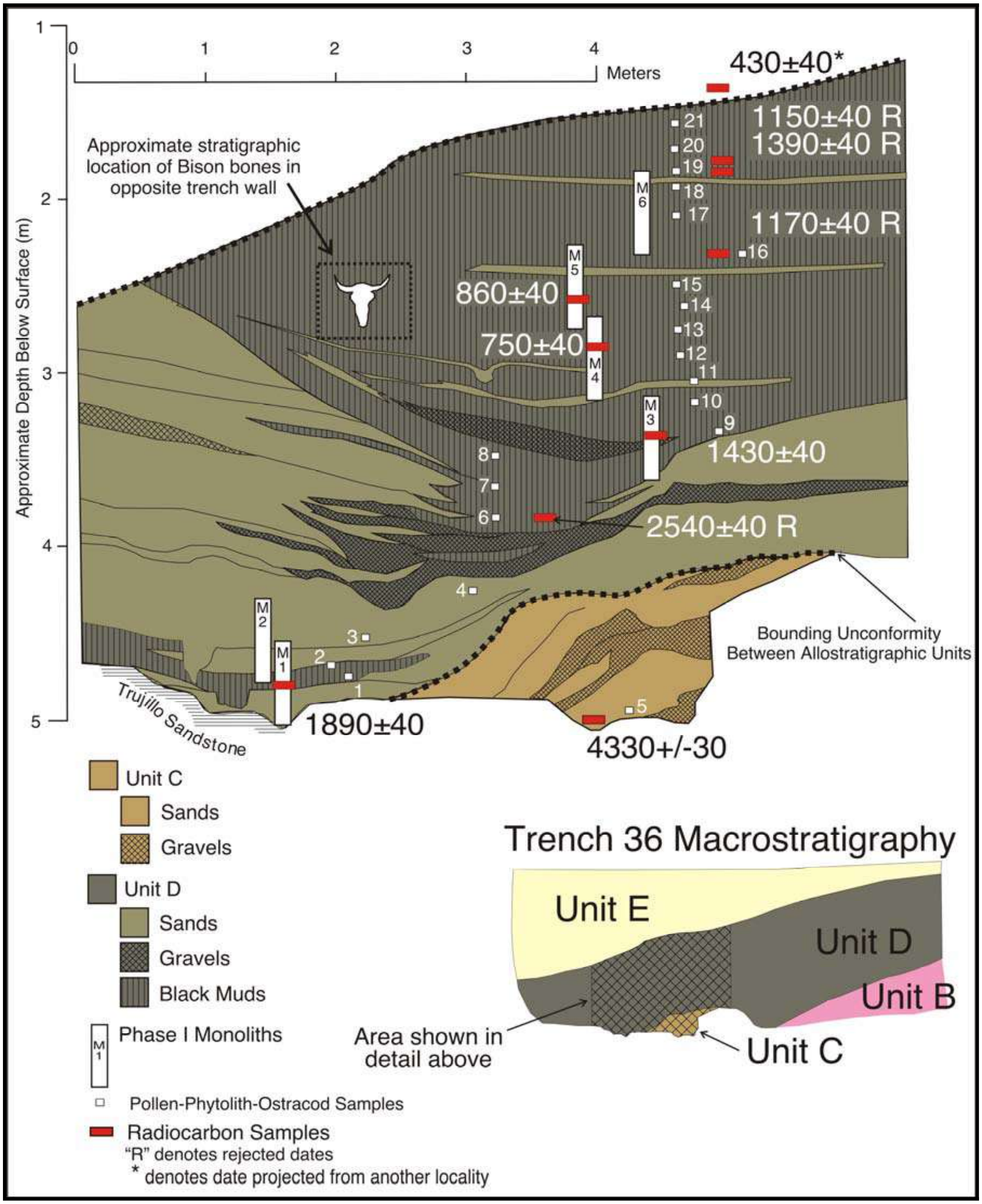


Figure 8-12. Backhoe Trench 36 Showing Depositional Units and Stratigraphy in Lower Terrace, and Subsequent Sampling Locations and Radiocarbon Dates.

Subsequently, Feature 3 was exposed by hand excavation of TU 20 on the safety bench on the north side of BT 35. A loose cluster of 28 mostly medium sized burned rocks (#198-002) was encountered between 80 and 90 cmbs. These rocks were clustered in an area that measured about 85 cm in diameter in an irregular ovate distribution pattern with a couple of burned rocks displaced outside the clustered pieces (Figure 8-13). These were all dolomite pieces between 5 and 15 cm in diameter, with a few that exhibited internal cracks. A gray matrix that surrounded the rocks lacked visible charcoal, any sign of *in situ* burning, or pit like depression. The gray matrix that surrounded the rocks yielded a single piece of lithic debitage.

Figure 8-13. Feature 3 that Shows Burned Rock Shapes, Sizes, and Distribution.

Feature 3 is interpreted to represent part of a discard pile of exhausted burned rocks that were discarded following their use in a cooking process. Support for this interpretation comes from lipid residue and starch grain analyses conducted on selected burned rocks. Four burned rocks (#198-003-1a, 2a, 3a, and 4a) sampled for lipid residues yielded insufficient lipid residues for taxon identification. Parts of those same four burned rocks (#198-002-1b, 2b, 3b, and 4b) were also sampled for starch grains and yielded some positive results. Sample #198-002-1b yielded one gelatinized starch grain indicative of exposure to heat and water. Sample #198-002-3b yielded one unidentifiable starch grain and one lenticular starch grain common to Canadian wildrye grasses (*Elymus canadensis*). The other two samples did not yield any starch grains (Appendix F). Minimally two burned rocks support the lipid residue analysis with the presence of grass starch grains and some evidence of cooking these grains.

Feature 4 was a tight cluster of 44 mostly large, irregularly shaped dolomite burned rocks (#213-002 and #214-003) distributed over an area nearly 1 m long, between 95 and 108 cmbs in TU 23 (Figure 8-14). The western edge of Feature 4 extended beyond the margin of the test unit and the very northern edge was truncated by BT 34. The grayish brown (10YR 5/2) sandy silty loam feature matrix lacked visible charcoal, dark-stained matrix, ash, or bone.

Figure 8-14. Top View of Hearth Feature 4 in TU 23, Following Excavation.

The sediments exhibited no visible sign of a prepared pit. However, towards the middle of the cluster, a few smaller rocks were directly below the larger pieces, hinting that a shallow basin was potentially present. One piece of chert debitage (#213-001) was discovered in between the burned rocks.

Lipid and starch analyses on selected burned rocks from Feature 4 support the initial interpretation that this cluster of burned rocks functioned as a cooking facility. Four burned rocks (#214-003-1b, 2b, 3b, and 4b) were examined for starch grains. Minimally two burned rocks (#214-003-1b and 2b) yielded gelatinized starch grains that indicate contact with heat and water. Sample #214-003-3b yielded two lenticular starches that are common to Canadian wildrye (*Elymus canadensis*, Appendix F).

Parts of those same four burned rocks were subjected to lipid residue analysis. Burned rock #214-3-1a yielded high-fat-content plant with a trace of animal lipids (Appendix G). Burned rock #214-3-4a yielded the presence of very-high-fat-content from plants such as nuts or seeds (Appendix G). This combined data indicates that minimally wildrye seeds were boiled in Feature 4.

This tight cluster of relatively large burned rocks is interpreted as an *in situ* cooking facility. Feature 4 was roughly 6.5 m east of Feature 3, and appears in the same depositional context, even though Feature 4 is slightly lower in the slightly sloping profile.

East to west oriented BT 35 revealed a couple of large bison bones at about 60 cmbs. The A horizon extended to about 75 cmbs and was a sandy loam characteristic of Units E/D and similar in appearance to the upper zone in BT 34. The general location of the exposed bison bones was targeted with two hand excavated units (TUs 18 and 19) off the southern and northern sides of the trench, respectively (see Figure 8-10).

Test Units 18 and 19 yielded sparse bone fragments, including one complete right bison scaphoid and a distal thoracic vertebrae spine between 65 and 85 cmbs. Although these bones were slightly higher in the profile than Features 3 and 4, they were about the same elevation within the same depositional unit and are likely close in age.

Nonbison taxa were represented by a few small rodent bones. Their surface was a brown color and lacked the root etching and weathered conditions exhibited by the bison bones. The nonbison bones appear intrusive and are not thought to be of cultural origin. Most bone fragments were very small (less than 3 cm in diameter) and could not be identified as to element or species. No other animal bones were identified in these deposits.

Scattered and fragmented bison bones were encountered in TUs 18, 19, 20, 22, 24, 25, and 26. These bones were generally at depths between 70 and 110 cmbs, with only a couple of exceptions (Table 8-2). No bones were observed in the 18 m long BT 34. BT 35, with two 1 by 1 m units (TUs 18 and 19) was about 13.5 m south of BT 35. During trenching the backhoe fragmented a bison metatarsal (25 pieces that weighed 218.7 g) at roughly 60 to 67 cmbs. Backhoe trench 36 was excavated into the lower terrace immediately east of BT 35 and encountered a couple of bison bones. The whole elements appeared to represent a single individual male bison.

Three radiocarbon dates on bison bone collagen were obtained from Locus C. A bison metatarsal (#262-002-1) fragment at roughly 60 cmbs from the safety bench/step in BT 35 yielded a $\delta^{13}C$ adjusted radiocarbon date of 2270 ± 40 B.P. (Beta-237024). A bison metacarpal fragment (#210-002-1) from between 70 and 80 cmbs in TU 22 yielded a $\delta^{13}C$ adjusted radiocarbon date of 2360 ± 40 B.P. (Beta-238315). A fragment of a bison radius (#236-002-1) from 97 to 102 cmbs in TU 26 yielded a $\delta^{13}C$ adjusted radiocarbon date of 2420 ± 40 B.P. (Beta-238316). These three bison bone dates document a use period of less than 200 years from roughly 2270 to 2420 B.P. during the Late Archaic period, or possibly a single occupation, given the overlaps in the calibrated age ranges. Either way, these three bone dates probably reflect a single cultural component, which varies slightly in depth across this area. It is possible that two closely spaced Late Archaic events are represented in this zone/component, but currently these cannot be separated.

Table 8-2. Bison Bones from Test Units at 41PT185/C

Test Unit	Depth (cmbs)	Cat No.	Bison Element/Part	Weight (g)	Burned	Cut marks	Surface conditions
19	60-70	187-002	thoracic vert spine frag	62.8	No	No	calcium covered
19	80-90	189-002	right scaphoid	18.8	No	No	light root etching
20	100-110	200-002	long bone fragments	8.4	No	No	
22	70-80	210-002	distal metacarpal -right	93.2	No	2 poss.	root etched,
22	80-90	211-002	long bone fragments	9.3	No	No	fresh surface
24	59	219-002	proximal metatarsal-right	29.5	No	1 impact	weathered, calcium, gnawed
24	62	220-002	long bone fragments	57.1	No	No	weathered, root etched
24	72	221-002	distal metatarsal-right	20.1	No	No	weathered, calcium, gnawed
25	30-40	224-002	long bone fragments	5.5	No	No	
25	70-80	225-002	thoracic spine fragment	11.4	No	No	weathered, calcium covering
26	30-40	231-002	caudal vertebrae	1.9	Black	No	
26	41-51	232-002	long bone fragments	18.8	No	No	light weathering
26	97-102	236-002	proximal radius-right	94.2	No	No	
26	100-104	237-002	sesamoid	0.7	No	No	

Two small stem sections of two dart points were recovered (Figure 8-15). One is a dart point stem (#245-010) from 70 to 80 cmbs in TU 28. The second is a dart point stem (#204-010) from 10 to 20 cmbs in TU 22. These two point stems are quite similar in overall appearance. Both are relatively small and exhibit slightly expanding stems and were broken in the neck area just below the blade. They are classified as general Late Archaic dart points with no specific type name assigned. The stem from higher in the profile (10 to 20 cmbs) is thought to have been displaced from the lower, better defined component. A third dart point fragment (#209-010), a distal tip of dark red Alibates, was recovered from 60 to 70 cmbs in TU 22.

Five edge-modified flakes were recovered from Locus C. One is the proximal end of a large Alibates flake with retouch along the two lateral edges (#242-010), recovered from 60 to 70 cmbs in TU 27. A second edge-modified piece (#219-010) is a complete flake of unidentified material with tiny scars along a thick, curved distal end. This piece was recovered from 58 cmbs in TU 24.

Two obsidian flakes (#210-010 and #221-001) were also recovered. Specimen #221-001 is a resharpening flake from 70 to 80 cmbs in TU 24. Specimen #210-010 is a complete biface resharpening flake recovered from 70 to 80 cmbs in TU 22. These two pieces were sourced by XRF analysis to El Rechuelos Rhyolite in the

Jemez Mountains of northern New Mexico (Appendix C). Their presence indicates a connection between this area and central New Mexico during the Late Archaic period.

Figure 8-15. Two Dart Point Stems (#204-010 and #245-010) from the Late Archaic Component at 41PT185/C. (scale in cm)

In summary, the four hand excavated units (TUs 20 through 23) on the sides of BTs 34, plus two hand excavated units (TUs 18 and 19) at BT 35, combined with seven hand units (TUs 24 through 30) between and adjacent trenches 34 and 35 revealed sparse, but significant, cultural materials. The area around and between BTs 34 and 35 yielded the highest concentration of cultural material from this project. The area around BT 35 probably functioned as a bison butchering and/or processing area. The area around BT 34 appears to have functioned as cooking area. Therefore, minimally two apparent activity areas are represented across this investigated area. This diversity, combined with the presence of minimally two different, well defined burned rock features (Features 3 and 4), two similar Late Archaic dart point bases, imported obsidian from northern New Mexico, and the apparent horizontal separation of different activity areas reveal a prime target area for Phase II data recovery.

The area between BTs 34 and 35 was recommended for a large block excavation that targeted what appeared to be a Late Archaic component dating from ca. 2200 to 2400 B.P. (Quigg et al. 2008). This component appeared to be roughly 20 to 30 cm thick. It also varies in depth because of the slope of the depositional units, varying from ca. 60 to 80 cmbs in the southwestern side to between 90 and 100 cmbs in the northeastern side. Cultural debris in higher levels was scattered and not as well defined. No diagnostic artifacts or cultural features were encountered in the upper deposits. As such, this scattered debris was thought not to be as significant as the lower, better defined Late Archaic, which included recognizable cultural features and diagnostic artifacts.

8.4.2.3 Locus C Integrity

The two dart point base fragments are quite similar in style, and potentially reflect a single cultural complex. As mentioned above, the elevation difference between the two points may indicate that bioturbation has displaced the upper specimen. This is the most likely interpretation as very little other cultural material was recovered from the upper levels in most units. Rodent disturbances were detected and observed in many of the upper deposits. The lower dart point was recovered from a similar elevation as were the two obsidian flakes and Features 3 and 4. The three radiocarbon dates on bison bone collagen document an age of ca. 2270 to 2420 B.P. for what appears a single component. The three radiocarbon dates appear to reflect a narrow time period of no more than ca. 200 years and the two diagnostic projectile points assigned to the Late Archaic are within this time frame. Some turbation is evident in these deposits as indicated by the one displaced dart point. Mixing of materials from different time periods does not appear a significant factor, as only one component appears to be present.

The Late Archaic period is well represented in the cultural history of the region (see Chapter 3.0 for additional details). However, few thoroughly reported, excavated sites exist in this region. The Chalk Hollow site in Randall County to the south has a suite of radiocarbon dates from the lower midden, which date to about this same time. The Late Archaic dates are generally associated with a variety of corner-notched dart points resembling the Marcos, Williams, Castroville, Ellis and Palmillas types of central Texas (Lintz 2002). A few poorly documented bison kill sites dated to the Late Archaic are known along the eastern edge of the Llano Estacado (D. Hughes 1977, 1989), the best known being the Twilla, Collier, Bell, and Strong sites, (D. Hughes 1977, 1989; Lintz et al. 1991), and the Certain site in western Oklahoma (Bement and Buechler 1994). Therefore, bison are known from this time period and are also represented in 41PT185/C. The component at 41PT185/C exhibits sufficient integrity and contain significant cultural materials (diagnostic projectiles, intact features, and imported obsidian) to contribute important information to this poorly known time period and its cultural manifestations. TRC recommended a major block excavation at Locus C for the Phase II data recovery (Quigg et al. 2008).

8.4.3 2008 Data Recovery Phase II Investigations at Locus C

8.4.3.1 Field Methods and Sampling Procedures

With approval by BLM for a large block excavation at Locus C, the Phase II investigations targeted the alluvial terrace deposits in Locus C, on the western side of West Amarillo Creek, and the Late Archaic component buried as much as 1 m below the current ground surface. The target block was planned for immediately south and toward the western side of BT 34 and north of BT 35. This part of the terrace was composed of a relatively thin layer (roughly 60 to 70 cm) of younger deposits thought to represent Units D and E (the last ca. 2100 B.P.) overlying a much thicker and older Unit B (ca. 10,700 to 8000 B.P.). An apparent pause in deposition occurred ca. 2150 to 2250 B.P. (see Chapter 6).

Phase II investigations were initiated at this locality with mechanical stripping to remove overburden above the projected target zone (Figure 8-16). The target zone was associated with previously excavated Features 3 and 4 between 80 and 110 cmbs along eastern end of BT 34 and shallower deposits closer to 40 cmbs at the far western end.

Figure 8-16. Locus C of the Pipeline Site, 41PT185/C that Shows Initial Mechanical Stripping of North End of Block with Burned Rock and Artifacts Flagged. (view west)

The mechanical stripping began immediately south of BT 34 adjacent to Features 3 and 4. The initially stripped area was mechanically dug to our projected target depth of roughly 70 to 90 cmbs without encountering any significant signs of cultural material. As the stripping expanded southward and westward, considerable quantities of burned rocks were encountered at roughly 45 to 50 cmbs, especially towards the western side. Based on the high frequency of burned rock encountered during the stripping in those areas, we adjusted the stripping depth to just above the burned rocks across the remaining southern and western sides of block area.

When completed, the mechanically stripped area measured about 15 m north to south by 20 m east to west (ca. 300 m^2). Our original projected target depth (ca. 70 to 90 cmbs) was reached in only about 30 percent of the stripped block, whereas nearly 70 percent of the block was stripped to only ca. 40 to 50 cmbs. The shallower depths towards the western side were necessitated because of aforementioned factor of the relatively dense burned rocks encountered during stripping. Once this nearly 300 m^2 block was stripped, a grid system outline was established across the surface of the block.

Dr. Chet Walker conducted geophysical investigations across this stripped area through the use of multiple instruments that included a flux gradiometer, conductivity meter, magnetic susceptibility meter, and a ground penetrating radar (GPR) across 280 m^2 of the stripped surface (Figures 8-17).

Figure 8-17. Dr. Chet Walker Conducting Geophysical Investigations across Stripped Block Surface at 41PT185/C.

This geophysical investigation was conducted with the goal of identifying subsurface anomalies to be targeted through subsequent hand excavations. The geophysical specialist marked the identified anomalies on the stripped surface of the block by numbered pin flags to aid in the planning of archeological efforts. A composite map that showed the geophysical investigation results of Locus C and presented the locations of the most likely cultural anomalies was provided to the TRC archeologists before Phase II data recovery hand excavation efforts.

Once the archeological crew arrived, the outlined grid system was filled in with 1 by 1 m divisions across the stripped block. Hand excavations began in individual units dispersed over the stripped area and began at several apparent concentrations of burned rocks and marked geophysical anomalies. The deeper stripped area in the eastern quadrant of the block south of BT 34 was investigated by about 16 1 by 1 m units distributed across that area (Figure 8-18). Several units targeted marked geophysical anomalies. These deeper hand excavated units yielded only a few recognizable stone tools, lithic debitage, and animal bones. The central and southwestern part of the stripped block where quantities of burned rocks were exposed during stripping, showed considerably more promise and yielded several cultural features together with other scattered cultural debris.

During the subsequent hand excavations in the western and northern areas of the block, a higher density of cultural material was discovered. This material appeared to extend farther north and possibly farther west and beyond the original stripped block. To follow the apparently higher density of cultural materials, the upper 30 to 40 cm of the deposits north and west of the initial stripped area were mechanically removed from a 7 by 15 m area. Additionally, a 5 by 15 m area along the western edge of the initial block was stripped (Figures 8-18 and 8-19). Excavation units were established in this area to target the zone roughly between 40 and 80 cmbs that was predicted to contain the Late Archaic component. These units were subsequently hand excavated (Figure 8-18).

As the hand excavations continued, 2 to 5 m long sections of excavated wall profiles were drawn in selected locations across the block to document the natural stratigraphy. These partial profiles exhibited the minor elevation variations for the base of the A horizon and the contact with the lower B horizon representing older soil. Geoarcheologist Charles Frederick also inspected and collected matrix samples from two short wall profiles in the extreme northern section, one on the eastern and one on the western side (Figure 8-20). These deposits were used to address questions that concern the depositional units. The results are presented in the following paragraphs.

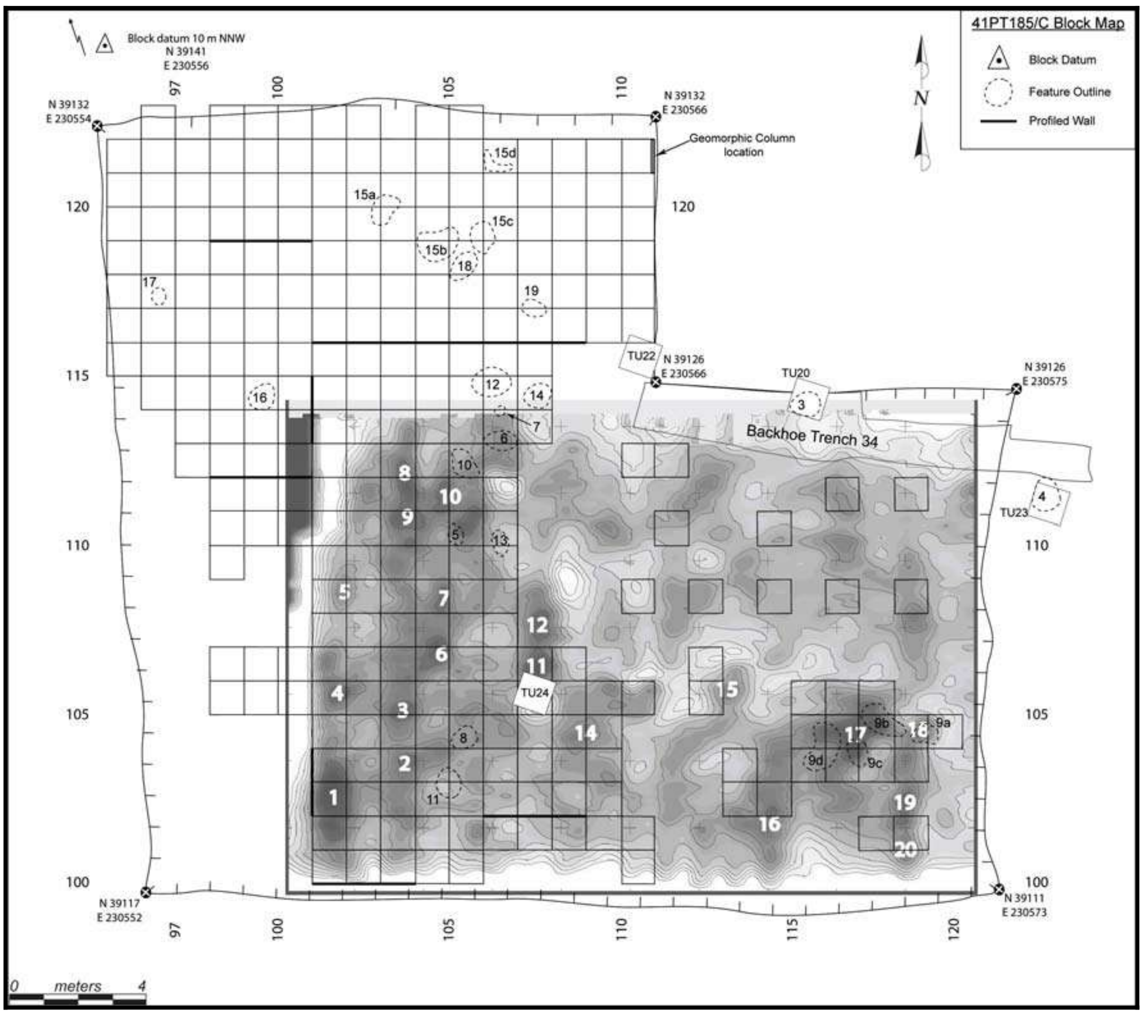


Figure 8-18. Excavation Block Map at Locus C at the Pipeline Site, 41PT185.

(Note: gray shaded area is the extent of the initially stripped area and subsequent geophysical investigations conducted. White numbers are geophysical anomalies.)

Figure 8-19. Overview of the Newly Stripped Expanded Excavation Block on Western and Northern Sides of Original Stripped Block at 41PT185/C.

(Note: This expansion area was not geophysically investigated).

In general terms, the deposits exposed by the block excavation consist of a thin drape of Unit E alluvium resting upon Unit B alluvium. The slope across the block excavation increases from east to west reflecting the gradual dominance of colluvial processes away from the channel of West Amarillo Creek. A wedge of colluvial sediment is present along the western margin of the block, and this colluvium, although thin within the block, was observed be more than 1.8 m thick in BT 37, which was located on the left bank of the creek at the next meander upstream from the site, west to southwest of the block about 100 m. The thick colluvial deposits in BT 37 (also visible in the cutbank just below the trench) consisted of thin, weakly developed A horizons separated by pedogenically unaltered colluvial sediments (C horizons). Along the western margin of the block excavation all of the colluvial deposits had been altered by pedogenesis to form a cumulic soil A horizon, with a slightly less melanized (dark) zone apparent in a few places. These colluvial sediments appear to interfinger with Unit E within the block, but the degree of this was difficult to establish within the block owing to pedogenic overprinting. In several places narrow linear rills filled with fine gravels and oriented roughly east to west were uncovered within the block excavation and these undoubtedly are small alluvial fan/colluvial slope distributary channels.

Two columns of samples (columns A and B; 35 samples in all) were collected from the upslope and downslope sides of the block, near the northern end of the excavation and these were examined for texture, calcium carbonate content and magnetic susceptibility. The results of these analyses are shown on Figures 8-21 and 8-22. Column A was located on the western (or colluvial dominated) side of the block and Column B was located on the eastern side of the block excavation directly opposite of Column A. Column B was located slightly north of the west end of Trench 34.

Figure 8-20. Profile of Column A on Northwestern Corner of Excavation Block.

(Note: this shows the entire profile from surface to base of hand excavations. The lower 40 cm was the hand excavated target zone. The top 40 cm was the deposit mechanically stripped before hand work.) (scale in cm)

8.4.3.1.1 Column A (Western Side of Block)

The deposits on the western side of the block are clearly, slightly coarser textured than the eastern side, and this is reflected in both the mean grain size and the percentage of gravel. The upper 40 cm of this column are classified as sandy loams, and the remainder of the column is classified as loams, but between 45 and 60 cm the deposits exhibit a 5 to 7 percent increase in clay which probably indicates a decrease in colluvial contribution below 60 cm. Column A the samples are consistently more poorly sorted than Column B (even when of similar mean particle size), which reflects the less effective sorting of slope transport as compared to fluvial transport by West Amarillo Creek. The gravel content of the samples is one way to evaluate the colluvial influx to the block and as can be seen on Figure 8-21. There appears to be approximately four episodic gravel peaks in the profile, which may represent distinct depositional episodes. It should be noted that postdepositional mixing or pedoturbation could alter the spatial distribution of gravel in the profile, so a direct interpretation of these gravel peaks should be viewed cautiously.

The calcium carbonate content also gradually increases with the clay content which further supports a shift in parent material around 60 cm on the west side. The magnetic susceptibility (lf) shows three subtle peaks, which may reflect pedogenic enrichment. The coefficient of frequency dependence (X fd) increases down section, and elevated values (>10 percent) are indicative of increased concentrations of fine-grained ferrimagnetic minerals, most often maghemite, in top soils (Dearing et al. 1996). The greater values below 60 cm may reflect differences in parent materials or time of exposure.

8.4.3.1.2 Column B (Eastern Side of Block)

Column B was collected from a point where alluviation by West Amarillo Creek appeared to be the dominant depositional process. A single large krotovina was present on the sampled wall, and the spatial distribution of this burrow fill with respect to the sampled column is shown on the stratigraphic diagram on Figure 8-21. This profile is subtly different from Column A. Nearly all of the samples within this column are classified as loams, with the exception of one sample near the krotovina which is classified as a silt loam, and the lowest sample, which was a sandy loam. The clay

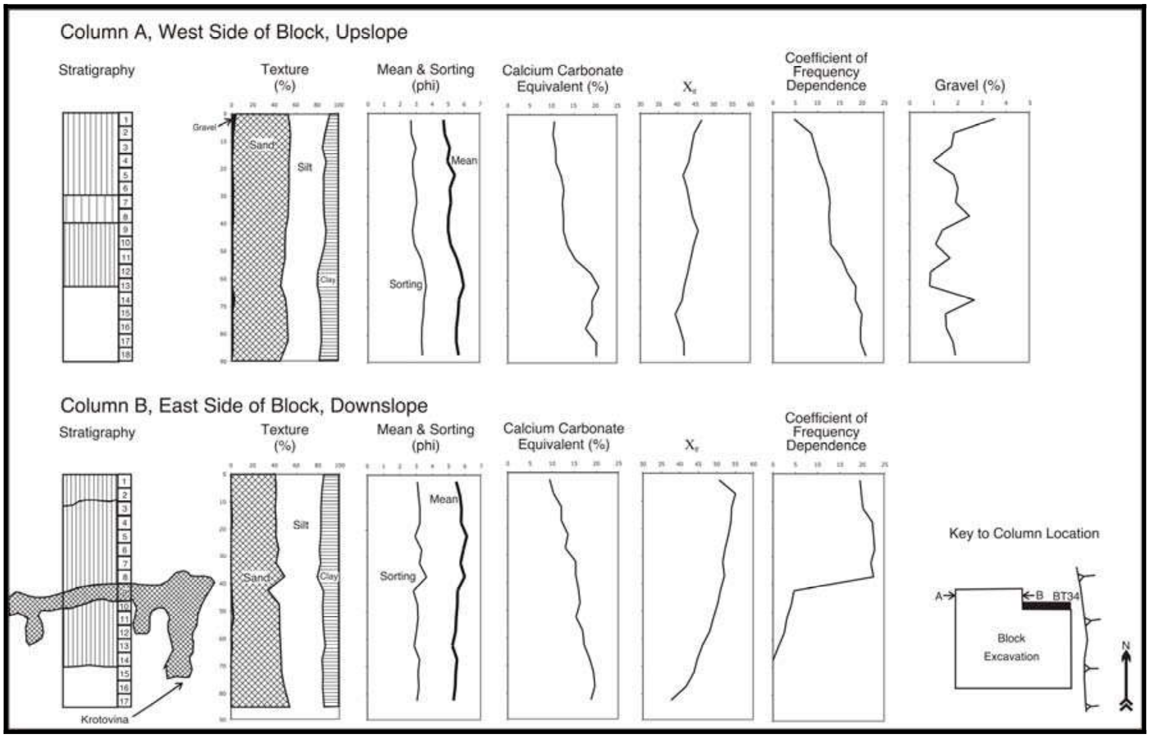


Figure 8-21. Graphic Display of Laboratory Results for Both Columns.

content is slightly greater in the top 40 cm, and slightly lower below that, but the majority of the textural variation is centered around the amount of silt, which co-varies with sand. As a result, the upper 40 cm of the profile is slightly finer textured than the lower, largely owing to a greater proportion of silt. The calcium carbonate content gradually increases with depth, which is opposite of the magnetic susceptibility, which gradually decreases with depth. There is a dramatic shift in the coefficient of frequency dependence at 40 cm, but the source of this is not understood.

In December, during the later stages of the block excavations, original BT 36 was reopened and expanded to bedrock at a depth of ca. 5 mbs, and was also lengthened to 20 m long, to expose part of Unit B towards the western end of the trench. This specific location and profile was targeted to address questions concerning the paleoenvironment in this valley during the last ca. 2,000 years. The geoarcheologist directed these investigations and further documented this profile that contained channel and overbank deposits (Figure 8-23). Once reopened, the previous monolith sample column locations (M-1 through M-6) were identified with four of the six sample locations (M-3 through M-6) precisely tied into the new profile. This allowed the 2007 and 2008 data to be integrated into one complete and meaningful document.

More detailed documentation and a closer spaced sampling program was conducted. The revised Unit D profile, combined with the additional intensive data collection that targeted Unit D, permitted detailed analyses of the environmental conditions in West Amarillo Creek valley during the last ca. 2,000 years. Over 100 matrix samples were collected for pollen, phytoliths, diatoms, ostracodes, insects, snails, texture, and radiocarbon dating. A new profile was drawn to show the precise locations of the collected samples in relationship to the observed stratigraphy.

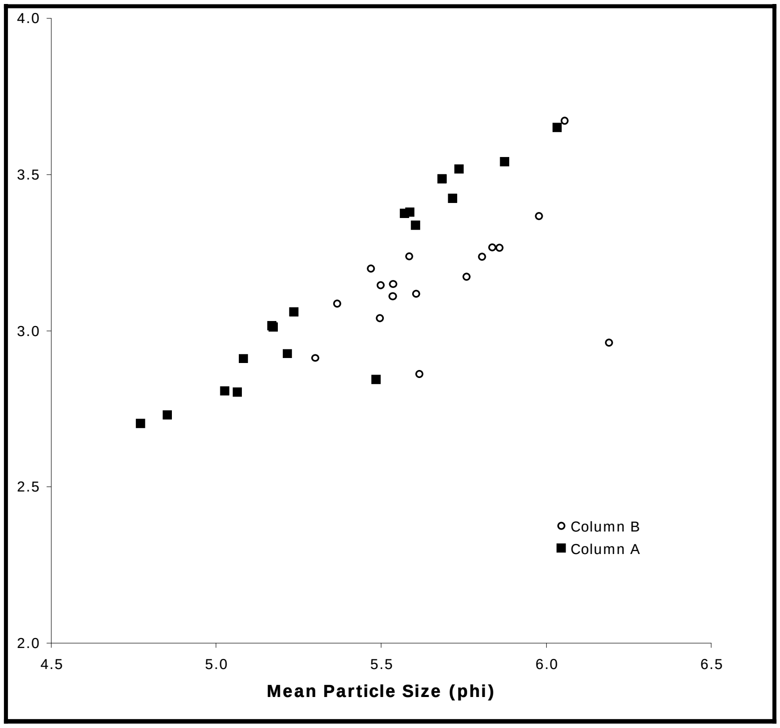


Figure 8-22. Plot of the Mean Particle Size Versus the Sorting (standard deviation) for the Particle Size Results from Columns A and B.

(Note: both axes are plotted in Phi units. Numbers reflect coarser particles [on the X-axis] or better sorting [on the Y axis]. For reference, sands are -1 to 4 phi, silts are 4 to 9 phi and clays are >9 phi. All values shown here reflect mean particle sizes in the coarse silt range [4.5 to 6.5 phi]).

During the widening of the northern side of BT 36 for access, additional bison bones from the same previously identified bison skeleton was encountered and a random bone sample was collected. This bison was determined to be a mature male (greater than 5.3 years-old) based on the fusion of all appendicular epiphyseal ends of all the long bones. The sex was determined based on metric measurements of selected leg elements. Nearly all parts of this bison were represented except for the skull and pelvis. The position and completeness of the skeleton and individual elements indicates a natural death. Based on a carbon isotope value of -9.9‰ (Appendix H) from a metacarpal, this animal consumed about 80 percent C_4 grasses during its lifetime.

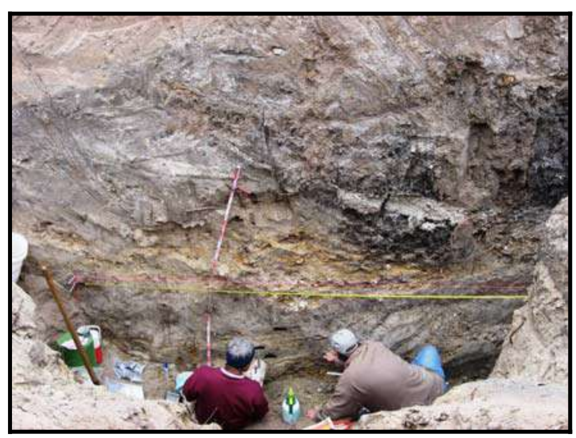


Figure 8-23. Start of Sampling Process at the Bottom of BT 36, View South.

(Note: Sloping Color Change in Upper Left Corner Marks the Division Between the Overlying Unit E at Roughly 430 B.P. and the Underlying and Unit D.)

8.4.3.2 2008 Data Recovery Phase II Results

The geophysical specialist, Chet Walker, identified 19 anomalies across the 280 m^2 area investigated (Figure 8-24). This scanned block was immediately south and west of BT 34 and did not cover the subsequently expanded block to the west and north (Figure 8-25).

Walker's survey defined anomalies in three of four quadrants, with the exception of the northeastern portion. These anomalies were numbered 1 through 20 (number 13 was skipped) in accordance to their potential to reflect possible cultural features.

Seventeen (89 percent) of the 19 anomalies were investigated through hand excavation. At least 7 (41 percent) of 17 investigated anomalies yielded some evidence of dense cultural material within 1 m of the marked anomaly (Table 8-3). The remaining anomalies appeared to represent rodent disturbances or nothing at all. The geophysical investigations followed by documentation through hand excavations identified several cultural features, but also reflected many subsurface rodent disturbances.

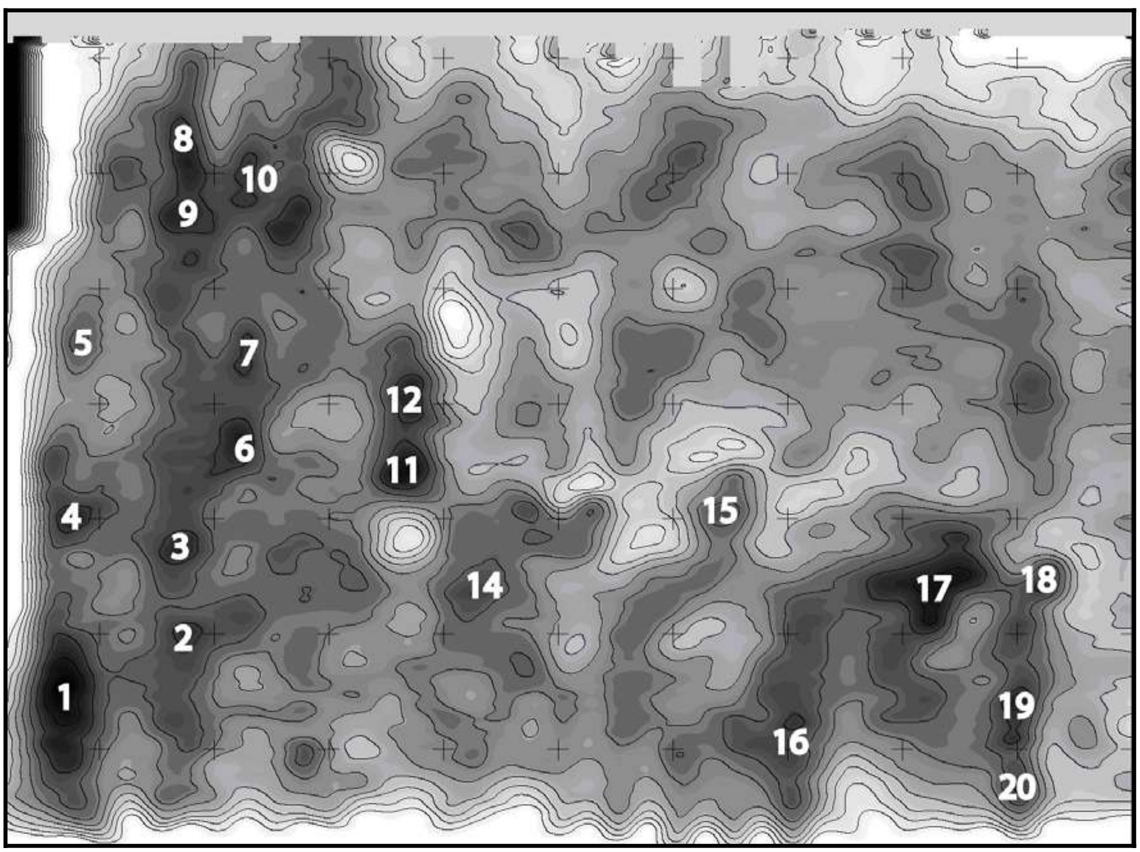


Figure 8-24. Locus C at the Pipeline Site, 41PT185/C that Reveals the Location of the 19 Identified Anomalies across the Initially Stripped Target Block.

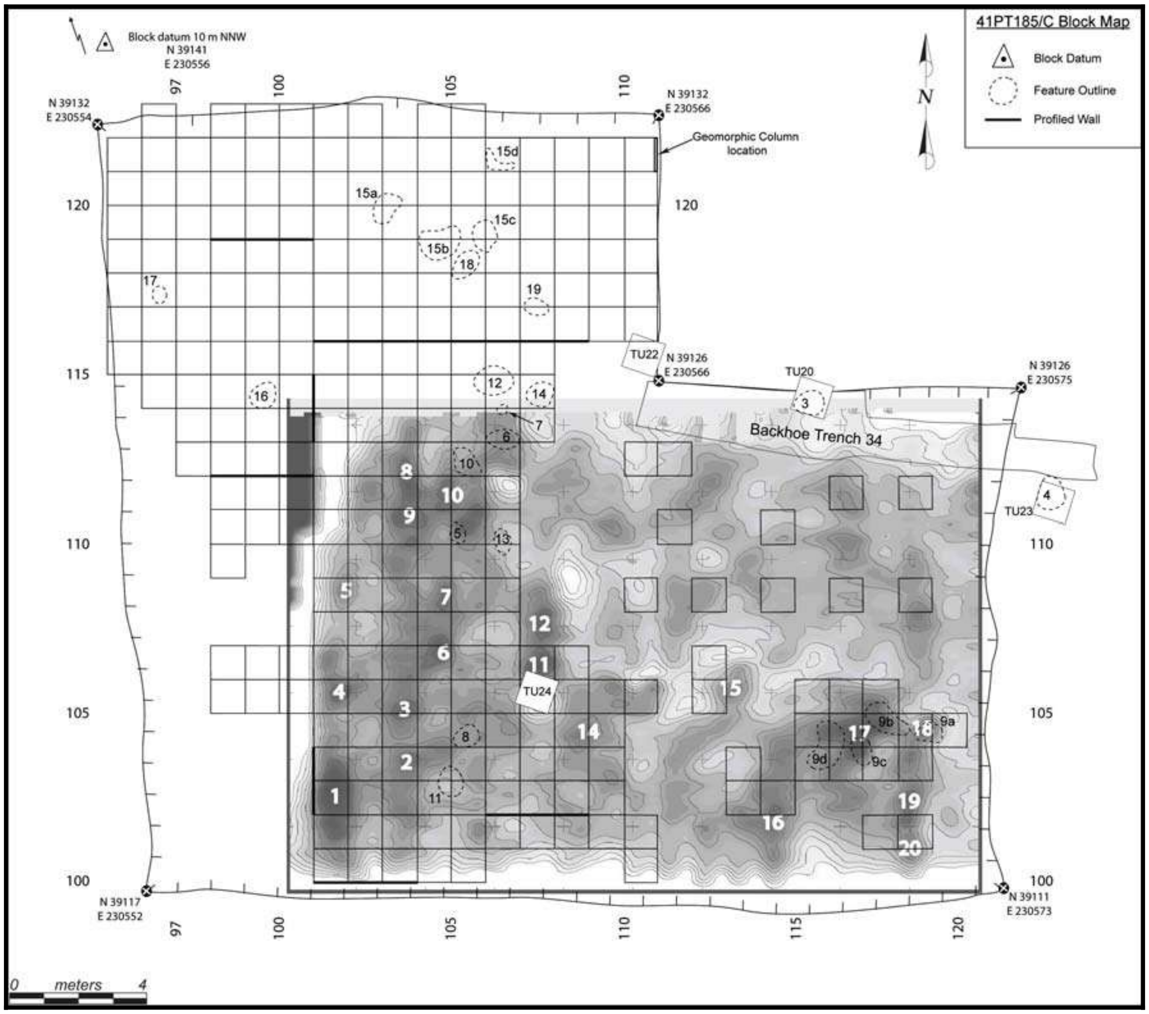


Figure 8-25. Final Excavation Block Over the Geophysical Survey Results to Show Location of the Detected Anomalies and Discovered Burned Rock Features.

(Note: white numbers refer to geophysical anomalies)

8.4.3.3 The Context of the Cultural Materials

The top of the target zone generally sloped from 40 to 80 cmbs eastward toward the creek bank, with minimally one area towards the northern end that also showed dipping deposits (Figures 8-26 through 8-28). The target zone was not a dense or thick layer of artifacts, but a light scatter of materials over a broad area. This occupational evidence was not obvious as the excavation progressed down through the deposits. The color of the sediment that contained the cultural materials was relatively consistent except for the effects of changes in moisture. The lower soil boundary was generally easier to detect, with the older deposits being lighter in color and much more compact. However, the cultural materials did not stop abruptly with the color change as artifacts were often discovered in the upper part of the lower, older deposits. Much of the vertical dispersions of artifacts is attributed to the turbation in a particular area.

Table 8-3. List of Geophysically Identified Anomalies and the Archeological Results of Investigations.

Anomaly No.	Provenience North / East	Cultural Material	Distance from marked Spot
1	102 /101	1 small burned rock at 54	over 1 small burned rock
2	104 /103	small burned rocks	on western edge of lots of burned rocks
3	105 /103	small scattered burned rocks	60-70 cm west of cluster of burned rocks
4	105 /101	none	possible rodent hole
5	108 /101	30 cm diameter rock	50 cm southeast of rock
6	112 /103		
7	108 /105	none	
8	112 /103	25 cm diameter rock	30 to 40 cm to east of rock
9	111 /103	none	nothing significant within 50 cm
10	112 /105	2 large rocks = 17.5 kg	50 cm northeast of 2 large rocks
11	106 /107	none	40-50 cm north of 1 x 1 m TU
12	no excavation		
13	skipped number		
14	104 /109	scattered burned rocks	over scattered burned rocks at 50-60 cm
15	106 /112	scattered burned rocks	over scattered burned rocks at 58-65 cm and rodent holes
16	102 /114	limited pieces	70 cm east of rodent hole
17	105 /117	lot of burned rocks	Top of Feature 9d burned rocks
18	104 /119	lots of burned rocks	Top of Feature 9a burned rocks
19	102 /117&118	None	possible rodent hole
20	101 /117&118	None	possible rodent hole

During the excavations, no obvious stacking of cultural features were encountered that would support multiple compressed or overprinted cultural events. In most excavation units one obvious occupation lens was apparent in the field. However, in some units, there were possible indications of more than one thin zone of cultural material. For example, four features (14, 16, 17, and 19), plus other scattered cultural debris appeared at slightly lower elevations than the majority of features in the upper occupation lens within the target zone. During laboratory analyses careful back plotting of the larger *in situ* cultural debris (bison bones and burned rocks) from various excavation units indicated some vertical separation of minimally six cultural features (including Features 3 and 4). Back plots of material from a few units reveal minimally two distinct zones of materials (Figures 8-29 through 8-31). Some vertical displacement of items is possible from the one of the higher elevation. In other parts of this broad excavation block, minimally two closely spaced and stratified cultural occupations were obvious. In at least one very limited area a third possible occupation may be represented, but the localized area combined with obvious turbation activity creates some doubt about what these lower and sparse cultural artifacts might actually represent. While evidence of multiple cultural occupations appeared within our roughly 40 cm thick target zone, in some places these were more or less vertically separated by about 10 cm of matrix. However, the widely distributed horizontal spacing of defined activity areas, the lack of visually clear stratigraphy, combined with the sparse and discontinuous nature of the cultural debris over the entire area prevented a clear definition of each cultural zone across the broad excavated area.

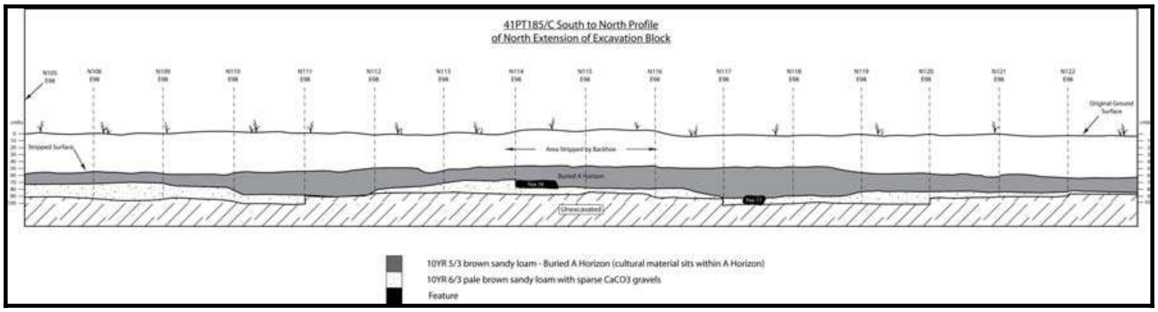


Figure 8-26. South to North Profile through the Western Side of the Excavation Block.

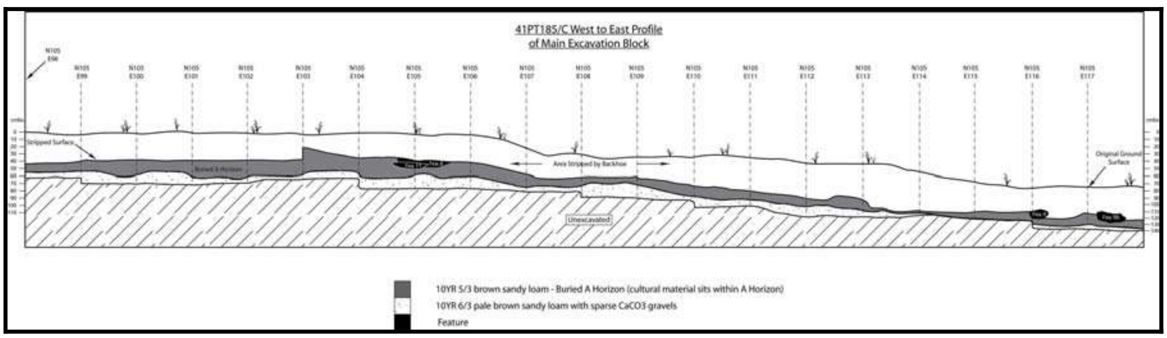


Figure 8-27. West to East Profile Across Southern End of Excavation Block that Shows the Sloping Buried A Horizon.

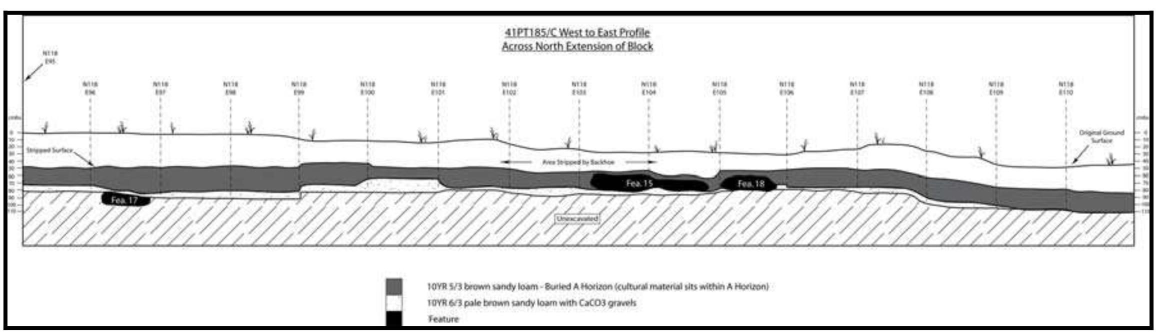


Figure 8-28. West to East Profile Across Northern End of Excavation Block that Shows the Sloping Buried A Horizon.

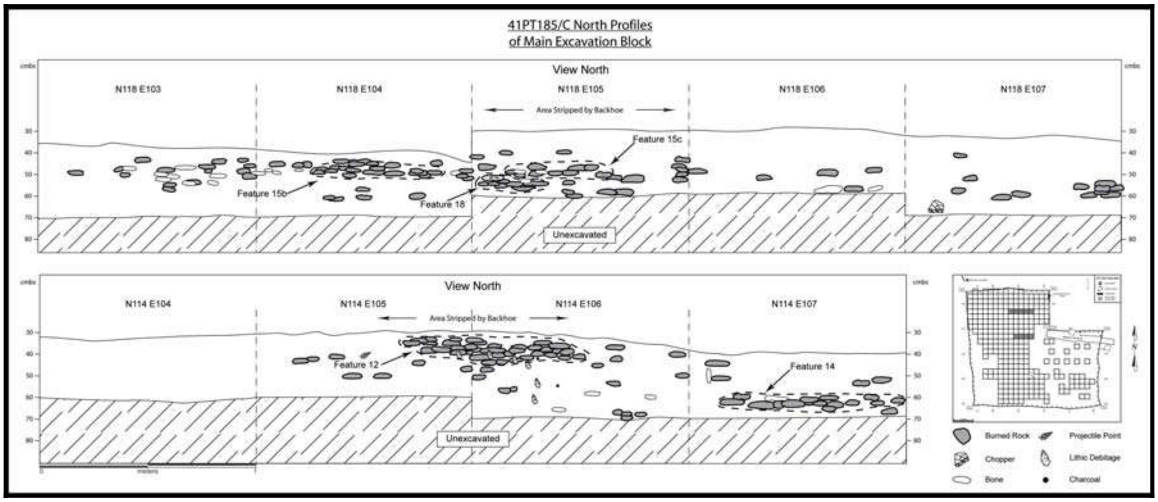


Figure 8-29. Vertical Back Plots of Cultural Materials Plotted In Situ across Five and Four Units in Northern Part of Excavation Block. (Note: view north)

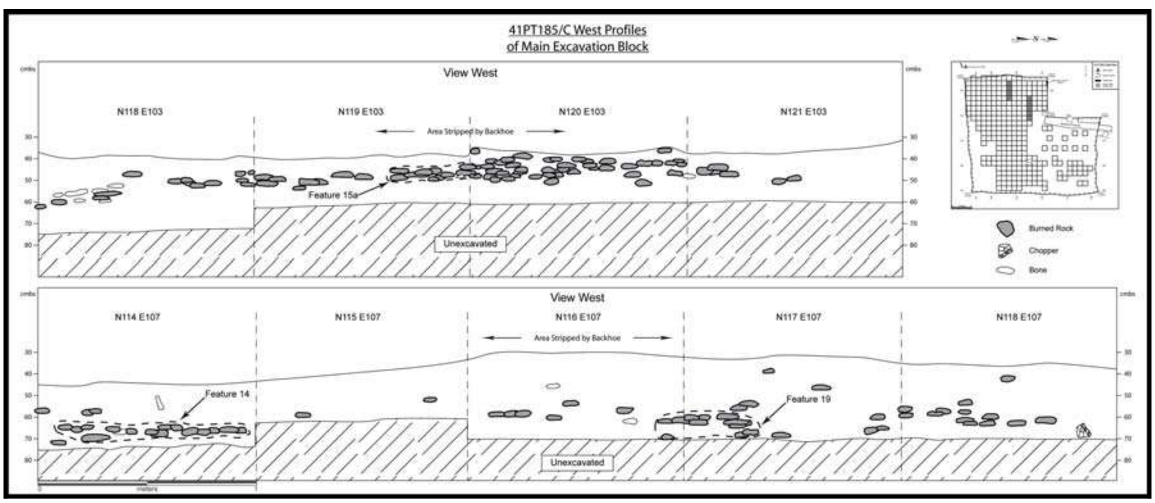


Figure 8-30. Vertical Back Plots of Cultural Materials Plotted In Situ across Four and Five Units in Northern Part of Excavation Block. (Note: view west)

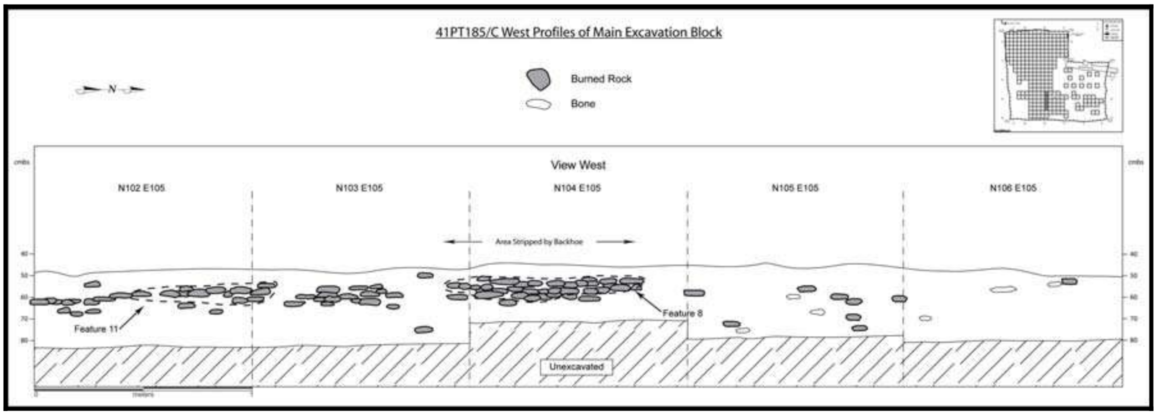


Figure 8-31. Vertical Back Plots of Cultural Materials Plotted In Situ across Four and Five Units in Northern Part of Excavation Block. (Note: view west)

The 14 radiocarbon dates obtained from the block excavations and test units in the immediate vicinity, combined with the 21 recovered Late Archaic projectile points and point fragments, forms the basis for assigning the entire targeted zone to a ca. 1,000 year period between ca. 1560 and 2550 B.P. (Table 8-4). Both radiocarbon dates on charcoal are not accepted at this time. The oldest date of 2850 B.P. (Beta-250878) on a single piece of charcoal is 250 years older than the oldest radiocarbon date on bone. The charcoal was not directly associated with any cluster of burned rocks or in any other type of cultural feature, even though a light scatter of cultural debris was recovered from the same depth (ca. 70 to 80 cmbs).

This dated charcoal, a sizable chunk, was just “floating” in very hard, compact dark brown (10YR 4/3) silty clay near a thin gravelly lens. Based mainly on its divergent age, this sample is rejected at this time. A second charcoal date of 1630 B.P. (Beta-250877) was derived from a single chunk of charcoal, found on the screen, and came from sediments just above Feature 8. Its apparent context from above the burned rocks, combined with its young age, implies that this chunk probably filtered downward and was not directly associated with the burned rocks in Feature 8. This interpretation fits with the obtained age, which is ca. 600 years younger than the four radiocarbon dates on bone from the southern end of the excavation block. The only two radiocarbon dates on charcoal are believed to be both older and younger than the more numerous and clustered bone dates from the southern end.

The 12 bone dates cluster in two well defined groups, with one exception (Figure 8-32). The oldest cluster consists of eight bone dates, four from the southern block, two from the northern end, and one each from the eastern and middle areas. These combined dates indicate an average age of ca. 2361 B.P. These eight dates document minimally one occupation within the Late Archaic component. The three bone and one charcoal date from the northern end of the excavation block indicate a definitely younger Late Archaic occupation with an average age of 1625 B.P. This average of four dates is about 740 years younger than the average of eight bone dates form the southern end.

A single bison bone date of 2010 (Beta-264925) from the northern end falls between

Table 8-4. Fourteen Radiocarbon Dates Derived from Cultural Materials in and Adjacent to Block Excavation at 41PT185/C.

Provenience	Catalog No.	Feature No.	Depth (cmbs)	Material Dated *	Weight of Material (g)	Beta Lab No.	Measured Age	13C/12C Ratio (‰)	Conventional Age (B.P.)	2 Sigma Calibration Age
PT185/C, 119/103	1174- A	15	47	1 bison bone frag	27.0	257845	1290 ± 40	-8.5	1560 ± 40	Cal AD 410 to 590
PT185/C, 115/96	914-2-1a		70-80	1 distal bison radius	14.0	264922	1310 ± 40	-8.9	1570 ± 40	Cal AD 410 to 580
PT185/C, 104/105	FSXX	8	41-50	1 charcoal	0.1	250877	1590 ± 40	-22.4	1630 ± 40	Cal AD 340 to 540
PT185/C, 118/103	FS1322	15	38	1 proximal bison radius	27.0	253240	1500 ± 40	-10.3	1740 ± 40	Cal AD 220 to 400
PT185/C, 120/100	1224-2-1a		52	1 bison distal radius	10.8	264925	1750 ± 40	-9.0	2010 ± 40	Cal 100 BC to AD 70
PT185/C, 120/108	1247-2-1a		40-50	1 proximal metacarpal	15.5	264924	2020 ± 40	-11.4	2240 ± 40	Cal 390 to 200 BC
PT185/C, 104/115	493-002-1	9d	41	bison long bone frag.	33	255837	2010 ± 40	-10.3	2250 ± 40	Cal 400 to 200 BC
PT185/C, BT 35-1	262-002-1		60	1 bison metapodial		237024	2000 ± 40	-8.7	2270 ± 40	Cal 400 to 340 BC
PT185/C, 100/104	279-002-1a		40-50	bison long bone frag.	11.9	255836	2020 ± 40	-7.5	2310 ± 40	Cal 410 to 360 BC
PT185/C, TU 22	210-002-1		70-80	1 bison metacarpal	13	238315	2130 ± 40	-10.9	2360 ± 40	Cal 520 to 380 BC
PT185/C, TU 26	236-002-1		97-102	1 bison radius	15	238316	2160 ± 40	-9.2	2420 ± 40	Cal 750 to 400 BC
PT185/C, 117/95	1027-2-1a	17	95	1 bison skull + horn core	37.3	264923	2250 ± 40	-8.9	2510 ± 40	Cal 790 to 510 BC
PT185/C, 112/104	FS1049		92	distal bison radius	52.0	253239	2270 ± 40	-8.8	2540 ± 40	Cal 800 to 720 BC
PT185/C, 104/101	FS630		76	1 charcoal	0.3	250878	2850 ± 40	-23	2850 ± 40	Cal 1120 to 910 BC
* bone dates were on collagen										

the two clusters of dates. It is not clear if this is an aberrant date or represents another possible occupation with this component. The 12 accepted radiocarbon dates on bison bones indicate that minimally two occupations, and possibly a third, within the excavation block.

During the excavations and stratigraphic assessment of the back plots at least two individual camping events (the main upper and a limited lower) appear presented by the recovered cultural materials. Both represent Late Archaic occupations. In the targeted Late Archaic component or uppermost occupation, stratigraphically between roughly 45 and 60 cmbs, yielded the most abundant cultural material, the majority of the cultural features, and most of the diagnostic projectile points. The lower occupation included a few formal tools and minimally three features (Features 14, 16, and 19) and probably Features 3 and 4. The assignment of the lower occupation to the Late Archaic period is based on the series of eight radiocarbon dates, stratigraphic profiles, artifact back plots, and the dart points recovered. The real possibility for vertical displacement of the smaller lithic items and small bone fragments does not allow specific assignment of all the cultural materials to the two recognized occupations with a high degree of certainty. Therefore, it is not possible to present the cultural materials according to individual occupations. The recovered materials are presented as one Late Archaic component with a time frame that represents no more than ca. 1,000 years. It is understood that minimally two separate occupations are represented within this one relatively thin component.

The overlying deposits that were mechanically removed probably contained widely dispersed Late Prehistoric materials. The 2007 Phase I investigations did not reveal any well defined cultural components above the one documented for the Late Archaic. Only a few scattered pieces of cultural material and no diagnostic artifacts, except for one dart point stem (#204-010), were recovered from the surface to ca. 40 cmbs. Consequently, no more recent component was anticipated or believed to have been present above the target zone. The stripped surface in the northwestern quadrant of the excavation block was left slightly higher than the target zone. In that general area some levels above ca. 40 cmbs

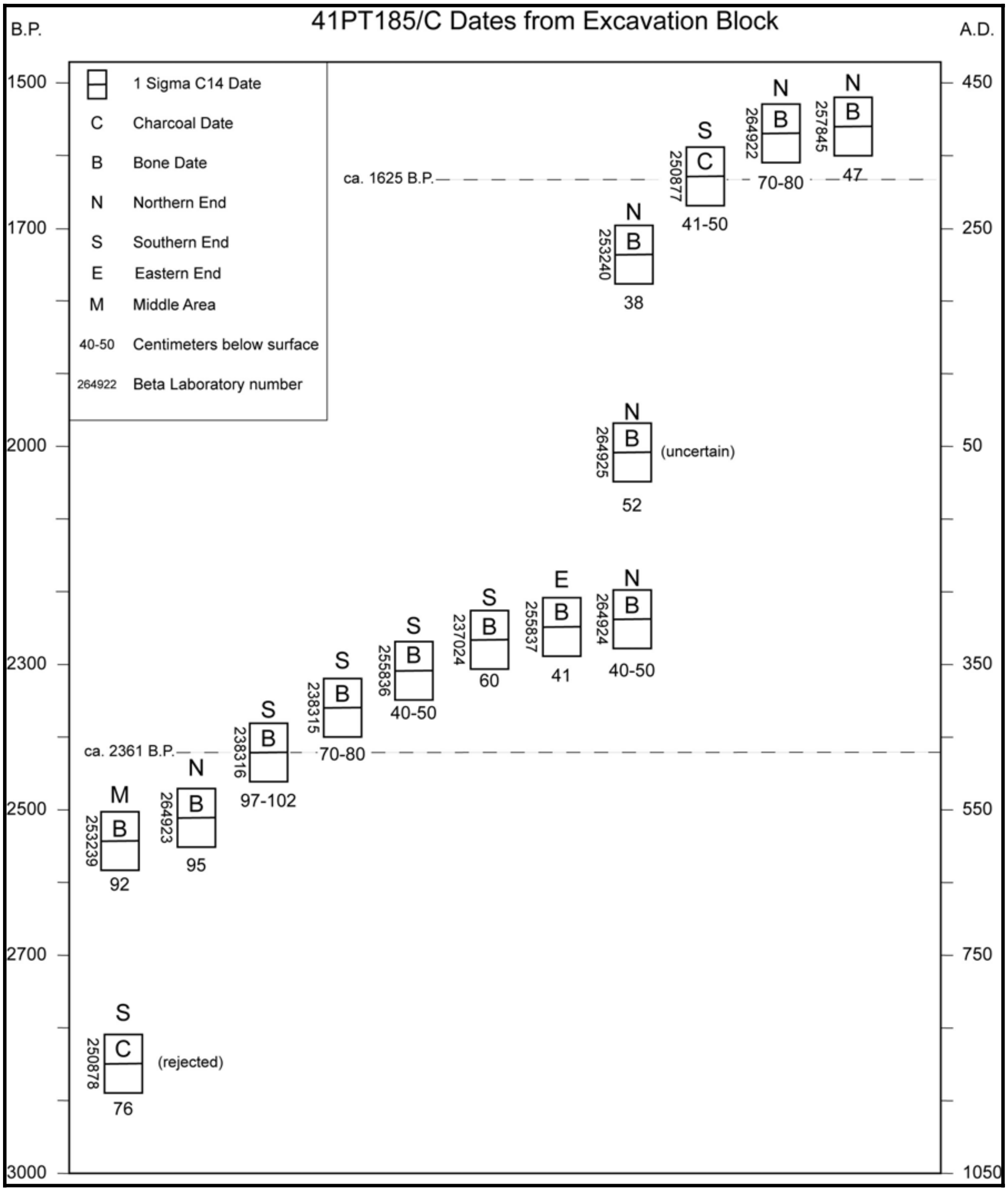


Figure 8-32. Graph of Fourteen Radiocarbon Dates from Excavation Block, 41PT185/C.

were hand excavated in a few units to reach the target zone that stated roughly at ca. 40 cmbs. Two Late Prehistoric arrow points and two tiny (less than 1 cm in diameter) ceramic sherds were recovered above 40 cmbs and above the upper Late Archaic occupation. An additional tiny (less than 1 cm diameter) ceramic sherd was recovered from 50 to 60 cmbs, which was within the Late Archaic component. This latter sherd is considered to be intrusive into the Late Archaic component. No documented cultural features are attributed to the Late Prehistoric period. Therefore, it appears that a few scattered Late Prehistoric materials were present above ca. 40 cmbs and even fewer were minimally represented in the target zone below 40 cmbs. It is possible that a few individual nondiagnostic Late Prehistoric items were displaced downward and became mixed with the Late Archaic materials.

Matrix turbation, primarily the result of rodent and insect activity, was detected in most excavation units. The rodent activity is easily recognized in the lower B and C soil horizons where burrows were filled with the darker A-horizon matrix from higher in the profile. Considerable rodent disturbance was also detected throughout the A horizon where a majority of the cultural material was deposited. Larger pieces of bison bone and burned rocks were probably not vertically displaced to any large degree, even though turbation possibly moved some smaller objects (e.g., lithic debitage and small bone fragments).

The two occupations represented in the Late Archaic component represent a period of time of ca. 1000 years from ca. 1550 to 2550 B.P. with most radiocarbon ages represented by two clusters of dates at ca. 1625 and 2400 B.P. This assignment is based on the 14 current radiocarbon dates and the 21 Late Archaic projectile points. At present, the Late Archaic period has been investigated and reported upon regionally through one or two major excavations and has not been well documented to any great extent across the Texas Panhandle. Therefore, the recovery of these materials and documentation of diverse intact cultural features from this relatively good context provides valuable data to address key research issues concerning human behavior during this period that may be extended to the broader region of the Texas Panhandle.

8.4.3.4 The Late Archaic Cultural Assemblage

Hand excavations yielded a diverse cultural assemblage that included 15 numbered features (Features 3 through 19) with Features 9 and 15 subdivided, i.e., 9a, 9b, 9c, and 9d, chipped stone tools, ground stone tools, faunal remains, bone tools, lithic debitage, charcoal, and quantities of burned rocks. These diverse classes indicate that a broad range of tasks were performed by the site's inhabitants, representative of general hunter-gatherer camp activities. Each class is presented, described and discussed in detail below, beginning with the cultural features.

8.4.3.4.1 Cultural Features

Fifteen features (3 through 19) were identified across this block excavation. Features 1 and 2 were identified and discussed above in Locus A at 41PT185. Features 3 and 4 were partially excavated during Phase I part of this data recovery project. These latter two features were along the northern edge of the subsequent block excavation and definitely part of the Late Archaic component. All features were recognized and assigned numbers in the field. In most instances detailed observations, more through recordings, and additional samples were collected from these feature proveniences than the rest of the excavated units. These features reflect both *in situ* heating/cooking elements and various discarded materials. Based on their size, shape, context, content, and association, each feature is interpreted following their descriptions.

A broad and illdefined area towards the northwestern corner of the expansion block exhibited quantities of lithic debitage and generally lacked concentrations of burned rocks. This area was west of Feature 15, the large burned rock concentrations. The area of concentrated lithic debitage was not assigned a feature number in the field,

Sediment samples were collected from most features. Flotation and/or fine-screening of selected feature sediment was conducted in anticipation of recovering botanical remains associated with these features. The results for flotation and/or fine-screening are presented with each feature.

Various technical studies such as lipid residue and starch grain analyses were pursued on burned rock samples from most features. Technical results are presented with individual features, and additional details on each analysis are presented in appropriate appendices. These analyses aid in determining what plant and animal resources were cooked by these rocks. The accumulated data from each feature provides information on the specific function, foods cooked, processing and cooking technologies, and cleaning activities.

Feature 3

This was a loose cluster of 28 small, fragmented burned rocks encountered between 85 and 93 cmbs in TU 20. This unit was excavated on the safety bench, 5.5 m east of the western end, on the northern side of BT 34 (Figures 8-33 and 8-34). Trench excavation undoubtedly removed an unknown amount of the southern part of this cluster. Therefore, the overall dimensions and the number of burned rocks present are not precisely known. This loose cluster was not well defined, as it lacked an obvious boundary, but exhibited an irregular, somewhat ovate shape with a few rocks displaced outside the main concentration (Figure 8-35), which measured about 85 cm by 60 cm. The rocks were all dolomite pieces between 5 and 15 cm in diameter with more than half less than 9 cm in diameter (Table 8-5). A few exhibited internal cracks. The average rock weight was 616 g.

The hard, grayish brown (10YR 5/2) sandy clay loam that surrounded the rocks lacked visible charcoal, ash, dark staining, or any sign of *in situ* burning. The matrix surrounding the clustered rocks yielded one piece of lithic debitage. To help interpret the function of the rocks and the feature in

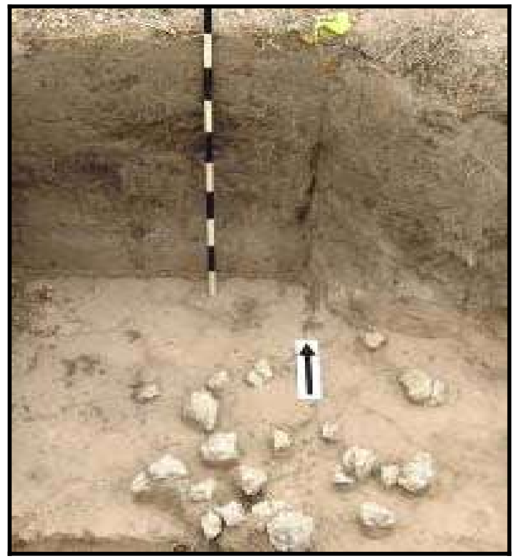


Figure 8-33. Overview of Feature 3 at 90 cmbs in TU 20

Figure 8-34. Close-up of Burned Rocks in Feature 3.

general, selected burned rocks were subjected to lipid residue and starch grainanalyses. Four burned rocks (#198-003-1a, 2a, 3a, and 4a) were sampled for lipid residues. All four burned rocks yielded insufficient lipid residues for identification (Appendix G). Pieces of the same four burned rocks submitted for lipid analyses were sampled for starch grains (#198-003-1b, 2b, 3b, and 4b) and yielded positive results. Sample #198-003-1b yielded plant fibers, starch fragments, and one clearly gelatinized starch grain. The one gelatinized grain indicates that heat and water were present and some starchy grass was cooked using these heated rocks. Samples #198-003-2b and #198-003-3b yielded plant fibers and starch fragments. Sample #198-003-3b also yielded one unidentified and one Pooid grass starch grain together with many plant fibers. Sample #198-003-4b yielded only plant tissues (Appendix F).

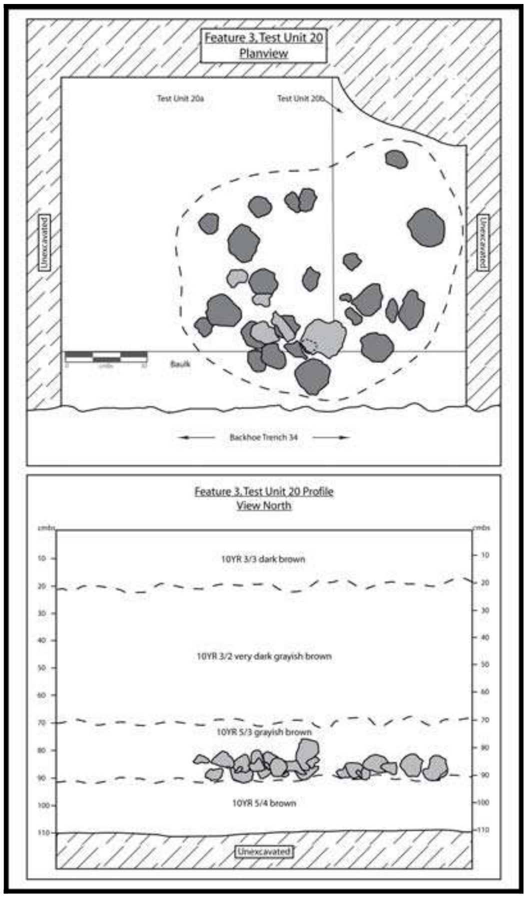


Figure 8-35. Plan and Profile of Feature 3

Bulk sediment (#198-004) from around and below the burned rocks between 80 and 90 cmbs was collected and subsequently floated. The 17.7 liters of floated sediment yielded 221.9 g of material in the heavy fraction. This includes 19 tiny pieces of burned rocks, 10 tiny pieces of lithic debitage, one tiny piece of charcoal, and seven tiny bone fragments. The recovered light fraction (24.1 g) yielded mostly tiny hair rootlets, six tiny unburned black sunflower seeds, but no burned seeds or charcoal (Appendix N).

In summary, the two analyses reveal that only plant products were cooked by heat and water employing heated rocks. The plants included minimally Pooid and likely one other grass type. The insufficient fatty acids may indicate that these rocks were only used a short time, perhaps in one or two cooking episodes, before they were discarded. This short term use may not have allowed sufficient residues to be captured on these rocks or to provide for more positive identifications. This irregularly shaped loosely association of burned rocks is interpreted to represent a discard locality of unwanted or exhausted burned rocks, used to cook plant products.

Feature 4

Feature 4 was first observed at roughly 100 cmbs in the southern wall of BT 34, about 4 m from the eastern end. Four large burned rocks were tightly clustered in the wall with extensive rodent activity around the exposed rocks. This cluster of four rocks was isolated from other rocks and appeared to represent an *in situ* cultural feature. Feature 4 was roughly 6.5 m east of Feature 3 towards the creek, and appeared in the same depositional deposit, although Feature 4 is slightly lower in the profile.

Subsequently, TU 23, a 1 by 1 m unit, separated from BT 34 by a 20 cm balk, was hand excavated over this burned rock cluster. Test Unit 23 was hand excavated from the surface to 120 cmbs. At roughly 85 cmbs the tops of many, relatively large, burned rocks were exposed over most of the northwestern quadrant of TU 23.

Following hand excavation of two additional 10 cm levels, a tight cluster of 69 mostly large burned rocks that weighed 48.8 kg was uncovered (Table 8-5). These rocks were clustered over an area nearly 1 m north to south by at least 65 cm east to west between

95 and 108 cmbs (Figures 8-36 through 8-38). The western edge of Feature 4 extended beyond the margin of TU 23. The northern side of the feature was probably removed during trench excavation.

Figure 8-36. Overhead View of Heating Element Feature 4, at 100 cmbs in TU 23.

Figure 8-37. Obtuse Angle Close-up of Feature 4 that Shows Size, Shape, and Type of Burned Rocks Employed in this *In Situ* Cooking Heating Element.

The overall dimensions and number of burned rocks originally present are unknown, so the original size of the feature is estimated to have been about 1 m in diameter. The light grayish brown (10YR 5/2) silty loam matrix surrounded the burned rocks lacked visible charcoal, ash, oxidized matrix, or bones, and exhibited no sign of a prepared pit. Towards the middle of the cluster, a few smaller rocks or fragments from the larger rocks were slightly below the larger pieces, hinting that a shallow basin was present. Just below the burned rocks the sediment changes to a pale brown (10YR 6/3) clayey sand.

Rodent activity was observed above and along the margin of this cluster, with many tiny hair-like roots throughout the rocks. A phytolith sample was collected from under one of the burned rocks along the western wall. A small matrix sample was collected at the very bottom of the lowest rocks near what was thought to be the center of the feature. The rocks were counted and weighed by size class (Table 8-5) with a sample retained and the rest discarded. The massive size of many of the rocks set Feature 4 apart from most other identified burned rock clusters. The average burned rock weight was 707 g, with many of the smaller pieces probably chunks from the larger pieces. One small piece of chert debitage was discovered in between the burned rocks.

Lipid and starch analyses were conducted on four selected burned rocks (#214-003-1, 2, 3, and 4) from Feature 4. The four burned rocks analyzed for starch grains (#214-003-1b, 2b, 3b, and 4b) all yielded starch fragments (Appendix F). Samples #214-003-1b and 2b yielded starch fragments and gelatinized starch grains. Sample #214-003-3b yielded charcoal, starch fragments, with minimally two starch grains identified as wildrye (*Elymus* sp.) grass. Sample #214-003-4b yielded no identifiable grains (Appendix F).

Lipid residue analysis resulted in positive results from two of the four burned rocks. Two rocks did not yield sufficient lipids for interpretation. Sample #214-003-1a yielded fatty acids that are similar to high fat content of some plants, and may also represent traces of animal products. Sample #214-003-4a yielded fatty acids that indicate high

Table 8-5. Burned Rock Counts and Weights within Identified Cultural Features at 41PT185/C.

Feature No.	Unit N E	Depth (cmbs)	Catalog No.	Total Count	Total Weight (g)	Burned Rock Size Categories							
						0 to 4 cm, Count	0 to 4 cm, Weight (g)	4.1 to 9.0 cm, Count	4.1 to 9.0 cm, Weight (g)	9.1 to 15.0 cm, Count	9.1 to 15.0 cm, Weight (g)	>15.0 cm, Count	> 15.0 cm, Weight (g)
3	TU 20	85-93	198-003	28	17250			19	3000	9	1450		
4	TU 23	95-108	213, 214-003	69	48800	11	300	24	3500	21	11000	13	34000
5	110 105	51-58	1348-003	14	2189	5	189	6	1000	3	1000		
6	113 106	43-53	854-003	13	8805	1	55	4	500	6	2500	2	5750
8	104 104	50-68	465, 468-003	22	7600								
	104 105	50-63	471, 1341-003	48	12183								
9a	104 118	62-73	508-003	16	6532			6	1500	9	4500	1	532
9b	105 117	48-60	1339, 1340-003	15	2144*								
	104 117	50-60	564-003	62	11845	36	95	15	2000	5	3000	6	6750
	104 117	40-50	501-003	23	6001	3	21	16	1844	2	636	2	3500
9c	104 116	40-50	1343-003	4	593			4	593				
	103 117	44-50	445, 444-003	22	3299	5	79	14	2130	3	1040		
	103 117	50-60	446, 1332-003	19	1909	12	95	4	1650	3	1164		
	104 117	40-50	502-003	9	713	3	21	6	292				
9d	103 115	39-50	1330-003	21	1902	12	52	9	1850				
	103 116	37-41	1331-003	22	3174	13	33	5	828	4	2343		
	104 116	40-50	1337, 1338-003	45	13582	8	66	17	2516	18	8000	2	3000
11	102 104	50-66	355, 1342-003	23	6709*								
	102 105	45-65	359, 361, 363-003	19	3951*								
	103 104	54-66	406, 408, 1328-003	21	5964*								
	103 105	53-57	413, 415-003	3	1219*								
12	114 105	32-50	896-003	15	5404	3	37	4	618	8	4750		
	114 106	40-50	901-003	44	14750	10	500	10	2250	21	9000	3	3000
14	114 107	61-67	907-003	19	6741	1	19	13	1355	4	2368	1	3000
15a	119 103	38-50	11675-003	19	7774	3	342	10	1860	4	2572	2	3000
	120 103	42-51	1234-003	13	1956	2	156	9	1000	2	800		
15b	118 104	40-50	1119-003	15	4112	3	182	9	2805	3	1125		
	119 104	40-50	1181-003	51	11806	2	56	38	7000	11	4250		
	119 105	40-50	1184-002	5	2061			2	668	3	1393		
15c	118 106	40-50	1131-003	3	509			2	187	1	322		
	118 105	40-50	1127-003	4	425	2	50	2	375				
	119 105	40-50		9	2340	3	75	4	1336	2	929		
	119 106	44-52	1192-003	43	12006	4	46	22	4210	15	6000	2	1750
15d	121 106	50-56	1295-003	14	4000			8	1750	6	2250		
16	114 99	68-78	875-002	21	16750			7	3500	12	9750	2	3500
18	118 105	50-60	1129-003	8	2889			4	932	4	1957		
	118 105	40-50	1352-003	2	475			2	475				
19	116,117 107	60-70	1070-003	14	4500	2	250	6	1500	6	2750		
				817	244875	144	2719	301	55024	185	86849	36	67782
* = estimated weights using average weights by size class													

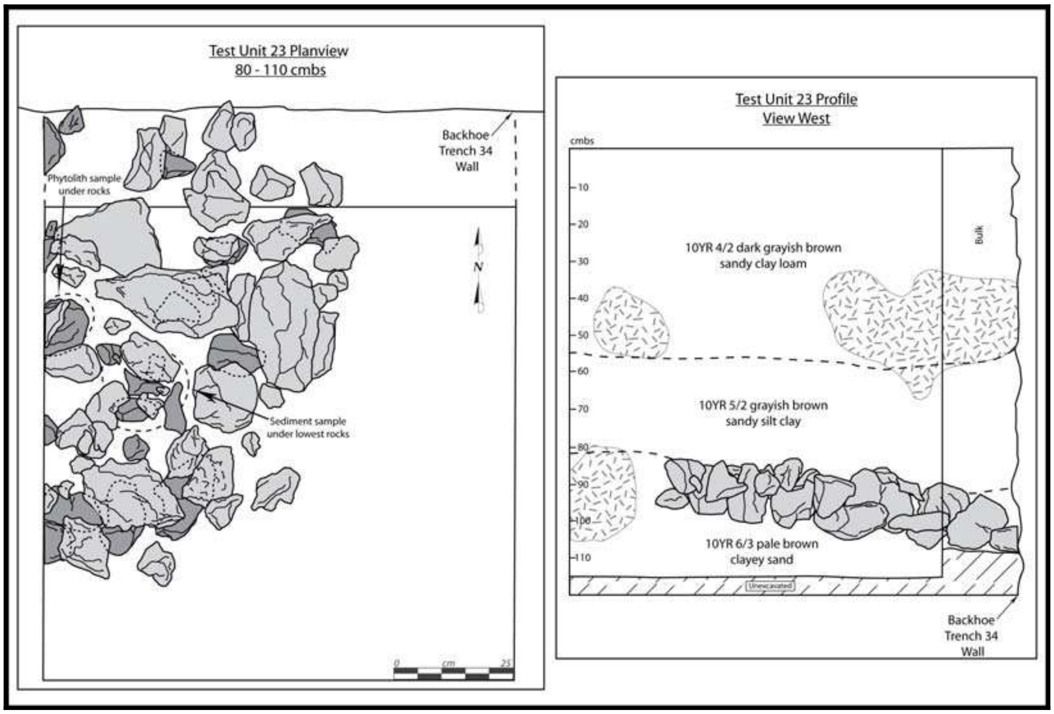


Figure 8-38. Drawing of Plan View (left) and Profile (right) of Feature 4.

plant fat contents, as from nuts or seeds (Appendix G).

A bulk sediment sample (#213-004, of 9.9-liters) was collected from between 90 and 100 cmbs around the burned rocks in the northern half of Feature 4, for mechanical flotation in the laboratory. The heavy fraction (549.9 g) yielded 78 tiny burned rock fragments, one tiny lithic debitage, three tiny bone fragments, two tiny charcoal pieces, two burned hackberry seeds, and 35 tiny black unburned sunflower seeds. The light fraction (15.1 g) yielded a moderate quantity of black, unburned black seeds from a sunflower, but no charcoal.

The presence of gelatinized starch grains, which occur in the presence of heat and water, indicate that these burned rocks and this feature was used for cooking. The large size of the rocks and the tight clustering indicate this cooking feature was intact and *in situ*. The starch grain and lipid residues make it clear that wildrye grass seeds with some fatty substance were cooked. The two burned hackberry seeds in the associated matrix are not considered a food resource, but more than likely became incidentally burned in the heating and/or cooking process. The lack of charcoal indicates that preservation is poor and that wood charcoal used as the fuel source for the heat has eroded away. The one small chert flake and tiny bone fragments, plus the tight clustering of the rocks, testify to the cultural nature of this feature, though small amounts of extraneous cultural debris became mixed into the matrix.

Feature 5

This feature was identified at a depth of 50 to 60 cmbs in N110 E105 and appeared to be associated with the upper occupation in the Late Archaic component. The feature contents included a variety of cultural materials that one would expect from across an occupation surface (Figure 8-39). Observed items include burned rocks, butchered bones (#1348-002), a few other bone fragments, a couple of pieces of lithic debitage (#1348-001), tiny reddish flecks of clay, and one basal stem of a dart point (#1348-10). These items appeared clustered across the western half of this unit with only a couple of items found on the eastern side. The feature had no obvious boundary but, rather, just a very irregular arbitrary outline. This material cluster measured about 80 cm north to south by some 60 cm east to west, and probably continued west and south into the adjacent units. This cluster was cross sectioned twice under the burned rocks. No visible sign of charcoal staining or a pit outline was observed. Most items were within 3 to 4 cm in elevation of each other, as if reflecting one occupation surface or one event.

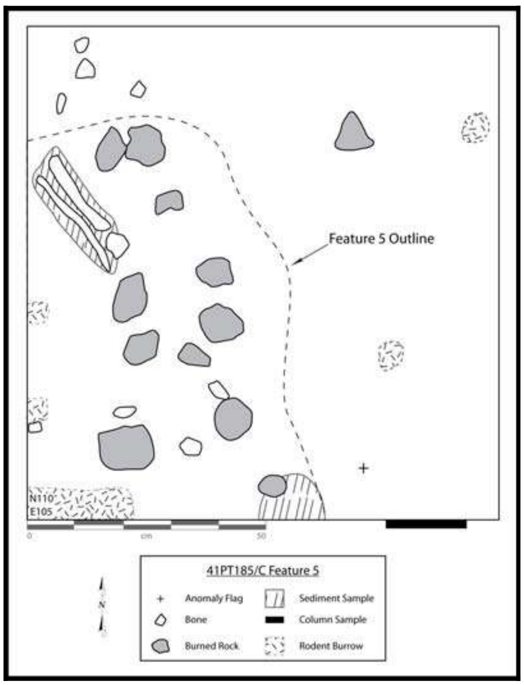


Figure 8-39. Plan Map of Feature 5 that Shows Distribution of Cultural Debris.

The 14 burned rocks recovered included both quartzite and dolomite pieces of relatively small size, with the average weight of 156 g (Table 8-5). None of the bones were burned and only a few pieces exhibit attributes that allow for taxon identification. Two major sections of bison long bone fragments, a pelvis fragment, and other unidentifiable bone fragments were present. Several small sediment samples were collected from various spots inside the cluster, two from under burned rocks, one under the long bone fragments, one about three liters in size from the southern half, and one from outside the feature for comparative purposes). One tiny chert thinning flake was recovered from next to a small bone fragment. The base of the dart point is similar in general outline to other dart point fragments from this Late Archaic component.

Two burned rocks, #1348-003-1a and #1348-003-2a, were sent to Dr. Malainey for lipid residue analysis. Sample #1348-003-2a yielded very-high-fat-content residues of plants such as seeds/nuts (Appendix G). Burned rock #1348-003-1a yielded insufficient fatty acids for identification, but the lipid biomarker azelaic acid was detected, indicating the presence seed oils. Also dehydroabietic acid was detected, which indicates that conifer products (likely juniper), are represented. The conifer product probably was introduced from resin in firewood (Appendix G).

Pieces of these same two burned rocks (#1348-003-1b and #1348-003-2b) were sent to Dr. Perry for starch grain analysis. Sample #1348-003-1b yielded only gelatinized starch grains, whereas sample #1348-003-2b yielded five lenticular starch grains common to Canadian wildrye (*Elymus canadensis*) grass (Appendix F).

One 1.85 liter sediment sample (#1348-004) from 54 to 58 cmbs on the southern side of N110 E105 was floated. The heavy fraction (32.5 g) yielded nine bone fragments, four of which are burned, one burned rock fragment, one tiny charcoal chunk, and one piece of lithic debitage. The light fraction (3.0 g) yielded no obvious burned seeds or charcoal.

The diverse classes of cultural debris (bones, burned rocks, debitage, and broken stone tools), reflect the discard of accumulated trash. The tight nature of these clustered materials supports the idea that these items arrived at this spot more or less simultaneously. If so, then this cluster of different materials is a secondary deposit that resulted from other cleaning activities and is a secondary discard pile.

Feature 6

This was a small cluster of burned rocks discovered between 43 and 56 cmbs along the boundary of two units, N112 E106 and N113 E106 (Figure 8-40). The cluster consisted of 13 burned rock fragments (#854-003) that included three different rock types of caliche/dolomite, two Potter chert pieces, and one quartzite piece. The quartzite piece exhibits very angular and hackled edges indicative of breakage by quick change from heat to cold. The rocks showed considerable variation in size. The cluster exhibited no obvious boundary line or sediment staining that would indicate a pit/basin, no charcoal or ash, nor any oxidized matrix. The rocks rested within an elongated oval area that measured 70 cm east-west by 40 cm north to south. A total of 13 various size burned rocks were present (Table 8-5). The average rock weight was 677 g. These burned rocks were isolated from other cultural materials around them. After they were weighed and measured, most rocks were discarded, whereas a few were retained for further analysis.

The surrounding matrix was a very dark grayish brown (10YR 3/2) silty loam. Only one chert flake and one tiny bone fragment were recovered from immediately around the burned rocks. The sediment (#854-004) from around and under the rocks was collected. An unfused bison distal radius was found about 20 cm north of the margin of the burned rocks. Eleven pieces of lithic debitage were recovered from the northern and southern sides of the burned rocks.

Two burned rock pieces #854-003-1a and #854-003-2a were sent to Dr. Malainey for lipid residue analysis. Both pieces yielded very high fat content of plant indicative of seeds/nuts. Sample #854-003-2a also exhibited dehydroabietic acid, which indicates that conifer products (likely juniper) were present. The conifer product was probably introduced from firewood, resins, or other products (Appendix G).

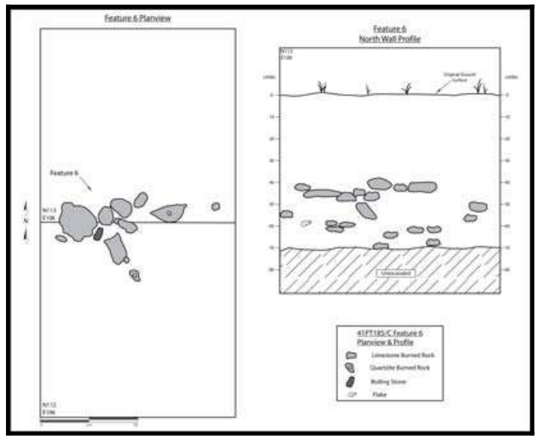


Figure 8-40. Plan Map and Profile of Feature 6.

Pieces of these same two burned rocks (#854-003-1b and #854-003-2b) were sent to Dr. Perry for starch grain analysis. Sample #854-003-1b yielded gelatinized starch. Sample #854-003-2b yielded one lenticular starch grain common to Canadian wildrye grass (*Elymus canadensis*; Appendix F).

A 2.7 liter matrix sample (#808-004) from 40 to 50 cmbs in N112 E106 was collected and floated. The heavy fraction (46.0 g) yielded 11 tiny bone fragments, three of which are burned, six tiny burned rock fragments, two tiny charcoal chunks, one piece of burned seed, and one tiny chert flake. The light fraction (3.7 g) yielded no detectable charcoal or burned seeds. A second sample (#854-004) of 2.1 liters from 40 to 50 cmbs in N113 E106 was also floated. The heavy fraction (44.3 g) from this sample yielded 11 tiny bone fragments (five burned bones), three tiny chert pieces, one tiny burned rock fragment, one tiny charcoal chunk, one burned hackberry seeds, and one unidentified burned seed. The light fraction (2.8) yielded some unburned black sunflower seeds, but no charcoal. One tiny bone fragment was observed.

The clustered materials were comprised mostly of burned rocks of different lithic types. Considering the lack of staining, charcoal, ash, or other evidence of *in situ* burning, this cluster is interpreted as a discard pile or dump of unwanted burned rocks. The rocks apparently were heated by wood, most likely juniper, to allow the transfer of heat to the foods. The quartzite rock with very hackled edges is indicative of rock contraction during cooling generally associated with stone boiling. These types of breakage patterns result from the rapid heat exchange as the hot rock goes into the cooler water (Jackson 1998). The residues extracted from the burned rocks reveals that these rocks were used for cooking starchy foods. Specifically, those foods include grass seeds with very high fat content indicative of seeds/nuts. This cluster appeared associated with the upper Late Archaic occupation.

Feature 7

This was a small, circular, light brown stain within a very dark grayish brown (10YR 3/2) silty loam about 40 to 50 cm north of Feature 6 burned rocks. This circular stain measured about 14 to 15 cm in diameter and appeared on the floor of the level at 33 cmbs in N113 E106. This light brown (7.5YR 6/4) silty loam was cross sectioned and appeared to run vertically for about 10 cm, then it changed directions and curved to one side. The loose fill within this stain was carefully examined in the field and no cultural materials were detected. Following hand excavation; the shape, orientation of the hole, and the loose nature of the fill led to the conclusion this was a rodent burrow. No further analyses were undertaken and no samples were collected.

Feature 8

Feature 8 was a tight cluster of burned rocks on the boundary between two units. The western side was in N104 E104 whereas the eastern side was in N104 E105, between 50 and 63 cmbs (Figures 8-41 and 8-42). The tops of the burned rocks that proved to be part of Feature 8 and those immediately outside the feature were encountered near the base of level 5, at roughly 45 to 48 cmbs. The feature rocks formed a well-defined, tight cluster that measured 80 cm in diameter and was about 13 cm thick in the middle. The 70 burned rocks were comprised mostly of dolomite (ca. 80 percent), but quartzite pieces (ca. 20 percent) were also present. These rocks varied in size from ca. 7 to 17 cm (see Table 8-5).

Figure 8-41. Close-up of the Top of Feature 8 that Shows Rock Positions, Shapes, and Types.

Two layers of burned rocks were detected, with the second layer toward the middle of the concentration and consisted of roughly 17 burned rocks. The burned rocks in the

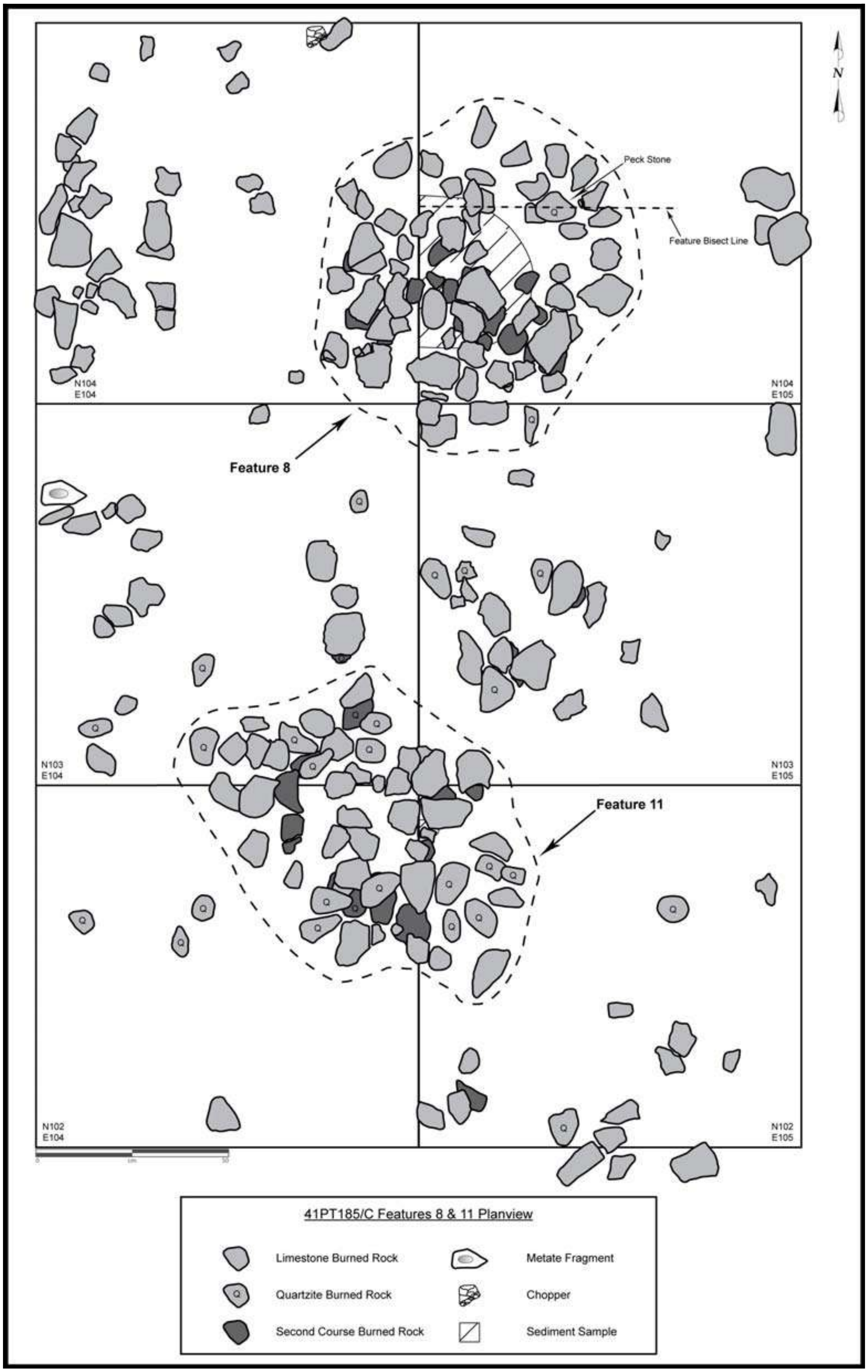


Figure 8-42. Overview of Associated Features 8 and 11 and Scattered Burned Rocks Around Features.

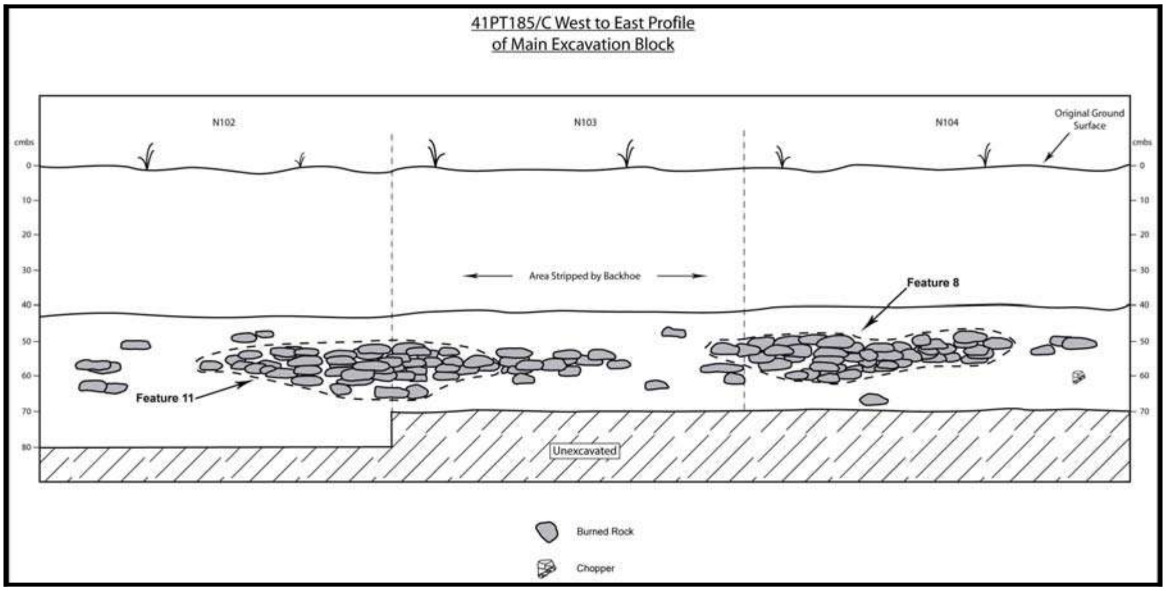


Figure 8-43. Profile of Burned Rock in Six Units the Encompass Features 8 and 11.

with gently sloping sides (Figure 8-43). Following the mapping and documentation of rock depths, the rocks were weighed and counted by material type rather than by size categories as in the other features. A small sample of burned rocks was retained for future analysis and the rest were discarded. The total weight of the rocks was roughly 19,783 g for an average rock weight of 283 g.

These burned rocks were in a very dark grayish brown (10YR 3/2) silty loam A horizon. Tiny grass rootlets and insect holes were observed around the rocks, but no obvious rodent holes were detected. No charcoal staining, ash, chunks of charcoal, or oxidized sediments were observed around or below the rocks. A couple of tiny pieces of charcoal were observed and collected from near the tops of the rocks. One tiny charcoal chunk (41PT185/C, FSXX) from screened sediment from between 41 to 50 cmbs and just above the rocks was radiocarbon dated. This piece yielded a $\delta^{13}C$ adjusted radiocarbon age of 1630 ± 40 B.P. (Beta-250877). During excavation around the burned rocks no other classes of cultural materials were encountered.

One complete quartzite cobble (#1341-010) near the top of the cluster in N104 E105 at 53 cmbs appears to bear a few tiny peck marks and probably functioned as a grinding stone/mano (see complete mano description below). Four sediment samples (#1341-004) were collected, three from below individually selected burned rocks and a relatively large sample from near the center of the lowest part of the feature at 66 to 68 cmbs. Only a very few pieces of lithic debitage (*N* = 3) and a few tiny bone fragments (*N* = 13) were recovered from the remaining parts of the two units that contained Feature 8. No tools other than one apparent mano were within or immediately around the margins of Feature 8. In the western side of N104 E104, opposite the Feature 8 cluster, were more loosely concentrated burned rocks (Figure 8-42). These initially appeared to represent another cluster, but further excavations yielded no formal feature, but merely a loose concentration of burned rocks in no apparent pattern. A nearly 40 cm wide space devoid of any materials was found between the loose concentration on the west and the western edge of Feature 8. The two units to the immediate south also yielded additional scattered burned rocks, with the northern edge of Feature 11 80 cm south of the southern edge of Feature 8 (Figure 8-42).

To determine what was processed and/or cooked with these burned rocks, some were sent for lipid residue and starch grain analyses. Parts of five burned rocks (#464-003-1a, #464-003-2a, #474-003-1a, #1341-003-1a, and #1341-003-2a) were sent to Dr. Malainey for lipid residue analysis. Samples #464-003-1a and #1341-003-2a yielded very high fact residues that likely represent seeds or nut. Sample #1341-003-1a also yielded a trace of animal fat. Sample #464-003-1a produced conifer residue. Sample #474-003-1a had high fat content of plant (seeds/nuts) with conifer residue present, as well. Sample #464-003-2a did not yield sufficient residues for interpretations, although it did yield azelaic acid, which is associated with unsaturated fatty acids as are most abundant in seed oils. The results indicate that plant seeds or nuts were cooked by these rocks (Appendix G).

Pieces of the same four burned rocks (#464-003-1b, #474-003-1b, #1341-003-2b, and #1341-003-3b) were sent to Dr. Perry for starch grain analysis. Burned rocks #474-003-1b and #1341-003-2b did not yielded any starch remains. Burned rock #1341-003-3b yielded a single lenticular starch grain common to Canadian wildrye grass seeds, at least one damaged starch grain, and one grain that may be gelatinized. Burned rock #464-003-1b yielded damaged starch, two lenticular grains, and a single starch grain from an unknown grass (Appendix F). A sediment sample (#1341-004-1b) from under one burned rock was analyzed for starch grains, but none were discovered. The absence of starch grains in the soil indicates that the starch grains discovered on the burned rocks and other artifacts did not come from the surrounding matrix. The starch grains must have come from use of the rocks in cooking starchy plant products.

A 5.2 liter sediment sample (#1341-004) from 56 to 61 cmbs was collected from around and below the burned rocks within the well defined limits of the feature. This sample was floated and yielded a heavy and a light fraction. The heavy fraction weighed 62.8 g and consisted of 22 tiny burned rock fragments (dolomite and quartzite), 17 bone fragments, and eight tiny chert flakes. No charcoal or burned seeds were recovered in the heavy fraction. A few of the tiny bone fragments were burned. The light fraction (8.8 g) included 26 to 50 tiny rootlets, six uncharred cheno-am seeds, 12 black unburned sunflower seeds, and tiny pieces of mesquite wood charcoal (Appendix N).

A second sediment sample (#471-004) of 2.0 liters from 41 to 50 cmbs and under the burned rocks in N104 E105 was collected and then floated. The heavy fraction (19.2 g) yielded seven tiny bone fragments, and five tiny fragments of burned rock, one unburned sunflower seed, but no charcoal. The light fraction (1.8 g) yielded no identifiable plant parts (Appendix N).

The well defined and tightly clustered burned rocks of Feature 8, the overall circular shape, and a possible shallow basin formed by the lower burned rocks document an *in situ* heating element with scattered burned rocks in the immediate vicinity. The residues from analyzed burned rocks indicate that these rocks were likely heated with juniper and mesquite wood. The rocks were then used to cook grass seeds combined and meat (based on a trace of animal fats residue).

Feature 9

Feature 9 was in the southeastern corner of the excavation block. During the mechanical stripping with the backhoe many pieces of burned dolomite were observed on the stripped surface, but no clear pattern of distribution was observable. As hand-excavations began in that area, the broad concentration of burned rocks was assigned feature number 9. As excavation proceeded, discrete clusters of burned rocks began to be uncovered and recognized, and each discrete cluster was assigned a letter designation (a, b, c, and d). Each of the four clusters of burned rock (Features 9a, 9b, 9c, and 9d) is described and discussed separately below (Figure 8-44). The units containing Feature 9 were excavated early on, but once the four clusters were exposed, they were left *in situ* for viewing by individuals and groups who visited the excavations.

Feature 9a

This feature was a more or less single row of burned rocks that formed a partial circle/arc on the very eastern edge of the broader cluster in N104 E118 and E119 (Figure 8-45). Twenty burned rocks were mostly side-by-side forming two arcs as parts of an apparent circle with a diameter of about 70 cm. The northwestern arc consisted of nine rocks, whereas the southeastern arc consisted of 11 rocks. The rocks, all dolomite pieces between 6 and 14 cm in diameter, were mostly angular fragments. The average rock weight was 326 g (see Table 8-5). No soil staining, charcoal, ash, or other signs of *in situ* heating were observed around or below the rocks. The burned rocks were in a dark brown (7.5YR 4/4) sandy loam. A slight slope to the depths of the rocks was detected with the rocks on the northern side a few centimeters higher than those on the southern side, with a second slight slope down to the east as well.

In general, the rock depths varied from 58 to 72 cmbs with the lowest ones to the southeast. Even though some rodent holes were in the immediate area, no obvious disturbance to the rocks was detected, other than they formed only part of a circle. This indicates that some pieces in the original layout had probably been displaced. No chert debitage or chunks of bone were in either of the two units at this level. A few other burned rocks were scattered outside these two arcs. Geophysical anomaly #18 appears to have detected Feature 9a as it was centered on the eastern edge of these burned rocks (see Figure 8-44).

No burned rocks or sediments samples from Feature 9a were selected for further analysis. The partial circular arc indicates an intentional construction. However, the lack of analysis and the absence of other signs of use make interpretations difficult. The burned rocks potentially encircled an area that contained a small fire, but the lack of charcoal, ash or other signs of *in situ* heating does not support that interpretation. These burned rocks possibly were just scattered from the adjacent features, but again the patterning of the rocks indicates intentional placement and the likelihood of a containment circle. Feature 9a function is not clear, but appears to be *in situ*.

Feature 9b

Feature 9b was roughly 40 cm to the northwest of Feature 9a. It consisted of a elongated, tight cluster of burned rocks (#501-003) in the northern side of N104 E117 and the southern part of N105 E117 (see Figure 8-45). The cluster measured 105 cm along the long axis and roughly 50 cm across the short axis. Rock depths varied from roughly 32 cmbs at the very northwestern end to 59 cmbs at the very southeastern end, in what appeared two layers of rocks. The rock depths document that this cluster slopes down to the southeast from the highest part in the northwest (Figure 8-46). The slope is towards Feature 9a. Three different rocks types were represented with at least one large quartzite piece (14 cm in diameter), some smaller caliche chunks, but mostly irregular dolomite pieces. Minimally 100 burned rocks (total weight of 17,846 g) included 39 small pieces 0 to 4 cm (weighing 116 g), 31 pieces 4 to 9 cm in diameter (3,844 g), seven pieces 9 to 15 cm diameter (3,636 g), and eight pieces greater than 15 cm in diameter (10,250 g) for an average rock weight of 179 g (see Table 8-5). The layers of rock were not neatly stacked, but appeared in a jumbled condition. These rocks were mostly complete, though a few were fragmentary, and some were cracked *in situ*. Eight rocks were randomly selected and collected. The matrix that surrounded the rocks was a dark brown (10YR 3/3) sandy loam.

A small bone fragment and minimally two lithic flakes (one Alibates and one siltstone) were amongst the burned rocks on the southern side. The bone is an unfused bison phalanx from just on top of the rocks at 43 cmbs. Tiny flecks of charcoal were observed under a few of the rocks and small matrix sample (#501-004) and charcoal stained sediment (#501-007) from under selected rocks were collected. The small charcoal sample (#501-007) included eight tiny mesquite wood fragments (Appendix N). A large Alibates flake (#564-001), a tiny chunk of charcoal (#564-007), and three small Alibates flakes (#564-001) were just north of Feature 9b burned rocks between 50 and 60 cmbs in N105 E117.

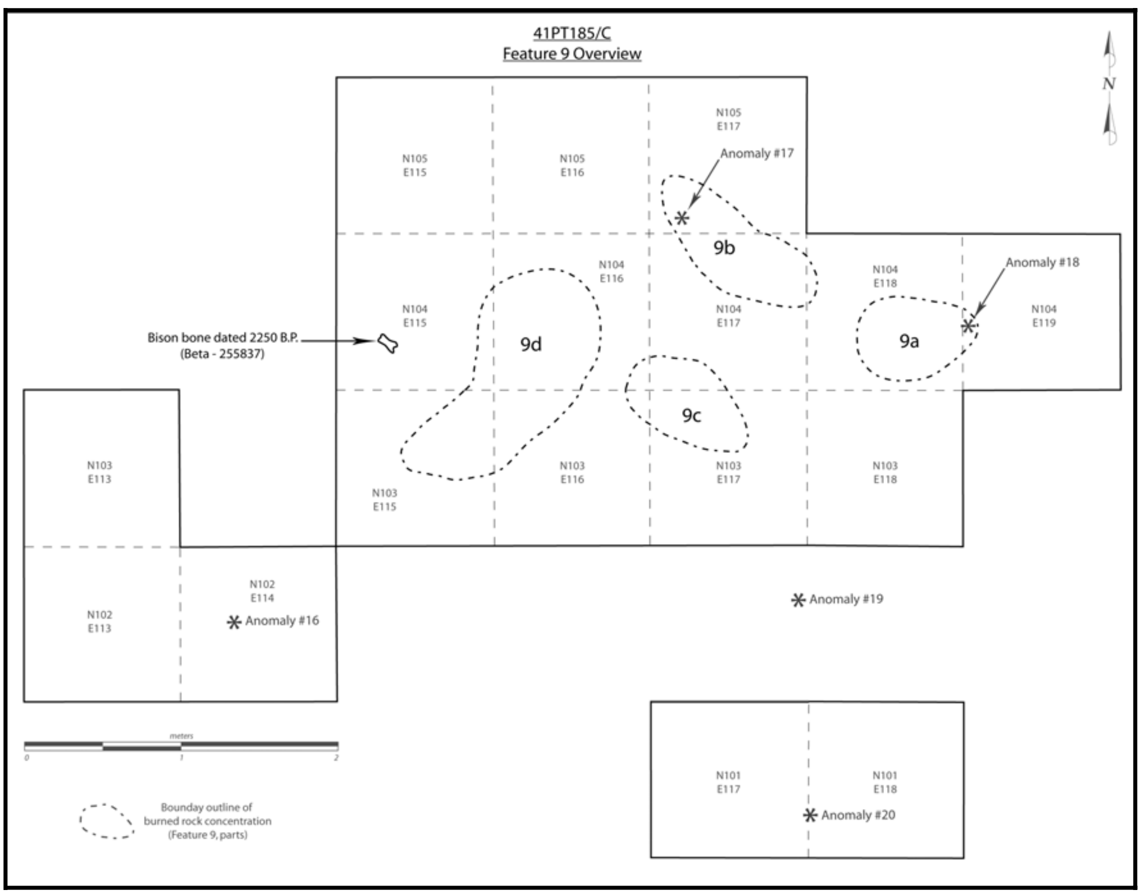


Figure 8-44. Horizontal Associations of Features 9a, 9b, 9c, and 9d in Southern Corner of Excavation block.

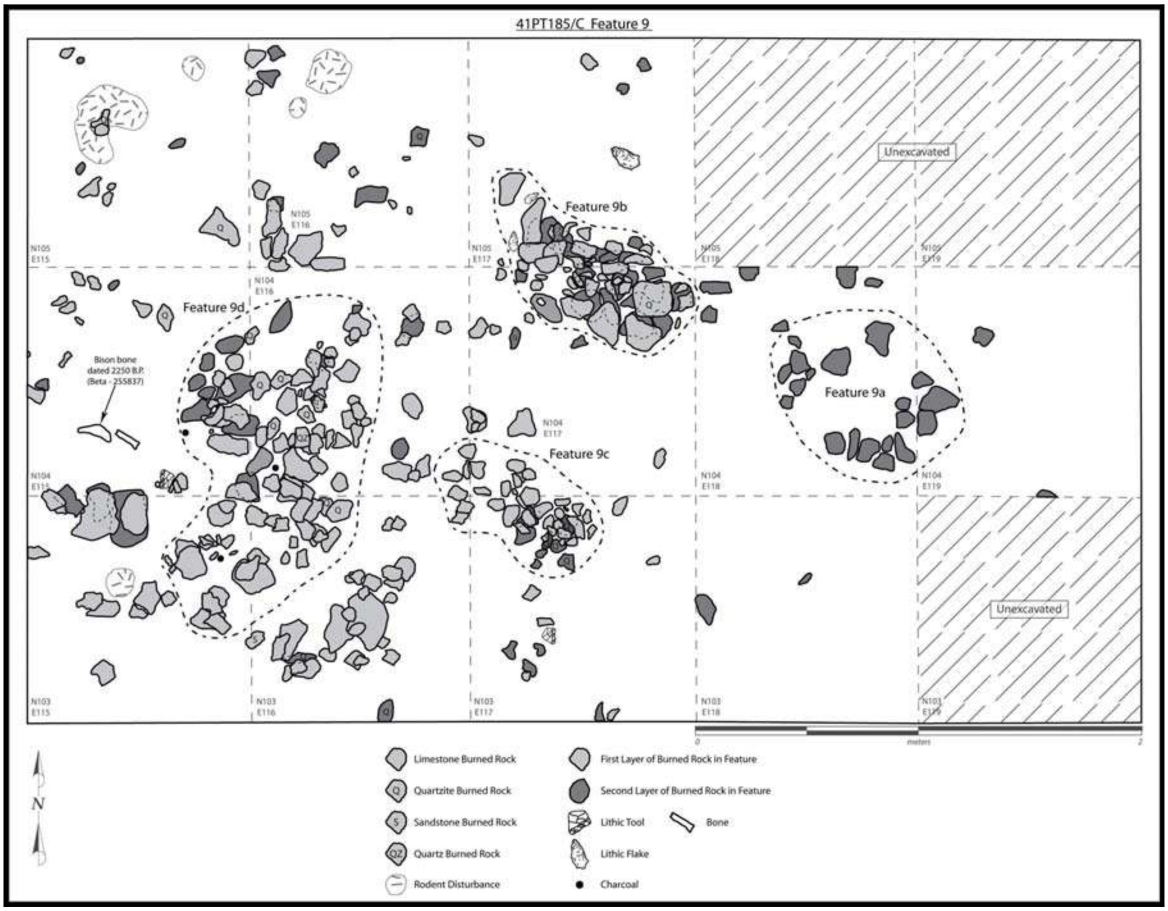


Figure 8-45. Detailed Plan Map that Exhibits Burned Rock Distributions in and Around Features 9a, 9b, 9c, and 9d.

Four burned rocks (#504-003-3a, #504-003-4a, #1340-003-1a and #1340-003-2a) were sent to Dr. Malainey for lipid residue analysis. All four samples yielded very similar results with high to very high fat content of plant seeds/nuts dominating, with trace amounts of animal lipids. Sample #504-003-3a also yielded residue of conifer (Appendix G). A piece of the same burned rock (#1340-003-2b) was sent to Dr. Perry for starch grain analysis. This piece yielded clearly gelatinized starch grains (Appendix F).

The overall elongated oval shape, with tightly clustered rocks in a couple of layers, has the appearance of a tossed discard pile. The apparent absence of charcoal concentrations, stained or oxidized sediment, combined with the slope of the rocks, indicates this was not the location of an in situ heating element. Feature 9b is interpreted as a toss or dump of discarded burned rocks that had been used a limited number of times. The rocks were probably heated using juniper wood as a fuel, judging by the presence of conifer residue. Once the rocks were heated, they were then used to cook very high fat content plant seed/nut (grass seeds most likely) with trace amounts of animal products. Because the rocks were not all broken up and lacked fractures, it is assumed they were used only a few times, at most.

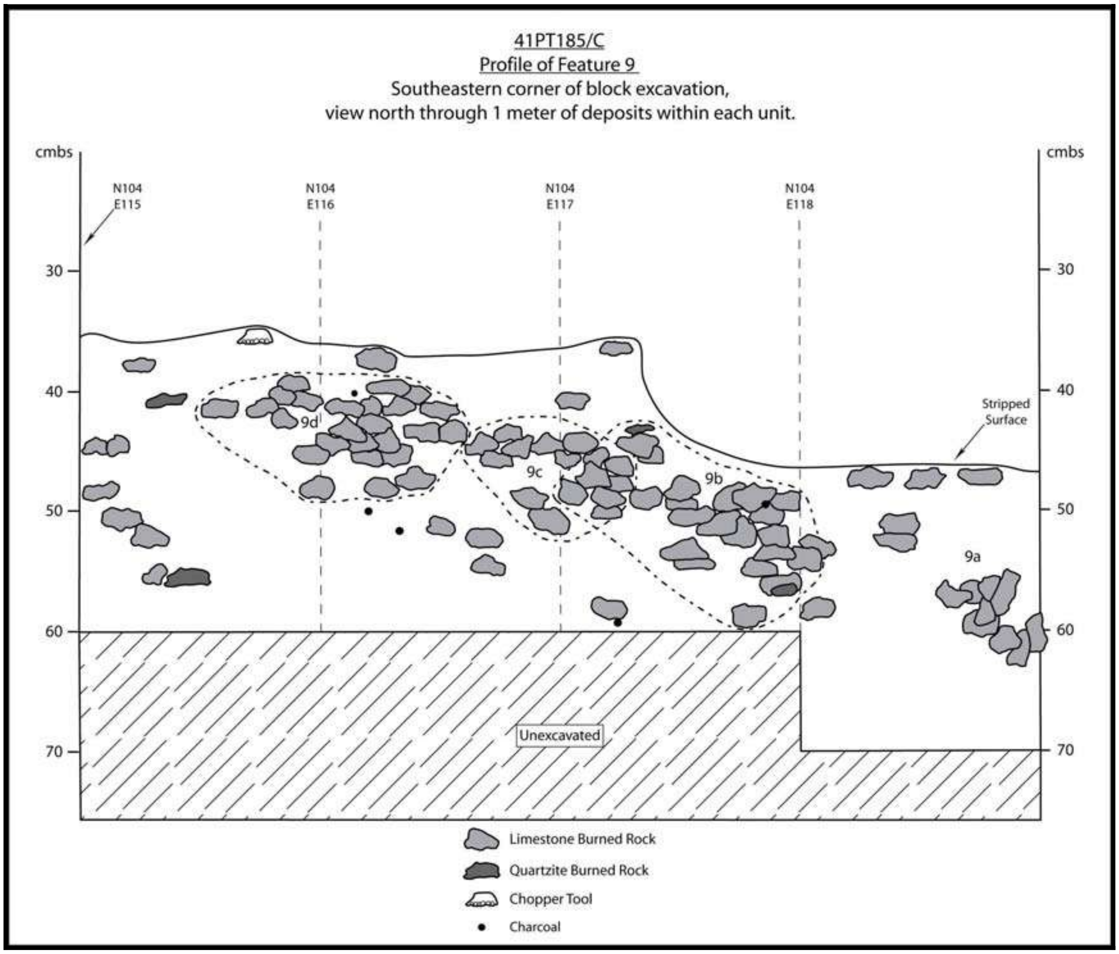


Figure 8-46. Profile of Burned Rocks in Feature 9 Showing Sloping Occupation Surface.

Feature 9c

This feature was about 60 cm south of Feature 9b near the junction of four units, but mostly along the northern edge of N103 E117 and the southern edge of N104 E117 (Figure 8-45). It was roughly 90 cm west of Feature 9a. Feature 9c consisted of an elongated cluster of burned rocks (#444-003, #445-003, #446-003, and #1332-003) that paralleled Feature 9b just to the north. Feature 9c measured about 70 cm along the long northwest to southeast axis and about 35 cm wide (four to five rocks wide) across the southwest to northeast axis. The northwestern end exhibited a loose concentration of burned rocks, whereas the opposite end exhibited a tight cluster of burned rocks with some rocks on top of other rocks. The 54 burned rocks (total weight of 6,514 g) included 20 small pieces 0 to 4 cm (195 g), 28 pieces 4.1 to 9 cm in diameter (3,665 g), and six pieces 9.1 to 15 cm diameter (2,201 g) for an average rock weight of 121 g (see Table 8-5). These burned rocks were about one third smaller than those in Feature 9b. The linear orientation of this cluster and the direction of slope were similar to that of Feature 9b. The two clusters were also at approximately the same elevation, with most rocks between 44 and 55 cmbs. Nearly all the burned rocks are dolomite with minimally four quartzite rocks recognized. The quartzite rocks appeared primarily at the bottom of the southeastern end. After counting and weighing, a few of the rocks were collected for further analyses and the remainder were discarded.

Just south of Feature 9c, in the southern part of N103 E117, were six to seven other scattered burned rocks and one large quartzite-spall tool (#446-010) (see Figure 8-45). Other cultural items such as chunks of bone or lithic debitage were absent from the two units.

To determine what the burned rocks were used for, selected samples were sent for lipid residue and starch grain analyses. Parts of three burned rocks (#502-003-1a, #502-003-2a, and #1332-003-1a) were sent to Dr. Malainey for lipid-residue analysis. Sample #502-003-1a failed to yield sufficient residues for interpretation. Sample #502-003-2a yielded high fat content as from seeds/nuts, plus with a trace of animal products. Sample #1332-003-1a yielded large herbivore bone marrow or meat prepared with moderate-to-high-fat-content seeds or nuts. The presence of triacylglycerols confirms the presence of animal products (Appendix G). Pieces of two burned rocks (#502-003-2b and #1332-003-1b) were sent to Dr. Perry for starch grain analysis. Sample #502-003-2b yielded damaged starch and a single unidentifiable grass starch grain. Sample #1332-003-1b did not yield any starch grains (Appendix F).

The elongated shape, the small size of the fractured burned rocks, the overall position of the Feature 9c, combined with the absence of charcoal or other signs of *in situ* heating indicate Feature 9c was a toss or dump/discard of burned rocks. These discarded rocks were probably used more extensively as they were quite fragmented and smaller than rocks in Feature 9b. The only major difference between the two elongated and parallel Feature 9c and 9b was that Feature 9b contained more, and less fragmented, rocks.

Feature 9d

Feature 9d was about 80 cm southwest of Feature 9b and 30 cm west of Feature 9c (see Figure 8-44). This feature was near the junction of four units that included the northeastern corner of N103 E115, the northwestern corner of N103 E116, the southeastern corner of N104 E115, and the western half of N104 E116 (see Figure 8-45). It consisted of an irregular and elongated concentration of burned rocks (#1330-003, #1331-003, and #1337-003) that measured about 160 cm north-south by roughly 80 cm east-west. The assigned feature boundary was quite arbitrary as other additional scattered and grouped burned rocks were in the immediate vicinity, but these were not contiguous with the clustered feature rocks. The northern end yielded a tighter concentration, whereas the southern half yielded scattered and somewhat larger burned rocks. The northwestern end also revealed some larger rocks that were slightly deeper than many of the other rocks. Potentially, those across the southern end had been displaced or raked out from the northern end. A couple of small, very localized areas (less than 7 cm in diameter) of dark-stained matrix were observed under or around a few burned rocks. However, no color changes in the overall matrix were evident and the measured depths of the burned rocks indicate that no basin was present. No obvious ash or charcoal pockets, lenses, or oxidized sediments were observed around or below the burned rocks. A small charcoal sample (#1337-007) included seven tiny fragments of mesquite wood (Appendix N).

The 88 burned rocks (total weight of 18,658 g) included 33 small pieces, 0 to 4 cm (151 g), 31 pieces 4.1 to 9 cm in diameter (5,194 g), 22 pieces in the 9.1 to 15 cm diameter (10,343 g), and two pieces greater than 15.1 cm that weighed 3,000 g, for an average rock weight of 212 g (see Table 8-5). These rocks were nearly twice the size of those that were in Feature 9c and just slightly larger than those in Feature 9b. The burned rocks varied in-depth from roughly 37 to 49 cmbs. The greatest proportion was comprised of dolomite; quartzite and a couple of sandstone pieces made up the remainder. Following counting and weighing the rocks, most were discarded, and a few were arbitrarily collected for future analyses. The burned rocks were in a dark brown (10YR 3/3) silty to sandy loam. Post depositional disturbances appeared limited to a few rodent burrows around 10 cm in diameter, in addition to insect and worm trails.

A moderate-size quartzite chopping tool (#493-010) was just outside the western margin at 35 cmbs in N104 E115. This same unit also yielded one Alibates flake (#3493-001) and a couple of bison long bone fragments (#493-002-1) at 41 cmbs. One bone fragment was submitted to Beta Analytic, Inc. for radiocarbon dating. It yielded a $\delta^{13}C$ adjusted radiocarbon age of 2250 ± 40 B.P. (Beta-255837).

Two burned rocks (#1337-003-1a and #1337-003-2a) were sent to Dr. Malainey for lipid residue analysis. Sample #1337-003-1a yielded lipids of large herbivore fatty meat or moderate-to-high-fat-content plants. Sample #1337-003-2a yielded lipids of high-fat-content plant seed/nuts with a trace of animal products (Appendix G).

Pieces of these same two burned rocks (#1337-003-1b and #1337-003-2b) plus one additional piece (#1337-003-2c) were sent to Dr. Perry for starch grain analysis. Burned rock #1337-003-1b yielded a single lenticular grain common to Canadian wildrye grass. Burned rock #1337-003-2b yielded damaged grains, minimally three of grains of other grasses, and one from an unspecified grain from a root. Burned rock #1337-003-2c also yielded damaged grains and one lenticular grain of Canadian wildrye grass (Appendix F).

The size and orientation of this cluster did not match the shape or pattern exhibited in the smaller Features 9b or 9c immediately to the east. Based on the presence of relatively large rocks in a broad concentration with the other discard features immediately next to Feature 9d, this is potentially the original *in situ* heating element used to heat the other rocks and/or cook foods. Again the lack of any clear sign of a basin, charcoal, or oxidized sediment fails to support an *in situ* heating element. Feature 9d may just represent another concentration of discarded burned rocks that represents multiple dumping episodes following cooking activities. Multiple dumping events could account for its irregular shape and the higher frequency of burned rocks. The burned rocks in Feature 9d were definitely used to cook foods as reflected in the gelatinized starch grains and the presence of lipid residues. The presence of plant seeds, specifically of grasses and lipid residues that represent large herbivore fatty meat indicate that multiple foods were cooked by these rocks. This may also indicate that multiple cooking episodes are represented.

Feature 10

This feature consisted of two sandstone slabs, one medium-size (22 by 24 cm, 5 kg) and one large (24 by 55 cm, 12.5 kg) between 57 and 67 cmbs in N112 E105 (Figure 8-47). These relatively large, thick flat slabs probably were not burned or intentionally shaped. The smaller piece refits to the end of the large piece. No obvious signs of cultural modification such as; peck marks, incisions/striations, grinding, polish, or impact scars were observed on each side of either piece. The two pieces (#801-005) weighted a total of 17.5 kg. These rested in a dark gray-brown (10YR 4/3) silty loam. Sediment samples from under both rocks (#801-004) were collected. Four small unidentifiable bone fragments (#801-002) were found immediately around these two rocks. Eleven small unidentifiable bone fragments, three small burned rocks, and one medial biface fragment (#800-010) were in the rest of this unit.

Sediment sample (#801-004-1b) from under the largest rock was examined for starch grains, but none were present. The absence of starch grains in this sediment supports the notion that those discovered on other burned rocks and artifacts analyzed are directly linked to those artifacts rather than contaminated from sediments surrounding the artifact (Appendix F). The remainder of the sediment sample (0.6 liters) was floated. The heavy fraction (17.7 g) yielded six tiny bone fragments, two of which were burned. No cultural materials were in the light fraction.

Figure 8-47. Close-up of Two Large, Unmodified, and Associated Sandstone Slabs in N112 E105.

A 0.5 liter matrix sample (#801-004) from 63 to 65 cmbs under the smaller slab was floated. The heavy fraction (1.9 g) yielded one tiny bone fragment and, again, no other cultural material. The light fraction (0.8 g) yielded tiny flecks of charcoal, but no burned seeds.

A 0.45 liter matrix sample (#801-004) from between the two big rocks was collected and floated. The heavy fraction (9 g) yielded three tiny bone fragments, two of which are burned, and two tiny pieces of chert. The light fraction (0.5 g) yielded no charcoal, and one tiny bone fragment.

The function of these two rocks is not readily apparent because of the lack of cultural modification to either slab and the apparent lack of charred organic matter under and between the slabs. The two slabs appeared associated with the lower Late Archaic occupation based on their depth. It is possible these manuports functioned as butcher blocks for smashing bones or preparing meat. They potentially functioned as butcher blocks without leaving a visible sign of alteration to either slab. The small bone fragments around the two slabs might indicate their use in bone processing, except that small bone fragments are not restricted to just this immediate vicinity and were generally scattered vertically and horizontally across broad areas. It is possible that these relatively heavy rocks held down something like a skin or supported some type of structure.

Feature 11

Feature 11 was an irregular, ovate cluster of burned rocks around the intersection of four units. The tops of these and other burned rocks were encountered between ca 46 and 49 cmbs and then totally exposed as a group in all four units (N102 E104, N102 E105, N103 E104, and N103 E105). Many burned rocks were exposed across this one occupation level, and as hand excavations proceeded it became clear that some rocks were tightly clustered, whereas others were scattered (Figures 8-42 and 8-48). The clustered burned rocks covered an area more or less 85 cm long by some 60 cm wide with some space between most rocks. A detailed plan map was drawn and the burned rock depths were measured. Unfortunately the rock sizes and weights were not consistently recorded for Feature 11. The bases of the burned rocks varied in elevation from 53 and 66 cmbs.

Feature 11 consisted of approximately 66 burned rocks that weighed an estimated total of 17,843 g for an estimated average of 270 g per rock. Both dolomite (ca. 75 percent) and quartzite (ca. 25 percent) rocks were represented, with no apparent pattern to the placement of either kind of rock. In a few instances burned rocks were slightly below the ones initially mapped in the northeastern corner of N102 E104 (see Figure 8-43). These formed a discontinuous arc of seven rocks. In the very northwestern corner of N102 E105 three burned rocks were again below the upper layer of burned rocks. The vertical depths hint at a possible shallow basin or pit under these rocks with fewer than 13 burned rocks in the possible pit. No charcoal staining, ash, charcoal concentrations, or oxidized sediment was detected anywhere around or under the rocks. Therefore, these burned rocks were mostly on relatively flat ground with some slight variability in their depths in one location. This may imply a possible small, shallow basin/pit near the junction of the four units. Post depositional processes likely caused slight vertical movement of a few burned rocks to deeper positions in the deposits.

Burned rocks were also scattered around the outside margins of Feature 11 and were of similar rock types. One stone tool, a sandstone metate fragment (#405-10) at 51 cmbs was recovered from the northwestern quadrant of N103 E104. A few unidentifiable bone fragments and one bison rib head (#352-002), together with12 chert flakes were found around the clustered burned rocks. A single charcoal sample (#354-007) from 55 to 60 cmbs in N102 E104 southwest of Feature 11 was collected and identified as juniper (Appendix N).

Figure 8-48. Overview of Feature 11 within Four Units with Large Pedestaled Area in the Central Cluster. (view south)

Pieces of three burned rocks (#355-003-1b, #361-003-1b, and #361-003-2b) from Feature 11 were sent to Dr. Perry for starch grain analysis. Burned rock #361-003-1b yielded gelatinized starch grains. Specimen #361-003-2b revealed gelatinized starch grains and damaged grains indicative of grinding (Appendix F).

Pieces of those same three burned rocks plus burned rock #406-003-1a were submitted to Dr. Malainey for lipid analysis. Sample #355-003-1b yielded residues from large herbivore and medium-fat-content plants with conifer lipids present. Sample #361-003-1b was interpreted to reflect high-fat-content plant seeds or nuts also with conifer detected. Sample #361-003-2b was interpreted to have high-fat-content plant seeds or nuts with a trace of animal products. It also yielded conifer products detected through the presence of biomarker dehydroabietic acid (Appendix G). Burned rock #406-003-1a yielded high-fat-content plant seeds/nuts with plant or possible animal products. No lipid biomarkers were detected and only a trace of triacylglycerols (Appendix G).

The small metate (#405-010) fragment (270 g) was submitted to Dr. Perry for starch grain analysis. Her analysis yielded 14 lenticular pieces common to grasses of the Pooidae subfamily, specifically identified as Canadian wildrye (*Elymus canadensis*) and two other unidentified grass starch grains.

Three sediment samples were collected from Feature 11. Ten small samples (#406-004) totaling 1.1 liters from 54 to 60 cmbs from directly under ten burned rocks were floated. The heavy fraction yielded only four tiny burned rock fragments and one tiny bone fragment. The light fraction sample (1.2 g) yielded moderate frequencies of tiny charcoal flecks. The charcoal (*N* = 9 weighs <0.1 g) was identified as cottonwood/willow (Appendix N). A second 0.45 liter sample (#1328-004) from 60 cmbs near the feature bottom was also floated. The heavy fraction (7.1 g) yielded five tiny burned rocks fragments. The light fraction (0.5 g) yielded some unburned black sunflower seeds. A third sample (#355-004) of 0.7 liters from 55 to 60 cmbs in N102 E104 was also floated. The heavy fraction (10.5) yielded no cultural materials. The light fraction (5.2 g) yielded moderate quantities of tiny rootlets, no burned seeds, no charcoal or other burned material (Appendix N).

These relatively fragmented burned rocks, their overall irregularly shaped clustering, the scattered burned rocks in the immediate vicinity, combined with the absence of a well-defined basin and signs of *in situ* burning, indicate Feature 11 represents a discard/disposal of used burned rocks. Its position less than 1 m south of the *in situ* heating element Feature 8 implies that these burned rocks had been used in conjunction with that feature. The lipid resides results indicate the rocks were used to cook high-fat-content plant seeds or nuts with a trace of animal products. Adding to this the fact that gelatinized and damaged starch grains were detected, it is clear that these burned rocks were used to cook at least grass seeds. It is not clear if these rocks were stock piled for possible reuse or if; rather, they were discarded, never to be used again. The fact is they did cook foods at one time, and it is likely these rocks were used in conjunction with the *in situ* heating element, Feature 8.

Feature 12

This ovate cluster of burned rocks was between 34 and 45 cmbs in the eastern half of N114 E105 and western half N114 E106. The rocks formed a well defined, tight cluster with some irregular spacing between some of the pieces (Figures 8-49 and 8-50). The larger pieces and tight spacing was observed on the western side of the cluster. The entire cluster measured 75 cm in diameter with the base of the rocks vertically spaced over about 9 cm with no detectable basin below the rocks. A few burned rock pieces were stacked, but a second continuous layer of rocks was not detected. The burned rocks varied in size from 3 cm to greater than 16 cm in diameter with the majority of rocks 8 cm or larger (see Table 8-5). The average rock weight was 342 g. The material types represented include mostly dolomite pieces, but minimally five pieces of sandstone, and at least one piece of quartzite were recognized. Four pieces of sandstone were sitting directly on top of the dolomite rocks near the center. One relatively large bone fragment (#901-002), some 35 tiny (less than 3 cm in diameter), very friable bone fragments, and one prairie dog mandible were recovered from throughout the feature rocks. Five Alibates flakes were recovered from amongst the rocks. Tiny flecks of apparent charcoal were also scattered amongst the rocks, but no obvious dark staining, ash, or charcoal chunks were present. Small sediment samples from below a couple of selected rocks were collected and a larger sediment sample was collected from below the middle of the feature.

Figure 8-49. Close-up of Feature 12 that Shows Tightly Clustered Burned Rocks, Their Shapes, Sizes, and Distribution.

Five small burned rocks, some 25 tiny bone fragments, six pieces of lithic debitage, and one basal fragment of a dart point (#895-010) were outside the well defined western edge of this cluster in N114 E105. On the eastern side in N114 E106, the cultural materials included 10 pieces of burned rocks, six chert flakes, 19 bone fragments, and a few flecks of charcoal (#901-007) down to about 46 cmbs.

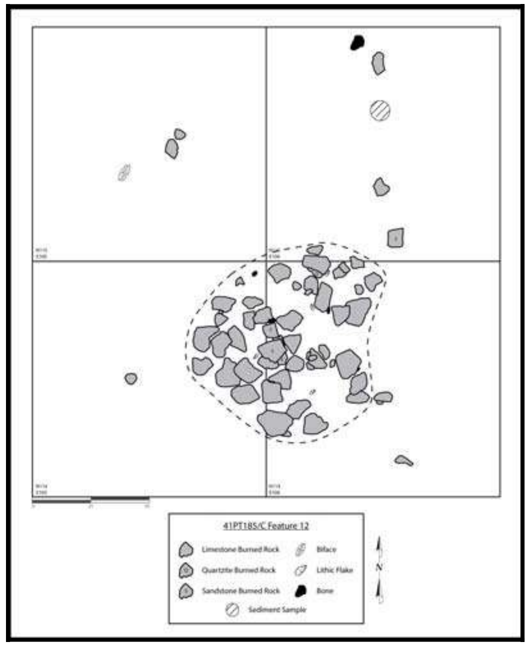


Figure 8-50. Plan Map of Feature 12 and the Surrounding Materials.

Pieces of three burned rocks (#901-003-1a, #901-003-2a, and #901-003-3a) were sent to Dr. Malainey for lipid residue analysis (Figure 8-51). Samples #901-003-1a and #901-003-2a yielded very-high to high-fat-content plant seed/nuts with a trace of animal lipids (#901-003-1a) or animal combination (#901-003-2a). The latter has high levels of triacylglycerols, a biomarker that indicates animal products. Sample #901-003-3a reflects residues of large herbivore bone marrow and meat prepared with moderate-to-high or high-fat-content seeds or nuts (Appendix G).

Figure 8-51. Unwashed Piece of Burned Rock (#901-003-4b) that Yielded 45 Starch Grains with Some Damaged from Processing. (scale in cm)

Two pieces of those same burned rocks (#901-003-1b and #901-003-2b) plus two additional pieces of burned rocks (#901-003-4b and #899-003-5b) were sent to Dr. Perry for starch grain analysis. Burned rocks #899-003-5b and #901-003-2b yielded clearly gelatinized starch grains, unspecified starch, lenticular starch grains common to Canadian wildrye grasses (N = 18 and 3 respectively), and starches from unidentified grasses (N = 11 and 6 respectively). Burned rock #901-003-4b revealed similar types of starch (N = 45 grains) with a damaged starch grain indicative of processing. Burned rock #901-003-1b yielded a single lenticular starch grain of Canadian wildrye (Appendix F).

A 0.6 liter sediment sample (#901-004) from 40 to 43 cmbs was collected from under a couple of the burned rocks and floated in the laboratory. The heavy fraction (29.2 g) yielded 12 tiny bone fragments, seven burned rocks fragments, and one tiny piece of chert. No charcoal or burned seeds were in the heavy fraction. The bone included tiny burned pieces. The light fraction (0.8 g) was macroscopically inspected and included only of few flecks of charcoal, but no burned seeds. This light fraction was not sent for analysis.

The overall ovate shape and tight cluster of burned rocks in more or less a single layer that lacks a well-defined basin indicates an *in situ* heating element. The relatively flat nature and tight clustering indicates a griddle-type cooking feature. The lack of substantial charcoal is most likely due to lack of preservation. The two residue analyses provide direct indication that these rocks were used in cooking. The foods cooked probably had very high to high-fat-content plant seed/nuts (likely seeds) with a trace of animal products that includes large herbivore bone marrow and meat. The seeds processed, as reflected by damaged starch grains, and cooked, as indicated by the gelatinized starch grains, indicate cooking of minimally wildrye with heat and water.

Feature 13

This was a cluster of small sandstone slabs between 40 and 45 cmbs in the northwestern margin N109 E106 (#677-010) and the southwestern part of N110 E106 (#712-010). The 10 pieces were clustered over a 50-cm-diameter area with about a 5 cm variation in their depths. These 10 pieces weighed a total of 18,140 g, for an average rock weight of 1,814 g. In the field, Feature 13 was recorded as a burned rock cluster. Most pieces were lying flat or slightly tilted down towards the outer margin (Figures 8-52 and 8-53). No charcoal, ash, or oxidized sediment was observed around or below the rocks. No sign of a basin or pit was observed. These pieces were in a dark brown (7.5YR 4/2) clay loam.

During laboratory analysis it was discovered that nine pieces were part of a one-sided grinding slab/metate. Five pieces refit to recreate roughly one half of the metate with that section measuring about 33 cm long by 15-cm-wide (Figure 8-54). A piece from near the center of the metate was sent for residue analyses (see below). The one utilized surface is smooth in the middle, but not polished or shinny. No peck marks, striations, or visible signs of use (other than grinding) are present across this used face. The outer margin of the metate is irregular and lacks the smooth surface of the middle section. The bottom or opposite side is bumpy and irregular, and had not been used. The outside edge on both faces exhibits flake scars with hinge fractures. These apparent scars are interpreted to be the result of manufacturing this sandstone slab into the desired size and shape, with generally rounded margins. When abandoned it was turned over, with the used side down.

Figure 8-52. Overhead and Close-up View of Feature 13, Upside Down Fragments of One Partial Metate.

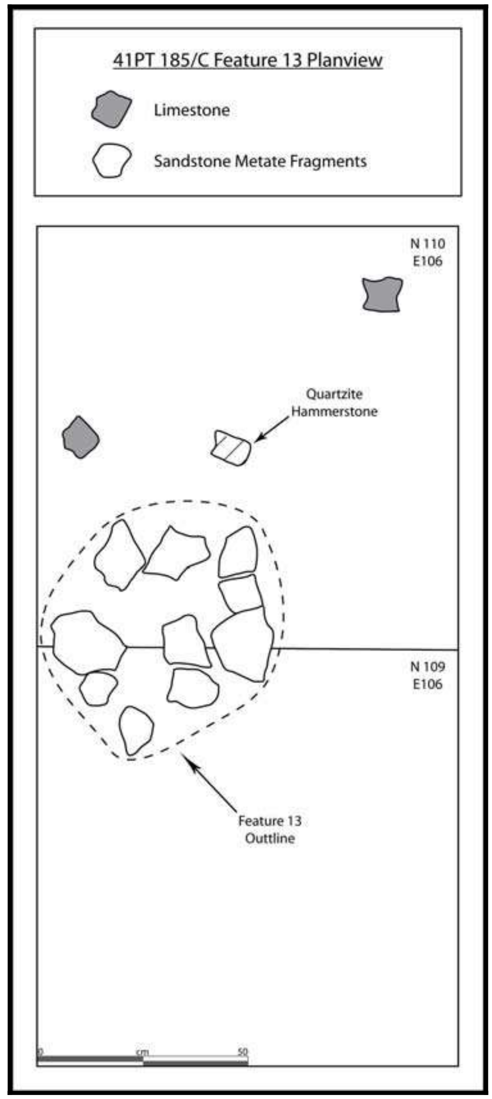


Figure 8-53. Plan Map of Feature 13 and Materials Around it.

The southern unit, N109 E106, also yielded one piece of opalite and one unidentifiable bone fragment. The northern unit, N110 E106, yielded one possible hammerstone (#709-010), five chert flakes, nine tiny unidentifiable bone fragments, and one tiny chunk of charcoal (#711-007) from outside the clustered sandstone pieces.

The small 76 mm long sandstone hammerstone (#709-010) was recovered from about 25 cm north of the cluster at 43 cmbs. Two sediment samples (#677-004) were collected; one from under the slabs and one near the middle of the cluster (#712-004).

A small metate fragment (#712-010a) was sent to Dr. Malainey for lipid residue analysis. The detected residues resemble large herbivore with fatty meat or high-fat-content plants (Appendix G). A piece of that same metate fragment (#712-010b), plus another piece from the adjoining unit (#677-010b) were sent to Dr. Perry for starch grain analysis. Neither sample yielded any starch grains (Appendix F). Based on the lipid residues identified this sandstone slab potentially functioned as a butcher block for processing meat and/or meat products. This interpretation also would support the presence of the nearby hammerstone.

Figure 8-54. Pieces of Metate (#712) refitted in Laboratory.

A sediment sample (#712-004) from 40 to 50 cmbs near the central part of the clustered pieces was subsequently floated in the laboratory. The nearly 4.3 liters of matrix yielded heavy and light fraction. The heavy fraction consisted of 60.5 g of materials that included of 29 tiny fragments of bone, some 19 black sunflower seeds, one unburned hackberry seed, three tiny burned rock fragments, and three tiny pieces of chert debitage. Several tiny bones fragments were burned. One burned hackberry seed was identified. The light fraction weighed 3.3 g and consisted of 26 to 50 tiny rootlets, one uncharred hackberry seed, and no charcoal (Appendix N).

Feature 13 was a fragmented metate/butcher block, a multiple functional processing slab that was turned over following its last use. The pieces are relatively close together, but it is not clear if it was disturbed following breaking. The lipid residues resemble large herbivore with fatty meat or high-fat-content plants. No starch grains were detected in the two pieces analyzed. The lack of polish and well defined grinding margins across the used surface indicates that if it was used, it was not used for either a long-time or very intensively for a short-time. This would fit with the interpretation of a metate used at a major base camp, discarded at the time of abandonment, rather than a tool that was reused over many seasons. However, it functioned, apparently not as a grinding slab for starchy grass grains, but as a possible butcher block for processing meat. Feature 13 was definitely associated with the upper Late Archaic occupation.

Feature 14

Feature 14 was a loose concentration of diverse cultural materials dominated by burned rocks with one fragmented bison bone discovered between 61 and 67 cmbs in N114 E107. This grouping, although not well-defined or tightly clustered, measured ca. 100 cm in diameter by 6 cm thick. Most of the somewhat loosely associated burned rocks had 10 to 30 cm space between them and no apparent pattern to their placement (Figure 8-55). This feature included 22 burned rocks (#907-003) that weighed minimally 6,741 g, for an average rock weight of 306 g. The cluster included 19 dolomite and three quartzite pieces. Following documentation a few of the burned rocks were retained, with most discarded. Next to one large rock was a splintered proximal bison metapodial fragment (#907-002). A bison mandible fragment was on the western margin.

No sediment staining, ash, charcoal, or other sign of *in situ* burning was visible. These burned rocks were in a brown (10YR 4/3) silty clay loam with calcium carbonate pieces and small dolomite gravels throughout the level. Two sediment samples were collected. Sample #907-004 of 0.8 liters was collected from 63 to 65 cmbs below and around the burned rocks. This sample was floated in the laboratory.

The heavy fraction (42.6 g) yielded five tiny bone fragments, two tiny chert flakes and one unburned seed. No charcoal was recovered. The light fraction (0.6 g) yielded no macroscopic observed charcoal and a few unburned black sunflower seeds. None of this material was sent for analysis.

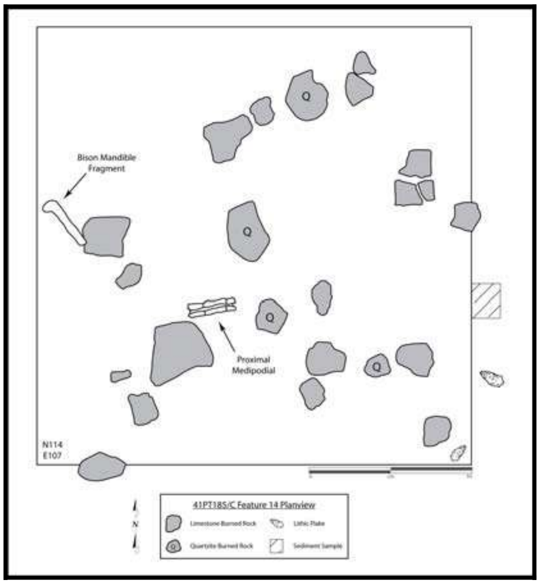


Figure 8-55. Plan Map of Feature 14 Materials.

The loose association of burned rocks and lack of any sign of *in situ* burning, the absence of a basin, indicates this was a secondary dump of diverse materials discarded from cleaning another location. The tiny pieces of the lithic debitage and other cultural items are all part of the general occupational debris. Feature 14 is one of the few features that appeared associated with the lower occupation within this Late Archaic component.

Feature 15

Feature 15 was scattered across the northern end of our excavation block, over about 13 m^2. The number 15 was initially assigned to a broad concentration of burned rocks with occasional bone fragments, which were partially exposed during the mechanical stripping. The exposed dolomite burned rocks were left *in situ* and became the target of subsequent hand excavations. The rocks observed near the stripped surface lacked obvious patterning and it was not until a broad area was hand excavated that specific clusters of materials were recognized. These smaller clusters within the broader area were labeled Feature 15, then assigned individual subfeatures (i.e., Features 15a, 15b, 15c, 15d, and 18). Each subcluster is described and discussed as individual features below.

Feature 15a

This feature was mostly across two units, the northwestern part of N119 E103 and the southern half of N120 E103. This ovate cluster of burned rocks (#1175-003 and #1234-003) was about 90 cm long by some 90 cm-wide, and between 44 and 52 cmbs. The rocks were generally tightly clustered, most often touching one another, but revealed an irregular outline (Figure 8-56). Feature 15a included 32 burned rocks that weighed minimally 9,730 g for an average rock weight of 304 g. Twenty-seven dolomite and five quartzite pieces were identified. These burned rocks were in a brown (10YR 5/3) sandy silt loam that exhibited no dark stain, ash, charcoal, or other sign of *in situ* burning.

On the northern side, but outside of Feature 15a in the remaining part of unit N120 E103 were another 21 burned rocks (#1233-003) with many forming an east west line across the northern edge of this unit (Figure 8-56). Also in this unit was a single chert flake (#1233-001) and two tiny bone fragments (#1233-002). At 44 cmbs was a relatively large quartzite cobble tool (#1234-010) that has small pits or peck marks. A single tiny charcoal sample (#1234-007) from 40 to 45 cmbs in N120 E103 includes two tiny pieces of juniper wood (Appendix N). Sediment

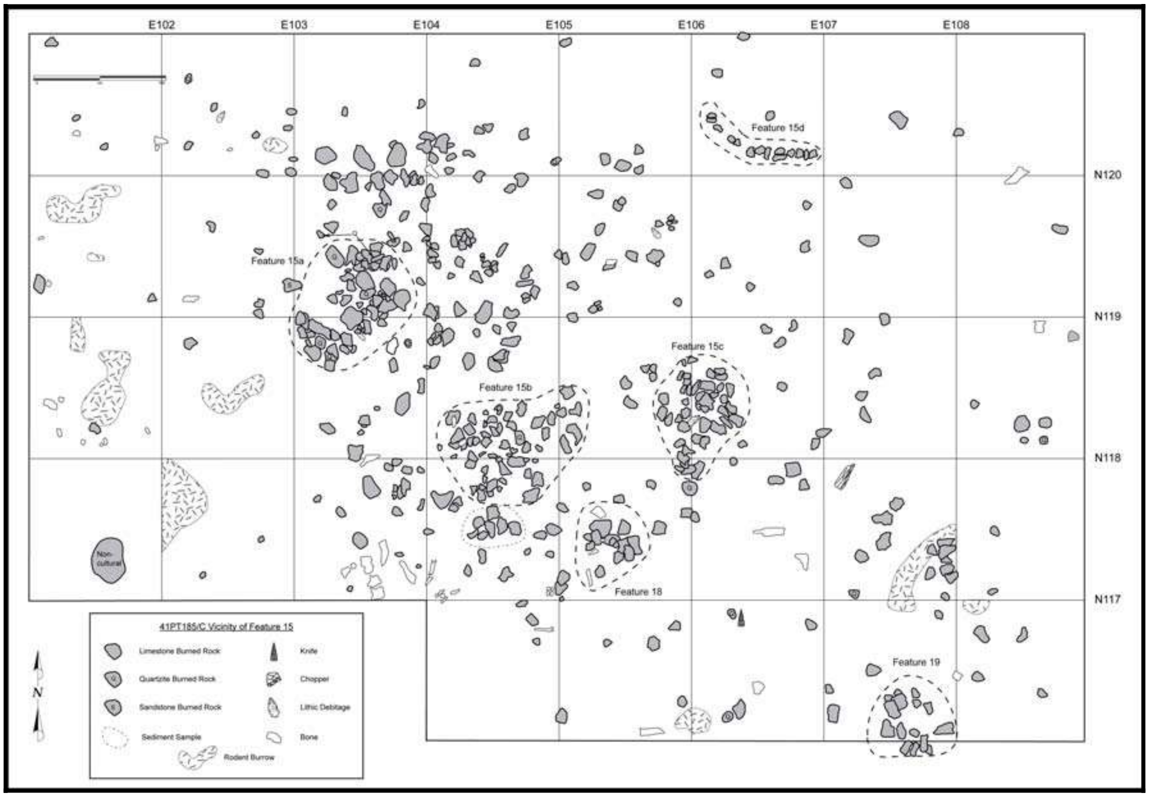


Figure 8-56. Plan Map of Feature 15 and its Subdivisions Plus Features 18 and 19.

samples were collected from under three burned rocks and those same three rocks were also collected.

On the southern side in N119 E103, 13 other scattered burned rocks and one bison long bone fragment (#1174-002) from 47 cmbs were recovered. This latter fragment was submitted to Beta Analytic Inc., for radiocarbon dating. The gelatin fraction yielded a $\delta^{13}C$ adjusted radiocarbon age of 1540 ± 40 B.P. (Beta-257845). Two burned rocks from inside Feature 15a and one from outside were collected for potential analyses. Three sediment samples from under those same three burned rocks were also collected.

Two different residue analyses were employed to determine what foods were cooked with these burned rocks. Two pieces of burned rocks (#1234-003-1a and #1234-003-2a) were sent to Dr. Malainey for lipid residue analysis. Rock #1234-003-1a failed to yield sufficient residues to attempt interpretations. Sample #1234-003-2a yielded very-high-fat-content plant seeds/nuts. No biomarkers were detected (Appendix G). Pieces of those same two burned rocks (#1234-003-1b and #1234-003-2b) were also sent to Dr. Perry for starch grain analysis. Both samples failed to yield any starch grains (Appendix F).

Feature 15a was associated with the upper occupation of the Late Archaic component. It is interpreted to reflect a dump of rock used in cooking events. The limited results from the two residue analyses may indicate that these burned rocks were used in a limited number of cooking events. The lipid results do indicate they were used to cook plant products that consisted of seeds/nuts.

Feature 15b

This feature was across parts of three units; the northern half was in N119 E104 and extended slightly into E105, whereas the southern half was in N118 E104. This relatively tight cluster of burned rocks was between 41 and 53 cmbs, with the rocks that generally touched one another across the western half, and scattered on the eastern end (see Figure 8-56). The cluster measured roughly 110 cm long by some 70 cm wide with rock depths that varied by about 8 cm. Feature 15b was 75 cm southeast of Feature 15a with a few scattered burned rocks in between. This feature included 71 burned rocks (#1178-002, #1181-002, #1118-002, and #1184-002) that weighed minimally 17,979 g for an average rock weight of 253 g (see Table 8-5). The rocks included 67 dolomite and four quartzite pieces.

Three small bone fragments (#1181-002) that include a bison mandible fragment and tooth enamel, plus a left, proximal metacarpal were inside the western edge of the feature. The elevations of the bases of the burned rocks were slightly variable with a gentle sloping surface in a brown (10YR 4/3) sandy silty loam. No sediment staining, ash, charcoal, or other sign of *in situ* burning was visible around or below the burned rocks. Feature 15b was cross sectioned a couple of times to look for a basin/pit, but no sediment color change or discernible stacking of burned rocks was noted.

Outside the northern edge of Feature 15b, in the remaining part of unit N119 E104, were another 12 scattered burned rocks (#1178-003) plus four chert flakes (#1178-001). The northeastern edge of Feature 15b included five burned rocks (#1184-002) in the corner of N119 E105. These five burned rocks, (weight of 2,061 g) were from 44 to 47 cmbs.

The southern margin of Feature 15b, in N118 E104, could not be defined with precision because of the many other burned rocks scattered throughout this unit (see Figure 8-56). A few small groups of burned rocks were present that made it difficult to distinguish rocks in Feature 15b from those outside the feature. One group of seven tightly spaced burned rocks (all 4.1 to 9 cm in diameter, and weighing 1,570 g) was just south of the main cluster and possibly was part of Feature 15b, but was considered to be outside. This potentially was a separate cluster, but was not assigned a feature number. A sample of feature rocks (#1118-003) and sediment (#1118-004) from below them was collected. The sediment surrounding the burned rocks was a brown (10YR 5/3) sandy loam with no indication of burning.

Beyond what was defined as Feature 15b in N118 E104 were a few scattered flakes and fragmented bones. The bones consist of bison ribs, a bison first phalanx, and a bison right distal metatarsal in the southwestern corner with one complete left bison astragalus in the southeastern corner (see Figure 8-56).

Pieces of three arbitrarily selected burned rocks (#1181-003-1a, #1181-003-2a, and #1181-003-3a) were sent to Dr. Malainey for lipid residue analysis. All three pieces yielded interpretable lipid residues with slight variations. Burned rock #1181-003-1a yielded large herbivore fatty meat or plants with moderately-high-fat-content. The high levels of biomarker triacylglycerols combined with low levels of cholesterol, indicates only large herbivore products, which perhaps are a combination of bison meat and marrow. Burned rock #1181-003-2a yielded borderline high- and very-high-fat-content plant seeds/nuts. Burned rock #1181-003-3a yielded very-high-fat-content plant seeds/nuts with a trace of animal products, plus conifer residues as indicated by dehydroabietic acid. The conifer residue is likely that from the fuel wood, most likely juniper. Cholesterol was detected, which indicates the presence of animal products (Appendix G). One piece of burned rock #1181-003-1b was sent to Dr. Perry for starch grain analysis. This rock did not yield any sign of starch grains (Appendix F).

Feature 15b was at the same elevation as Feature 15a and the two clusters represent the same uppermost occupation of the Late Archaic component. This cluster is interpreted to represent discarded burned rocks that once were used for cooking. The scattered nature of these burned rocks within this cluster, their slightly variable depths, the presence of bison bones, the lack of any sign of *in situ* burning, all support this conclusion. The residue analysis documented their previous use in cooking mostly meat, though plant products were involved as well. Apparently the rocks were heated with some conifer wood as fuel, likely juniper in this setting.

Feature 15c

Feature 15c was a well-defined, relatively tight cluster of burned rocks that measured about 70 cm north-south by 45 cm east to west with the rock bases between 46 and 52 cmbs (see Figure 8-56). This cluster was near the junction of four units, with the western half in N119 E105, the eastern half in N119 E106, whereas the southern tip was in the northeastern corner of N118 E105 and the northwestern corner of N118 E106. Feature 15c was 60 cm east of Feature 15b with just a few scattered burned rocks in between. This cluster included 59 rocks (#1192-002, #1184-002, and #1131-002) that weighed a total of minimally 15,280 g for an average rock weight of 259 g (see Table 8-5). All were dolomite pieces with the exception of one quartzite rock. The burned rocks were in a single layer with no detectable underlying basin or pit. These burned rocks were on a relatively flat surface in a brown (10YR 4/3) sandy silty loam. No sediment staining, ash, charcoal, or other sign of *in situ* burning was visible around or below the burned rocks. No sizable bone pieces were present within the clustered rocks.

In the adjacent unit N118 E107 was elongated Potter chert chopper (#1136-010) was recovered along with a few burned rocks. This elongated cobble exhibits a battered distal end with possible flake scars on the proximal end. This heavy and pointed tool is of sufficient weight to have broken green bones.

To investigate what foods might have been cooked by these rocks, two types of residue analyses were conducted on a limited suite of samples. Two pieces of burned rocks (#1192-003-1a and #1192-003-2a) were sent to Dr. Malainey for lipid residue analysis. Both samples yielded lipid residues with only minor variations. Sample #1192-003-1a yielded lipids of very-high-fat-content seeds/nuts, with the biomarker dehydroabietic acid indicating the presence of conifer products. Sample #1192-003-2a yielded high-fat-content plant seeds/nuts with animal products, plus conifer products (Appendix G). Two pieces of those same burned rocks (#1192-003-1b and #1192-003-2b) were sent to Dr. Perry for starch grain analysis. Both burned rocks failed to yield any starch grains (Appendix F).

Feature 15c was approximately at the same elevation as 15a, and 15b, in the same area as those features, and represents the same upper occupation of the Late Archaic component. Feature 15c was another discard pile of burned rocks used for cooking. The conifer residues most likely came from the wood used as fuel in heating the rocks. The foods cooked included minimally very-high-fat content seeds/nuts as well as some animal products.

Feature 15d

This feature consisted of a curved line of 14 burned rocks between 50 and 56 cmbs in N121 E106. The 14 burned rocks (#1295-003) formed a well defined slightly curved line or arc about 1 m long and one rock wide with the rocks touching one another. The arc was in a somewhat west to east line open to the northeast (see Figures 8-56). No charcoal or staining of any kind was visible around or on either side of the rocks. The surrounding matrix was a dark brown (10YR 3/3) compact, silty clay with tiny caliche flecks throughout. The burned rocks were slightly above the bottom of the A horizon. The 14 burned rocks weighted a total of ca. 4,000 g, for an average rock weight of 286 g (see Table 8-5). These rocks fell into two size categories; with eight between 4.1 and 9 cm and six between 9.1 and 15 cm in diameter. The hand-excavation of this unit was completed at the end of the field time and the unit to the north of this was never excavated, so it is unknown if more segments of the arcuate alignment rest to the north.

Twelve other smaller burned rocks with a total weight of 369 g were scattered across this unit. This ca. 10 cm level also yielded some 16 small unidentifiable bone fragments, but no lithic debitage or tools. In the level above (from 42 to 50 cmbs) burned rocks were generally scattered about, and one piece of lithic debitage was recovered.

It is not clear what purpose this well-defined arc of rocks served. The close spacing and regular pattern strongly indicates that these burned rocks were intentionally place in this arc. It is possible that the individual that recorded these rocks misidentified them as burned rocks and they were actually just natural rocks, but this would still not contribute to understanding the function of this arc.

Feature 16

Feature 16 was a burned rock concentration between 68 and 79 cmbs in southern half of N114 E99. It consisted of 21 burned rocks tightly clustered in an elongated triangular shape with the long axis north-south (Figures 8-57 and 8-58). The cluster measured 70 cm long by 45 cm wide. The base of the triangle or southern end yielded larger burned rocks with smaller pieces at the northern end.

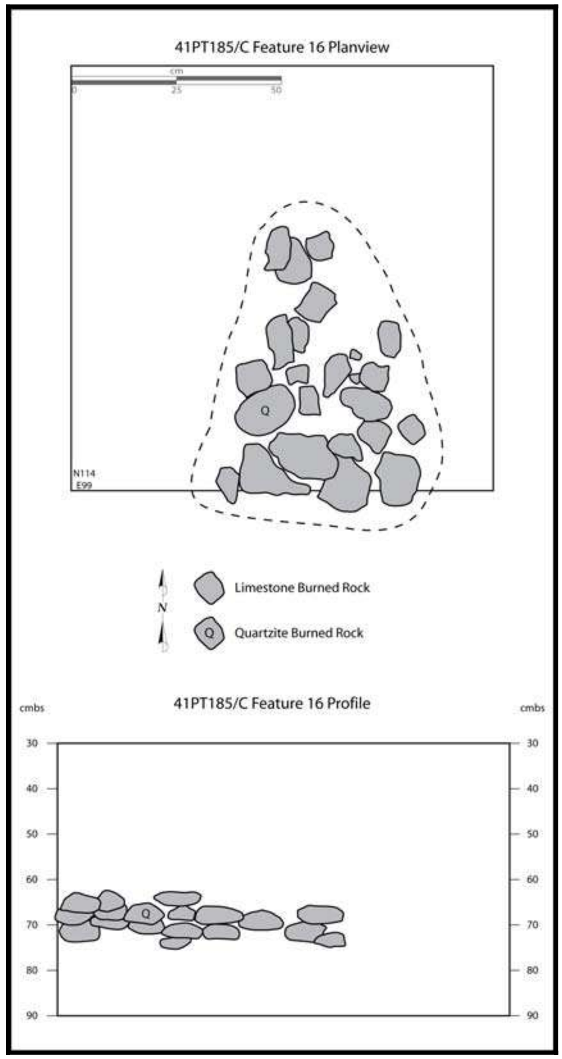


Figure 8-57. Plan Map and Profile of Feature 16.

The 21 rocks (#875-002) weighed 16,750 g and ranged in size from 7 to 19 cm long and included seven (3,500 g) in the 4.1 to 9 cm size class, 12 (9,750 g) in the 9.1 to 15 cm size class, and two (3,500 g) greater than 15 cm for an average weight of 798 g (see Table 8-5). Twenty pieces were sandstone and one was quartzite. The rocks were on a nearly flat surface with a slight slope down to the north. No significant disturbance was recognized in this brown to dark brown (10YR 4/3) sandy silty loam. No charcoal staining, ash, oxidation, or chunks of charcoal were observed under or around the burned rocks to indicate *in situ* heating.

Figure 8-58. Close-up of Burned Rocks that Exhibit Burned Rock Size, Shape and Distribution that Formed Feature 16.

Slightly above the clustered rocks (at 60 to 70 cmbs) seven flakes (#872-001) and one tiny bone scrap (#872-002) were recovered. From 70 to 80 cmbs came a single Alibates flake (#875-001) and two tiny unidentifiable bone fragments (#875-002). Following the documentation of the rocks most were discarded, and a small sample was collected for future analysis. Five small sediment samples (#875-004), one each from under five separate burned rocks, were collected for potential analyses in the laboratory.

Two pieces of burned rock (#875-003-1a and #875-003-2a) were sent to Dr. Malainey for lipid residue analysis. Burned rock #875-003-1a yielded medium-fat-content, which is ambiguous in terms of taxon identification. No lipid biomarkers were detected in this rock. Burned rock #875-003-2a yielded high-fat-content plant lipids (seeds/nuts) with conifer represented detected by the biomarker dehydroabietic acid (Appendix G).

Two pieces of these same burned rocks (#875-003-1b and #875-003-2b) were sent to Dr. Perry for starch grain analysis. Rock #875-003-1b yielded one lenticular starch grain that is Canadian wildrye, and one starch grain from an unknown grass. Rock #875-003-2b) yielded 10 lenticular starch grains common to Canadian wildrye grasses as well as damaged starch grains indicative of processing (Appendix F).

A 1.1 liter matrix sample (#875-004) from below the burned rocks at 73 cmbs was collected and floated. The heavy fraction (37.7 g) yielded one tiny charcoal fleck and lots of tiny gravels. The light fraction (2.1 g) yielded no macroscopic charcoal, no burned seeds, or any other type of cultural materials. No further analysis was conducted on the light fraction.

The lack of evidence for *in situ* burning or a basin or pit below the rocks, combined with the overall triangular shape indicates this clustered burned rocks was a toss or dump of burned rocks. The rocks were used for cooking as indicated by the residues found on the two rocks analyzed. Feature 16 is one of the few features associated with the lower occupation of this Late Archaic component.

Feature 17

This feature consisted of an inverted bison cranium (#1027-002) between 83 and 96 cmbs in N117 E96. Even though the maxillary side was turned up, no teeth were *in situ* or recovered. The skull (605 g) was badly weathered and fractured into many pieces, but was held together with the surrounding matrix (Figure 8-59).

Figure 8-59. Overhead View of Inverted, weathered Bison Cranium, Feature 17.

In general, it measured about 40 cm across and was about 13 cm thick. The skull was mostly present except for the left horn core, teeth, and the mandibles were missing with the right horn core was only partially present. The nasal cavity was pointing to the east. The top of the cranium was mostly present, with minimally one small area that revealed crushed bones and an impact mark near the brain cavity area (Figure 8-60).

Figure 8-60. Crushed Skull Around Point of Impact on Top of Bison Cranium.

The skull was in a light brown (10YR 6/3) hard, compact, clay loam. Apparently, the skull was exposed on or near the surface for a lengthy period before burial, resulting in its poor and weathered condition. The matrix surrounding the skull was older than the skull itself and thought to be Unit B at ca. greater than 8,000 years old. A fragment of this bison skull (#1027-002-1a) from 95 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon date of 2510 ± 40 B.P. (Beta-264923). This unique context probably resulted from years of turbation of the older sediments in which the older matrix was displaced over time and eventually encased the skull. More recent rodent burrows were observed on two sides, but almost no cultural material was in the immediate vicinity. A single tooth fragment and two chert flakes were between ca. 80 and 90 cmbs. A small chunk of charcoal (#1027-007) was collected from *in situ* at 94 cmbs on the western margin of the skull. A small matrix sample (#1027-004) from immediately below the skull was also collected.

The inverted nature of the skull combined with the one obvious impact scar on top of the cranium indicates this skull was modified by human activity. Feature 17 was associated with the lower occupation of the Late Archaic component, which yielded minimal other cultural materials and no other identifiable features.

Feature 18

This was a possible two-part (upper and lower) burned rock feature in N118 E105, within the scattered burned rock that was labeled Feature 15. Two parts were recognized, but it is questionable if they were truly linked or if they represent two different features. The upper part was not assigned a separate feature number in the field as it was not recognized as such, although several burned rocks and a couple of butchered bison bones were loosely clustered together (Figure 8-61). This upper part appeared as a small, loose cluster of 11 burned rocks associated with four different bison bone fragments in an area that measured 60 cm north to south by 45 cm east to west. This upper part was about 45 cm southwest of Feature 15c and a similar distance southeast of Feature 15b. The bison bones (#1152-002) include a small maxillary section with two molars, the distal

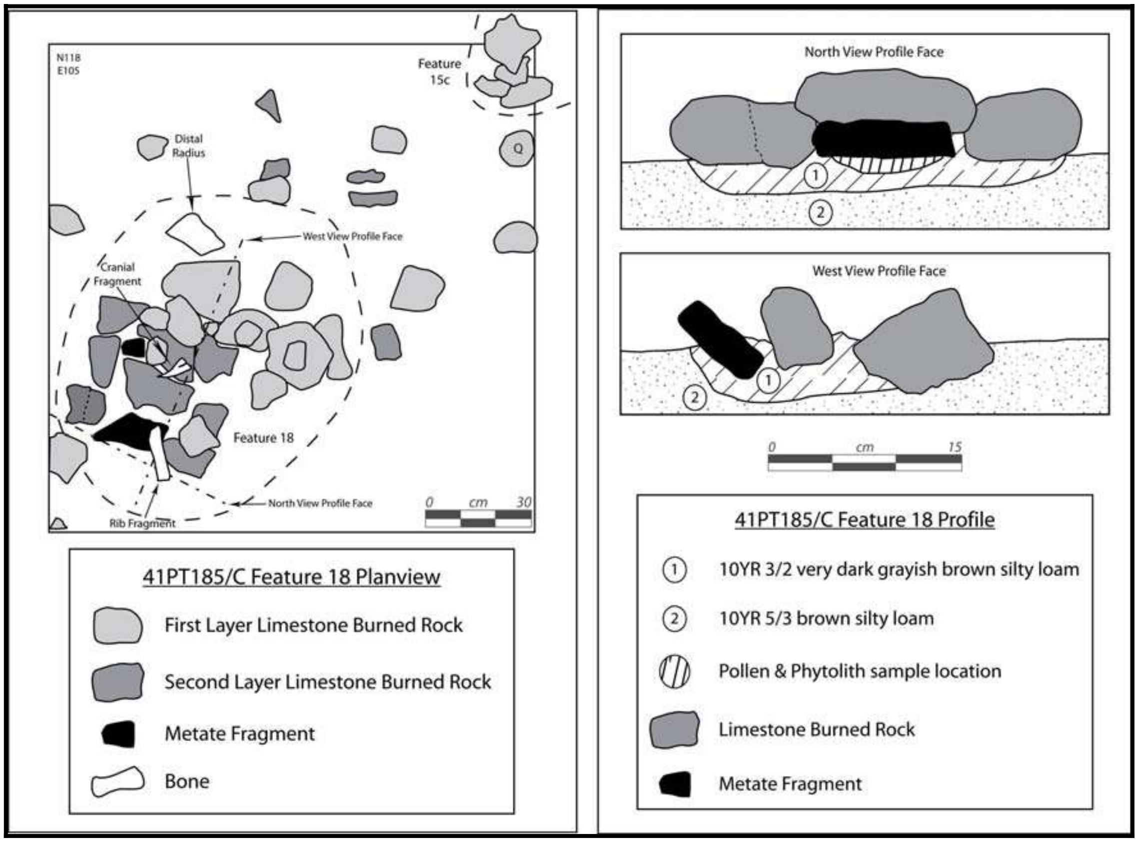


Figure 8-61. Plan Map of Probable Top and *In Situ* Bottom with Profile of Lower Part of Feature 18.

end of an immature bison radius with three cut lines, a section of rib, part of the nasal cavity of the cranium, and a few unidentifiable fragments. Other burned rocks were scattered across this unit and the unit to the west. Two pieces of burned rocks (#1129-003-1a and 2a) from outside the clustered 11 rocks, and two from inside the cluster (#1352-003) were collected for future analyses.

Almost directly beneath this small upper cluster of 11 burned rocks and bison bones was what is interpreted to be the lower and more intact part of the upper cluster. The lower cluster was visually apparent, and labeled Feature 18 in the field. This lower part consisted of a very tight cluster of 10 burned rocks and burned metate fragments (#1129-003) between 55 and 58 cmbs in the southwestern quadrant of N118 E105 (Figures 8-62 and 8-63). These tightly clustered burned rocks formed a square outline that measured 35 cm across. Just below these well-positioned pieces was a 2 to 3 cm thick, saucer shaped, very dark gray brown (10YR 3/2) organic stain with tiny flecks of charcoal. The bottom surfaces of the burned rocks were dark-stained. This cluster was cross sectioned twice, once in each of two intersecting directions. The 10 burned rocks included six in the 4.1 to 9 cm size class (1,407 g), and 4 in the 9.1 to 15 cm size class (1,957 g) for a total weight of 3,364 g and an average rock weight of 336 g (see Table 8-5). The square consisted of dolomite (N = 7) and sandstone slabs (N = 3).

Figure 8-62. Overhead View of the Lower *In Situ* Part of Feature 18 with Scattered Burned Rocks in Northeastern Part and an End Scraper in the Wall at the Top.

Figure 8-63. Close-up of Profile Under Eastern Side of *In Situ* Burned Rocks that Formed the Lower Part of Feature 18.

The burned rocks and darker-stained sediment below the rocks were surrounded by a brown (10YR 5/3) sandy loan with tiny (pea size or smaller) calcium carbonate nodules scattered throughout. A phytolith sample (#1129-004) was collected from directly under one of the middle burned rocks. The dark stained matrix (#1129-004-1) was also collected as a sediment sample for possible flotation. All the burned rocks (#1129-003) were also collected. Once in the laboratory, and working with the many plotted burned rocks from within and around this cluster, it was determined that Feature 18 was probably the intact, lower part of a pit/basin, whereas the upper part of the feature was not recognized in the field as directly related.

Five other burned rocks that included two between 0 and 4 cm in diameter (92 g), two between 4.1 and 9 cm in diameter (201 g), and one between 9.1 and 15 cm in diameter (147 g), plus two chert flakes (#1128-001) and one complete left bison scaphoid (#1128-002), were scattered across the northeastern part of this unit between 53 and 62 cmbs. A well made red end and side scraper (#1128-010) was found *in situ* at 58 cmbs along the north wall of this unit.

The end and side scraper #1128-010 has a broken distal end that was subsequently reworked, resulting in an irregular shape (Figure 8-64). The scraper was manufactured from red Alibates. It has an overall rectangular shape with a very thick distal end that tapers to the proximal end. The proximal end lacks the striking platform and bulb of percussion, both of which were intentionally removed. The ventral surface is nearly flat with a couple of small flake scars at the proximal end. The dorsal surface was fully flaked with several flakes driven from the proximal end, as is evidenced by multiple hinge fractures. Both lateral edges have been flaked and are relatively steep. The distal end is irregularly shaped with minimally three large flake scars originating from the ventral surface that have extended up and across the distal face. One relatively large hinge fracture is near the left lateral end. A few small hinge scars are along a very limited area of the distal end. The appearance of the distal end would indicate extensive reworking after it broke with a final irregular and distorted configuration. The flake scar ridges exhibit wear and polish, indicating that this piece was probably hafted. This scraper was sent to Dr. Hardy for use-wear analysis. The use wear revealed starch grains and hard, high silica polish along one lateral edge, which is interpreted to indicate use in scraping starchy plants (Appendix L).

Figure 8-64. Unwashed Alibates End and Side Scraper (#1128-010) from just North of Feature 18.

To determine what potentially was cooked in Feature 18; small pieces of burned rock were subjected to two different residue analyses. Two pieces (#1129-003-1b and #1129-003-2b) were sent for starch grain analysis. Burned rock #1129-003-1b yielded damaged starch grains from processing, and one grain identified as Canadian wildrye. Burned rock #1129-003-2b yielded gelatinized starch grains indicative of cooking with heat and water, plus one unspecified starch grain (Appendix F).

A couple of the sandstone pieces that initially were thought to be metate fragments were selected for additional detailed analysis. A 147 g piece of a thin sandstone metate fragment (#1129-010) was sent to Dr. Perry for starch grain analysis. This fragment yielded starch grains damaged by grinding, nine lenticular starch grains common to grasses in the Pooidae subfamily, and two other grass starch grains (Appendix F). A 692 g piece of another thin slab of sandstone (#1129-011) was also sent for starch grain analysis. This second piece (#1129-011) yielded 14 lenticular Canadian wildrye starch grains common to grasses in the Pooidae subfamily, and one other grass starch grain (Appendix F). A third small piece (36 g) of the larger fragment (#1129-011) was sent to Dr. Malainey for lipid residue analysis. This piece yielded high-fat-content seeds/nuts with conifer indicated by the biomarker dehydroabietic acid (Appendix G).

Also, two burned rocks (#1129-003-1a and #1129-003-2a) were sent to Dr. Malainey for lipid residue analysis. Sample #1129-003-1a yielded a medium-fat-content plant and animal combination, plus the presence of with conifer lipids. Sample #1129-003-2a yielded high-fat-content plant seeds/nuts and animal lipids, and, again, conifer lipids (Appendix G).

Pieces of these same two burned rocks (#1129-003-1b and #1129-003-2b) plus one sediment sample (#1129-004-1b) from beneath the lower cluster of burned rocks were sent to Dr. Perry for starch grain analysis. No starch grains of any kind were discovered in the underlying sediment. This indicates that the starch grains discovered on the burned rocks and the metate fragments did not come from the surrounding matrix, but were present as the result of use related contact with plants. Rock #1129-003-1b yielded one damaged starch grain that indicates processing and one lenticular grain common to grasses in the Pooidae subfamily. Rock #1129-003-2b yielded one gelatinized starch grain and one other grass grain (Appendix F).

The matrix sample (#1129-004-2) from between 55 and 60 cmbs and immediately below the tightly clustered burned rocks was floated. This 3.95 liter sample yielded both a light and a heavy fraction. The heavy fraction yielded a total of 153.4 g of material that includes; 84 tiny fragments of burned rock that account for nearly all the weight, 22 tiny fragments of bone, six tiny pieces of charcoal, one burned hackberry seed, and two tiny pieces of lithic debitage. Two of the tiny bone fragments were burned. The light fraction (3.9 g) yielded 26 to 50 rootlets, three unburned cheno-am seeds, and five unburned sunflower seeds, but no charcoal or carbonized seeds (Appendix N). A subsample of #1129-004-1b was submitted for starch grain analysis. Dr. Perry recovered no starch grains of any type (Appendix F), indicating that the starch grains from the burned rocks were derived from the foods that were cooked with those burned rocks rather than from the surrounding sediments.

The lower, well defined burned rock square appears to be the bottom of a shallow basin/pit in which the upper part was potentially disturbed. This square cluster is in the vicinity of Feature 15 and may be apart of that broad cluster. If Feature 18 was the bottom part of a shallow basin/pit, then it is likely that it was the bottom of a small oven. If food was cooked in this oven, as one would assume (see above), then once the food inside was cooked, it was removed causing the top part of the oven to be moved. The food removal would account for the disorganized scatter of burned rocks found over Feature 18. The creation of a pit for oven baking would also account for the well defined bottom left intact. A pit here would also account for the preservation of the dark organic stain below the rocks, in contrast to most other features, which lacked any visible dark stains. Therefore, Feature 18 is interpreted as the intact bottom of a small rock/earth oven with the amorphous burned rock scatter above representing the removed cap. The depths of the bottom rocks in Feature 18 are only about 5 cm below the other scattered burned rocks in the vicinity, so it can be inferred that the basin was quite shallow and that most of the top part of the possible oven was above ground.

Feature 19

This feature consisted of 14 clustered burned rocks and one bison bone (#1070-002) between 61 and 70 cmbs in N116 and N117 E107. The clustered burned rocks were in a somewhat circular pattern that measured roughly 60 cm in diameter (Figures 8-65 and 8-66). The 14 rocks ranged in size from 3 to nearly 12 cm in diameter and weight a total of 4,500 g (see Table 8-5). These cultural items were in a gray-brown (10YR 5/2) silty loam. The surrounding matrix lacked charcoal staining, ash, or any other sign of *in situ* burning. Following recording and photo documentation, two burned rocks, but not sediment samples, were collected. In the laboratory, one of the collected rocks was recognized as a metate (#1070-011, see description below).

Two burned rocks (#1070-003-1a and #1070-003-2a) were sent to Dr. Malainey for lipid residue analysis. The results are quite similar to those obtained on other specimens, with only minor variations. Burned rock #1070-003-1a yielded high-fat-content plant seeds/nuts as revealed by azelaic acid, plus evidence of with animal products. Burned rock #1070-003-1a yielded lipids of moderately high-fat-content plant seeds, plus conifer, as indicated by dehydroabietic acid (Appendix G). One piece of burned rock (#1070-003-1b) was sent to Dr. Perry for starch grain analysis, but it revealed no evidence of starch grains (Appendix F).

Figure 8-65. Overview of Feature 19 that Shows Associated Burned Rocks.

Figure 8-66. Profile of Feature 19, View North.

The shape of this cluster implies it was a pile of discarded rocks that were no longer effective in heat retention. Based on its depth and stratigraphic position, Feature 19 is one of many features associated with the lower occupation of the Late Archaic component.

Discrete activity areas appear mostly within the lower occupation of the Late Archaic component, representing a reasonably intact camping area, which has suffered some post depositional disturbances, mostly through rodent activity. The upper occupation of the Late Archaic component is represented by fewer identified cultural features, and by stone tools that are very similar in appearance to those from the lower occupation.

Discussion of Features

Twenty two clusters of cultural materials (not counting the rodent burrow, Feature 7) were labeled as features and pertain directly to the Late Archaic component. Two, Features 3 and 4, were discovered adjacent to BT 34 during the Phase I data recovery along the northern and eastern margins of the excavation block. The remaining 20 were within the excavation block.

The stratigraphic assessment indicates that minimally two Late Archaic occupations are represented. The vertical positions of seven cultural features (Features 6, 12, 13, 15a, 15b, 15c, and 15d) indicate they were associated with the upper occupation. The stratigraphic position of the other 15 features (Features 3, 4, 5, 8, 9a, 9b, 9c, 9d, 10, 11, 14, 16, 17, 18, and 19) or 68 percent of the total are roughly only 10 cm below the upper occupation. Materials potentially associated with the latter 15 features are relatively more abundant in comparison to the upper occupation. However, the overall light scatter from both occupations, combined with the sloping stratigraphy, and the roughly 10 cm or so between the cultural occupations, creates some doubt as the original association of the smaller artifacts. Over time, turbation has undoubtedly displaced the smaller cultural debris. Therefore, although two occupations within this Late Archaic component are documented stratigraphically based upon the depths of the features, there were not sufficient concentrations of the smaller artifacts in discrete levels to allow for precise assignment to one of the two projected occupations.

The 22 cultural features are dominated (86.4 percent) by various quantities of burned rocks with only three exceptions (Features 10, 13, and 17). The 19 burned rock features yielded 817 rocks weighing a total of 244,875 g (Table 8-5). The average burned rock weight is calculated at roughly 300 g. The four size classes are identified in these features, with the 0 to 4 cm size accounting for 21.1 percent, the 4.1 to 9 cm size accounting for 44.2 percent, the 9.1 to 15 cm size accounting for 27 percent, and those greater than 15 cm accounting for only 4.4 percent. The rocks are predominantly dolomite/caliche, with sandstone and quartzites rocks much less numerous.

Most burned rock features lacked well-defined margins or obvious patterned placement of individual rocks. In large part this lack of obvious placement of the rocks may reflect the type of feature and/or possible disturbances following abandonment. In general, features also lacked charcoal lenses, charcoal concentrations, ash, or oxidized soil. This lack of organic and visible remains of fires may be due to their absence from a given feature, but it seems highly unlikely that none of the investigated burned rock features involved wood fires. The complete absence of such evidence is attributed to preservation problems, rather than to feature function. The absence of staining and charcoal made it much more difficult to interpret specific function and/or use of these burned rock features. Most features also lack obvious basins; however, a few exhibited a couple of stacked rocks in limited parts of the clusters. The dark soil in which most features were discovered, certainly hindered recognition of soil color changes as would mark the margins of basins. So, the interpretations presented for each feature are somewhat tentative.

Nonetheless, about 26 percent (5 out of 19) of the burned rock dominated features are interpreted as *in situ* and generally intact heating elements (including Features 4, 8, 9a, 12, and 18). These are viewed as locations at which a fire was built to heat rocks and cook food. Two other features (9d and 15b) are possible *in situ* heating elements, but the supporting evidence is relatively weak. In contrast, the other 74 percent of the features are interpreted as places where burned rocks were dumped as discard following minimally one episode of use. These clustered burned rocks were used in cooking activities at other locations, potentially in the heating elements or in above ground boiling containers, but after their use they became no longer desirable, and so they were then discarded at these locations.

To ascertain what was cooked by these rocks, samples were sent for lipid residue and starch grain analyses. In general, a single rock was intentionally broken in order to provide samples for each kind of analysis from the exact same rock. In most cases, we maximized the information obtained from a single burned rock and were able to cross check the results against the other analysis.

For the lipid residue analysis 17 different features were sampled using a total of 46 burned rocks (Appendix G). The generalized lipid interpretations clearly reflect the presence of large herbivore products that include meat and bone marrow (N = 6 or 13 percent), the presence of high-fat-content plant (seeds/nuts) (N = 19 or 41 percent), sometimes a combination of the two (N = 16 or 35 percent), plus trace biomarkers of conifer products (N = 16 or 35 percent), which undoubtedly reflects the types of wood used as fuel to heat the rocks. About 20 percent (N = 9) of the samples failed to yield sufficient residues for interpretations. The overall lipid results were quite positive, and very helpful in understanding what products were involved with the burned rocks. That large herbivore products were cooked, could have been expected given the high frequency of bison bones recovered (see below). Beside the animal meat and/or grease products, an unexpectedly high frequency of plant products was also detected in the lipid residues. These plant residues are dominated by lipids from seeds and/or nuts.

The starch grain analysis also yielded mostly very positive results, with 65 percent of the analyzed burned rocks yielding starch microfossils of some type. A total of 17 features were sampled and 40 individual burned rocks were analyzed (Appendix F). Not only were starch grains recovered from 65 percent of the samples, but specific conditions of the grains were detected such as damaged (9 samples) and gelatinized (13 samples) specimens, reflecting processing and contact with heated water, as in boiling. About 38 percent of the samples also yielded identifiable starch grains dominated by Canadian wildrye (*Elymus canadenses*) grass seeds.

Three other features included two large natural sandstone slabs that are definitely manuports (Feature 10), approximately half of a broken grinding slab (Feature 13), and a severely weathered bison cranium (Feature

17). The clear function of the manuports is not apparent. They potentially served as anvils or butcher blocks used in the processing of meat and bones. The other two features represent separate, individual tasks of individual discarded items.

Unfortunately the broad excavations did not encounter any obvious habitation structures, although structures of some nature potentially were present at one time. Most structures would have had wooden pole frameworks. If these rested on the ground surface and were not dug or pushed into the soil, they would leave no archeologically identifiable trace. If rocks were somehow employed along the base of a structure, then those would help define the location and/or shape of the structure. In some instances a small circular hearth/stain surrounded by either a broad circular concentration of cultural debris or a broad circular void may be interpreted as the location of a possible structure. These types of distributional patterns were sought and looked for, but none were identified. No matter what the cause structures were not identified.

The horizontal distribution of the 22 features that represent the Late Archaic component reveals an interesting pattern (Figure 8-67). Four broad concentrations of burned rocks were found around burned rock Features 8, 9, 12, and 15 with seven subfeatures designated within these broad areas. These four concentrations encompassed an area of roughly 42 m^2, or just over 14 percent of the excavation block, and were separated across the block.

In the southeastern corner was Feature 9, which covered approximately 12 m^2 with its four individually recognized clusters of burned rock (Features 9a, 9b, 9c, and 9d). Although far from clear, Feature 9a possibly functioned as an *in situ* heating facility for the rocks used to cook foods. This is based primarily on its overall shape and the few rocks involved. Minimally Features 9b and 9c, and possibly 9d represent discarded burned rocks following their use in cooking. No recognizable basins or charcoal rich sediments were present to help in the interpretations. This area also yielded very few bones, lithic debitage, formal and informal stone tools. The combined information recovered from this concentration reflects focused cooking activities were carried out in this area. This concentration is part of the lower Late Archaic occupation.

A second major cluster of burned rocks was roughly 10 m west, centered around closely associated Features 8 and 11 (Figure 8-67). These two features plus the scattered burned rocks around them encompassed about 6 m^2. Feature 8 is interpreted to represent an *in situ* heating/cooking facility. The immediately adjacent Feature 11 is interpreted as a discard pile of used burned rocks. The scatted burned rocks around these two recognized features are thought to represent scatters of burned rocks used in the cooking process. The area around burned rock Features 8 and 11 had a near absence bones, lithic debitage, and stone tools. If Feature 8 functioned as an *in situ* heating element, it was not constructed within a deep basin. Support for this having been an *in situ* heating element is the mass of scattered burned rocks that surrounded it, including the rocks clustered in Feature 11. The lack of quantities of other classes of cultural materials in this vicinity also supports the idea that activities focused on rock heating and cooking. This activity area is also part of the lower Late Archaic occupation.

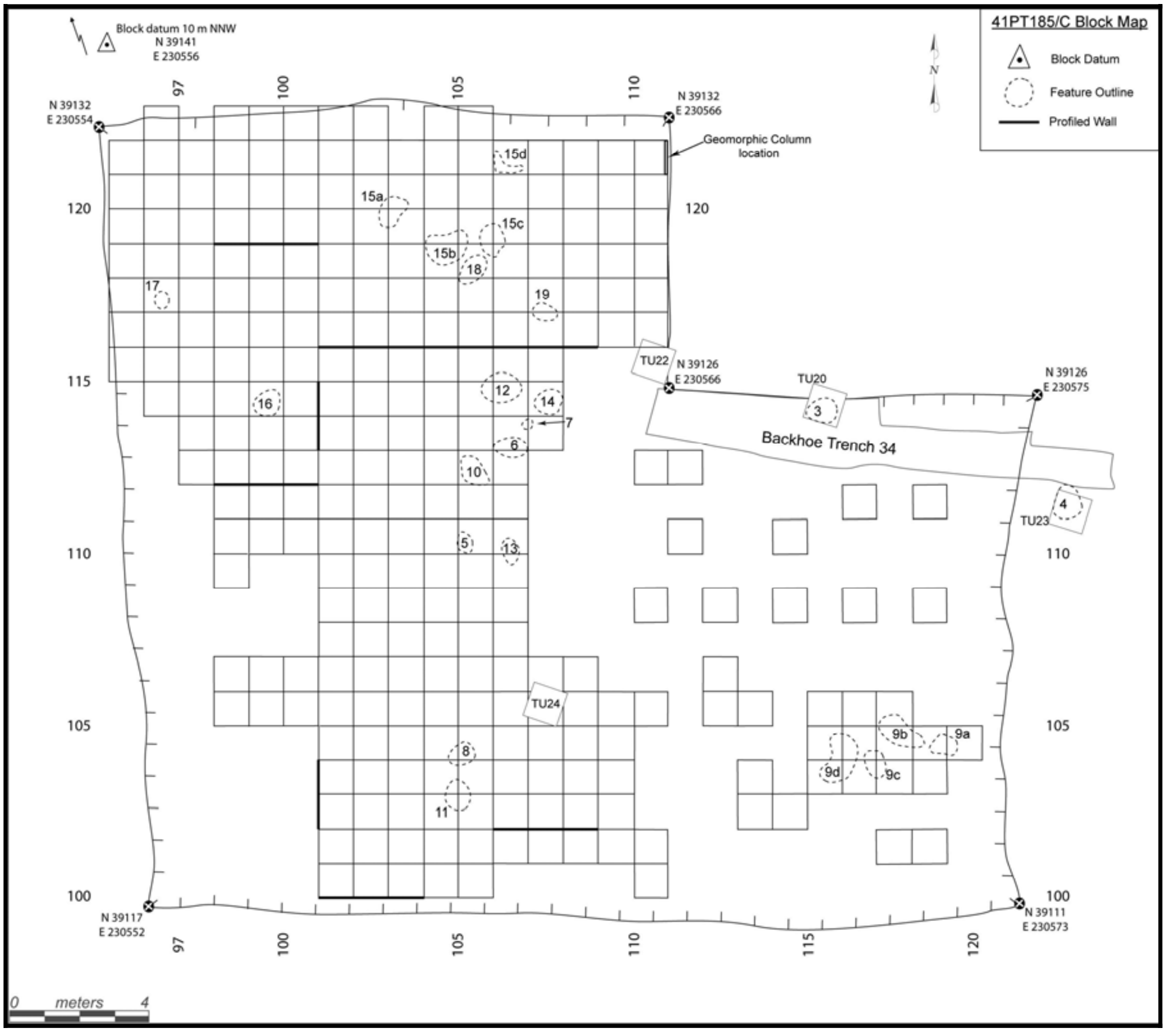


Figure 8-67. Horizontal Distribution of Recognized Features in Excavation Block at 41PT185/C.

The third major concentration was ca. 13 m north of the second concentration and ca. 18 m northwest of the first, in the northern end of the block. There, five clusters of burned rock associated with Features 15 and 18 and other scattered burned rock were again concentrated in an area of roughly 16 m^2. Feature 18 is interpreted an *in situ* heating/cooking facility. The other numbered concentrations (Features 15a, 15b, 15c, and 15d) may all reflect discard/dump areas of used burned rocks. A difference in this concentration is the presence of scattered butchered bones, numerous lithic debitage, and scattered stone and bone tools. If Feature 18 was the only *in situ* heating element in this concentration, then it potentially was used over an extended time to have heated all the burned rock in this one area. The high concentration of burned rock in this area testifies to the extensive heating, use, and discard of rocks used for cooking. As with the other two areas this third concentration was clearly the focus of intensive cooking activities. However, this activity is part of the upper Late Archaic occupation.

The fourth concentration was centered on Features 6, 12, and 14. However, it was apparent that Features 6 and 12 were part of the upper occupation, whereas Feature 14 was part of the lower occupation. Therefore, part of the apparent concentration comes from the presence of two closely overlapping occupations and not a single use episode, as postulated for the three previous concentrations. But here again, all three features are interpreted to reflect heating and/or cooking activities with very limited quantities of other classes of cultural materials in this immediate vicinity. The dominant activity reflected in the four burned rock concentrations is heating and/or cooking.

These four dense concentrations were distinct and separate from one another with 3 to 13 m between them. The first three concentrations appear to represent discrete and localized activity areas that reflect a focus on cooking tasks with each possibly centered on an *in situ* heating/cooking facility (Features 9a, 8, and 18). Around these heating elements were discarded burned rocks that were still in discrete clusters with others scattered about. The main difference between the three concentrations is that the most northern one, centered on Features 15 and 18, also yielded higher frequencies of butchered bones, lithic debitage, and stone and bone tools. This area also has yielded slightly more recent radiocarbon dates for a Late Archaic occupation. This is in contrast to the earlier concentrations centered on Features 8 and 9.

The forth and smaller concentration of burned rocks reflects an overlap between the two identified occupations. Although this was also a cooking area, Feature 12 is interpreted as an *in situ* cooking/heating facility, whereas Features 6 and 14 again reflect disposal of various sizes and types of burned rocks.

These four burned rock concentrations are dense and broad enough to imply that they were positioned outside any type of formal structure. These concentrations would have been work areas away from the structures or sleeping areas allowing discard of materials without interference from other activities.

Feature 10 with its two large sandstone slabs that potentially served for butchering or bone breaking, was situated a couple of meters south of heating element, Feature 12, and could have been the focus of a meat and/or bone processing task. Feature 13 was an inverted and broken half of a metate. Its location ca. 3 to 4 m from any of the other apparent concentrations indicates it probably represents another discard area that was segregated from the cooking areas. It is also possible that this location reflects a separate primary use location. Although the adjacent Feature 5 reflects the discard of multiple classes of cultural debris, most likely from cleaning work areas.

All of the previously discussed concentrations and associated cultural features appear to reflect two occupations that are very close in vertical elevation. Although two occupations are represented, their horizontal distributions reflect specific human activities and behaviors that were spatially organized.

Feature 17, the poorly preserved bison cranium, was definitely lower than the adjacent Features 15 and 18. A piece of the skull was radiocarbon dated to 2510 B.P., which is near the earlier end of the oldest cluster of radiocarbon dates. The skull reveals evidence of cultural modification only in a single impact scar on the top of the cranium. The presence of this skull may indicate a bone processing areas away from the different cooking activities. The burned rock features across the southern half of the block are probably associated with this skull.

From the 22 cultural features, most of which consisted of dense concentrations of burned rocks, it is quite apparent that heating rocks for use in cooking and the actual cooking were primary tasks conducted in this Late Archaic component. Further discussions of the cooking technology employed are presented below under the section dealing with technology. More specific chronology of the two stratigraphically identified occupations will be discussed under the chronology section.

8.4.3.4.2 Chipped Stone Tools

Hand excavations (in the block and adjacent TUs) yielded a variety of formal and informal chipped stone tools that total 133 individual pieces or 1.1 percent of the total assemblage. Based on general morphological form, these include diverse functional types such as 21 projectile points and point fragments, 21 complete and partial bifaces including a corner-tang knife, eight scrapers, 74 edge-modified tools, five choppers, two hammerstones, one uniface, and one drill base. Individual tool descriptions are presented by tool class, which are generally assumed to represent the primary tool functions. Individual attributes and metric characteristics are recorded for each formal and informal tool (Appendix Q).

In addition to assigning the recovered chipped stone tools into standard functional classes based on their overall morphology/form, 31 tools (23 percent of the total) were selected from the various morphological classes and subjected to high-powered microscopic use-wear analysis (Appendix L). The tools selected consist of 10 complete or fragmented bifaces, seven edge-modified flakes, six end and side scrapers, five projectile points and point fragments, two bifacial choppers, and one drill base. This use-wear analysis focused on identifying the specific motion and target material that each tool was used on by incorporating observations of microfossils and organic remains on the tools. This microscopic technique often reveals a much broader range of tool functions, which also broadens our understanding of the various activities conducted at this specific component. Individual use-wear findings are presented with each tool subjected to this analysis.

Projectile Points (N = 21)

The projectile point assemblage (14.5 percent of the total stone tool assemblage) is quite fragmentary and includes the following specimens; two complete points (#1104-010 and #1288-010), one base and midsection with partial notches (#635-010), five distal tips (#193-010, #209-010, #375-010, #962-010 and #1355-101), one medial section that lacks notches but has a short contracting stem (#1226-010), one lateral edge (#1169-010), and 11 stems with basal edges. Metric measurements and observed characteristics are provided for each specimen in Appendix Q. Most specimens remain unwashed for potential future analyses. No refits were possible. Three point bases (#984-010, #1033-010, and #1348-010) and two completed points (#1104-010 and #1288-010) were subjected to high-powered use-wear analysis (Appendix L). Artifact specific information on the use-wear results is presented with each specimen below. Three small fragments of points were sent for INAA and were destroyed.

Only three specimens are sufficiently complete to enable discussions of specific details concerning their overall shapes and hafting characteristics. The three more complete specimens (#635-010, #1104-010 and #1288-010) that retain their bases and notches can be assigned to a general corner-notched dart point classification (Figures 8-68, 8-69 and 8-70). However, the three hafting areas are all slightly different in appearance. The largest and most complete specimen (#1104-010) has notches that are broad and deep that creates short barbs that terminate near the end of the notch and a relatively narrow, slightly expanding stem with a very slightly convex basal edge. Use-wear analysis detected plant fibers and resin on the proximal half with hard, high-silica polish on the stem, which, combined with the impact fractured tip, indicates that this artifact functioned as a hafted projectile point (Appendix L).

Figure 8-68. Unwashed Projectile Point #1104-010 that has a Narrow,Slightly Expanding Stem. (scale in cm)

The second specimen (#1288-010) has relatively narrow and deep notches with long barbs that terminate much closer to the basal edge. The stem is much broader and the basal edge is again slightly convex. Use-wear analysis revealed plant fibers on the stem and in the neck area with abraded flake scar ridges on the stem, indicating that this point was hafted halfway up the neck. No functional interpretation was provided (Appendix L). The lack of clear use-wear generally reflects lack of repeated use to create sufficient wear for observation.

The third specimen (#635-010) has broken barbs and only part of the stem so it is more difficult to compare with the previous two. It has much narrower notches with a much shorter stem with a basal edge that is slightly concave. These three specimens each show slightly different notch configurations, creating slight variation in the shapes of the stems and overall hafting elements.

A proximal and medial section (#1226-010) has no notches or barbs, and a short slightly tapering stem that appears to be complete (Figure 8-71). This overall form is completely different from all the other specimens, which may imply that this is not a projectile point, but in fact served some other function. However, the overall size is quite similar to the three more complete projectile points. An alternative is the base was broken and subsequent reworking of the stem created a different appearance for this particular specimen.

Figure 8-69. Unwashed Projectile Point #1288-010 that has a Broad, Expanding Stem. (scale in cm)

Figure 8-70. Projectile Point #635-010 that has Narrow Notches and Expanding Stem. (scale in cm)

The 11 stem fragments exhibit only slight variations (Figure 8-72), and are, as a group, most similar to complete point #1104-010. The most obvious characteristic is the slight expansion of most or the stems toward the proximal base compared to the more acute expansion on the two other more complete corner-notched points. In terms of their basal edge shapes, five have slightly convex basal edges, two are straight, two are slightly concave, and two are unknowns.

Figure 8-71. Unwashed Projectile Point #1226-010 that has Unusual Contracting Stem. (scale in cm)

Figure 8-72. Unwashed Projectile Point Bases that Exhibit Similar Expanding Stems and Similar Break Locations. (scale in cm)

(Top left to right #1033-010, #1168-010, #1138-010, #1279-010, #984-010, #895-010, #245-010, and #204-010)

Variation also occurs in the basal grinding as ten specimens have light grinding, four have indeterminate grinding, one has heavy grinding, and two show no grinding. The heaviest grinding is on base #984-010. The partially complete point #635-010 and one base (#895-010) have no apparent grinding. Basal grinding is one characteristic that generally separates arrow points from dart points as well. In 53 percent of the cases the lateral edges of the stem are also lightly ground. The stem grinding is important in the hafting, with the dulled edges reducing the potential cutting of the lashings that bind the stone tips to the wooden shafts. Stem thickness varies from 4.27 to 6.3 mm, with an average of 5.0 mm. These measurements relate to the size of the notch made in the wooden haft where these dart points were inserted. The proximal base/stem width varies from 12.13 to 20.4 mm with, an average of 16.18 mm. These measurements relate to the width of the haft where it was attached to the stone point. The average is considered roughly 5 mm wider than most arrow point hafts and supports that the shafts used at this time were much wider. Stem lengths were measured for the broken bases as well to detect if a standard stress point is evident. The stem lengths vary from 9.74 to 17.55 mm with an average of 12.19 mm. One base (#1348-010, not pictured) appears aberrant in terms of its overall size as it is much longer, wider, and thicker than all the other bases and even the complete points. If this one base is removed from the analysis it reduces the overall length and width averages by more than 0.5 mm.

The metric measurements on the two more complete points (#1104-010 and #1288-010) that are visually different also show slight metric differences as well. The stem length on the specimen that is more stemmed in appearance (#1104-010) has a longer stem, a slightly narrower distal stem width, and a slightly thinner stem thickness. Potentially these metric measurements may contribute to establishing subclasses or groups within the larger corner-notched Late Archaic category.

As a group, the projectile points were all manufactured from local tool stone resources. Alibates account for 58 percent, Tecovas for 23.5 percent and the Dakota quartzites for the remaining 18.5 percent. The fact that these were all manufactured from local materials indicates that the residents of the site were inhabitants of this region. Why Alibates was used twice as much as Tecovas is not clear, as Tecovas is certainly more widespread than Alibates. Alibates is a slightly higher quality material, and it may have been preferentially selected for that reason. The absence of nonlocal materials also reveals that these groups were not trading for exotic materials to obtain better quality materials.

Use-wear on three bases/stems #984-010, #1033-010, and #1085-010 revealed polished and abraded flake scar ridges on #984-010 indicative of hafting. Stem #1033-010 shows light polish, and even though it was interpreted as unused, the break type indicates otherwise. Stem #1348-010 revealed no evidence of wear and again was interpreted to have been unused.

INA analysis was conducted on three point fragments, two bases (#596-0101 and #928-010) and one tip (#962-0101). The INAA consumed all of these tiny fragments. The chemical analysis verified the visual identifications in all three pieces with the two bases identified as Alibates (#545-0101 and #928-010) and tip identified as Tecovas (#962-0101). Even through limited number, the INA results confirm the manufacture of projectiles from local, high quality materials.

Two complete points were subjected to high-power use-wear analysis. The most complete point (#1104-010,) has plant fiber, resin, and hard, high-silica polish on the stem, a tiny impact scar on the very tip, with polish and resin that extends past the notches and half way up the medial section (Appendix L). The other nearly complete point (#1288-010) also has plant fibers and abraded ridges in the stem area, but the haft polish extends only to the neck/notches. These two complete corner-notched points, with somewhat differently shaped hafting elements, indicate slightly different hafting strategies. In the first instance (#1104-010,) the shaft to which the point was attached appears to have extended to the midpoint of the artifact. In the second instance (#1288-010) the shaft appears to have terminated at the notches. At present, the significance of these differences is unclear. One has resin and the other does not, but that may simply be a function of differential preservation. The small stem of #1033-010 shows only slight polish. Stem #984-010 has hard, high-silica polish and abraded scar ridges (Appendix L).

As indicated above, all the broken bases resemble the basal portion of the largest and most complete dart point (#1104-010) that has haft wear to about the midpoint of the blade. If lashings were used to bind the base to the shaft through the notch area and not further up the shaft, then even though mastic may have been added to help hold the shaft in place past the notches, the tightest lashing spot would still be at the neck area, and that would be the stress point at which the point would have broken.

Bifaces (N = 21)

Twenty one specimens are classified as bifaces and account for 16 percent of the total sample of chipped stone tools. These include seven complete or nearly complete specimens that represent 33 percent of the total, six medial sections, two distal pieces, and six small lateral edge fragments. The more complete bifaces show a wide range of sizes (Figure 8-73). The complete specimens are nearly equally divided between ovate and teardrop shapes.

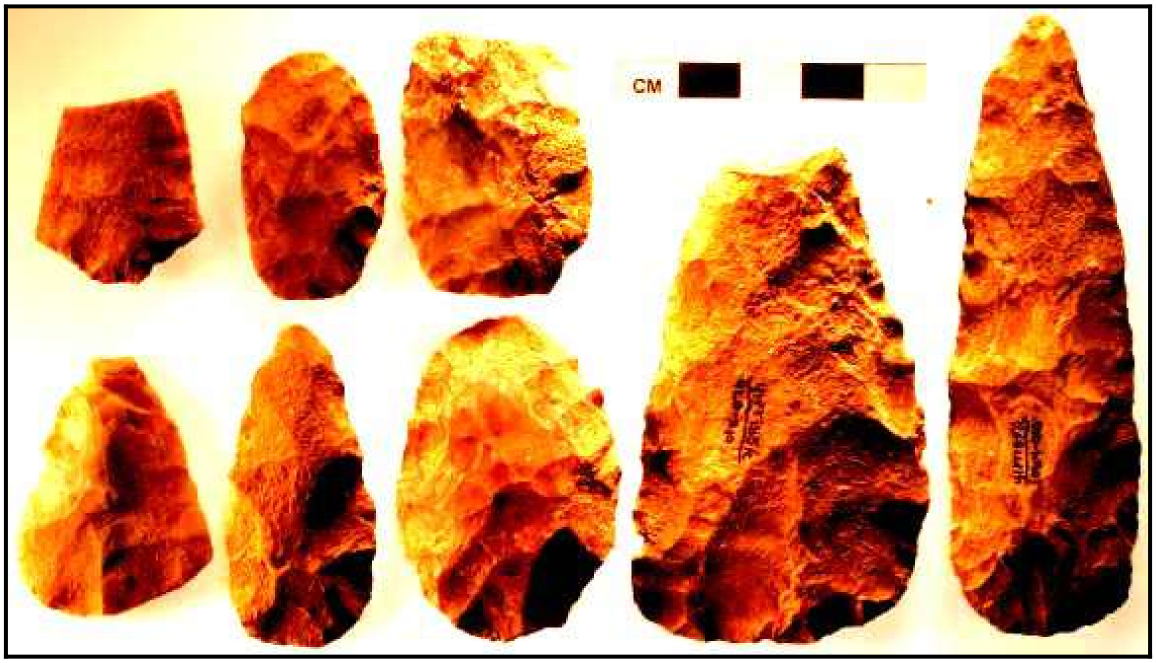


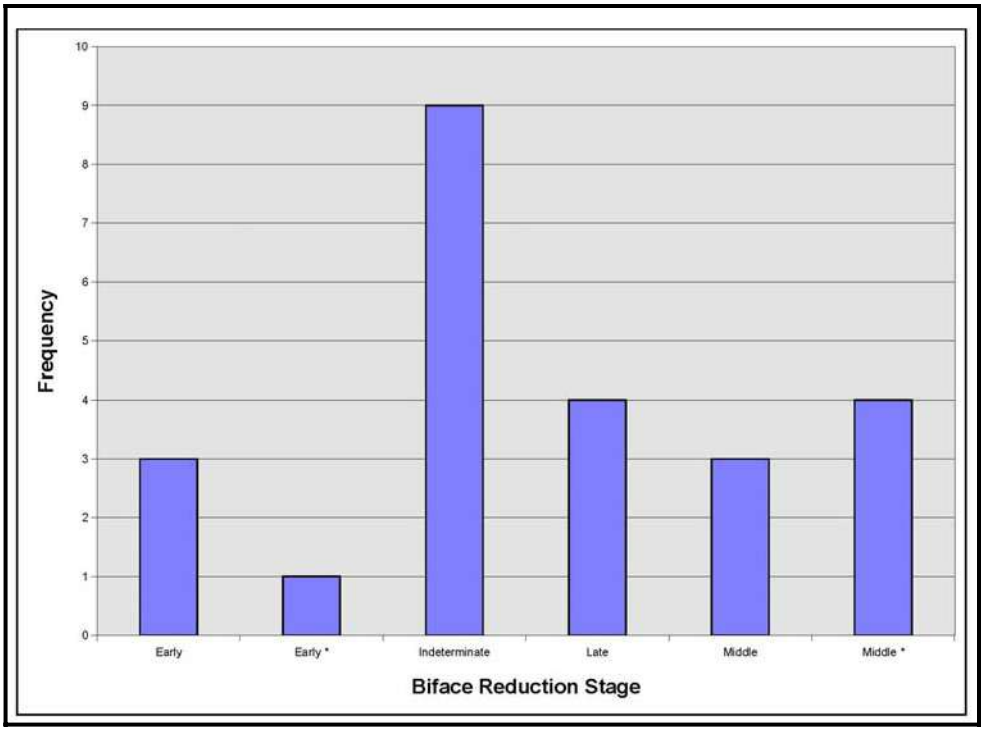
Figure 8-73. Selected Bifaces from Excavation Block, 41PT185/C. (top #317-010, #868-010, #1163-010; bottom #967-010, #1212-010, #494-010, #420-010, and #1064-010, specimens unwashed)

Different stages of manufacture are represented by the various pieces (Figure 8-74). Late stage pieces account for 19 percent of the sample, middle stage pieces comprise 14 percent, three bifaces or 14 percent are categorized as early stage, and the majority is indeterminate at 43 percent. The indeterminate and middle stage bifaces are mostly proximal and distal fragments.

The more complete bifaces are in the early stage represented by two Alibates and one quartzite biface. Only one biface (#1107-010), manufactured from chalcedony, reveals a limited amount (1 to 25 percent) cortex. The rest, 95 percent have no cortex at all. Most bifaces arrived on site in the middle to late stages of reduction or as finished forms.

Sixty seven percent of the bifaces are made of Alibates, 19 percent are of quartzites and include three Potter chert and one Dakota quartzite, 5 percent are dolomite, 5 percent are chalcedony, and 5 percent are Tecovas. Alibates is clearly the dominant material. Its high frequency indicates that the site's occupants had recently been at the quarry locale. However, bifaces include multiple types of local materials with no obvious nonlocal materials identified. This follows a trend in the projectile points. The higher frequency of quartzite in this group may be influenced by the fact that quartzite is generally more coarse-grained material, which contributes to less wear during use. None of the bifaces were heat treated to facilitate knapping.

The longest complete biface (#1064-010) is a slightly patinated piece of unidentified material type at 99 mm long and a narrow 30.6 mm wide. It does not show visible wear and use-wear analysis could not detect evidence as to how this item was used. The smallest complete biface (#868-010) is only 40 mm long by 23 mm wide. The longest complete Alibates piece (#785-010) is about 58 mm long, which is 7 mm longer than the longest complete quartzite biface (#1212-010). The broad range of stages of reduction includes various shapes and sizes,



***These are bifaces that were classified into the stages shown using the width to thickness ratios that Callahan (1979) established for classifying Paleoindian bifaces.**

Figure 8-74. Bar Chart Showing the Frequency of 41PT185/C Bifaces Sorted into Reduction Stages Established by Callahan (1979).

and the numerous fragments present, hinders a concise summary of the metric data for these bifaces.

The corner-tang (#609-010) is the only biface that was intentionally notched to facilitate hafting (Figure 8-75), although other bifaces were also definitely hafted, despite lacking notches.

Figure 8-75. Dorsal View of Corner-Tang Knife (#609-010). (scale in cm).

This is a rare notched biface that was manufactured from a light colored Alibates with dark bands. The ventral surface is nearly flat with a few broad flake scars along one left later edge with smaller and narrower scars along the opposite edge. The dorsal surface is convex with more scars along the left lateral edge, which is also relatively steep (45 degrees) for a cutting edge. The tip has been snapped off during use. The haft area is well executed with very "U" shaped notches that create an expanding stem with a well executed convex basal stem edge. The basal edge and notches are heavily ground. The notches were created after the base was formed. High-power use-wear analysis observed plant fibers, starch grains, wood, and hair residues, with hard, high-silica use-wear from cutting soft material such as hide (Appendix L, Table L-2). Also observed were abraded ridges and polish on the proximal third around the haft elements, which Dr. Hardy interprets to indicate the position of the haft (Appendix L, Figure L-2). This hafted tool functioned to cut hides and starchy plants.

In summary, this group of bifaces shows a wide range of overall forms, shapes, thicknesses, lengths, even in the fragments represented. No refits were possible and no two pieces were from the same biface, so each biface and fragment represents an individual tool. No biface template was apparently in use by the craftsmen, since the range of shapes, sizes and thickness are so diverse. The relatively high frequency of mostly completed specimens seems unusual with the amount of meat and bone processing that occurred. In contrast, the relatively high incidence of small fragments of lateral edges testifies to the extensive use of bifaces, and that edges occasionally broke off. The high frequency of breakage most likely reflects stress during use on the meat and bones of the animals being processed.

At first, the broad diversity in shapes and thickness was thought to have been connected to the type of function for each of the various shapes. Eleven bifacial specimens, that included the corner-notched knife, were selected and submitted for high-power use-wear analysis. Details concerning each biface are presented in Appendix L with only a brief summary presented below and in Table 8-6. These specimens were not washed or handled before this analysis. The analyzed specimens include seven more or less complete bifaces, the corner-tang knife, one midsection, and one lateral edge. Eight (73 percent) revealed evidence of use with plants that consist of fibers, starch grains and wood. Five have wood fragments whereas two have starch grains. Animal products (hair) were observed only on the corner-tang knife. Two specimens, the biface edge fragment and complete biface #494-010 did not exhibit any residues at all. Use-wear in the form of hard, high-silica polish was observed on three, together with abraded ridges on two others. Five bifaces were hafted including three of those unnotched pieces.

In all three instances the abraded ridges indicative of haft-wear extended to half way or middle of the biface. Biface #868-010 has resin in the haft area together with the hard, high-silica polish. The tiny wood fragments observed on five specimens appear on three proximal ends, one distal end, and one medial area. The wood on the proximal end may well represent part of the

Table 8-6. Tool Function through High-Powered Use-Wear.

Artifacts By Period	Inferred Function									Contact Material and Observed Residues										
	Unknown	Scraping	Cutting	Boring/Drilling	Whittling	Hafted	Slicing	Pounding	Chopping	Plant Tissues	Polish	Bone	Hard, High Silica Plant	Wood	Animal Hair	Starch Grains	Raphides	Hide	Resin	Unknown
Late Archaic Tools																				
Points	3					3				2	2								1	
Bifaces	2		2			2				3			2	4		1		1	1	1
Corner-tang Knife			1			1				1			1	1	1	1		1		
Scrapers	1	5								4	1	1	1	2	2	3		1		
Edge-Modified Tools	1	1					3			2	1		2	2		4			1	
Chopper								1	1	1			1	1		1				
Drill		1								1			1	1						

haft rather than the material it was used on. Minimally, three bifaces (#420-010, #494-010, and #1085-010) have unknown functions or were not used sufficiently to accumulated detectable wear. However, two of those bifaces were of relatively coarse-grain materials, which are difficult to detect good evidence of use-wear.

Minimally three bifaces in which use-wear was conducted revealed haft-wear that extends to near the midpoint of the biface. This extensive haft-wear is similar to the haft-wear observed on one complete projectile (#1104-010). This is consistent and repetitive behavior in the hafting technology.

Parts of five biface fragments, three medial sections (#347-010, #800-010 and #1038-011) and two lateral edges (#785-0101 and #1206-010) were sent for INA analysis. Three were chemically identified as Alibates (#800-010a = TRC457, #347-0101 = TRC450, and #785-010a = TRC456), one as Tecovas (#1206-010 = TRC469), and one (#1038-0101 = TRC464) did not fit either group (Appendix E). The latter piece is a small lateral edge with color and texture characteristics similar to Tecovas and Alibates, and is potentially burned. Its source is unknown. Both Tecovas and Alibates occur locally and definitely exploited by these Late Archaic populations. The chemical determinations helped to guide the remaining visual identifications on other tools.

Scrapers (N = 8)

Eight specimens or 5 percent of the total chipped stone tools were classified as scrapers (Figure 8-76). These consist of two proximal ends (#1091-010 and #1269-010), two side scrapers (#332-010 and #1221-010), and four end scrapers (#402-010, #452-010, #767-010, and #1128-010). Individual metric and nonmetric observations for each scraper are presented in Appendix Q. Below is a summary of these data.

Figure 8-76. End and Side Scrapers from Excavation Block, 41PT185/C. (top #767-010, #402-010, #332-010; bottom #1221-011 and #1128-010).

Most scrapers do not exhibit extensively worn distal edges. They all lack cortex and signs of heat alteration. End and side scraper #1128-010 is the exception with an extensively reworked distal end that resulted in the very irregular shaped end, which was no longer usable (see Figure 8-76). The reworking or potentially resharpening would have removed the worn out edge and may explain why one is not still present, and why it was discarded. Two specimens (#1091-010 and #1269-010) are thought to represent only the proximal ends of scrapers without the diagnostic distal end present. The classification is based on the observed suttle characteristics. The characteristics include well pronounced and prepared striking platforms on relatively thick, expanding flakes, flat ventral surfaces, and marginal retouch along one of both lateral edges. They are 22 and 24 mm long proximal sections. Specimen #1269-010 has a heavily worn ridge down the left side of the dorsal surface and both specimens exhibit haft-wear. If these represent proximal sections of end scrapers, then extensive pressure had to come to bear on these two tools during their use to snap them in half. These types of specimens are not often recognized in most assemblages, so it is difficult to determine if this is an unusual snap for a scraper. The two side scrapers contrast with one another in that specimen #1221-011 is a very large and thick Alibates piece with one long and convex working edge. This piece was manufactured from a broad side struck flake. The other side scraper (#332-010) is a much smaller and thinner piece of Alibates flake with a much thinner and shorter working edge (see Figure 8-76).

Eighty eight percent of the scrapers were manufactured from Alibates with side scraper #332-010 from Tecovas. The material types illustrate a clear selection for the Alibates even though both are locally available and easy to procure.

Five scrapers, two side and three end and side scrapers, were selected for high-power use-wear analysis. The details concerning each scraper are presented in Appendix L with more of a summary presented below. The typically shaped expanding end and side scraper #402-010 (see Figure 8-76) exhibited hair, bone, and wood fragments, plus hard, high-silica polish all along the very distal end, whereas the proximal end exhibited abraded scar ridges, striations and hard, high-silica polish. Dr. Hardy interpreted the results to indicate this scraper was hafted and used to scrape bone (Appendix L).

End scraper #452-010 has an irregular outline was worked along one lateral edge and the somewhat pointed distal end, with plant and starch observed on the more pointed distal end. This scraper was used to scrape starchy plants. End and side scraper #767-010 is more of your typical shape with soft polish and hair on the distal end and hard, high-silica polish near the middle of the proximal end (see Figure 8-75). This piece was interpreted to have scraped hides.

The very thick and irregular shaped and reworked end and side scraper #1128-010 has hard, high-silica polish along the two lateral edges (see Figure 8-76). One edge also shows some possible starch grains. This piece was interpreted to scrap starchy plants. No haft-wear was detected on the nicely tapered proximal end in which the bulb was removed.

One relatively large and thick Alibates side scraper #1221-011 has plant fibers and starch grains, plus light polish that is indicative of scraping soft starchy plants (see Figure 8-76) (Appendix L). It is interesting that only one of five (20 percent) analyzed scrapers was interpreted to have been used on hide. In contrast, 60 percent were thought to have starch grains and scraped starchy plants. Only two, 40 percent revealed abraded ridges that would indicate they were hafted. However, the occurrence of two proximal ends would indicate that these pieces were hafted and that during intensive applied force they snapped or broke at the point where tight hafting stopped.

Two fragments removed from the two proximal ends of scrapers (#1091-010a = TRC466 and #1269-010a = TRC471) were sent for INAA. Both were chemically determined to be Alibates (Appendix E). These chemical results support the visual identifications.

Edge-Modified Flakes (N = 74)

Seventy four edge-modified flakes were identified and considered informal tools created and used on site. Informal or expedient tools represent flake blanks that have not been significantly altered to change the shape of the original flake. The working edge(s) of these informal tools exhibit only use-related or tiny retouch along their edges. These 74 pieces account for 52 percent of the stone tool assemblage. These readily available flakes or flake fragments were used on site, and discarded following their use. These pieces represent a wide range of shapes and sizes with no apparent attempt to create a formal shape (Figure 8-77). It is assumed that these pieces represent a wide range of functions (i.e., cutting, sawing, scraping, boring, whittling, etc.). Individual pieces are not presented, but those that have been subjected to detail technical analyses are discussed.

As a group 82.4 percent are Alibates followed by 9.5 percent Tecovas, 4.1 percent unidentifiable, 2.7 percent are Dakota quartzite, and 1.4 percent are opalite. This is a very similar trend that was detected in the lithic debitage and formal chipped stone tools. The length of these pieces varies from 9.2 to 96.6 mm with widths varying from 11.3 to 57.5, thicknesses vary from 1.2 to 13.2 mm, and the weights vary from 0.2 to 131 g. The largest piece is quartzite, which is a primary decortification flake with 76 to 100 percent cortex on one face. The shape of most pieces is indeterminate (50 percent) to irregular (42 percent), with 6.8 percent actually exhibiting a recognizable shape. As for the location of the used edge it is most often on the lateral edge (46 percent), with 32.4 percent indeterminate because 80 percent are broken pieces and cannot be orientated. Only 13.5 percent are on the distal ends with the remaining 8 percent on two or more edges.

Figure 8-77. Selected Sample of Edge-Modified Flakes from Excavation Block, 41PT185/C. (#750-010, #965-010, #958-010, #956-010 top row; #848-010, #323-010, #980-010, and #1249-010 bottom row).

Seven edge-modified flakes (ca. 10 percent of total) were selected and sent for high-powered microscopic use-wear analysis (Appendix L). The selected flakes include #273-010, #446-010, #517-010, #588-010, #832-010, #957-010, and #1275-010. Table 8-6 provides a summary of the inferred functions, the contact material, and the observed residues on these seven specimens.

Twelve edge-modified flakes were selected and sent for INAA (Appendix E). Eight (67 percent) were chemically identified as Alibates, two (17 percent) were Tecovas, and one was neither Tecovas nor Alibates. Again, this demonstrates that the majority of tool stone used by these groups was from local sources and that Alibates was dominant.

Tomka (2001) sees two major draw backs for use of informal/expedient tools. First, there is a loss of control at higher pressures and second, there is discomfort and strain on fingers holding and manipulating the tools. He acknowledges that various experiments in butchering deer and other medium size mammals have demonstrated that unmodified flake edges are more efficient than bifacially retouched edges (e.g., Elliott and Anderson 1974; L. Patterson 1975; Brose 1975; Hester et al. 1976; Odell 1980) particularly in cutting muscle (Walker 1978:7110). Therefore, these informal tools were undoubtedly used in the butchering process. The hafted bifaces may have preformed the bulk of the tasks over longer periods.

Choppers (N = 5)

Five specimens were assigned to this functional category and represent 3.7 percent of the total stone tools recovered. The assignment was based on the overall size, shape and cultural alterations to the various pieces with the perceived intent to pound like a hammer or chop like an axe. In some instances it is not clear if the tools was intended or used to chop or pound. Each piece is described and discussed below.

Specimen #467-010 was recovered from 62 cmbs in N104 E104 just outside and west of Feature 8 amongst many burned rocks. It is a small (245 g) complete cobble of Potter chert with cortex covering most of the proximal end and one lateral edge, and about 50 to 60 percent of each of the two faces (Figure 8-78). The cortex is water worn and smooth. This cobble measures about 77.4 mm long by 67.2 mm wide and 44.3 mm thick. The flat, smooth proximal end severed as a platform to remove several flakes from one lateral edge and part of one face. One tapered lateral edge was unifacially worked, with flake scars extending over about 40 percent of one face. This edge is 78 mm long, and is slightly convex in shape, with an edge angle of 70 to 85 degrees. This lateral edge appears extensively utilized with many short flake scars. This crushed and rounded edge was dulled through use. The lateral edge and proximal end juncture also has extensive use, with rounding and crushing in one localized area. This artifact remains unwashed.

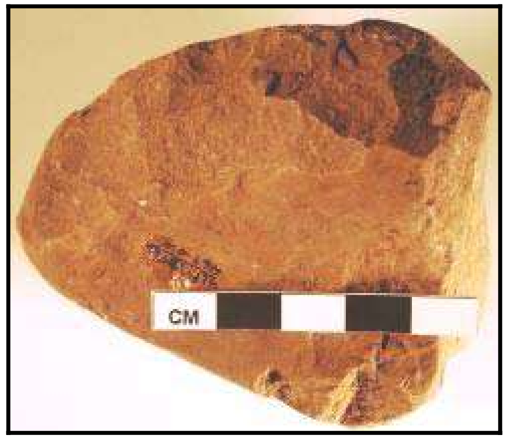


Figure 8-78. Chopper (#467-010) that shows Work Ends, Top Edge has Worked and Crushed Edge Through Use.

High-power use-wear analysis indicates that the distal end bears striations, starch grains, and modified starch grains. The starch grains appear to have been cooked. Dr. Hardy interpreted this tool to have been used to pound cooked starch grains (Appendix L). No organic material was observed along the lateral edge. Subsequent, starch grain analysis yielded 19 lenticular grains derived from Canadian wildrye (*Elymus canadenses*), most of which were damaged (Appendix F). The damaged starch resulted from some type of processing, and definitely was not in its original, natural state. Therefore, this chopper was used to pound/crush wildrye grass seeds. In the fourier transform infrared spectroscopy analysis the recovered residues were said to have matches with hickory (*Carya* sp.) or walnut (*Juglans* sp.) nutmeat, bird blood, and rabbit meat (Appendix R). If these matches are correct, then this was certainly a multifunctional tool. However, the lack of matches with the positive starch grain grasses may call into question this analysis technique.

Another specimen (#627-010) was recovered from 35 to 50 cmbs in N107 E106. It is 8.5 cm long by 5.5 cm thick and is made from a high quality chert cobble that has bifacial working along one thinned edge. This piece weighs 409.4 g. Cortex covers about one third of the tool on the flat unworked proximal end and part of one unworked lateral edge (Figures 8-79 and 8-80). The cortex is very smooth, rounded, and is a yellowish brown (10YR 5/8) with a light gray (10YR 7/2) patina over about two thirds of the cortex.

Figure 8-79. Side View of Unwashed Bifacial Chopper (#627-010) with Contracting Distal, End at the Top.

Flakes have been removed from the flat cortex end along about one quarter of the edge that has removed some cortex. Most flakes appear driven from the opposite end to create a relatively thin bifacial edge. That distal edge bears many small flake scars and hinges. The edge angle measures between 60 and 65 degrees. This style of artifact is sometimes referred to as a butted biface as one end served as the unworked handle

Figure 8-80. Profile View Chopper #627-010, Made of Edwards Chert. Tapered Working Edge is Towards the Top.

opposite the working edge. This chert cobble reflects bright yellow under the short and long wave ultraviolet light. This reflection generally indicates Edwards chert. It is a light olive brown (2.5YR 5/3) that grades into a grayish brown (2.5YR 5/2). This unwashed and unhandled specimen was sent for high-powered use-wear analysis. Dr. Hardy observed wood fragments and hard, high-silica polish and striae on the worked distal end, which he interprets to indicate use in chopping wood (Appendix L), an inference also supported by the relatively thin, but stout, bifacially worked distal edge. The worked/used edge was left unwashed for possible future analysis. The fourier transform infrared spectroscopy analysis recovered residues said to have matches with sunflower (Helianthus) nutmeat (Appendix R). This latter result and interpretation conflicts with the use-wear analysis, which currently seems more probable. Therefore, this heavy, stout, butted bifacial chopper likely served to chop wood.

Artifact #630-010 was from 64 cmbs in N108 E101. This chopper weighs 680 g, is ovate in overall shape with water worn, smooth cortex on a quartzite cobble that measures about 11 cm long by 5 cm thick. The naturally thinner edge has at least four large flake scars along one face with four to six smaller hinge fractures in the same area (Figure 8-81). The limited cultural modification along one edge has created one unifacial worked edge that has some minor crushing from use. It is believed that this tool functioned in a chopping manner, probably to break bison bones. The used edge was left unwashed for possible future analysis.

Figure 8-81. Profile of Flaked and Worked Edge of Chopper #630-010.

Specimen #786-010 was recovered from 50 to 60 cmbs in N112 E102. This is an irregularly shaped water worn smooth, quartzite cobble measuring 12 cm long by 4.5 cm thick, and weighing 429 g. The cobble was intentionally broken by a percussion blow on one narrow end (Figure 8-82), creating a relatively long, sloping sharp edge. This edge has relatively small (less than 1 cm long) flake removals along the edge on both sides of the edge. It is not clear whether these scars were intentional or created by use. In either case, the end product is a dull, sinuous edge. That edge was left unwashed for potential future analysis.

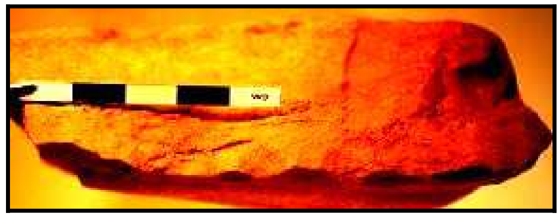


Figure 8-82. Profile of Long Worked/Used Edge of Chopper #786-010. (scale in cm)

Chopper #1136-010 was found at 60 to 70 cmbs in N118 E107. This is a 186 mm long by 62.9 mm wide, and 57.6 mm thick, rectangular blocky piece of naturally weathered greenish-gray Potter chert that was culturally modified on both ends. This blocky piece has recent flake scars, hinged and crushed areas on both ends. The less worked and smaller proximal end has a large ca. 5 cm long flake scar that hinged on one flat face, as well as a small cluster of tiny hinges that indicate a crushing from pounding. The distal and more intensively worked end shows several large flake scars with crushed platforms on three sides, apparently caused by intensive pounding or direct percussion (Figure 8-83). This piece weighs about 850 g and is of sufficient weight for breaking open bones. An excavation impact broke this piece into three fragments. The worked ends remain unwashed for possible future analysis.

Figure 8-83. End View of Use Area of Long Chopper (#1136-010) that has Flake Scars from Direct Impacts.

No use-wear studies or lipid residue analysis were conducted on four of the five specimens. It is postulated that these served as multifunctional pounders or hammers. Specimens remain unwashed so that future residue analysis can be conducted. These potentially served as hammers, possible for smashing and crushing bones, shaping metates, chopping meat, or pounding starchy plants.

Hammerstones (N = 2)

Two specimens (#709-010 and #1223-010) resemble hammerstones, with some visible crushed edges potentially from weathering, along with slight smoothing and/or polish that may be the result of water rounding.

A small cylindrical sandstone hammerstone (#709-010) came from 43 cmbs in N110 E106 and about 25 cm north of the fragmented metate, Feature 13. It is 76 mm long by about 52 mm wide and weighs 288 g. One very flat end may indicate an old break, whereas the opposite rounded end appears to have been battered (Figure 8-84). A couple of broad flake scars or crushed areas are on one side and one is on the rounded end. This elongated, but relatively small rock (288 g) might have been the object that was used to flake and shape the metate. It could also have functioned in several other tasks.

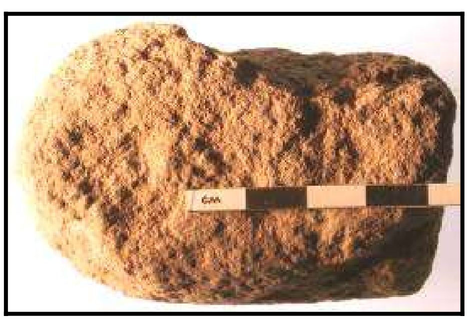


Figure 8-84. Hammerstone #709-010.

Specimen #1223-010 was from 46 cmbs in N120 E100. This rounded ovate, water worn cobble is about 8 cm long by 5.5 cm thick and weighs 403 g. One end has a smooth, rounded cortex with two or three minor pits that may or may not be natural (Figure 8-85). The opposite end has an irregular, crushed area that exposes the coarse interior. No flake scars, striations, or intensive smoothing are visible. One end is artificially altered, although no obvious impacts are represented.

Figure 8-85. Hammerstone #1223-010 with Crushed End.

Drills (N = 1)

A single specimen (#1220-011), from 37 cmbs in N120 E99, is the proximal section of a drill (Figure 8-86). The distal end was snapped at the intersection of the narrow bit and the much broader base. The proximal end is relatively large (41 mm long, 31.9 mm wide, and 8.5 mm thick). It is bifacially worked, the base is straight, and the lateral edges are slightly convex. It was manufactured from a light colored Alibates. The location of the drill bit was slightly off center. The base of the bit measures 8.1 by 5.6 mm. This drill base was in the vicinity of a concentration of lithic debitage west of the burned rock concentration Feature 15. This tool fragment was submitted for use-wear analysis. Dr. Hardy observed wood and plant fibers and hard, high-silica polish along the basal edge (Appendix L; Figure L-10). No obvious signs of hafting, such as abraded ridges were present. The observed wood fibers may be an indication this piece was mounted in a wooden haft. This base is, however, sufficiently large to have been hand held, but most drills would have been hafted.

Figure 8-86. Unwashed Proximal End of Drill (#1220-011) with Bit Broken from the Top Edge. (scale in centimeters)

The horizontal distribution of all chipped stone tools and the positions of the identified features are displayed in Figure 8-87. The overall pattern exhibits wide dispersal of the various tools with very limited clustering.

It is obvious that chipped stone tools were not discarded in the vicinity of the cooking debris labeled Feature 9 in the southeastern corner. A single complete biface (#494-010) was recovered from the margin of discard pile, Feature 9d. Because this biface is complete, it may have been dropped following its use. Unfortunately, use-wear analysis did not detect any residues or wear to indicate function. Although unlikely, the absence of detectable wear indicates that this biface was not used.

Only a few chipped stone tools were in the vicinity of Features 8 and 11, another cooking activity area (see Figure 8-87). The biface (#420-0101) and scraper (#402-010) were both complete. Plant residues were observed on the biface during use-wear analysis. Hair, bone fragments, and wood were detected on the scraper. These results indicate that these tools may have been used in this vicinity to perform a number of tasks. This may indicate that diverse tasks other than cooking were conducted along the margin of the heating element, Feature 8.

A few broken tools, a medial fragment of a biface (#800-010), a projectile point tip (#1355-010), and projectile point base/stem (#895-010), were discarded in the vicinity of Features 6 and 12 (see Figure 8-87). Feature 6 is interpreted as a discard area of burned rocks used in cooking. Next to Feature 5, a discard/dump of multiple classes of materials was a projectile point base (#1348-010). Apparently this broken base was discarded with other discarded materials from cleaning of another area. In at least a few instances broken tools were discarded in areas with other discarded materials. This implies cleaning tasks were conducted within this camp.

The cluster of features in the northern end related to Features 15 and 18 yielded a few tools as well. Again, this is a pattern similar to the other two major concentrations of burned rocks features that yielded a few tools on the margins of the features. The scraper (#1128-010) on the northern side of Feature 18 was reworked to what appeared a nonfunctional state. This would likely have preceded discard of that tool.

The northwestern corner of the excavation area, which lacked well defined burned rock features of any kind, contained the greatest concentration of broken and occasionally complete tools (Figure 8-87). That area yielded the greatest number of bifaces (about 50 percent of the total sample), the only drill base (#1220-010), nearly 38 percent of the scrapers, and about 50 percent of the broken projectile points. The one nearly complete point (#1104-010) was also in that area. This still functional and complete projectile may have been lost during refurbishing or rehafting activities. The concentration of broken tools in this northwestern corner supports tasks related tool maintenance activities. This area is clearly separated from the area of focused cooking activities, although other material classes were still scattered throughout the area.

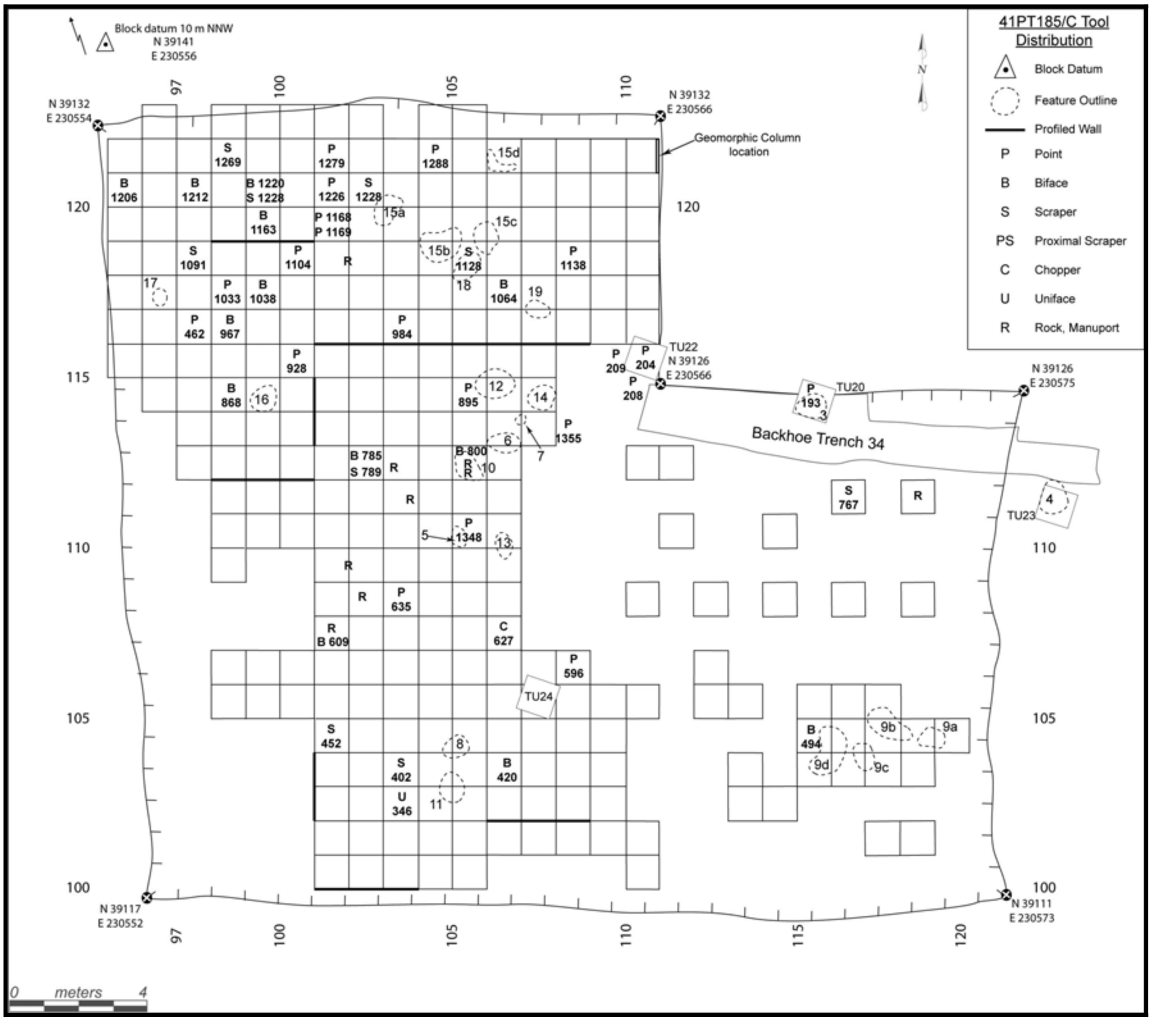


Figure 8-87. Horizontal Distribution of Chipped Stone Tools Across the Excavation Block.

8.4.3.4.3 Ground Stone Tools (*N* = 11)

The ground stone tool assemblage is relatively limited in terms of frequency and diversity with two recognizable functional types based on general morphological characteristics. These items include parts of one mano, and ten ground slabs (metates). Individual descriptions are presented below by tool class, which are generally assumed to represent primary tool functions, however individual tools potentially served in a variety of tasks. The metate pieces are nearly all small fragments with individual attributes and metric characteristics recorded for each piece. These fragments provide very limited information on the overall size and shape of metates and other characteristics than one might be able to observe on more complete specimens.

Specimens from this ground stone tool class were selected for lipid residue and starch grain analyses. The results from the detailed technical studies provide significant contributions to a broader understanding of the specific foods processed by these tools. These results help in determining what plants were gathered and processed by the population at this site. Microfossil remains were sought through the starch grain analyses, which when discovered would hopefully be specifically identified to allow for discussion of the plant gathering aspect of the subsistence activities performed by this community. This is extremely important, as charred botanical remains are quite limited, as is the case in most open-air archeological sites. The lipid residues are combined with starch grain analysis to address the question of function and type of plant processing. Fourier transform infrared spectroscopy was also conducted on the one mano and two metate fragments to try and enhance the identification of the resources used with these artifacts. Individual results are presented with each tool description, below.

Mano (N = 1)

A single specimen (#1175-010), from 37 to 44 cmbs in N119 E103, is thought to represent a mano used in grinding. It is a nearly complete ovate shaped pink quartzite cobble that measures about 154 mm long by 99 mm wide and 55 mm thick, and weighs about 1200 g. One end has a relatively large flake scar with a small area of possible crushing, which may have occurred during reuse as a hammer (Figure 8-88). The other end is flatter, with a weathered area and one small flake scar, which may or may not be the result of utilization. One face that is slightly convex is lightly polished and bears about 15 small pits or peck marks. No striations were observed. The lightly polished surface covers an area about 126 cm^2. The opposite face is slightly concave with 12 to 14 tiny pits or peck marks.

Starch grain analysis on this mano, and possible hammer (#1175-010) yielded the highest frequency of identifiable Canadian wildrye (*Elymus canadensis*) grass starch grains (*N* = 47) of any artifact analyzed, plus five other unidentifiable starch grains. Some grains appeared damaged from processing, whereas others were gelatinized from contact with heat and water (Appendix F). It is not clear if the starch grains were ground after they were heated or if a little moisture combined with the frictional heat from grinding could cause gains to gelatinize. The fourier transform infrared spectroscopy analysis recovered residues from the tools surface, but no specific matches could be made (Appendix R). Signatures representative of cellulose and carbohydrates were recognized and might indicate the processing of plant materials. Proteins, fats, and lipids make only a small contribution (Appendix R). This mano obviously was used to grind wildrye grass seeds.

Figure 8-88. Mano/Hammer (#1175-010) with Pecked face, and Battered and Crushed Ends and Sides. (scale in cm)

Metates (N = 10)

Ten small metate fragments were identified, based on shape and observed human alterations on one or more surfaces. Each piece represents a different metate based on visual inspection of rock texture, shape, wear patterns, and rock type. Feature 13 yielded multiple pieces (#677-010 and #712-101) of a single broken metate, which when refitted represents about one third of the original artifact. This is the most complete metate recovered. Each specimen is described and illustrated below.

In order to gain an understanding of what foods were processed on these slabs, six samples were selected for three separate chemical analyses. Three metate fragments #514-010, #1089-010 and #1129-011 were sent to Dr. Malainey for lipid residue analysis (Appendix G). Individual interpretations of the detected lipid residues are presented with the individual artifact discussions. Eight metate fragments #405-010, #514-010, #712-010, #966-010, #1089-010, #1070-010, #1075-010, and #1129-010, were sent to Dr. Perry for starch grain analysis (Appendix F). Her individual results are also presented below. Two metate fragments, #405-010 and #1129-010, were submitted to PaleoResearch Institute for fourier transform infrared spectroscopy analysis on extracted residues. The detailed results of the latter are presented in Appendix R.

A small metate (#405-10) fragment (270 g) was recovered form 51 cmbs in N103 E104. It was about 70 cm northwest of Feature 11 and nearly the same distance west of Feature 8. This is a small (about 10 cm long), triangular piece of fine sandstone that has three broken edges (Figure 8-89). Tiny mica flecks are present in this local sandstone. This is the thickest piece of the group, at close to 3 cm. One face has a shallow (2.2 mm deep) concave ground surface that is quite smooth and lacks visible striations, pits, or impact scars.

Figure 8-89. Oblique-Angle View of Metate Fragment #405-010 that shows Ground Surface.

The opposite face is nearly flat, slightly irregular with no apparent macroscopic use and appears to be a naturally weathered surface (Figures 8-90 and 8-91). This metate fragment was submitted to Dr. Perry for starch grain analysis. Her analysis yielded 14 lenticular starch grains common to grasses of the Pooidae subfamily, and specifically identified as Canadian wildrye (*Elymus canadensis*). Two other unidentified grass starch grains were also present (Appendix F). Following starch grain analysis, this same piece was submitted for fourier transform infrared spectroscopy analysis on recovered organic residues from the artifact surface. The signatures indicate the presence of absorbed water, fats, oils, lipids, and/or plant waxes, aromatic esters, pectin, protein, cellulose, carbohydrates, starch, and the polysaccharides glucomannan and galactoglucomannan (Appendix R). However, no matches were made. The largest contributions to the signature were proteins, cellulose and carbohydrates, and polysaccharides (Appendix R). This metate functioned, at least in part, for grinding of Canadian wildrye grass seeds.

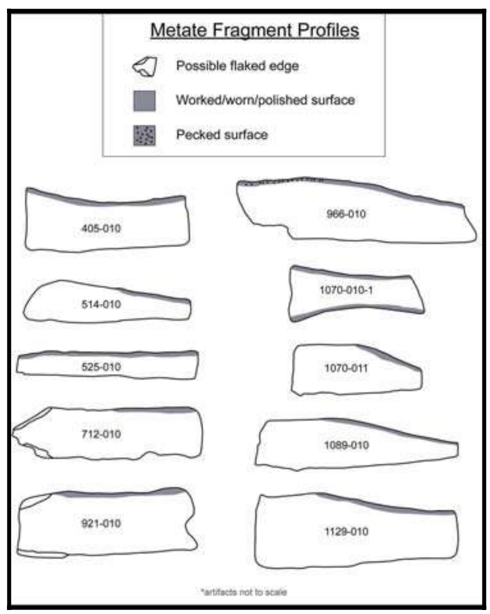


Figure 8-90. Projected Profiles of Individual Metate Fragments, Depicting Worn Surfaces.

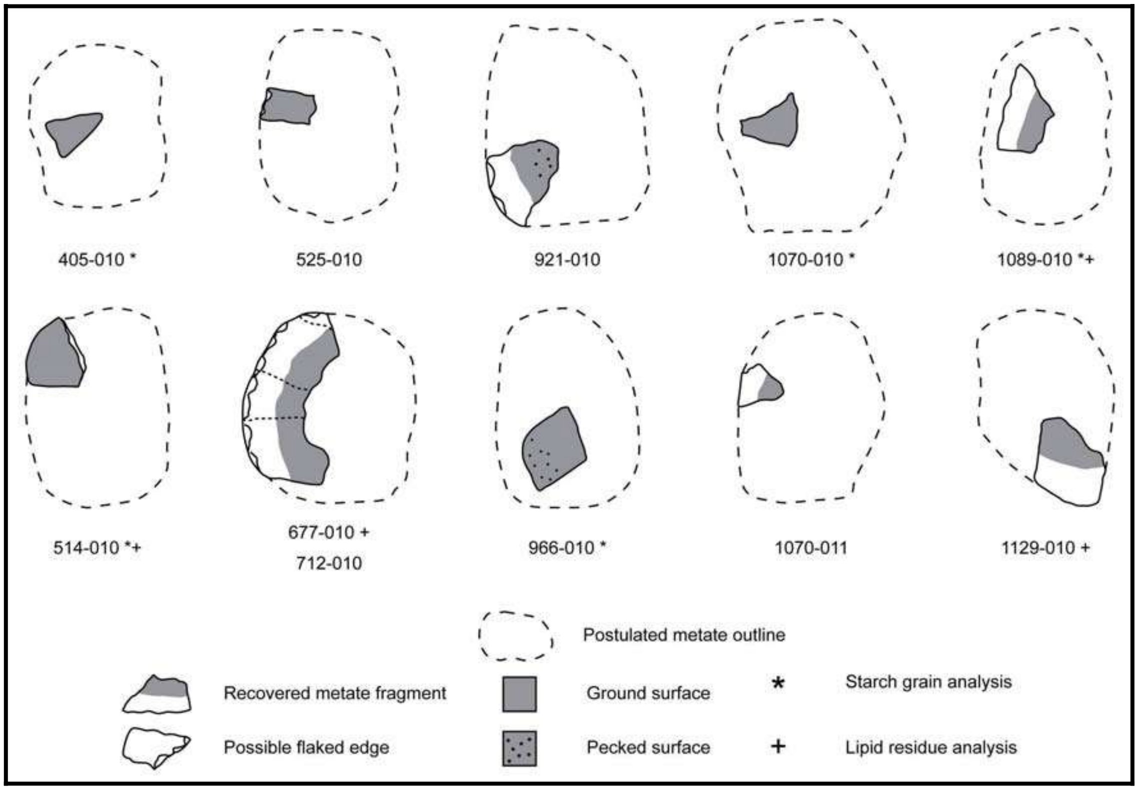


Figure 8-91. Metate Fragments Projected onto Postulated Whole Metates.

Metate fragment #514-010 came from 71 cmbs in N105 E98. This small (14 cm long by 3.5 cm thick) section weighs about 320 g. It is of soft and somewhat platy sandstone with one rounded and slightly curved outer edge and two broken edges. The ground surface tapers towards the middle. In cross section this piece has a wedge shape with the thinner part towards the middle (Figures 8-90, 8-91 and 8-92). The thinner edge has a smooth, ground surface, but lacks polish and does not extend to the outer margin. Only a small 21 cm^3 area appears highly smoothed. The outside edge is much thicker, horizontally and vertically rounded, and appears to be in a natural state, as it lacks any sign of flake scars.

A small 23 g middle piece with an obvious ground surface was submitted for lipid analysis. Dr. Malainey detected large herbivore fatty meat or possibly moderate-high-fat content plant, plus conifer residue as indicated by traces of dehydroabietic acid (9MQ 39). The source of the conifer products is likely from firewood, resins or other conifer products (Appendix G). From another fragment off the original piece Dr. Perry extracted one lenticular starch grain of Canadian wildrye (*Elymus canadensis*) that is both damaged from processing and gelatinized from exposure to heat and water.

Figure 8-92. Oblique-Angle View of Metate Fragment #514-010 that Shows Ground, Worn Surface to the Right.

One other, unspecified grass starch grain was observed in addition to Canadian wildrye (Appendix F). This metate fragment apparently served in multiple capacities that included the grinding of grass seeds, and as a meat platter or, possibly, as an anvil to pound meat on. The traces of conifer products would imply it was heated in a wood fire.

Specimen #525-010 is a small (ca. 8 cm long by 5.4 cm wide) rectangular piece of flat (18.8 mm) sandstone (Figure 8-93). This piece came from 36 to 50 cmbs in N105 E102. One face appears to be unmodified and in its natural state. The opposite face has a smoothed and worked face. In profile the piece shows only one slightly concave ground surface. Three of the four edges appear broken with the forth possible being the outside edge of the metate. The outer edge is more rounded than the other three edges. This possible outer edge has one rough 2 cm long and wide flake scar that extends toward the interior on the worked face. This may be a scar that indicates this thin slab of sandstone was intentionally shaped before use. No technical analyses were conducted on this piece and it remains unwashed.

Figure 8-93. Surface of #525-010 with Culturally Modified Outside Edge on Left.

A fragmented slab metate (#677-010 and #712-010), designated Feature 13, was between 40 and 45 cmbs along the margin of two units. Six pieces (#677-003) were in the northwestern margin of N109 E106 and four (#712-003) were in the southwestern part of N110 E106. These 10 sandstone pieces were clustered over an area about 50 cm in diameter and within an elevation range of about 5 cm (see Figure 8-52). Their total weight is 18,140 g for an average rock weight of 1,814 g. In the laboratory, five pieces were refit to reconstruct about one third to one half of a one sided grinding slab/metate. The reconstructed section measures about 33 cm long by 15 cm wide (Figure 8-94). The projected overall size would have been about 40 by 35 cm. The overall shape is oval and the curved outer edge has flake scars that indicate that the original sandstone slab was intentionally shaped and prepared (see Figure 8-91). This slab measures between 2 and 2.5 cm thick and is nearly flat. The one worked surface does not exhibit polish, peck marks, or striations, but is smoothed towards the middle. The opposite side is irregular and lacks a flattened or smoothed surface. When this artifact was abandoned, its used side was down.

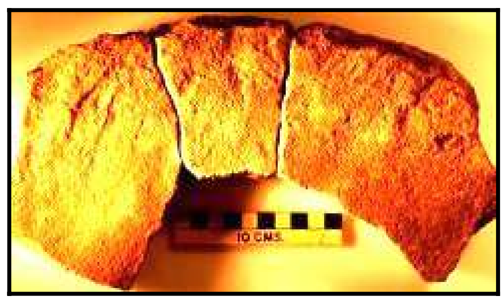


Figure 8-94. Partially Reconstructed Metate #712-010, Feature 13.

A small fragment of this metate (#712-010a) was sent to Dr. Malainey for lipid residue analysis. The detected residues resemble large herbivore with fatty meat or high-fat-content plants (Appendix G). A piece of this same metate fragment (#712-010b), plus another piece from the adjoining unit (#677-010b) were sent to Dr. Perry for starch grain analysis. Neither sample yielded any starch grains (Appendix F). Based on the lipid residues identified, combined with the lack of starch grains, this sandstone slab probably functioned as a butcher block for processing meat and/or meat products following its earlier function as a grinding slab. This interpretation may be supported by the presence of the nearby hammerstone, and possibly by its broken state.

Specimen #921-010 is a triangular piece of sandstone that measures about 10 cm long by 3 cm thick. It was from 80 to 90 cmbs in N115 E98. It has two broken edges and one curved/rounded edge, with one obvious flake scar from the rounded edge. One face is relatively flat and appears culturally unmodified. The opposite face is flat, lacks obvious polish, and has about a dozen small (less than 4 mm) indistinct pits that appear to be artificial modifications. The curved and rounded edge represents the original edge of the metate. This edge was modified as it is rounded both vertically and horizontally, with the one obvious flake scar originating from the edge (see Figures 8-90 and 8-91).

Specimen #966-010 came from 42 cmbs in N116 E98. This small fragment weighs 384 g and measures nearly 11 cm long by about 2.5 cm thick. It is a rectangular piece of fine-grained sandstone with four broken edges (Figures 8-95 and 8-96). The edges show old breaks, but appear smoothed and worn. One face is relatively flat, but has a rough natural surface that lacks any sign of artificial modification. The opposite face is quite smooth with a concavity in one small area towards one corner. A dark stain is apparent near the middle of this face together with tiny rootlet markings. This generally smoothed surface also has some 30 to 40 small pits across it.

This piece yielded very similar starch grain results with some damaged lenticular grains of Canadian wildrye, and one other unidentified grass seed (Appendix F).

Specimen #1070-010 is a very small (ca. 8 cm long by 3.1 cm thick) triangular piece of

Figure 8-95. Oblique-Angle View of Sloping Worked Surface of Metate Fragment #966-010.

Figure 8-96. Pecked Surface of Metate Fragment #966-010.

coarse-grained sandstone that functioned as a slab for grinding (Figure 8-97). This piece was from 60 to 70 cmbs in N117 E107. In profile this piece is slightly wedge-shaped, with both faces slightly concave indicating that both faces were used and that this piece is from near the center of the metate. The thinner edge (2.4 cm thick) of the two worked surfaces reflect greater use and thus, closer to the center of the metate. This small triangular piece yielded starch grains damaged by grinding. At least two grains represent Canadian wildrye (Appendix F).

Specimen #1070-011 is a small (about 8 cm long by 4 cm thick) rectangular fragment representing the outside edge of a much larger metate (Figure 8-98). It was recovered from Feature 19 at 60 to 70 cm in N116 E107. This coarse sandstone piece shows a very limited use area, about 8 cm^3, on one sloping corner of one face. The use area is characterized by an abrupt change in the surface plane (sloping downward) on one face, about 3.5 cm from the outer edge. The sloped surface area is not polished, nor does it exhibit striations or pitting. It is assumed that this downslope area 3.5 cm from the edge represents the very margin edge of a grinding surface that has weathered.

Figure 8-97. Metate Fragment that Reveals Worn Surface.

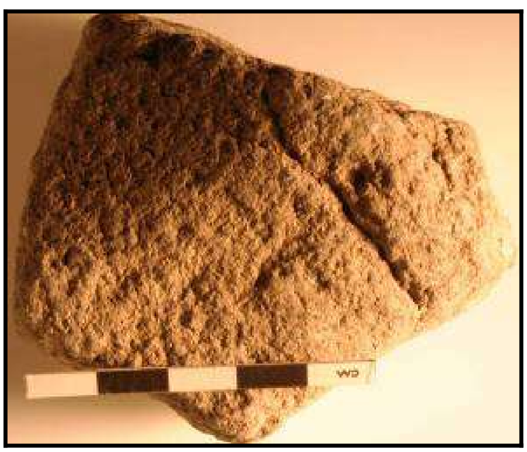


Figure 8-98. Metate Fragment #1070-011 that Shows Worn Sloping Surface on Part of Face. (scale in cm)

This metate fragment (#1089-010) weighs 501 g and is a piece of platy sandstone measuring 16 cm long by 2.5 cm thick (Figure 8-99). It was found at 58 cmbs in N118 E97. This is the outer edge of the original larger metate. In profile, the piece is wedge shaped, with a distinctly tapered surface dipping toward the center of the original complete artifact (see Figures 8-90 and 8-91). The tapered edge, furthest toward the center, is about 5 mm thick. One face is flat with no apparent artificial alterations. This worked face is ground, but not polished, with an about 17.2 mm worn away.

Figure 8-99 Oblique-Angle View of Tapered Ground Surface of Metate Fragment #1089-010.

A 32 g piece of the worked sloping surface was sent for lipid residue analysis. This small fragment (9MQ 41) yielded moderately-high-fat-content from animal substance, or a possibly a combination of animal and plant. Significant levels of triacylglycerols occur that indicate the presence of animal products. No lipid biomarkers were detected in this piece (Appendix G). The bulk of this metate fragment (470 g) was sent for starch grain analysis. That piece yielded one clump of unidentifiable starch grains plus three lenticular Canadian wildrye grains. Interestingly, none of the grains were damaged (Appendix F). The presence of both plant and animal indicators on this metate fragment indicates that it served multiple functions and could have served as some type of meat platter and as a slab for grinding starchy grass seeds.

Specimen #1129-010 was recovered from the top of Feature 18 at 50 to 60 cmbs in N118 E105. It is a moderate size (17 cm long by 3.5 cm thick) section of a course-grained sandstone grinding slab with one worked face (Figure 8-100). This piece weighs about 850 g. The obviously ground area is limited to about 54 m^3 or about 40 percent of the one face. That ground area is smooth, but not polished and lacks pit marks, striations or other modifications. The opposite face has just a hint of use. The cross section reveals only a slightly sloping ground surface. The outer edge, opposite the worked area, is more or less rectangular and does not exhibit obvious artificial shaping.

Figure 8-100. Oblique Angle of the Ground Metate Fragment #1129-010.

The majority of this piece (692 g) was sent for starch grain analysis and yielded nine Canadian wildrye (*Elymus canadensis*) starch grains, plus two other unidentified starch grains. As one might expect, some starch grains were damaged through grinding (Appendix F). A small 32 g piece from the area that included the ground surface was sent for lipid residue analysis. The recovered lipids were interpreted to indicate the presence of high-fat-content plant (seeds/nuts), with conifer products indicated by the detection of lipid biomarker dehydroabietic acid (9MQ 40, Appendix G). The presence of that biomarker indicates that after breakage of the metate, this fragment was recycled and heated by a conifer wood fire. Following the above analyses, fourier transform infrared spectroscopy analysis recovered organic residues from the artifact surface. The signatures indicate the presence of absorbed water, fats, oils, lipids, and/or plant waxes, aromatic esters, pectin, proteins including nucleic acids, cellulose, carbohydrates, starch, and the polysaccharides glucomannan, galactoglucomannan, and arabinoglucuronoxylan (Appendix R). However, no matches were made. The largest contributions to the signature were proteins, cellulose and carbohydrates, and polysaccharides (Appendix R). These results are very similar to the metate fragment #405-010 analyzed by this same procedure indicating that both were used to process similar materials.

Ground Stone Tool Discussion and Distribution.

The 11 recognized ground stone tool fragments were widely distributed across the excavation block in no detectable pattern (Figure 8-101). Aside from the refitted fragments of #712-010 in Feature 13, no two fragments represent the same parent metate based on texture and grain size differences, combined with overall form and thickness. Three metate fragments (#921-010, #966-010, and 1989-010) were 6 to 7 m west of Feature 15 in three separate units, but relatively close to each other. These three pieces were just south of the major concentration of lithic debitage. It is hard to envision that these small fragments reflect an *in situ* or primary grinding task area. More likely, their horizontal distribution reflects a discard pattern. These three pieces varied in their elevations from 42, 58, and 80 to 90 cmbs. This vertical separation creates doubt about their actual association with one another, though the vertical separations may be accounted for through postdepositional turbation. All three fragments are considered associated with the upper Late Archaic occupation.

Two metate fragments (#1070-010 and #1070-011) were directly associated with Feature 19, just 2 m southeast of Features 15c and 18. These two small chunks do not exhibit extensive use and may have been recycled and employed as burned rock heating elements in Feature 19.

Three other metate fragments (#405-010, #514-010 and #525-010) were scattered across the southern part of the block west of Features 8 and 11. These fragments appear unrelated to each other, and again most likely reflect discard behaviors rather than *in situ* grinding activity. Metate fragment #405-010 was directly associated with a cluster of burned rocks between Features 8 and 11 and possibly recycled as heating element. All three fragments are considered associated with the lower Late Archaic occupation.

No ground stone tools were recovered from the 17 excavated units in the immediate vicinity of Feature 9 in the southeastern corner of the excavated area. Feature 13, somewhat centrally located, and consisted of about one third of a broken metate. No other fragments were recovered it that vicinity, but a hammerstone was just on the northern side (Figure 8-101). Moderate frequencies of burned rocks were also recovered from that area.

Seven metate fragments exhibit tiny mica flecks, indicating that the raw material most likely came from the Trujillo Formation, which outcrops in the West Amarillo Creek valley and many of the surrounding valleys, including those of the Canadian River to the north and Palo Duro Creek to the south.

The Trujillo sandstone is generally fine-grained and bedded, and suitable for use as grinding slabs. Three metate specimens (#514-010, #525-010, and #1070-010) appear macroscopically to lack tiny mica flecks in the sandstone. This may indicate they represent a different geological formation than the local Trujillo Formation sandstone.

The two hammerstones and one mano were also in the northern end of the excavation area, near Feature 15a (see Figure 8-101). The hammerstone (#1225-010) was in an area, west of Feature 15a, that yielded a high frequency of lithic debitage. This hammer may have served in the stone tool knapping activities.

The single mano (#1175-010) was in the massive burned rock concentration designated Feature 15 and between two smaller inclusive burned rock clusters Features 15a and 15b (see Figure 8-101). This location may reflect reuse of the mano as a hot rock in cooking, and then subsequently discard.

In summary, the stone tool assemblage of a 143 pieces represents a mere one percent of the cultural materials recovered from this Late Archaic excavation block and adjacent test units. The tools however, represent diverse tasks such as killing, butchering, scraping, drilling, cutting, pounding, chopping, and grinding. These functions involved work with starchy plants, plants in general, meats, hides, seeds, bones, and woods. These functions and various materials document a campsite occupied by both males and females. One would expect that children were also present within this group(s), but the actual tools cannot be assigned to the various age groups.

8.4.3.4.4 Lithic Debitage (*N* = 2,507)

The analysis of unmodified debitage is directed towards: 1) providing a descriptive characterization of the collection; 2) identifying the stages of reduction represented; 3) identifying the reduction technique conducted; 4) identifying the raw materials and their sources, and; 5) investigating the spatial distribution of the collection to identify knapping or discard areas.

Pieces referred to as debitage were derived from the production or resharpening of chipped stone tools. This includes all aspects of testing cobbles, the production of flakes from cores, the manufacture of

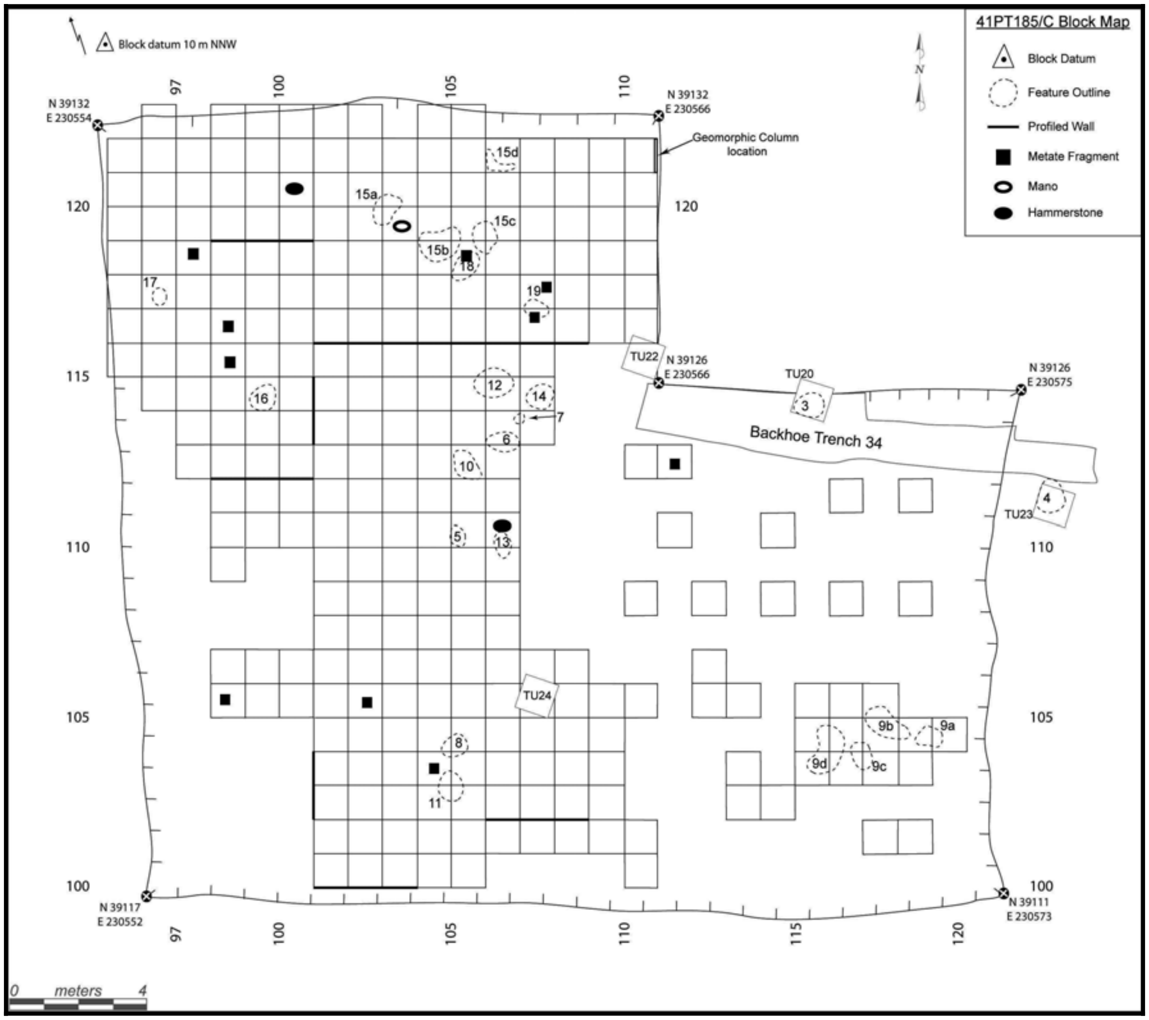


Figure 8-101. Horizontal Distribution of Ground Stone and Hammers Across Excavation Block.

various bifacial and unifacial chipped stone tools, and the reworking of worn/dulled stone tools. This class includes complete and fragmentary flakes, angular shatter, distal flake fragments, indeterminate pieces, and cores. The debitage assemblage is characterized by examination of multiple attributes to discern the type of tool production, manufacturing, or reduction that occurred on site. The attributes investigated include debitage size, morphology, flake types, platform types (flat, multifaceted, abraded, dihedral, and crushed), and material types. Based on platform attributes, flakes were determined to represent hard or soft hammer percussion or pressure flaking.

Specimens with platforms are referred to as flakes, which include both complete and broken pieces. Specimens lacking platforms were assigned to distal flake fragments, if they retain other flake characteristics, but lack only the platform. Pieces without flake attributes are referred to as angular debris/shatter. The discussions that follow present the unmodified debitage from only the block excavations, which employed only 6.4 mm size screens. A total of 2,507 pieces were recovered. This frequency represents 20.3 percent of the total cultural materials recovered from this block.

Debitage Size

The majority (70.5 percent) range in size from 6.4 to 12.8 mm in diameter (Figure 8-102). Even with the 6.4 mm screens, 18.1 percent are less than 6. 4 mm. The third most frequent group, at 7.5 percent, is between 12.8 and 19.2 mm. A meager 3.8 percent is greater than 19.2 mm. In general, the relatively small size reflects late stage tool production, reduction, and/or resharpening.

Debitage size may have been influenced by the completeness of the pieces. While only 11.5 percent are considered shatter, 47.6 percent are distal flake fragments, and another 29.2 percent are proximal flake fragments (Figure 8-103). That contrasts with only 12.1 percent complete flakes.

A surprising number of platform bearing flakes are present (*N* = 1,035), which include complete and proximal pieces (Figure 8-103). The distal flake fragments (*N* = 1,194) are nearly 1.5 times as frequent as the proximal fragments (*N* = 731).

Examination of the platforms reveals six categories (Figure 8-104). Multifaceted platforms dominate at 50 percent, followed by 22.6 percent that are crushed, 17.5 percent that are flat, and 6.2 percent that are dihedral. Abraded and cortical pieces account for less than 2 percent each. The high incidence of multifaceted platforms reflects a focus on tools, specifically bifacial reduction. In contrast, the few flat platform flakes document the fact that cores and/or unifacial tool modification was limited. The flat platforms may have originated from

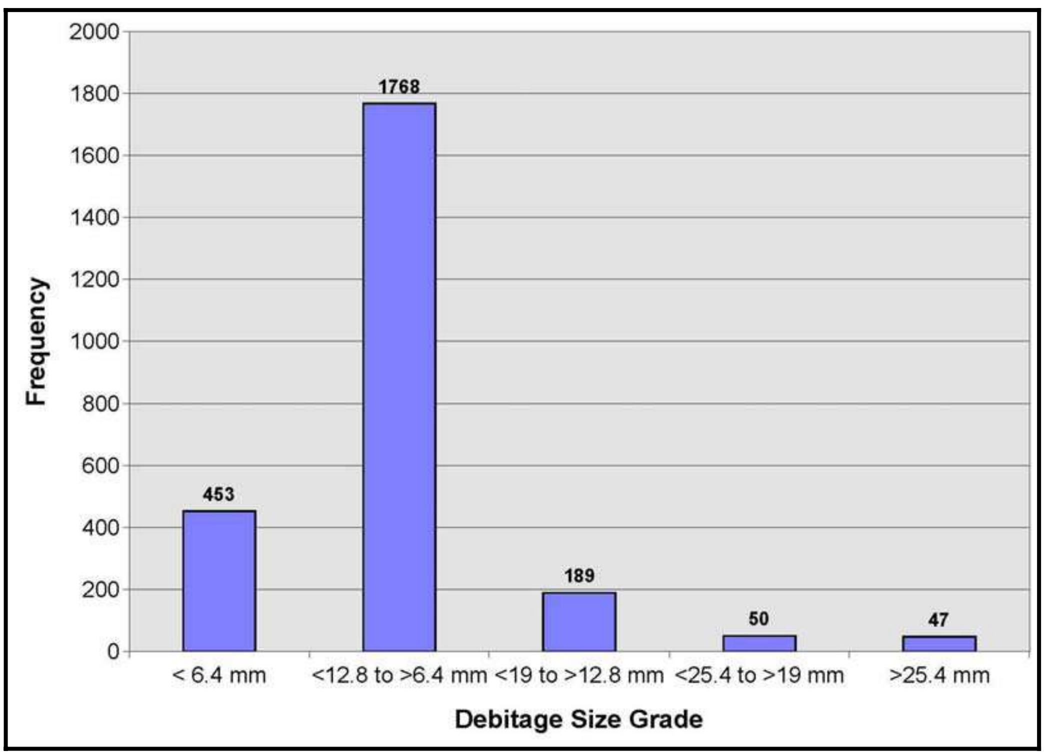


Figure 8-102. Frequency of Debitage Size Groups.

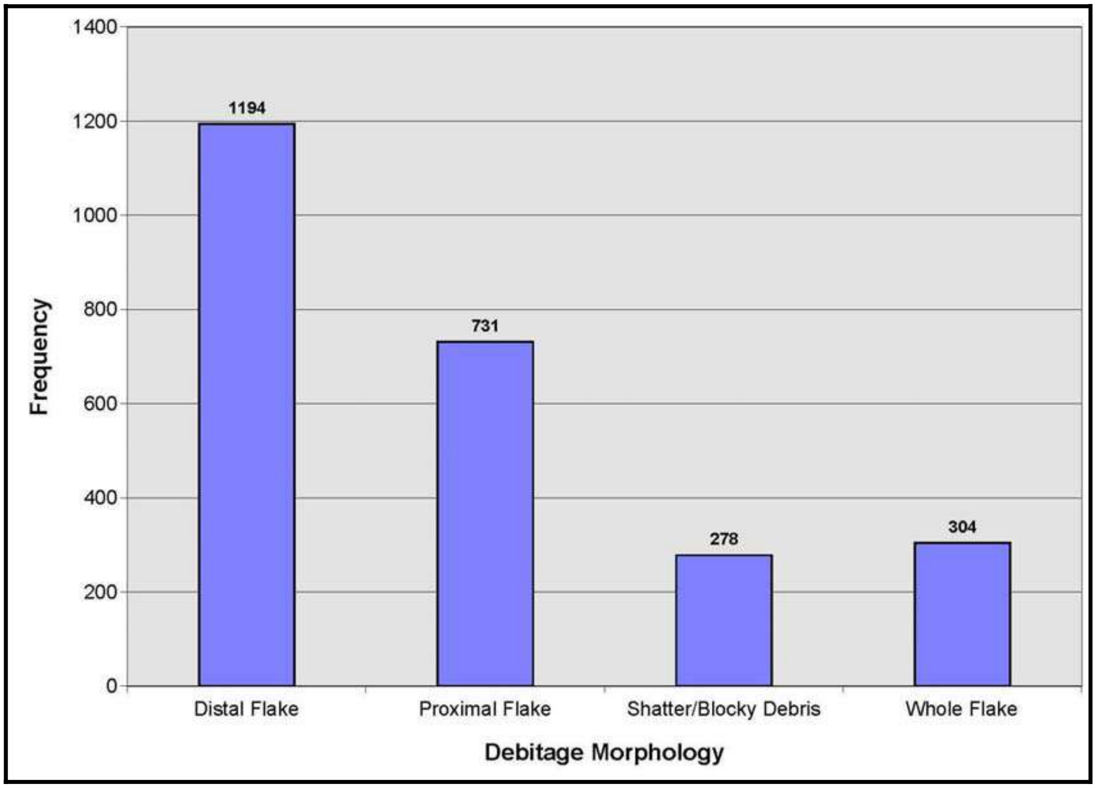


Figure 8-103. Frequency of Debris Types

unidirectional cores, an objective piece with flat sides such as a scraper or a flake blank. The flat or single faceted platforms might indicate flakes were derived during earlier stage reduction, with target pieces devoid of many flake scar ridges (Magne 1989:17).

These different types of platforms and other general flake attributes are associated with different instruments used to detach flakes. The platforms as a group reflect a complete dominance (94.6 percent) of soft hammer percussion tools being used to generate these pieces (Figure 8-105). Soft hammer percussion was most advantageous in the thinning, flattening and shaping of bifaces (Whittaker 1994:185).

The hard hammer produced flakes account for a meager 4.3 percent, whereas pressure flakes account for only 1.2 percent. The low frequency of pressure flakes is interpreted to reflect limited late stage thinning or retouching of worn tool edges. However, small pressure flakes, if they were present, were most likely not accounted for in this assemblage because of the screen size employed. The limited number of hard hammer derived pieces most likely reflects minimal initial cobble testing, cobble reduction, and early to middle stage reduction of the target piece.

The different types of platforms associated with the different reduction choices in the techniques used to detach the flakes are shown in Figure 8-106.

Another easily recognizable attribute is the presence or absence of cortex. Only 5.3 percent of the debitage contains any cortex. Cortex is most often associated with reduction of cobbles, and the percentage of cortex on an individual piece often indicates parts of the cobble reduction sequence. The amount of cortex on each piece was recorded in 25 percent increments. Cortex covering 1 to 25 percent of a piece occurs on

39.9 percent (Figure 8-107). Cortex covering 26 to 50 percent of the object occurs on 21.7 percent.

Cortex covering 51 to 75 percent of the piece occurs on 12.8 percent. Cortex covering 76 to 100 percent of the piece occurs on 26.3 percent. The limited percentage of pieces with cortex, again indicates limited cobble reduction occurred on site.

Thermal Alteration

Figure 8-108 shows the frequency of thermally altered pieces. Heat treatment can improve the flaking qualities of cryptocrystalline silicates (Whittaker 1994:72). The practice of heat treatment of raw materials is generally conducted to enhance the flaking properties. If done properly and at high enough temperatures, the stone changes in color and texture. The stone also becomes less grainy and smoother in texture, more brittle, and easier to flake (Whittaker 1994). Almost all (99 percent) of the debitage exhibits no evidence of thermal alteration. These results indicate that either the material worked within the block was of such good quality that heat treatment was determined not necessary, or these Late Archaic populations did not know of this process and never employ this strategy. Currently, it is not known if heat treating experiments have been conducted on Alibates to determine how it responds to heat treatment.

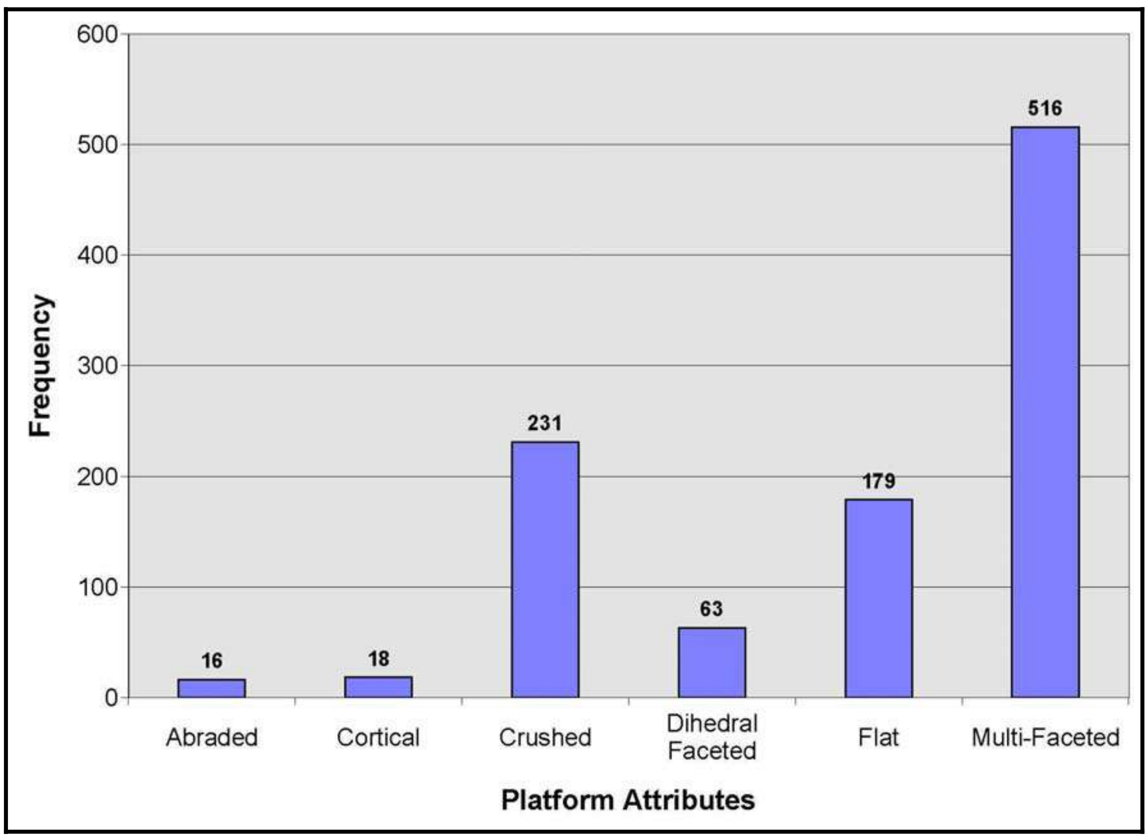


Figure 8-104. Frequency of Platform Attributes.

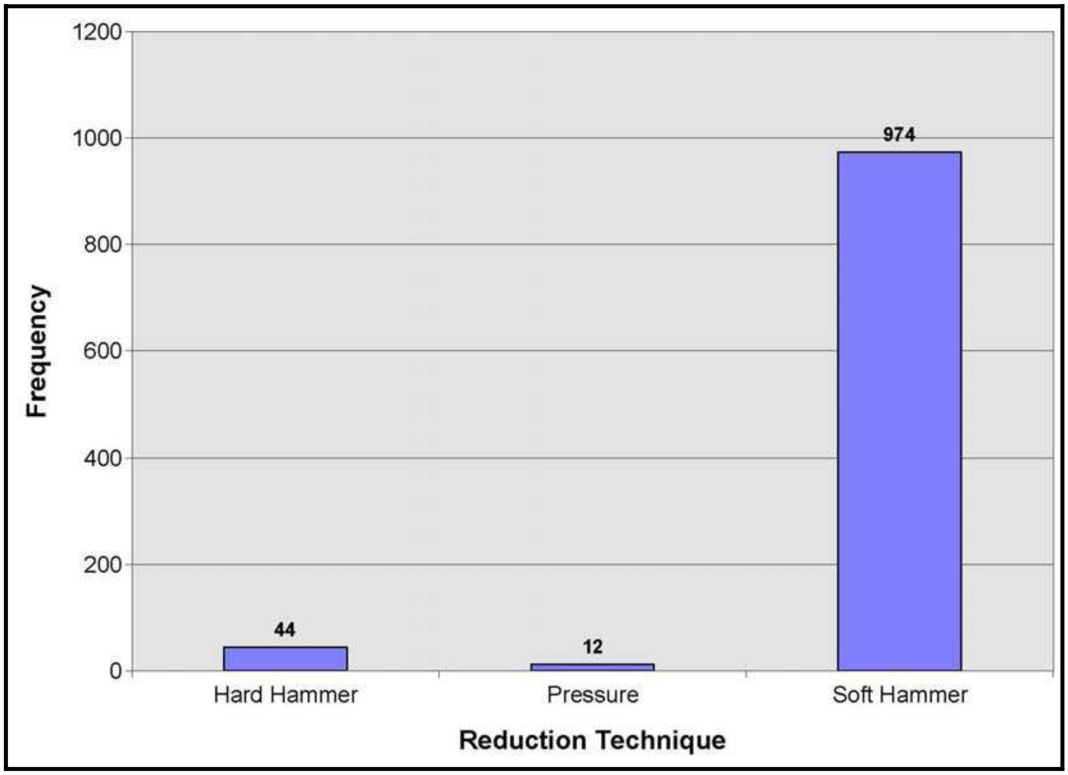


Figure 8-105. Frequency of Techniques to Detach Flakes.

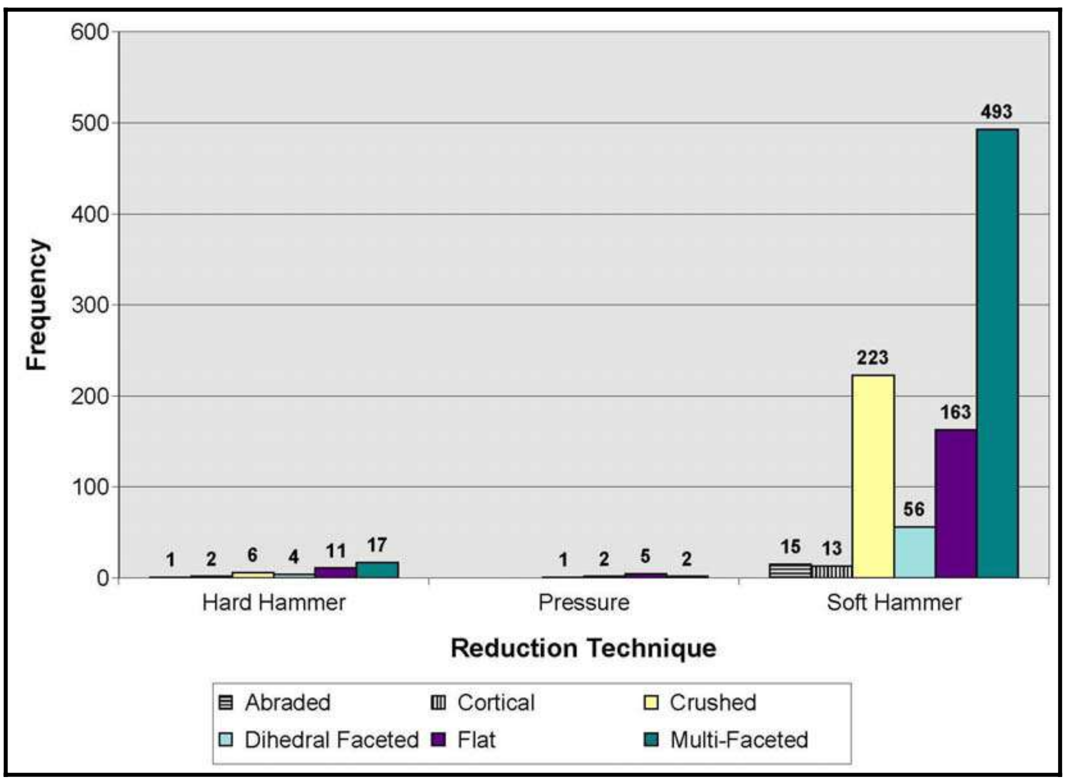


Figure 8-106. Platform Type Sorted by Reduction Technique.

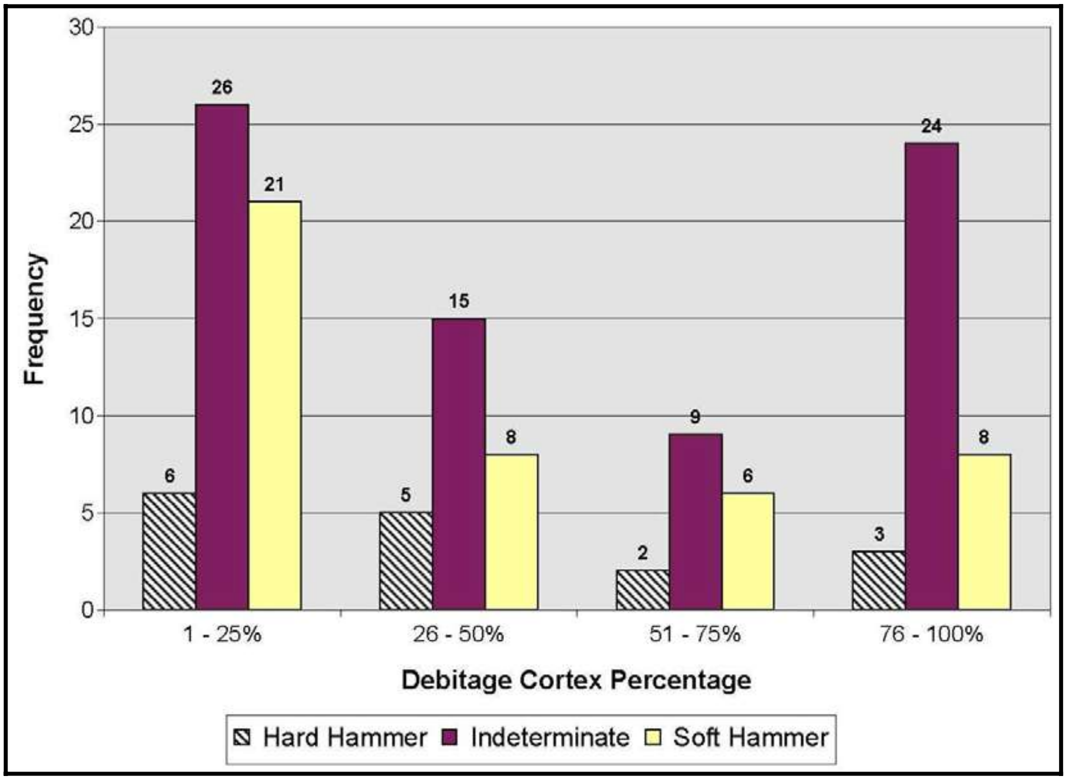


Figure 8-107. Cortex Percentages by Detachment Technique.

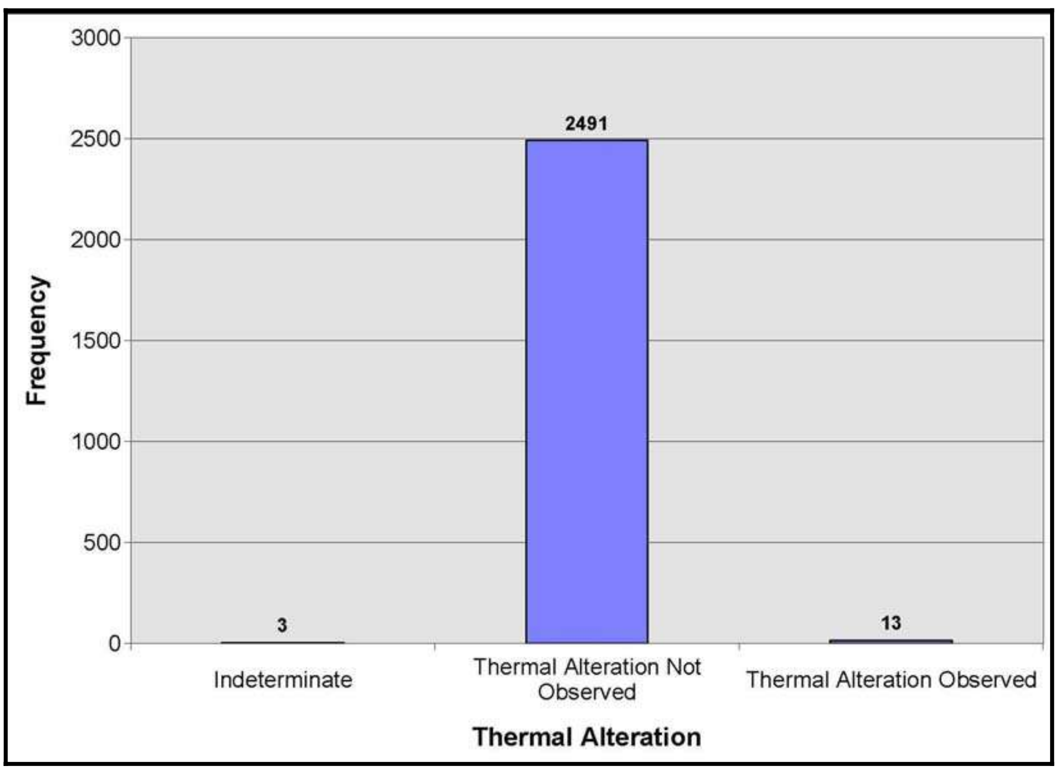


Figure 8-108. Frequency of Thermally Altered Debris

Raw Material Types, Sources, and Uses

Identification of raw material types used by these Late Archaic occupants reveals the probable source of known materials, use patterns, procurement areas, and distances and/or directions these groups likely traveled/traded to procure those nonlocal resources. Macroscopic analyses of lithic debitage allowed sorting into known raw material types. Visual identifications were augmented by INA results conducted on cultural debitage and chipped stone tools, combined with raw material from a few selected geologic outcrops in the region. The chemical results permitted comparisons between the cultural pieces and the known source pieces to aid in the material identifications.

Identifications reveal an intensive use of Alibates silicified dolomite, at 76.3 percent of the total assemblage (Figure 8-109). At least seven other identified, and some unidentified, material types are represented (obsidian is not depicted in Figure 109), but in frequencies of less than nine percent per for each type. The second most frequent material was unidentifiable pieces with 8.7 percent. This is followed by nearly equal amounts of Tecovas at 4.9 percent, Potter chert at 4.6 percent, and Dakota quartzite at 4.6 percent.

Potter chert is a fine-grained quartzite (often reddish or greenish in color) that is recognized in the region and is from the Ogallala gravels. Very limited amounts of Ogallala gravels (0.7 percent) are present, and even less frequent is obsidian (0.4 percent) and Edwards chert (0.2 percent).

Edwards chert and obsidian are the only two material types that are clearly nonlocal, and both are represented by less than one percent

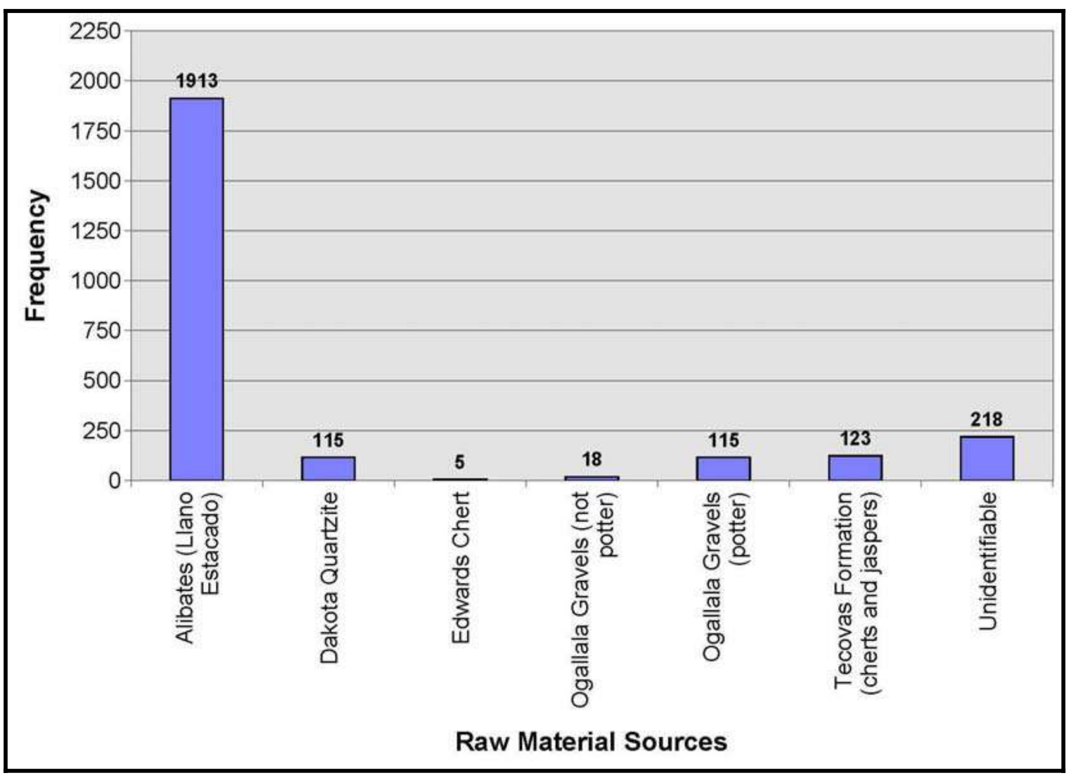


Figure 8-109. Bar Chart Showing Raw Material Types and Frequency.

of the total. The obsidian was sourced to outcrops in northcentral New Mexico (Appendix C). Edwards chert came from sources south of the project, with the Callahan Divide being the closest known outcrop.

The remainder, or 99 percent, of the debitage recovered are locally or regionally available. Tecovas jasper is available with outcrops scattered across the Texas Panhandle region along various valley walls (Holliday and Welty 1981; Lynn 1986; Banks 1984). The Ogallala also the origin of many of the various quartzites, the unidentified cherts, and probably the chalcedony. Ogallala gravels are present throughout the Canadian River valley and along the eastern Caprock Escarpment (Holliday and Welty 1981; Banks 1984; Reeves and Reeves 1996:3). Dakota quartzite originates in the extreme northwestern corner of the Texas Panhandle and western Oklahoma (Banks 1984), but it is not known if pieces from that outcrop are available in the various gravel sources south of there. The opalite, a silica replaced caliche, is from the upper part of the Ogallala Formation and is locally and regionally available (Lintz 1998).

The dominant Alibates type originates in a massive outcrop and in subsurface deposits next to Lake Meredith, about 56 km north of the project area. This is primarily a bedrock source that outcrops along the margin of Canadian River valley at one specific locality and along a couple of small tributaries to the Canadian River at that same location. Some rounded cortex bearing pieces may occur in Canadian River gravels downstream from this outcrop, which cut through the formation by the Canadian River. The sizes and amounts transported downstream from Lake Meredith are unknown, and Alibates from archeological sites downstream may have come from either the primary source at Lake Meredith or the secondary gravels. However, 41PT185/C is upstream from the outcrop at Lake Meredith, the closest available source. Thus, the distance and direction of the procurement can be pinpointed. Clearly, Alibates from the outcrop at Lake Meredith was targeted and intentionally selected for use by these Late Archaic populations.

The Alibates pieces are most often (70.8 percent) in the 6.4 to 12.8 mm size class. Another 19.3 percent are smaller than 6.4 mm, even though 6.4 mm screens were employed. Less than 10 percent of the Alibates was greater than 12.8 mm in size. Alibates is one of two materials types, the other being Ogallala, with a few flakes greater than 26 mm.

The sizes of the various nonAlibates pieces are presented in Figure 8-110. The larger pieces are dominated by unidentifiable material, Tecovas, and Ogallala quartzites. Most materials, other than Alibates, come in larger forms, with the possible exception of chalcedony, the highest frequencies are in the small to medium size categories. This indicates that these materials were probably not reduced on site, and that much of the knapping activity targeted small pieces, probably in late stages of production.

For the nonAlibates material, cortex was examined, and the percentage present was recorded in 25 percent increments. Figure 8-111 reveals the results of the percentages of cortex documented in the assemblage. Nearly all the assemblage (97 percent) was cortex free. Only two percent reveals 50 percent or more cortex. This documents the low frequency of primary and secondary flakes, and shatter from early stage reduction. Materials with cortex (water rounded cobbles from the Ogallala gravels) were not often targeted or reduced at this location. The near absence of cortex indicates that the majority of the debitage present was either decortified prior to its arrival, or that the raw material originally lacked cortex.

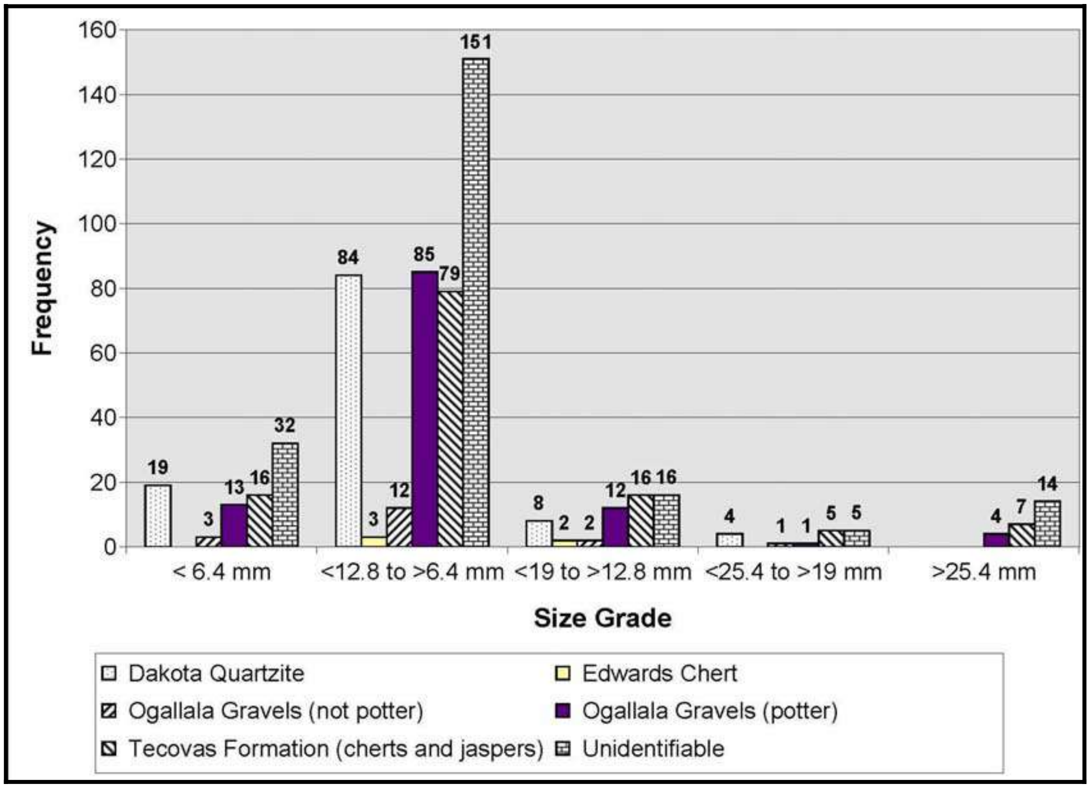


Figure 8-110. Frequency of Flake Size by NonAlibates Debitage.

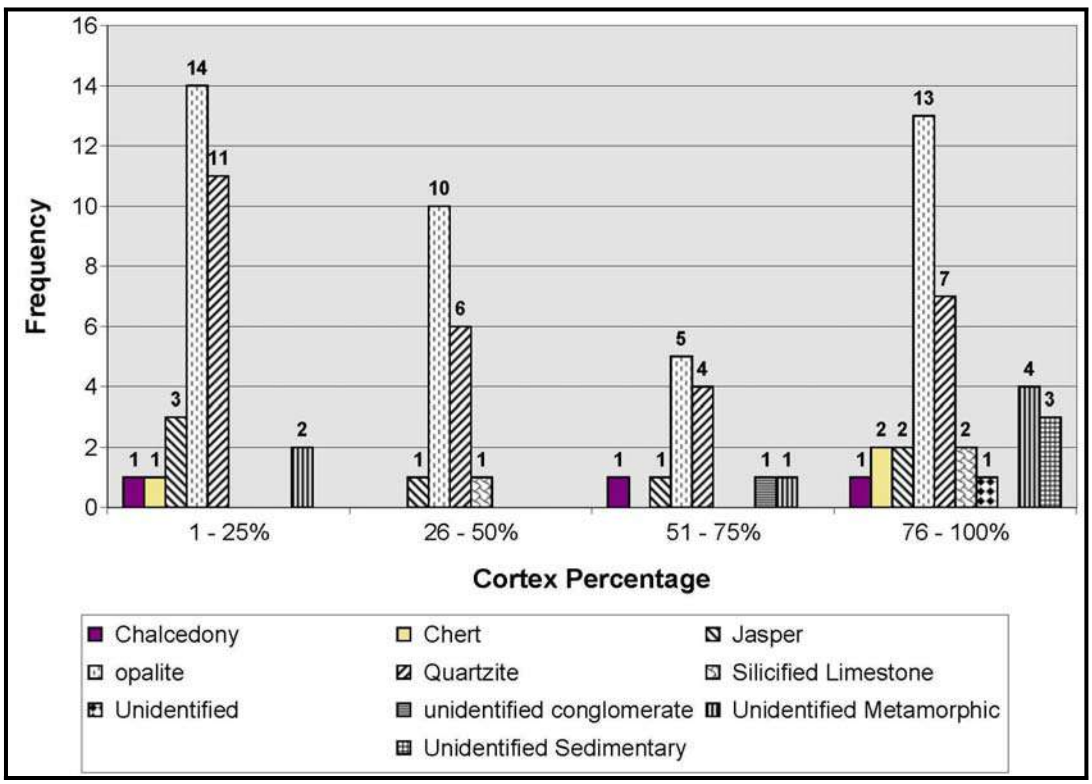


Figure 8-111. Frequency of Cortex by Material Type.

High quality materials, such as Tecovas and Alibates, reveal minimal cortex. Within the Alibates pieces only 1.6 percent (*N* = 31) exhibit cortex. Other than Ogallala quartzite, no raw material types exhibit significant amounts of cortex. Cortex on Ogallala quartzite pieces indicate that early stage reduction of this material occurred on site. This may stem from the presence of gravels in the immediate vicinity and the desire for expedient tools. With Alibates, the dominant material present, and its occurrence primarily as a bedrock source, the lack of cortex is not surprising.

Figure 8-112 shows the various platform types recognized in the nonAlibates materials. A lot of diversity is present with multifaceted platforms dominating (39.8 percent), followed by flat platforms (26.4 percent). Again, the least frequent are the abraded and cortical platforms. In contrast, the Alibates pieces reveal a high percentage of crushed platforms (45.5 percent), followed by flat platforms (33.1 percent), with significantly fewer dihedral (11 percent), abraded (3.3 percent), and cortical (1.6 percent).

The nonAlibates materials also reflect a near total reliance (88 percent) on soft hammer percussion (Figure 8-113). Although a hard hammer was used in a few instances, the majority of hard hammer knapping targeted the hard, coarse-grained quartzites. Apparently, the different types of materials did not cause knappers to deviate from the use of a soft hammer.

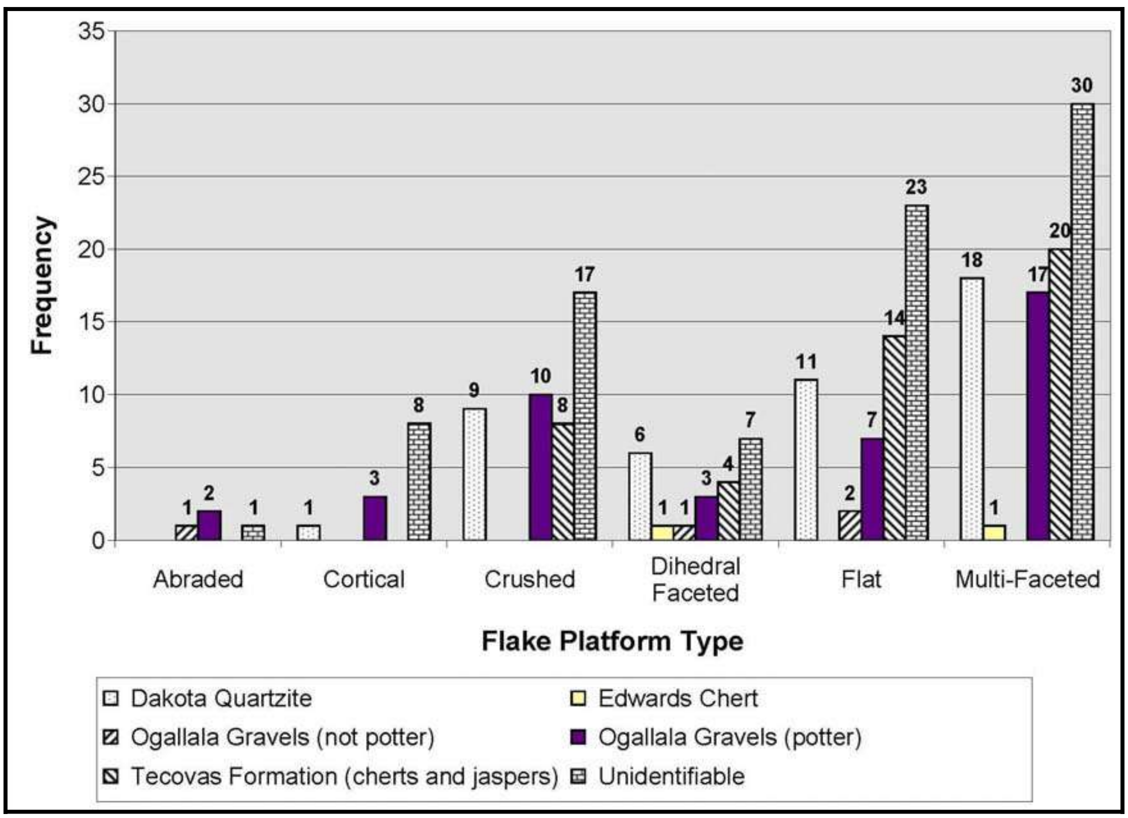


Figure 8-112. Frequency of Platform Attributes for NonAlibates.

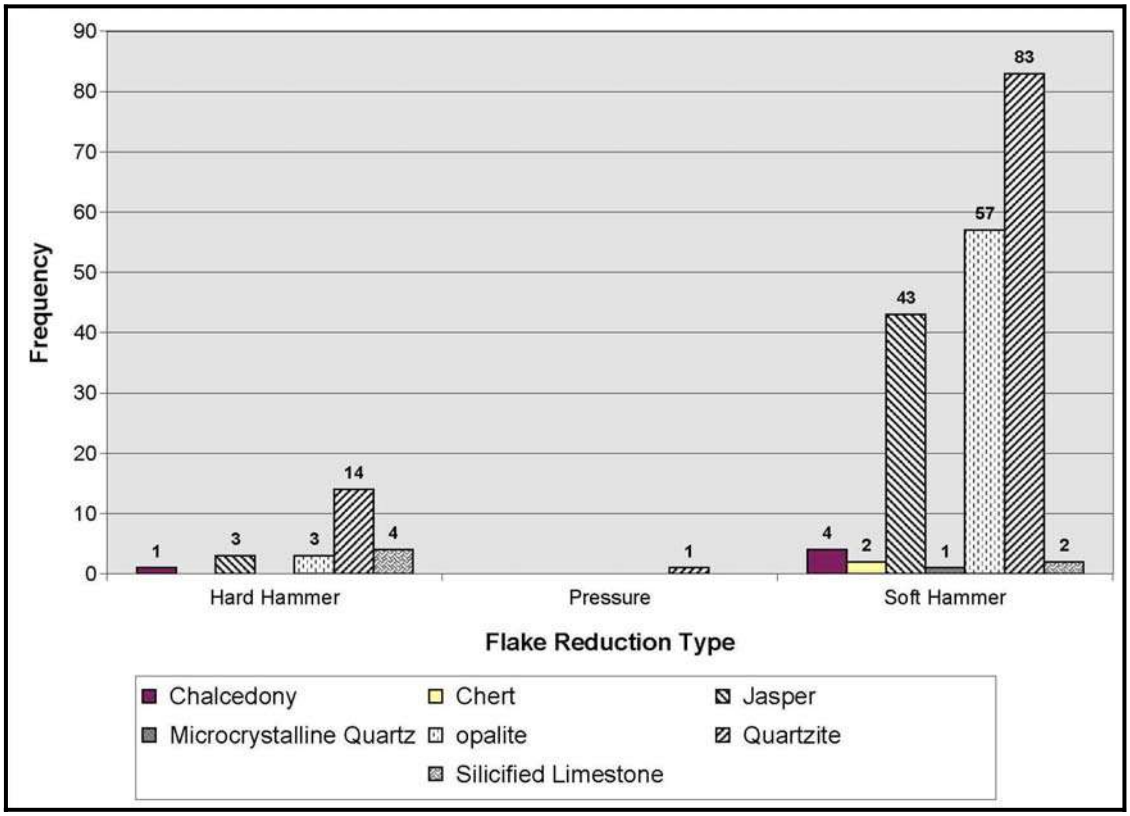


Figure 8-113. Bar Chart Showing the Frequency of Flake Reduction Type for NonAlibates.

Ten obsidian pieces were recovered from the target zone (Figure 8-114). Eight exhibit platforms, three crushed and five multifaceted. All were detached with a soft hammer and less than 3 cm long. Their small size, and the high frequency of crushed and multi-faceted platforms, reflects late-stage resharpening of bifacial tools dulled from use.

Nine pieces were sent for XRF analysis to determine their origin (Figure 8-114). The chemical results indicate that eight were derived from the mountain regions of northcentral New Mexico, and represent at least three different obsidian outcrops (Appendix C). The three recognized sources include Cerro Toledo Rhyolite (*N* = 3), El Rechuelos (*N* = 2), and Valles Rhyolite (*N* = 3) with nearly equal representation of each source. One piece (#857-001-1) from 60 to 70 cmbs in N113 E106 in the lower Late Archaic occupation was chemically

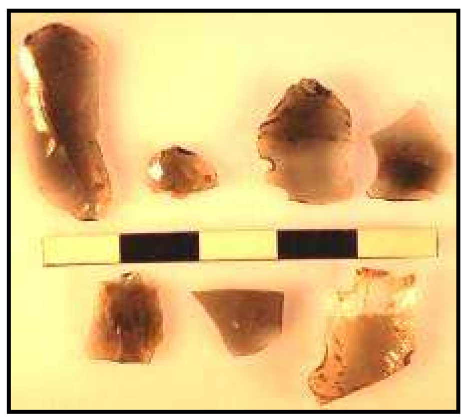


Figure 8-114. Obsidian Debitage from this Late Archaic Component Sourced to Northcentral New Mexico. (Top #310-001-1, #312-001-1, #326-001-1, #480-001-1, Bottom #480-001-2, #642-001-1, and #857-001-1) (scale in cm)

determined to be more like glass, but may lack an adequate chemical signature because it is very thin. These ten pieces came from three different arbitrary levels, 50 to 60 cmbs ($N = 3$), 60 to 70 cmbs ($N = 3$), and 70 to 80 cmbs ($N = 4$). This indicates no clear vertical distribution or direct association with either of the two recognized cultural occupations. Turbation activity may account for some vertical differences and could have been sufficiently intensive to homogenize their vertical positions.

Horizontal Pattering of Lithic debitage

The horizontal distribution of the debitage appeared clustered in the northwestern quadrant of the block (Figure 8-115). This large and obvious cluster reflects one intensive knapping area. This task was clearly separated from any of the other defined activity areas, and away from the identified burned rock features. This area of the block is interpreted to represent the upper Late Archaic occupation. Within that dense knapping area, four units yielded 60 to 99 pieces per unit and reflect a localized knapping or discard area. This dense concentration was surrounded by 17 units (6 percent of the total) with moderate to high frequencies. The broader scatter of lower frequencies surrounding that majority of debitage demonstrates a general scattering of the materials. This may have occurred following site abandonment. Outside this major concentration, another 20 units (7 percent) yielded low frequencies (11 to 22 pieces) clustered in five other areas (Figure 8-114). These other five areas were in the vicinity of various burned rock features. All but the 4 m^2 cluster just east of Feature 8 were associated with discard features. The one next to Feature 8 may reflect minor knapping activities conducted while a person was tending or enjoying the heat from this fire. The latter area is thought to reflect the lower occupation.

The horizontal distribution of obsidian was clearly outside the primary knapping area. This would indicate that no obsidian tools were reduced in that area. In fact, only one piece of obsidian came from any of the lower frequency clusters (Figure 8-116). The wide distribution of the obsidian flakes indicates obsidian tools were used across the camp(s), became dulled through use, and were then minimally refurbished, leaving these few small flakes at the resharpening locations. The resharpening occurred more or less in a general north south axis across the eastern side of the excavation block, rather than directly associated with any of the observed discard areas or *in situ* features. The obsidian is interpreted to be associated with the lower, early Late Archaic occupation.

The distribution of these obsidian flakes had little to do with their original source. However, the two pieces from TU 24, which ended up in the southern part of the excavation block, a couple of meters northeast of Feature 8, did come from the same source. No apparent association exists between the individual pieces. Only the possible glass piece (#857-001-1) at 60 to 70 cmbs was near a recognizable feature, Feature 6, a burned rock discard pile.

Examination of Figures 8-117 and 8-118 show the horizontal distribution of multifaceted (2+ facets) platforms and flat platforms across the excavation block. The highest concentrations of multifaceted platforms and flat platforms were in the northwestern corner, and thus show no marked differences. Multifaceted platforms are indicators of bifacial production, reduction, and resharpening. Flat platforms are a general reflection of unifacial production, reduction, or resharpening. No obvious clustering outside one dense knapping area comes to light as both platform types show a light scatter across much of the block. The distribution of these two platform types indicate the two principal tool types represented (bifaces and unifaces/cores) were worked in the same location.

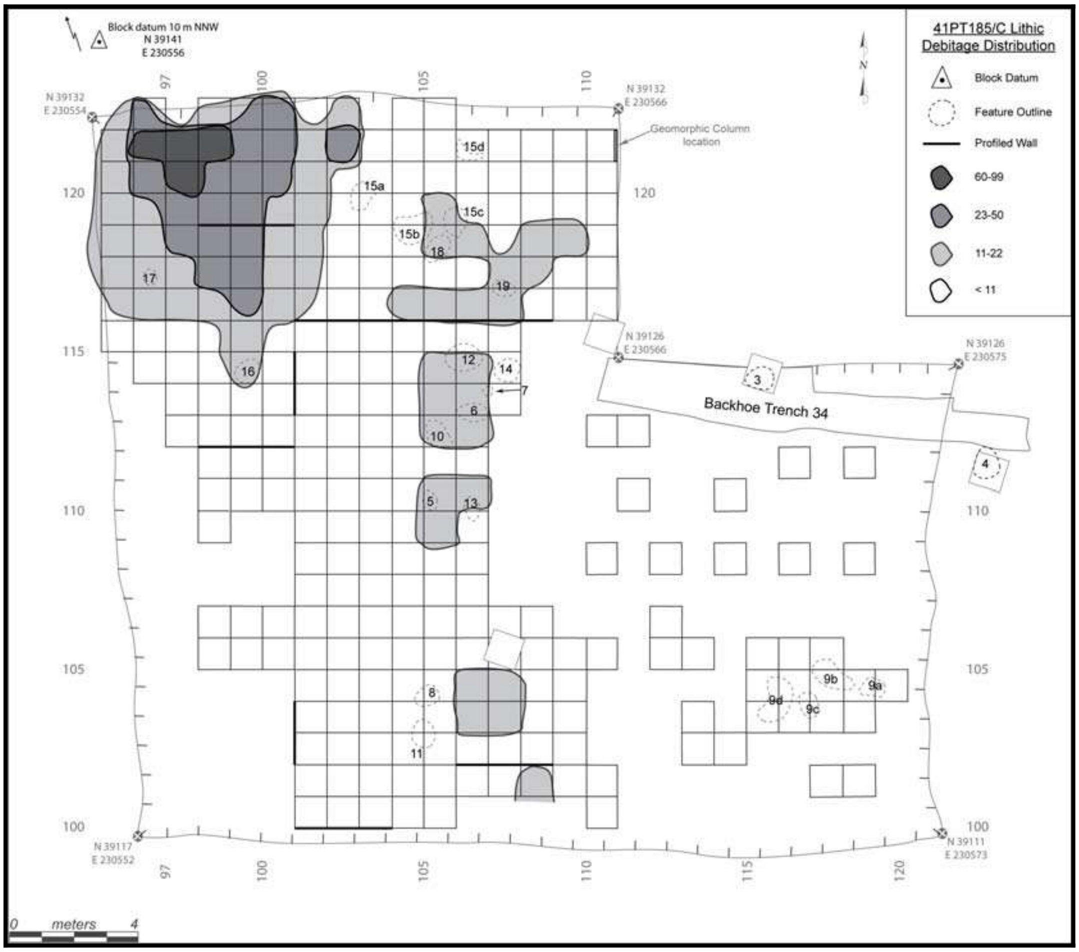


Figure 8-115. Generalized Distribution of Lithic Debitage Across Excavation Block.

In summary, the block excavations at 41PT185/C yielded relatively few pieces of lithic debitage (*N* = 2,507), although they account for about 20 percent of the total recovered materials. Most debitage was relatively small, with 70.5 percent in the range of 6.4 to 12.2 mm. Even using 6.4 mm size screens, 18.1 percent was still less than 6.4 mm. Less than 10 percent was greater than 12.8 mm.

The analysis yielded a very high incidence of flakes and flake fragments (89 percent) compared to shatter (11 percent). The low percentage of shatter indicates a focus on late stage manufacturing or tool maintenance where precise control was exercised.

The very high frequency (94.7 percent) of debitage lacking cortex also supports late stage production of tools or tool maintenance. The presence of some cortex indicates mostly initial cobble reduction, with minimal early stage reduction as indicated by hard hammer percussion flakes at 1.8 percent of the assemblage. The presence of flat platforms indicates that flakes were detached from nonbifacial tools (Andrefsky 2000:94). Most likely limited knapping of cores and unifaces, such as scrapers or reworking unifaces, occurred in comparison to bifacial working. Also, the low percentage (7.1 percent) of flat platforms indicates this was a minor activity. In contrast, the high frequency of multifaceted platforms (20.6 percent)

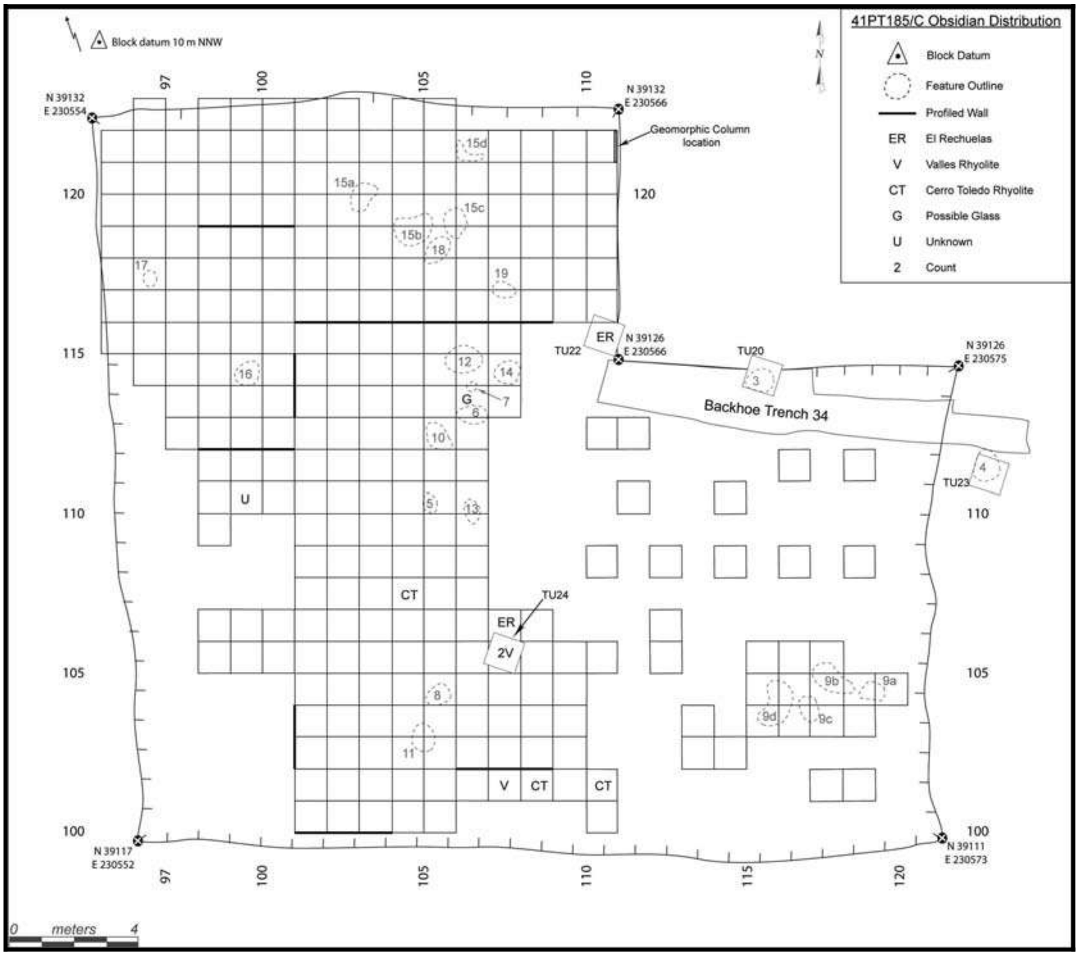


Figure 8-116. Horizontal Distribution of Obsidian Flakes.

combined with crushed platforms (9.2 percent) reflect a focus on biface maintenance. Faceting is an effective way to remove irregularities on a platform surface. It also increases the exterior platform angle to aid in more successful flake termination from the objective piece. The high frequency of flakes created through soft hammer percussion (94.6 percent of the assemblage) document knapping was most often associated with thinning, flattening, and shaping bifaces. These flakes exhibit small bulbs of percussion and small flake curvature. Therefore, knapping activity conducted within the block focused on thinning, flattening, and shaping late stage bifaces or their maintenance. The majority of the debitage (99 percent) was not heat altered to help facilitate the workability of the material. The lack of cortex in this assemblage also reflects the fact that Alibates comes from a bedrock layer that most often reveals no cortex.

Bamforth (1986, 1991) and Andrefsky (1994) propose that the availability of lithic raw materials is a factor in the technology of stone tool assemblages. It is suggested that tools are made and used for specific tasks

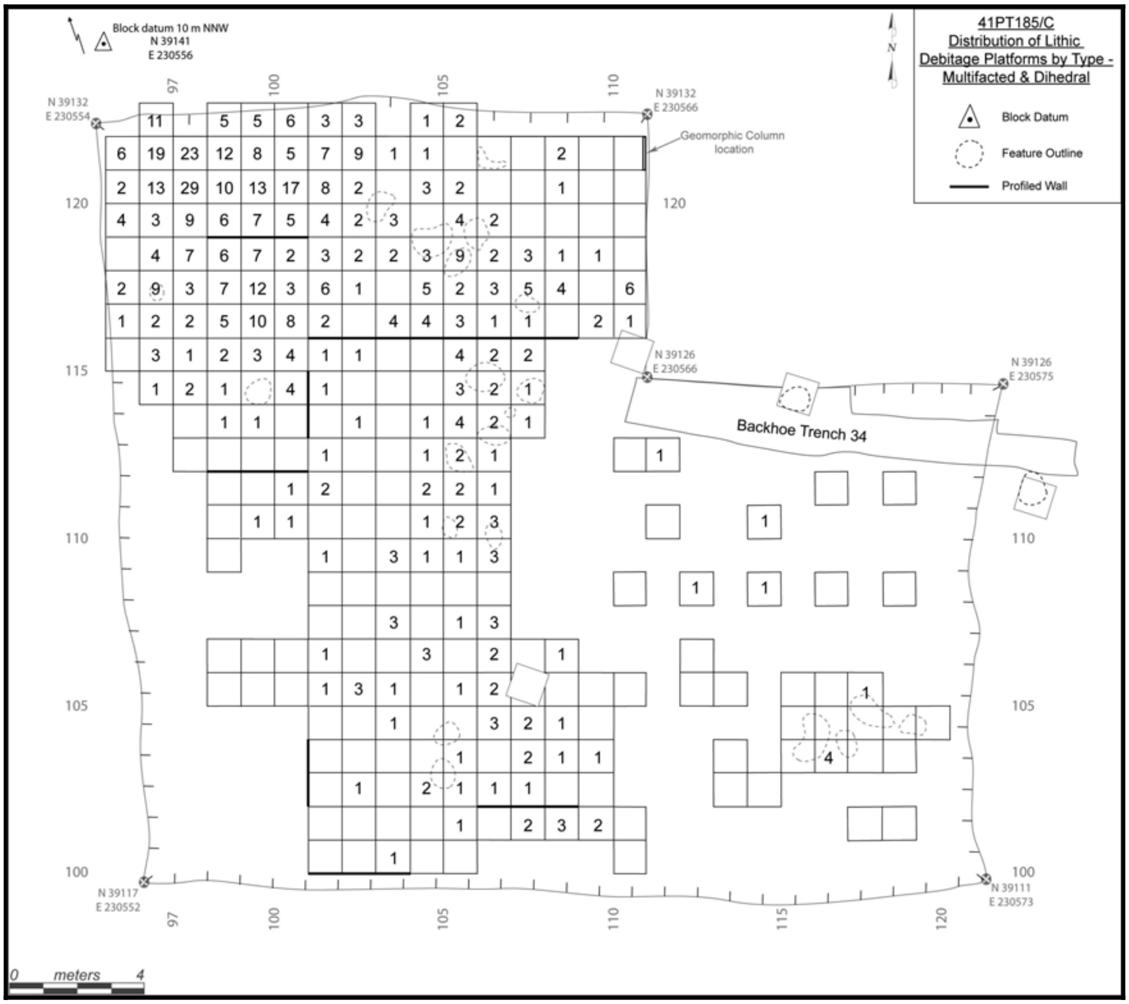


Figure 8-117. Horizontal Distribution of Flakes with Multifaceted Platforms.

based on the quality and abundance of lithic resources. The on site knapping activities were primarily directed towards Alibates (76.3 percent). This is a high quality, fine-grained and colorful material locally available at one specific locality, Late Meredith 57 km to the north. Alibates was the preferred and selected raw material, and was targeted in the biface reduction activities.

The second most frequent material, quartzite is represented by 11.2 percent. This also accounts for most of the pieces with cortex. Ogallala quartzite, an orthoquartzite, can be found throughout the southern, central, and northern Plains (Banks 1984:71, 1990; Reeves and Reeves 1996:3). Ogallala cobbles are present throughout Potter County. Ogallala quartzite is harder to flake, with its coarse-grained nature, which makes it more resistant to controlled flaking and makes fracture paths more unpredictable (Cotterell and Kamminga 1987:678). This makes formal tools more difficult to produce. Tools made from Ogallala quartzites, specifically Potter chert, are common in southern Plains assemblages. Generally, quartzites are used as hammerstones, informal/expedient tools, pecking stones, and other percussion tools.

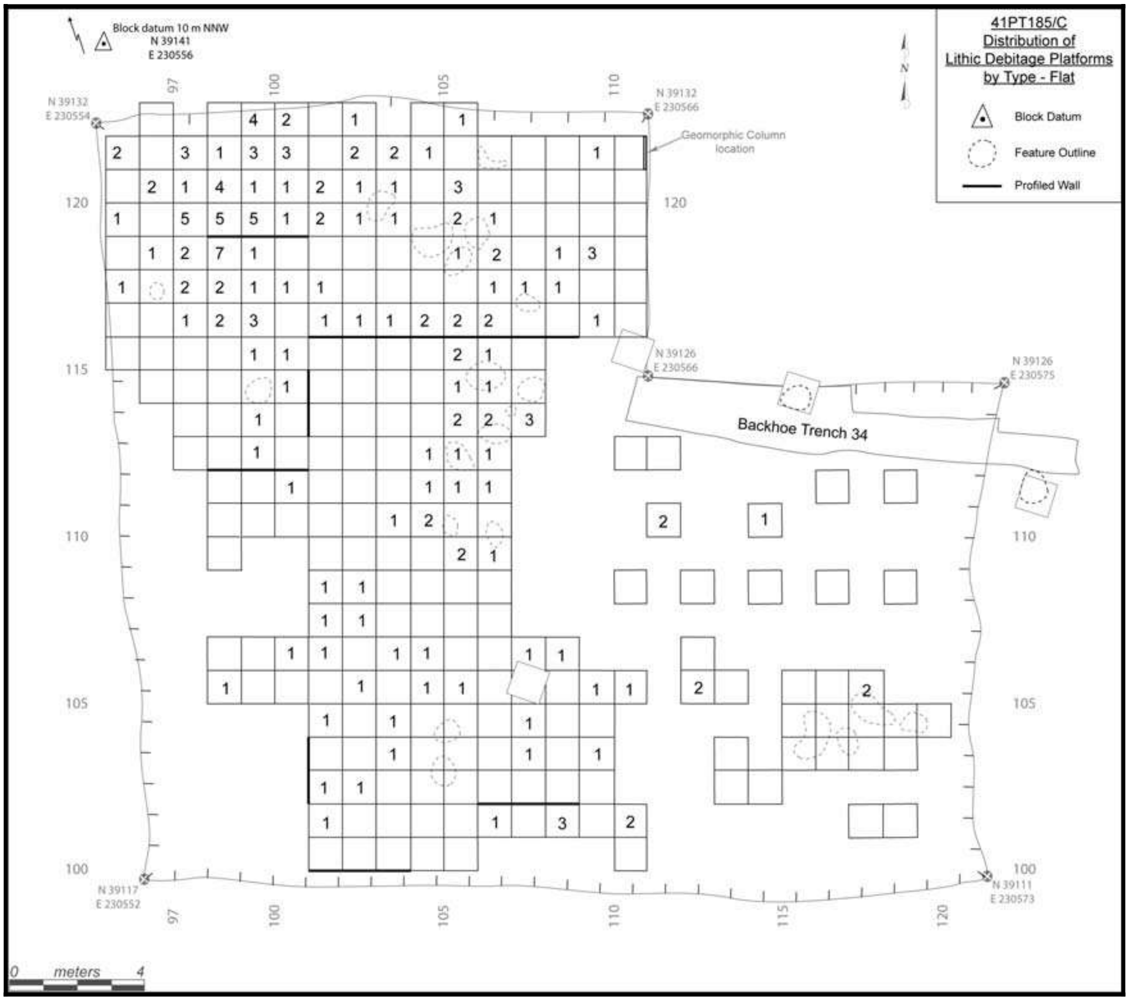


Figure 8-118. Horizontal Distribution of Flakes with Flat Platforms.

Less than five percent of the debitage represents the local Tecovas. Tecovas jasper is a variety of chert coming in a variety colors, including red, yellow, and grayish-blue, with similarities in appearance to Alibates. The quality of the Tecovas, although not formally studied, is similar to Alibates. The cryptocrystalline nature of Tecovas chert increases the likelihood of controlled knappability (see Moffat 1981:197), although much variability in lateral bedrock deposits potentially exists across the region. The near absence of Tecovas is surprising since at least one known outcrop exists only 21 km downstream and is more wide spread across the region than Alibates.

Although few in number, other material types including chalcedony, poor quality opalite, various other quartzites ranging from fine- to coarse-grained pieces, and silicified dolomite are represented. Each of these latter materials account for five percent of less. The dominant bifacial reduction activities were directed towards the higher quality (fine-grained) materials such as Alibates and Tecovas, whereas flake blank production and modification spans across a diversity of fine (Alibates and Tecovas) and coarse materials (i.e., Dakota and Ogallala quartzites; opalite, and chalcedony).

8.4.3.4.5 Vertebrate Faunal Assemblage (*N* = 5,337)

The vertebrate assemblage from Phase I data recovery investigation in Locus C (13.4 m^2 in 1 by 1 m units and from two BT 34 and 35), coupled with the subsequent block excavations (285 m^2) at Locus C during Phase II, are combined to address the entire Late Archaic component represented from the 299.4 m^2 of hand excavated area. Test Units 25 and 26 along the very eastern edge of Locus C did not contain positively identifiable Late Archaic cultural materials and will not be included here.

The Late Archaic component was primarily below about 40 cmbs. Post depositional rodent activity has undoubtedly dispersed some Late Archaic artifacts above this arbitrary elevation. These artifacts potentially became mixed with materials from more recent occupations, which are scarce at best. The larger pieces of bone were generally piece-plotted *in situ* during the excavations. These and other plotted cultural items allow for the assessment of the vertical positions of the different occupational episodes in this component, if in fact such are present. The stratigraphic position of these materials was complicated by the absence of visible stratigraphy in the homogenous dark brown sediments. The deposits that contained these Late Archaic materials sloped in two directions, downward to the east and slightly downward to the north. In a few instances, small bone fragments recovered from above the Late Archaic component have not been included. The Late Archaic component yielded 5,337 vertebrate specimens weighing 15,621.1 g. This faunal assemblage accounts for 43 percent of the total cultural materials recovered from this component.

Analyses of this assemblage quantifies the number of individual specimens (NISP), identifies the minimum number of elements (MNE), minimal animal units (MAU) and minimum number of individual (MNI) species represented. These estimations will follow element identification, assignment of side (right and left), determination of sex and estimated age. Analysis also addresses issues such as primary and secondary butchering practices, and camp seasonality based on the faunal assemblage. The NISP is the number of all identified specimens, which is commonly reported in most faunal analyses. This count has its strengths and weaknesses which have been discussed over time (Grayson 1978, 1979, 1984; Klein and Cruz-Uribe 1984). Minimal effort was given to species identification of smaller long bone fragments, which generally do not retain attributes of a specific long bone. Many medial long bone fragments were assigned to a specific element when they exhibit a very recognizable characteristic. The use of MNE is also common in the literature and reflects the minimum number of times an element or a part of an element occurs in the assemblage. Fragments of elements are not included in the MNE counts as the idea is to determine the actual number for each element without overstating that number. MAU value counts the minimum number of times a bone unit of the skeleton occurs in the assemblage. This measure was designated by Binford (1978) then later refined by Binford (1984a) and Todd (1987b). Flaws exist in each of these measures. Grayson (1984:88-90) criticized Binford's (1978) calculation of MAU for his use of fragments. Here, the assignment of the specimen to a particular side avoids the problem of multiple fragments representing a single element. Many researchers use NISP, but the more accurate value of MAU is a better determination of the number of elements present.

Bone preservation was generally not very good. Most sizable bones reveal minimally one weathered, root etched surface, and often at least one surface covered with a thin coating of calcium carbonate (Figure 8-119). The weathered surfaces often exhibit longitudinal drying cracks, exfoliation,

Figure 8-119. Examples of Root-Etched Surfaces. (scale in cm)

eroded surfaces, and/or splintering, all contributing to the poor preservation. Based on the weathered surfaces of some bones, it is postulated that at least the earliest (lowest) Late Archaic occupation was exposed on the surface for a considerable length of time. The root etching undoubtedly came later, as did the rodent gnawing and calcium carbonate. The latter calcium incrustation is a result of normal water percolation process moving calcium down through the profile and adhering to the under side of large objects. Another negative impact came from small rodents gnawing along the edges of many elements. Their paired incisor teeth marks are not often clearly visible, but the apparent gouging of bone tissue is present on many elements. Many bone edges and some surfaces were negatively affected by gnawing. In some instances, these weathered surfaces, combined with gnaw marks, appear similar to tool chop marks that might have been created by humans during butchering or bone processing activities. These poor surface conditions significantly affected our ability to identify the small artificial cut lines created by the sharp edges of stone tools during skinning and defleshing processes. The larger bone elements were inspected for these thin cut lines and some were observed even under these less than ideal conditions.

The assemblage was initially visibly scanned for different taxa. It was quite apparent that the vast majority (98+ percent) of the identifiable elements represented various parts of the bison skeleton with very few other taxa recognized. A few small rodent elements were observed, together with a few turtle and deer bones. With the vast majority of identifiable bones representing bison, the very thick cortical wall long bone fragments that lack diagnostic epiphysis were assigned to the bison class, even without a positive identification. The very small fragments of bone, less than 2 cm long were generally not assigned to a specific taxon. These small fragments may or may not represent bison elements. However, it is felt that most tiny fragments were probably from bison bone processing activities.

Nonbison Remains (N = 89)

As mentioned above the nonbison remains were sparse (*N* = 89, weighing 148.5 g) with only eight taxa identified. Identified nonbison remains consist of deer (*Odocoileus* sp.), dog (*Canis familiaris*), prairie dog (*Cynomys ludovicianus*), pocket gophers (Geomyidae), mink (*Neovison vison*), box turtle (*Terrapene ornate*), badger (*Taxidea taxus*), and snake (Colubridae). Each identified taxon is briefly discussed below.

Deer (*N* = 9, weight 20.2 g) is minimally represented by several identified specimens (NISP) that include a mandible fragment with three molars (#1044-002), fragmented teeth (#914-002), two third phalanges (#861-002 and #1244-002), a second phalanx (#581-002), a proximal rib head (#1084-002), rib fragments (#1089-002), a sesamoid (#301-002), and some long bone fragments (#1277-002). The partial mandible represents a very old individual with extensively worn molars. The MNI represented by these few elements is one, an old individual with worn teeth. These nine elements exhibit weathered surfaces similar to the many bison elements. They do not reveal specific human alterations such as cut lines or impact fractures. One exception is

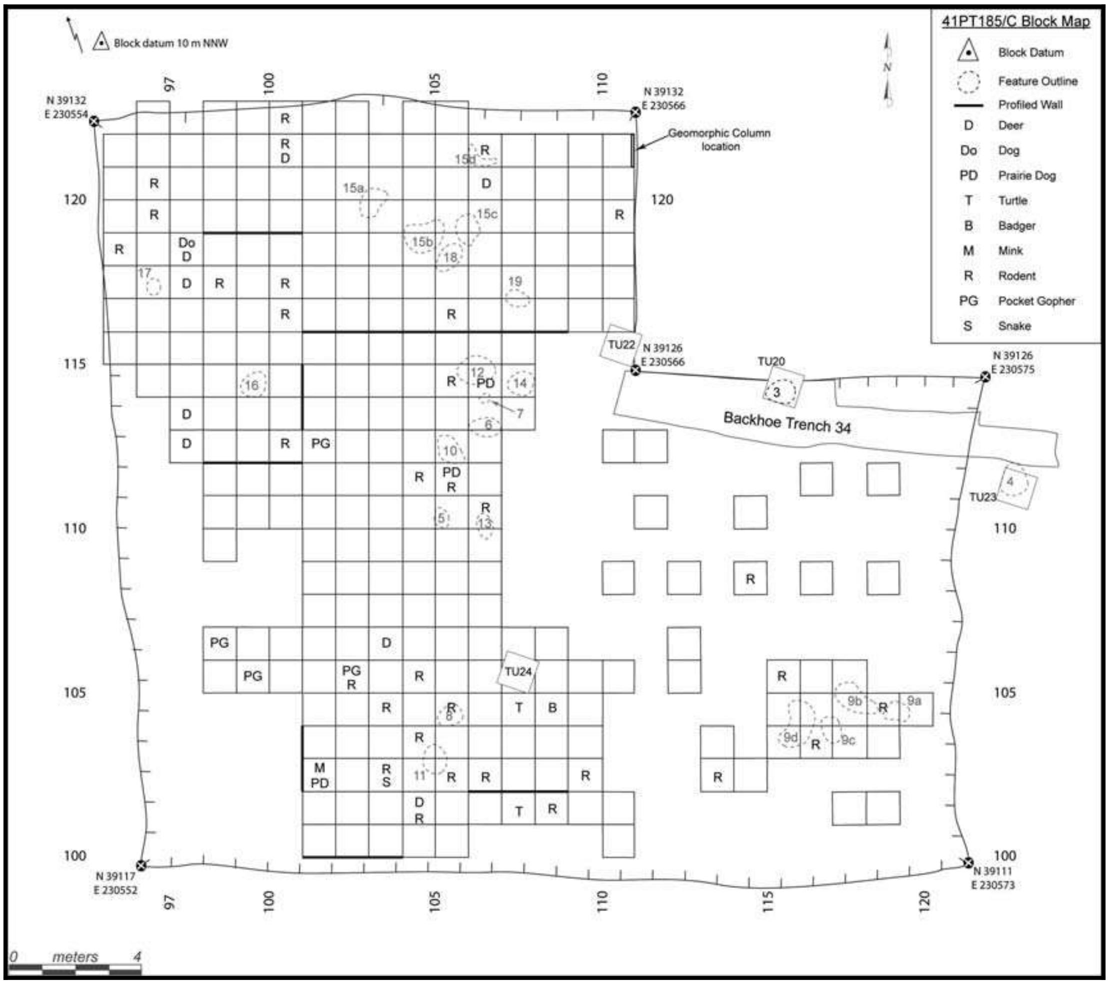


Figure 8-120. Distribution of Nonbison Identified Elements.

the possible spiral fracture of the long bone fragments and the obviously butchered section of the mandible. This deer (MNI = 1) is considered part of the Late Archaic component and likely represents a part of the subsistence base. The entire deer carcass was brought to this camp for processing as evident by the presence of phalanges and the mandible.

The horizontal distribution of these nine deer specimens was somewhat concentrated in the northwestern side of the excavation block, as represented by four pieces (Figure 8-120). A third phalange was just east of Feature 15 and a long bone fragment was west of Feature 15 at the northern end of the block. A few deer bones were scattered on the northern and southern sides of Features 8 and 11. No recognizable pattern is apparent in this distribution.

A nearly complete left canid mandible (#1090-002-2) with six socketed teeth that weighs 36.2 g was recovered from 60 to 70 cmbs in N118 E97 (Figures 8-121 and 8-122). Measurements on this mandible (Table 8-7; see van den Driesch 1976:60 for locations of measurements) indicate that it represents a domesticated dog rather than a coyote (Figure 8-121). Two short, thin cut lines on the inside of the gonion caudale are interpreted to be cut marks from a thin edged stone tool (Figure 8-120). The cuts would have occurred during the removal of the mandible from the skull. These cut lines indicate that this dog was definitely associated with this extensive Late Archaic faunal assemblage and is part of the Late Archaic component. This dog mandible was in the same unit as one of the deer ribs (Figure 8-120).

Prairie dogs are common in the region and live and tunnel in the ground. It should not be surprising to find their bones (*N* = 8, weighs 2.8) naturally deposited in this component. A left mandible (#340- 002) weighs 1.8 g and came from 50 to 60 cmbs in N102 E101.

Figure 8-121. Left Canid Mandible (#1090-002-2) that Shows Tooth Wear and Cut Marks at the Extreme Left Margin.

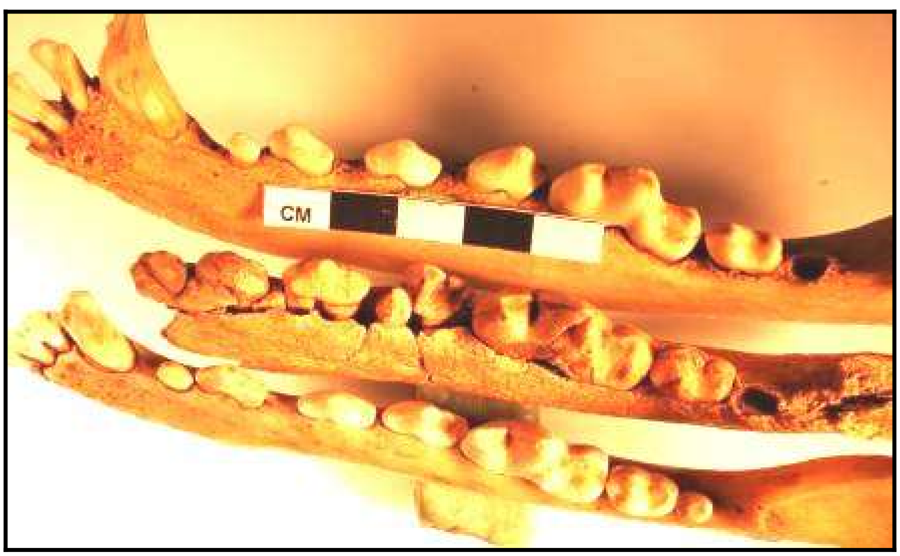


Figure 8-122. Comparisons of Modern Coyote (top), Prehistoric Dog from 41PT185/C (middle), and Modern Dog Mandibles (bottom).

Table 8-7. Measurements on Dog Mandible from 41PT185/C.

Measurement No.	Description of Measurement *	Measurement (mm)
4	length: the condyle process - aboral border of the canine alveolus	144
5	length from the indentation between the condyle process and the angularprocess - aboral border of the canine alveolus	137.1
6	length: the angular process - aboral border of the canine alveolus	138.9
7	length: the aboral border of the alveolus of M3 - aboral border of the canine alveolus	89
8	length of check tooth row M3-P1 measured along the alveoli	83.4
9	length of check tooth row M3-P2 measured along the alveoli	77.1
10	length of molar row measured along the alveoli	43.7
11	length of premolar row P1-P4 measured along the alveoli	45.2
12	length of premolar row P2-P4 measured along the alveoli	37.7
13	length and breadth of the carnassial measured at the cingulum	26.4
14	length of the carnassial alveolus	24.8
19	Height of the mandible behind M1 measured on the lingual side and at right angles to the basal border	28.2
	Length of M1	26.3
	Breadth of M1	11.5
	Length of M2	11.3
	Breadth of M2	8.3
20	Height of the mandible between P2 and P3 measured on the lingual side and at right angles to the basal border	23

* Measurements taken from von den Driesch 1976:61

The surfaces appear fresh and lack any sign of artificial alterations (Figure 8-123). Part of a mandible with loose teeth (#760-002) came from 60 to 70 cmbs in N11 E105. This mandible has a fresh surface, indicating it was probably not deposited at the same time as the Late Archaic assemblage. Both specimens are considered to be noncultural background fauna, rather than representing part of the Late Archaic procurement, processing, or subsistence base. These elements were scattered across the excavation block (see Figure 8-120).

Pocket gophers are also quite common in the region and also live in the ground. The MNI (*N* = 4, weighs 2.4 g) is minimally two individuals. In two instances, single incisors were identified. One (#518-002) was from 80 to 90 cmbs in N105 E94 and the second (#526-002) was from 50 to 60 cmbs in N105 E102. A mandible with a couple of teeth was identified. One (#518-002) was from 80 to 90 cmbs in N105 E94 and the second (#526-002) was from 50 to 60 cmbs in N105 E102. A mandible with a couple of teeth (#566-002) was from 70 to 80 cmbs in N106 E98. These tiny fragments exhibit relatively fresh surfaces and because they are natural to the region, they are not considered part of the Late Archaic subsistence base.

A mink is represented by one complete right mandible (1.1 g) with molars and premolars still in their sockets (#340-002). This mandible was recovered from 50 to 60 cmbs in N102 E101. This element has a fresh, unweathered surface with no sign of cultural alterations (see Figure 8-123). The mink has a prized fur and potentially was highly sought after by prehistoric populations, but this single mandible is considered noncultural because of the fresh surface. This mandible came from the same unit as a prairie dog element (see Figure 8-120).

Figure 8-123. A Badger Claw (left, #483-002-1), a Mink Mandible (top, #340-002), and Prairie Dog Mandible (lower) that Have Fresh Surfaces Unlike those Observed on the Bison Bones.

Box turtle remains were not numerous, but at least two complete or nearly complete turtles (#769-002 and #312-002) and one other tiny fragment (#479-002) were recovered. Box turtles are common in the region and are sometimes found in below ground sediments. Specimen #769-002 (39.4 g) was from 90 to 100 cmbs in N111 E118, towards the extreme eastern side of the block. Specimen #312-002 (37.2 g) was at 55 cmbs in N101 E107 along the block's southern edge. Both are identified as box turtles with plastron, carapace, and appendages represented (Figure 8-124). The bones themselves exhibit relatively fresh surfaces with minimal root etching and no calcium carbonate build up, which is in contrast with most of the bison bones. The fact that these two turtle skeletons are nearly complete and lack any sign of human alterations such as burning, cut marks, disarticulation, and do not reveal extensive weathering or a calcium carbonate film, combine to indicate that they are part of the background fauna. They are believed to postdate the Late Archaic occupation(s). One tiny turtle carapace piece (#479-002, 0.2 g) was from 32 to 50 cmbs in N104 E107. This isolated piece lacks calcium carbonate and root etching, and has a fresh surface. These characteristics indicate that this turtle also occurred naturally in the matrix as background, but its isolated position from other turtle pieces may indicate it was part of the human subsistence base. The evidence is weak for this being a cultural taxon.

Figure 8-124. Selected Remains of One Unaltered Box Turtle (#312-002) Thought to be a Natural Occurrence. (scale in cm)

A single badger element (0.3 g), a complete third phalanx (#483-002-1), was identified from 50 to 60 cmbs in N104 E108. This element is a dark brown color and unlike the color of those elements from this same depth thought to be introduced by human agency (see Figure 8-123). The bone surface has a fresh appearance, with no root etching, weathering, or calcium carbonate attached. Badgers are common in the area, but rarely seen. They live in the ground and dig relatively large holes and tunnels. This element is considered noncultural and part of the background fauna.

Snakes are nearly absent, except for one tiny (0.2 g), unburned vertebra (#346-002). This element came from between 40 and 50 cmbs in N102 E94. The presence of one snake vertebrae in this deposit is not unexpected. Snakes often live and die in the ground and their remains become naturally buried in the deposits. The presence of only a single snake vertebra that lacks visible signs of human alterations indicates that snakes were not part of the subsistence base for the Late Archaic people at this site.

In a broad excavation area like this one, it is surprising not to find greater taxon diversity. Other game animals such as pronghorn (*Antilocapra americanus*), mule deer (*Odocoileus hemionus*), rabbits (*Sylvilagus* sp), coyotes (*Canis latrans*), various other small fur bearers, and even some bird species were expected. It is also surprising that so few elements of each of the identified taxa were represented in this assemblage. It is difficult to say where the rest of the dog and deer elements might have been discarded. It is possible that these individual carcasses were processed at a location beyond the excavated area and that only a few selected pieces were brought into this particular area.

Bison Remains (N = 938)

The bison assemblage is comprised mostly of fragmented bones, with many proximal and distal articular ends identifiable, combined with many unidentifiable thick walled fragments. At first glance these specimens represent an unknown number of animals that were killed elsewhere, with disarticulated sections brought back to this camp for further processing. The NISP for bison is 938, weighing a total of 12,804.8 g. This includes complete and fragmentary bison elements, those specifically identified plus the thick walled long bone fragments (*N* = 579) presumed to represent bison bones. As expected, fragments (51.3 percent of the total) of both unidentifiable (42.6 percent) and medial sections (8.7 percent) clearly dominate this assemblage. More than 26 percent of the elements are considered complete or nearly complete. Recognizable proximal (12.5 percent) and distal (9.8 percent) ends account for 22.3 percent.

Bison Age Groups, Gender and Seasonality

Four broad age groups of bison were defined and reflect general bone growth and development. The groups include fullterm fetal or neonatal animals, immature (unfused elements) and mature (fussed elements) animals, and unknowns. The fetal or neonatal group consists of elements that represent the very early developmental stage from unborn or just born bison. Fetal elements are recognized by a general structural morphology that mimics the corresponding mature element, as well as by their very small size, light weight, porous or spongy appearance, and often flakey surface compared to the more solidified and dense cortical tissue in older bison elements. The spongy appearance is a reflection of the fact that the multiple periosteum layers of tissue that form the bone's structure have not fused into a solid cortical wall. During the fetal growth stage the bones develop in a general sequence. The limb bones of most mammals, including *Bos taurus* with a gestation period of 284 days (similar to *Bison bison*), grow most rapidly during the second half of uterine development. This is in contrast to the axial part that shows relatively minimal growth during this same period (Vsyakikh 1969:227-233 cited in Wilson 1974:146-147). Following birth, this growth trend reverses, with the axial bones growing faster and the peripheral bones developing slower than before.

The periosteum tissue is deposited in layers separated by thin cancellous interspaces that form the shaft of the bones. At this early stage, the articular epiphyses ends have developed into their general overall shape, but are not yet fussed to the ends of the proximal and distal shafts. The ends of most long bone shafts exhibit a bumpy, irregular articular surface where the epiphyses ends will eventually fuse. The lack of well developed proximal and distal ends may hinder the identification of young shaft segments, but the overall morphological characteristics and general shape of the mature elements are reflected in the fetal and neonatal shafts. The vertebrae bodies, skull, pelvis, and metapodials all occur in multiple pieces at this developmental stage. This creates more bones per fetal animal than is the case with the mature adults.

These fetal and neonatal elements are readily recognizable, and often can be assigned to a very specific period in their development stage. Wilson (1974) presented a possible aid in the aging of fetal bison bones, other than the obvious size developmental characteristic. This aid to aging is made possible through the stratification of periosteum layers, with thin cancellous interspaces. The separation of the periosteum layers/strata allows for counting individual layers. Wilson (1974) discovered that the counts of the periosteal layers revealed a fairly consistent trend for older individuals to show more strata. However, the actual number of strata is does not correlate directly with specific fetal ages. Because so few elements are represented, the overall sizes provide the best attribute for assessing age, as opposed to the counts of layers.

Once the fetus comes into this world as a new born calf, the periosteum layers begin to solidify (by reabsorption) as the animal's weight is placed on the limbs. In many instances it is difficult to identify bones between a full term fetus and a new born calf (neonatal). The presence of fetal or neonatal bones is a very useful age category that can contribute to the interpretation of the season of death and hence the timing of the occupation(s) in the annual cycle.

Full Term Fetus or New Born Bison

Actual elements recognized as full term or new born are very sparse (*N* = 7) and quite fragmented (28.6 g), with the exception of one relatively complete bison ulna (Figures 8-125, 8-126, and 8-127). These elements consist of a distal radius fragment, a distal metatarsal shaft that is fused, a distal metapodial fragment, a medial long bone shaft fragment, and a proximal ulna (Table 8-8). The distal radius is only about half present with the articular surface that has the characteristic nubbins for the articulation with the epiphysis end. The cortical wall is very thin and lacks a good area to count the periosteum growth layers.

Figure 8-125. New Born Bison Elements, Ulna (#1167-002), Distal Radius Fragment (#1310-002), Distal Metapodial, and Long Bone Fragment (#1207-002).

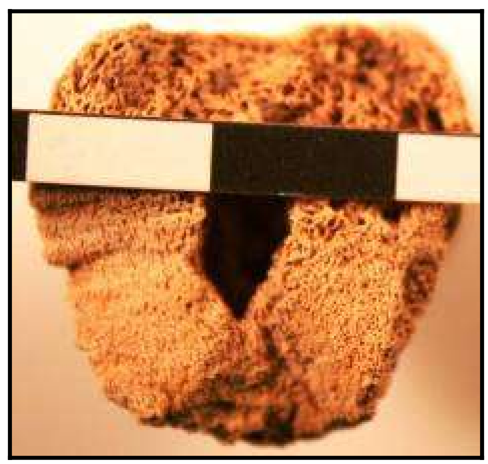


Figure 8-126. Fetal Bison Second Phalanx (#500-002) that has Layers of Tissue Before Their Solidification into the Cortical Wall. (scale in cm)

The fragmented distal metapodial shows the undulations of the articular surface with mostly cancellous tissue present. The medial long bone shaft fragment has an apparent chop mark or possible rodent gnawing into the broken edge. Close inspection of stratification in the periosteum indicates 14 to 15 visible layers.

Figure 8-127. Fetal Bison Bone (#1207-002) that has Cultural Chop Mark into the Layered Tissue. (scale in cm)

The very few elements recovered, plus their fragmentary nature, provides a very limited data set to interpret. Based on the general similarity in size and development stage of these few elements it is apparent that the MNI is one and this animal is a full term fetus or newly born calf. The fusion of the two halves of the one metapodial and the 14 to 16 layers observed in a couple of these elements supports a greater probability of a neonatal animal. If this one animal is representative of the normal bison life cycle and part of the regular calving period, then this animal would have been born between around April 1 and April 15, during the peak calving period in the Southern Plains (Halloran 1968 citing Mosby 1960).

The horizontal distribution of these recognized elements indicates that two animals may be represented (Figure 8-128). Three pieces were widely spaced across the very southern end of the block. Four elements were somewhat clustered in the northwestern corner. The lack of clustering of the seven elements is surprising, if they represent one individual. Also surprising is that they were not anywhere near one of the *in situ* heating elements, with the possible exception of the one second phalange in Feature 9 cluster.

Immature Elements

The maturity of a specific element does not reflect the animal's ability to produce young. Maturity reflects bone growth and is

Table 8-8. New Born Bison Remains from the Late Archaic Component at 41PT185/C.

Catalog No.	Element	Provenience	Depth (cmbs)	Weight (g)	Length (mm)	Width (mm)	Wall Thickness (mm)	Comments
269-002	Long bone fragment	N100 E101	50-60	0.5	21.5	12.8	2.3-3.0	1 tiny piece, exterior surface is porous, not solidified, layers just starting to solidify, 15-16 layers
326-002	Medial metatarsal	N101 E110	78-79	11.1	58.1	16.9	1.9-3.1	10 pieces, two halves are fused together, could be 2 elements, calcium covered, 14-15 layers
500-002-1	2nd phalange	N104 E117	43	5.1	37.7	23.3		complete, weathered that exhibits layered tissued on proximal end.
1167-002-1	Proximal ulna	N119 E100	60-70	9.0	84.2	29.1		Unfused, outer tissue not solidified, carbonate present
1207-002-1	Medial long bone frag	N120 E95	60-70	3.0	42.5	19.5		outer tissue not solidified, exhibits chop marks, 14-16 layers
1219-002-1	Distal metapodial frag?	N120 E98	80-90	1.2	22.8	21.5		2 pieces, fragments, outer tissue not solidified
1310-002-1	Distal radius frag	N122 E98	70-80	3.8	30.3	24.3		5 pieces, outer tissue not solidified

a reflection of the degree of fusion of the proximal and distal epiphyses to the main bone shaft or body. The proximal and distal epiphyses of each element fuse at different times during the bison's' life cycle. Individual bones experience different rates of epiphyseal closure, therefore, different elements from a single individual animal may be classified as "mature", whereas other elements will be classified as "immature". Very little is known about the exact timing of bone fusion rates in North American *Bison bison*. Previously, most researchers used Koch's (1935) study of European bison (*Bison bonasus*) to approximate the general trends in the timing of various epiphyseal fusions in North American bison. In 1950 Sisson and Grossman (1950) provided fusion rates based on modern cow (*Bos Taurus*), which may or may not be similar to fusion rates in *Bison bison*. From the 10,000 to 11,000 year old Cooper site faunal assemblage in Oklahoma, Bement and Basmajim (1996) created a fusion chart for *Bison antiquus* from the many articulated skeletons they discovered. They aged some 50 individual articulated animals using the tooth eruption sequence and wear patterns on the mandibular dentition following Reher (1974) and Todd (1978a). Then they examined the rest of that animal's skeleton to document the rate of fusion of the long bones. They did this for many animals up to five years-old on an assemblage that represented a catastrophic kill event. The analyses of the mandibular tooth eruption showed that the animals died at about 0.3 of a year after the peak calving period. This provides a season of death for the Cooper animals at late summer or early fall (Bement 1999). Consequently, the Bement and Basmajim (1996) chart provides yearly age determinations from birth to five years old. These fusion rates may not be appropriate for our ca. 1,500 to 2,500 year old *Bison bison* assemblage, but it provides another rate to select from. For the *Bison antiquus* from the Cooper site, all epiphyses of the appendicular skeleton were fused by the age of 5.3 years (Bement 1999). The Bement and Basmajim (1996) fusion rates were followed, with a caution to the reader that this may not be the exact timing for *Bison bison*.

In total, 20 elements (weighing 896.8 g) lack the articulated proximal or distal ends and are considered elements that represent immature or incomplete bone development. This total includes eight vertebrae bodies (613.2 g) that range from nearly complete to quite fragmentary and lack the epiphyseal union of their articular surfaces, plus one epiphyseal disk (8.5 g). The total weight of these vertebrae accounts for nearly 70 percent of the weight of the unfused group of elements. Bement and Basmajim (1996) do not provide age estimates for the fusion of the axial skeleton, therefore, the approximate ages of the animals from which these were derived elements are unknown.

The remainder of the immature elements (*N* = 11, with a weight of 283.6g) represent appendicular pieces of the front and rear legs (Table 8-9). Each fragmented element is identified and its projected age is estimated based on the fusion rates presented by Bement and Basmajim (1996).

The immature distal radii are the most numerous and reflect a MNI of two individuals less than 5.3 years-old. Four immature phalanges are present, but may only represent one individual less than 1.3 years-old. Minimally one animal less than 1.3 years old, one less than 3.3 years, and two that are less than 5.3 years-old are represented, based on these 11 immature appendicular elements.

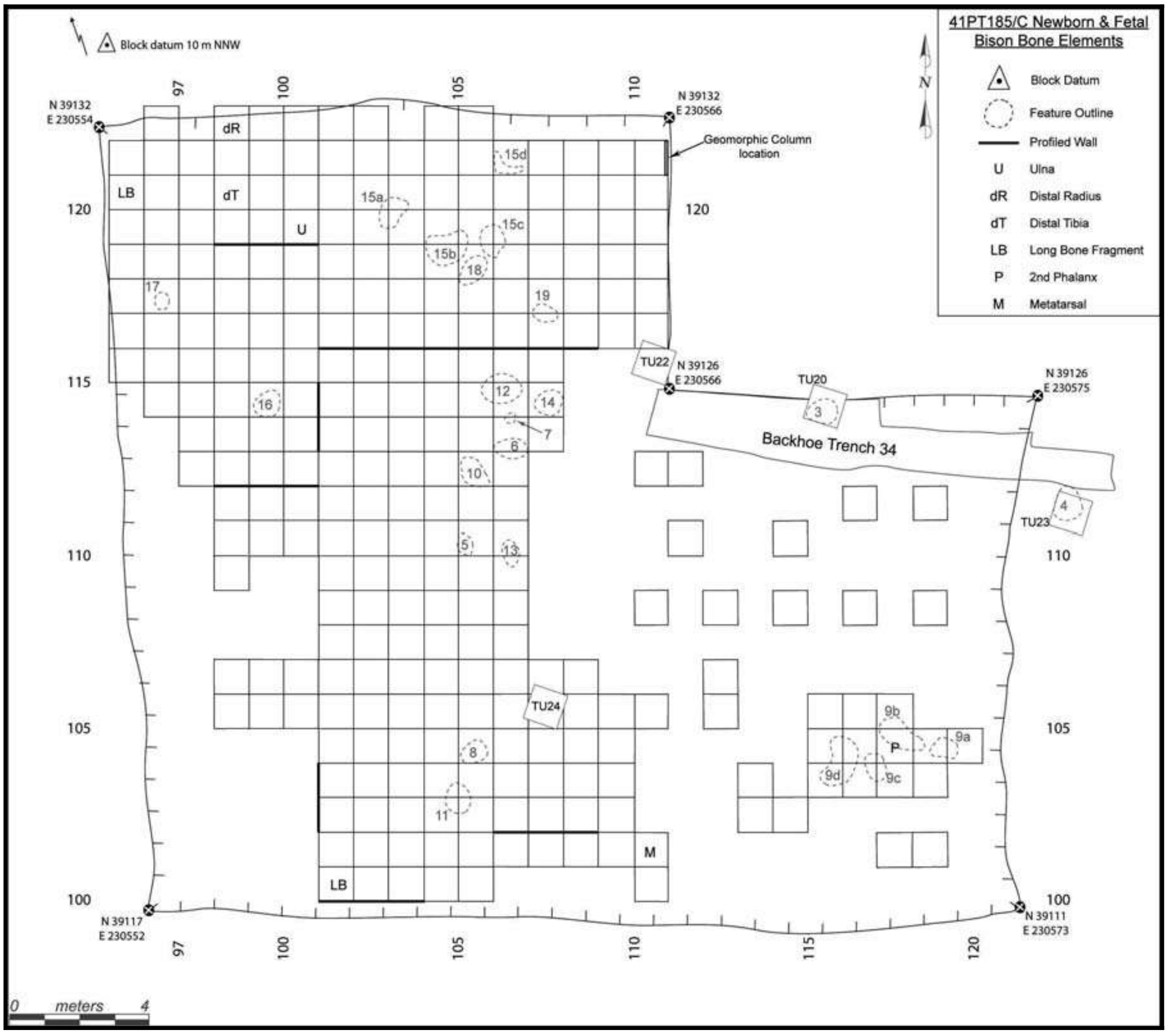


Figure 8-128. Horizontal Distribution of New-Born/Fetal Bison Elements.

The horizontal distribution of these unfused elements is depicted in Figure 8-129. Seven or 35 percent were widely scattered over mostly the southern part of the block. The other 65 percent were distributed in around the western and southern side of Feature 15. The four articulated vertebrae bodies were next to Feature 15b. It is not clear why the distribution is so broad, with generally only one unfused element per unit.

Bison Mandible Tooth Eruptions and Wear Descriptions, plus Age Estimates

No complete bison mandibles or even complete intact tooth rows of mandibles were recovered. Only four small sections of mandible fragments with one to three socketed teeth, plus three more or less loose teeth are represented. In addition to these few whole teeth, many small pieces/fragments of bison tooth enamel were also recovered. These scattered enamel fragments indicate either extensive cultural processing or excessive deterioration of teeth and mandibles through weathering processes following site abandonment.

Table 8-9. List of Immature Bison Elements with Projected Age Assigned from 41PT185/C.

Catalog No.	Bison Element/Part	Unit	Depth (cmbs)	Weight (g)	Side	Projected Age (years)
Appendicular Elements						
295-002	unfused 2nd phalange	N101 E102	80	2.6	-	<1.3
426-002	unfused proximal femur epiphysis	N103 E108	50-60	22.6	right	<5.3
554-002	unfused calcanium	N105 E112	60-70	88.5	right	<5.3
632-002	unfused 1st phalange	N108 E102	50-60	9.4	right	<1.3
771-002	unfused 1st phalange	N104 E117	43	5.1	-	<1.3
853-002	unfused distal radius epiphysis	N113 E106	40-50	24	left	<5.3
985-002	unfused distal metapodial epiphysis	N116 E103	60-70	9.1	-	<3.3
1209-002	unfused proximal femur epiphysis	N120 E96	58	13.6	-	<5.3
1213-002	unfused calcanium body	N120 E97	60-70	47.1	left	<5.3
1224-002	unfused proximal femur epiphysis	N120 E100	54	24.6	right	<5.3
1352-002	unfused distal radius shaft	N118 E105	40-50	37	left	<5.3
Axial Elements						
187-002	unfused vertebrae body	TU 19	60-70	62.8	-	unknown
481-002	unfused vertebrae body	N104 E107	70	161	-	unknown
888-002	unfused vertebrae epiphysis	N117 E103	47-60	8.5		unknown
935-002	unfused vertebrae body	N115 E102	70-80	29.5	-	unknown
1112-002	4 unfused lumbar vertebrae bodies	N118 E103	21-103	346.1	-	unknown
1226-002	unfused vertebrae body	N120 E101	44-60	5.3	-	unknown

The key to aging bison remains in an assemblage is the state of eruption and wear on mandibular molar (M) teeth in the younger animals (Lorrain 1968; Frison and Reher 1970; Reher 1973:89-105; Reher 1974). The following detailed descriptions of the few fragmented mandibular sections and individual loose teeth are presented in conjunction with detailed metric data. Tooth terminology and wear facets follow the Roman numeral numbering system employed by Frison, et al. (1976:38, Figure 8). The numbering system counts each internal and external facet form the anterior to the posterior (Figure 8-130). The following detailed descriptions are intended to provide the necessary data for comparisons with other published data to estimate individual animal ages and contribute towards identifying the season(s) of use for this component. Table 8-10 compares the 41PT185/C tooth eruption and wear observations described below to other selected published data to obtain an approximate age for each tooth or mandible section represented in this very limited assemblage. Bison molar teeth erupt at known ages, are systematic in their eruption, and wear at relatively constant rates (Frison and Reher 1970; Reher 1973:89-105, 1974; Frison 1978b:51; Reher and Frison 1980). At communal bison kills excavated across the Plains, the age determined through analyses of mandibles has most often determined that the kill events occurred in the fall of the year (Frison and Reher 1970; Reher 1973:89-105; Reher 1974; Fawcett 1987; Bement 1999). Other seasons have also been identified such as spring at the Garnsey (Speth 1983), Sanders (Quigg 1997, 1998), and Massey Draw sites (Anderson et al. 1994), and winter at the

Broken Jaw site (Quigg et al. 1993). More specific ages are determined from younger animals (less than 5 years of age) as the molars erupt and wear during this period. As the animal grows older than five years, all the molars have erupted and the tooth wear becomes more erratic and is less reliable for identifying a specific season of death. The first two molars are the most useful (Reher and Frison 1980:65). Once the approximate age of each tooth or mandible is established, it was then possible to project the approximate season(s) in which those animals were killed. The larger the sample form a single provenience, the greater the reliability of the result.

Specimen #583-002 is a loose right premolar 4 (P_4) from 60 to 70 cmbs in N106 E103. This tooth is in full wear (Figure 8-131) and similar in wear to P_4 in #836-002 (see below). Based on the discoloration on the tooth enamel on the lingual side it appears that the roots are just at the level of the alveolus. P4 measures 23.9 mm long, 13.1 mm wide, with the enamel height of 26.2 mm as measured on the lingual side. The overall height of P_4, measured from the base of the root to the tip of the enamel is 45.9 mm. Reher (1974:115) stressed that the premolars in bison can vary almost two years in their eruption and are not useful indicators of age. The absence of associated molars hinders age assignment for this loose P_4.

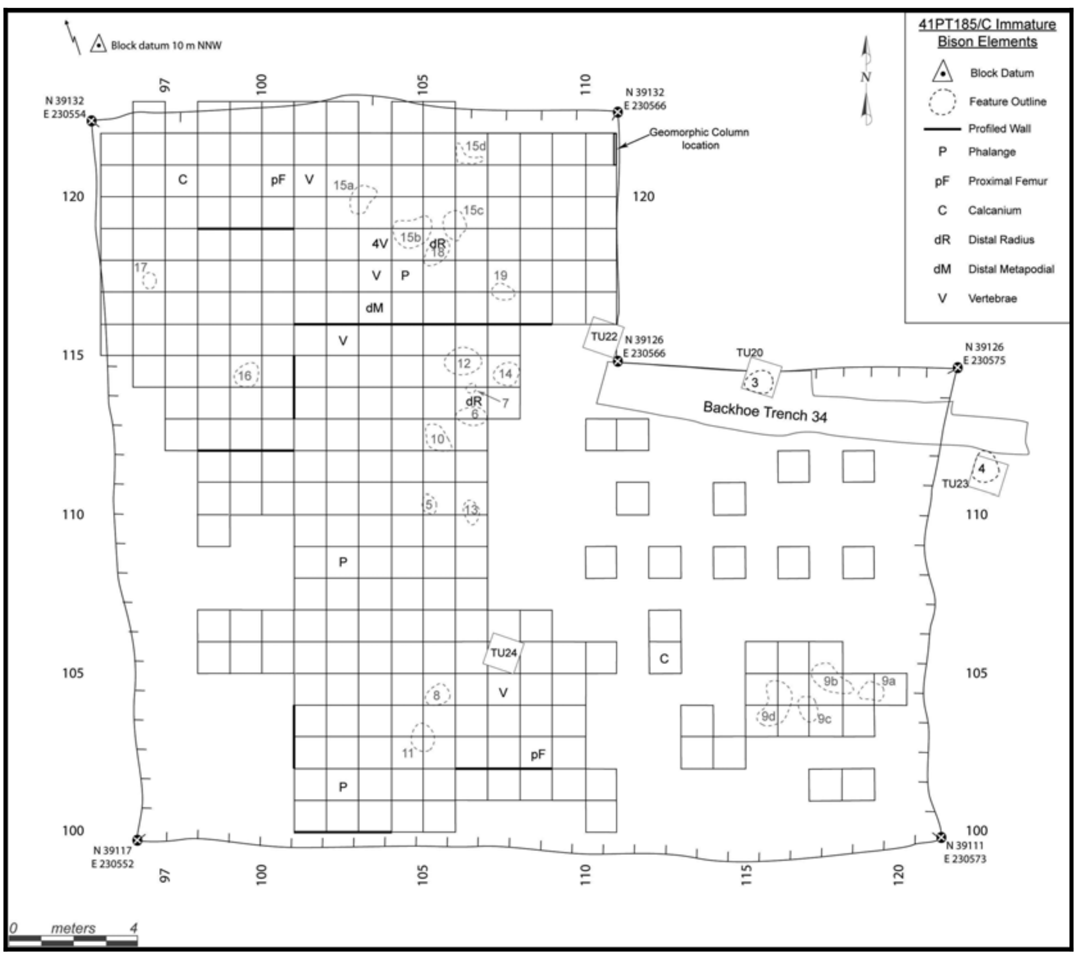
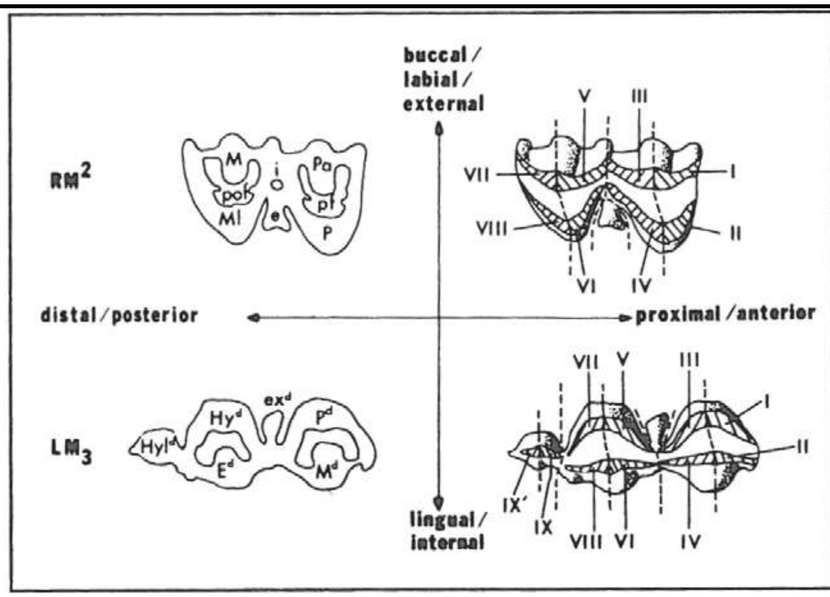


Figure 8-129. Horizontal Distribution of Unfused, Immature Bison Elements.



Descriptive aids for the discussion of bison dental morphology and wear. Upper left: right M^2 (worn), showing cusps and fossettes; e, ectostylid; i, interfossette; M, metacone; Ml, metaconule; P, protocone; Pa, paracone; pf, prefossette; pof, postfossette. Upper right: right M^2 (lightly worn) showing numbering of wear facets referred to in text. Numbers increase in posteriad direction. Lower left: left M_3 (worn), showing cusps. E^d, entoconid; ex^d, exostylid; Hy^d, hypoconid; Hyl^d, hypoconulid; M^d, metaconid; P^d, protoconid. Fossettes as in RM^2. Lower right: left M_3 (lightly worn) showing numbering of wear facets referred to in text. Numbers increase in posteriad direction. Directional terminology for teeth is shown at termini of the four cardinal axes: alternatives reflect the varying usage of different authors. Other terms are also available, and are used in specialized context (Frison, Wilson, and Wilson 1976:38, used by permission).

Figure 8-130. Bison Tooth Descriptive Terminology and Guide. (after Frison et al. 1976)

Table 8-10. Age Assessments of Loose Teeth and Fragmented Mandibles from the Block Excavations Based on Comparison with Aged Bison Mandibles from Across the Plains.

	41PT185/C, Catalog Numbers and Tooth Idnetifications								
Comparison	**#583-002**	**#692-002**		**#836-002**	**#847-002**	**#988-002**	**#1114-002**		**#1266-002**
Site, Age, Author	**Right P4**	**Right M2 &**	**M3**	**Left P2, P3, P4**	**Left M1**	**Right M3**	**Right M1**	**Right M2**	**Right dP4**
Cooper site, 10,000 B.P., summer kill, Bement 1999		4.3	4.3*	5.3 - 6.3	~4.3	3.3	~6.3	~5.3	ca. 1.3
Garnsey site, 500 B.P., April/May kill, Wilson 1980			>4.0 <6.0		-	3		~5.0	>1.0 <2.0
Wardell Trap, ca. 1000 B.P., fall kill, Reher 1973			<4.4		-	>3.4, <4.4		~4.4	ca. 1.4
Hawken site, ca. 6200-6500 B.P., fall kill, Frison et al. 1976			~4.7		-	2.7		~4.7	?
Ayers-Frazier site, 2100 B.P., November kill, Clark and Wilson 1981			~4.6	~4.6	3.6 <4.6	>2.6, <4.6	~4.6, <5.6	~4.6	ca. 1.6
Glenrock Jump, ca. 200-300 B.P., October/November kill, Frison and Reher 1970						>3.5			ca. 1.5
Best age estimate	**ca. >4.4**	**ca. 4.3**	**ca. 4.6**	**ca. 4.6**	**ca. 4.5**	**ca. 3.6**	**ca. 4.6**	**ca. 4.4-4.7**	**ca. 1.4**
* age is in years									

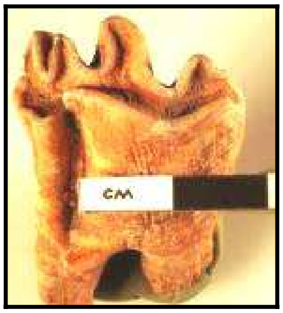


Figure 8-131. Loose Right Premolar 4 (#583-002) that Shows Wear.

Specimen #692-002 contains M_2 and M_3 in a section of buccal bone (Figure 8-132). This specimen came from 53 cmbs in N110 E101. The teeth are fragmentary and had to be refitted as well as possible, still lacking small fragments. Both M_2 and M_3 still lack some dentition at the very surfaces, creating some uncertainly concerning the wear on the facets. The M_2 exostylid is damaged. M_2 measures 35.1 mm long, 15.5 mm wide, and the total height on the proximal lingual side is 48.0 mm. The enamel base of M_2 is well below the alveolus, about 21.1 mm on the proximal buccal side. The exostylid on M_3 is present, unworn, and about 11.7 mm above the alveolus and 18.5 mm below the highest part of the enamel. M_3 measures 46.7 mm long, by 13.5 mm wide, and the total enamel is 61.4 mm high on the lingual side. Facets VI and V are in light wear, facets VII and VIII are broken, and facets IX and X are just in wear.

Figure 8-132. Socketed and Damaged M_2 and M_3 (#692-002) with Exostylid on M_3 Present, but Unworn.

An intensively butchered left mandible fragment (#836-002) that is 126 mm long, contains three socketed premolars (P2, P3,and P4) with the lower border below the tooth roots chopped away leaving a maximum of 38 mm of bone (Figure 8-133). This section came from 50 to 60 cmbs in N113 E102. The buccal surface has root etching, whereas the lingual surface is in relatively good condition but exhibits no cut marks. The lower section of the butchered bone has a series of rodent teeth marks from gnawing along the previously broken edge. It also lacks the distal and proximal sections beyond the three socketed teeth. The roots of P_3 and P_4 are visible below the butchered bone edge. The three socketed teeth are fully erupted and show regular wear. The P_2 is erupted with roots about 5.2 mm above the alveolus on both sides. The P_3 exhibits enamel at the height of the alveolus on the buccal and lingual sides. The P4 has enamel still below the alveolus on the buccal side. The distance from medial/front of the P_2 to distal/back of P_4 is 58.25 mm with a general height of P_4 at 27.4 mm on the lingual side. The P_4 measures 24.5 mm long, 13.0 mm wide with an overall height from the base of the root to the tip of the enamel being 52.3 mm. With all premolars present and moderately worn, this animal is estimated to have been 4.4 to 4.6 years old (see Table 8-10). The absence of the molars hinders a more precise age determination for this mandible.

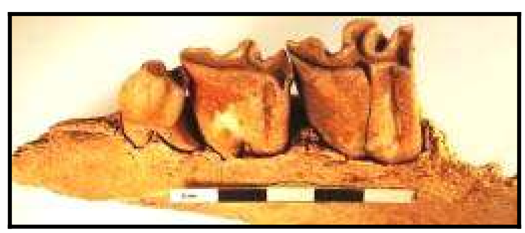


Figure 8-133. Socketed Premolars P_2, P_3, and P_4 (#836-002) that Shows Wear.

Specimen #847-002 includes one left M_1 in a small section of the buccal side of the mandible that is 86 mm long by 30 mm wide. This fragmented section came from

60 to 70 cmbs in N113 E105. This small mandible section is root-etched with longitudinal drying cracks. The tooth is in good condition with only a thin piece of enamel missing from the proximal side. The tooth is fully erupted, is in full wear, moderately bilophodont, with fossetids strong and arcuate (Figure 8-134). The exostylid is worn to a long loop connected to the main wear surface. The enamel base is slightly below alveolus. The metaconid height is 32.7 mm. One thin band/ridge (hypoplasia) is present on the buccal side that extends around to the posterior side of the tooth. This is generally considered a reflection of some type of developmental stress during eruption. This M_1 measures 29.4 mm long, 17.2 mm wide, with total enamel height of 32.7 mm on the lingual side.

Figure 8-134. Socketed Left M_1 (#847-002) that has Exostylid Worn to a Loop.

A single loose M_3 (#988-002) came from 50 to 60 cmbs in N116 E104. This right tooth has no attached bone. Light root etching and calcium carbonate are visible on a limited part front edge. The roots are just forming. Based on wear only on facets I and II, this molar was not fully erupted or in full use (Figure 8-135). The exostylid is present, but not in wear, and is 25.9 mm below the tip of the tooth. M_3 measures 42.7 mm long, 13.7 mm wide, weighs 38 g, and has a total enamel height of 56.4 mm.

Figure 8-135. Loose Right M_3 #988-002 that Shows Wear on Facets I and II of Enamel and Unworn Exostylid.

Specimen #1114-002 consists of M_1 and M_2 in a very short (73 mm long by 28 mm tall) section of the buccal side of the right mandible (Figure 8-136). This piece came from 40 to 50 cmbs in N118 E103. The attached bone is mostly fresh in appearance, with some root etching and an apparent green bone tear under M_2. M_1 is complete, fully erupted and in full wear with moderately bilophodont, fossetids are strong and arcuate. The exostylid is worn to a loop that joins the main wear surface. The enamel base is below the alveolus by about 3.7 mm. M_1 measures 27.7 mm long, by 16.2 mm. The metaconid height is 26.5 mm. M_2 is nearly complete, lacking one root, is strongly bilophodont, and has strong and arcuate fossetids. The exostylid is worn to an ovate shape that is not attached to the main wear surface. The enamel base is well below (25.2 mm) the alveolus. The M_2 measures 36.1 mm long, 15.1 mm wide, with a metaconid height of 60.2 mm.

Specimen #1266-002 is a loose, right deciduous premolar 4 (dP_4) from 80 to 90 cmbs in N121 E97 (Figure 8-137). This tooth is highly fragmented and was partially reconstructed from the fragments recovered. The tooth is in full wear except for the anterior exostylid that has a touch of polish on the very tip and is 2.35 mm below the closest worn surface. The posterior exostylid is worn to a loop and connected to the crown. This fragmented tooth measures 30.0 mm long by 13.7 mm wide with a total enamel height above the roots of 20.0 mm.

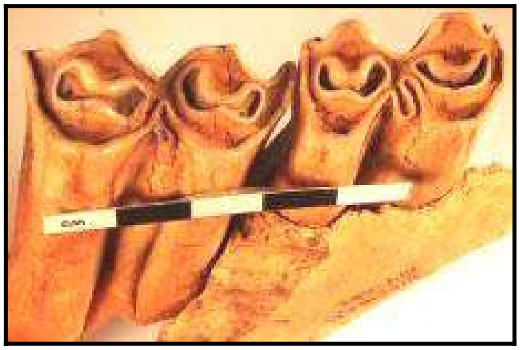


Figure 8-136. Right M_1 and M_2 (#1114-002) that Exhibit Tooth Wear.

Figure 8-137. Loose and Fragmented Deciduous Premolar 4 (#1266-002) that Shows Wear.

Age estimations for the very fragmented individual mandible sections with socketed teeth and individual loose molars were established based on comparisons with selected published archeological data (see Table 8-10). This procedure is not ideal, but must suffice as modern regional data from bison of known ages have not been published and details on other Late Archaic assemblages are not available for this region. The archeological data used for comparative purposes are from diverse locations and they present ages thought to be reasonable guidelines for tooth eruption and wear patterns (Frison and Reher 1970; Reher 1973; Frison et al. 1976:28-57; Wilson 1980:88-99; Clark and Wilson 1981:23-77; Bement 1999). The tooth eruption and wear data that Bement (1999) presents is from the 10,000 to 11,000 years old Cooper site that had *Bison antiquus* and may present some problems because of the early time and structural differences in those larger animals. The Cooper site animals died about 0.3 years after peak calving or about late summer. The data presented by Clark and Wilson (1981) is of similar Late Archaic age (ca. 2100 B.P.), but is from Montana in the northern reaches of the Plains where environmental conditions may reflect slightly different time sequences of the life cycle because of cold weather conditions. The bison there were determined to represent individuals at one year age intervals (1.6 years, 2.6 years, 3.6 years and so on) that indicate a November kill event. The Wilson (1980) data is from the Late Prehistoric (ca. 700 B.P.) Garnsey site in eastern New Mexico and is somewhat later in time, ca. 400 B.P. with more arid environmental conditions. At Garnsey, the ages of the animals were determined to be 1 year, 2 year, and 3 years-old at the time of death indicating a spring (April) kill. The Frison et al. (1976) mandible data is from an early Altithermal (ca. 6400 B.P.) arroyo bison trap in Wyoming and its earlier age and different environmental setting may hinder a direct comparison. There, the mandibles were aged to about 0.7 years, 1.7 years, and 2.7 years, representing a fall kill. The Frison and Reher (1970) mandible data is from the Glenrock Buffalo Jump, a Late Prehistoric kill (ca. 200 to 300 B.P.) in Wyoming that may be somewhat more comparable. Age assessment on some 251 mandibles indicated a kill during the fall (October/November) with mandibles in half year intervals. The Wardell Buffalo Trap provided 274 bison mandibles, from three separate stratigraphic levels, but was reported as one assemblage (Reher 1973). Discrete age groups were documented, indicating a fall event with animals assigned to groups at 0.4 years, 1.4 years, 2.4 years, 3.4 years, 4.4 years and older. The relatively few Sanders site (41HF128) mandibles represent a comparable Late Archaic assemblage that was determined to represent a March event and this has been used as a guideline (Quigg 1997). The specimens from Sanders were all highly fragmented as well and only the verbal descriptions are available.

Slight age variations were observed between the 41PT185/C specimens and the various sets of aged mandibles used in the comparisons. This was not unexpected as the comparative materials used span thousands of years, comparative mandible ages are also considerably different, as were the environments from which the mandibles were derived. The few loose teeth and mandible sections recovered from the block excavations tend to represent animals aged at 1.4 years, 3.6 years, 4.4 years, and 4.6 years-old. These assignments of animal ages indicate that the animals represent an apparent single kill event that occurred in the fall of the year around October through November. If multiple kill events are represented by this meager tooth and mandible assemblage, then all events occurred in the fall of the year.

The fragmented mandible sections combined with the more or less complete loose teeth were widely distributed across the middle section of the excavation block. (Figure 8-138). No obvious pattern of clustering is apparent as no adjacent units yielded these specimens. Also surprising is the fact that only two (29 percent) were even close to discard piles of burned rocks. Apparently these mandible fragments were processed and discarded in complete disregard to the burned rock features.

Bison Gender Analysis

Determination of gender in bison bones has been based on the consistent difference between the body size of males and females. Sexual dimorphism has been demonstrated in modern bison and documented by actual weight measurements in modern carcasses. With these documented size differences in bison, the next logical step has been pursued by several researchers. The gender differences in bison bones have been documented by many individuals (i.e., Lorrain 1968; Duffield 1973; Bedford 1974, 1978; Peterson and Hughes 1980; Speth 1983; Todd 1986; Morlan 1991). The MAU for mature elements was estimated based on the number of complete distal and proximal articular ends of long bones that could be assigned to a specific side. These elements were then measured to determine gender (Table 8-11). The early literature developed for sexing mature bison elements (presence of completely fused epiphyses) focused on metapodials and employed whole specimens and measured the transverse width at the center of the shaft (Skinner and Kaisen 1947; Lorrain 1968; Bedord 1974, 1978).

Since those first studies Todd (1986) investigated and demonstrated that the forelimbs (the humerus and radius) showed the same sexual dimorphism. Morlan (1991) measured bison carpals and tarsals and documented gender differences as well. Unfortunately, most prehistoric campsites excavated do not yield many whole elements, especially metapodials or other long bones. Therefore, many of the cited measurements applied to metapodials to identify sex are not available for use on fragmentary specimens. Measurements provided by Speth (1983) on the proximal and distal ends are very useful for the more fragmented elements often recovered. The metapodials are useful elements for determining gender as they carry much of the animal's weight and should reflect the size difference between males and females. Consequently, the heavier animals should exhibit proportionally larger elements and this should be born out in the lower extremities that include the metapodials.

Here, measurements generally follow those employed by Speth (1983:171-206) on proximal and distal ends of long bones. Speth (1983) conducted these measurements on modern museum specimens of known gender to allow direct comparisons to his prehistoric samples. He also provides all the actual measurements which can be used comparatively.

North American bison experienced a general decrease in overall body size, and horn core size and shape from the late Pleistocene through the middle Holocene (Wilson 1978:9-22; McDonald 1981). Bison are believed to have reached their modern size and appearance by about 4500 B.P. Therefore, the Late Archaic bison from this component should be similar in size to the modern museum specimens measured by Speth (1983). In addition to the long bones, seven astragalii and one calcanium were also measured to determine their sex. Astragalii measurements were based on those presented by Driesch (1976:88-90) and Morlan (1991).

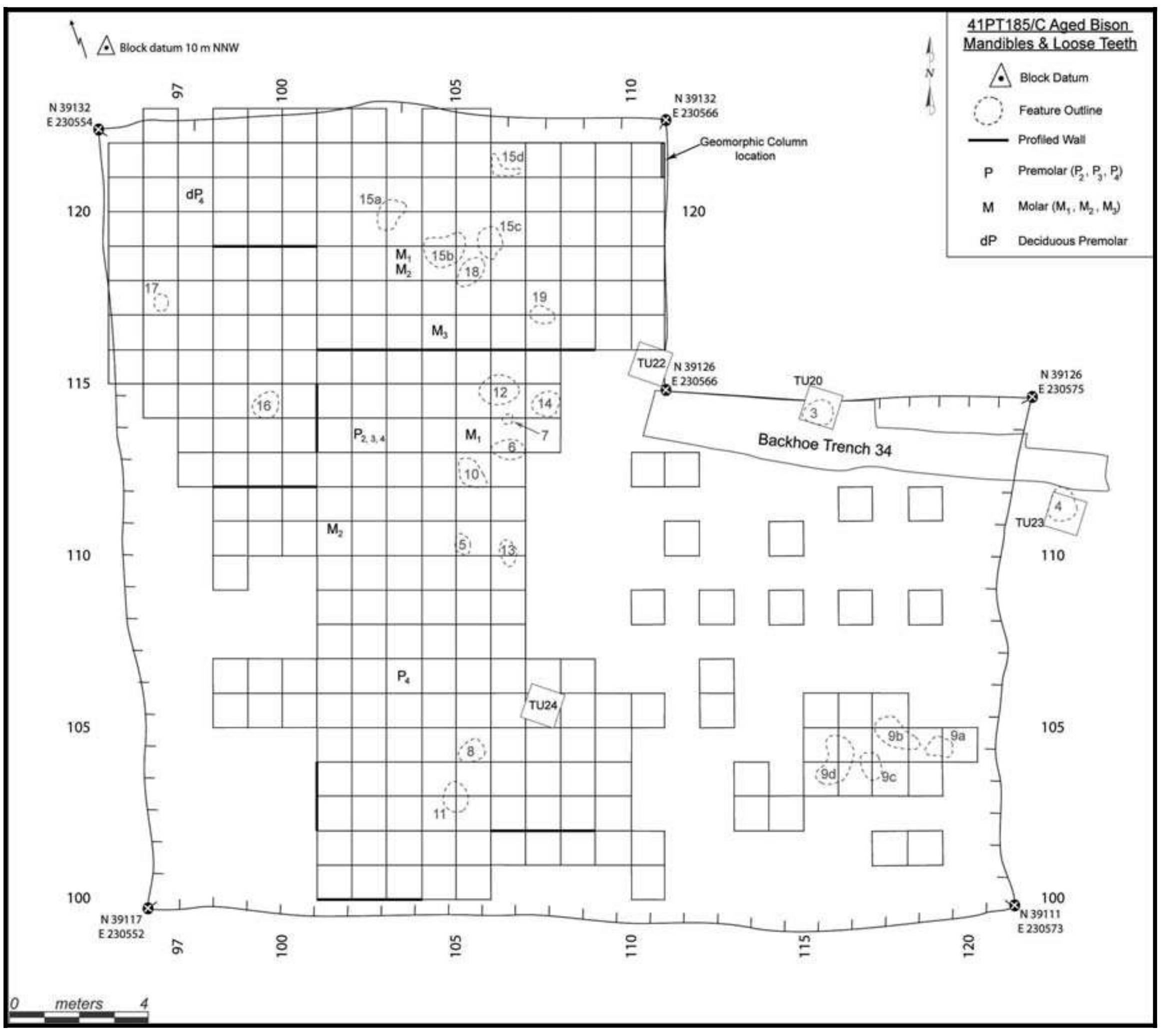


Figure 8-138. Distribution of Aged Bison Mandibles and Loose Teeth.

Table 8-11. Bison Bone Measurements on Selected Elements for Gender Determination, 41PT185/C.

Catalog No.	Element	Unit N E	Depth (cmbs)	Side	Location and Measurement* (mm)	Gender
1081-002	Distal metatarsal	117 110	60-70	Right	D=69.2, E=31.7, F=30.5, G=28.5, H=27.6	Male
1010-002	Distal tibia	116 109	40-50	Left	H=77.0, I=55.8, J=52.2	Male
1015-002	Distal metacarpal	116 110	60-70	Left	D=75.3, E=36.6, F=36.4, G=30.6, H=26.6	Male
1015-002	Distal metacarpal	116 110	60-70	Right	E=36.9, G=29.3, I=35.4	Male
1118-002	Distal metatarsal	118 104	40-50	Right	D=57.5, E=28.1, F=27.2, G=27.3, J=35.5	Female
1292-002	Distal tibia	121 105	40-50	Right	J=47.2, I=41.9, H=62.4	Female
1224-002	Proximal radius	120 100	50-60	Left	E=57.9, B=39.0, A=78.8, C=27.0	Female
1220-002	Distal femur	120 99	45	Right	H=46.0, I=102.4, M=45.4, J=52.6	Female
1247-002	Proximal metatarsal	102 108	40-50	Left	A=69.4, B=40.1, C=42.3	Male
797-002	Distal radius	112 104	90-100	Left	G=85.1, H=44.2, I=49.3, K=33.4	Male
954-002	Distal tibia	116 95	60-70	Right	H=65.2, J=47.0, I=46.0	Female
914-002	Distal radius	115 96	70-80	Right	H=35.9, I=40.2, K=30.3,	Female
210-002	Distal metacarpal	TU 22	70-80	Right	D=69.5, E=36.4, F=33.2	Male
853-002	Distal radius	113 106	40-50	Left	K=29.1, J=16.7, I=39.7	?
698-002	Distal femur	110 103	40-50	Right	C=51.7	? Female
624-002	Distal metatarsal	107 105	50-60	Left	E=27.1, D=62.1, F=27.1, J=34.0	Female
583-002	Distal metacarpal	106 103	69	Left	G=23.2, I=31.2, J=29.4	Female
544-002	Distal metacarpal	105 108	40-50	Right	F=28.6, J=31.0, H=23.4	Female
157-002	Distal tibia	TU 15	75	Left	J=45.6	Female
526-002	Distal tibia	105 102	50-60	Left	J=46.2, I=48.7	Female
529-002	Distal metacarpal	105 103	50-60	Left	A=55.0, B=332.0	? Female
552-002	Distal humerus	105 110	60-70	Left	I=92.3, M=81.2, O=47.3	Male
481-002	Proximal metatarsal	104 107	60-70	Left	A=53.5, C=27.9	Male
483-002	Proximal metacarpal	104 108	56	Left	A=77.0, B=43.2, C=46.9	Male
483-002	Distal metacarpal	104 108	50	Left	D=72.1, E=39.1, F=37.1, G=32.9, J=36.8	Male

*Measurements based on Speth 1983.

Metapodials: A= greatest breath of proximal end, B=greatest depth of proximal end, C=greatest breath of articular facet of fused 2d-3d, D=greatest breath of distal end, E=breth of medial condyle, F=breath of lateral condyle, G=depth of medial trochlea, H=depth of lateral trochlea, I=depth of medial sagittal, J=depth of lateral sagittal ridge.

Tibia: H=greatest breath of distal end; I=greatest depth of distal end; J=greatest breath of lateral and medial articular grooves.

Humerus: I=greatest breath of distal condyle, J=length of trochlea from bottom of shallow depression immediately caudal to proximal edge of articular surface of trochlea to bottom of shallow depression immediately caudal to distal edge of articular surface, M= breadth of distal condyle at proximal edge of articular surface, O=length of lateral epicondyle from and perpendicular to distal edge of lateral epicondyle to proximal eminence of lateral epicondyloid crest.

Radius: A=greatest depth of proximal end, B=greatest depth of proximal end, C=depth of capitular articular surface, D=breath between lateral and medial ulnar facets, E=depth of sagittal ridge, F=length of proximal ulnar articulation from proximal end of interosseous sapce to proximal eminence forme by medial edge of medial ulnar facet. G=greatest breath of distal end between points of lateral and medial epiphyseal fusion, H=length (medial) od distal epiphysis form distal extremity of carpal articular surface to proximal edge of prominent tuberosity for attachment of medial carpal ligament, I= grathest breath of articular surfaces or facets of intermdediate and radial carpals, J=minimum breath of radial carpal facet.

Femur: C=greatest craniocaudal diameter of head, H=greatest breath of medial condyle, I=greatest breath of distal end, J= greatest length of lateral condyle from bottom of shallow depression immediately cranial to proximal edge of articular surface to distal edge of articular surface,, M=greatest breath of lateral condyle.

A group of 33 mature, distal and proximal long bone elements was measured to determine gender. The measured elements include 14 rights and 19 lefts (see Table 8-11). The measurements were compared to measurements provided by Speth (1983). The results reveals a frequency of 41 percent male elements verses 59 percent female elements among 27 elements that could be assigned to gender (see Table 8-11). At first glance, this 18 percent difference appears to reflect greater or more intensively processed male elements over the female elements. However, this ca. 40 to 60 percent ratio also reflects a ratio similar to the frequency of males to females identified for the entire assemblage. So the apparent processing difference is just the reflection of the gender frequency identified. The different sides of the animals represented reveal a nearly equal split between the right (45 percent) and left (55 percent) sides. This frequency documents no significant selection pattern or preference for one side or the other.

The seven astragalii represent three rights and four lefts (Table 8-12). Measurements on the seven astragalii reflect a MNI of six animals, one male and six females (Figure 8-139). Plotted measurements reveal the clear separation between the genders.

Next, the projected numbers of individuals from these measured, mature and sexed elements are combined with those of the immature elements to obtain a more complete picture of the total number of animals and their gender. Based on the immature appendicular elements, there is at least one animal less than 1.3 years-old (unfused second phalange plus dP_4), one less than 2.3 years (unfused first phalange), one less than 3.3 years (unfused distal metapodial epiphysis fragment), and two animals that are less than 5.3 years old (ages of two M_1, M_2, and M_3, combined with two unfused left distal radii and two unfused proximal femur epiphyses). Based on seven mature left metacarpals, at least seven animals are greater than 3.3 years of age. The four left fused proximal ulnas indicate at least four animals greater than 5.3 years. The mature elements indicate a minimum of three males and five females. At least one neonatal individual of unknown sex is present. From the above different data sets the MNI is 13 animals with both males (MNI of 3) and females (MNI of 6) represented. Some individuals are represented by the bones that were not assigned to a specific gender. The three mature males probably represent two very massive individuals, as reflected by a distal tibia (#1010-002), two proximal and three distal metacarpals (#1015-002 and #483-002), an astragalus (#1351-002), and a distal humerus (#552-002), plus one relatively small, not yet fully grown individual, as represented by a distal metacarpal (#2102-002) and a proximal metatarsal (#481-002).

Table 8-12. Metric Measurements on Completed Astragalii.

Catalog No.	Element	Unit	Depth (cmbs)	Side	Location and Measurement* (mm)	Gender
420-2	Astragalus	N103 E106	60-70	Left	Dl=39.7, Wd=43.3, Bd=41.8, Ll=66.2, Lm=68.1, Wp=45.7	Female
686-2	Astragalus	N110 E99	70-80	Left	GLm=72.0, GLl=72.7, Dm=41.6, Dl=42.8, Wd=46.6, Lm=72.7	Female
772-2	Astragalus	N112 E98	57	Right	Lm=60.3, Wp=43.0, Ll=68.5, Dl=37.4	Female
784-2	Astragalus	N112 E101	70-80	Left	Ll=73.5, Lm=69.3, Wd=45.7, Wp=47.2	Female
1089-2	Astragalus	N118 E97	45-60	Right	Dm=39.4, Lm=67.3, Wp=49.9,, Wd=46.7	Female
1118-2	Astragalus	N118 E104	40-50	Left	Dm=43.2, GLm=58.9, GLl=71.4, Wd=45.7, Wp=52.3,	Female
1351-2	Astragalus	N115 E102	40-50	Right	Dl=44.1, Dm=42.0, Wd=51.8, Wp=50.2, Lm=74.8	Male

* Measurements based on Morlan (1991, Figure 5). Ll= lateral length, Lm= medial length, WP=proximal width, Wd=distal width, Dl=lateral depth, Dm= medial depth,

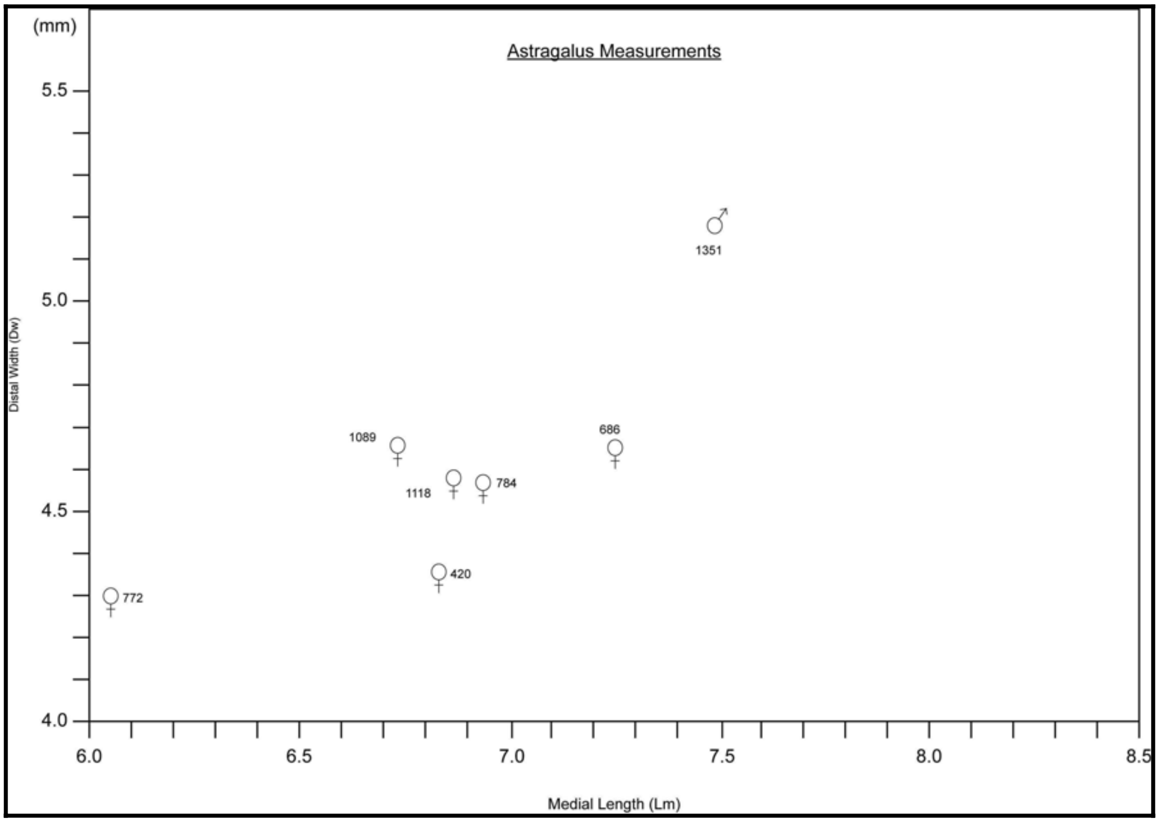


Figure 8-139. Bivariate Plots of Astragalii Measurements thatShow Separation of the Male and Female Specimens.

Animal ages based on the mandibular teeth, combined with the estimated ages based on fusion of the long bones, provide a strong indication that these animals died in the fall of the year, between September and mid November as the aged animals are near their half year life cycles. The tooth eruption and wear indicate minimally two animals about 0.3 into the year. In support of this fall period, many long bone elements still exhibit epiphyseal fusion lines along their proximal and distal ends, which would support a period of about a month immediately following fusion of the epiphyseal ends near 0.3 ages. If the season of their death was truly in the fall of the year as the mandibular teeth and long bone fusion rates indicate, then the one neonatal animal would represent an out of season birth. Out of season births are not altogether extraordinary, as Reher (1974) and Wilson (1974) documented out of season calves for the Casper site in Wyoming, which was identified as a November kill event. Frison (1978b:45) also notes that 5 to 10 percent of the claves are born outside the limits of the normal calving period, even in modern herds. The premise of a fall kill event assumes that one occupation is represented by the entire faunal assemblage. In support of a single bison assemblage is the recurrent fact that the aged mandibles and teeth indicate a relatively narrow time range of a couple of months. This determination is partially supported by the consistency in the observed fused and unfused long bone elements. If multiple occupations are represented by the recovered assemblage, then it would follow that each recurrent occupation occurred in the fall of the year. If this was the case, Late Archaic populations returned to this exact location in the fall of the year on a recurrent basis.

The horizontal distribution of the measured and gender assigned elements is presented in Figure 8-140). It is obvious from this distribution that no one specific location was used as the discard area for these bones. In almost 88 percent of the instances, only one element was recovered from a single unit. This indicates that a general scatter is reflected by most elements. One cluster of broken metapodials, plus one distal tibia, was found in the northern end at the eastern margin of the block. Four adjacent units yielded five proximal and distal ends, all of which represent male bones.

This is an obvious discard pile of elements from a minimum of three males that followed the extraction of bone marrow from these butchered elements. A second discard pile appears at the southern end, south and east of TU 24 (see Figure 8-140). There, distal and proximal metapodials from two males and one female were clustered in three units. A third possible cluster was just a couple of meters northwest of Feature 8 where three female elements were found in three adjoining units (see Figure 8-140).

Bison Bone Processing

The actual kill location(s) undoubtedly occurred away from this site, possibly a considerable distance from camp. This

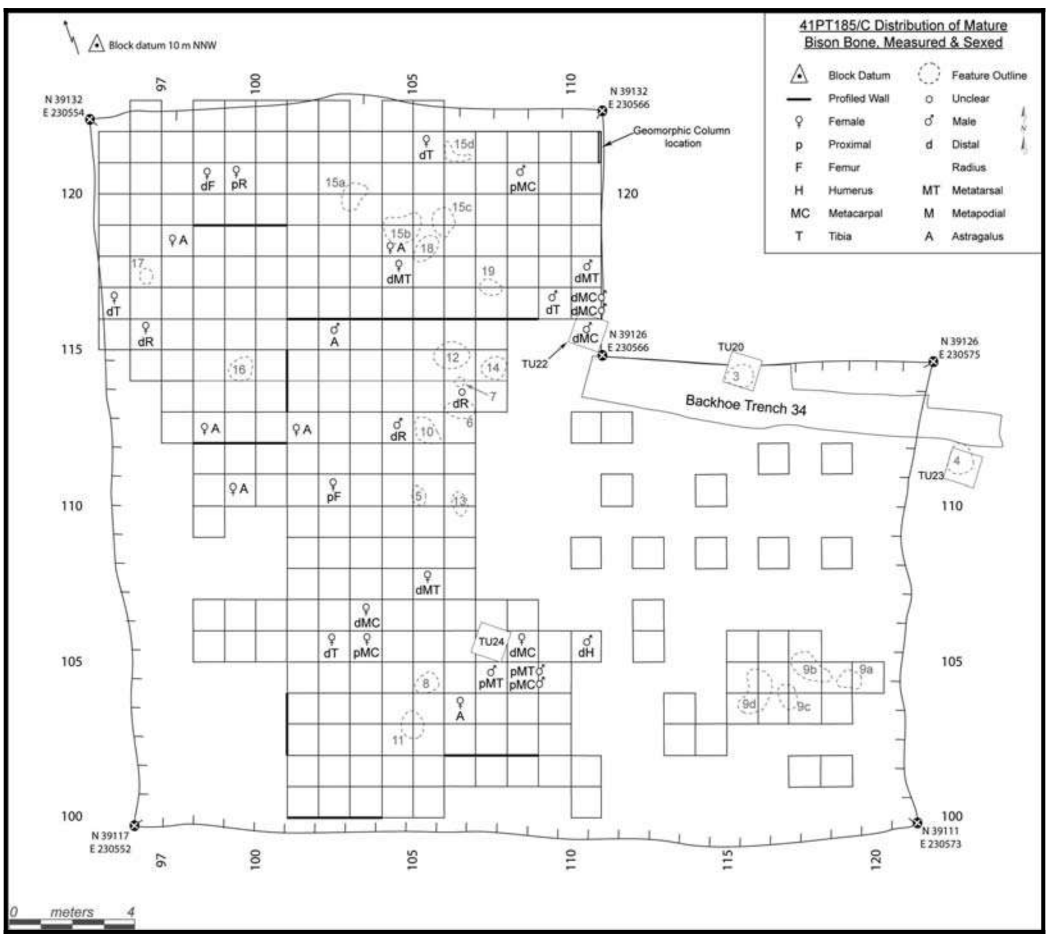


Figure 8-140. Horizontal Distribution of Measured Bison Bones Assigned to Male or Female.

interpretation is based on the near absence of the bulky bison skulls and mandibles that lack much meat and the limited number of vertebrae. After the bison were killed, initial processing would have involved skinning the animals, then opening up the stomach and extracting the soft tissue contents (stomach, heart, liver, etc.). After skinning and gutting were accomplished, the carcasses would have been dismembered. The dismembering would have involved cutting the carcass into sizable sections to transport back to the campsite. A European fur trader in the Northern Plains provides a general description of one such dismembering following the kill. Harmon (1911:287) observed:

> "The Natives generally cut up the body of an animal into eleven pieces, to prepare it for transportation to their tents, or to our forts. These pieces are the four limbs, the two sides of ribs, the two sinews on each side of the backbone, the brisket, the croup, and the backbone. Besides these they save and use the tongue, heart, liver, paunch, and some parts of the entrails".

At that point, decisions would have been made concerning what pieces required transport to camp and what could be left at the kill site. The size of the transportable sections would have been dependent upon how far they needed to be moved, plus who was conducting the transport, humans or dogs. The decisions made at the kill as to what to keep and transport, and what to discard, were undoubtedly made by individual(s) to address their short and long term needs, and current circumstances. The different health conditions and needs of the group all factored into the hunters' decisions with regard to the selection of portions transport.

Several body part utility models have been generated that indicate the relative value of different carcass units based on their yield of one or more desirable products (meat, marrow, bone grease). These models aid in the evaluation of archeological faunal assemblages and in making informed inferences about human behavior. Most models have been developed for application to kill site assemblages (i.e., Binford 1978; Metcalfe and Jones 1988; Speth 1983; Emerson 1990). These models relate the number and kinds of bones recovered from an archeological assemblage to the economic value of the various body parts. Some of Binford's (1978) models such as marrow index (MI), meat utility index (MUI), general utility index (GUI), or modified general utility index (MGUI) have often been used and applied to bison. A foundational problem in Binford's models is that they were based on caribou and sheep carcasses and their applicability to bison has been questionable. Metcalfe and Jones (1988) reviewed Binford's models and constructed simplified utility models of their own called standard food utility index (SFUI). They assumed that differences between gender and age were not a significant factor. Speth (1983) argued that meaningful differences probably do exist in products from bison related to the animals' age, gender, and condition. Such factors would have influenced the specific decisions made by a hunting group. Emerson (1990) conducted a major study using modern bison of different ages, gender, and conditions to determine respective body part contributions. She applied the data in multiple tests and evaluations and successfully demonstrated that bison of different ages and gender and body conditions do provide different amounts of meat, bone marrow, and bone grease. She provided various models including a bison utility model based on calorie data rather than upon animal weight differences. In the end, however, she acknowledges that the individual hunter still made many choices depending upon his immediate needs and circumstances. These various models have been mostly applied to kill sites, but many of the underlying fundamentals are applicable to this campsite.

Most initial processing activities at the kill site are not detectable when viewing the end product of highly fragmented bones at a campsite such as this. The campsite does reveal what items were transported to the camp. The extensive processing techniques employed after the transported sections arrived at this Late Archaic camp likely destroyed many elements that were transported. Therefore, one cannot automatically assume that the lack of specific elements from this campsite means those elements were left at the kill.

The generally poor conditions of the bison bone surfaces do not allow detection of many visible signs of the skinning process, such as the thin cut marks that were made by sharp stone tools where the shin was detached from the bones. Sometimes these cuts are on metapodials or in the joints of the carpals and tarsals. Lyman (1987) indicated that human behavioral inferences based on the morphology and positions of cut marks are problematic. However, Binford (1981:124) observed significant locational differences of dismemberment of fresh animals compared to stiff animals. Therefore, the location of cut and or impact marks may reflect different carcass conditions. One possible indication that some skins were present at this camp was the recovery of two caudal vertebrae.

All parts of the bison skeleton were represented in the excavation block at this campsite, but in different frequencies (Table 8-13). The very limited quantity of identifiable axial fragments (*N* = 118, that account for 33 percent of the total identifiable pieces) likely indicates that most bulky skulls and vertebrae columns were left at the kill, or shattered beyond recognition. This would reflect the perception that the cost of transport of those segments to this camp for processing was too high in relation to the dietary value of those axial sections. In one instance, a small articulated section of four immature lumbar vertebrae (#1112-002) was transported to this camp (N118 E102, just south of Feature 15) (Figure 8-141). In fact, these were the only articulated bones discovered in the entire bone assemblage. The generally poor condition of the bones (due to relatively intensive bone processing bone, extensive weathering and root etching, considerable rodent gnawing, and finally, postdepositional calcium carbonate build up), makes it impossible to reliably identify the specific steps in the dismembering and defleshing process.

Other than a few vertebrae, the axial skeletons are represented only by a few small sections of fragmented mandibles and loose teeth. Obviously, mandibles were brought into camp and their highly fragmented condition, along with the presence of the loose teeth, indicates that they were intensively processed. In a historic documentation of processing mandibles by the Calling Lake Cree, Zierhut (1967) stated

> … the interior portion of the body and most of the ramus is broken out by blows from the blunt end of a small axe. An anvil stone may be used in the operation. Marrow is obtained from the cavity in the body of the mandible immediately inferior to the alveolar portion. Often the mandible is further broken into small sections in order to be used in making bone grease.

Such observed bone processing for marrow and grease would account for the fragmented condition of the recovered mandibles.

Table 8-13. List of Bison Bone Elements from 41PT185/C.

Element/Fragments	Complete		Distal		Medial	Proximal		Frag ments	NISP* Total	MAU**	MAU Ratio***
	Left	Right	Left	Right		Left	Right				
SKULL =									**58**		
Skull	1							2	**3**	1	14.3
Maxilla											
Mandible					2=L, 4=R			4	**10**	4	57
Hyoid											
Incisor											
Tooth	7	3						35	**45**	2	28.6
VERTEBRAE + PELVIS =									**60**		
Atlas	1							1	**2**	2	28.6
Axis											
Cervical	2				2			2	**6**	1	14.3
Thoracic	1		2		7				**10**	1	14.3
Lumbar	4								**4**	1	14.3
Caudal	1							1	**2**	1	14.3
Rib (heads, shafts)					3	9		17	**29**	1	14.3
Sacrum											
Pelvis (Ischium, Ilium)								3	**3**	1	14.3
Acetabulum					4				**4**	1	14.3
FRONT LEG =									**69**		
Scapula						2	2	3	**7**	2	28.6
Humerus			2	1	1	1		4	**9**	2	28.6
Radius			3	3	2	4	1	1	**14**	4	57
Ulna					4	4	1	2	**11**	4	57
Unciform	3	1							**4**	3	42.9
Scaphoid	2	1							**3**	2	28.6
Cuneiform											
Lunate		2							**2**	2	28.6
Metacarpal			4	4		7	3	1	**19**	7	100
REAR LEG =									**60**		
Femur		1	1	2			3	4	**11**	3	42.9
Patella	1								**1**	1	14.3
Tibia			3	3	2		1	4	**13**	3	42.9
Lateral Malleolus		1							**1**	1	14.3
Astragalus	4	3							**7**	4	57
Navicular Cuboid	3	3							**6**	3	42.9
Calcanium	2	3						2	**7**	3	42.9
Magnum	2	1							**3**	2	28.6
Metatarsal		1	1	3	1	2	2	1	**11**	3	42.9
OTHER =									**112**		
1st Phalanx	17							2	**19**	3	42.9
2nd Phalanx	7							5	**12**	1	14.3
3rd Phalanx	5					2		1	**8**	1	14.3
Long Bone fragments					3			38	**41**	1	14.3
Cancellous								3	**3**	1	14.3
Unknown fragments								11	**11**	1	14.3
Sesamoids	13								**13**	1	14.3
Metapodial			3		1	1			**5**	1	14.3
TOTAL	**96**		**35**		**31**	**45**		**152**	**359**		

* number of identified specimens; ** Minimum number of units; *** MAU Ratio = rank according to the most frequent element.

Figure 8-141. Three of the Four Articulated and Unfused Lumbar Vertebrae (#1112-002) from Just South of Feature 15. (scale in cm)

The lack of other skull parts firmly reflects the nearly complete absence of skulls in the Late Archaic camp. One bison skull, recorded as Feature 17, was the deepest (95 cmbs) cultural bone recovered. It was radiocarbon dated to 2510 B.P. which indicates it was part of the lower (oldest) cluster of radiocarbon dates. Even though it appeared in the very old, light colored Unit B sediments of ca. 8000 B.P. and was lower than most other bones, the radiocarbon date places it in with the Late Archaic period. If other bison skulls were present and extensively processed, minimally the inner ear bone would have remained. This element is much harder and would be preserved long after the other elements were destroyed.

Based on a combination of data, (identification of the sides of the recovered elements, the ages of the animals, and the sex of the animals), the MNI is calculated at 13 animals. Table 8-13 shows that the MAU represented is seven, based on the seven left proximal metacarpals. Therefore, a vast majority of the elements from 13 individual animals are not represented or recognizable in the recovered assemblage. Some of the missing elements presumably remained at the kill site, while others probably were smashed beyond recognition.

With seven animals being the most readily recognized on the basis of actual element counts, the metacarpals then represent 100 percent of the MNI. The frequencies of other elements are presented in Table 8-13 under the MAU ratio. Based on counts alone, the radius, ulna, and astragalus minimally represent four animals, with all other identified pieces representing less than four animals. This is an indication that most elements are missing or crushed beyond recognition. Even the much smaller and often dense carpals and tarsals do not represent half the minimal number of individuals.

Eighteen small, thin cut lines were observed on eight different elements (Table 8-14). These cut lines presumably resulted from the use of very thin edged stone implements to cut tendons and other tissues from the bones. Having observed these few cut lines, and considering the poor preservation of most bone surfaces, it is assumed that many additional cut lines were probably once present. Cut lines were observed on different elements that represent the different parts of the carcass (Figures 8-142, 8-143, and 8-144), so it is assumed that the processing technique employed, cutting meat and/or tendons, was conducted on all body parts without regard to which one. After the meat was cut from the bones, the whole bone could have been discarded unless the bone still contained some other desired resources such as marrow or bone grease. If one of the targeted food resources was bone marrow, then the various elements that contain marrow would have been broken open to extract the marrow. With only 85 elements or nine percent of the bison assemblage considered complete or mostly complete, the majority (91 percent) of bison elements were obviously broken and/or smashed.

The complete elements are dominated by the very small elements that include phalanges (*N* = 39), followed by tarsals (*N* = 24), sesamoids (*N* = 13), and a few carpals (*N* = 9). Only five (25 percent) of the nearly 20 bison vertebrae identified are relatively

Table 8-14. Cultural Alterations (Burned, Cut Lines, and Cut Marks) Observed on Bison Bones from 41PT185/C.

Element/Fragments	Burned		Butchering Acts	
	Counts	Weights (g)	Impacts	Cut Lines
SKULL				
Skull				
Maxilla				
Inner ear				
Mandible				3
Hyoid				
Incisor				
Tooth	6	3.1		
VERTEBRAE				
Atlas				
Axis				
Cervical			1	
Thoracic				
Lumbar				
Caudal	1	0.4		
Rib (heads, shafts)	10	31.7		2
Sacrum				
FRONT LEG				
Scapula				1
Humerus			2	
Radius				2
Ulna			1	
Unciform				
Scaphoid				
Cuneiform				
Lunate				
Metacarpal	4	305.2	3	1
REAR LEG				
Pelvis (Ischium, Illum)				
Acetabulum				
Femur	1	7.7	1	1
Patella				
Tibia	1	73.4	1	
Lateral Malleolus				
Astragalus				
Navicular Cuboid				
Calcanium				
Magnum	3	8.2		
Metatarsal	2	222.3	3	
OTHER				
1st Phalanx			1	
2nd Phalanx				
3rd Phalanx	1	17		
Long Bone fragments	16	240.3		5
Condyles				
Cancellous	3	7.6		
Unknown Fragments	770	293.3		3
Sesamoids	3	4.9		
TOTAL	**821**	**1215.1**	**13**	**18**

complete and those exhibit the removal of their spinous processes. The only complete long bone was a metatarsal from BT 35, about 10 m south of the excavation block, which was subsequently crushed by the backhoe.

The high fragmentation rate (91 percent) reveals marrow was a targeted resource. Bone marrow accounts for only about 0.4 percent of the total bison carcass (Emerson 1990), but is considered in most meat utility indices (Binford 1978) or food utility indices (Metcalfe and Jones 1988; Lyman 1992), due to its very high fat content. The desire for bone marrow potentially was one reason behind the decisions made at the kill as to what to transport to camp.

The impact blow that broke open the hard, dense cortical walls of long bones leaves parts of concentric circles along the cortical wall and flake scars on the interior of the cortical wall, while producing small bone flakes as by products of the impact. A heavy instrument (a natural rock or hammerstone) is required to create this impact scar on these thick, hard green bones. Table 8-14 shows that 13 impact scars were observed on eight different elements, and Figures 8-142 and 8-143 indicates the locations of those impact scars on the various long bone shafts. This limited count of 13 impacts is considered a minimum number, as it is assumed that many other impact scars were present on other long bones, but most became unrecognizable during further bone fragmentation and/or post depositional processes such as weathering, rodent gnawing, and calcium carbonate build up. Metapodials exhibit the most impact scars ($N = 6$), a fact that reflects their higher frequency compared to other long bones. More impacts were obviously made than the few scars that were detectable during analysis.

Burning of bone was not an uncommon practice. This presence/absence of this characteristic was recorded for all bones and 820 pieces, or about 15 percent, showed some evidence of having been burned. About 94 percent were unidentifiable tiny fragments (see Table 8-14). These pieces weigh, on average, 0.4 g. This low average weight reflects the tiny size of the burned pieces. Given the lack of other taxa represented in this assemblage, these tiny burned pieces that lack diagnostic characteristics are most likely parts of bison bones. No nonbison elements identified showed evidence of burning.

Fifty one pieces of bison bones (weigh 921.7 g), or about 14 percent the identified bison bones, exhibit some type of burning. These include pieces burned to a black, brown, black and brown, gray, and white state. The different colors reflect the different intensity in the burning process. Most larger size ungulate bones, which include bison bones, exhibit a black and brown color as a result of temperatures less then 400°C, whereas the white color signifies a bone burned at temperatures above about 700°C (Nicholson 1993). The identifiable burned bison pieces include tooth fragments, caudal vertebrae, rib heads and shafts, parts of the femur, parts of the tibia, magnum, metatarsals and metacarpals shafts, a third phalanx, sesamoids, long bone fragments, and cancellous tissue chunks (see Table 8-14). The identified burned bison fragments indicate that small parts of the entire skeleton (front and rear legs and parts of the axial skeleton), were burned. Smaller pieces of unidentifiable bones were entirely burned.

The medial shaft area of many long bones, especially on the metacarpals and metatarsals, were lightly burned to a very pale brown (10YR 7/4). This discoloration is assumed to have been caused by subjecting this area to heat for a relatively short time. These lightly burned areas also have longitudinal splintering along the shaft, but not across the distal or proximal ends (Figure 8-145).

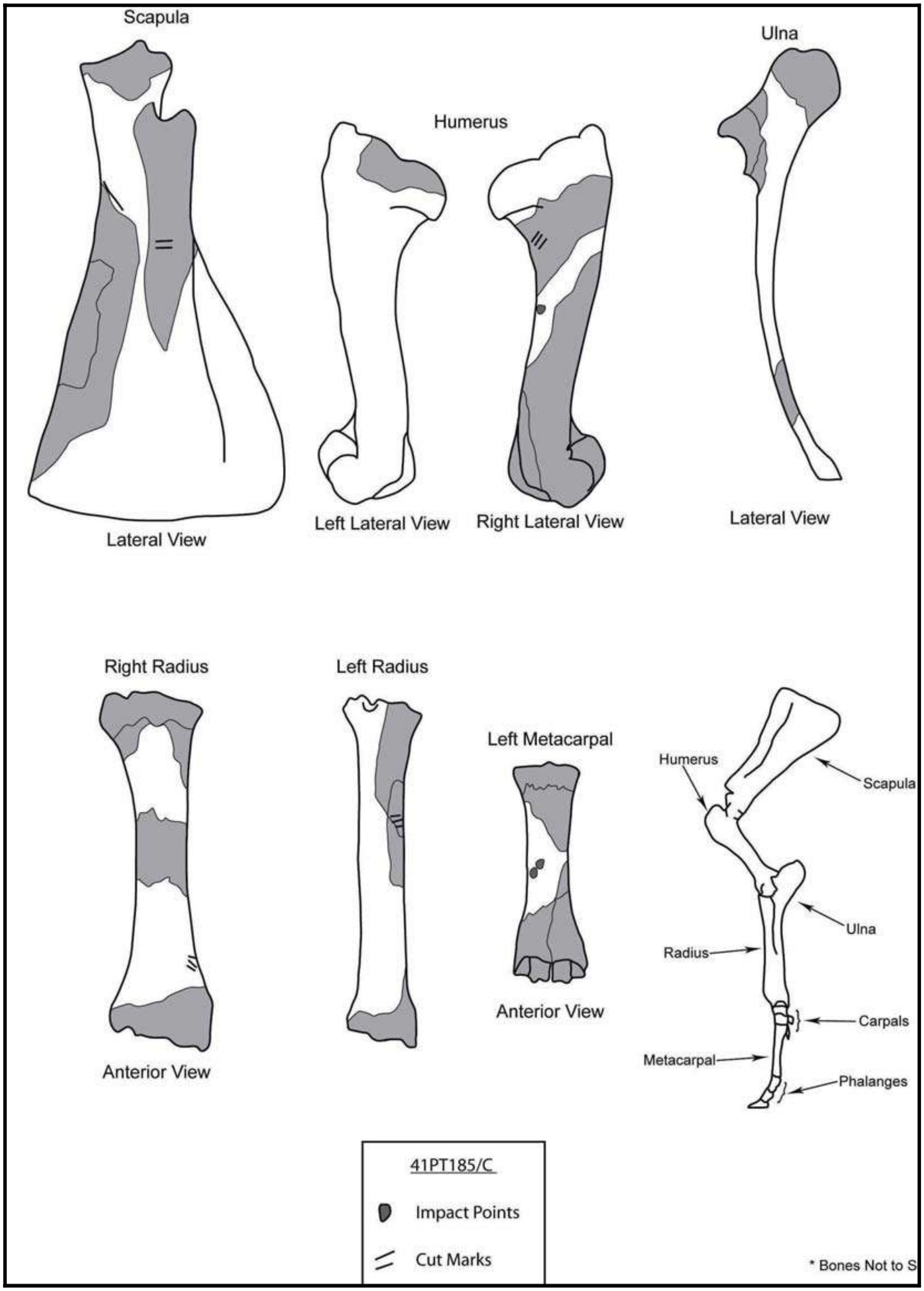


Figure 8-142. Bison Front Leg Elements Depicting Element Fragments, Impact Scar Locations, and Cut Mark Locations.

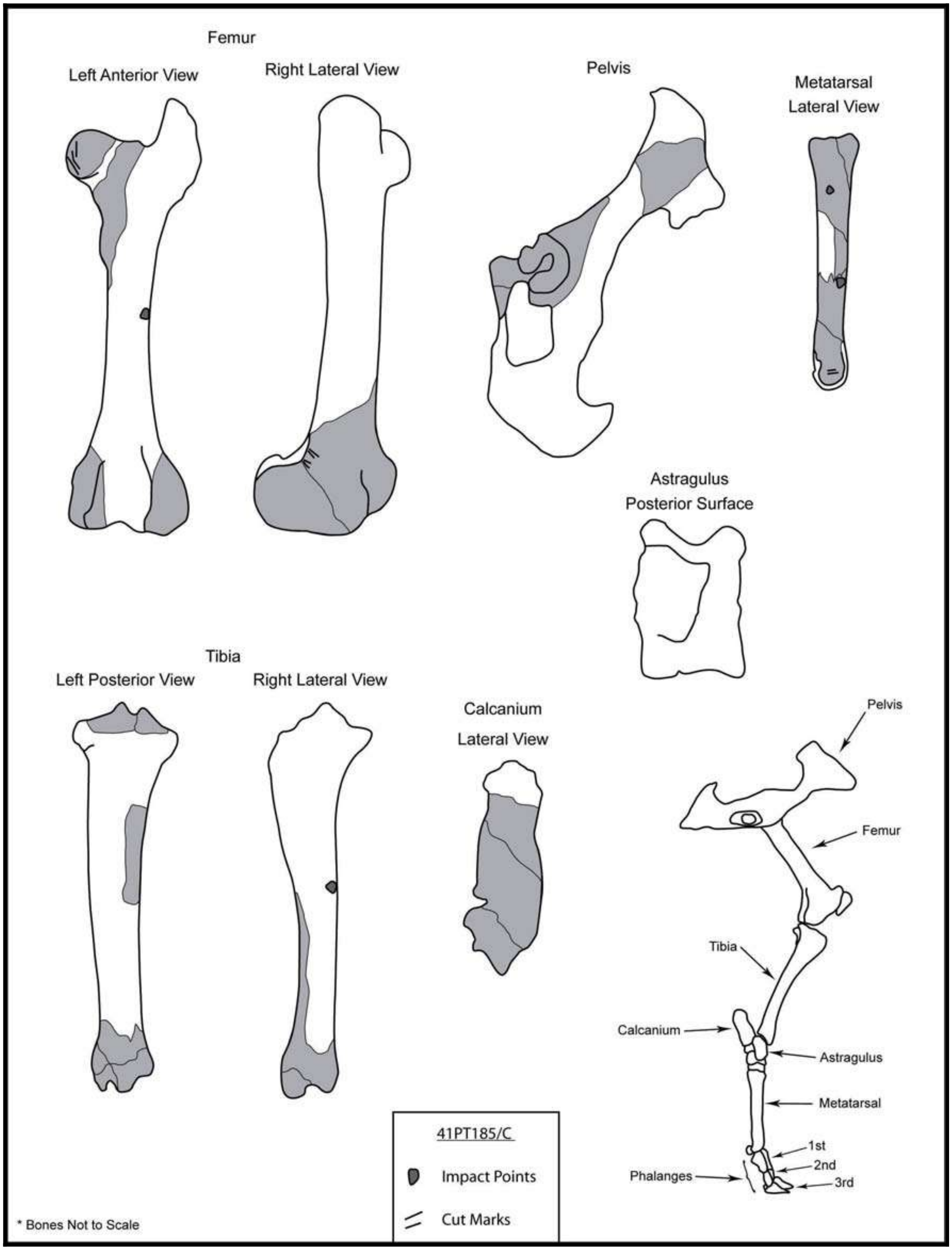


Figure 8-143. Bison Rear Leg Elements Depicting Element Fragments, Impact Scar Locations and Cut Mark Locations.

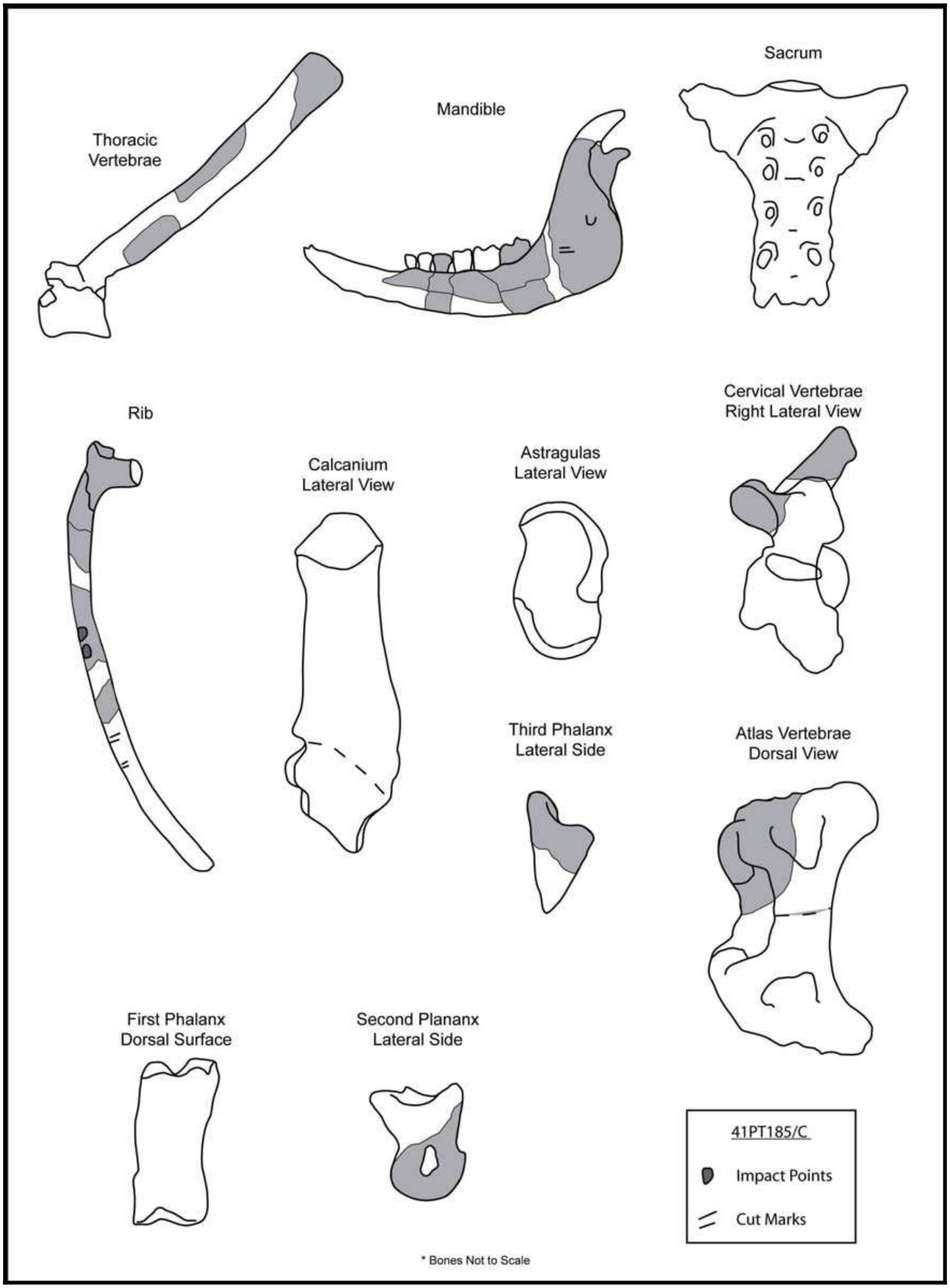


Figure 8-144. Bison Axial Elements Depicting Element Fragments, and Impact Scar and Cut Mark Locations.

These lightly burned long bones contribute the greatest weight to the total of burned elements. This practice was consistently observed on many long bones and had a direct purpose. The Calling Lake Cree in northern Alberta placed defleshed bones on or next to an open fire to make the bones easier to break (Bonnichsen 1973:10). Heating would have removed the periosteum sheath (tissue layer) that surrounds the bone along the mid-shaft.

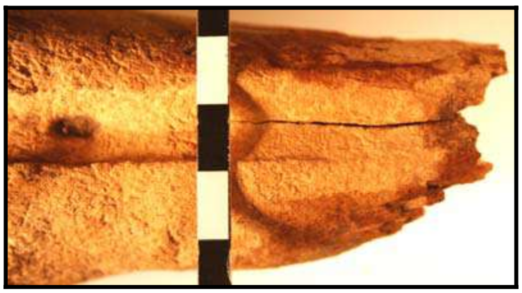


Figure 8-145. Burned and Cracking Medial Section of Bison Metatarsal.

The heating helped to drive out some of the bone grease and create a brittle area to facilitate breaking open the shaft. This intentional and targeted light burning was thus part of the process to remove the marrow from the internal cavity. In the example of the Calling Lake Cree, after the bones cooled, they were broken open by blows to the middle of the shaft, and the marrow was then extracted (Bonnichsen 1973:10).

Seven hundred and ninety seven bison bones were assigned to five size categories based on their maximum length. The smallest size class, 0 to 3 cm was represented by 58 percent of the pieces (Table 8-15; Figure 8-146). The 3.1 to 6 cm size class was represented by 20 percent. The 6.1 to 9 cm class was represented by 10 percent, followed by the 9.1 to 12 cm class at 6.4 percent, and the greater than 12 cm class is represented by a mere 6 percent. It is clear from these size assignments that 78 percent of the bison pieces are less than 6 cm in length. This does not include the many tiny, unidentifiable fragments that were too small for any type of identification. These tiny bones reflect intensive processing that these bones were subjected to following their breakage for marrow extraction. The fact that nearly 60 percent of the fragments are under 3 cm long supports the interpretation that the bones were smashed for extraction of bone grease.

Table 8-15. Bison Bone Fragment Sizes.

Size Class (cm)	Number
0 to 3	462
3.1 to 6	159
6.1 to 9	77
9.1 to 12	51
greter than 12	48
Total count	**797**

Figure 8-146. The Smallest Size Class, Less Than 3 cm in Length.

Bone Tools (N = 4)

Bone tools are few and include one well made awl (#1112-010) and three proximal or distal bison long bones with pointed medial shafts that probably functioned as pounders. Each bone tool is described and discussed below.

Specimen #1011-002, a probable pounder, came from 50 to 60 cmbs in N116 E109. This is a short (65 mm long) medial section of a bison metatarsal (Figure 8-147). The surface bears root etching, a couple of possible chop marks, and multiple longitudinal drying cracks. One end displays a jagged dry bone break, whereas the opposite end is roughly pointed along a spiral fracture. The pointed tip is slightly rounded with at least two flake scars that run parallel the long axis and into the thick cortical wall on the exterior side. The combination of flake scars and rounded point indicate this section was used in some type of pounding motion, which caused the flake scars and rounding.

Specimen #1112-010 was recovered from 21 to 40 cmbs in N118 E103 immediately west of Feature 15b. This is the distal end of a well crafted bone awl (Figure 8-148). It measures 60.2 mm long, 8.2 mm wide, and weighs 1.7 g. The very distal tip is missing as is the proximal end. The surface has root etching, rodent gnawing, and possibly acid pot marking. Under low power magnification linear, longitudinal lines can be seen running most of the length, but these are part of the natural bone rather than production striations. This awl was crafted from the edge of an angular bone with one side that includes the bone's interior, cortical wall. The wall thickness measures about 2.3 to 3.7 mm thick, indicating that this is piece was not made from a bison a long bone. It could have been made from a

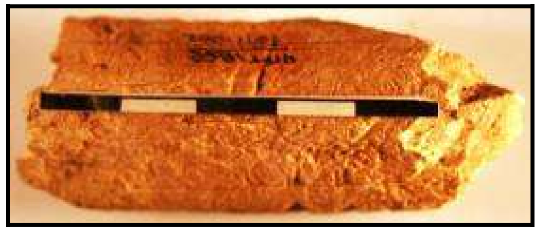


Figure 8-147. Bone Tool (#1011-002) with Worked End and Flake Scars Along Cortical Wall of a Long Bone Shaft. (scale in cm)

bison rib section, as these do have a similar thickness.

Specimen #1112-011, a probable pounder, was recovered from the same unit as the awl, from 38 cmbs in N118 E103 just west of Feature 15b. This specimen consists of 17.6 cm long proximal radius and shaft (180.1 g) with the medial section exhibiting a pointed spiral fracture (Figure 8-149). The bone's surface has light root etching with a couple of longitudinal drying cracks. The tip of the point exhibits at least three flake scars along the spiral fractured cortical wall with slight rounding of the very tip. This specific location is on the thickest part (ca. 13 mm) of the cortical wall. A thick cortical section (27 g) of this element was sent for radiocarbon dating. It yielded a $\delta^{13}C$ adjusted radiocarbon date on collagen of 1740 ± 40 (Beta-253240).

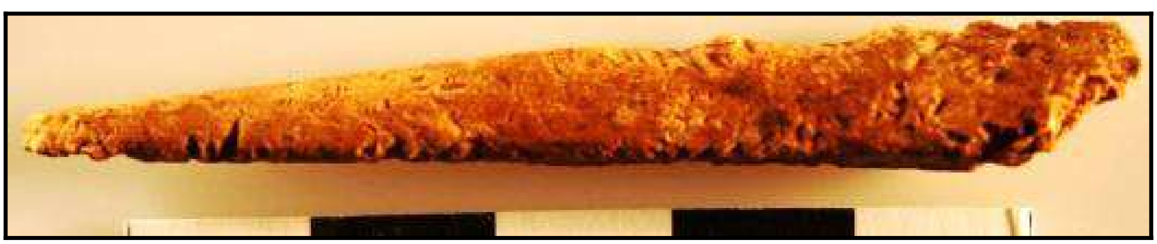


Figure 8-148. Bone Awl (#1112-010) with Root Etched Surface. (scale in cm)

Figure 8-149. Close-Up of Worked Medial Section of a Bison Proximal Radius (#1112-011) that Has Flake scars and Worn Rounded End that Indicates Use. (scale in cm)

Specimen #1114-010 (37.3 g) is another probable pounding tool that was recovered from 40 to 50 cmbs in N118 E103 just west of Feature 15b. This is the distal half of a bison metatarsal that lacks the distal articular surface. The pointed medial shaft area exhibits flake scars that run longitudinally along the long axis (Figure 8-150). The posterior side is mostly missing as the spiral fracture removed most of that end. The exterior surface is extensively root etched with very minor rodent gnawing on one spiral fractured edge. The pointed end, near the original medial part of the original element, has at least three flake scars indicating that this bone was used in a pounding motion to create scars up the shaft, while using the proximal end served as a handle.

Bone Distributions

The radiocarbon results and the vertical distribution of the Late Archaic features indicate at least two separate occupations. The overall horizontal distribution of the bones on the other hand, seems to indicate that one occupation is represented (Figure 8-151). The overall horizontal distribution of the bones reflects a general pattern, rather than just randomly scattered bones that might have occurred from overprinting of multiple cultural occupations. Based on bone weights, only six to seven areas of high concentration (277 to 859 g) were identified across the block. As a reference point for the weights involved, a complete, dry metatarsal weights about 350 g.

Figure 8-150. Worked Medial Section of Distal Metatarsal (#1114-010) that Has Flake Scars from Use Along the Cortical Wall. (scale in cm)

These identified high concentrations were widely distributed across the central area of the excavated block, and they are interpreted to reflect discard areas where larger proximal and distal ends of long bones were discarded. Based on the relatively concentrated and limited areas of these higher weights, it is apparent that most bones were highly fragmented and those fragments were well scattered. These higher concentrations were not in most features, which were dominated by burned rocks with the exception of Feature 17, a badly weathered bison skull that appeared at a somewhat lower elevation than almost all the other bones in this component. One bone concentration, in N118 E103, was next to a couple of burned rocks discard piles in Features 15a and 15b. These discarded bones were apparently dumped in the same area as the burned rocks. The areas that yielded high frequencies of bone weights covered only about three percent of the total area of the block excavations, documenting their concentration, and infrequent and limited nature.

The units/areas with moderate weight frequency (91 to 199 g) were again widely scattered (Figure 8-151). A few units were near burned rock discard piles, Features 14, 15b, and 18 with some moderate bone weights around and in near Feature 15. For

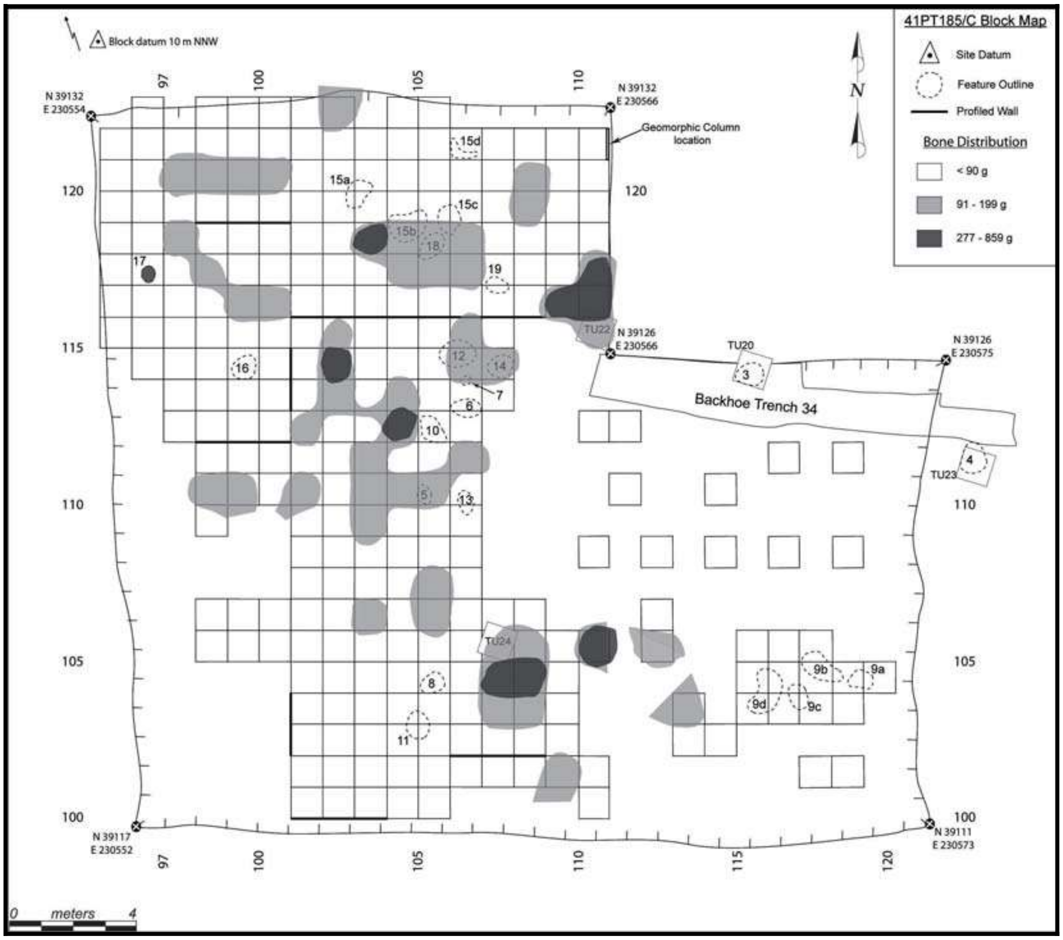


Figure 8-151. Horizontal Distribution of Bison Bones by Weight.

the most part, these moderate areas were again away from features. These areas of moderate weights account for about 17 percent of the total area within the excavation block.

The broad patterning of bone distribution by weight appears to reflect discard outside and away from any type of structural retainer and primarily away from burned rock concentrations. It is also clear that high concentrations of bone were not around the clustered Feature 9 burned rocks, or Features 8, 11, and 12, which were for *in situ* cooking activities. This pattern may indicate that those cooking features were not focused on cooking bones, meat and/or meat products, or if they were, the bones were discarded well away from the actual cooking feature.

Faunal Summary and Discussion

Very few nonbison bones were recognized. The identified nonbison remains include two and possibly three turtles, one dog, one deer, one badger, at least three pocket gophers, three prairie dogs, one snake, one mink, and one other unidentified small animal. The dog and deer were probably the only two taxa, other than bison, that were part of the Late Archaic component. The near completeness of the two turtle skeletons indicates that these were not culturally deposited, but most likely were natural inclusions within the cultural deposits. The few elements recovered for each of the other taxa were most likely intrusive and noncultural. This assumption is supported by the lack of weathering, root etching, and calcium carbonate build up on those nonbison elements. The hunting conducted by the Late Archaic occupants was clearly focused on bison, although at last one deer was also killed. The dog is also considered part of the Late Archaic population, but may not have served as a targeted food resource. It may, rather, simply represent the death of one of the camp dogs.

The general lack of identified bison vertebrae and skulls indicates that most of the bulky (low utility) axial skeleton was left at the kill site(s). Following the kill, a decision was made to strip the desired meat from these parts and leave the bulky and heavy skulls and vertebral columns at the kill. The very few mandible sections recovered indicate that this part of the skull was also not often removed from the kill. The absence of most axial skeleton parts from the camp supports the notion that the kill was a considerable distance from the camp and the camp was not move to the kill.

After the animals were disarticulated at the kill site, only the appendicular skeleton and possibly selected butchered sections of the hump, rib cage, and pelvis were transported to this camp. A few intact articular ends of long bones and lower leg elements that included many phalanges were recovered, supporting the appendicular sections (i.e., front and rear legs) were transported to this camp. Once at the camp, the meat was stripped from the bones. The bones were then broken to extract the marrow as indicted by the presence of various articular ends that lack the medial sections. The bone breaking is supported by the low frequency of whole elements and the impact marks on some elements. The general lack of articular ends also indicates that further bone processing targeted bone grease, which requires smashing the bones into small splinters then boiling out the grease.

The age structure of the 13 animals identified is difficult because of the low frequency of intact bison mandible sections. A few bison elements of a full term fetus or newly born animal were identified. Often the presence of a neonatal individual would imply a spring event. However, multiple lines of evidence indicate that the season of occupation was fall. This is based on the identified ages of a very limited number of mandible sections with socketed teeth and a few loose molars. The mandible fragments indicate that bison were killed at about 0.5 year of their life cycle. If the latter few specimens are an accurate reflection of the season of death as is suspected, then the one neonatal individual represents an out of season birth. The limited seasonal indicators (i.e., tooth eruption and wear, plus the one neonatal individual) produce mixed results, but the majority of evidence indicates a fall occupation, with the neonate bison representing an out of season birth.

The few identifiable bison distal and proximal ends of long bones were measured and compared to known sexed individuals. These few elements reflect only part of the herd killed, but the documented sex indicates that females were more frequent, by about a 2 to 1 margin. Apparently the heard composition included both sexes with more females than males. The latter included at least two very old males and one medium aged male. This generalization of a mixed herd supports a fall herd composition.

8.4.3.4.6 Burned Rocks (*N* = 4,286)

Great quantities of burned rocks (*N* = 4,286 pieces weighing 645,379.5 g) were recovered from the hand excavations, both in identified cultural features (*N* = 817 pieces weighing 244,875 g) and scattered across the block (*N* = 3,469 pieces weighing 400,505 g). The burned rocks directly associated with features were counted, weighed, and have been discussed above in the context of descriptions of the individual features. Here, all burned rocks including those scattered outside individual features are described and discussed. The burned rocks contribute significantly to our understanding of human behavior within the area of the block excavation. Not only do these burned rocks contribute to our understanding of the cooking and heating processes undertaken, but they also reflect cleaning and discard patterns/processes employed. The horizontal distributional data helps to define broader activity areas and intensity of the cooking process, which leads to an understanding of the intensity of the occupation. Field documentation was done to obtain rock size, counts, and weights by unit and level. Most burned rocks were documented in the field and then discarded. However, limited numbers from nearly every identified burned rock feature were collected and returned to the laboratory for further analyses. The different types of rocks employed also contribute to our understanding the resources available to them and which kinds of rock were selected for use.

The total also includes burned rocks from the test units (20 through 24) that were in 41PT185/C. Test unit 24 was within the excavation block, whereas TUs 20 through 23 were immediately outside the block. All burned rocks are attributed to the Late Archaic component. Of the total of 4,286 burned rocks, about 51 percent were in the small (0 to 4 cm) size class, 36.7 percent were in the 4.1 to 9 cm size class, about 11 percent were in the 9.1 to 15 cm size class, and the remaining 1.9 percent in the greater than 15 cm size. The burned rocks were most often part of the very small size groupings, with more than 87 percent less than 9 cm class. In general, the 0 to 4 cm burned rocks weighed an average of about 20 g, the 4.1 to 9 cm rocks averaged about 147 g, the 9.1 to 15 cm size averaged about 457 g, and the greater than 15 cm rocks averaged about 1,936 g.

The feature rocks account for nearly 20 percent of the total by count and about 38 percent of the total by weight (Table 8-16; unfortunately a couple of the features were not completely weighed in the field). On average, burned rocks outside the features weighed about 150 g, whereas those in individual identified features weighed about 300 g. The contrast in rock size between feature and nonfeature burned rocks comes in the 9.1 to 15 cm size range, where inside the features that size accounts for nearly 23 percent of the rocks, whereas outside that size accounts for only 11 percent. It is clear that rocks less than about 9 cm in diameter were discarded and no longer serviceable as heat storage elements. These small pieces were undoubtedly scattered about due in part to foot traffic during the occupation and may also have been moved some by natural processes following site abandonment. The larger and heavier rocks would be less likely to have been moved by either of these agencies.

In terms of rock types represented, dolomite/caliche is predominant. In addition to the dolomite/caliche, hard sandstone slabs and rounded quartzite cobbles were identified, but both in much lower frequencies.

The horizontal distributions of the weights of the various size classes of burned rocks are of interest and help broaden our understanding of the camp activity areas and the relationships with the specific features. Distributional patterns are recognized for each of the various size classes. The weights of the different size classes are graphically presented and discussed separately below.

Figure 8-152 provides a generalized distribution pattern for the weights of the smallest burned rocks (0 to 4 cm). Broadly speaking, the highest and even the moderate weights were not directly linked to the identified features, but these rocks were

Table 8-16. Burned Rock Counts and Weight for Identified Features, 41185/C.

Feature No.	Unit N E	Depth (cmbs)	Catalog No.	Total Count	Total Weight (g)	Burned Rock Size Categories							
						0-to-4-cm, Count	0-to-4-cm, Weight (g)	4.1-to-9.0-cm, Count	4.1-to-9.0-cm, Weight (g)	9.1-to-15.0-cm, Count	9.1-to-15.0-cm, Weight (g)	>15.0-cm, Count	> 15.0-cm, Weight (g)
3	TU 20	85-93	198-003	28	17250			19	3000	9	1450		
4	TU 23	95-108	213, 214-003	69	48800	11	300	24	3500	21	11000	13	34000
5	110 105	51-58	1348-003	14	2189	5	189	6	1000	3	1000		
6	113 106	43-53	854-003	13	8805	1	55	4	500	6	2500	2	5750
8	104 104	50-68	465, 468-003	22	7600								
	104 105	50-63	471, 1341-003	48	12183								
9a	104 118	62-73	508-003	16	6532			6	1500	9	4500	1	532
9b	105 117	48-60	1339, 1340-003	15	2144*								
	104 117	50-60	564-003	62	11845	36	95	15	2000	5	3000	6	6750
	104 117	40-50	501-003	23	6001	3	21	16	1844	2	636	2	3500
9c	104 116	40-50	1343-003	4	593			4	593				
	103 117	44-50	445, 444-003	22	3299	5	79	14	2130	3	1040		
	103 117	50-60	446, 1332-003	19	1909	12	95	4	1650	3	1164		
	104 117	40-50	502-003	9	713	3	21	6	292				
9d	103 115	39-50	1330-003	21	1902	12	52	9	1850				
	103 116	37-41	1331-003	22	3174	13	33	5	828	4	2343		
	104 116	40-50	1337, 1338-003	45	13582	8	66	17	2516	18	8000	2	3000
11	102 104	50-66	355, 1342-003	23	6709*								
	102 105	45-65	359, 361, 363-003	19	3951*								
	103 104	54-66	406, 408, 1328-003	21	5964*								
	103 105	53-57	413, 415-003	3	1219*								
12	114 105	32-50	896-003	15	5404	3	37	4	618	8	4750		
	114 106	40-50	901-003	44	14750	10	500	10	2250	21	9000	3	3000
14	114 107	61-67	907-003	19	6741	1	19	13	1355	4	2368	1	3000
15a	119 103	38-50	11675-003	19	7774	3	342	10	1860	4	2572	2	3000
	120 103	42-51	1234-003	13	1956	2	156	9	1000	2	800		
15b	118 104	40-50	1119-003	15	4112	3	182	9	2805	3	1125		
	119 104	40-50	1181-003	51	11806	2	56	38	7000	11	4250		
	119 105	40-50	1184-002	5	2061			2	668	3	1393		
15c	118 106	40-50	1131-003	3	509			2	187	1	322		
	118 105	40-50	1127-003	4	425	2	50	2	375				
	119 105	40-50		9	2340	3	75	4	1336	2	929		
	119 106	44-52	1192-003	43	12006	4	46	22	4210	15	6000	2	1750
15d	121 106	50-56	1295-003	14	4000			8	1750	6	2250		
16	114 99	68-78	875-002	21	16750			7	3500	12	9750	2	3500
18	118 105	50-60	1129-003	8	2889			4	932	4	1957		
	118 105	40-50	1352-003	2	475			2	475				
19	116,117 107	60-70	1070-003	14	4500	2	250	6	1500	6	2750		
Totals				817	244875	144	2719	301	55024	185	86849	36	67782
* = estimated weights using average weights by size class													

more often around or in the vicinity of the features.

A very broad scatter of medium-weight rocks encompassed nearly 36 m^2 across the northern one third of the excavation block. One small concentration of higher frequency was apparent at the northern edge of this scatter in N121 E103, outside Feature 15. Another small area of high concentration was around the southern edge of Feature 12 with a moderate scatted that continued further south and east. The northern part of the excavation block yielded the higher concentrations and the greatest weights of these smallest pieces. Interestingly, relatively limited weights were associated with the four Feature 9 clusters at the southeastern corner of the excavated area. This same limited frequency is again apparent in and around Features 8 and 11 in the southern end of the block. These low weights around these latter features testifies that few small burned rocks were involved with these features.

The weights of 4.1 to 9 cm size burned rocks also delineate relatively moderate distribution across much of the northern half of the block (Figure 8-153). No obvious circular patterns are recognized that would imply any type of structure limiting their distribution. A couple of linear patterns reflecting moderate weights are evident.

These linear patterns may reflect some sort of possible wind break or shade arbor, which might have constrained the distribution of those rocks. In contrast to the case of the smallest burned rocks, the higher densities appear centered around the identified features with other burned rocks scattered around those features. Pockets of moderate densities were also visible that were not associated with features.

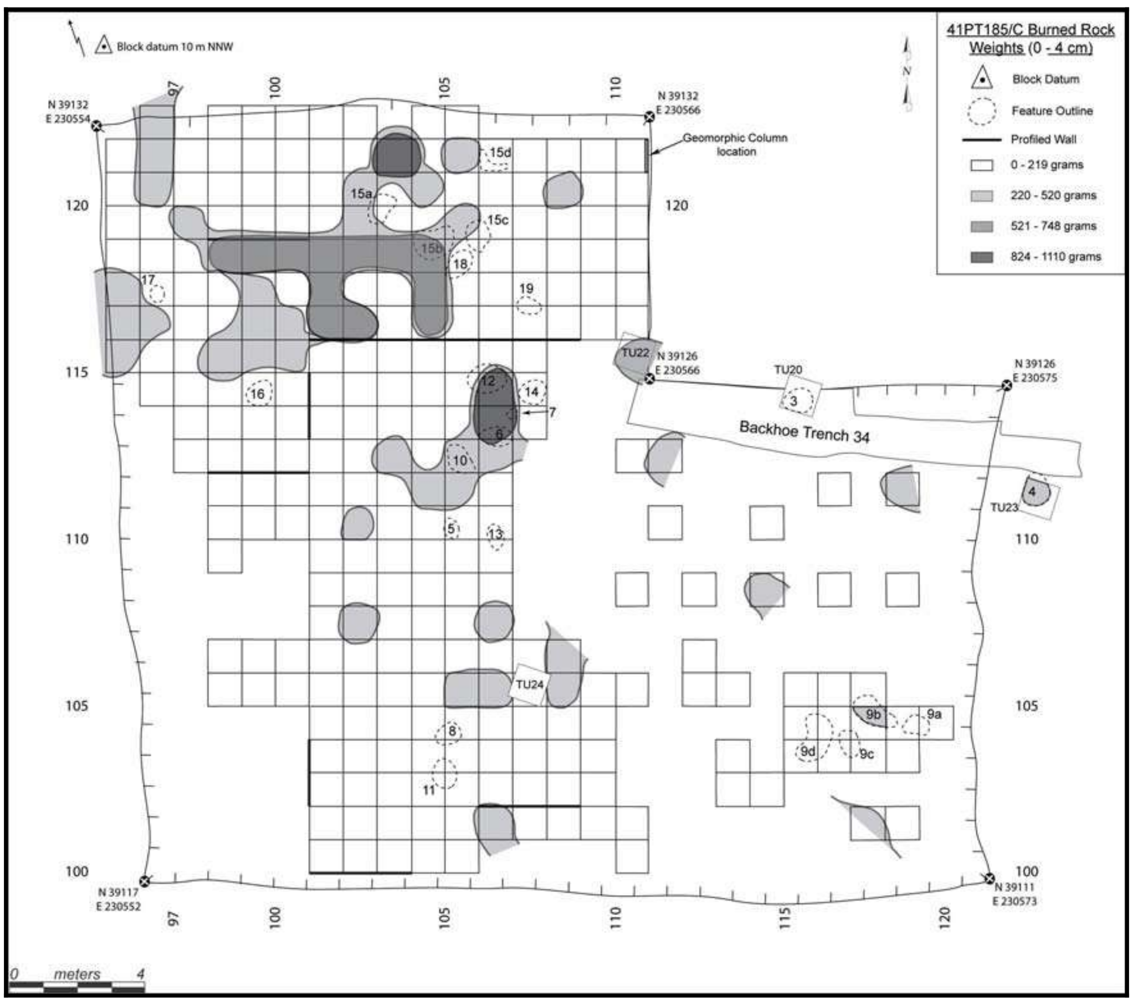


Figure 8-152. Generalized Horizontal Distribution Pattern of the Burned Rocks Weights in the 0 to 4 cm Size Class.

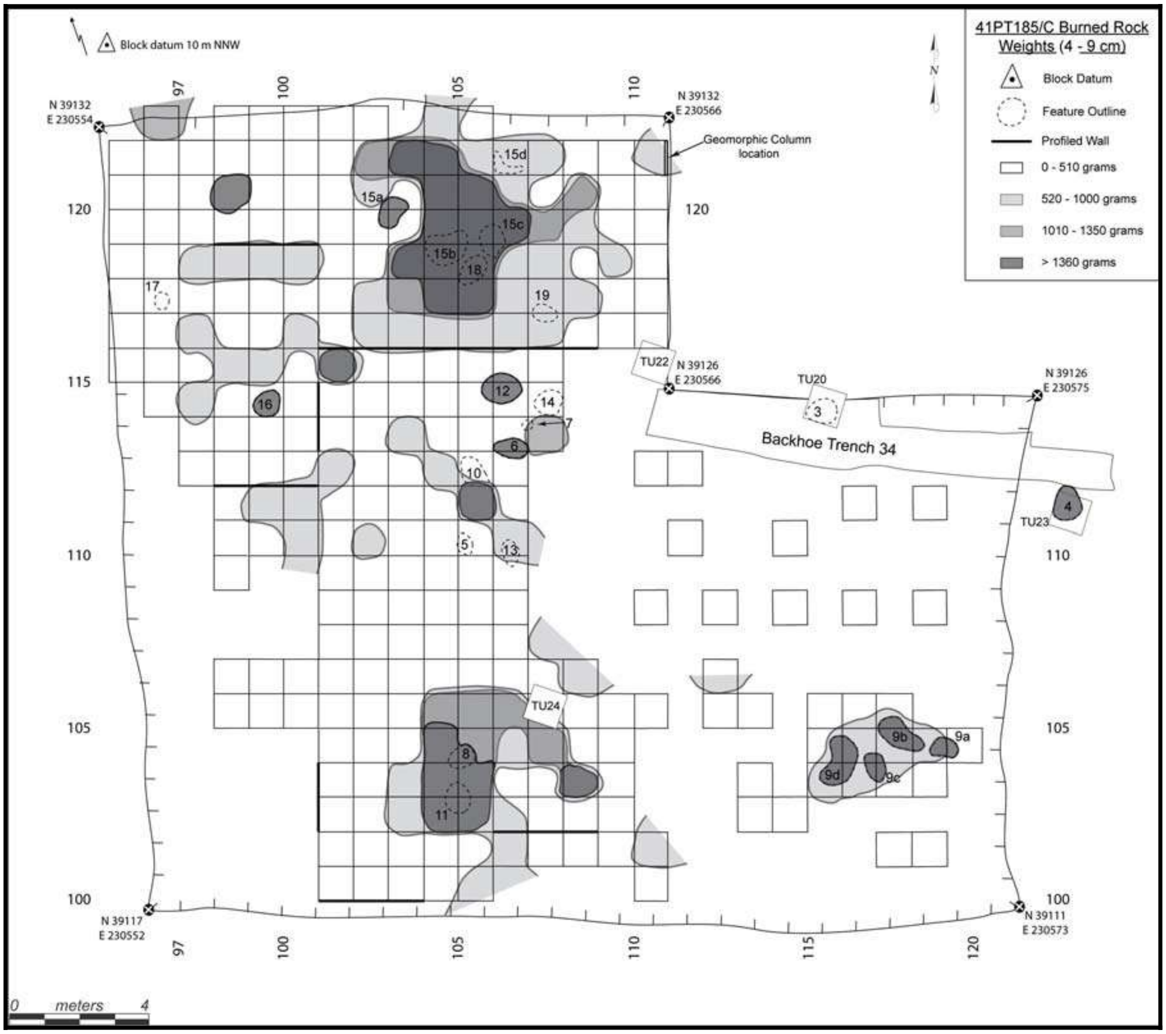


Figure 8-153. Generalized Horizontal Distribution Pattern of the Burned Rocks Weights in the 4.1 to 9 cm Size Class.

Figure 8-154 depicts the horizontal distribution, by weights, of the 9.1 to 15 cm size burned rocks. It appears that the highest weights were directly associated with features. The moderate weights were generally around those features, with a few exceptions. At least five small clusters of moderate or higher weights were west of Feature 15, with a few other small clusters scattered across the block. This indicates that some larger pieces were either discarded away from an identified feature or that the rocks represent scatter of a feature that was not be recognized as such.

The generalized distribution of the weights associated with the largest burned rocks, those greater than 15 cm, reveals that the greatest weights were inside features. Few of these bigger pieces were strewn across the entire block (Figure 8-155).

Apparently, a few individual pieces were just along the margins of the features, possibly representing scattered pieces or small clusters stockpiled for another use episode. Feature 4 in TU 23, an *in situ* heating element, yielded the highest frequency of these large rocks ($N = 24$) and the highest weight (66,250 g), reflecting use of very large pieces. The second highest frequency (*N* = 10) was in discard Feature 6, which potentially served as a stockpile for *in situ* heating element Feature 12 just a meter or so to the north of it. A couple of apparent locations with moderate weights were present in two widely dispersed units, one in N101 E106 and another in N116 E95. These generally reflect one or two large burned rocks.

8.4.3.4.7 Charcoal (*N* = 76)

Charcoal was not encountered in large quantities in any proveniences and was not obvious in any of the identified cultural features. No intensive charcoal stains or lenses were observed, not even in any of the features. Only scattered small chunks (less than 1 cm) and flecks were encountered, mostly outside features where contexts may be questionable. A total of 76 samples were collected from across the block excavations. Eight samples, or 10.5 percent, were directly associated with features. These small pieces may have been vertically displaced through root and rodent disturbances due to their small size. These limited charcoal specimens were recovered from within, above, and below the elevations of the two apparent cultural occupations. These small pieces indicate that preservation was not ideal and charcoal was lost through weathering/deterioration over time.

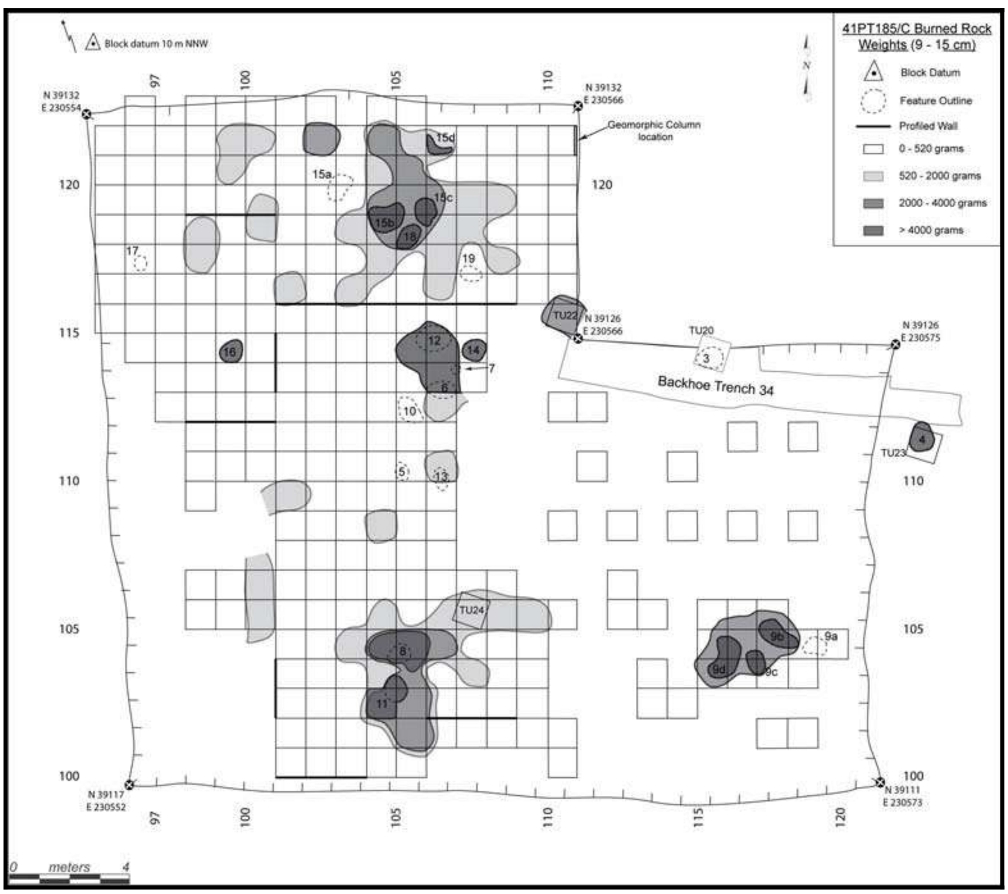


Figure 8-154. Generalized Horizontal Distribution Pattern of the Burned Rocks Weights in the 9.1 to 15 cm Size Class.

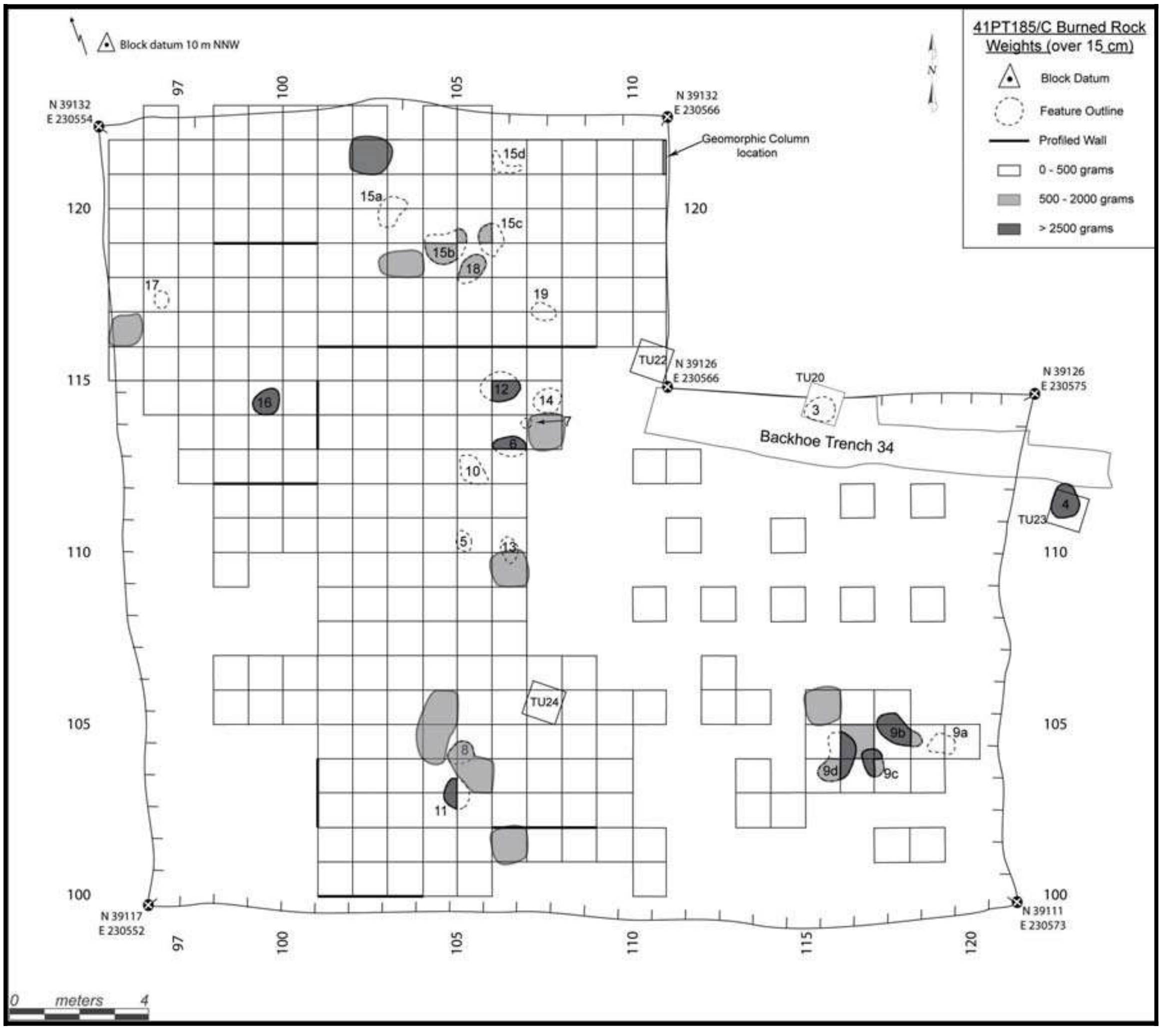


Figure 8-155. Generalized Horizontal Distribution Pattern of the Burned Rock Weights in the Greater than 15 cm Size Class.

The horizontal distribution of the samples collected is displayed in Figure 8-156. This clearly illustrates the scattered nature of the samples and the very limited number of samples around the cultural features. This distribution creates uncertainty as to association with the other cultural debris.

Twenty five charcoal samples were selected and subjected to wood identification, with two sent for radiocarbon dating. These small charcoal pieces are prone to displacement, therefore, the focus of radiocarbon dating this component was on bison bone from what was presumed to be less questionable contexts and clearly cultural in nature.

Dr. Dering identified 13 samples as juniper wood, four samples as mesquite wood, and found eight samples to be indeterminate or to small to provide positive identification (Appendix N). Tiny fragments were insufficient for positive identification. Juniper and mesquite were intentionally selected for use as fire wood. Both species are hardwoods that create a more intensive heat than do the softer and faster burning cottonwood/willows in the vicinity. The flotation of sediments from selected features yielded almost no identifiable charcoal pieces with only one sample identified as mesquite (from Feature 8) and one as cottonwood/willow (from Feature 11). The latter also indicates the presence of this species at the time of the occupation. The lack of significant pieces of mesquite wood, especially larger pieces where individual ring sizes could be examined, precluded the application of xylem analyses, which would have potentially provided clues to the paleoenvironment at the time of the occupation(s).

8.4.3.4.8 Mussel shell (*N* = 4)

Only four samples of freshwater mussel shells were recovered and the total weight is 8.7 g. Three of the samples are quite small fragments, less than 2 cm in diameter, with no umbos/hinges present. None of these are culturally altered and their edges appear angular rather than water rounded. Only one specimen (#785-006), from 37 to 50 cmbs in N112 E102, represents most of one half of one valve and it does not retain a hinge. This one sizable piece came from questionable context and was near the top of the Late Archaic component. It is likely that these fragments were naturally deposited. None were near any of the identified

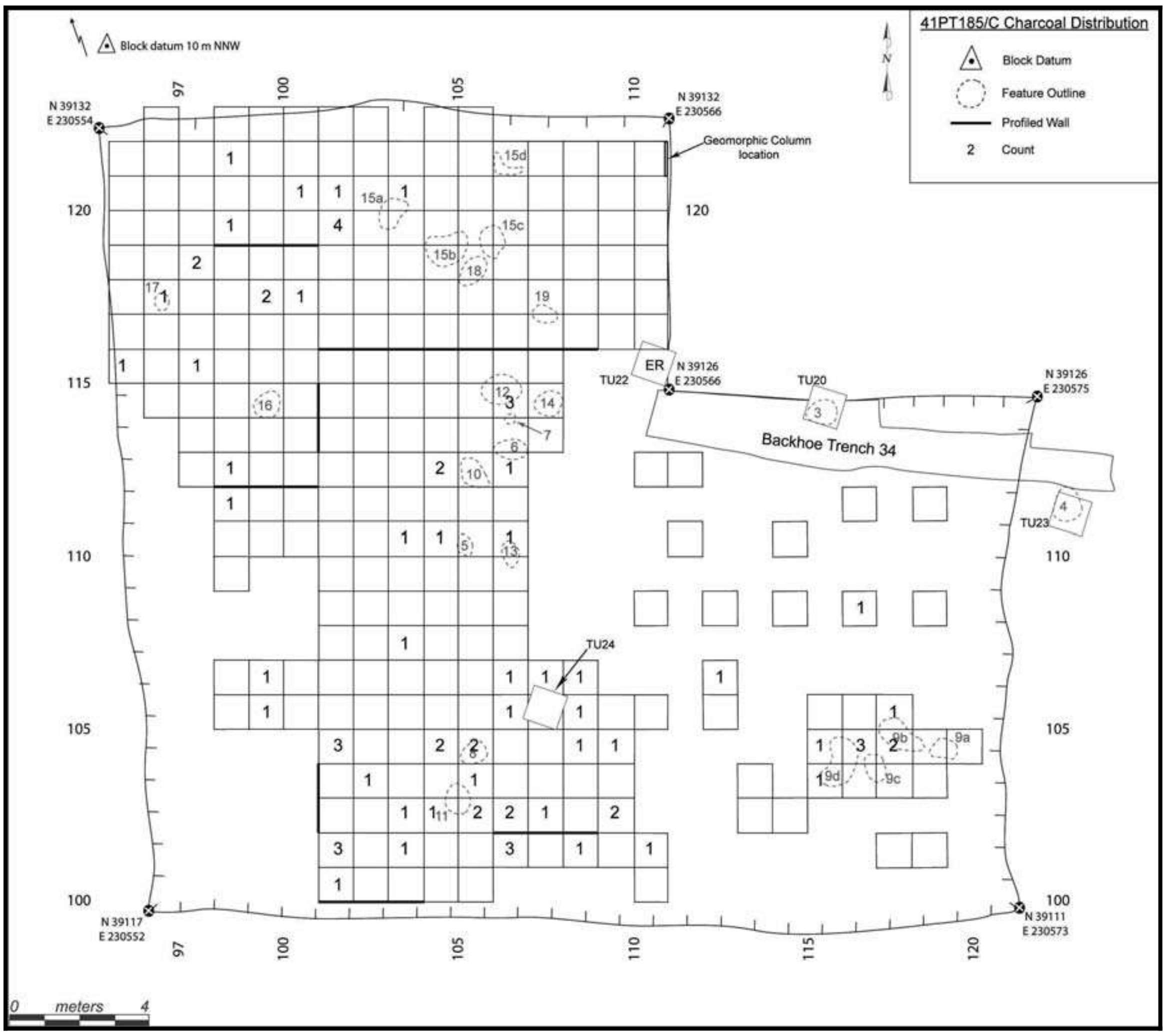


Figure 8-156. Horizontal Distribution of Individually Collected Charcoal Samples.

features. It is obvious mussel meat was not targeted by the Late Archaic populations at this camp.

8.4.3.4.9 Discussion and Interpretations of Late Archaic Component

Currently, the general understanding of climatic conditions at about 2250 B.P., during the earliest of the Late Archaic occupations, indicates this period was relatively moist and humid. Deciduous shrubs and trees were present in low numbers along the creek; whereas the moderately aggrading terrace was mostly covered with short C_4 grasses (Appendix D). It was probably about this time that the marl formed on the valley floor. Apparently, the earliest Late Archaic occupation at 41PT185/C, ca. 2400 B.P., occurred just before the deposition of the sediments from the lowest part of BT 36. However, the latest Late Archaic occupation (ca. 1600 B.P.) documented in the block excavations overlap with the paleoenvironmental information gathered from BT 36. Sometime between 2250 and 1900 B.P. the West Amarillo Creek channel was incised about 3 to 4 m and created a new floodplain. Unit D was deposited in this new floodplain. During the younger, second Late Archaic occupation the creek was probably a flowing stream with period flooding. West Amarillo creek was roughly 2 to 3 m wide and ca. 50 cm deep. Brief periods of ponding may have also occurred. Sometime around 1900 the conditions were much warmer and more arid based on the dominance (83 percent) of Chloridoids phytoliths and decrease in Pooids (Appendix D). Pollen from cattail (Typha) and willow (Salix) and sedge family indicate the presence of a pound. Pine pollen (*Pinus ponderosa* and *P. edulis*) was blown in from the west. Shortly after that at ca. 1840 B.P. the local conditions were cooler and moister, with an aggrading site surface.

The relatively infrequent, but diverse cultural assemblage recovered from this Late Archaic component is interpreted to reflect two, moderately long camping events (a few weeks at most) in which the occupants conducted diverse tasks. These included hunting bison, collecting Canadian wildrye (*Elymus canadensis*) grass seeds, defleshing bison bones, extracting marrow and bone grease from the bones, cooking the gathered grass seeds, and many other tasks related to every day camping and living.

These tasks appear to have been horizontally distributed across the excavation block in this broad alluvial surface. The horizontal patterning reflected by the recognized features and artifact distributions document specific human behaviors and intrasite patterns. These types of recognizable distributions reflect relatively intact cultural events and provide an opportunity for greater understanding of human behaviors. The diverse cultural assemblage, the moderate frequencies of cultural items, the number and horizontal separation of the cultural features, combined with the fair preservation of faunal remains in the excavated block indicates that many specific and general research questions for this specific Late Archaic component can be addressed. These are the types of components that provide the greatest opportunities for reconstructing cultural behavior.

The two apparent cultural occupations represented in this relatively thin (40 cm thick) deposit indicate repeated human occupations at this specific locality by similar groups of hunter-gatherers over a period of less than a thousand years or so, from ca. 1600 to 2400 B.P. From a depositional perspective only about 40 cm of alluvial deposits represent that ca. 1,000 year period. This provides a measure of how infrequently small volumes of sediment were deposited on this terrace from the adjacent West Amarillo Creek during that period. In all likelihood, cultural debris left behind at the time of abandonment remained exposed for a considerable period of time before being buried. This allowed for the bones to weather and the botanical remains to deteriorate. The sediments that subsequently covered the cultural debris were fine-grained silts and clays, but in very limited amounts and likely unevenly distributed across the terrace. Over time, debris representing site occupation was subjected to turbation that vertically displaced smaller objects. Leaching of the minerals in the sediment allowed the calcium carbonate to build up on the underneath sides of the larger objects, mostly the bone.

This indicates that many Late Archaic components in this region may be commingled during this time period because of the relatively limited sediments deposition. Future work in the region should be aware of the limitations of these deposits during this time, which may account for its low visibility and/or the compressed nature and the associated cultural materials.

8.4.3.4.10 Interpretations of the Results from the Block Excavations at 41PT185/C

J. Michael Quigg and Paul Matchen

Chapter 4 established broad overarching theoretical bases which presents how the anticipated findings of the specific project may be used to address explicit issues and questions, and thus guided and justified the various methods employed. This included guiding the fieldwork and the subsequent documentation and analyses of the recovered remains. As stated in Chapter 4, the general research issues for the Southern High Plains region are poorly developed because of the scarcity of comprehensive excavation data sets from across the Texas Panhandle. Due to the paucity of information, the important research issues, research questions, and data sets for the Southern High Plains region are generalized. Since no substantial historic corollary is known for these sites, the research issues pertain to the period before EuroAmerican settlement of the area. The four broad research issues presented in Chapter 4 are presented and discussed below. These include chronology, subsistence, settlement and community patterns, exchange and regional interactions, site function and intrasite patterning, and technology. Specific questions under these general headings are also posed and addressed.

Chronology and Cultural Affiliation Issues, and Discussions

What absolute age(s) is represented by the targeted component at 41PT185/C?

An absolute radiocarbon age range for this ca. 30 to 40 cm thick Late Archaic component is based on 14 radiocarbon dates. The age range is between ca. 1550 and 2550 B.P. based on 12 bison bone collagen and two wood charcoal radiocarbon dates (Table 8-17). Charcoal and other macrobotanical remains (i.e., seeds and nuts) were poorly preserved throughout the targeted deposits, with only the occasional small chunk of charcoal recovered, mostly from scatter outside identified cultural features. The absence of abundant charcoal from any of the well defined cultural features creates suspicion as to the true association of those scattered pieces recovered. Dating wood charcoal also presents problems with old wood and can be misleading (Smiley 1985; Schiffer 1986). Smiley (1985:34-35) lists 17 sources of error in radiocarbon dating charcoal and agues for quantification and control for the bias in radiocarbon dating. Very large old cottonwood trees are in the immediate project area and deadwood collected by prehistoric populations for use in their camp fires would probably not directly reflect the precise age of the cultural occupation(s).

Table 8-17. Radiocarbon Dates from Excavations at 41PT185/C

Provenience	Catalog No.	Feature No.	Depth (cmbs)	Material Dated *	Weight of Material (g)	Beta Lab No.	Measured Age	13C/12C Ratio (‰)	Conventional Age (B.P.)	2 Sigma Calibration Age
PT185/C, 119/103	1174- A	15	47	1 bison bone frag	27.0	257845	1290 ± 40	-8.5	1560 ± 40	Cal AD 410 to 590
PT185/C, 115/96	914-2-1a		70-80	1 distal bison radius	14.0	264922	1310 ± 40	-8.9	1570 ± 40	Cal AD 410 to 580
PT185/C, 104/105	FSXX	8	41-50	1 charcoal	0.1	250877	1590 ± 40	-22.4	1630 ± 40	Cal AD 340 to 540
PT185/C, 118/103	FS1322	15	38	1 proximal bison radius	27.0	253240	1500 ± 40	-10.3	1740 ± 40	Cal AD 220 to 400
PT185/C, 120/100	1224-2-1a		52	1 bison distal radius	10.8	264925	1750 ± 40	-9.0	2010 ± 40	Cal 100 BC to AD 70
PT185/C, 120/108	1247-2-1a		40-50	1 proximal metacarpal	15.5	264924	2020 ± 40	-11.4	2240 ± 40	Cal 390 to 200 BC
PT185/C, 104/115	493-002-1	9d	41	bison long bone frag.	33	255837	2010 ± 40	-10.3	2250 ± 40	Cal 400 to 200 BC
PT185/C, BT 35-1	262-002-1		60	1 bison metapodial		237024	2000 ± 40	-8.7	2270 ± 40	Cal 400 to 340 BC
PT185/C, 100/104	279-002-1a		40-50	bison long bone frag.	11.9	255836	2020 ± 40	-7.5	2310 ± 40	Cal 410 to 360 BC
PT185/C, TU 22	210-002-1		70-80	1 bison metacarpal	13	238315	2130 ± 40	-10.9	2360 ± 40	Cal 520 to 380 BC
PT185/C, TU 26	236-002-1		97-102	1 bison radius	15	238316	2160 ± 40	-9.2	2420 ± 40	Cal 750 to 400 BC
PT185/C, 117/95	1027-2-1a	17	95	1 bison skull + horn core	37.3	264923	2250 ± 40	-8.9	2510 ± 40	Cal 790 to 510 BC
PT185/C, 112/104	FS1049		92	distal bison radius	52.0	253239	2270 ± 40	-8.8	2540 ± 40	Cal 800 to 720 BC
PT185/C, 104/101	FS630		76	1 charcoal	0.3	250878	2850 ± 40	-23	2850 ± 40	Cal 1120 to 910 BC
* bone dates were on collagen										

Potentially the small pieces of scattered charcoal recovered were not directly associated with this component as they easily could have been displaced through a variety of turbation processes. The oldest radiocarbon age (2850 B.P.; Beta-250878) was derived from an isolated piece of wood charcoal recovered from very light colored sediments at 76 cmbs. The age of the light colored sediment was determined to be ca. 8000 B.P. The charcoal appears too young to represent the age of the light colored sediment and presumably this piece was out of context. This charcoal was not directly associated with substantial quantities of cultural materials or from a defined feature, so its context is questionable. In comparison to the oldest cluster of eight radiocarbon dates on bison bones, this wood charcoal date is ca. 300 years older (see Table 8-17). This obtained age is too old in comparison with other radiocarbon ages derived from the bison bones and is therefore, rejected.

The larger bison bones, which are definitely cultural and directly associated with this component, are much less likely to have been vertically displaced, and thus are relied on for establishing the absolute age range for these cultural events. The reliability of radiocarbon dates on bison bones appears quite to be good with a limited absolute age range of ca. 1,000 years from ca. 1550 to 2550 B.P. This determined age range incorporates at least two obvious clusters of radiocarbon dates, nearly all derived from bison bones. The older cluster includes eight dates; all derived from bison bones, 75 percent of which are from the southern end of the excavation block, test units, or backhoe trenches in the immediate vicinity (Figures 8-157 and 8-158). This cluster of dates spans 300 years, ca. 2240 to 2540 B.P. A second cluster, ca. 740 years younger, is represented by four dates. This younger cluster ranges over ca. 200 years from ca. 1560 to 1740 B.P. All the younger dates, with the exception of one wood-charcoal date of 1630 B.P., were derived from bison bones recovered from the north end of the excavation block. The one charcoal date was from the southern end of the block on top of the burned rocks designated as Feature 8.

This charcoal date is ca. 500 years younger than the youngest age of 2250 B.P. in the older cluster. It is also ca. 730 years younger than the average derived age for the southern end. It just so happens to be in the range of the younger cluster of dates from the northern end of the block, but it is not an accepted age for Feature 8 or the other cultural materials recovered from across the southern end. One other radiocarbon date on bison bone from the north end, 2010 B.P., which falls between the two clusters of dates, may represent another undefined cultural event in this component. This entire Late Archaic component is therefore radiocarbon dated to less than a ca. 1,000 year period with the probability of two well dated components, one at ca. 2400 B.P. and the other at ca. 1600 B.P. Both dated occupations fall within the broader Late Archaic period on the Southern High Plains.

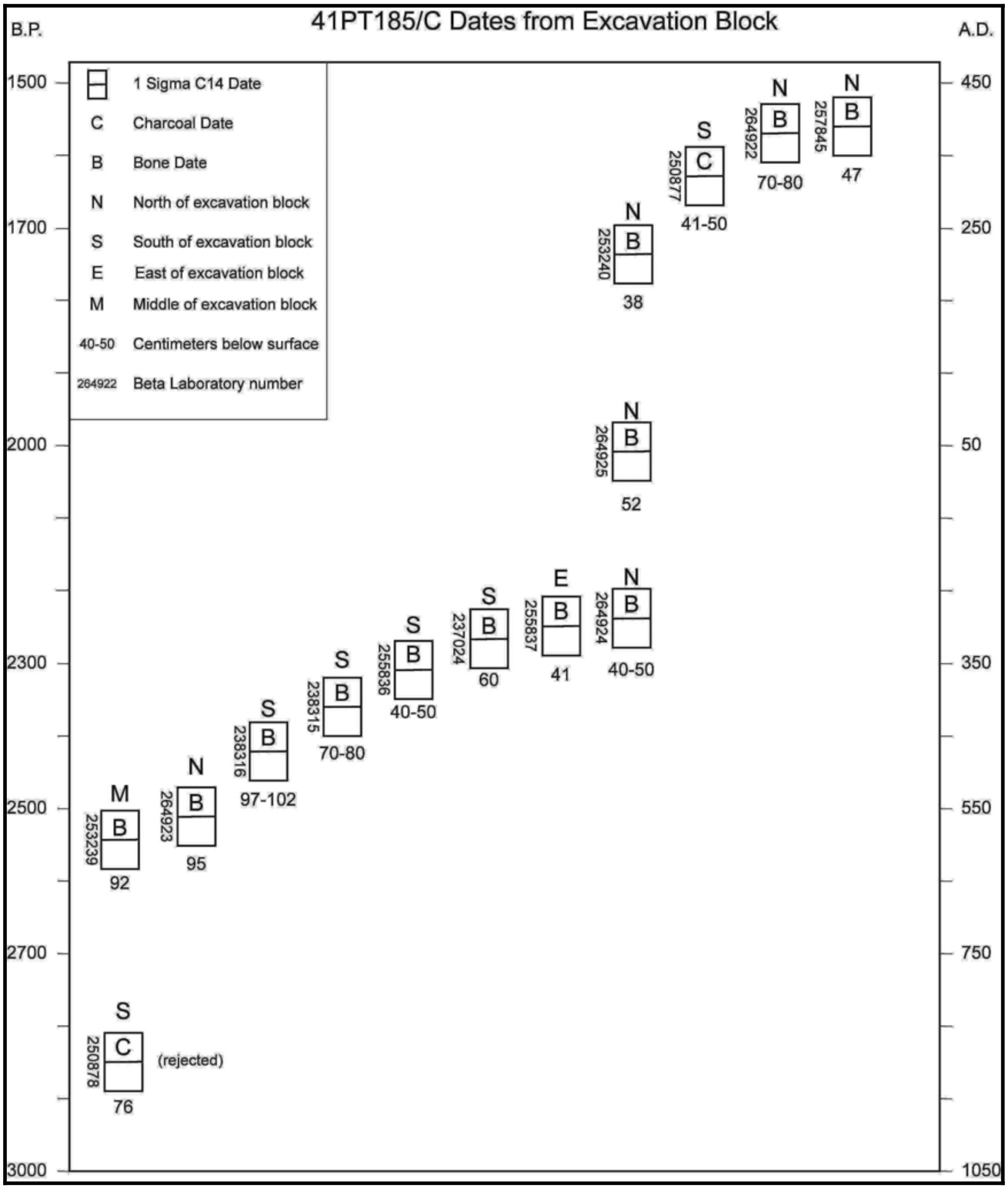


Figure 8-157. Plot of Fourteen Radiocarbon Dates from Excavation Block at 41PT185/C.

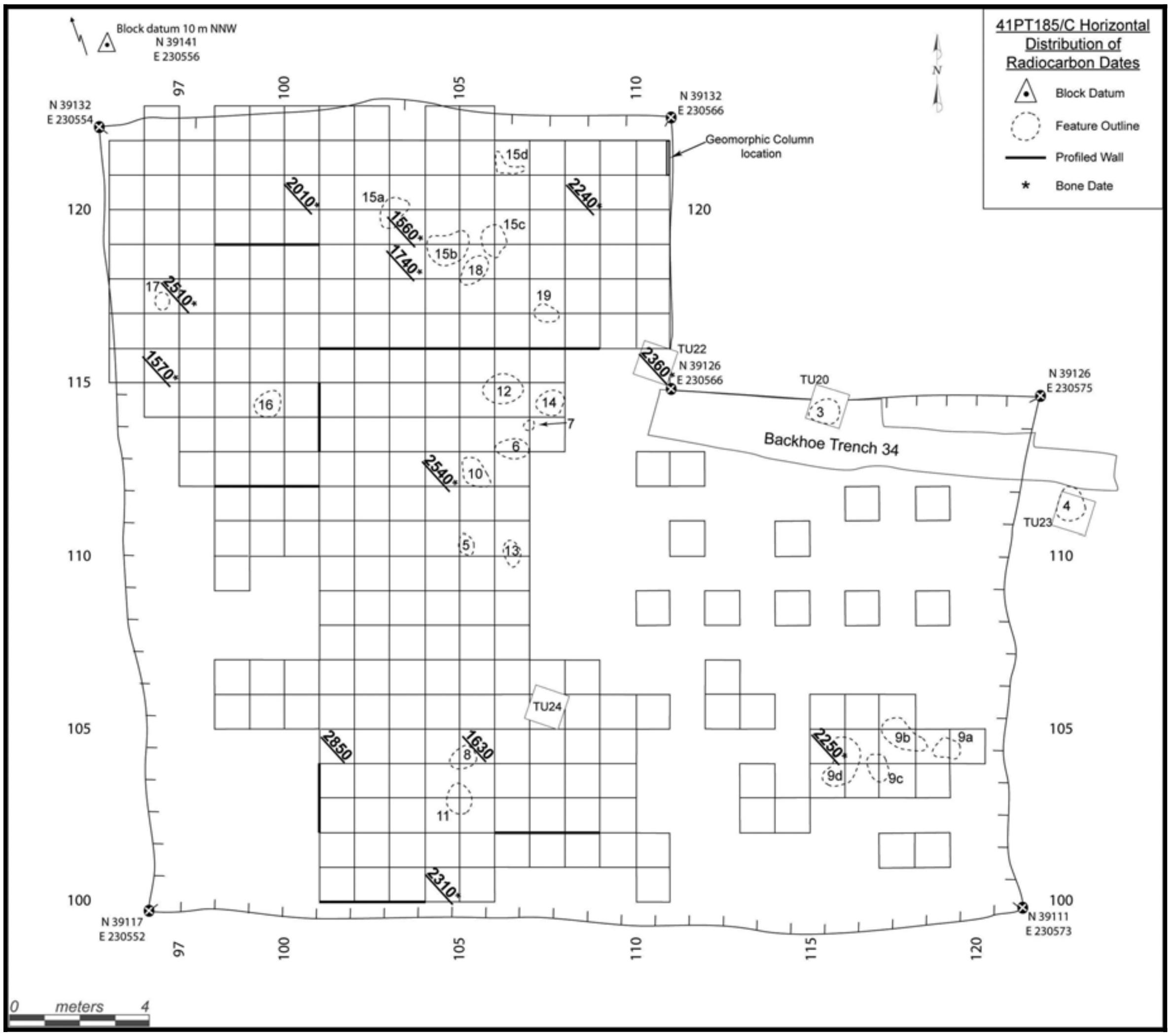


Figure 8-158. Horizontal Distribution of Radiocarbon Dates within Excavation Block. (Dates are all B.P.)

What archeological complex is represented by this Late Archaic component?

The cultural affiliation of this component is defined on the basis of associated “diagnostic” tool forms, specifically, the projectile points. Two slightly different corner-notched point styles are represented. One is a broad corner-notched style ($N = 9$) that approaches a stemmed form, whereas two points exhibit much narrower corner-notches and shorter stem (Figures 8-159 and 8-160). Both styles were the recovered from this Late Archaic component. Unfortunately, most points have proveniences only to resolution of 10 cm levels within widely dispersed units. The general vertical and horizontal proveniences of these few points reveal no clear clustering or vertical separation between the two slightly different styles.

No recognizable or obvious association of one style was detected with either of the two recognized and dated occupations. The vertical unevenness observed in the living surfaces/zones, their close vertical proximity

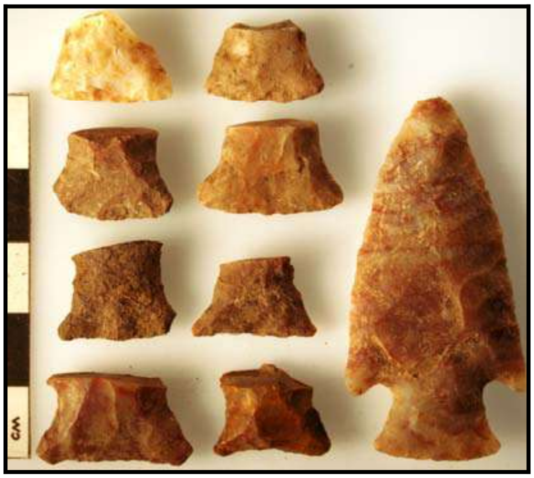


Figure 8-159. Corner-Notched Dart Points Bases on Left and Complete Point on Right that Show Broad Open Notches.

(Note: pieces left unwashed for possible future residue analyses)

Figure 8-160. Two Corner-Notched Projectile Points (#635-010 and #1104-010) that Show Narrow Corner-Notches with More Expanding Stems than the Majority of Bases above.

with one another, observed turbation, combined with the detected vertical displacement of some objects, hinders any clear chronological assignment or separation of these two projectile point styles. Currently, the more stemmed forms dominate, with the two narrow corner-notched forms mixed in without obvious indications that they came from one of the identified occupations.

In 1997 Boyd (1997) "reassessed" the Late Archaic period (ca. 4000 to 1450 B.P.) for the southern Panhandle Plains region in Texas. He presented two assumptions. One is that all the broad bladed, corner- to side-notched, straight- to expanding-stemmed dart points that reveal considerable stylistic variability represent approximately contemporaneous styles. Second, is that the specific point type names for Late Archaic points are useful for characterizing the morphology of particular specimens. He also believes these types reflect a single cultural tradition. Boyd goes on to lump all the broad-bladed corner- to side-notched, straight- to expanding-stemmed dart points from this region and western Oklahoma into a "redefined" Little Sunday complex after the Little Sunday site that J. Hughes (1955) labeled as the type site for the Little Sunday complex. As Boyd (1997) redefined this complex, it now contains all the various styles of broad-bladed dart points, which include at least the diverse styles that are similar or like at least nine Late Archaic types referenced in central Texas and labeled as; Ellis, Marcos, Castroville, Palmillas, Williams, Ellis, Trinity, Ensor, and many more named and unnamed styles. These types have come from diverse surface and excavated context, but have not been studied in detail. Therefore, the currently unnamed corner-notched points from 41PT185/C are considered part of the Little Sunday complex as defined by Boyd (1997).

How are these projectile points related to the regional manifestations of the Late Archaic? Is this component

contemporaneous with other Late Archaic complexes in the region?

Clearly these two slightly different corner-notched point styles collectively reflect what is currently known and thought of as the general style of Late Archaic point type in the Southern Plains. The lack of large assemblages of Late Archaic dart points from good context at any one of the few excavated and reported sites has hindered research into the possible separation of various Late Archaic styles into recognizable groups and/or more specific and/or narrower time periods. Late Archaic points from this region have yet to be sorted into discrete, formal typological groupings. With the lack of specific point names or types for this panhandle region, researchers often apply the term "like" to a previously named point from outside the region, which looks similar to what they recover from the panhandle region.

Close examination of shape and size of the corner-notch differences in points recovered from any one site and across the region shows considerable variation (see Cultural Background in Chapter 3). In most instances, notches were initiated from the corner of the base or slightly up the side from the corner. These variations have been assigned to the Late Archaic period across the Southern Plains. The dominant form recovered here, the broad corner-notched that creates a longer more stemmed form, has not been identified from any of the known assemblages thus far reviewed. Currently, with the lack of excavated Late Archaic sites and the limited projectile assemblages from most Late Archaic sites, it is not clear if this is a site specific style, a regional style, and just part of the broad range of corner-notched points for this period. It is not presently known if the minor variations in form reflect the idiosyncratic behavior of individual craftsmen, or different cultural patterns within a region.

The 14 radiocarbon dates obtained from this site component contribute to understanding the age range for this specific, longer stemmed corner-notched dart point group and the broader corner-notched styles in general recovered from the longer Late Archaic period. The vertical association is not sufficiently clear to state with confidence which of the two different styles represented here were associated with which of the two dated occupations. No specific type names have been assigned to these few Late Archaic points, which are only classified on the basis of corner-notching of the base. In his work Boyd (1997) cites six bison kill/processing sites that yielded 16 radiocarbon dates, plus 12 campsites that yielded 40 radiocarbon dates as his foundation to establish a general age range for the Little Sunday complex as occurring between ca. 4000 and 1450 B.P. The dart points from 41PT185/C fall within this currently defined age range for the Little Sunday complex, and one of the few sites with a well dated and documented occupation prior to 2000 B.P., at ca 2400 B.P.

Subsistence and Resource Variability Issues and Discussions

Is bison the sole contributor to the diet or did these Late Archaic peoples subsist on a range of animals and plants? Most researchers believe that the Late Archaic populations were hunter-gatherers. However, plant food resources have been extremely difficult to find and/or identify. Are plant food residues evident in and/or around burned rock features? Did the plant and animal food resources exploited represent a nutritionally complete resource base, or merely reflect supplemental resources used during specific seasons or during stress periods? How were prehistoric groups extracting and processing raw subsistence materials for consumption? These questions are addressed below.

Animal bones were well represented across the excavation block, but not in overwhelming numbers (*N* = 5,337). The recovered faunal assemblage exhibits post depositional preservation problems (i.e., root etching, weathered surfaces, and calcium carbonate coatings), but the bone was still moderately well preserved, and larger pieces are identifiable. The assemblage is nearly all represented by identifiable bison bones or thick wall chunks that undoubtedly represent fragmented bison bones. A few other animals are represented as well, including deer, dog, prairie dog, turtle, pocket gopher, and mink, but by only a few elements each. With the exception of deer and dog, the others are probably natural background species that were not actual food resources targeted by the human inhabitants. The dominance of bison bones indicates that bison was the predominant meat resource. Bison are represented by a minimum of 13 animals, including three mature males, six mature females, three immature animals, and one new born. If the four aged bison teeth and the four fragmented mandibles, combined with the fusion rate of the long bones can be relied upon as accurate indicators of the season of death, then the component represents fall occupations.

The 13 bison represented had a minimum total live weight of about 6,575 kg (Table 8-18). This calculation is based on their approximate ages identified by the fused and unfused elements recovered, the determined sex of most animals, with projected weight based on a modern female animal weighed in the fall (Emerson 1990:31-32). If the minimal hide weight (354 kg), minimal head and shank weight (480 kg), plus the minimal bone weight (754 kg) are subtracted from the minimal total animal weight, the total weight of consumable products (meat, organs, marrow, and grease) is 4,987 kg. The bison head has very limited meat (Emerson 1990) and is quite heavy; therefore the head is often left at the kill location. This Late Archaic component generally lacks skull parts, with the exception of the one skull assigned Feature 17 that was at the very bottom of the cultural zone and likely associated with the earliest occupation. The near absence of skull parts, with the exception of a few fragmented mandibles and tooth fragments, indicates that the heavy skulls never made it back to camp. Thus, whatever meat was on the skull is not taken into account for consumption.

These bison would have been gaining weight for the winter ahead following the summer rut. Fall is the time of year that bison would have been in their optimal condition (Ewers 1958; Roe 1970; and Wissler 1910). The MNI of 13 would have provided significant amounts of meat, fat, and protein (see Table 8-18). Adult males are generally larger than adult females and would have provided more meat per animal. Males generally surpass females in live weight between 2.5 and 3.5 years-old. Therefore, males potentially were targeted first, if meat was the sole targeted resource. The animals' condition directly affects fat levels in the carcass. The animals should have higher levels of fat during the fall than in other seasons, assuming they were not subjected to nutritional stress (Emerson 1990:332). Three principal fat deposits are recognized in bison. One is the outer layer beneath the skin. The second is the intermuscular fat. The third is in the body cavity. The tongue and heart have particular high fat content and outrank all other carcass units in fat content (Table 8-19; Emerson 1990:499). The ribs and thoracic vertebrae are the best sources of intermuscular fat. These carcass units would have been valuable regardless the sex of the animal. In general, the axial skeleton provides the majority of meat in a bison carcass followed by the hind limbs and then the fore limbs. Again, if meat was the principal target, the carcass parts with the most meat were potentially targeted before other parts of the animal.

Table 8-18. Total Bison Weights and Body Parts Calculated for Projected Animals Recovered from 41PT185/C.

	Males 7.	Females	New Born 8.	Assumed Females	Totals
Average fall weight per animal (kg)	700	495	20	495	
Minimum number of animals	3	6	1	3	13
Total Class (sex) weight (kg)	2100	2970	20	1485	6575
Hide weight (kg) 1.	88.2	176.4	1.2	88.2	354
Organ Weight (kg) 2.	429	858	0.3	429	1716.3
Head and Shank weight (kg) 3.	120	240	0.1	120	480.1
Marrow weight (g) 4.	2934	5868	0.7	2934	11737
Bone grease weight (g) 5.	4017	8034	1	4017	16069
Bone weight (kg) 6.	234.6	344.5	2.3	172.3	753.7

1. Average hide weight per individual is 29.4 kg (Emerson 1990:31).
2. Average organ weight per individual is 143 kg (Emerson 1990:31)
3. Average weight per individual is 40 kg (Emerson 1990:31)
4. Average marrow weight per individual is 978 g (Emerson 1990:272)
5. Average weight per individual is 1339 g (Emerson 1990:272)
6. Bone weight is 11.6 percent of the carcass or 57.4 kg per animal (Emerson 1990272)
7. Estimated weight based on average data from Halloran (1961)
8. Percentage for various parts same as percentage used for females.

Table 8-20 shows the type and frequency of the identified elements recovered from this Late Archaic component, and then the types and weights of food resources (meat, marrow, grease) that the various elements provide. To this is added the amount of protein and percent fat for elements, in order to indicate the contributions that various elements made towards the prehistoric diet. The lack of meat, marrow, and grease in the skull provides a good indication as to why transporting the head back to the camp made little sense. Few axial skeleton parts were identified in the assemblage even though the axial skeleton provides a significant quantity of meat. The desire for bone grease contained within those elements that constitute the axial skeleton would have resulted in fragmentation of those elements, potentially creating unrecognizable fragments.

Assessing the entire animal carcass for potential food, the most meat would have been derived from the axial part (60 percent), followed by the hind limb (27 percent), then the fore-limb (13 percent).

Table 8-19. Bison Organ Food Value Characteristics.

Bison Organ	Weight (g)	Percent of Carcass	Percent of Fat	Protein (g)
Heart	2,863	0.9	10.3	465
Liver	7626	2.5	7.4	1770
Kidney	556	0.2	5.4	102
Tongue	1680	0.5	18.7	287
Total	12,725	4.1	41.8	2624

The hind limb provides twice the amount of meat as the fore limb, indicating it had greater meat value. By element, the highest percentage of meat and protein would have been on the femur (23 percent), ribs (15 percent), and the cervical vertebrae (13 percent). The internal organs (i.e., heart, liver, kidney, and tongue) of bison provide excellent sources of fat and protein (see Table 8-19). These few organs account for only 4.1 percent of the total carcass weight, but a substantial percent (41.8 percent) of group of organs would certainly help offset the carcass fat. The consumption of this leanness of muscle meat, which likely accounts for why the heart and tongue were so highly favored ethnohistorically.

Bison meat was an excellent source of protein, which is essential for human health. Bison meat and products are rich in iron and zinc, various vitamins including B6 and B12, phosphorus, niacin, and contain all the essential amino acids. It was the fat component of the bones that provided the best source of fat and calories, muscle meat was quite lean. From the faunal assemblage recovered it appears that meat, marrow, and bone grease were all targeted at this component. All these parts contributed in different ways to the general health of the human population.

After the meat and tissues were stripped from the bones, the fresh bones themselves were very valuable as they contained both bone marrow and bone grease. Not only was bison meat targeted by these occupants, but the bone marrow inside the major long bones and in the epiphyses of the bones was also targeted. The ethnographic and ethnohistoric literature indicates that the Plains Indians engaged in bone processing activities (Wilson 1914, 1934; Turney-High 1937; Schoolcraft 1851-57; Flannery 1953). However, these references provide few details as to the process or what tools were involved. Tool impact marks on many of the long bone shafts, combined with burned and fractured medial sections of a few articular ends of metapodials, and the fact that only nine percent elements were whole, indicates that nearly all bison elements were broken open to extract the marrow.

Binford (1978) distinguishes bone marrow found in the medullary cavities of the limbs from bone grease in the cancellous tissues of the proximal and distal ends. He uses the term “white grease” to refer to grease from the cancellous tissue of the long bones and the term “yellow grease” to refer to the grease from the cancellous of the axial skeleton. Physiologists refer to the axial skeleton grease as red marrow and all other as bone marrow (Tavassoli and Yoffey 1983). Red marrow is mobile as is the fat outside the bone, and therefore subject to greater fluctuations in quantity depending on the health of the animal (Emerson 1990:217). Binford (1978) used the different terms to account for differences in how marrow and bone grease were extracted and used by the Nunamiut peoples. He sees a quality difference between the two fat types, which is a difference in the fatty acid composition, specifically oleic acid that has a low melting point. This fatty acid affected how the fat was used by the Nunamiut.

The amount of marrow in the medullary cavities of the limb elements is directly related to the size of the marrow cavity. The marrow in the cavity is resistant to mobilization (Emerson 1990:217). The marrow in the bones has higher proportions of the oleic acid, a mono unsaturated fatty acid (Binford 1978). An adult female bison killed in the fall would yield about 450 g of marrow fat with over 70 percent from the humerus, femur, and tibia (Emerson 1990:219). These three elements would be the primary or first three bones targeted if bone marrow was sought. The scapula and the phalanges both have less than 5.0 g of marrow and would be the least desired for marrow and therefore, the least likely to be smashed for the extraction of bone grease.

Bone grease is found throughout the skeleton without regard to animal age or size, but females yield more bone grease than males. Bone grease accounts for about 0.48 percent of the carcass weight (Emerson 1990:272). The white grease is found in the cancellous tissue of the appendicular skeleton, whereas the yellow grease is found in the axial skeleton. The highest percentage of white grease is found in the ribs, sacrum, pelvis, and thoracic vertebrae. Two elements are atypical as the sacrum

Table 8-20. List of Bison Bone Elements, MAU, Meat, Marrow, Grease, Protein and Fat from 41PT185/C.

Element/Fragments	NISP* Total	MAU**	MAU Ratio***	Meat Weight (kg)	Bone Marrow**** (g)	Bone Grease**** (g)	Protein and Ash (g)****	Percent Fat
SKULL =	**58**			1.4			301	4.8
Skull	**3**	1	14.3					
Maxilla								
Mandible	**10**	4	57					
Hyoid								
Incisor								
Tooth	**45**	2	28.6					
VERTEBRAE + PELVIS =	**60**							
Atlas	**2**	2	28.6	12.9			2730	4
Axis								
Cervical	**6**	1	14.3			15		
Thoracic	**10**	1	14.3	8.7		34.6	1834	6.9
Lumbar	**4**	1	14.3	8.9		24.1	1855	4.8
Caudal	**2**	1	14.3	0.1		4.7		
Rib (heads, shafts)	**29**	1	14.3	14.9		90	3145	5.4
Sternum						9.9	1352	6
Sacrum				6.7		43	1356	3.4
Pelvis (Ischium, Ilium)	**3**	1	14.3		7.4	46		
Acetabulum	**4**	1	14.3					
FRONT LEG =	**69**							
Scapula	**7**	2	28.6	6	0	21	1278	4.1
Humerus	**9**	2	28.6	5.4	116	117	1215	2
Radius	**14**	4	57	1.8	72	62	430	0.4
Ulna	**11**	4	57		12			
Unciform	**4**	3	42.9					
Scaphoid	**3**	2	28.6					
Cuneiform								
Lunate	**2**	2	28.6					
Metacarpal	**19**	7	100	0	28	3.4		
REAR LEG =	**60**							
Femur	**11**	3	42.9	23.2	136	129	5293	1.7
Patella	**1**	1	14.3			4.5		
Tibia	**13**	3	42.9	3.5	145	48	776	1.8
Lateral Malleolus	**1**	1	14.3	0.001				
Astragalus	**7**	4	57			5.9		
Navicular Cuboid	**6**	3	42.9			3.7		
Calcanium	**7**	3	42.9			12		
Magnum	**3**	2	28.6					
Metatarsal	**11**	3	42.9	0.02	38	24	3	3.7
OTHER =	**112**							
1st Phalanx	**19**	3	42.9	0	8	57		
2nd Phalanx	**12**	1	14.3					
3rd Phalanx	**8**	1	14.3					
Long Bone fragments	**41**	1	14.3					
Cancellous	**3**	1	14.3					
Unknown fragments	**11**	1	14.3					
Sesamoids	**13**	1	14.3					
Metapodial	**5**	1	14.3					
TOTAL	**359**							

* number of identified specimens. **Minimum number of units.
*** MAU Ratio = rank acording to the most frequent element. **** Fall adult female used after Emerson (1990).

yields more white grease and the scapula is more productive of the yellow grease (Emerson 1990:372). The most productive elements for white grease are the distal femur and radius and the proximal femur, humerus, and tibia (Emerson 1990:407), and thus these latter elements would have been targeted first for bone grease extraction. These elements are represented in this assemblage by only a few more or less complete proximal and distal ends. The ends of femur, humerus, and tibia are not as frequently represented as the metacarpals and metatarsal, which yield limited bone grease.

The bones of an adult female bison killed in the fall would yield at least 511 g of white grease (Emerson 1990:219). And similar to the bone marrow, about 57 percent of the white grease comes from three bones; the humerus, femur, and tibia. These three elements would have been the first elements selected for grease extraction, if indeed a selection process was used. The animal's health/condition would have affected the amount of bone grease present, as this fat is mobile (Emerson 1990:276).

The extraction of bone grease at this component is evidenced by the fact that most elements were intensively processed with 58 percent of all bones recovered being fragments less than 3 cm long and 78 percent being less than 6 cm long. These small fragments reflect intensive processing of the bone following meat and marrow extraction, which do not require such a high degree of bone fragmentation. The principal target of this smashing processing was grease contained within the bone. Based on ethnographic references, bone grease processing appears to have been the only reason to have smashed the bones into small splinters.

Leechman (1951:335-356) describes ethnographic accounts which discuss bone grease extraction and provides personal observations of comminuted bone in archeological sites. He describes the bones as having been smashed into fingernail size pieces then boiled/simmered with water in a pot. When heated the grease rose to the top, it was skimmed off and placed in a separate container, usually an animal stomach, for later consumption. The Plains Cree performed similar procedures in the 1860s and 1870s as described by Mandelbaum (1940:193)

> Large bones were split open and pounded with a maul. The crushed splinters were placed in boiling water; the grease rose to the surface [and] was skimmed off with shell spoons and stored in buffalo pouches. It was called oskanpimi (bone grease) (cited in Dyck 1977:264).

Another reference to grease extraction is found in the historic literature of the Mandan Indians. In June, 1811 it was observed that "Very little of the buffaleo (sic) is lost, for after taking the marrow, they pound the bones, boil them, and extract the oil." (Brackenridge 1904:137). How the extracted grease was used is not well documented in the ethnographic literature.

Historically, the extracted bone grease has been used for the production of pemmican in the Yukon, used as a butter, and also could have been added to other foods as a seasoning (Leechman 1951:355; Vehik 1977:171). Most skeletal elements have been cited as having been used for bone grease production. These include at least the vertebra, ribs, legs, ilium, ischium, pubis, scapula, and foot bones (Dorsey 1884; Jenness 1922; Wilson 1924; Bonnichsen 1973). Leechman (1951) indicates that this processing of bone grease was not limited to any particular season. If all elements were potentially useful for bone grease extraction, then their absence from this assemblage could indicate they were used in this manner.

Binford (1978:159) also describes debris that results from bone grease processing:

> The archaeological remains of such an operation are unmistakable. There is a large pile of pulverized bone approaching the appearance of bone meal. This is generally a dump to one side of a substantial hearth containing large quantities of ash.

The archeological features (bone dumps of tiny slivers of bone or intensively used hearths) that might be indicative of long heating episodes for the extraction of bone grease as Binford (1978) mentions were not visible or at least were not identified in this Late Archaic component. Nor were formal processing tools such as stone mauls identified among in the recovered artifacts, although small stone hammers potentially functioned for this purpose. Anvil stones upon which bones may have been were potentially smashed were present. Some four or five unmodified rocks 20 to 30 cm in diameter were recorded in the field and identified as manuports; potentially, these stones served in this capacity. These manuports reveal no sign of formal alterations or impact scars, and thus have no recognizable function. Bonnichsen (1973:11) also mentioned that logs may have served as supports upon which to break bones.

Given the differences between white and yellow grease discussed above, it is possible that the axial elements that contained yellow grease, were not processed as intensively as the appendicular skeletal elements that contained white grease. The overall lack of identifiable elements from this component reflects no detectable preference by the humans for avoiding any particular element or part of the carcass. The occupants extensively processed most elements brought back to this camp. The bones least processed/smashed are elements that are low in bone grease. Given the extensive smashing of most the bones from all carcasses, without significant attention to the type of grease or the amount of grease in a particular element, the occupants must have been extracting as much bone grease as possible. The intensive smashing also masks any particular human selection process for extraction of marrow in the previous step, if in fact there was a selection process.

The bone grease extraction process does not place the fragments in direct contact with the fire, and in fact, most small fragments were not burned. Only about 15 percent of the identified bison bones from this component were burned. The light brown discoloration from exposure to heat observed on some medial bone sections was likely related to the bone marrow extraction process. Speth (2004) suggests the pattern of partial and patchy charring most likely resulted form activities such as roasting, baking, and heating marrow bones. These potential heating processes contrast with the direct discard or disposal of bones directly into an open fire where intensive burning would have occurred.

Evidence of bone grease extraction is not uncommon at archeological sites in this region where bison remains have commonly been recovered. Other Texas Panhandle sites such as the Late Prehistoric Broken Jaw site (41HF8) and Late Archaic Sanders site (41HF128) exhibit bone grease production during late winter to spring occupations (Quigg et al. 1993; Quigg 1977, 1978).

The bison meat, marrow, and bone grease have long disappeared from this component. No direct evidence is available as to how the meat was prepared, in what form the meat was consumed, or how the unconsumed meat might have been transported from this site. It is assumed that, following consumption of as much fresh meat as the inhabitants wanted or needed, the remainder of the meat was transported from this site. The newly acquired meat was potentially dried, jerked, boiled, and/or used in making pemmican (a high calorie storable food that was prepared for long term storage and use). Spencer and Jennings (1964:358), in discussing the Teton and other Plains tribes, state that … "meat had to serve as food for many months to come" ... and there was a need to preserve the meat. The meat was cut into thin strips and hung on poles to dry, "some dried meat was pounded with dried berries and tallow to form the concentrated pemmican". Driver (1972:93), in describing natives in the Plains and in parts of the neighboring areas, states that:

> the dried meat was first softened by holding over a fire, then pulverized, mixed with berry or fruit paste to give it the desired taste and texture. The whole mess was then packed in a folded rawhide container called a parflech.

This generally describes the basic process of making pemmican that can be easily stored and transported. These two principal processes, jerking or making pemmican, were the two primary means of preserving meat for future consumption. Dried meat weighs considerably less than fresh meat and is, therefore, easier to transport.

Preservation of botanical resources was poor within this Late Archaic component. Even charcoal from fires was almost nonexistent. The macrobotanical analysis of the flotation remains from feature contents did not identify any carbonized plant resources (i.e., nuts and seeds) other than wood charcoal (Appendix N). If seeds, nuts, or other plant resources were used during the occupation(s) of this component, poor preservation limited their recovery.

Two types of analysis targeted burned rocks to extract organic residues to identify plant and animal resources that might have been cooked for food. The chemical approach involved lipid residues/fatty acids that might be preserved in the pores of the burned rocks. A total of 45 burned rocks and four metate fragments from this Late Archaic component were submitted and analyzed for their fatty acid contents. The positive and interpretable results indicate that 36.8 percent of the burned rocks came in contact with high- to very-high-fat content plant seeds or nuts. Another 39.5 percent yielded high- to very-high-fat content plant (seeds or nuts) with a trace of animal products. Minimally, five samples (13.2 percent) yielded a combination of large herbivore fatty meat and plants, three other samples (7.9 percent) that yielded combinations of plant and animal, and one sample (2.6 percent) with ambiguous results (Appendix G). The large herbivore (potentially deer, antelope, and bison) and plant residues were identified from at least six cultural features (Features 9b, 9c, 11, 12, 13, and 15b). Cholesterol, the lipid biomarker of animal products, was present in almost half (45 percent) of the identified residues.

In this case, the large herbivore represented in the fatty acids is most likely bison, as bison elements dominate the identified faunal bone assemblage. In the few instances in which large herbivore animal products were not identified, and only animal products are represented, the animal products may be the residues from bone grease or marrow, or possibly small game animals.

Starch grain analysis was also conducted on fragments of the exact same 41 burned rocks analyzed for their fatty acids. Fourteen burned rocks (34 percent) yielded lenticular starch grains, nine (22 percent) yielded damaged starch grains from processing the natural grains, and 13 (31.7 percent) yielded gelatinized starch grains. The gelatinization was created by exposure to heat and water. The lenticular starch grains were identified as Canadian wildrye (*Elymus canadensis*) grass of the subfamily Pooidae of the tribes of Bromeae and Triticeae (Figure 8-161). Damaged starch grains occurred during grinding or pounding of the plants.

Figure 8-161. Modern Canadian Wildrye (*Elymus canadensis*) Seeds and Seed Head (scale in cm).

In addition to these specifically identified starch grains on burned rocks, at least yielded a few starch grains of other unidentifiable grass species. Form the burned rocks, the starch grain analysis documented overwhelmingly that Canadian wildrye (*Elymus canadensis*) was cooked by the burned rocks analyzed. In support of the starch grains being a food resource, the analysis of three sediment samples from directly under three burned rocks in Features 8 (#1341-004-1b), 10 (#801-004-2b), and 18 (#1129-004-1b) yielded no starch grains whatsoever. Therefore, the starch grains recovered from the burned rocks did not come from the natural sediments. Thus, Canadian wildrye starch grains are considered part of the targeted food resources processed and cooked by the inhabitants.

Further support for the human use and physical processing of Canadian wildrye grass seeds as a food resource came from starch grain analysis of eight metate fragments. All eight pieces yielded lenticular grains, six (75 percent) pieces yielded damaged grains indicative of having been processed in some way (i.e., grinding), and two (25 percent) yielded gelatinized grains that had been exposed to heat and water. These lenticular starch grains were again identified as Canadian wildrye.

In addition to the identified Canadian wildrye grains, six (75 percent) metate fragments also yielded other unidentified grass grains (Appendix F). The ground stone results are further supplemented by data recovered from four chipped stone tools analyzed for starch grains. Two (50 percent) chipped stone tools; a small cobble chopper (#467-010) and a large side scraper (#1221-011) also yielded 19 and 2 lenticular starch grains respectively, and the starch grains again represent Canadian wildrye (*Elymus canadensis*) grass. The chopper also yielded damaged grains from processing starchy seeds.

The tools employed for processing the grass seeds are thus documented. After the large wildrye seed heads were collected, most likely by hand and placed in baskets, the seeds were potentially scraped from the seed heads by the scraper (#1221-011), pounded by the chopper (#467-010), ground on the metates using manos, then cooked with heat and water through the use of hot rocks. The cooking is postulated to have been through a stone boiling technique. Support for this particular cooking process comes from three burned rocks analyzed by fourier transform infrared spectroscopy (#899-003-5, #901-003-2, and #1337-003-2), which documented absorbed water in all three pieces (Appendix R).

Many researchers have assumed that grass seeds were part of the wide range of plant resources used throughout the Archaic period (i.e., Carmichael 1986:213; Jennings 1964:150; Irwin-Williams 1979; Matson 1991). However, direct archeological evidence for seed consumption is extremely limited. Grasses were used historically and prehistorically as bedding, basketry, rappings, mats, in structures, etc. (i.e., Shafer 1988; Turpin 1998). (Note: Turpin 1998 presents good descriptions of several grass features from a rock shelter with a few grass features radiocarbon dated to the Late Archaic. These kinds of finds are not preserved in open air campsites). Consequently, small amounts of charred grass seeds may have been incorporated into the sediments at archeological sites without actually having been targeted as food resources.

Carbonized grass seeds are not often reported in macrobotanical analyses in the archeological literature across the Plains region (see Wandsnider 1996 for review of the ethnographic literature). One of the few archeological sites reported to contain carbonized grass seeds is the Barton Gulch site (24MA171) in western Montana, just west of the Plains proper. There, seeds of at least seven grass taxa, including red threeawn (*Artistida* sp.), sideoats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), fescue (*Festuca* sp.), little barley (*Hordeum pusillum*), scribner witchgrass (*Panicum* sp.), and needlegrass (*Stipa viridula*), were recovered in small quantities. Also found there was a host of other plant taxa (a total of 27 taxa represented by some 2,050 seeds), all within a Paleoindian component radiocarbon dated to ca. 9400 B.P. (Aaberg 1992; Armstong 1993). These few grass seeds where recovered from basin shaped pit features, which provide some of the best context that can be expected in an archeological site.

Loendorf (1985) found wildrye grass (*Elymus* sp.) growing in association with archeological cave sites in the Pryor Mountains – Big Horn Canyon area of southcentral Montana. Nearly 75 percent of the 35 caves recorded were observed to have wildrye growing next to them. The caves were not excavated, but some have archeological deposits in them. Loendorf provides several possible explanations for this association, but no hard evidence to directly link the wildrye with cultural occupations.

Just beyond the southwestern edge of the Plains, in the lower Pecos River valley of southwestern Texas, 38 analyzed human coprolites dated to ca. 1050 B.P. (A.D. 900) from Baker Cave yielded no grass seeds (Sobolik 1991). Two coprolites yielded unidentified seeds and at least one sample is most likely grass. The few possible grass seeds present may have come from animal or bird sources eaten by the humans, and thus, would not represent a targeted food resource. The wide range of coprolite studies in the lower Pecos area that represent last 8,400 years (i.e., Riskind 1970; Bryant 1974; Williams-Dean 1978; Stock 1983; Reinhard et al. 1991) have all found grass pollen and seeds, but in very low frequencies. Most often the grass seeds have been interpreted as accidental ingestants (Williams-Dean 1978; Sobolik 1991).

Ethnographic accounts of Plains Indians gathering and/or eating grass seeds are also very limited (i.e., Yanovsky 1936; Lowie 1954; Morton 1963; D. Jones 1972; Muir 1979; Brown 1986). Beyond the Plains region, more references concerning grass seed gathering and processing are available (i.e., Castetter and Bell 1951; DeQuille 1963; Allen 1974; Muir 1979; Doebley 1984). These and other references document women gathering grass seeds in baskets. These accounts also indicate that grass seeds were important and were targeted by some prehistoric populations for use as food. In southeastern Australia, Allen (1974) documented the storage and processing of grass seeds (principally Panicum grass and *Portulaca* seeds). He made only one reference of grass being cut with a stone knife, whereas most often grass was pulled up, or the seeds were pulled from the heads. Some seeds were stored in grass bundles coated with mud and others in skin bags. Processing seeds included grinding on large flat stones with water, with the resulting dough eaten raw or cooked in the ashes of a fire (Allen 1974:315). Women were said to carry the grinding stones from camp to camp during the harvest season, and then to leave them at a favorite camping spot at the end of the harvest.

Limited information is available concerning the processing of grass seeds. Doebley (1984), in discussing the use of dropseed (*Sporobolus airoides* [Torrey]), among the

Southwest Indians, states that seeds were ground and mixed with corn meal and water to make a mush, boiled and eaten as porridge, or ground into a flour to make bread. These same processes would be the same for wildrye seed.

The use of Canadian wildrye (*Elymus canadensis*) by Native Americans has been reported in the literature (i.e., Chamberlin 1911; Steward 1933; Yanovsky 1936; Morton 1963; D. Jones 1972; Muir 1979; Brown 1986; Kindscher 1987). In 1869 Muir made a firsthand observation of Indians in the Mono Desert in the Sierra high country of California:

> [Muir] came to a patch of Elymus, or wildrye, growing in magnificent varying clumps six to eight feet high, bearing heads six to eight inches long. The crop was ripe, and Indian women were gathering the grain in baskets by bending down large handfuls, beating out the seed, and fanning it in the wind. The grains are about five eighths of an inch long, dark-colored and sweet. I fancy the bread made from it must be as good as wheat bread. A fine squirrelish employment this wild grain gathering seems, and the women were evidently enjoying it, laughing and chatting and looking almost natural…

A few archeological reports beyond the Plains have reported wildrye grass use (i.e., Green and Tolmie 2004; Messner 2008). Messner (2008) reported wildrye from Woodland components in the Middle Atlantic sites, mostly in Delaware and New Jersey. Green and Tolmie (2004) reported wildrye from a Late Prehistoric component (post A.D. 1500) at Blood Run in western Iowa. At Blood Run the wildrye seeds were the third most abundant (8.5 percent or 216 seeds) small seed type, and occurred in 43 percent of the samples. The seeds were tentatively identified as slender *Leymus villosus*, which prefer shaded, understory habitats in low woodlands, and have seeds that ripen in mid to late summer.

Canadian wildrye (*Elymus canadensis*) is a cool season (C_3) perennial bunch grass, with seed heads typically 8 to 15 cm long. The plants are generally found in relatively moist areas, such as along creeks and streams. This species grows throughout the state of Texas except in the southern end of the Rio Grande Plains and is common on wooded slopes near streams and springs (Correll and Johnston 1979). At maturity, the seed head will droop, which signals that it was ready for harvesting. The upper stretches of West Amarillo Creek had ponds and marsh deposits present at the time of these occupations that would have provided a suitable environment for wildrye to grow and flourish. It is also one of the grass species present in the valley today (Philips 2000).

Gremillion (2004) and Geib and Jolie (2008) discussed various roles that small grass seeds have played in areas outside the Plains. Gremillion acknowledges that small grass seeds are often inefficient to exploit (i.e., Cane 1989; Barlow and Metcalfe 1996), but are, nonetheless, consumed and sometimes cultivated in many parts of the world. He uses ethnographic, experimental and nutritional studies of the small grains used prehistorically in eastern North America to show they yielded low returns relative to the energy and time investments required for gathering and processing. He stresses that resource stress and technological innovation are unlikely explanations for the adoptions of such low-ranking resources in the eastern United States at ca. 3500 B.P.

Geib and Jolie (2008) acknowledge that despite the low ranking of net caloric benefit relative to other foods, small seeds were of importance in the Great Basin. These authors see basketry as part of the tool kit necessary to exploit small seeds. They point out that baskets would have been useful in the winnowing and parching tasks that were fundamental components of the technology needed in exploitation of small seeds.

Matson (1991) argues that Archaic grass seed exploitation set the stage for later agriculture. Stiger (1998) also discusses the role of grass seeds in the Archaic of the Southwest, as a precursor to the introduction of agriculture. He presents a thorough discussion of the use of grass seeds in the Southwestern Archaic and the importance of grass seeds as a source of starch. However, he questions the antiquity of intensive grass seed collection, storage, and use prior to farming. Stiger acknowledges that large expanses of grass were a potential food source, but believes that preceramic populations were limited in their ability to exploit the seeds. Interestingly, in the same article Stiger cites both DeQuille (1963) and Muir (1979) and their descriptions of Natives gathering grass. He goes on to state that most archeological evidence concerning prehistoric grass seed use is open to question and cites some coprolite evidence in the western United States. The coprolite evidence he cites also reveals very low frequencies of wild grass seeds in the samples analyzed, with one exception, Dust Devil Cave in southern Utah where 97 percent of the samples yielded wild grass seeds (Van Ness 1986).

Stiger (1998) also discusses starch digestion and cooking techniques. He points out that starch is a major nutritional component of grass seed and that, however, the structure of raw starch is not digestible by humans. The grains must be disrupted and glucose formed to absorb any nutrients. Mechanical techniques such as pounding and grinding will not disrupt starch granules in the seeds. Stahl (1989:177 states that:

> Starch extraction is a common goal of soaking and is reported for a variety of plants including sago, maize, potatoes, and cassava. Exposure to water is generally preceded by pounding and grading. The pulverized mass is then added to water and filtered to separate indigestible fibrous constituents form the non fibrous carbohydrates fraction such as starch.

Stiger (1998) states that cooking is the most effective way of disrupting or changing the structure of starch grains, rendering them digestible. Moist heat has been shown to be an effective method of cooking starches (Stiger 1998:27). The gelatinization, the swelling in heated water, caused by moist heating is recognizable in archeologically recoverable starch grains. Stiger states that five percent concentrations of corn starch are completely gelatinized after boiling for one or two minutes. At temperatures of 95°C it takes only five minutes for gelatinization. He also discusses dry heat cooking, which also disrupts the granular structure of starch. However, too much heating can result in the loss nutritional value. Dry heat cooking techniques include parching, baking, and popping of starchy foods.

Nutritionally, not much is known about wild grass seeds and specifically, Canadian wildrye grass, although it is known that domesticated grasses are good sources of vitamin E. In general, the Gramineae species have very little fat, but are high in nitrogen free extracts, which consist of carbohydrates, sugars, starches, and major portions of the hemicelluloses (Schroeder et al. 1974). Coulam and Barnett (1980) compare various food values and indicate that Gramineae is moderately high in protein (11.9 to 26.9 percent), low in oil (1.6 to 3.2 percent), and contains starch. Stiger (1998) indicates that vitamin E probably played a role in grass seed acquisition as the peoples high-fat diets potentially increased the need for vitamin E (Ames 1972:313). Deficiency in vitamin E may cause abortion, male sterility, and reabsorption of the fetus (Mason and Horwitt 1972a, 1972b; Scott 1969; cited in Stiger 1998). Vitamin E, a collective name for a group of fat-soluble compounds with distinctive antioxidant activities, is recommended in human diets. This vitamin is found in green leafy vegetables, whole grains, and nuts. Vitamin E acts as an antiinflammatory, and helps with immune system enhancement. As an example, about one ounce of dry roasted sunflower seeds provides about 30 percent of the daily recommended intake of vitamin E. A healthy dose of vitamin E probably increased birth rate and contributed to the overall health of the population. Many fatty acids are found in the lipids in native seeds with extremely high levels of C18:2 isomers (Malainey 1997; Malainey et al. 1999).

Wright (1994) cites the Alyawara groups in southwest Asia as using grass seeds in a major way. She also provides a general caloric value (Kcal/kg) of 3,450 for grass seeds in general. She indicates that the processing time (hr/kg) = 6.0, the processing method was grinding, and the total return was 575 Kcal/hr.

In summary, the faunal analysis identified bison as the primary meat resource in this component. The fatty acid analysis combined with the starch grain analysis on burned rocks and other artifacts, documents the presence and intensive use of Canadian wildrye (*Elymus canadensis*) grass as a major food resource. This is one of the few instances in archeological sites older than about ca. 1000 B.P. in the Southern Plains for which the specific plant used as food has actually been demonstrated, despite the poor preservation of macrobotanical remains.

The principal plant and animals processed and consumed at this site have been identified, but the exact means of the human extraction processes for both resources is not clear. The ethnographic references indicate that women, and potentially young females, collected the grass seeds in baskets. It is assumed that the males were the principal hunters, even though we do not know how hunts were accomplished. Multiple strategies were possible, such as stalking individual animals or conducting massive kills, or killing small groups of animals. Bison kill sites are known from this Late Archaic time period in this panhandle region (D. Hughes 1977, 1989; Bement and Buehler 1994), and those identified thus far across the Southern Plains probably reflect communal efforts that involved both men and women. In most known instances, bison kills occurred in natural arroyo traps formed by steep walled erosional gullies that were used to corral or trap the bison. After corralled, the animals were killed and often initially processed in the trap, and the carcasses left (Bement and Buehler 1994).

These two principal food resources, the bison and the Canadian wildrye grass, were harvested in the fall of the year, possibly in surpluses that could be used during the relatively lean winter months. Bison herds may have been more available during the fall as 67 percent of the Late Archaic kill sites reported in the Texas Panhandle have been shown to pertain to late summer or fall. If bison were not more readily available in the fall, then that season seems to have been preferred season during which large quantities of bison meat and other bison products were a priority resource.

Settlement and Community Pattern Issues and Discussions

House structures are not known in the Late Archaic in Texas, but that does not preclude some type or presence of temporary shelters, especially in winter camps. Were living structures of any kind in use at this location? Do the small burned rock features represent any type of intrasite patterning? Do tool and artifact diversity infer a permanent year round occupation, a short term campsite, or a resource extraction locality? Does the density and type of material culture reflect group size? Do the two apparent activity areas, for animal processing and cooking, delineate aspects of social structure, and if so, what kind of social

structure? What was the duration of this occupation?

The Phase II data recovery excavations clearly documented at least two occupations in this Late Archaic component. These two occupations were minimally apparent during the excavations. Occasionally in the field and primarily towards the northern end of the block, a few burned rock features (i.e., Features 19 and 14) were slightly below (ca. 10 cm) other burned rocks features (Features 12 and 15), and radiocarbon dating indicates two Late Archaic episodes and, possibly, more. Features 3 and 4 appear on the same plane as the lower, or earliest, occupation. However, Features 3 and 4 were not directly radiocarbon dated, so their specific age is not known. The younger of the two dated occupations was generally across the northern part of the block, whereas the older occupation was primarily across the southern end of the block. Very limited direct overlap of activity areas was detected, what could be, was observed was near the middle of the block at Features 12 and 14. The sparse quantity of other cultural debris could not be traced across broad areas during excavation. Sloping of the deposits eastward towards the creek, the consistent color of the sediments in which the materials were generally encased, as well as similar camping debris, all made it impossible to separated and trace individual occupational surfaces. In short, the material remains from the two occupations were indistinguishable. As such, the cultural debris was analyzed as a single temporal and cultural unit that represents a single archeological component at this site.

This Late Archaic component represents a long term habitation site, as define by Wheat (1979:146-148). This interpretation is supported by the relatively high density of burned rock features (*N* = 20), consisting of both heating elements (hearths) and discard locations, all representing multiple, recurrent cooking events. Further support is evident by the processing of the meat, marrow, and bone grease from a minimum of 13 bison, tasks that would have probably required more than a few days. The near absence of articulated elements, skulls and vertebral units, the presence of at least three taxon, also contributes to the identification of a long term campsite, as opposed to a short term processing local. The tool diversity identified in the assemblage, which incorporates both ground and chipped stone tools representing at least 9 or 10 different functional classes, reflect diverse tasks, as would be the case at relatively long term camps. “Long term” in the context of a hunter-gatherer group means a duration of weeks, not months or years.

One potential indicator of long term habitation is house structures. However, poor preservation of most organic remains (bones being the exception), the lack of visible distinctions in the dark colored sediments (as would permit postmold identification), combined with the fact that most structures would have been removed at the time of abandonment, hinder the identification of structures. Locations of house structures were sought in distributional patterns of the burned rock features, circular voids of cultural materials, or circular concentrations of materials. The horizontal distribution of cultural materials across the excavation block does not reveal any such patterns.

The Late Archaic groups that occupied this locality were general foragers that continually moved across the landscape to take advantage of the various resources necessary for life. This part of the West Amarillo Creek valley obviously provided multiple resources (i.e., wood, water, shelter, rocks, grass seeds, and meat) necessary to fulfill immediate needs and potentially to stock up on food resources for the future. This favorable terrace setting was returned to many times during the Late Archaic period, as indicted by two occupations radiocarbon dated at 41PT185/C and other Late Archaic camps in the Landis Property. The repeated fall camping episodes in this valley reflect a seasonal cyclic pattern that coincided with the ripening of the wildrye grass seeds and the availability of the bison populations in the vicinity. It is not clear if this camp represents a number of groups that aggregated at his location. A larger aggregate of people would have facilitated the successful killing of a herd of bison, and a successful large kill would have assured quantities of meat and other products for the winter months ahead.

Exchange and Regional Interaction Patterns and Discussions

What other specific stone tool resources in addition to the dominant Alibates were exploited at this time, and where were those natural resources on the local landscape? Do these different resource localities indicate contacts with adjacent groups? If so, what does this say about patterns of regional interaction? Does the exchange of goods indicate that this population was not self sufficient during this Late Archaic period? Were group interactions conducted seasonally or year round, and were they part of a more regional interaction system?

This Late Archaic component yielded 10 pieces of obsidian, all less than 2 cm in diameter. This obsidian was imported from the mountains in northcentral New Mexico (Figure 8-162). Obsidian is an easily recognizable sign of contact and/or exchange between nomadic Plains hunter-gatherers with more sedentary Southwestern populations familiar with obsidian tool stone outcrops in the mountains. Based on their small size and limited numbers, only a few obsidian tools were resharpened at this site. These few pieces may also reflect the scarcity of obsidian items, or indicate the importance of curation of the parent obsidian tools. This conservation approach to the parent tools may reflect the importance of the obsidian tools. Specific evidence as to how obsidian arrived at this site is lacking, but down the line trading rather than direct procurement from the mountain outcrops is the most likely means by which these Plains hunter-gatherers obtained this material.

This is not the only Late Archaic site in the Southern Plains region to yield obsidian. Obsidian use is documented from at least one other site that has also yielded Late Archaic corner-notched dart points, 41BV171. The site is a dense surface scatter that sits atop a flat hill in Beaver County, Oklahoma, about 160 km north of this project (Bement and Brosowske 2001). Site 41BV171 has yielded a temporally diverse projectile point assemblage that includes several large corner-notched dart points, but no Plains Village artifacts. At least 12 exhausted obsidian cores have been recovered. The obsidian from 41BV171 was sourced to both Obsidian Cliff (N = 6 pieces) in the extreme northwestern corner of Wyoming and Valle Grande (N = 6 pieces) in northcentral New Mexico (Bement and Brosowske 2001). Thus, it is apparent that Late Archaic populations of the Southern Plains obtained obsidian from at least these two principal source areas. The absence of obsidian at the Sanders site, dated to ca. 1800 B.P., testifies to the fact that not all Late Archaic populations had access to obsidian, further suggesting that only limited quantities of this material were reaching peoples on the Southern Plains (Quigg 1997, 1998).

Lang (1978; cited in Stuart and Gauthier 1984) reports that nearly 50 percent of the Late Archaic corner-notched points just across the state line in the upper Canadian River region of northeastern New Mexico were manufactured of obsidian. Because of the relatively limited excavations at Late Archaic sites in this region, it is not clear if obsidian use was quite rare or if the sampled sites are too few to determine the true extent of obsidian use.

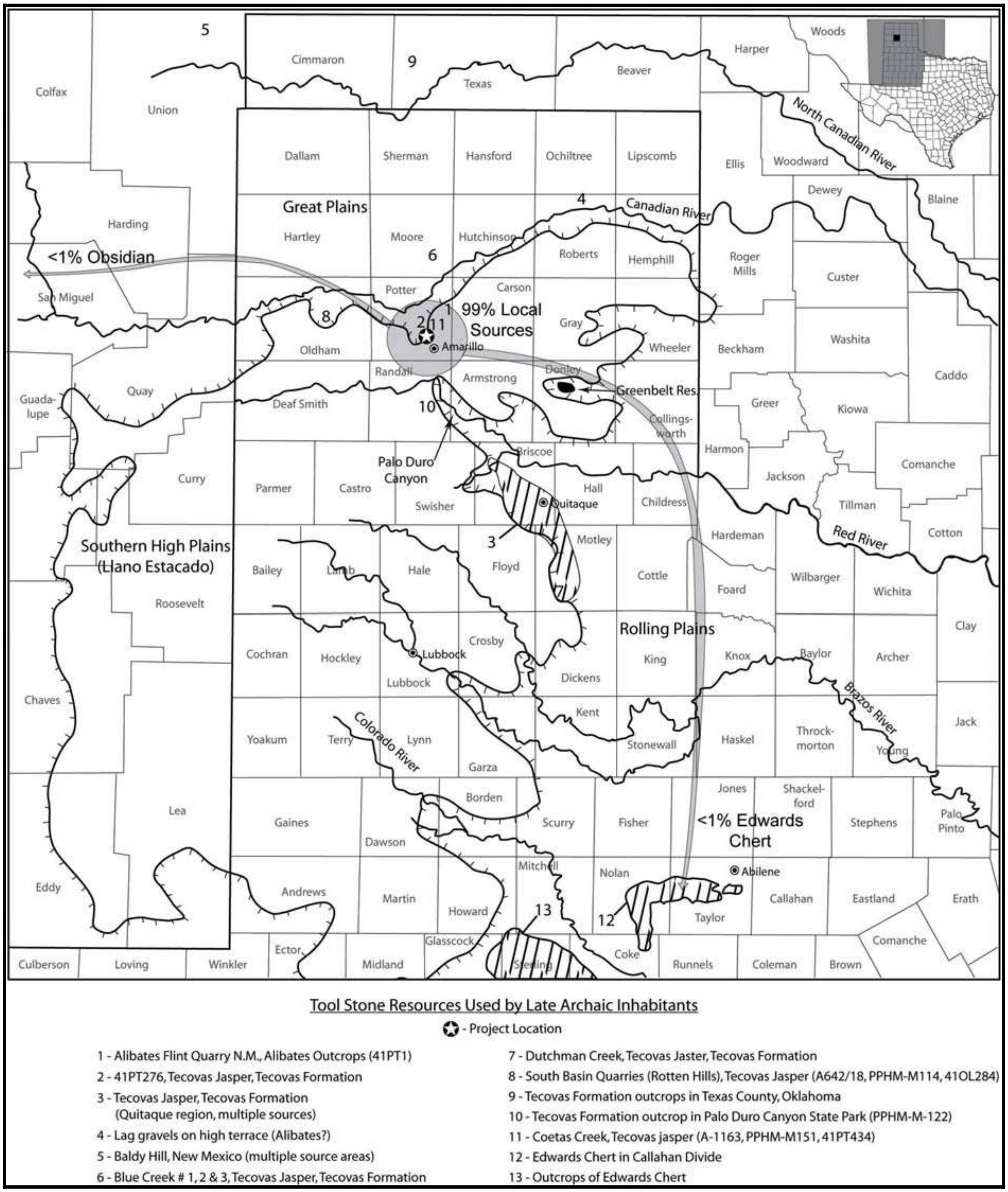


Figure 8-162. Tool Stone Resources Used by the Late Archaic Inhabitants

This is not the earliest use of the Valles Caldera source in northcentral New Mexico. The movement of exotic obsidian eastward from its outcrops had very early origins. A Clovis point (TMM 937-862) from the Plains of eastern New Mexico at Blackwater Locality #1, found in association with mammoth bones, and dating to between

11,500 and 11,000 B.P. was also sourced to the Valles Caldera (Johnson et al. 1985). The use of obsidian from this caldera, and likely other nearby sources, occurred quite early and probably persisted through the Holocene. It should not be a surprise that obsidian from northcentral New Mexico quarries was exploited early on and continued into the Late Archaic period on the Southern Plains. The occurrence of obsidian in the Texas Panhandle is direct evidence that long distance trade networks were in operation during the Late Archaic period. It is perhaps surprising that so little of this high quality tool stone is recovered on the Plains. This may reflect infrequency of contact or the lack of any pressing need, real or perceived, for this tool stone. Certainly, the Plains populations had ready access to various types of high quality tool stones, especially the Alibates found in the Southern Plains.

The more numerous excavated Late Archaic sites across southeastern Colorado apparently have not yielded any obsidian. The latest synthesis of the Arkansas River Basin in southeastern Colorado does not mention obsidian use (Zier and Kalasz 1999). This apparently contrasting distribution may reflect trade connections that were orientated east to west more than north to south. Social interactions and/or cultural boundaries may have influenced this distribution pattern, as well.

In the Northwestern Plains and Northern Rocky Mountains, the second highest use period for Obsidian Cliff obsidian occurred during the Late Archaic Pelican Lake phase, which is characterized by corner-notched dart points and dates to ca. 2700 to 1700 B.P. (Davis 1972; Davis et al. 1995). The Obsidian Cliff plateau was exploited by peoples of the Hopewell Interaction Sphere, with obsidian from that source reaching as far as the Ohio River Valley during the Middle Woodland period ca. 2950 to 1550 B.P. (Frison et al. 1968; Griffin et al. 1969; Hatchet al. 1990). This is contemporaneous with the Late Archaic occupation of the Pipeline site.

During later Plains Village/Antelope Creek period (ca. 750 to 450 B.P. [A.D. 1200 to 1500]) obsidian was obtained by trade with the Southwestern groups in northern New Mexico (Lintz 1986, 1991; Hughes 1991; Boyd 1997; Brooks 2004; Brosowske 2005). Brosowske (2005) investigated the development of the exchange between small scale societies in the Southern High Plains from 450 to 1400 B.P. (A.D. 500 to 1500). He indicates that trade started with a limited transfer of materials during the Early Ceramic period (ca. 1450 to 750 B.P. or A. D. 500 to 1200) and later the exchange increased dramatically during the Middle Ceramic period (Plains Village period, ca. 750 to 450 B.P. or A. D. 1200 to 1500). Brosowske (2005) documented extensive use of obsidian during the Plains Village period with most obsidian (ca. 80 percent) having been sourced to the Cerro Toledo area in the Jemez Mountains of northcentral New Mexico. The large quantities of obsidian at only a few Plains Village sites (i.e., Alibates Ruin 28, Odessa Yates, and Chimney Rock Ruin 51) led Brosowske (2005) to suggest that regional trade centers had emerged and that obsidian from the Jemez Mountains was one of the commodities exploited and redistributed during the Plains Village period. He believes these few communities are likely candidates for regional trade centers that participated in direct exchange with Puebloan communities (Brosowske 2005:336). Researchers recognize extensive trade in obsidian during the Plains village period in the southern Plains, but the current data from this Late Archaic component at the Pipeline site indicates that this east to west trade for obsidian started much earlier, at ca. 1500 to 2700 B.P. The amount of obsidian was not great, but its presence with this Late Archaic Plains orientated population reflects the existence of a trade network much earlier than the Late Prehistoric period.

Movement of the Cerro Toledo Rhyolite obsidian also occurred to the south. At least two pieces of this specific glass were recovered from Arenosa Shelter (41VV99) in Val Verde County of southwestern Texas along the Pecos River (Hester et al. 1991:191-198). These two pieces were recovered from Stratum 9 that radiocarbon dates to ca. 2070 to 2230 B.P. This is the same general time period as the 41PT185/C component and indicates a more extensive obsidian trading network. Hester et al. (1991) report that at least 30 other obsidian pieces have been recovered from sites in Texas, including pieces from Hutchinson and Roberts counties.

If the obsidian did not arrive by direct acquisition by these Late Archaic peoples, then who were the middle men they interacted/traded with? Answers to these and similar questions will have to await many more data recovery projects between here and the Cerro Toledo Rhyolite outcrops, followed by detailed sourcing studies.

One chipped stone tool, a relatively large (410 g) chopping tool (#627-010) is made of visually identified Edwards chert. Under ultra violet light it fluoresced a bright yellowish color (see Hofman et al. 1991), which supports the visual identification. This cobble is of very high quality chert that lacks visible flaws, cracks, or impurities. It is light olive brown (2.5Y 5/3) to grayish brown (2.5Y 5/2) in color with tiny dark gray spots. The very smooth, water rounded cortex is a yellowish brown (10YR 5/8) with a whitish (10YR 7/2) patina covering about two thirds of the unworked surface. Five pieces of lithic debitage (0.2 percent of the total) were also identified as Edwards chert. One Edwards chert flake (#1170-001) from 60 to 70 cmbs in N119 E101 is a small (2.3 g.) biface thinning flake of light olive green (5Y 6/2). This thinning flake indicates that a minimum of one other tool of made Edwards chert was present. The latter also has an amber-orange-yellow range of fluorescence to support the visual identification. Hofman et al. (1991) points out that not all is known when it comes to the fluorescence of tool stone in the Southern Plains and much more exhaustive research is needed. Currently, these few pieces are believed to be Edwards chert, from sources to the southeast. A slim possibility exists that some other chert also has a similar fluorescence.

The closest known source of Edwards chert is the Callahan Divide, some 350 km (206 miles) to the south of this project location (see Figure 8-161). It seems unusual that such a large, high quality cobble like this chopper would have been transported that far to be used only as a chopping tool and then discarded. Such high quality material could have easily served to manufacture many other tools if so desired. In this general region, large chopping tools were generally manufactured form locally available, coarse-grained materials such as Potter chert or Ogallala gravels, which are easily procured from readily accessible gravel sources in the immediate vicinity. The presence of Edwards chert in the Amarillo region of the Texas Panhandle indicates long distance trade to the southeast during the Late Archaic.

Because of the lack of large scale excavations and well reported sites that contained Late Archaic components across the Southern Plains, the broader interactions with adjacent groups are virtually unknown at this time. As discussed above, most literature dealing with regional interactions has focused on the Late Prehistoric Antelope Creek phase and Protohistoric periods (i.e., Baugh and Terrell 1982; Lintz 1986; Baugh and Nelson 1987; Baugh 1991; Spielmann 1991a, 1991b; Habicht-Mauche 1991; Brosowske 2005). Those discussions and interpretations center on the movement of obsidian and ceramic vessels from northern New Mexico across the Southern Plains. The evidence is very strong for obsidian as one of the major trade commodities. The 10 obsidian pieces from the Late Archaic component is certainly a strong indicator that the eastward movement of this prized tool stone from northcentral New Mexico was much earlier than previously demonstrated. The question arises: What products were traded in the other direction.

Two commodities found across the Southern Plains, bison products and quality tool stone, were likely exchanged for the black glass and pottery. Both are mentioned in the ethnographic and historical documents. The presence of a few flakes of Alibates from sites located in the obsidian source area in northcentral New Mexico testify to the movement of high quality tool stone (Wiseman 1992). The inferred generation of surplus meat and other bison products (e.g., pemmican), as indicted for Late Archaic occupation(s) at 41PT185/C, fit with such a scenario. As mentioned, bison products such as pemmican probably were produced at this Late Archaic component. It is not clear if this storable and easily transportable food product was for intragroup consumption throughout the winter or for trade with neighboring groups to the west, and perhaps in other directions, as well. Bison products could have been traded to the east or south, and southeast into the eastern or central Texas regions as those regions probably lacked quantities of bison during the Late Archaic. With high quality tool stone (i.e., Edwards chert) available to the southeast in central Texas, bison products probably provided a very valuable exchange commodity. This may have been linked, either directly or indirectly, to G. Hall's (1981) postulation of an import to export trading sphere in eastern and southern Texas. Currently, it is too soon to state with certainty that bison products were used for a broader trading network across the Southern Plains, but the production of apparent excess bison food resources would have provided a commodity for trading.

G. D. Hall (1981:291-309) discussed an import and export sphere during the Late Archaic period in Texas with groups to the east. One item involved in that exchange system was the corner-tang knife. After examination of extensive distributional data G. Hall (1981) suggested that the corner-tang knife as a product made locally mostly of high quality chert from central Texas sources. Detailed analyses directed at identifying the material types employed in the manufacture of corner-tang knifes has not been undertaken. G. Hall sees the corner-tang knife as a utilitarian item that was exported to adjacent groups. The export is indicated by the wide distribution of this unique artifact across most of the Plains states (Patterson 1936, 1937; Kraft 1993, 1994).

The corner-tang knife from this Late Archaic campsite at 41PT185/C was manufactured from locally available Alibates. Therefore, this knife was not imported. However, the idea or mental template for the manufacture of this distinctive tool form may have arrived with the occupants or potentially was imported to this group.

Also during the Late Archaic in Texas, artifactual evidence in the form of boatstones manufactured from lithic sources in the Ouachita Mountains in eastern Oklahoma and western Arkansas in conjunction with marine shells from the coastal regions indicates that these Late Archaic populations participated in an eastern import export trading sphere. This sphere reached into at least the eastern half of Texas, but the lack of data from the Texas Panhandle leaves some doubt as to its extension into the panhandle. At 41PT185/C, no boatstones or marine shells were recovered from the extensive block excavations. Generally, those prestigious items of high importance and/or high value are most often recovered from burial context rather than open camps. Thus, their absence from this Late Archaic component is not unexpected, even if this group was part of an extensive trading sphere. A few scattered boatstones and shell artifacts have been recovered from burials in the region (see Boyd 1997). G. Hall (1981) also suggests that the development of the Caddoan cultural pattern in northeastern Texas after the time of Christ virtually halted most of the import export transactions with central and southern populations in Texas by ca. 1450 B.P. Although the timing of the groups involved is not clear by any means, the idea and reality of trading/exchanging goods between groups were manifested during the Late Archaic period in eastern and southern Texas. This undoubtedly contributed to the development of the trading/exchange networks to the west in central New Mexico for the glassy obsidian and the movement of Edwards chert northward.

Site Function/Intrasite Patterning Issues and Discussions

Although the depths of Features 3 and 4 and some of the bison bones are at slightly different elevations, we believe that this represents one sloping living surface. With at least two apparent activity areas present, what does this say about site function and intrasite patterning? Does the cultural assemblage reflect a broad range of diverse activities? Does the bison bone reflect a specific site function, namely hunting and processing activities?

Site function is generally determined from the types and quantities of the different classes of cultural material recovered including the type and number of features, the type and number of artifacts to indicate the range of activities performed. Briefly these classes will be reviewed and the site type determined. Faunal bone (*N* = 5,337) was the most frequent class of cultural material and constitutes 43 percent of the entire cultural assemblage. The relatively high frequency testifies to a primary task focused on processing bison. The second most frequent artifact class was that of burned rocks (*N* = 4,286), which accounts for 34.5 percent of the total assemblage. These rocks combined with the 18 burned rocks features represent extensive cooking tasks – food processing. Lithic debitage represents the third most abundant class, comprising nearly 21 percent of the total materials. This third class, combined with the 133 chipped stone tools (1 percent of the total assemblage) reflects a focus on the manufacture, refurbishing, and discard of chipped stone tools. The chipped stone tools represent diverse tasks, and use-wear analysis reveals that the tools were used on various materials to process animal and plant products. Additionally, the few ground stone tools represent plant processing, specifically grass seeds. Burned rock dumps and clusters of bison long bone fragments testify to camp maintenance activities. The entire assemblage represents many and diverse tasks that principally targeted the procurement of plant and animal resources, the processing and cooking those resources. These diverse tasks reflect a relatively long term encampment by a group of hunter-gatherers. The combined cultural materials indicate this site functioned as a base camp. Therefore, the multiple sets of tasks represented support this base camp for a group(s) of foragers that moved to this location to take advantage of the wildrye grass available in this valley during the fall combined with the exploitation of the bison in the vicinity. This is interpreted as residential mobility with once this base camp was established, and then tasks groups involved in the acquisition of specific types of resources went forth and brought back targeted resources to this base camp. It is not clear if the one dominant raw lithic material - Alibates was acquired by one of the talks groups that ventured out form this base camp, or if this raw material was previously acquired while the groups was camped close to the Alibates quarry. The late stage production debitage recovered from this camp would indicate that latter was most likely, and a necessary step prior to conducting the acquisition of food resources.

Horizontal distribution of various classes of the abandoned cultural materials reveal intrasite patterning or the lack there of. Ideally, one would hope to see well defined activity areas where people or groups of people performed individual tasks across the block, similar to what was detected in the Protohistoric occupation at 41PT186.

Nearly 82 percent of the units yielded less than 100 g of bone per unit (Figure 8-163). This distribution is interpreted to mean that small bones fragments were widely scattered, with an occasional small section of a proximal or distal long bone mixed in with the small fragments.

The moderate concentrations (amounts from 91 to 199 g) of bone were in 43 (or 15 percent) of the units. Another 9 m^2 or 3 percent of the units yielded the highest concentrations (amounts from 277 to 860 g), This clustering of the larger and heavier bones, the proximal and distal ends of long bones, is interpreted to represent intentional discard at specific locations and patterned behavior as regards the disposal of bone debris (see Figure 8-163).

Burned rocks were widely distributed across most of the area excavated with some 124 units (or 44 percent of the total) yielding amounts greater than 520 g per unit (see Figure 8-163). This represents a broader, more scattered distribution than was observed in the case of bone fragments. The largest pieces of burned rock, those greater than 15 cm in diameter, were mainly concentrated in the identified features or immediately surrounding those features. In a few instances, one or two large burned rocks were recovered some distance from features. The composite depiction in Figure 8-162 illustrates the distribution of burned rock in the 9 to 15 cm size class with weights greater than 520 g per unit.

The 12 m^2 area that encompassed Feature 9 in the southeastern corner of the excavation block reveals very meager cultural remains, except for the scattered burned rocks around four well defined burned rock clusters (see Figure 8-163). The absence of other classes of materials obviously reflects a specific *in situ* activity area that focused on cooking with hot rocks and the dumping of those rocks following their use. It is postulated that Feature 9a was the *in situ* heating element used to heat rocks, and that Features 9b, 9c, and 9d were individual discard piles or dumps following use of the rocks in boiling food. The tight clustering and elongated nature of these three dumps indicates that these represent individual discard events. The actual boiling feature(s) is postulated to have been an above ground structure, such as a skin draped over a wooden frame, since no boiling pit for cooking was identified in this immediate area. It seems reasonable to assume that the cooking and the subsequent dumping of used rocks would be quite close to one another. This assumption is based on the assumption that used rocks were dumped near where they were used. No other tasks other than cooking occurred at this location.

Another well defined activity area was in the southern end of the excavation block where a pair of burned rocks features (Features 8 and 11) were next to one another (see Figure 8-163). The two defined clusters were surrounded by a light scatter of burned rocks. Very little else was within 1 to 2 m of these features. Three broken chipped stone tools and one metate fragment were on the margins of the scattered burned rocks. It is not clear if these three different tools were discarded near where they were used or indicate *in situ* activities. Feature 8 is interpreted as an *in situ* heating element, whereas Feature 11 was a discard/dump area. If this was truly the case, the discarded burned rocks were less than 1 m from the heating element. Again, no sign of a cooking pit was evident. Since stone boiling was the probable means of cooking food

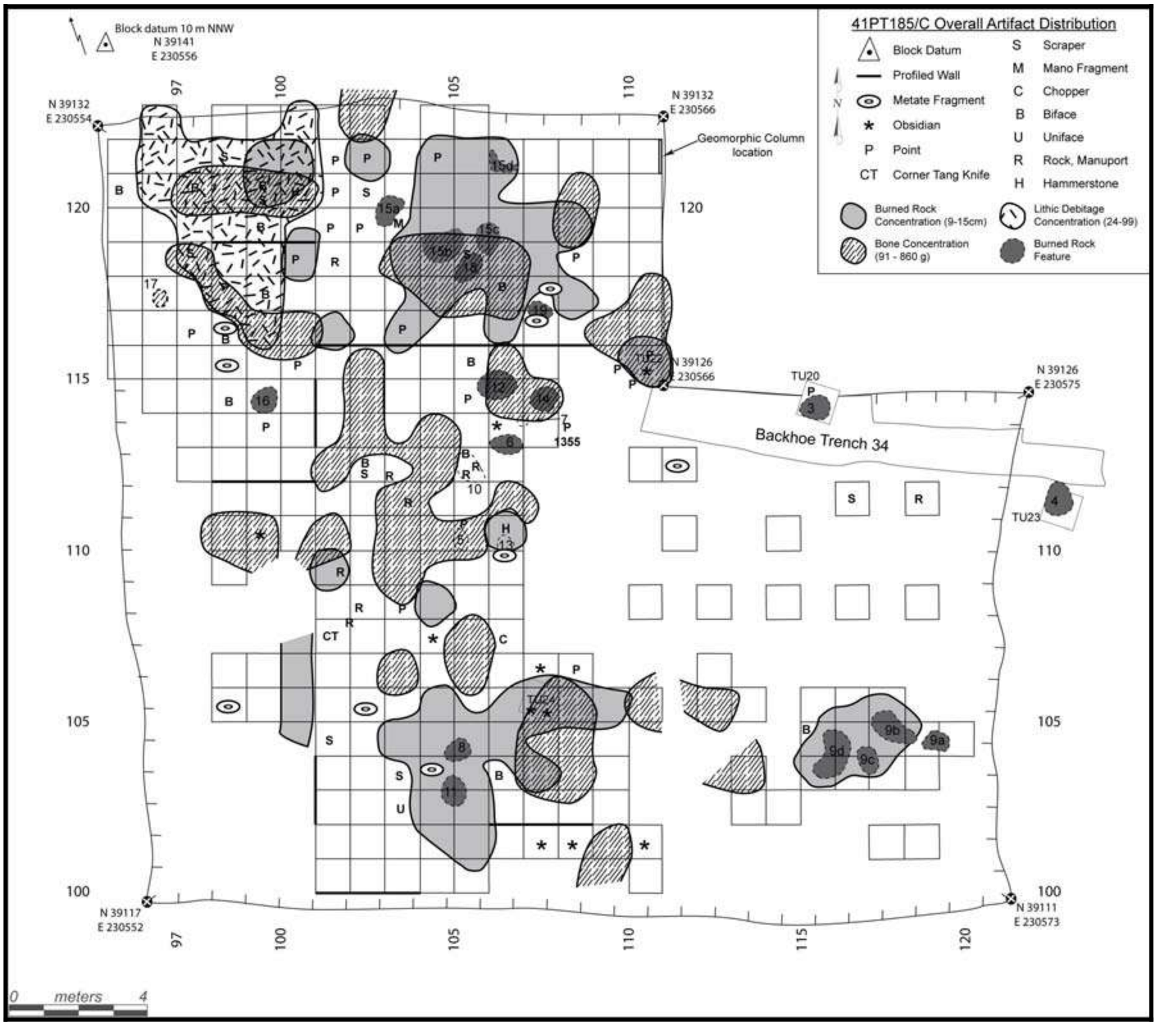


Figure 8-163. Horizontal Distribution of All Cultural Materials Across the Excavation Block.

here, the cooking apparatus is again postulated to have been above ground. This is a similar situation as presented for Feature 9. These two cooking areas, centered on Feature 9, 8 and 11 reveal isolated and well defined activity areas focused on one task.

A relatively broad concentration of scattered burned rocks surrounded Features 15 and 18 near the northern end of the block (see Figure 8-163). The well defined burned rock discard features were surrounded by scattered burned rocks that represent another cooking area. The quantity of burned rocks, combined with the features, may indicate that multiple cooking apparatuses were present. Feature 18 is postulated to have been an *in situ* heating element, possibly a small oven. Therefore, it is possible that cooking technologies other than stone boiling were also employed at this site. Here again, based upon the absence of a large pit in which stone boiling could be done, it is assumed that an above ground apparatus was used.

Besides these three concentrations of burned rocks, nine other much smaller concentrations were encountered (see Figure 8-163). These smaller areas generally covered 1 to 3 m^2, and often yielded one or more small burned rock concentrations, generally not next to or associated with identified burned rocks features. These may reflect disturbed dumps, either during or after the occupation.

The tightly clustered burned rocks in Feature 12 are also interpreted to represent an *in situ* heating element. This form indicates a possible griddle used to cook food. However, wildrye grass seeds were associated with the burned rocks, results similar to most burned rocks from the other burned rock features likely used in stone boiling activity. Therefore, the function of Feature 12 is not clear, since its form indicates one function, and the residues indicate another.

Features 14 and 19 were stratigraphically below Features 12 and 15, and thus, are considered to be older than those adjacent features. The similarity in the appearance of these two features to most other burned rock features in the slightly higher occupation illustrates similar activities in both occupations.

The greatest concentrations of faunal bone and burned rocks co-occurred in only 13 1 m^2 units (or 4.6 percent of all units) (see Figure 8-163). This co-occurrence was in two principal areas. One was the 6 m^2 area on the southern side of burned rock Features 15b, 15c, and 18. If feature 18 was an *in situ* heating element, that would explain the concentration of bone and burned rocks immediately around the feature. If Feature 18 was not an *in situ* heating element, then this 6 to 10 m^2 area, centered on Feature 15 and 18, served as a general discard area for unwanted burned rocks and bones. Very few chipped stone tools ($N = 2$) were in this concentration, which may support the idea that this was a disposal area.

A second co-occurrence was in a 3 m^2 area roughly 1 m east of Feature 8 (see Figure 8-163). This reflects disposal just east of the cooking area. Although bones and burned rocks co-occurred here, the lipid residues do not indicate that large herbivore products were cooked with the rocks. The implication is that two separate activities, cooking and bone processing, occurred in this areas, with the unwanted materials from both activities discarded in the same place. This behavioral pattern illustrates a conscious decision to maintain a tidy camp area. The very low co-occurrence of these two classes of debris also reflects relatively distinct horizontal distribution of these two classes.

Lithic debitage was evenly distributed across the block, except in the northwestern quadrant. There the high concentration (greater than 24 pieces per m^2) covered about 21 m^2 (or 7.3 percent of the total units). Roughly 75 percent of the units yielded less than 11 pieces per unit. Although not depicted on Figure 8-163, the moderate frequency, (i.e., those units with 12 to 23 pieces per unit) account for only 17.5 percent of the total units. Moderately dense units surrounded the high-density units in the northwestern corner. They were also scattered across the northern end in small (less than 4 m^2) areas. Although somewhat dispersed over 21 m^2, this area defines the primary knapping locality. The type of debitage recovered represents a focus on bifacial thinning.

The corner-tang knife is a rare discovery, especially in this kind of campsite setting. Not only is the discovery rare, its context is highly unusual, as well. This artifact was discovered under a natural rock, away from any other recognizable cultural feature or material concentration (Figure 8-164), which represents behavior not often detected in a campsite, and indicates that this corner-tang knife was purposefully cached under the rock. That action documents a special significance for this biface.

As previously discussed, this corner-tang knife exhibited no evidence of unusual function when subjected to high-power microscopic use-wear and starch grain analyses. The caching of a single, unique artifact in a campsite setting indicates an intention to return to this specific campsite in the foreseeable future, to retrieve this unusual and presumably highly valued tool. This indication of intentions to return to the site accords with the fact that multiple Late Archaic events were detected in the narrow confines of the Landis Property, as well as at other localities across the area, indicating that groups returned to this area on a regular basis.

Figure 8-164. Corner-Tang Knife Cached Immediately Beneath a Large Unmodified Rock.

Technological Issues and Discussions

The hunting strategy/technology employed by this group(s) is not clear, with the exception of the use of projectile points. Very limited data is available to allow speculation on whether the hunting strategy consisted of individual kills or a large communal effort. If this group(s) was preparing for the lean winter months ahead, as can be inferred from the fall seasonality of the occupation, they needed to meet their immediate and future needs. Given this, it is possible that a more or less large communal bison kill is reflected in the faunal assemblage. If this assumption is a correct, then one sizable group or multiple small groups came together to perform a communal bison kill.

In historic times, Plains groups would come together so a sufficient number of people were present to assure a successful kill operation (Spencer and Jennings 1964:358; Forbis 1978; Verbicky-Todd 1984; Fawcett 1987). In most instances, both men and women would participate, although their roles were probably different. The specific mechanics of how the hunting process took place will not be speculated upon. Definition of specific hunting strategies/technologies must await broad scale excavation of multiple Late Archaic kill sites. The currently identified Late Archaic bison kills in the panhandle region are thought to have been conducted by use of arroyo traps (D. Hughes 1977, 1989; Fawcett 1987; Bement and Buehler 1994). This apparently preferred means of acquiring sufficient animal resources may have been a response to the topography of the natural landscape.

Medium size game animals such as deer and antelope were most likely hunted by individuals or small groups stalking one or a few animals. No bone or wooden tools were recovered that might have functioned as snares or traps for trapping small game or birds. It is likely that such equipment was constructed of mostly perishable items such as wood and sinew that do not remain as parts of the archeological record.

The few, relatively small Late Archaic dart points (N = 19) recovered are, of course, the stone tips that were attached to the killing instruments. Exactly how these points were propelled is not clear from the current data from this open camp. The stem widths of these points are greater than 10 mm, implying these projectiles were attached to dart shafts (Knight and Keyser 1981), and most likely employed with an atlatl. As with all open air campsites the perishable parts (the wooden shafts and hafting sinew), of this technology were not preserved. Little is known about the specific strategies of how dart points were hafted to the shaft, and the types or size of the dart shaft. Based on the few Late Archaic projectile fragments recovered, slight variations exist in notching techniques, which were designed for lashing the point to the dart shaft. Two of the three more complete projectiles (#635-010 and #1288-010) exhibit relatively narrow corner-notches and broad expanding stems and wider expanding stems (Figure 8-165). Thus, two slightly different corner-notch styles are represented. The other complete point (#1104-010) and most broken stems/bases reveal a much broader corner-notch that effectively resulted in the production of a stem. (Figure 8-166). This slight difference in the notches does not affect the effectiveness of the point in penetrating into the animal. These slight visible differences may then reflect stylistic preferences of individual craftsman or groups.

Figure 8-165. The Two Examples of Narrow Corner-Notched Projectile Points (#635-010 and #1288-010). (scale in cm)

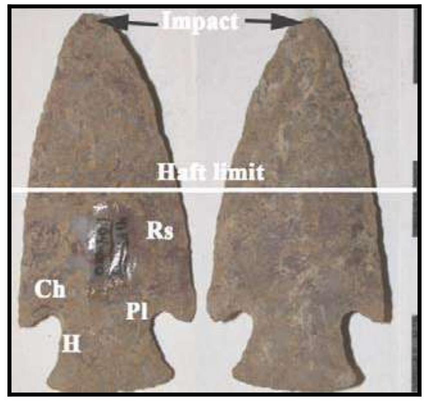
The recovered point bases/stems (N = 11) were broken/snapped at roughly the same place on the stem, the narrowest part of the neck between the notches, the inherent weakest place (Figure 8-167). This may indicate a week spot or stress area in this style of projectile and/or the specific spot were the binding was the tightest.

Not all projectile points were analyzed through high-power microscopy. The five points that were analyzed indicate that they were hafted to a hard shaft, because haft-wear is evident as abraded and polished flake scar ridges on the stems and blades. However, in the case of the complete corner-notched point #1104-010, the attached haft appears to have extended past the notches to the mid section of the blade (Figure 8-168). This same projectile point also revealed traces of resin above the notches and below the apparent haft limit, which indicates resin as a binding agent. In contrast, complete projectile #1288-010 exhibited haft-wear (hard, high-silica polish) stopped at the notches (see Figure 8-168). Interestingly, these two complete projectiles reveal different hafting techniques, along with slightly different stem shapes and notch configurations, as discussed above.

Here again, the observed differences may reflect different individual group predilections. Until more projectiles points can be analyzed in this same manner to determine if such differences are a recurrent pattern, it is not clear what the real meaning of these haft differences reflect.

Figure 8-166. Projectile point #1104-010 that Has a Stemmed Appearance. (scale in cm)

Figure 8-167. Selected Stems/Bases from the Late Archaic Component.



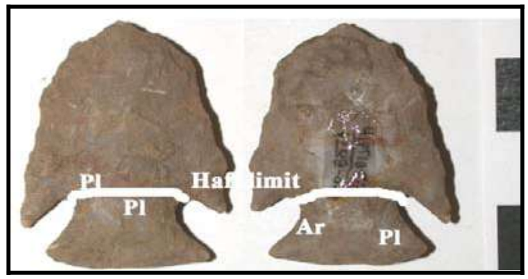


Figure 8-168. Projectile Points (#1104-010 and #1288-010) Showing Contrasting Extents of Haft-wear. (scale in cm)

After food resources were collected, either through hunting animals or collecting/gathering plants, most collected foods had to have been processed and/or cooked in some manner. Various food processing tools were recovered and include hammer stones, anvils, butcher blocks, manos, and metates. Processing tools were relatively limited in number, but were part of the tool kit employed at the site. Presumably, many of these processing tools functioned with either animal or plant products, or both. The hammerstones may have served to pound meat, break open bones, crush bones, or pound roots. The relatively flat metate fragments served to grind plant products, and might also have served as butcher blocks on which to cut or pound meat. Without detailed multiple technical analyses (e.g., lipid residue and starch grain) on each and every artifact, it is impossible to specifically state how each artifact potentially functioned or what percentage of these tools functioned in a particular task.

Can a single animal processing pattern be discerned in the faunal assemblage?

The specific butchering technology employed by the Late Archaic occupants of this site is not obvious from the highly fragmented bison remains from this campsite. The overall processing of bones to extract marrow and grease has greatly hindered the detection of a specific butchering process. One can only speculated as to what might have occurred immediately following the kill, but a plausible scenario can be derived from ethnographic accounts. Wissler: (1910:41) states:

> Assuming the carcass was in camp [a questionable assumption in the case of bison], the procedure for buffalo or deer was about as follows: -- The quarters were removed by cutting down through the shoulder joints. Then cuts were made at the shins. The hind legs were

> cut off and the quarters cut at the hip joints. The back fat was removed in broad bands. The breast and belly were cut away in one piece; then the short ribs, eight on a side, in two pieces; Also two similar pieces of neck ribs. The parts of the loin containing the kidneys were taken next. The "boss ribs" (hump) were stripped. If there was a feotus it was tied up with the "boss ribs". The backbone was cut into two pieces. A chunk of meat from the rump and one from the neck were taken. The heart, tongue, brain, paunch and small intestines were taken. Sometimes the hoofs and some of the head meat were also taken. The marrow from the leg bones was usually eaten raw during the butchering.

It is not clear at what distance the bison were killed from this camp, but the distance definitely affects the decision making process. Decisions concerning the distance required to transport the animals include the number of humans involved in the transport, whether or not dogs and/or women were present to help with transport, and the current group needs, all influenced how the hunter proceeded following the kill. It is likely that the kill, postulated to be an arroyo trap as discussed above, may be in the vicinity, possibly in West Amarillo Creek valley. In the final analysis, no single processing pattern was discerned, except the bones were smashed to extract bone grease.

What plant gathering and processing technologies are evident?

The Late Archaic gathering technology was probably much less involved than the hunting technology and required minimal artifacts, and limited planning or organization. As indicated above in the ethnographic references, the women, and probably young girls, would collect seeds in baskets, and presumably all other useful wild vegetables plants, nuts, and other plant resources. Baskets, which were not preserved here, were probably the only artifact necessary for seed or other plant collection (i.e., Geib and Jolie 2008). Judging from the different historical accounts, collecting did not require formal stone tools. In at least one ethnohistoric account, Wilson (1924:259) does indicate that the natives "cut a great deal of dried grass with our knives". Apparently, a cutting tool was used on some occasions in the plant gathering process. Other perishable tools such as a digging stick were undoubtedly part of the plant collecting technology, especially if roots and tubers were targeted. No direct evidence exists for the use of these artifacts. None of the recovered bone tools are likely to have been used in the plant gathering process.

Once gathered, plant processing technology involved several perishable tools and/or nonperishable stone tools. The perishable plant processing tools probably included baskets and/or woven trays and digging sticks. Baskets would have been essential in the collection, transportation, and potentially in the winnowing, and parching of the smaller seeds (i.e., Gremillion 2004; Geib and Jolie 2008).

The preserved stone tools include grinding slabs (metate fragments), hand held grinding stones (manos), hammers/pounders used to pound/smash the collected plant parts, and the burned rocks, resulting from cooking the processed plants. All these processing tools were recovered from this Late Archaic campsite. Grinding evidence was observed on surfaces of the metate fragments, but the amount or depth of grinding varied and was generally not extensive. Lipid residue analysis on a few analyzed pieces also indicates that meat products were in contact with these same pieces. This may indicate that meat and/or bones were also placed on these generally flat rocks for processing.

The mano used to grind the different plant products was evident with only one possible artifact that served in this capacity. It was only a lightly used specimen. With minimally 10 separate metate fragments recognized, it is not clear why manos were not recovered. It is possible that manos appeared more as natural rocks and were just not recognized in the field, or that they were unbroken by use and were carried away when the site was abandoned. For whatever reason this specific grinding instrument was not recovered from the block excavations. It is possible that the hammerstones were multifunctional tools and served as grinding stones.

With the presence of minimally two types of burned rock features identified, dumps and *in situ* heating elements, are multiple cooking technologies (i.e., stone boiling, roasting, earth/rock ovens) evident here?

Once acquired, the plant and animal foods were processed, and at least some were cooked. At the same time, it is probable that a variety of foods such as berries, fruits, and some nuts were not processed or cooked, and consumed after collection. Other foods, such as meat and possibly berries were probably sun dried for later consumption without cooking. The ethnographic and ethnohistoric literature is full of accounts of cooking various foods using different types of facilities and most involved the use of hot rocks (i.e., Catlin 1851; Lowie 1922; Castetter 1935; Castetter and Opler 1936; Castetter and Bell 1937; Castetter et al. 1938; Turner-High 1941; Wilson 1924; Driver and Massey 1957; Pennington 1963). These ethnographic sources reveal that a variety of foods were cooked and included a wide range of plants, meat from various large and small animals, fish, and shellfish. The most common foods cooked with the use of hot rocks appear to have been plant foods, (see summaries by Thoms 1989; Wandsnider 1997).

Often, the most common artifact class in open air hunter-gatherer campsites is burned and fire cracked rocks, natural rocks heated in a fire and then used to transfer heat to foods either directly or indirectly. The three most common and often mentioned cooking techniques that used hot rocks for heating elements are stone boiling, rock griddles, and earth or rock ovens. Over the past few decades considerable advances have been made in understanding the use of various kinds of hot rock cooking facilities (i.e., House and Smith 1975; Lintz 1989; Brink and Dawe 1989; Thoms 1989; 2008a; 2008b; Doleman et al. 1991; Black et al. 1997; Wandsnider 1997; Tennis et al. 1997; Ellis 1997; Stark 1997; Schalk and Meatte 1988; Black et al. 1998; Leach et al. 1998; Jackson 1998; Dering 1999; Smith and Martin 2001). However, the overall results of these and other experiments indicate that thermal alteration of stone is very complex and variable. Some variables include the specific lithic material types employed, the temperatures obtained in the fires, the length the rocks were subject to the fire, the cooling process, the reuse of the rock, etc. Currently, however, no proven systematic means have been developed for identifying with unreserved certainty in what way a given burned rock feature was used. Clear characteristics of the actual function of burned rock features are not often preserved, although inferences are increasingly possible as the result of an increased use of residue analyses for determining which general classes of food resources into which the rocks came in contact (Quigg and Cordova 1999; Quigg et al. 2000, 2001, 2002a, 2002b).

A variety of other methods were also available for cooking foods, and included parching with coals, broiling directly on coals, steaming, and roasting over an open flame. Due to poor organic preservation and postdepositional disturbances, most cooking technologies are difficult if not impossible to identify archeologically. The extensive accumulation of burned rocks found scattered across the excavation block and in discrete clusters is direct evidence that hot rocks were one of the primary means of cooking foods at this Late Archaic camp.

Ethnographic sources also indicate that hot rocks were used for warming the inside of a residential or ceremonial (i.e., sweat lodge) structure. At this Late Archaic campsite these other possible uses were not identified.

When analyzing burned rocks either scattered or in clusters, one must consider the selection of the natural stones used, whether the rocks were local or nonlocal, the distance to the source area(s), and the size and weight of selected rocks. The lower part of the West Amarillo Creek valley is covered by alluvium and the creek bottom is mostly free of cobbles. However, in some places the creek has down cut into older sandstone formations. Since this downcutting probably occurred following the Late Archaic occupation, it is likely that this sandstone was buried and generally unavailable to the Late Archaic populations. The valley walls reveal both dolomite/caliche and in some places Ogallala gravels. In fact, Ogallala gravels currently outcrop on the opposite (east) side of West Amarillo Creek. These gravel outcrops and the dolomite from the higher valley walls would have been easily accessible and close at hand for collection.

After the rocks were collected, the next step would have been to heat them in fires for various uses. Heating and cooling gives the rocks distinctive morphological characteristics, which provides clues as to how those rocks functioned. Three types of rock shapes have been repeatedly identified in burned rock assemblages and through experiments. These include angular/blocky shapes from contraction (experimentally reproduced in stone boiling; i.e., McParland 1976, 1977; Thoms 1986; Schalk and Meatte 1988; Doleman et al. 191), curvilinear/spalls from expansion fractures (experimentally reproduced in hearths and earth ovens), and intermediate shapes (i.e., Jackson 1998 and others). Importantly, researchers have reported that all three shape types are often present in both stone boiling and earth oven archeological features, but in different frequencies.

Driver and Massey (1957) document that stone boiling was the dominant method of food preparation in the Plains, Great Basin, and adjacent regions where pottery was absent and populations were highly mobile. Stone boiling involved first heating the natural rocks in an open fire, then transferring to the water. As the hot rocks entered the water the heat inside the rock was transferred, thus causing the water to boil. As the rocks cooled they were removed, and set or tossed aside.

Stone boiling technology is often difficult to detect in archeological sites. The container and other organic (perishable) artifacts used are nearly never visible or preserved in open camp sites. Sometimes a small (< 1 m in diameter) rock filled basin or heating element with or without charcoal indicates where the rocks were may have been heated, and this type of feature might still be intact and recognizable. The presence of charcoal in a pit would eliminate that feature as a boiling pit, since fire was not built in the boiling container. The presence of charcoal could indicate the preceding step, in which the rocks were initially heated. If in ground pits were not used for boiling food, then above ground devices were probably used. Such a device might consist of a bison skin pouch supported on the sides by sticks thrust into the ground into which water could be placed (Wissler 1910:27). If above ground technology was employed, it would be virtually impossible to detect archeologically.

Stone boiling, steaming, and simmering are referred to as moist cooking techniques, which require lower temperatures than dry cooking. Reid (1989) reports that boiling is important for cooking starchy cereal grains and roots, which do not completely gelatinize below a temperature of 93°C. In contrast, simmering at 85 to 88°C is most suitable for stewing meats and for oil and grease rendering from seeds and fractured bones. Grinnell (1961:106) indicates that meat was usually boiled only enough to change its color. If the latter is true, then only a few hot rocks would be required to cook meat compared to more intensive boiling to extract bone grease. Dry cooking includes broiling, roasting, baking, and parching. These techniques require hotter temperatures in the coals from 150 to 625°C. Meat begins to broil at 150°C (Reid 1989).

The broad block excavations yielded 22 cultural features, 18 of which were comprised mostly of burned rocks. A summary of feature attributes, specific observations, analyses of selected burned rocks, and interpretations are presented in Table 8-21. All 22 cultural features are part of the Late Archaic component, and radiocarbon documented to the millennium between ca. 1500 and 2500 B.P.

Figure 8-169 graphically displays general feature size (area in m^2) compared to the total weight of the burned rocks involved. This provides an approximate understanding of the overall size of rock involved in each Late Archaic feature. A group of six features (lower left of graph) were quite small (less than 0.5 m^2), with relatively few rocks. This group represents at least minimally two types of inferred functions. Four of the six are classified as burned rock dumps or discard piles, whereas two (Features 9a and 18) are thought to have been *in situ* heating elements. As shown at the top of the chart, Feature 4 was of medium size (1 m^2) with a very significant weight for the many inclusive rocks. Feature 4 is also interpreted as an *in situ* heating element. The other 12 features generally covered less than 1 m^2, and contained less than 21 kg of rock per feature.

Of those 12 features, only Features 8 and 12 are considered *in situ* heating elements and both were relatively small (less than 1 m in diameter). In general terms, no large cooking elements such as a rock oven or massive discard piles (i.e., midden deposit) are represented. Apparently, small heating elements and/or individual discard/dumps less than 1 m^2 were in use across this the excavated area.

The five defined, *in situ* heating elements, Features 4, 8, 9a, 12, and 18, exhibited different shapes, sizes, and rock sizes, suggesting that more than a single function is these features. Apparently multiple cooking technologies were employed, or there was considerable variation in the ways in which the features were constructed.

The gross shape of the burned rock clusters is graphed in Figure 8-170. This simple graphic reveals that three of the five *in situ* heating elements (Features 9a, 8, and 12) were roughly circular and of similar size.

Features 4 and 18 provide the extremes in size range and are not quite as circular. Most other features interpreted as burned rocks dumps were more elliptical in overall shape. This elliptical shape may reflect the tossing action as the rocks emptied out of a container such as a basket rather than discarded individually. Feature 15d was an anomalous shape, as it appeared as a broad arc or curved row of burned rocks.

Table 8-21. Summary of Metric and Nonmetric Observations and Characteristics of Features.

Feat. No.	Provenience (unit & depth, cm)	Catalog No.	Measurements (cm)	Late Archaic Event (upper and lower)	No. of Burned Rocks/Total Weight (g)	Average Burned Rock Weight (g)	Charcoal Present *	Other Artifacts in Cluster **	Lipid Residue Results	Starch Grain Results	Interpretation
3	Test Unit 20, 85-93	198	85 wide x 8 thick	lower	28/17,250	616	No	1 lithic	4 no residues	1=wildrye starch, 1gelatinized starch	discard pile
4	Test Unit 23, 95-108	214	100 wide x 15 deep	lower	69/48,800	707	No	1 lithic	1 high fat plant, trace animal 1seed/nut, high fat	2 gelatinized starch, 1 wildrye starch	? shallow basin heating element
5	N110 E105, 51-58	1348	70 long x 7 thick	lower	14/2,189	156	1 tiny chunk in float	dart point base, bones, lithics	1 seed/nut very high fat	1 gelatinized, 5 wildrye starch	Trash discard pile
6	N112, 113 E106, 43-53	808, 854	80 x 40 x 10 thick	upper	13/13,305	677	3 flecks in float	none	2 seed/nut, very high fat	1 gelatinized, 1 wildrye starch	dump/discard pile
7	N113 E106, 33-50	855	12 wide x 17 tall	NA	NA	NA	No	none	NA	NA	rodent hole
8	N104 E104 105, 50-60	464, 474, 1341	80 wide by 13 deep	lower	70/19,783	283		1 mano	2 seed/nut, high fat, 1 seed/nut high fat, trace animal	2 damaged starch, 2 wildrye starch	shallow basin rock filled heating element
9a	N104 E118, 62-70	508,	68 long x 8 thick	upper	20/6,532	326	No	none	NA	NA	partial arc
9b	N104, 105 E117, 49-60	501, 504, 1340	105 long x 8 thick	lower	100/17,846	179	flecks under rocks	1 bone, 2 flakes	4 seed/nut, high fat, trace animal	1 gelatinized starch	discard pile
9c	N103, 104 E117, 45-55	444, 502, 1332, 1343	70 x 35 x 8 thick	lower	54/6,519	121	No	none	1 large herbivore bone marrow , 1 seed/nut high fat, trace animal	1 damaged starch, 1 unknown grass starch	discard pile
9d	N104 E115, 116, 42-50	1330, 1331, 1334, 1337	160 x 80 x 8 thick	lower	88/18,658	212	3 chubks, flecks in float	none	1 large herbivore fatty meat, 1 seed/nut high fat, trace animal	2 damaged, 2 wildrye, 1 unknown, 3 other grass	discard pile
10	N112 E105, 51-61	804	50 long x 5 thick	lower	5/17,538	NA	No	none	NA	NA	2 large slab manuports, unknown
11	N102- E105, 55-62	361, 1010, 355, 1342	80x 60 x 7 thick	lower	66/14,806	247	tiny flecks in float	bones, lithics	1 large herbivore medium fat, 2 seed/nut high fat	1 damaged, 2 gelatinized starch, 1 other grass starch	discard pile
12	N114, 115 E106, 44-68	894, 896, 899, 901	75 wide x 9 thick	upper	59/20,154	270	flecks in soil	40 bone fragments, 5 lithics	2 large herbivore, high fat plant, 2 seed/nut high fat, trace animal	1 damaged, 2 gelatinized, 3 unknown, 4 wildrye starch	heating element
13	N109,110 E106, 40-45	712	50 long x 5 thick	upper	10/2,556	256	No	none	NA	1 none	broken slab metate
14	N114 E107, 61-67	907	100 long x 6 thick	lower	22/6,741	306	No	2 bones	NA	NA	dump/discard pile
15a	N120 E103, 42-51	1234,	90 wide x 9 thick	upper	32/9,730	304	flecks in soil	none	1 seed/nut, high fat	2 none	discard pile
15b	N119 E104, 45-56	1119, 1181	110 long x 70 wide	upper	71/17,979	253	No	3 bones	1 large herbivore, high fat plant, 2 seed/nut high fat	1 none	discard/dump pile
15c	N119 E106, 44-52	1192	70 x 45 x 8 thick	upper	59/15,280	259	No	none	2 seed/nut high fat	2 none	discard pile
15d	N121 E106, 50-56	1295	100 long X 15 wide	upper	14/4,000	286	No	none	NA	NA	arc of burned rocks ?
16	N114 E98, 69-78	875	70 x 45 x 9 thick	lower	21/16,750	798	1 fleck in float	none	1 medium fat, 1 seed/nut high fat	1 damaged starch, 1 wildrye starch	discard pile
17	N117 E96, 83-98	1027	40 long x 15 deep	lower	NA	NA	1 tiny chunk in float	none	NA	NA	Inverted bison cranium
18	N118 E105, 50-60	1129	60 x 45 x 5 thick	lower	10/3.364	336	No	??	1 seed/nut, high fat , animal, 1 plant + animal	1 damaged, 1 gelatinized, 1 other grass	in situ heating element
19	N117 E107, 60-70	1070	60 wide x 6 thick	lower	14/4,500	321	No	none	1 seed/nut, high fat, animal	1 none	discard pile
		* = includes the results from floation analysis. ** = Floatation results not included here.									

The average weight of the burned rocks recorded for each feature is graphed in Figure 8-171. Four features (Features 3, 4, 6, and 16) had relatively large rocks in comparison to the others. From this group, only Feature 4 is interpreted as an *in situ* heating element, which one might have assumed should have had relatively large rocks. However, the other three features in this group are considered discard piles of burned rocks. This seems to contradict the suggesting of some researchers to the effect that rocks of relatively larger size were culled out for reuse after they had been used only one time. Generally, as rocks were put through a series of heating and cooling episodes, the initial size is reduced due to thermal fracturing. The rocks eventually attained a size that was no longer suitable as they would not hold sufficient heat. In these three instances, some rocks were used and discarded, were still of sufficient size that they would have been able to hold and transfer heat if the user wanted to reuse that rock.

Therefore, it is possible some piles of larger rocks were set aside for drying and reuse. It also indicates that different types of rocks would not always break down in the same manner at the same time. In an experiment that employed central Texas dolomite cobbles in a constructed rock oven, all cobbles fractured into many pieces. The 27 original cobbles (27 = 3,500 g) broke into 217 pieces that yielded an average weight of 4,437 g. (Leach et al. 1998). At least 19 percent of those fractured rocks were in the 12 to 16 cm size class, whereas the highest percentage, 34 percent, was in the 8 to 12

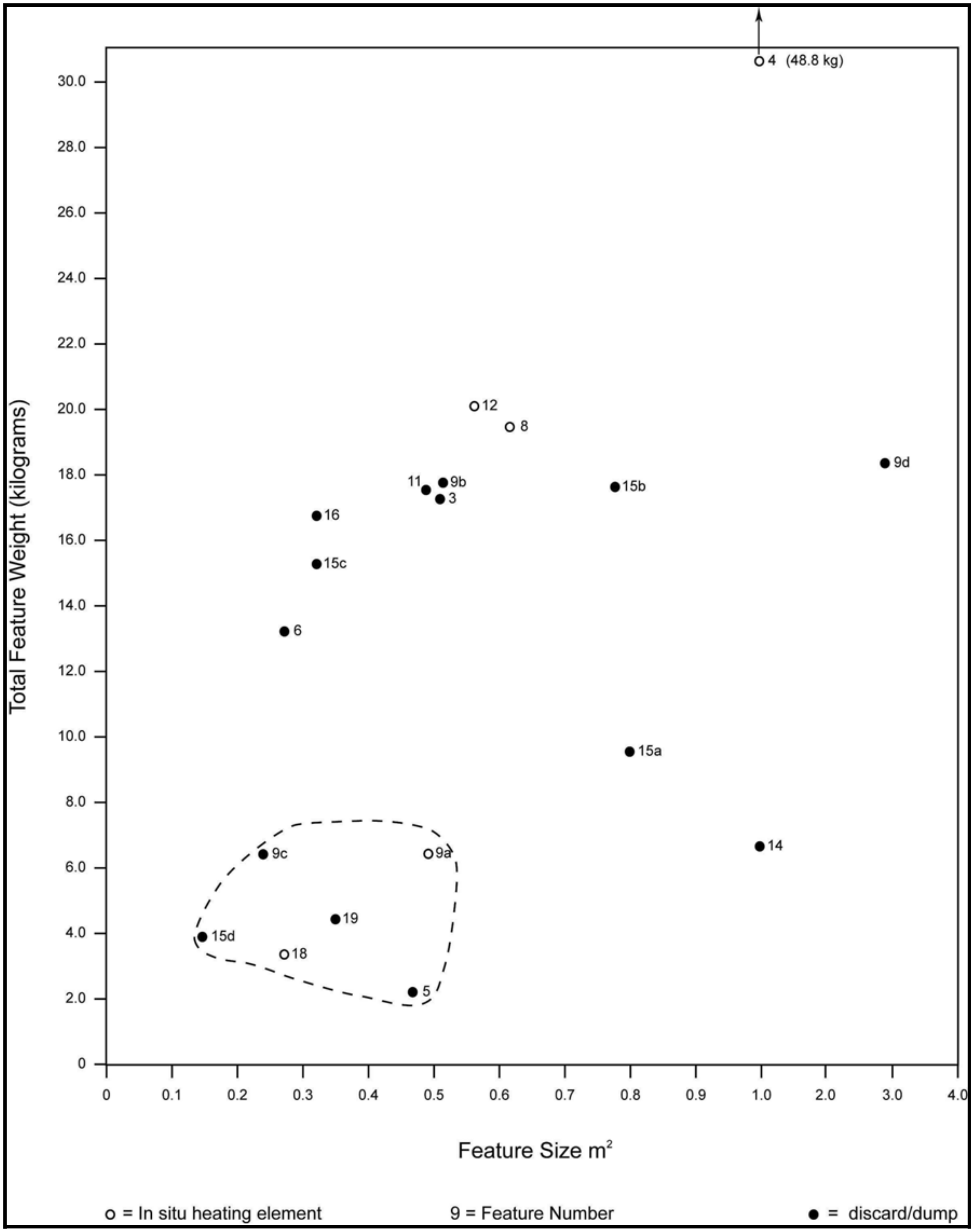


Figure 8-169. Graph Depicting Feature Size with Total Weight of Burned Rocks per Feature.

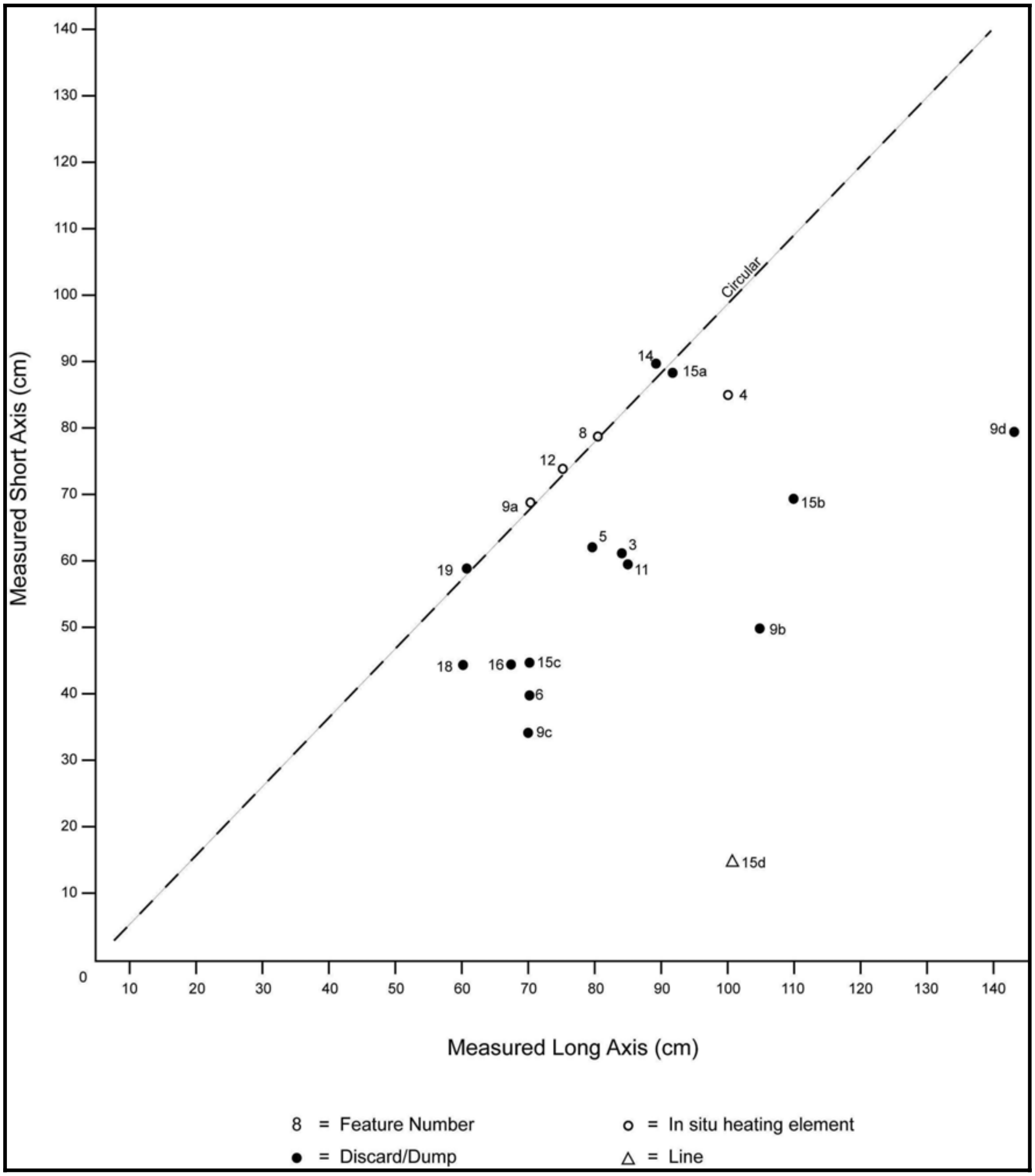


Figure 8-170. Feature Length Verses Width Provides Generalized Shape.

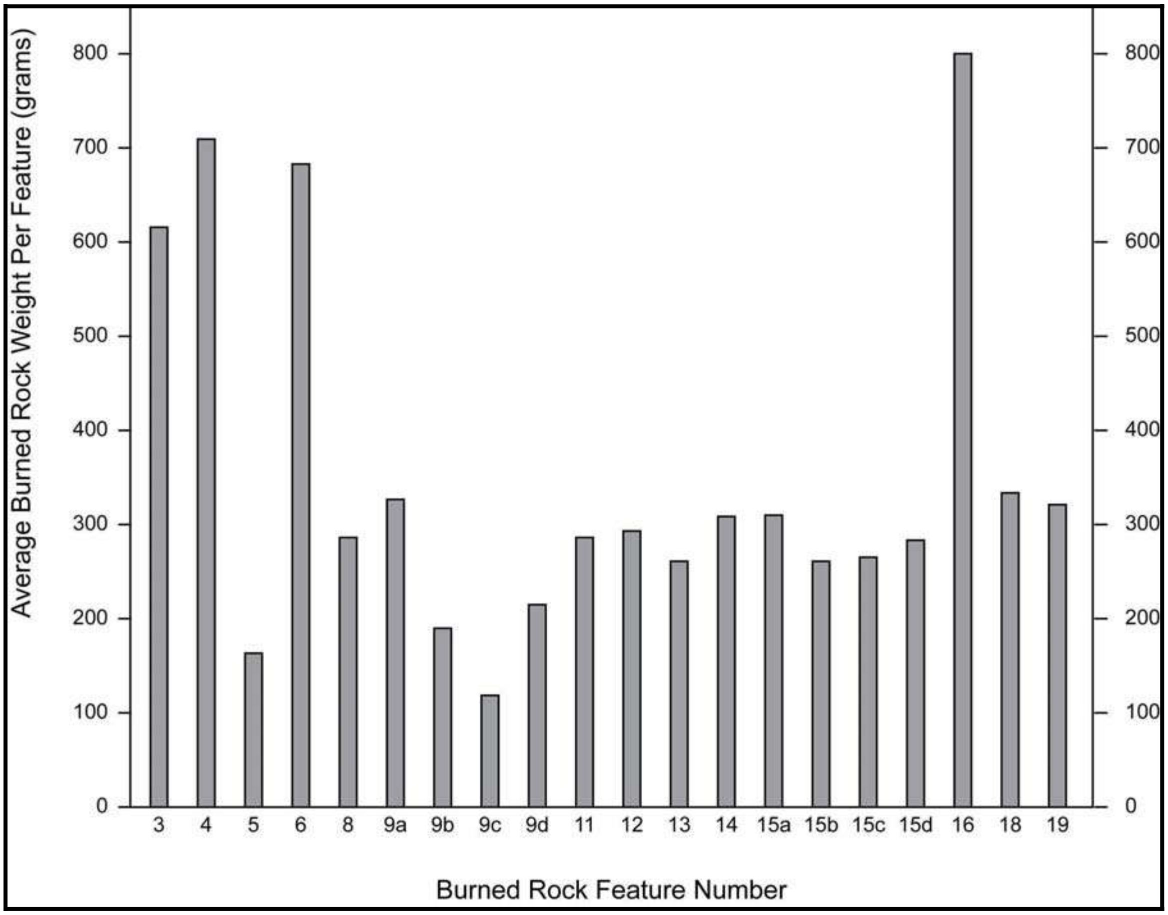


Figure 8-171. Average Burned Rock Weight per Individual Feature.

cm size class. This example demonstrates that after two heating and cooling episodes, only 20 percent were probably of sufficient size to hold sufficient heat for effective reuse.

The five *in situ* heating elements (Features 4, 9a, 8, 12, and 18) reflect three different overall sizes (see Figure 8-170). One assumes that the size and shape differences reflect different types of heating/cooking facilities. The lack of obvious well formed basins below the rocks in three *in situ* heating elements (a possible exception is Feature 18, which had a very shallow basin) would be most similar to a rock griddle, specifically Features 8 and 12. Rock griddles are generally considered short term heating facilities, used for just a few hours. The griddle provided a dry, open air convection heat (broiling or roasting) to cook food. This would be most effective for meats and not so great for many plants (Driver and Massey 1957:233). The meat would have been placed directly on the hot rocks to cook. After the meat was cooked on the hot rocks, the rocks were allowed to cool in place. If Features 8 and 12 truly represent rocks griddles, this would help explain why these still appear as *in situ* features. Following their use in the grilling process, there would be no particular reason to move the rocks from the grilling location.

Feature 12 physically resembled a rock griddle heating element. The analyses of a few rocks from Feature 12 indicate that wildrye grass seeds were cooked with these rocks (Appendix F). All four rocks analyzed for starch grains yielded identifiable Canadian wildrye starch grains. In two of the four instances, the starch grains were gelatinized, indicating that they were exposed to both heat and moisture. In one instance, one rock yielded damaged starch grains from having been processed (ground/pounded). The burned rocks from Feature 12 yielded the most identifiable starch grains of any of the sampled features. Feature 8 also appeared similar to a rock griddle with a possible shallow, poorly defined basin near the middle. The burned rocks analyzed from Feature 8 again yielded a few Canadian wildrye grass seeds with two of the four rocks yielding damaged starch grains (Appendix F). The presence of gelatinized grass starch grains on the burned rocks from these two features implies that the rocks were likely used in a stone boiling strategy with only a slight possibility that they were used for grilling or roasting of meat.

The other *in situ* heating element, Feature 4, had significantly larger rocks over a slightly larger area and did not have the appearance of a griddle. The large, irregularly shaped rocks were not laid flat, but rested in a jumble. Thoms (1986) and Schalk and Meatte (1988) indicate that larger rocks were preferred for earth ovens because they could store large amounts of heat for long periods. Large rocks were found in Feature 4, but the function of this feature is unclear. The overall form does not fit with expectations for an oven, as it lacked a defined basin, was relatively small, and appeared to be intact with no central space for food. The analyzed burned rocks from Feature 4 again yielded a few Canadian wildrye starch grains with minimally two of the four burned rocks yielding grains damaged from processing. Feature 4 is interpreted to be an *in situ* heating element, with the rocks possibly having been through a reheating episode.

Therefore, multiple shapes and sizes of features with different total weights of burned rocks all show evidence of cooking Canadian wildrye grass seeds. One possible interpretation is that many rocks were recycled. The rocks were most likely used to stone boil the wildrye grass seeds and were then reused n another type of cooking element. This would account for the presence of the starch gains of small grass seeds in what are assumed to be open, intact heating elements, such as Features 4, 8, 12, and 18. Dr. Perry (personal communication) indicates that the starch grains would mostly still be preserved even after reheating the rocks. The parched grains would have been recognizable in the analysis, but were not observed, supporting the notion these starch grains were directly related to the cooking activities at this camp. Therefore, the presence of wildrye starch grains on the rocks reflects the final cooking episode.

Four features (3, 4, 6, and 16) contained relatively large rocks. All but Feature 4 are considered locations of discard. From this, one may assume that in a few instances, larger pieces of burned rocks were dumped, but were not always set aside for subsequent reuse. Figure 8-171 shows that most features yielded burned rocks with average size of about 300 g or less.

Much experimental work with burned rocks has addressed which rock types have the best conductivity, which holds the heat the longest, which would have been better suited for certain types of cooking facilities, and so forth, thus generating insights into why one rock type may have been preferred over another in specific situations. House and Smith (1975:79) suggest that hard sandstone was more resilient under repeated heating and cooling than were quartzite or chert. Similarly, Brink et al. (1986:290-292) found that sandstone survived multiple heatings in hearths, yielded higher temperatures, and was less susceptible to sudden fracturing upon cooling. They also pointed out that sandstone absorbed more water and required longer drying times between use episodes. Researchers have also indicted that sandstone was not well suited for stone boiling as it drops individual grains (i.e., Brink et al. 1986; Jackson 1996). Quigg et al. (2000, 2002a) clearly documented the use of sandstone for cooking, most likely in stone boiling. Research indicates that high porosity decreases rock strength, but heating increases an object's elasticity (i.e., Jackson 1996:57) and that porous rocks survived multiple use episodes better than less porous rocks. Lintz (1989) documented that metaquartzite and chert are better thermal conductors than caliche, sandstone, and basalt.

The burned rocks observed in most features and scattered about our block excavations were various grades of dolomite/caliche, but a few sandstone and quartzite rocks were also mixed in with these. Many observed features included all three rock types. Sandstone was only dominant in one instance, Feature 16. The presence of three rock types in one feature indicates that the users were not highly selective in which rock types were used in their cooking apparatus. The hillside or sloping valley wall opposite this site (east) reveals a massive outcrop of rounded and dense quartzite cobbles. However, these rounded quartzite cobbles did not constitute the majority of rocks in any one feature. Some higher outcrops expose considerable dolomite. Most sandstone appears to be lower in the valley and was probably covered by alluvial deposits or water at the time of this occupation.

Burned rock size is often discussed as important in characterizing burned rocks and sometimes may also reflect feature function. Larger rocks work well in earth ovens because they have a lower surface to mass ratio, which allows them to retain heat for longer periods (i.e., Schalk and Meatte 1988). Small rocks (less than 10 cm in diameter) are good for stone boiling because they have high surface to mass ratios, which allows them to store and release heat quickly. Experimental stone boiling by Jackson (1998) using quartzite rocks indicated that 13 of 16 rocks used in three heating and cooling episodes fractured during use, most after the first cycle of heating and cooling. Schoolcraft (1852:176) observed that the Sioux Indians required only three to four stones of about 2.72 kg (six pounds) to boil meat. Brink and Dawe (1989:68) indicate that the size limit at which burned rocks are no longer useful is less than 10 cm and they observed archeologically that larger pieces were occasionally stockpiled near boiling pits. At 41PT185/C just over 66 percent of the rocks in the 18 features were less than 10 cm in diameter (Figure 8-172). This indicates that highest percentage of rocks in most identified features were relatively small. In fact, 21.3 percent were less than 4 cm in diameter. This indicates that the rocks comprising most features were probably too small to retain much heat and most likely would not have been suitable for reuse. Presumably, these rocks were discarded.

Data concerning discard behavior is very limited in the ethnographic literature. Yellen (1974:207) describes family living space for Kung Bushman as centered mainly around hearth areas. In a comprehensive review of the ethnographic data concerning discard of materials Murray (1980) offered some revealing information. One discovery was that there is very limited data concerning discard behavior in the literature. She hypothesized that migratory populations who use temporary locations would discard materials were they were used and the family living space was outside the hut, but in the campsite. Her literature review indicated that migratory populations discard materials outside their use locations and that only some peoples discard material elements at their use locations. Apparently, the discard of elements is not as predictable as we would hope, making the interpretation of patterns in archeological context more difficult.

Storage technology in the form of pit features in the ground similar to those in the later Plains Village cultures such as the Antelope Creek phase, were not identified in this Late Archaic component. This may be due to the fact this population did not have any subsistence resources in excess of their immediate needs in which to store. The storage of excess food in pits would imply this population was here for an extended period of time and/or had something that could be stored in the ground. We encountered no evidence of permanent structures to support an extended stay. The accepted lifeway of most Late Archaic populations has been shown over and over again that these were primarily nomadic groups and not semisedentary. With at least 13 bison processed, it is quite likely they acquired food resources that were in excess of that which was consumed on site, but the surplus was not kept in subterranean storage facilities. If a surplus of food was generated for future use as discussed in the case of bison meat, those products were processed in a way that would preserve them and make them transportable. For instance, the projected number of bison present would have provided such a large quantity of meat that it was quite likely that not all the fresh meat was consumed on site. Therefore, the excess meat was dried (jerked) and/or turned into pemmican.

Many early photographs of Native American camps depict meat cut into small strips drying on wooden frames outside habitation structures. The production of pemmican was the hunter-gatherers' way to store excess meat for future use. If wild grass seeds or products made from the seeds were in excess of what was consumed at this site, these plant products may also have been stored/curated, but not in the ground. The end product of the grass seeds could have taken the form of dry cakes or breads, which facilitated their storage and transport in skin bag containers for future use. Thus, a food storage technology was most likely used by this Late Archaic population, but it is archeologically undetectable.

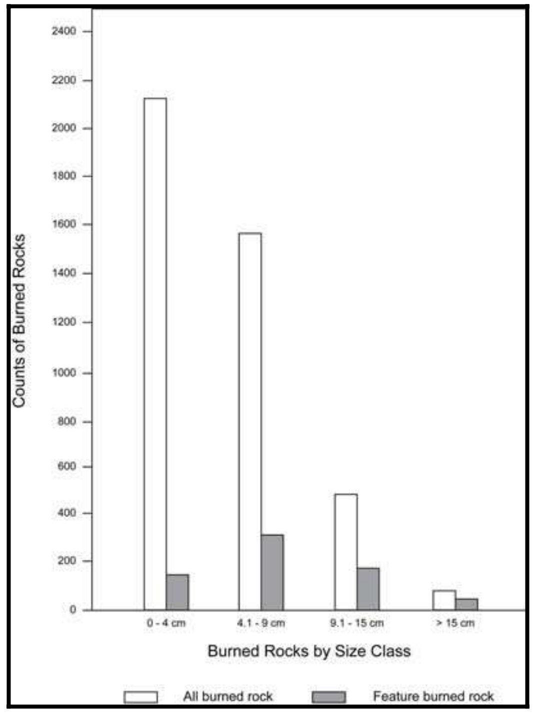


Figure 8-172. Comparison of Burned Rock Size Classes for Features and Nonfeatures at 41PT185/C.

Is there a specific pattern of stone-tool manufacture in use at this time?

Stone tool technology

Most researchers have assumed that one uniquely crafted and easily recognizable chipped stone tool, the corner-tang knife (Figure 8-173), represents a specialized function for processing some specific resource. This uniquely shaped and hafted biface has been recovered from other Late Archaic contexts across much of south and central Texas, were it appears most often, as well as across most of the Plains in general, with outliers extending into Montana and

Figure 8-173. View of Dorsal Side of Corner-Tang Knife #609-010. (scale in cm)

Illinois (i.e., Patterson 1936; Hall 1981; Kraft 1993, 1994b).

In central Texas this artifact type is most often associated with Frio, Ensor, and Marcos dart point types, which are all part of the Late Archaic material culture in central Texas. Use-wear studies on Late Archaic corner-tang knives from Texas broadly indicate they were utilized as knives or as multifunctional tools, probably for processing soft tissue plants and animal products (McReynolds 1984; Mitchell et al. 1984; Ward 1990 cited in Kraft 1993). Though most corner-tangs have been recovered from the surface (over 725 in Texas alone), many have also been recovered from burial contexts in Texas (G. Hall 1981; Mitchell and Orchard 1984; Mitchell et al. 1984; Broehm and Lovata 2004). This latter association indicates this tool had special importance or high value to select individuals and may indicate a specialized function. For example, at the Ernest Witte mortuary site (41AU36) only one out of 145 burials (Burial 31, a young adult female) in the "Group 2" cemetery, contained corner-tang knives (N = 2) as grave offerings (G. Hall 1991).

The corner-tang knife (#609-010) from 41PT185/C was recovered in a clearly defined context and can definitely be associated with the Late Archaic component dated to ca. 2500 B.P. This rare tool came from 62 cmbs immediately under a 30 cm diameter unmodified rock (less than 1 cm of soil separated it from the rock). The corner-tang has a broken distal tip caused by use and lacks obvious resharpening or extensive modification following its initial manufacture. Before washing and touching with bare hands, this artifact was subjected to high-power microscopic use-wear analysis by Dr. Hardy. In his examination he observed what appeared to be starch grains and hair fragments on the shorter lateral edge near the broken tip, and abraded flake scar ridges, hard, high-silica polish, and wood fragments on the proximal end around the two notches. He interpreted that this tool was clearly hafted and functioned in cutting soft material such as hide and starchy plants (Appendix L).

Following use-wear analysis this corner-tang knife was subjected to starch grain analysis by Dr. Perry. She sampled the two different lateral edges, but failed to recover any starch grains (Appendix F). Based on the high-powered use-wear and starch grain analyses, this biface probably did not serve any specialized function, or have any functional difference from other thin, bifacial cutting tools.

This bifacial tool is however, technologically different from most other bifaces recovered as it has notches to facilitate hafting, and the notches are positioned at one corner (Figure 8-174). The two well executed notches at the corner of the proximal end sets this biface apart from hafted projectiles with notches and other cutting tools that lack the notches to facilitate hafting (see discussions below).

The placement of the two notches on the proximal corner must have had a specific purpose that could not have been completed by more standard hafted bifaces. Based on Dr. Hardy's use-wear observations, the wooden haft extended across about 25 percent of the proximal end and at an oblique angle to the tool's long axis (see Figure 8-174). The oblique angle between the haft and tool provides an unusual cutting angle in comparison to other hafted tools. This angle would also change the stress point from the angled stem.

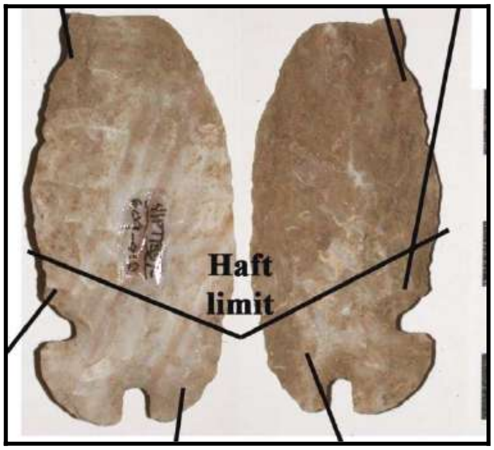


Figure 8-174. Corner-Tang Knife (#609-010) that Shows Location of Haft-wear, Diagonal Line above Notches Marks the maximum Extent of Observed Wear. (scale in cm)

After chipped stone tools were manufactured, they would then haft the finished artifact to a wooded shaft. Use-wear analysis provides a glimpse of how some chipped stone tools were hafted to their shafts, identified through abrasion detected on the elevated ridges between the flake scars. Haft differences on the two complete projectile points were previously addressed (see Figure 8-168). In one instance, the shaft appeared to have extended to the midshaft of the blade (#1104-010) in contrast to the shaft that stopped at the narrowest spot at the neck (#1288-010).

Other detected haft-wear was observed on 63 percent of the examined bifaces (i.e., #868-010, #1064-010 and #1212-010) excluding the corner-tang knife (Figure 8-175). In these instances, plant fibers, wood fragments, resin, and hard, high silica polish were detected on the proximal half of these unnotched bifaces. In these three instances, the detected haft-wear extended to about the midpoint of the blade (see Figure 8-175). Regardless of how these bifaces were hafted, either socketed inside a bone or wood shaft, or lashed into a split shaft, about one half of the flaked tool would not have been usable. The presence of resin on biface #868-010 indicates that binding was supplemented by resin, which may have been a the normal practice in securing the tool to the haft.

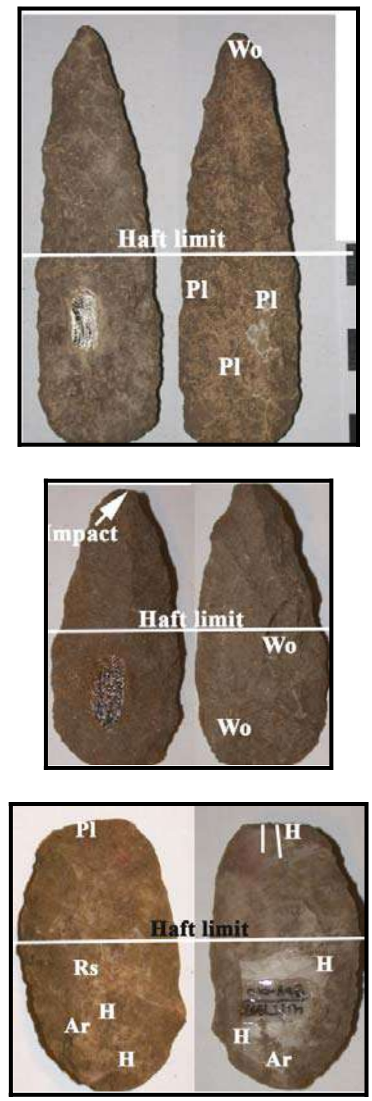


Figure 8-175. Three Use-Wear Analyzed Bifaces (#1064-010, #1212-010, and #868-010) that Show Haft Locations. (scale in cm)

Thirty three percent of the scrapers analyzed (#402-010, #446-010, and #767-010) also revealed haft-wear that extends to near the midpoint (Figure 8-176). Abraded ridges between the flakes scars appear on each face the proximal part, indicative of the wooden shaft on both sides of the tool. In at least two instances (only 12 percent of the tools analyzed) small spots of resin were also identified in the haft area.

The resin was apparently used in combination with lashings to bind and hold the tool firmly in the split haft. If lashings were used and extended along the entire haft, this technology would have reduced the amount of lateral edge available for use. In two instances, the proximal halves of end scarpers were identified in this assemblage. The breakage locations on these two proximal sections reflect the point where the scraper was tightly supported in the haft with lashing. Considerable force must have been applied to these hafted scrapers to snap off the distal ends.

This detected hafting technology appears to have been employed for the entire assemblage of formal chipped stone tools. The strategy of extending the haft to near the midpoint of the tools was detected on one projectile point, three bifaces, and three end scrapers. Regardless of the intended function or shape of the tool, this hafting strategy was employed. This has not been detected in other assemblages, because they have not been subjected to high-power use-wear analysis.

Not only was this hafting strategy detected on multiple end scarpers from the Late Archaic component at 41PT185/C, but this same strategy was also detected minimally on one of the end and side scrapers (#446-013) from the Protohistoric component at 41PT186. Apparently this hafting strategy was employed by different groups over a span of ca. 2,000 years in this region. Tomka (2001) has suggested that the hafted tools allows for greater leverage and reduced hand strain, in contrast to hand held tools. He then translates that into a significant advantage for lengthy processing tasks and/or physically stressing tasks for the user. This would be the case if a large quantity of meat needed processing at one time, that as that following a major fall kill event.

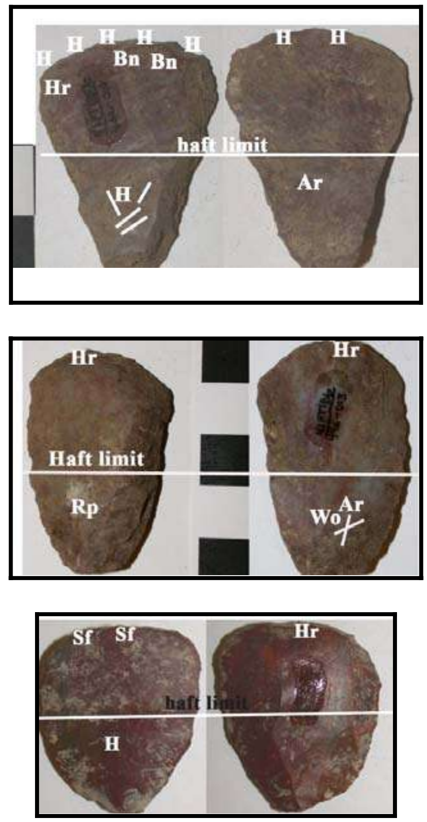


Figure 8-176. Three Scrapers (#402-010, #446-013, and #767-010) Analyzed for Use-Wear that Show Haft Locations. (scale in cm)

It is also interesting that the slightly larger and more robust side scrapers, as compared to the smaller end scrapers, do not show any evidence of abraded ridges or haft-wear (Figure 8-177). The lack of abraded ridges may indicate these side scrapers were not hafted and were of sufficient size to be hand held. This may imply that these tools were made for use on materials that did not require the intense pressure or force to which hide scrapers were subjected. The side scrapers still functioned as scrapers, but they may not have been used on hides. In fact, all three side scarpers analyzed exhibited starch grains, indicating that they were used on starchy plants.

The high frequency of bifaces (*N* = 21), the preponderance of bifacial reduction flakes, combined with the fact that no cores were recovered and there is limited evidence for core reduction, indicates that the bifaces and dart points were crafted from bifaces and not flake blanks. The high frequency of bifaces may also reflect the intensive processing requirements of the 13 bison. These formal hafted tools, in contrast to expedient/informal tools, permit the application of greater force or higher load limits, for greater control, and easier handling for the processing the great quantities of meat at this site. Although relatively high frequencies of edge-modified tools are present (*N* = 74), their overall small size, with limited and irregular flake patterns, do not support they served in intensive processing.

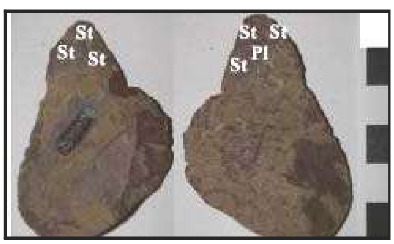


Figure 8-177. Dorsal View of End and Side Scraper #452-010. (scale in cm) (artifact not washed)

Botanical remains, including wood charcoal from the cultural features, were very poorly reserved with the two most productive features (burned rock Features 11 and 8) yielding less than 1 g of identifiable wood charcoal. The charcoal from these two features was identified as cottonwood/willow and mesquite wood (Appendix N). Twenty five other charcoal samples were of sufficient size to potentially allow for identification and were submitted for analysis. Those pieces were identified as mostly juniper (52 percent) and mesquite wood (16 percent). Even with only a few features that yielded chunks of charcoal and poor botanical preservation, the lipid residue analysis on the burned rocks provides a clear indication of what types of fuel resources (i.e., wood or animal chips) were used in fires. Trace amounts of the biomarker, dehydroabietic acid, documents the presence of conifer products, most likely introduced from the firewood, in the burned rocks analyzed. This biomarker was identified on burned rocks from 69 percent (11 of 16) of the analyzed features. In this locality, the only available conifer would have been juniper trees, which are present in most valleys across the region. If juniper wood was the source of the dehydroabietic acid, then the Late Archaic populations primarily selected this slow burning hardwood, together with some hard mesquite wood, for use as fuel. The botanical and lipid residue evidence clearly documents a consistent preference for juniper and mesquite, as other woods (cottonwood, plum bushes, and various other types of bushes), and even buffalo chips were present along this stream and in the immediate surroundings.

8.4.3.5 Miscellaneous Materials

8.4.3.5.1 Introduction

A few hand excavated units were started above the arbitrary 40 cmbs that was thought to mark the top of the Late Archaic component. In a few instances, cultural materials were encountered in the sediments above 40 cmbs. It is believed that those materials may represent more recent occupations, and not part of the targeted Late Archaic component. In support of this interpretation are the findings of two arrow points and two tiny ceramic sherds from above 40 cmbs. These few items are described and discussed below.

Chipped stone Tools

Two arrow points and a multifunctional scraper (#1228-010) were recovered from above the Late Archaic component. Each specimen is described below with other attributes presented in Appendix Q.

A small, complete corner-notched arrow point (#1063-010) was recovered from 26 to 40 cmbs in N117 E106 (Figure 8-178). It measures 19.4 mm long by 12 mm wide and 3.3 mm thick. This complete point only weights 0.7 g. The narrow neck width is 7.0 mm, supporting its classification as an arrow point. It was manufactured from a reddish chert that resembles red Alibates, but lacks the characteristic stripes. The notches were executed from the corners, which created an expanding stem. The base is straight (Figure 8-177).

Figure 8-178. Corner-Notched Arrow Point #1063-010. (scale in cm)

A basally notched arrow point (#1198-010) was recovered from 30 to 40 cmbs in N119 E108 and about 2.5 m from the previous arrow point. The point is complete except for a tiny broken area along the base and just above one notch (Figure 8-179). It measures 37.0 mm long by 16.6 mm wide and 3.1 mm thick. The neck width is 8.4 mm wide, and the point weighs 1.9 g. The one intact ear extends downward indicating that the notch was created from the base rather than the corner. The base is more or less straight and the stem is slightly expanding. This point was manufactured from orangish brown jasper, probably Tecovas.

The scraper #1228-010 was manufactured from a dark-reddish tertiary flake of Alibates that has a whitish quartz area at the proximal end. This tool was recovered from 28 to 40 cmbs in N120 E102. The proximal end lacks a definite bulb and the quartz area appears to have served as the platform. The ventral surface is flat and concave. The dorsal surface has a long ridge that runs the entire length of the tool creating a convex profile. The left lateral edge is steeply retouched with both large and small flake scars near the very margin. The right lateral edge is minimally retouched with one relatively large flake scar that appears to represent a misstrike. The distal end is steeply retouched, with a narrow and sharp engraver tip at the juncture of the right lateral edge and distal end. This tool is unlike any from the Late Archaic component and is interpreted as unassociated with the early component.

Figure 8-179. Basally-Notched Arrow Point #1198-010. (scale in cm)

Ceramic Sherds

Two tiny (less than 1 cm-long) ceramic sherds were recovered towards the northern end of the excavation block. Both sherds are believed to date to the Late Prehistoric period or later and are not in any apparent way associated with the Late Archaic component discussed above.

Sherd #850-008-1 was recovered from 30 to 40 cmbs in N113 E106. This tiny body sherd is 8 mm wide and has a relatively flat, plain exterior surface. The exterior surface is dark brown (7.5YR 3/2) to pink (7.5YR 7/4) on this smooth surface. The interior surface is a very dark gray (7.5YR 3/N3) to brown (7.5YR 5/2) and has thin striations from wiping (Figure 8-180). The sherd is 4.4 to 4.6 mm thick with a dark brown (7.5YR 3/2) to dark gray (7.5YR N4) core. There is no apparent temper.

An edge of the sherd was broken off, crushed and wet mounted on a slide. It was too small for the normal thin section process used in petrographic analysis. Dr. Robinson determined that the paste is dense with few tempering particles. The tempering is medium to fine-grained quartz particles, with a secondary tempering material consisting of fine-grained, subrounded particles of opaque white feldspar (Appendix I).

Sherd #915-008-1 was recovered from 50 to60 cmbs in N115 E97. This tiny body sherd measures 12 mm in diameter. It has a partially painted exterior and smooth plain interior. The exterior reveals three parallel black stripes/lines on a weak red (2.5YR 5/2) background (Figure 8-181). The sherd measures 2.7 to 3.5 mm thick, and has a platy structure. The core is a pale red (2.5YR 6/2), as is the interior of the sherd. This painted exterior indicates this sherd is not local and probably represents a pot from the west, in New Mexico.

Again, this sherd was too small for normal thin sectioning. Therefore, a small corner was broken and crushed with the matrix wet mounted on a slide for petrographic analysis. Dr. Robinson observed a course to medium grained feldspar temper in small quantizes. Quartz particles were observed in lesser amounts. Caliche strands were observed along the internal horizontal planes. The platy layers are thought to have formed during firing and are uncommon in earthenware (Appendix I).

Figure 8-180. Interior Surface of Sherd #850-008-1. (scale in cm)

Figure 8-181. Exterior Surface of Sherd #915-008-1 with Two Painted Lines. (scale in cm)

Dr. Robinson could not place either sherd into currently defined paste groups as the temper agents of quartz and feldspar are in varying amounts and lack distinctive markers. These two tempering agents are widespread across the Southern Plains.

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9.0 SITE 41PT186 – CORRAL SITE

J. Michael Quigg and Paul M. Matchen

9.1 NATURAL SETTING

The Corral site lies within a single right bank meander of West Amarillo Creek about 1.3 km from the headwaters. The site is circumscribed by the creek on the south, west and north, and is bordered on the east by a gentle colluvial slope, which articulates with the eastern valley wall (Figure 9-1). Three constructional geomorphic surfaces are present: T_1, T_{0a} and T_{0b}. The core of the site, upon which the wooden corral is constructed, is the first terrace (T_1), which here lies about 6 m above the creek channel (Figure 9-2). Immediately abutting the first terrace south of the corral is the modern floodplain, the higher surface of which (T_{0a}) forms a narrow (10 to 20 m wide) band of flat ground that lies about 4 m above and parallel to the current channel. This surface pinches out just southwest of the corral, but extends continuously onto the next meander to the south. A small portion of the low floodplain (T_{0b}) lays inset below the upper floodplain, south of the corral. West of the corral, the ground surface gradually slopes downward towards the stream channel, eventually leveling off about where the bike trail crosses the meander. Inset below this portion of the higher floodplain is a small bar of the lower floodplain, which lies immediately opposite the confluence of West Amarillo Creek and an unnamed tributary. North of the corral, the first terrace abuts the channel, but a clear view of the ground between the first terrace and the channel is obscured by a dense stand of wild plums. The site lies in a grassland setting. The central area of the site is covered in ragweed and various grasses with a couple of elm and mesquite trees along the eastern and southern edges of the wooden corral. The creek valley is lined with trees including large cottonwood, willow, elm, honey locust, a few scattered mesquite, and plum trees. A modern surface pollen record is dominated by Cheno-am pollen at 60 percent with Low-spine Compositae pollen showing a secondary value of 19.5 percent, whereas grass pollen is a low 1.5 percent (Gish 2000).

9.2 SUMMARY OF THE 2007 PHASE I DATA RECOVERY INVESTIGATIONS

Five backhoe trenches (BTs 5 through 9) were excavated primarily along the margins of the T_1 surface and into the lower T_0 deposits (Figures 9-1 and 9-2). Trenches 6, 7, and the eastern end of BT 9 targeted the upper T_1 surface. Trenches 5, 8, and the western end of BT 9 targeted the lower, younger terrace deposits (T_0). A total length of 64 m of deposits was exposed by these five trenches. Four depositional units, Units B, C, D, and E veneer were exposed in BT 9. These varied in thickness and distribution horizontally and vertically across this site. Each trench was documented by the geoarcheologist and inspected for cultural remains. A vertical column of eight diatom samples though depositional Unit C, which included the faint, buried A horizon and marl, was collected from between 90 and 193 cmbs next to TU 6 towards the western end of BT 9 (Figure 9-3). Two 50 cm long monolith column samples were extracted from the western wall of TU 6 that again included the marl atop buried paleosol. The marl appeared as a brown (10YR 4/3) sandy clay loam. The paleosol was a brown (10YR 4/3) sandy silty clay loam. These monolith columns captured matrix from about 80 to 160 cmbs. Random bison bone samples (N = 27, weighing 3,895 g) were collected from the backdirt during the trench

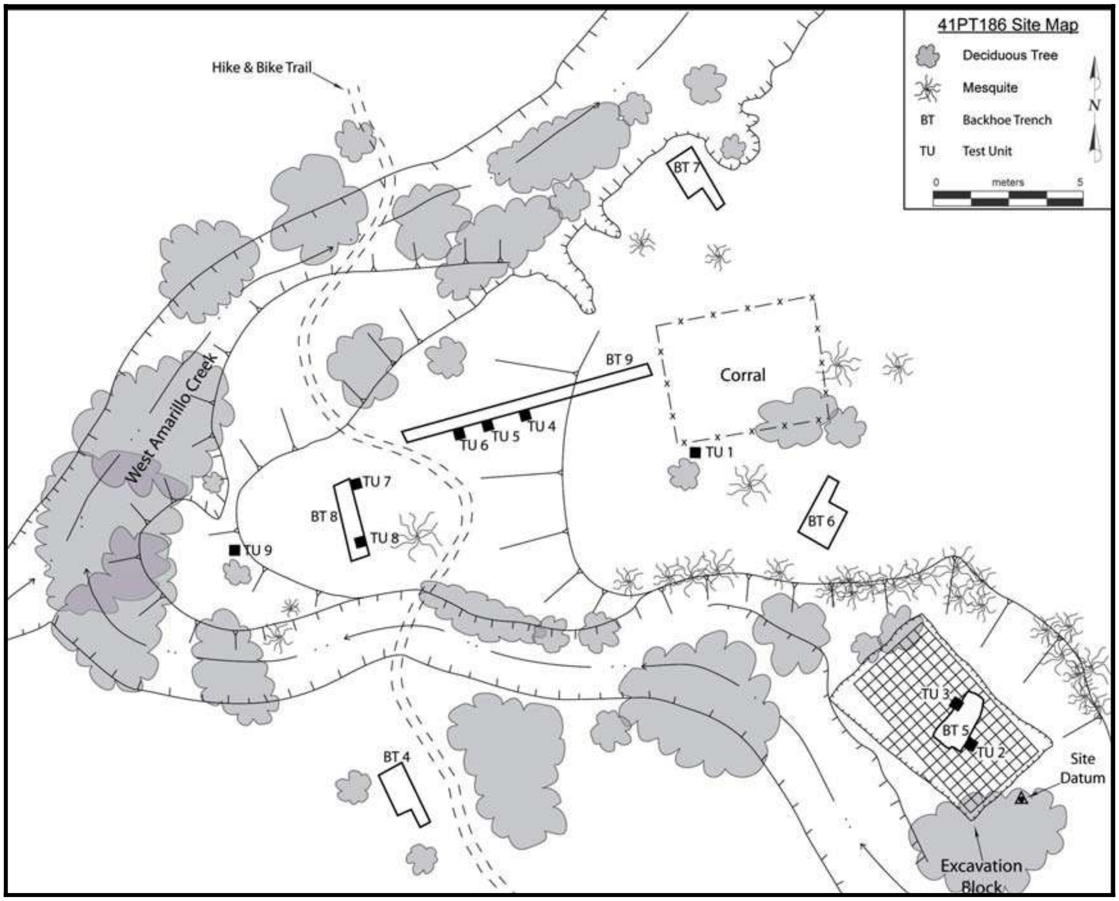

Figure 9-1. Map of the Corral Site, 41PT186 that Shows Locations of Excavations and Natural and Cultural Features. (Phase II Block Excavation in Lower Right Corner)

Figure 9-2. Overview of Corral Site Across Broad T1 Surface. (View is West, with Corral to Right of Truck Under Trees)

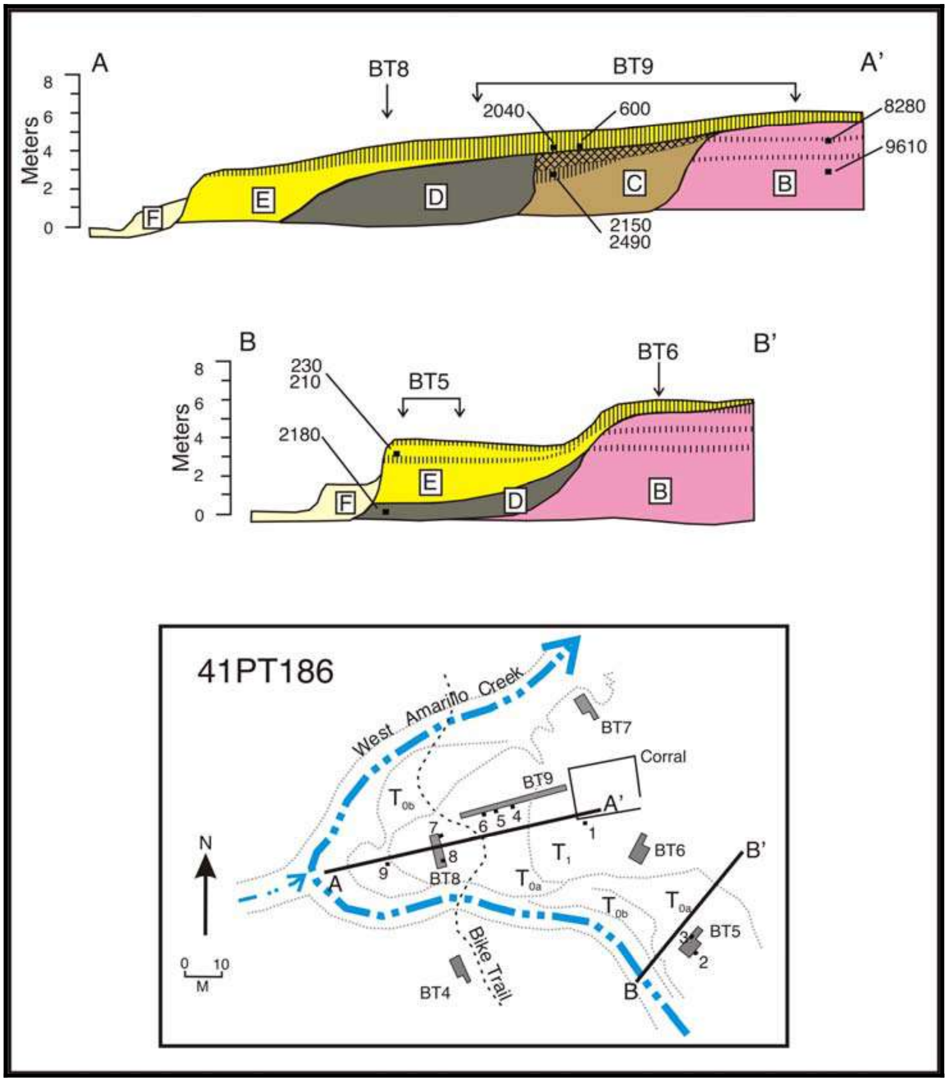

Figure 9-3. Profile of Generalized Stratigraphy and Plan Map of the Corral Site.

excavations of the western end of BT 9 and BT 8.

A bulk soil sample (#343-4-2b) from near TU 6 in the buried A horizon below the marl yielded a δ^{13}C adjusted radiocarbon age of 2150 ± 40 B.P. (Beta-235486; see Figure 9-3). Eight 1 by 1 m test units, 2 through 9, were excavated primarily off the sides of the trenches (see Figure 9-1). A total of 11.8 m^2 was hand excavated. These units varied in depth, with TUs 2 and 5 reaching 150 cmbs, TUs 6 and 7 reaching 200 cmbs, and others having much shallower depths. Test Units 3 and 8 each targeted specific depths where cultural materials were detected within a zone, and were not excavated from the original ground surface. In a couple instances where deep hand excavations were conducted, such as TU 7, this unit was excavated in two parts— 7a and 7b— and stepped to one side of the original unit (7a) to facilitate access to the deeper levels. The lower section (7b) was moved over and not directly below the upper section (7a) to facilitate the excavations below roughly 1 m in depth using the trench for easy access.

9.3 STRATIGRAPHY

The stratigraphy of the Corral site is complex, with multiple terraces, and evidence of multiple cut and fill events over the last ca. 11,000 years. The sloping and beveled edges of the oldest terrace edges have been covered with a veneer of younger deposits. Figure 9-3 illustrates the general stratigraphic relationships of the five identified depositional units (Units B, C, D, E, and F) documented during trench excavations. The broad first terrace (T_1) is primarily underlain by Unit B (radiocarbon dated to between 10,590 and roughly 8000 B.P.) visually distinguished by its reddish color and fine texture. The top of Unit B is covered with the variably thick (30 to 50 cm), sloping veneer of Unit E (modern to roughly 430 B.P.). It is possible that the surface of Unit B was also flooded during the subsequent deposition of Units C and D, with the deposits becoming mixed over time, and thus now indistinguishable. Trenches 6, 7, and the east end of BT 9, reveal this general stratigraphic sequence. Hence, it is apparent that the restricted site boundaries identified by surface observations during the original pedestrian survey (Haecker 1999) are on an old surface, which has existed for about 8,000 years, incrementally accumulating small amounts of sand (roughly 50 cm or less) during the last 2,000 years.

The stratigraphy west of the corral, underlying the sloping T_1 surface, is complex. It was exposed in BT 9, which extended from the western end of the corral to the bike trail (Figures 9-1 through 9-5). In this section, four alluvial fills were revealed. Unit C extends within the trench for about 8 m and is inset against Unit B in the middle part of the trench, which is in turn truncated by an inset of Unit D at the western end. Unit C dates roughly from ca. 5000 to 2100 B.P. with a hiatus in deposition around 2150 to 2250 B.P., allowing for the development of a now buried soil. A buried A horizon soil rests at the top of Unit C, overlain by prominent marl that postdates 2250 B.P. While most of Unit C is quite sandy, there were at least a couple of thin gravel lenses in the lower part. In BT 9, both Units C and D were draped by a relatively thin veneer of sandy sediment, Unit E.

Figure 9-4. Backhoe Trench 9, View Northeast with Corral at Far End and Bike Trail in Foreground.

Unit E is part of the modern floodplain surface (T_0) and dominates the deposits along the margins of West Amarillo Creek toward its southern and western ends, and possibly on the northern end of the site as well. Unit E is roughly 3 m thick along the creek channel and dominates the deposits in BTs 5, 8 and the western end of BT 9. It is visually distinguished by a very sandy matrix with a buried soil horizon at roughly 1 m deep (Figure 9-6). A thin sliver of Unit D (radiocarbon dated to roughly between 1900 and 800 B.P.) was exposed beneath Unit E in BT 5, and inset into Unit C at the western end of BT 9. Unit D is distinguished by fine-grained, dark colored muds representing an interval of more humid climate when small ponds and marshes dominated the valley floor for nearly 1,000 years. A small fragment of the low, recent floodplain deposits along the

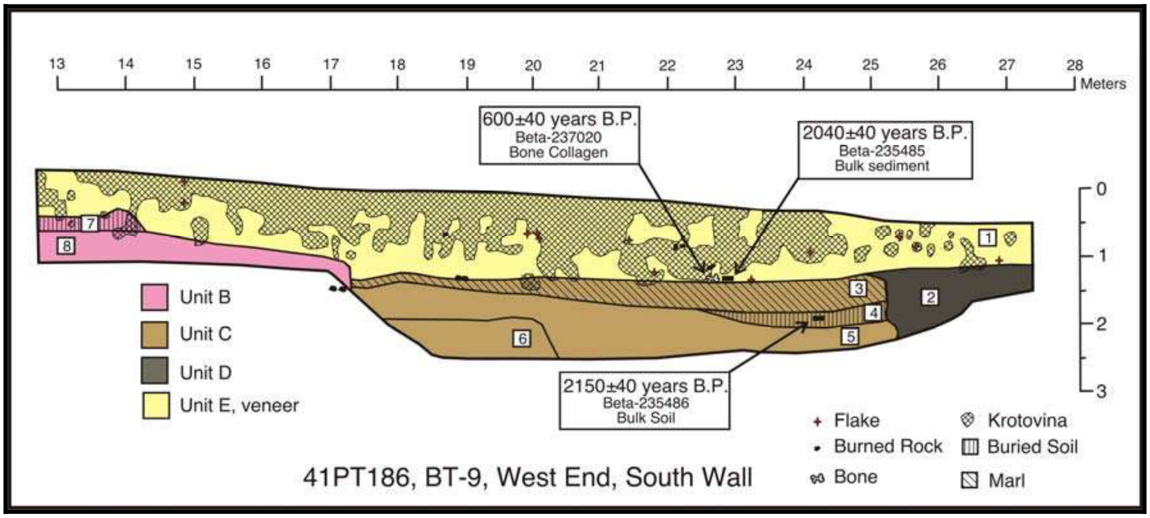

Figure 9-5. Depositional Units Observed in Stratigraphic Profile of BT 9 at 41PT186.

(Note: see Appendix A for detailed description of the deposits labeled 1 through 8)

very margin of the creek is designated as Unit F.

The context of the cultural material present is quite variable. The recent (ca. 200 to 300 year old) cultural occupation detected in BT 5 on top of the buried A horizon is well

Figure 9-6. Backhoe Trench 5, Revealing Thick Deposit of Depositional Unit E with Thin Gravel Lens, Above Thick Buried Soil at 1 m Below Surface.

(Note: cultural Feature 1, ash lens lies on top of the buried soil and below thin gravel lens)

preserved in a Pompeii-like alluvial setting, and appears to have considerable potential for well preserved cultural material and horizontally definable activity areas. Although extensive prehistoric remains were revealed by BT 9, most cultural materials in the upper 1 m are in the young sandy veneer (Unit E) that was extensively disturbed by rodent bioturbation (see Figure 9-5). The radical juxtaposition of the 2000 and 600 B.P. radiocarbon dates support this general observation.

9.4 PHASE I DATA RECOVERY RESULTS

The remains of multiple cultural occupations are scattered across this multiterraced site. They yielded diverse data from various contexts and with different interpretive implications. Each of three general site areas (southern, western, and central), is discussed below. At the very southern edge of the lower terrace (T_0), two test units (TUs 2 and 3) on the southern and northern edges at BT 5 penetrated through the upper 120 cm section of lower T_{0a} (Unit E). These two units yielded sparse, but diverse, cultural remains of a recent Protohistoric component (Figures 9-1 and 9-7). Together these two units revealed an intact cultural occupation surface buried roughly 100 to 110 cmbs, and on top of the aforementioned buried A soil horizon. Within this very limited area, at least two different, well defined activity areas, horizontally separated by roughly 3 to 4 m, were identified.

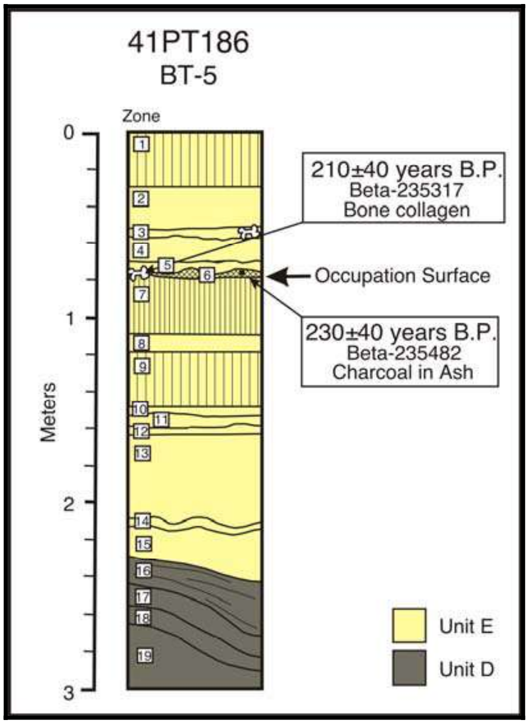

Figure 9-7. Profile of BT 5 that Shows Depositional Units in Relation to Cultural Occupation.

(Note: see Appendix A for detailed description of the deposits labeled 1 through 19)

Backhoe trench 5 truncated Feature 1, an ash lens visible along the southern edge of the trench as a nearly 120 cm long by 1 to 3 cm thick lens of white ash with a few, small chunks of charcoal towards its margins (see Figures 9-6 through 9-8). A few chunks of charcoal (#340-007) and a sample of the ash were collected from the trench profile.

The remaining ash deposit was then targeted and completely excavated in TU 2, excavated from the surface to 150 cmbs. The hand excavated and screened levels yielded no cultural materials until the ash deposit was encountered at roughly 100 cmbs. A charcoal chunk from the trench profile (#340-007-1) yielded a δ^{13}C adjusted radiocarbon date of 230 ± 40 B.P.

Figure 9-8. Overview of Southern Half of Feature 1, Ash Lens in TU 2 with BT 5 at Top.

(Beta-235482). This ash deposit was roughly 90 to 100 cm in diameter with irregular margins that were thin and difficult to define with precision. The ash was on top of a dark brown (10YR 4/3) sandy loam buried A horizon that was nearly 30 cm thick and exhibited only one small rodent disturbance. The entire ashy matrix (#259-004) and a sample of the sediment below the ash was collected.

Three small pieces of lithic debitage were found immediately adjacent to the ash within TU 2. These include a tiny resharpening flake, a core reduction flake, and a piece of angular shatter. No other cultural materials, such as animal bones, burned rocks, or stone tools, were observed on the margins of the ashy matrix of TU 2.

Mechanical excavation of a safety step on the northern side of BT 5 partially exposed butchered bison bones. Further troweling at the top of the A horizon exposed a cluster of butchered bison bones. This bone cluster was then targeted with TU 3. The hand excavations began just above a gravel lenses at 80 cmbs and continued to 150 cmbs. The gravel lens yielded a few bone fragments that included a nearly complete bison distal tibia at about 89 to 91 cmbs. The main cluster of butchered bones was encountered at the top of the buried A horizon between 114 and 120 cmbs. The cluster included a right distal metatarsal of a female bison (#261-002-3), a complete bison maxillary tooth, a complete bison 3rd phalange, a complete navicular cuboid, a cuniform pes, a left proximal tibia (#261-002-2) of a female, and a right immature bison radius shaft (#261-002-1; Table 9-1). Extensive rodent activity was also noted in many of the excavated levels. No lithic debitage, burned rocks, or other cultural materials were encountered in the 10 cm level with the butchered bison bones. A 5 g fragment of the immature bison radius (#261-002-1a; FS 99) from 118 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon age of 210 ± 40 B.P. (Beta-238317). Six grams of that same immature radius (#262-002-1b) were also sent for stable carbon and nitrogen isotope analyses. The radius yielded a $\delta^{13}C$ value of -8.4‰ and a $\delta^{15}N$ value of 5.7‰ (Appendix H). This bone date supports the charcoal date of 230 B.P. from Feature 1 and confirms the age of this deeply buried and well defined cultural occupation. No burned rocks, no stone tools, and only three pieces of lithic debitage were directly associated with the ash lens (Feature 1) and the clustered, butchered bison bones (Appendix B).

Table 9-1. Bison Bone Identifications and Characteristics from TU 3.

Catalog No.	Unit	Bison Element/Part	Weight (g)	Burned	Cut Marks	Surface Condition
261-002	TU 3	Complete left navicular cuboid	35	No	No	root etched, weathered
261-002	TU 3	Complete left cuneiform pes	6.5	No	No	root etched, weathered
261-002	TU 3	Complete 3rd phalanx	17.1	No	No	mostly intact
261-002	TU 3	Complete upper molar	9.5	No	No	mostly intact
261-002-1	TU 3	Medial immature right radius * and **	61.7	No	No	root etched, weathered
261-002-3	TU 3	Mature distal right metatarsal, female *	92.9	No	No	partially root etched
261-002-2	TU 3	Mature proximal left tibia, female *	180.1	No	No	rodent gnawed
* element used for carbon and nitrogen isotope analyses						
** piece used for radiocarbon dating						

This deeply buried cultural zone, radiocarbon dated to 200 to 250 B.P., rests on the well defined, buried dark brown (10YR 4/5) sandy loam A soil horizon (see Figures 9-6 and 9-7; Figure 9-9). This buried soil extends throughout BT 5 and most likely extends throughout this lower T_0 terrace. The cultural occupation that rests on the buried A horizon was sealed quickly enough by a low velocity overbank flood deposit that the ash and other perishable materials such as bones and charcoal remained well preserved and *in situ*.

Towards the western end of the site under the T_{0b} surface, specifically around the western end of BT 9 and all around BT 8, is another young, late Holocene deposit (Unit E; see Figure 9-1 and 9-5). This fill extends from the surface to at least 220 cmbs. Backhoe trench 8 exposed a number of bison bones at depth, a tiny charcoal sample from 175 cmbs (#342-007), an irregularly shaped quartzite edge-modified flake (#342-011), and a well formed complete end and side scraper made of Alibates (#342-010). The sample of collected bison bones (#342-002) includes one thoracic vertebrae body, two cervical vertebrae bodies, numerous rib fragments, and an immature right, proximal tibia fragment with a total weight of 546.1 g. These few elements indicate the representation of at least two bison in the trench which, coupled with the other artifacts indicate these animals were deposited by human activity, as opposed to representing natural deaths of the animals.

Test Units 7 (7a and 7b) and 8 (a total of 3.5 m^3 of excavation) off the eastern side of BT 8 targeted these young culturally relevant

Figure 9-9. North Wall Profile of TU 3 Depicting Extensively Disturbed Upper Sandy Deposits of Unit E Overlying Buried A Horizon at 100 cmbs (dark sediment at bottom) within Unit C.

deposits in Unit E. The two units revealed various quantities and types of cultural materials, including one tiny ceramic sherd (#314-008-1), one edge-modified flake (#307-010), one obsidian flake (#305-001-1), 29 pieces of lithic debitage, and 197 bone fragments. The one pottery fragment is a body sherd (#314-008-1) which came from 100 to 110 cmbs in TU 7b. The sherd measures 20.4 mm in diameter by 7.3 mm thick, and weighs 1.4 g. It exhibits a smooth plain exterior surface, while missing the interior surface. The paste was tempered predominantly with coarse angular quartz sand. The lithic debitage was vertically scattered with no clear concentration in an occupation zone (Appendix B). The obsidian flake (#305-001-1), from between 20 and 30 cmbs, was submitted for XRF analysis, which determined its geologic source to be the Cerro Toledo Rhyolite area in the Jemez Mountains of northern New Mexico (Appendix C).

In general, TU 7, excavated to 200 cmbs in two parts (7a and 7b), yielded very limited quantities (N = 25) of chert debitage vertically dispersed over 13 of the 20 excavated levels. No more than five pieces occurred in any one 10 cm level. Some 88 bone fragments were also vertically distributed over 16 and the 20 levels. The one sherd (#314-008-1) was from 100 to 110 cmbs. The obsidian flake (#305-001-1) was from 20 to 30 cmbs. Evidence of rodent holes and runs was observed in most excavated levels. Gravel lenses consisting of small caliche pebbles and gravel were encountered at 80 to 120 cmbs and again from 160 to 200 cmbs. The vertically diffuse occurrences of the cultural materials preclude any clear definition of a buried occupation surface.

Bone was the most prominent material encountered in this western end of the trench. It appeared in two vertically separated concentrations as detected in TU 8 and observations in the western end of BT 9. Test Unit 8 targeted a concentration of bones between 90 and 160 cmbs that was encountered during the excavation of BT 8. This unit yielded 109 pieces of bone weighing 4,770.4 g, with 13 pieces (#325-002) occurring in one concentration (Feature 3) between 83 and 110 cmbs, along with a single chert flake, a piece of charcoal, and a distal arrow point fragment (#326-010). The bones in the concentration included a distal tibia, multiple vertebrae, multiple rib sections, and pieces of long bones (Table 9-2). The bones were in sloping dark brown (7.5YR 4/3) silty sandy loam that was highly disturbed by rodent activity. A nearly complete butchered bison skull (#345-005-2) was found at 160 cmbs (Figures 9-10 and 9-11). The skull was turned upside down with an irregularly shaped, 10 to 12 cm diameter hole smashed into the top of the cranium. The skull was in a hard, compact dark brown (7.5YR 4/3) sandy loam. A butchered tibia fragment lay on top of the skull, whereas a 15 cm long piece of dolomite rested directly under the skull. A piece of this rock from under the skull (#331-003-1b) was submitted for starch grain analysis. Gelatinized starch grain fragments were found (Appendix F). Lipid residue analysis on a 21 g piece of this same rock (#331-003-1a) failed to yield sufficient residues for interpretations (Appendix G). The starch grain results indicate that this rock had been used for cooking. Thus, this rock was used in multiple ways, including as a heating element, possibly for stone boiling, and potentially to break open the skull.

Table 9-2. Identifiable Bison Bone Elements from TU 8.

Catalog No.	Bison Element/Part	Depth (cmbs)	Weight (g)	Burned	Cut Marks	Surface Condition
290-002	distal calcanium, large, butchered	70-80	64	No	No	root etched, weathered
324-002	small fragments	80-90	11.9	No	No	root etched
325-002	nearly complete rib, no head	89-93	79.8	No	Yes	root etched, weathered
325-002	distal tibia, large, right, male *	83	146.7	No	No	root etched, weathered
325-002	crumbled vertebrae body	89	44	No	No	root etched, weathered
325-002	cervical vertebrae body, immature	91	53.2	No	No	root etched, weathered
326-002	large nearly complete rib	100	71.3	No	Yes	root etched, weathered
326-002	medial rib section	97	18.3	No	Yes	root etched, weathered
326-002	proximal tibia, right, butchered	105	326.2	No	No	root etched, weathered
326-002	proximal rib section	100	31.3	No	Yes	root etched, weathered
326-002	23 bone fragments	90-100	32.8	4	No	root etched
327-002	complete 1st phalanx	108	25.5	No	No	root etched, weathered
327-002	mostly complete thoracic vertebrae	115	137.5	No	No	root etched, weathered
327-002	thoracic vertebrae spine fragments	100-110	21.1	No	No	root etched, weathered
327-002	complete thoracic vertebrae mature	114	107.1	No	No	mostly intact
327-002	mostly complete 2nd phalanx	110	22.6	No	No	root etched, weathered, rodent gnawed
328-002	fragmented rib	111	12.5	No	No	root etched
328-002	complete 1st phalanx	113	37.2	No	No	root etched, weathered
329-002	complete right scaphoid	113	17.8	No	No	weathered
329-002	distal humerus	125	465.6	light	No	weathered
345-002	bison skull with hole in cranium	150-160	3044	No	chop	root etched, weathered

* piece used for stable carbon and nitrogen isotope analysis

Figure 9-10. View of Inverted Bison Skull In Situ at 160 cmbs in TU 8.

Figure 9-11. Reassembled Bison Skull Showing Butchered Hole into Brain Cavity.

A matrix sample (#325-004-1) at ca. 83 to 90 cmbs from between the clustered bison bones in Feature 3 was collected and floated. The 8.9 liters of matrix yielded a heavy fraction (406.2 g) that included 160 tiny bone fragments (one burned), 16 tiny charcoal pieces, 16 pieces of hackberry seeds (two burned), four tiny pieces of lithic debitage, four pieces of hematite/limonite, plus many tiny snail shells and a few small bivalves. These results support the culturally relevant nature of this deposit. The light fraction (406.2 g) from this same sample (#325-004-1) yielded four tiny pieces of chert, four tiny rounded pieces of hematite, 16 hackberry seeds (2 burned), 16 tiny charcoal flecks, and 160 pieces of bone.

Test Unit 9 was hand excavated from the surface to 130 cmbs at the extreme western end of the site, roughly 15 m west of BT 8 in the low T_0 deposits (see Figure 9-1). Here, again, bone fragments dominated (with 218 pieces found between 10 and 90 cmbs), though no occupation surface was identified. Although a possible peak in bone frequency was between 60 and 70 cmbs, wherein were found 110 fragments, these were mostly small fragments of a shattered bison scapula, meaning that little more than that single bone element was represented. Although most pieces from TU 9 were quite small and unidentifiable, a bison vertebrae was identified at 48 cmbs, and some butchered long bone shaft fragments and some rib pieces were also identified. Two or three tiny bones fragments that were burned to a dark brown color reflect alteration by human agency. Considerable rodent activity was encountered throughout TU 9, which may account for the vertical dispersion of the bone fragments. Only three chert flakes were encountered, between 30 and 50 cmbs, and were in a dark brown (10YR 3/3 and 5/4) sandy loam. A 63 mm long, thin, rib section (#335-010) from 40 to 50 cmbs has one round and rounded end. The rounded end creates a spatula appearance with no obvious striation of grinding marks. This 4.4 g fragment is badly root etched with drying cracks. This bone tools would have been ideal for removing the skin from the meat of an animal leaving undetectable use-wear. The bone from TU 9 was definitely present as the result of human activity, and represents parts of at least one bison. The bison was most likely butchered in this vicinity. However, the absence of a well defined occupation surface/layer or zone indicates that TU 9 may be mostly disturbed, which limits the potential of the pertinent deposits to address significant archeological questions.

Towards the last 4 m or so of the western end of BT 9, numerous bison bones were observed during the trenching. A small random sample of those bones (#343-002) was collected (N = 27, weighing 3,895 g). The collection includes at least two partial skulls, two mandible sections from two different animals, seven mature and five immature thoracic vertebrae, six rib heads, three mature cervical vertebrae, and a few long bone fragments (Table 9-3). Measurements (see Speth 1983) taken on the distal humerus indicate that a large male bison is represented. The vertical distribution of the bones appeared to be partially separated by about 10 cm of sediment, which indicates possibly two separate zones in this younger depositional Unit E.

Table 9-3. Identifiable Bison Bone Element Sample from Western End of BT 9, Corral Site.

Catalog No.	Bison Element/Part	Weight (g)	Burned	Cut Marks	Surface Condition
343-002	7 partially complete, mature thoracic vertebrae bodies *	1018.2	No	No	root etched, rodent gnawed
343-002	5 mostly complete immature thoracic vertebrae bones and partial spines	794	No	No	root etched, rodent gnawed on spine edge
343-002	3 mature cervical vertebrae bodies	481.8	No	No	root etched,
343-002	1 rib head with medial section	67.2	No	No	root etched,
343-002	6 rib heads **	100.6	No	yes 3	root etched,
343-002	1 large complete axis	344.5	No	No	mostly intact
343-002	1 left distal humerus, butchered, male***	227.1	No	No	root etched
343-002	2 mandible sections with 3rd molar	698.9	No	No	partially root etched
343-002	1 left distal humerus, butchered	163.1	No	2 clusters	root etched

* piece used for radiocarbon dating; 600 ± 40 B.P. (Beta-237020)
** one head element used for carbon and nitrogen isotope analyses
*** Sex determined by measurements from Speth 1983

A bison vertebrae fragment (#342-002-1) from between 115 and 125 cmbs in the lower of the two bone zones of BT 9 yielded a δ^{13}C adjusted radiocarbon date of 600 ± 40 B.P. (Beta-237020). This one bone collagen date provides a general age for this bison processing activity area, which probably represents all the cultural materials from this depositional unit (Unit E) between Trench 9 and the creek including all that was recovered from BT 8 and TUs 7, 8, and 9. Although no diagnostic projectile points were recovered, one distal tip of a unifacial arrow point (#326-010) from 94 cmbs in TU 8, plus one plain ceramic sherd (#314-008-1) from 90 to 100 cmbs in TU 7, combined with the 600 B.P. radiocarbon date, strongly indicates a Late Prehistoric age for this bison processing area. This date falls within the general age for the Antelope Creek phase that is well represented in the surrounding region. The two peaks in vertical frequencies of the bone concentrations detected in the western end of BT 9 may represent two separate events of similar age, and both may be related to the Antelope Creek phase. The poorly defined vertical distribution may reflect the complex nature of the sloping alluvial deposits and/or the extensive rodent activity in this sandy loam in this area of the site.

The central area of the site, within the lower sloping T_1 surface west of the corral, was investigated through the hand excavation of three test units (TUs 4, 5, and 6) along the southern side of BT 9 (Figure 9-12). These three units were excavated to depths of 70, 150 and 200 cmbs respectively. Cultural materials found in these three units include lithic debitage (*N* = 138), bone fragments (*N* = 326), burned rocks (*N* = 37), mussel shell

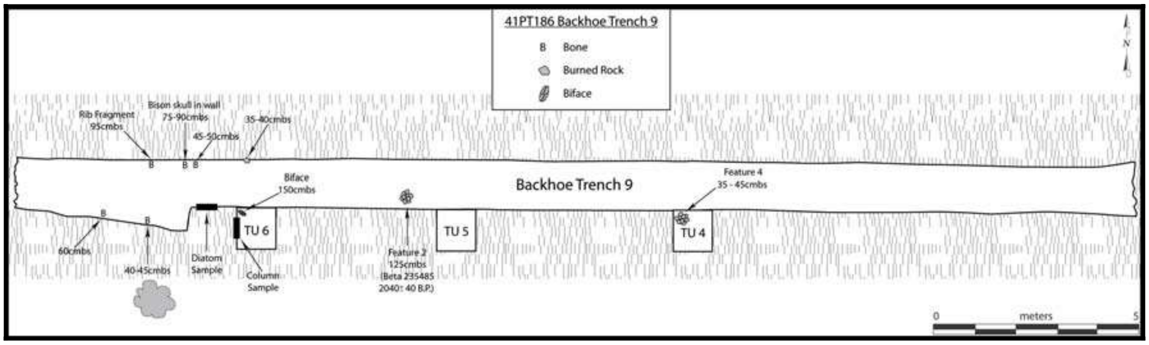

Figure 9-12. Plan View of BT 9 Showing Placement of Test Units and Exposed Bison Bones.

(*N* = 1), the occasional stone tool fragment (*N* = 6), and one partial and questionable burned rock feature (Feature 4). A cluster of burned rocks between 35 and 47 cmbs in the northwestern corner of TU 4 was labeled as Feature 4. The overall dimensions of Feature 4 are unknown since the clustered rocks were truncated by BT 9 and the cluster appeared to extend further west, and beyond TU 4. The exposed portion measured about 50 cm across the northern edge of the unit and 60 cm along the western edge (Figure 9-13). This feature revealed a concentration of 11 burned rocks that weighed 11.25 kg, including three or four possibly recycled ground stone metate fragments (#267-010, 011, and 012). The rocks varied in size from about 5 to 15 cm in length and rested at slightly different angles.

Figure 9-13. Oblique View of Feature 4 Rocks in TU 4, at 41PT186. (View West)

Three of the possible metate fragments (375 g) exhibit flat surfaces that showed minimal wear. One piece (#267-012; 197 g) exhibits extensive wear on both faces indicating that it was part of a two-sided grinding slab. No technical analyses were conducted on these pieces as they were thought to be recycled pieces with possible mixed residues that accumulated over time and represent different functions/events. The brown (10YR 5/3) sandy loam matrix inside the cluster was the same texture and color as outside the burned rocks, with no visible sign of charcoal or a pit. A matrix sample (#267-004-1) from ca. 30 to 40 cmbs in the northwestern corner was collected and floated. The heavy fraction (27.6 g) of the 3.0 liters of floated matrix yielded 15 bone fragments (two burned), seven tiny pieces of lithic debitage, two tiny charcoal pieces, one tiny burned rock fragment, and one burned seed. The light fraction (11.2 g) from this same sample (#267-004-1) yielded no recognizable charcoal or other macrobotanical remains.

Scattered pieces of smaller burned rocks and five pieces of lithic debitage were in the matrix surrounding this cluster of rocks. It is not clear what this feature represents and its function is not known. It may represent discard of burned rocks from some heating process. No specific age was determined or assigned to this burned rock feature.

Although multiple classes of cultural material were encountered in TUs 4, 5, and 6, these items were vertically dispersed and revealed no obvious occupation surface/layer or zone. Extensive rodent activity may have caused at least some of the vertical dispersal (Figure 9-14). It is also possible that the deposition of sediments in this area was not sufficient following each occupation to provide detectable separation of cultural events in the deposits. The context is not well suited for significant and meaningful interpretation of the materials given the uncertainty of their original association.

Figure 9-14. South Wall Profile of TU 5 that Shows Rodent Turbation in Dark Unit E Overlying Light Colored Unit C.

The collected surface materials from in and around the corral include one cordmarked sherd (FS 68.1) and one obsidian flake (FS 20.1) (Haecker 2000). The subsurface deposits exposed in BTs 6 and 7 on the northern and southern sides of the corral revealed no substantial cultural materials in the trench walls. The eastern end of BT 9 yielded limited quantities of cultural materials. A tiny untypable body sherd (#343-008-1) came from the top 15 cm of BT 9. It has the appearance of a corrugated utility ware, which may have been imported from the west, in New Mexico (Figure 9-15). This sherd measures 14.2 mm by 19.6 mm and ranges from 3.9 to 5.7 mm thick, and weighs 2.0 g. The exterior exhibits a corrugated finish with some smoothing and polish. The interior is plain and polished. The core reveals tiny angular, mostly clear sand grains. This sherd was split into two parts and one part was sent for INAA (#343-008-1a) and the other sent for petrographic analysis (#343-008-1b). The INAA indicates that this sherd was probably not manufactured from the local clays included in this analysis (Appendix J). In the INAA, a hierarchical cluster diagram links this corrugated sherd with a redware sherd (41PT245-#401-8-1e) from the Pavilion site (Appendix J). The petrographic analysis places this sherd into Paste Group 3 and the only member of this group. The ceramic material showed enough differences in its composition to give it distinction from the other two paste groups. The petrographic analysis revealed a moderately dense reddish-black matrix interrupted by jagged pore strips. Its primary distinction is its tempering with a crushed rock made up (Rock B) of quartz and biotite.

Figure 9-15. Corrugated Exterior of Sherd (#343-008-1). (scale in cm)

The rock seems aberrant in its lack of feldspar, which is also lacking elsewhere in the section. This situation appears to be idiosyncratic, as feldspar is nearly ubiquitous in the collection and in the igneous rocks of the panhandle and other regions. Paste Group 3 could have been manufactured from various clay resources found within Potter County, based on the broad similarities with the studied local sediment samples (Appendix I).

The previous sherd contrasts with a Borger Cordmarked sherd (FS 68.1, Figure 9-16) recovered from the surface during the previous investigation (Haecker 2000). The cordmarked sherd measured 12.4 by 16.2 mm, was 4.0 to 4.3 mm thick, and weighed 0.9 g. The exterior cordmarking was smoothed over and nearly obliterated with a shiny surface, a gray color, and some visible temper particles. The interior was reddish with a smooth surface and lots of visible temper particles. The core revealed lots of rounded quartz and feldspar that were clear, white, and gray. Only INAA was conducted on this tiny sherd. In the INAA a hierarchical cluster diagram links this cordmarked sherd with three local sediment samples, two local clays, and one local sandy loam sample from West Amarillo Creek (Appendix J). In general, the constituents are very similar to Meier's (2007) Group 1 that contains Border Cordmarked sherds from the Antelope Creek site 41PT109 further down the West Amarillo Creek valley. This INAA indicates local production and links this cordmarked sherd to the Antelope Creek phase of local Plains Village culture.

The third sherd (#314-008-1) was recovered from 90 to 100 cmbs in TU 7b. This specimen is 20.4 mm long by 7.3 mm thick and exhibits a smooth plain exterior surface with a slight curvature, whereas most of the interior surface is missing. The additives include coarse angular sand grains. Based on the exterior finish of these three sherds they appear to represent three separate vessels. All three represent the Late Prehistoric or Protohistoric period, although

Figure 9-16. Cordmarked Exterior of Sherd FS 68.1. (scale in cm)

they may represent at least two different cultural patterns, one being the local Antelope Creek phase and one an unknown or unidentified pattern.

Feature 2 was discovered at 125 cmbs inside BT 9 during trench excavation with the backhoe (see Figure 9-12). This illdefined cluster of cultural materials appeared to be limited in area and consisted of a few small burned rocks and a couple of pieces of chert debitage. Tiny flecks of charcoal in a clump of dirt (#343-004-2a) from this cluster of burned rocks yielded a δ^{13}C adjusted radiocarbon date of 2040 ± 40 B.P. (Beta-235485). Below Feature 2, at 205 cmbs, dark stained sediment (#343-004-2b) associated with scattered cultural material yielded a δ^{13}C adjusted radiocarbon date of 2150 ± 40 B.P. (Beta-235486). This latter date is suspect and may reflect younger organic matter moving down profile. It may also reveal a very slow deposition rate in this area.

Three obsidian flakes were recovered. Specimen FS 20.1 is piece of shatter from 10 to 20 cmbs in TU 1 (Haecker 2000). Specimen #305-001 is a biface thinning flake from 20 to 30 cmbs in TU 7. Specimen #344-010 is a biface thinning flake from the surface east of the corral. These three flakes were sent for XRF analysis to determine their original source. Two of the three pieces were chemically determined to be from the Jemez Mountain region of northern New Mexico and represent two distinct outcrops. The two sourced specimens were from Valles Rhyolite and Cerro Toledo Rhyolite, with the third from an unknown source (Appendix C). Although their precise cultural affiliation is not known, the Antelope Creek phase contains quantities of obsidian from northern New Mexico (Lintz 1986; Brosowske 2005) and it is likely these date to that period or later.

The distal tip of a dart point (#277-010) was found at 60 to 70 cmbs in TU 5. It was manufactured from a dark grayish blue Alibates.

A small biface fragment (#280-010) was recovered from 90 to 100 cmbs in TU 5. This piece appears to be one edge of a much larger specimen with pressure retouch along the lateral edge. It was manufactured from a dark grayish blue Alibates.

A complete combination end and side scraper (#288-010) from 50 to 60 cmbs in TU 6 is thought to be of Late Prehistoric age. It is teardrop in outline with a steeply worked right lateral edge, a steeply worked distal end, and is also steeply worked from the ventral surface of the left lateral edge (Figure 9-17). The proximal end is pointed and lacks a striking platform. The distal end is convex. The dorsal surface is relatively flat, but mostly worked. The ventral side is generally flat and smooth although the one edge has been beveled. This piece was manufactured from a mostly gray (GLEY1 5/N) Tecovas with very dark gray (GLEY1 3/N) speckles. The material type and the fact that this is a beveled piece, which is common in the Antelope Creek phase bifaces, indicate an Antelope Creek affiliation for this end scraper.

A medial and very thin, very well crafted biface fragment (#300-010) was recovered from 157 cmbs in TU 6. This was within the 30 cm thick buried A horizon in Unit C, from a vertical position 20 cm below bulk sediment dated to 2150 ± 40 B.P. (Beta-235486). This places this finely crafted and overall workmanship indicate this might be the midsection of a large dart point (Figure 9-18). biface in the Late Archaic period. The thinness, the excellent symmetry,

Figure 9-17. Complete End and Side Scraper (#288-010) from TU 6. (not washed)

The break at the distal end appears to reflect a snap that may be associated with a projectile. Both lateral edges exhibit tiny flake scars and are still very sharp. This piece was manufactured from a dark reddish Tecovas flake.

Figure 9-18. Medial Biface/Point (#300-010). (not washed)

A very thin distal arrow point fragment (#326-010) came from 94 cmbs in TU 8. It was made from a flake, as is evident from a partially unworked ventral surface with impact rings still evident (Figure 9-19). The distal end is worked on both faces, but part of the dorsal surface is not worked. It was manufactured from a mottled reddish and white Alibates. The partially worked nature of this arrow point fragment is similar to Late Prehistoric projectile points, indicating, along with its context, a possible Antelope Creek phase affiliation.

Figure 9-19. Distal Arrow Point Fragment (#326-010) from 90 to 100 cmbs in TU 8.

The complete end and side scraper (#342-010; Figure 9-20) from BT 8 is assumed to be of Late Prehistoric age and most likely is affiliated with the Antelope Creek phase. It is complete, but exhibits a small rectangular fractured area along the right lateral edge. The overall outline is somewhat rectangular with the left lateral edge tapering to a thin retouched edge. The distal end, right lateral edge and proximal end are all steeply worked and appear to have been used as scraping edges. Much of the dorsal surface is unworked as is the entire ventral surface. The distal end of the ventral surface shows a slight curve or hook at the very end. The piece was manufactured from deep, weak reddish (2.5YR 4/2) and reddish gray (2.5YR 6/1) speckled Alibates.

An edge-modified flake (#552-010) was collected from the surface just southeast of the corral. It exhibits a flat ventral surface with couple of scars along two different lateral edges. No platform was detected. The edges are irregular with two limited areas with retouch. This piece was manufactured from a dusky red (10YR 3/4) Tecovas with minor pale yellow (2.5Y 8/2). The rough cortex is a pink (7.5YR 8/4).

Figure 9-20. Complete End and Side Scraper (#342-010) from BT 8.

9.5 SITE INTEGRITY AS DETERMINED FROM THE 2007 PHASE I INVESTIGATIONS

The context of the cultural materials scattered across three distinct areas is quite variable. The majority of the expanded Corral site is under the broad T_1 surface, which includes the vicinity of the corral and much of BT 9. This area exhibits a variable, 50 to 120 cm thick sandy fill (Unit E) deposited during the late Holocene (< 430 B.P.) and potentially mixed with deposits older than this (Units C and D). This soft sandy fill contains cultural materials, as evident by the 20 bone fragments, 12 burned rocks, and the roughly 40 pieces of lithic debitage recovered from TU 1 next to the corral (Haecker 2000). The results from the upper parts of TUs 4, 5, and 6 yielded a similar vertical dispersal of various cultural artifact classes. However, this late Holocene fill (depositional Unit E veneer, possibly mixed with some Unit C and D deposits) is extensively disturbed by rodent bioturbation. Those cultural materials in the soft turbated fill have the potential for having been displaced. As an example, a wire nail and twentieth century bottle glass fragment were recovered from between 10 and 20 cmbs in TU 1 (Haecker 2000). A pocket of charcoal (FS 24.1) collected from 47 cmbs in TU 1 yielded a $\delta^{13}C$ adjusted radiocarbon date of 80 ± 40 B.P. (Beta-135418; Haecker 2000; Table 9-4). Above that, a fragment of a bison bone from 40 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon date of 340 ± 40 B.P. (Beta-138513; Haecker 2000). These two dates are inverted and indicate problems of context in the upper deposit. It also reveals the difficulty in trying to determine how cultural materials are associated with other materials in this context.

Table 9-4. Radiocarbon Dates from 41PT186 in Potter County, Texas.

Provenience	Catalog No.	Feature No.	Depth (cmbs)	Material Dated *	Weight of Material (g)	Beta Lab No.	Measured Age	13C/12C Ratio (‰)	Conventional Age (B.P.)	2 Sigma Calibration Age
PT186, TU 1	FS 24.1		47	charcoal chunks		135418	80 ± 40	-14.7	80 ± 40	Cal AD 1680 to 1955
PT186, TU 3	261-002-1		118	1 immature bison radius	5	238317	100.8 0.5	-7.8	210 ± 40	Cal AD 1640 to 1950
PT186, BT 5-1	340-007-1	1	99	1 charcoal	0.1	235482	220 ± 40	-24.5	230 ± 40	Cal AD 1540 to 1950
PT186, 488/489	FS 643	8	75	1 charcoal	0.1	250879	370 ± 40	-29.6	290 ± 40	Cal AD 1480 to 1660
PT186, TU 1	FS 71.1		40	1 bison bone frag		138513	100 ± 40	-10.0	340 ± 40	Cal AD 1450 to 1620
PT186, BT 9-1	343-002-1		110-115	1 bison vertebrae		237020	350 ± 40	-9.9	600 ± 40	Cal AD 1290 to 1420
PT186, BT 9-1	343-004-2a	2	125	sediment	0.1	235485	1940 ± 40	-19.2	2040 ± 40	Cal 170 BC to AD 50
PT186, BT 9-2	343-004-2b		205	sediment Ab	0.1	235486	2160 ± 40	-25.5	2150 ± 40	Cal 360 BC to 280 BC
PT186, TU 6	302-007		180	1 charcoal in buried A	0.1	237021	NA	NA	2490 ± 40	Cal 780 to 410 BC
PT186, BT 6-1	341-004-1a		136-139	2Ab? sediment	0.1	235483	8240 ± 50	-22.7	8280 ± 50	Cal 7480 to 7170 BC
PT186, BT 6-2	341-004-2		264-268	3Bk sediment	0.1	235484	9560 ± 50	-22.0	9610 ± 50	Cal 9230 to 8800 BC

* bone dates were on collagen

Displacement of cultural materials was apparent even in deeper deposits. Organic sediment (#341-004-1) from the top of a buried A horizon at 136 to 139 cmbs in BT 6 yielded a $\delta^{13}C$ adjusted radiocarbon date of 8280 ± 50 B.P. (Beta-235483). A chunk of charcoal (#302-007) from 40 cm below that at 180 cmbs in BT 6 yielded a $\delta^{13}C$ adjusted radiocarbon date of 2490 ± 40 B.P. (Beta-237021). Below that a sediment sample (#241-004-2) from 264 to 269 cmbs in a 3Bk horizon yielded a $\delta^{13}C$ adjusted radiocarbon date of 9610 ± 50 B.P. (Beta-235484). Obviously the dated charcoal from 180 cmbs was displaced downward as its age is significantly younger than the mean resident date derived from the sediment some 40 cm above. It is probable that turbation activities displaced this tiny charcoal piece. Consequently, the smaller cultural materials in those deposits have potentially been displaced. It is not clear which materials are translocated and how materials were originally associated with one another since the sandy sediments are visually indistinct. Therefore, this broad central area under the T_1 surface of 41PT186 has limited potential to yield important information concerning cultural events. TRC did not recommend this area of late Holocene fill, across much of T_1 and the high part of the $T_{0B,}$ for Phase II data recovery (Quigg et al. 2008).

The ca. 220 year old, deeply buried Protohistoric component identified on top of the buried A horizon at 110 to 120 cmbs in BT 5 is well preserved in an alluvial setting with no other defined occupation above or below. This context has excellent potential to yield well preserved cultural material in horizontally definable activity areas. Some rodent activity was detected in this general area, which may have caused some displacement of cultural items. However, even if some turbation has potentially displaced some cultural materials from this tight occupation zone, there is no chance of mixing with different age events since no other zones of cultural materials were detected. Test Units 2 and 3 revealed small sections of an intact occupation surface, with well defined activity areas (an ash lens - Feature 1 and a cluster of butchered bison bones) that indicated excellent potential for obtaining significant information about this unique time period. TRC recommended this buried and well defined Protohistoric occupation surface as a prime target for a Phase II data recovery block excavation. The one possible drawback is the apparent lack of lithic artifacts (lithic debitage, stone tools, burned rocks) associated with these two identified activity areas. If this component represents Native American activities, which is what we believe, it is possible that metal tools dominated the tool assemblage at that time. If this was the case, then potentially very few lithic artifacts may be present, with the highly valued metal tools removed at the time of site abandonment.

The T_{0b} surface at the western end around BT 8, and possibly the western end of BT 9, had some potential for productive Phase II data recovery excavation. However, the complexity of the depositional deposits (sloping in at least two directions and possible erosion of parts of the deposits) on this narrow land form, coupled with the lack of well separated occupation surfaces/zones and low density of lithic debris, created a number of potential problems. The vertical distribution of materials from the test units hinted at the likelihood of considerable turbation, adding to the difficulty of interpreting this young deposit. Thus, TRC did not recommend this specific area as a target for a Phase II data recovery block because of the nonstratified nature of the cultural deposits and the apparent complexity of the natural deposition and subsequent erosion (Quigg et al. 2008).

9.6 2008 Data Recovery Phase II Investigations

The BLM approved our proposal to conduct a Phase II block excavation investigation on the low alluvial terrace (T_{0a}) dominated by depositional Unit E along the very southeastern margin of the site immediately adjacent West Amarillo Creek (see Figures 9-1 and Figure 9-21). Unit E deposits are less than 430 years old, are quite sandy, and contain some gravel lenses and one well defined buried A horizon. This Phase II data recovery investigation centered on BT 5 and TUs 2 and 3 adjacent to BT 5. The previously recovered data indicated a well defined and well preserved Protohistoric occupation that included a large ash lens and butchered bison bones resting on the buried A horizon at approximately 100 to 110 cmbs at the western end of BT 5.

Figure 9-21. Phase II Target Block on Lower T0a Surface, Bare Ground is Location of BT 5.

The Phase II block investigation was initiated at this locality with mechanical stripping to remove the overburden above the targeted buried A horizon that contained the identified Protohistoric occupation. Starting in the northwestern corner, an area roughly 20 m north to south by 10 to 11 m east to west (210 to 220 m^2) was mechanically stripped to between roughly 60 and 80 cmbs. The east to west dimension was the maximum width of this low, narrow T_{0a} surface, except for a roughly 1 m wide buffer along the creek side and at locations at the northern and southern margins of the block with substantial tree clusters. During stripping it was determined that the buried A horizon was not at a consistent level below the current ground surface. The initial stripping removed a limited area of the A horizon in the northwestern corner before the A horizon was recognized, whereas the base of the stripping was still considerably above this A horizon in eastern parts of the stripped block. The stripping also encountered and removed at least two relatively thin gravel lenses above parts of the targeted A horizon. These gravel lenses contained scattered, large, mostly whole bison bones. These bones exhibit various degrees of weathering and appear to have washed into this location from upstream at the time the gravel was deposited by high energy floods. These bison bones are definitely above and younger (less than 200 years old) than the targeted cultural materials in the top of the A horizon. The stripping process also uncovered a complete glass bottle. At the targeted A horizon, the mechanical stripping exposed a couple of white ashy areas (subsequently labeled Features 7 and 8) and one tight cluster of chipped stone tools (subsequently labeled Feature 6).

Following mechanical stripping, a 1 by 1 m grid system was established across the stripped block surface. Next, geophysical investigations were conducted by Dr. Chet Walker across 160 m^2 of the stripped surface, using a flux gradiometer, conductivity meter, magnetic susceptibility meter, and GPR. This technique was conducted to identify subsurface anomalies that might be targeted through subsequent hand excavations. Following the manipulation of the recovered electronic data, each anomaly that had been identified and numbered during the geophysical interpretations was marked on the ground to guide the archeological investigations. The resulting hard copy geophysical data showing the anomalies was presented to the archeologist for use in planning the hand excavations (Figure 9-22).

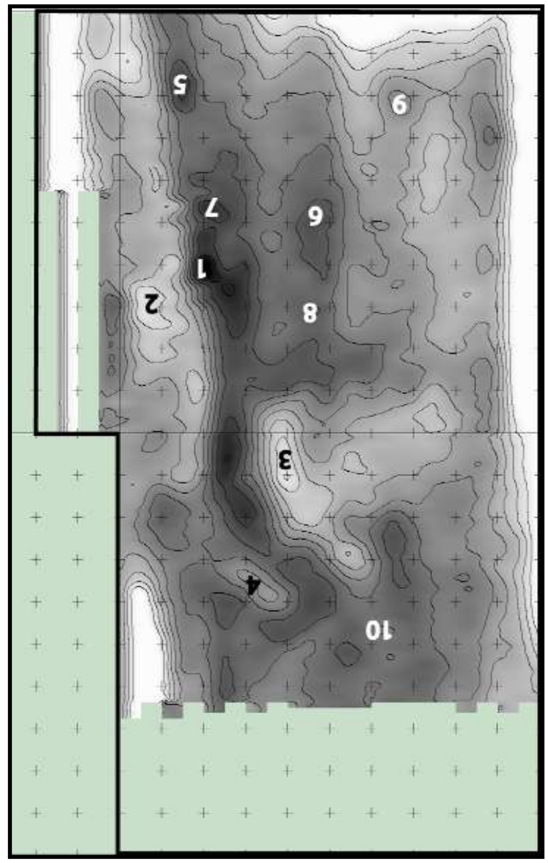

Figure 9-22. Geophysically Identified Anomalies Across the Stripped Target Block at the Corral Site.

The original goal for the Phase II data recovery program was to hand excavate a roughly 100 m^2 block. It was anticipated that this area would capture horizontally definable human activity areas and a sizeable Protohistoric material culture assemblage that could be used to address research questions. However, at the Pavilion site (41PT245), which was the first block excavated during Phase II, the targeted cultural zone failed to yield sufficient cultural material to justify completion of the projected 150 m^2 excavation block. Therefore, part of the time allotted for that effort was in fact used

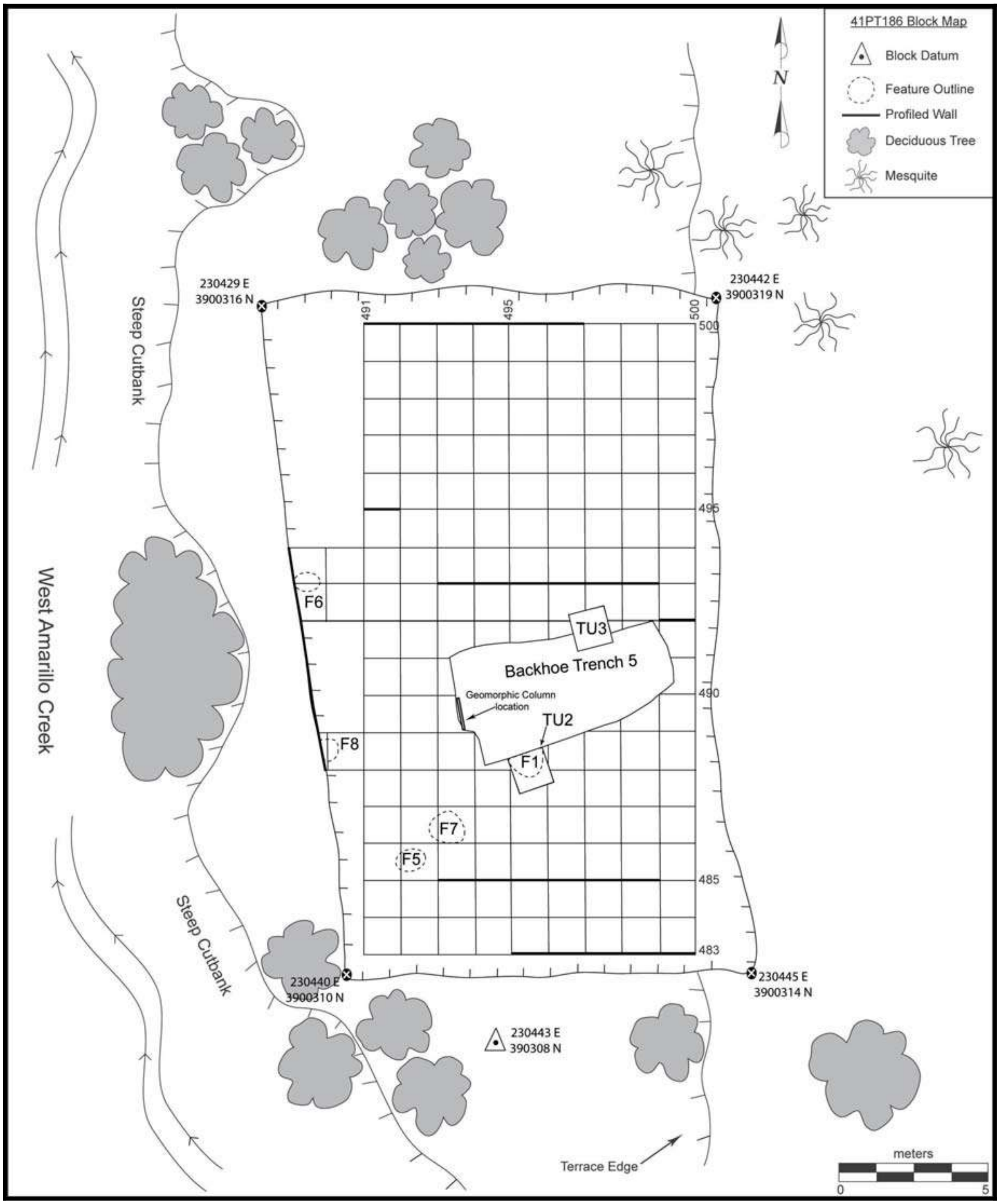

Figure 9-23. Block Map that Shows Hand Excavated Units within Stripped Area and Location of Identified Cultural Features.

Figure 9-24. Archeologists Conducting Hand Excavations Across the Northern End of the Target Block in Area of Dense Lithic Debitage.

to expand the excavation block at the Corral site. Consequently, a greater effort was directed towards the Corral site block than originally recommended. In total, 144 m^2 were hand excavated within the mechanically stripped area (Figures 9-23 and 9-24).

The investigated block also contained the original mechanically excavated BT 5 that measured roughly 7 m long by 3 m wide. Thus, a roughly 21 m^2 area near the middle of our excavation block was not hand excavated and represents an undocumented void in the horizontal distribution pattern within the block.

As the hand excavations progressed, five sections of unit walls were profiled to document the natural stratigraphy at selected locations across the block. Most profile drawings were conducted along east to west sections to document the sloping relationship of the buried A Horizon and the overlying gravel lenses (Figures 9-25, 9-26, and 9-27). Since the block was stripped and the Hand excavations stopped primarily towards the bottom of the A horizon, these profiles only captured a small vertical slice of the total natural stratigraphy represented in this terrace.

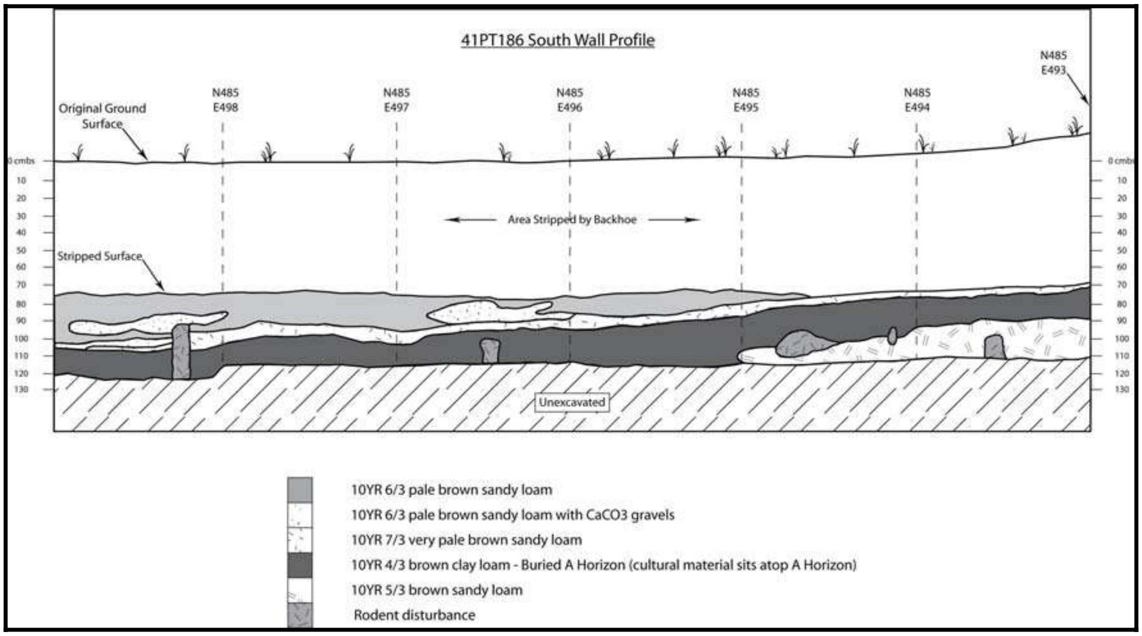

Figure 9-25. South Wall Profile Across Six Meters that Shows Sloping Buried A Horizon.

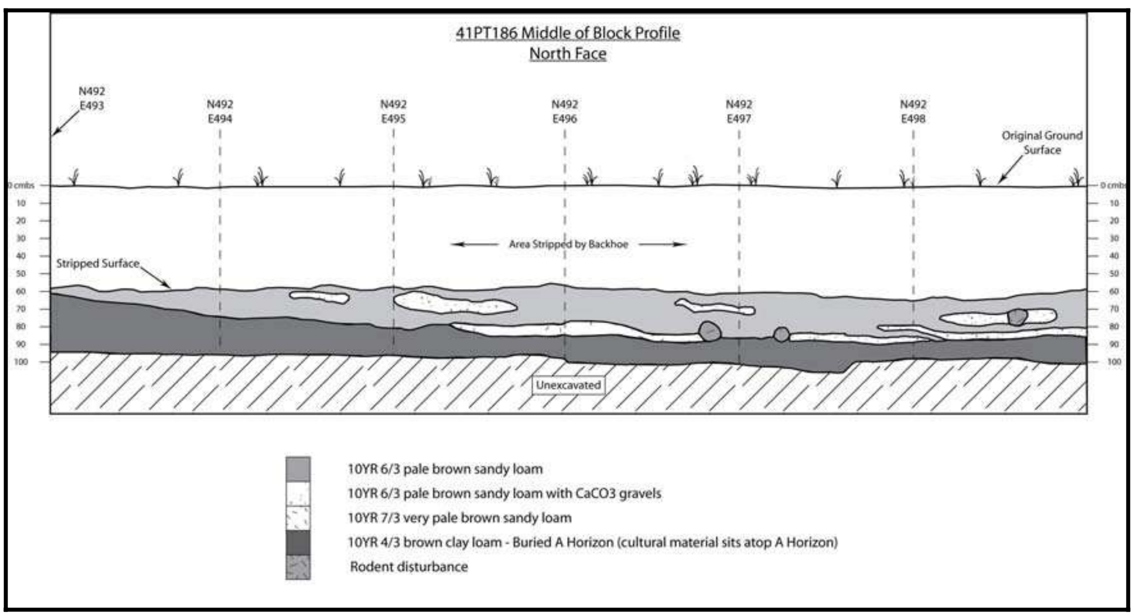

Figure 9-26. Middle of Block Profile Across Six Excavation Units Showing Position of Buried and Sloping A Horizon.

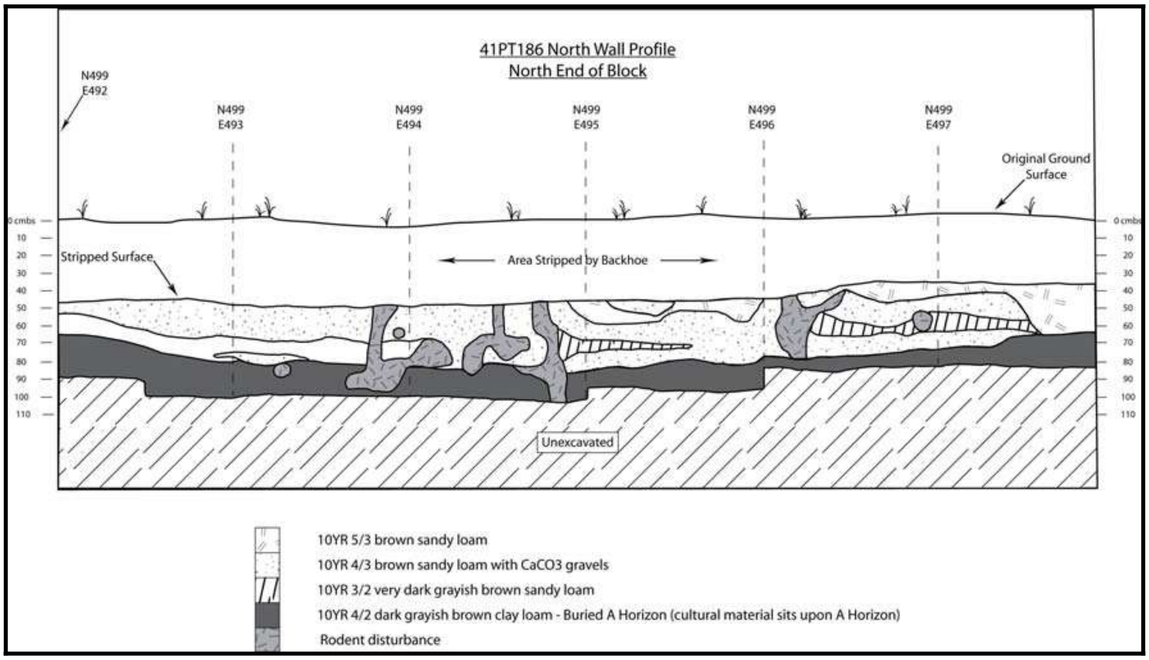

Figure 9-27. North Wall Profile Across Six Excavation Units that Showing Sediments and Rodent Disturbances

9.7 PHASE II DATA RECOVERY RESULTS

9.7.1 Geophysical Results

The geophysical specialist identified 10 anomalies (#1 through #10) across the 160 m^2 area electronically scanned (see Figure 9-22; Figure 9-28). These electronic signals were not reflective of specific types of anomalies and were numbered according to Dr. Walker's interpretation for their potential to be of cultural significance, with anomaly #1 having the highest potential. All 10 anomalies were hand excavated during our investigations. Anomaly #2, identified along the western edge apparently reflected the tight cluster of chipped stone tools labeled Feature 6. Anomaly #4, in the southwestern quadrant apparently reflected a buried ash dominated basin heating element labeled Feature 7. In eight other instances (80 percent of the total), the marked anomaly appeared to reflect rodent disturbances, at least in the 30 to 50 cm thick hand excavated matrix. In the case of Anomaly #10, it was not clear what caused the electronic signal. The geophysical investigations conducted do not appear to have identified significant cultural features in this sandy and turbated matrix. However, the cultural features here were generally thin, lacked concentrated burned rocks, or dense concentrations of other cultural materials.

9.7.2 The Cultural Features

The hand excavations across the block yielded a very limited cultural assemblage that included only five identified cultural features (Features 1 and 5 through 8; see Figure 9-28). The identified cultural features include at least two ash dominated, basin shaped heating elements (Features 7 and 8), one broad ash lens (Feature 1), one small dark organic rich stain (Feature 5), one cluster of butchered bison bone (unassigned a feature number), and one stone tool cache containing eight pieces (Feature 6). Each feature is described and discussed below.

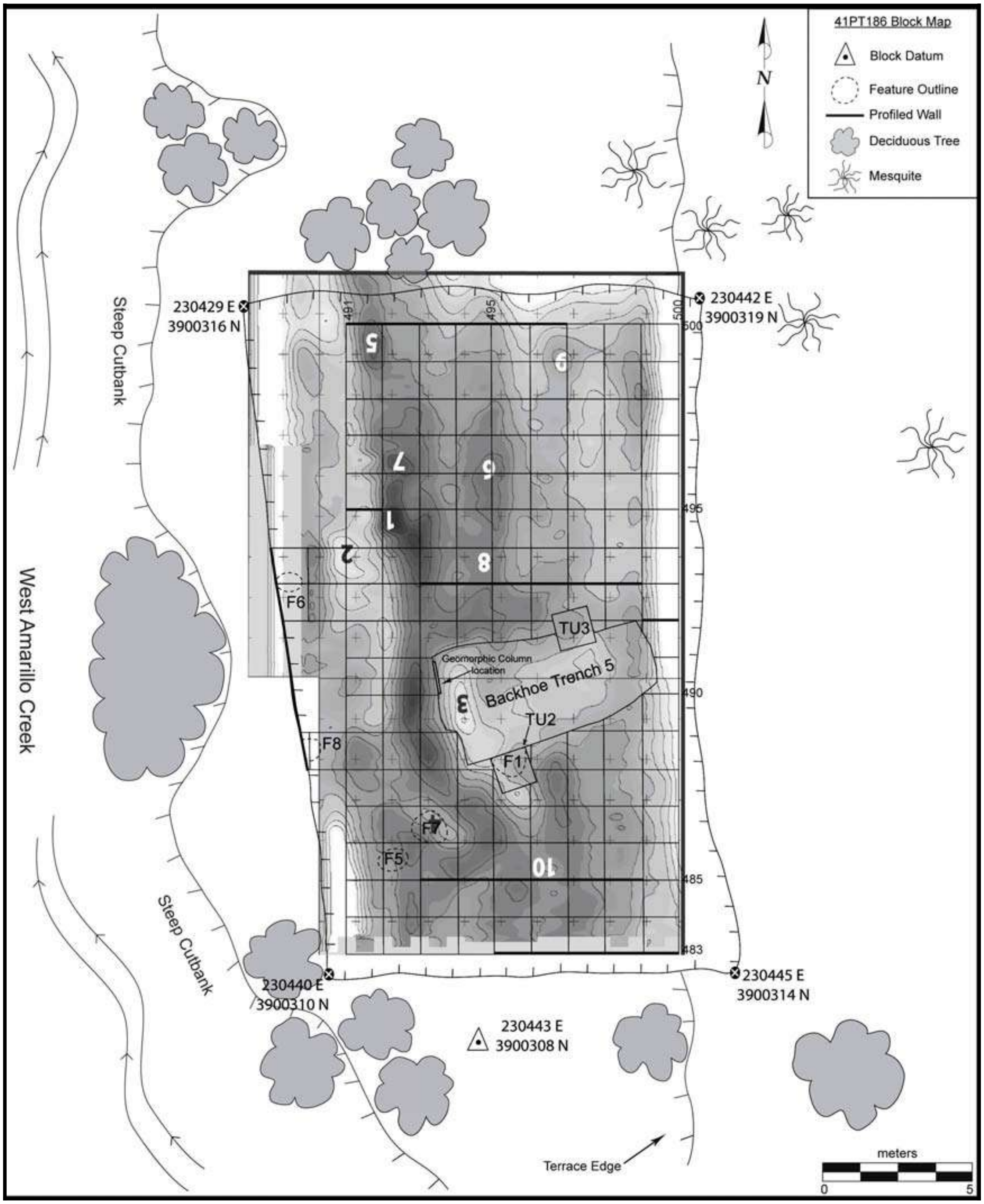

Figure 9-28. Block Map that Shows Feature Locations Overlaid onto Geophysical Map with Anomalies Marked with Upside Down White Numbers. (Black Numbers Refer to Cultural Features)

9.7.2.1 Feature 1

This white (10YR 8/1) ash was first observed during the troweling of the southern side wall of BT 5. It appeared as a lens about 120 cm long by about 2 to 3 cm thick with a few scattered charcoal chunks just east of the edge of the ash. Two point provenienced charcoal chunks were collected from the trench wall at that time for possible radiocarbon dating. One sample (#258-007) yielded cottonwood/willow fragments (Appendix N). This white ash lens was then targeted with TU 2 during the Phase I investigations. Hand excavations from the surface down to 150 cmbs encountered the top of the ash at 92 to 94 cmbs. This 1 by 1 m, 10 cm thick level revealed three chert flakes (#258-001) and a couple of chunks of charcoal (#258-007) just outside the margins of the ash (Figures 9-29 and 9-30). An ash sample (#259-004) and sediment sample from directly below the ash (#259-004) were collected. Within TU 2 the ash measured 90 cm east to west by 60 cm north to south with the bottom of the ash at 99 cmbs.

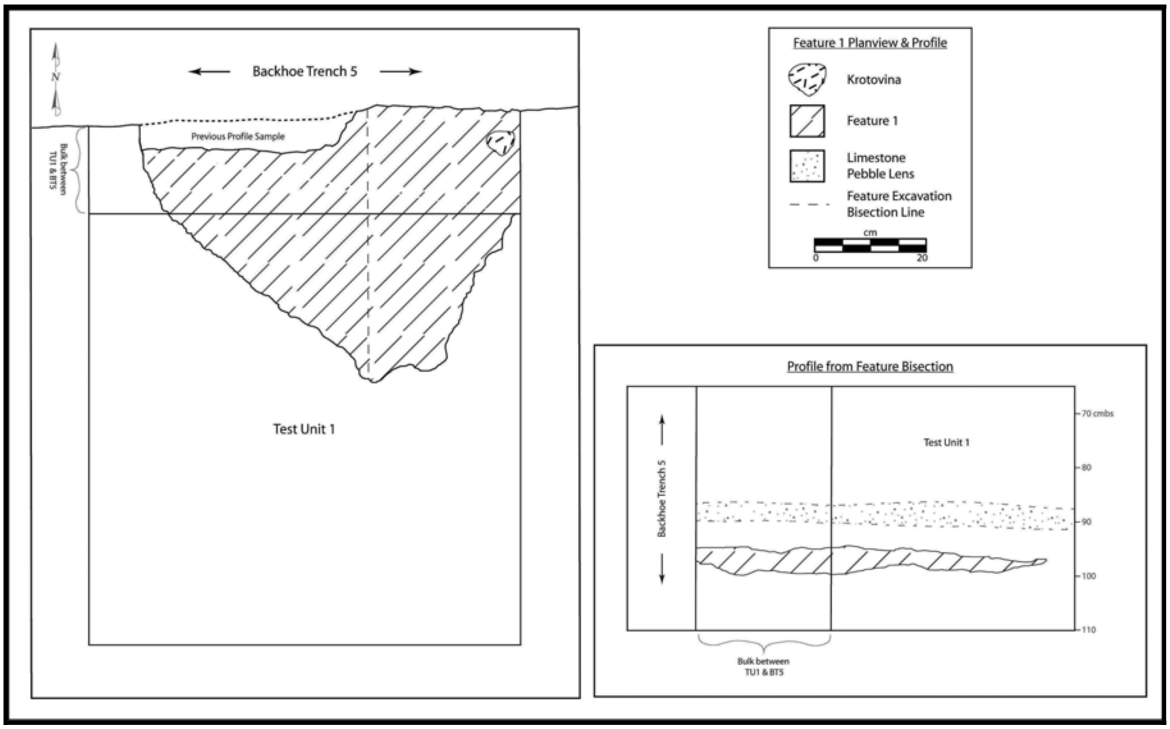

Figure 9-29. Plan Map and Profile of Feature 1, Ash Lens in TU 2.

The profiles indicated that the ash was up to 4 to 5 cm thick with a slightly irregular bottom, which rested directly of the top of the dark brown (10YR 3/3) A horizon. No obvious basin/pit, matrix oxidation, or charcoal lens was observed under or around the ash. The margins of the ash were irregular and poorly defined. Since the backhoe removed an unknown portion of the northern side of this ash lens its overall shape and size are not clear. A 0.1 g charcoal sample (#340-007-1) from BT 5 wall was submitted for radiocarbon dating. The charcoal yielded a δ^{13}C adjusted age of 230 ± 40 B.P. (Beta-235482). To have created an abundance of ash with little or no charcoal, a wood fueled fire would have to have burned long enough for complete combustion of the fuel. The lack of any observed oxidation of the sandy loam below this ash lens indicates that it represents an ash dump on the surface of the A horizon, with the top slightly smoothed and/or truncated during subsequent alluvial deposition.

The entire 8.9 liters of ashy matrix (#259-004-12) from Feature 1 was floated at the

Austin laboratory. The heavy fraction yielded 150 tiny pieces of lithic debitage, 35 tiny pieces of charcoal, three tiny burned bone fragments, one tiny unburned vertebra, and 13 burned pieces of hackberry seeds. The one unburned vertebrae (less than 2 mm long) is considered intrusive, whereas the burned bone is cancellous tissue from inside the cortical wall. The lithic debitage includes the shatter from knapping activities and a few actual resharpening flakes. Between 60 and 70 percent of the flakes appear heat altered with a reddish hue to them. The burned hackberry seeds may have come from hackberry wood being used as fuel. The light fraction (7.1 g) from this same sample (#259-004-1&2) yielded quantities of fine rootlets, insect parts, and 0.2 grams of charcoal (Appendix N). The charcoal pieces were identified as mesquite (N = 2), indeterminate wood (N = 13), cottonwood/willow (N = 24), and grass stems (N = 2) (Appendix N). No charred seeds or nuts or other plant parts were identified.

Figure 9-30. Plan View of Southern Section of Ash Lens Feature 1 in TU 2.

Feature 1 is interpreted as a dump of ash from one of the two adjacent *in situ* heating elements (Features 7 and 8). Feature 7 was only about 2 m southwest, whereas Feature 8 was about 5 m to the west. The dump interpretation is based on the absence of a basin under the ash, the amorphous shape and variable thickness of the lens, the absence of any sign of oxidation in the surrounding matrix, plus the presence of the tiny lithic debitage. The lithic debitage recovered from the ash was most likely dumped into the fire while the fire was still hot enough to cause a slight color change to the light colored Alibates flakes. A knapping activity was identified immediately east of Feature 7 and likely where these tiny flakes came from.

9.7.2.2 Bone Cluster

Unassigned a feature number, the bison bone cluster uncovered in TU 3 appeared to be a concentration following the hand excavations of the surrounding units during Phase II (Figure 9-31). The bones were encountered in one level between 110 and 120 cmbs. The cluster included seven identifiable bison bones (#261-002) weighing 402.8 g. These elements include a complete navicular cuboid, a complete third phalanx, a butchered left proximal tibia of a female, a right distal metatarsal of a female, one upper molar, and an immature radius shaft (Table 9-5). These identified bison bones rested in a dark brown (10YR 4/3) sandy loam A horizon. No burned rocks, lithic debitage or other cultural items were recovered immediately around these bones. Tiny flecks of charcoal were observed in the soil matrix, but extensive rodent burrows were also observed throughout this and other excavated levels, making contexts and associations unclear. Hand excavated levels above or below this 10 cm level yielded no other cultural materials. It is possible that other bison bones were just south of these, but the mechanically excavated trench would have removed them.

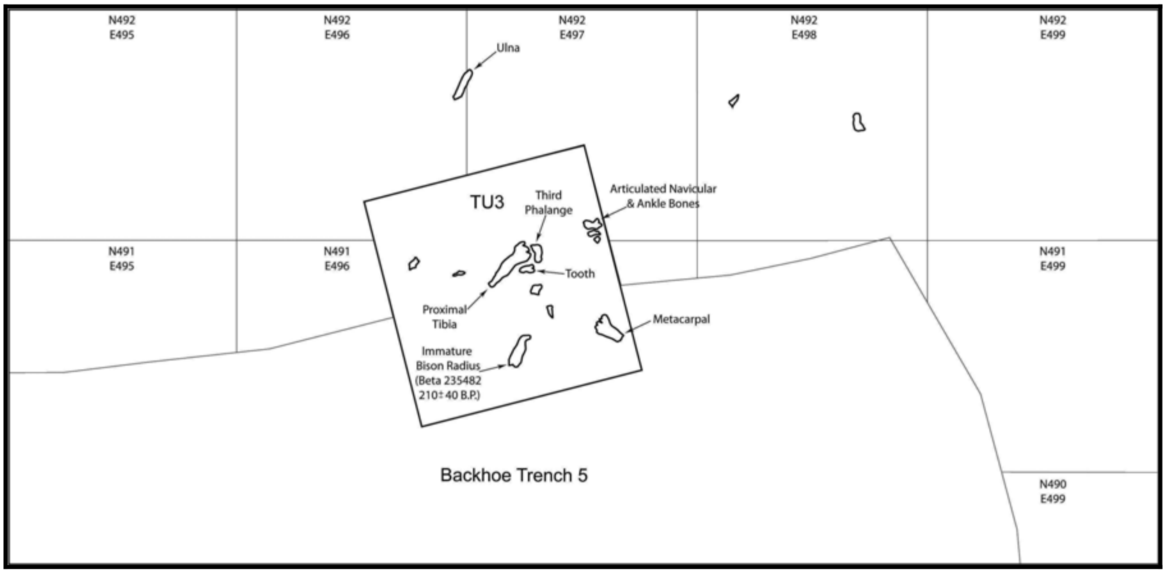

Figure 9-31. Cluster of Bison Bone Discovered in TU 3 and Subsequent Surrounding Units in Block Excavation.

This clustered bison bone was aerially restricted, represents a number of different nonarticulated elements of at least two individuals, and is, therefore, interpreted to represent a dump of butchered bison bones following defleshing and marrow extraction. Marrow extraction is inferred on the basis of the broken condition of the long bones. Bone grease was not likely targeted as the bones would have been smashed into much smaller pieces. A fresh proximal tibia would contain a high percentage of fatty acid (33 percent), considerable fat content, and the highest marrow content (see Table 2-2). Therefore, this element would have been extensively fragmented and likely crushed beyond recognition if bone grease extraction was carried out.

9.7.2.3 Feature 5

This was a small irregular and poorly defined patch of dark stained matrix about 72 cmbs in the northeast quadrant of N485 E491. It appeared as flecks and tiny chunks of charcoal over and area that measured roughly 40 to 50 cm long by 10 cm wide. Sediment samples (#538-007) encompassing the stain were collected. In adjacent unit E492, a decayed root was found in the vicinity and may partially account for the darker stained matrix. No burned rocks, ash, or other cultural materials were in the stained matrix or immediately adjacent to it. It is not clear if this dark patchy matrix was a cultural phenomenon or a stain from decaying natural organic matter.

9.7.2.4 Feature 6

This was a cache of eight stone artifacts that includes four complete end and side scrapers, two edge-modified flakes, and two unmodified flakes. This cluster of artifacts was exposed during the backhoe stripping of the overburden to reach the targeted buried A horizon. The cache was in the targeted buried A horizon, but shallower than expected. The eight artifacts were tightly concentrated in a roughly oval area that measured 18 by 14 cm, between 64 and 69 cmbs, on the very southern edge of N493 E489 along the western edge of the block (see Figure 9-28).

Table 9-5 Identifiable Elements from Protohistoric Occupation Zone from Block Excavation.

Catalog No.	Unit	Bison Element/Part	Weight (g)	Burned	Cut Marks	Surface Condition
261-002	TU 3	Complete left navicular cuboid	35	No	No	root etched, weathered
261-002	TU 3	Complete left cuneiform pes	6.5	No	No	root etched, weathered
261-002	TU 3	Complete 3rd phalanx	17.1	No	No	mostly intact
261-002	TU 3	Complete upper molar	9.5	No	No	mostly intact
261-002-1	TU 3	Medial immature right radius * and **	61.7	No	No	root etched, weathered
261-002-3	TU 3	Mature distal right metatarsal, female *	92.9	No	No	partially root etched
261-002-2	TU 3	Mature proximal left tibia, female *	180.1	No	No	rodent gnawed
386-002	N486 E499	Complete 3rd phalanx	27	No	No	intact
386-002	N486 E499	Proximal left humerus, 4 pieces	249	No	No	intact
394-002	N487 E494	Rib fragments, small	7.3	No	No	root etched, weathered
425-002	N491 E494	Scapula glenoid cavity fragment	7.9			root etched, weathered
438-002	N492 E496	right olecron & notch of ulna	69.6	No	No	slight root etching
453-002	N494 E494	Fragment of pelvis	50.1	No	No	root etched, weathered
455-002	N494 E495	Rib head and fragments	2	No	No	root etched, weathered
467-002	N495 E495	Rib fragments, small	5.2	No	No	root etched, weathered
513-002	N498 E498	Acetabulum fragment	26.1	No	No	mostly intact
519-002	N499 E492	Rib fragments	25.4	No	No	root etched, weathered
520-002	N499 E493	Articular facets of lumbar vertebrae	10.9	No	No	mostly intact
522-002	N499 E494	Rib fragments	8.9	No	No	root etched, weathered
522-002	N499 E494	Lumbar spines process	4	No	No	root etched, weathered
* element used for carbon and nitrogen isotope analyses			**896.2**			
** piece used for radiocarbo						

Catalog No.	Unit	Element/Part	Weight (g)	Burned	Cut Marks	Surface Condition
346-002	N483 E492	Deer, complete left calcanium, immature	13.5	No	No	root etched, weathered
346-002	N483 E492	Deer, complete left navicular cuboid	4.9	No	No	root etched, weathered
346-002	N483 E492	Deer, complete left cuneiform pes	0.9	No	No	root etched, weathered
358-002	N484 E492	Deer/antelope proximal left metatarsal	8.6	No	No	root etched, weathered
440-002	N492 E497	Deer/antelope medial metatarsal	3.6	No	No	root etched, weathered

It was detected a few centimeters into the dark brown (10YR 4/2) buried A horizon and definitely within the targeted cultural zone. All eight pieces rested flat and were nearly touching one another, with five pieces across the top and three, 1 to 2 cm directly below the upper five pieces (Figures 9-32 through 9-34). Some pieces rested with the dorsal side up and others with the dorsal side down. Four pieces were fashioned into steep sided end and side scrapers, two are large retouched flakes, and two are large unmodified flakes (see descriptions of items below under tools). The pieces appeared to be in a very shallow, 3 cm deep basin. However, a soft rodent hole (10YR 5/3) with tiny hair rootlets was directly under the stacked tools, which may have caused some slight downward movement of the items. The excavation units around this cache also exhibited rodent runs. A few tiny chert chips near these scrapers appear to have been broken off a couple of the cached artifacts at the time the backhoe exposed this cache.

Figure 9-32. Top View of Cached Chipped Stone Artifacts in Feature 6. (scale in cm)

Figure 9-33. Profile of Chipped Stone Tool Cache Feature 6 that Exhibits Stacked Pieces in Buried A Horizon, 41PT186. (scale in cm)

The total weight of the eight artifacts is 201.7 g. The four end and side scrapers weigh 108.2 g, the two edge-modified flakes weigh 66.6 g, and the two unmodified flakes weigh 26.9 g.

Figure 9-34. Close-up of Stacked Chipped Stone Tools in Lower Part of Feature 6 Cache with Rodent Burrow Under Artifacts.

The individual items in the cache were not touched with bare hands and were placed directly into individual plastic bags. Small sediment samples from under and around each artifact were also collected. A couple of tiny charcoal flecks (#446-007) were observed in the matrix around the cache, and collected. A few tiny charcoal chunks were also recovered from the adjacent units/levels that surrounded the cached tools. Two charcoal samples were submitted to Dr. Dering for identification. Sample #446-007 is of indeterminate wood. Sample #440-007 is juniper wood (Appendix N). However, no other cultural materials were detected within a meter or so of this cache with the exception of a single burned rock in the block wall 40 cm to the west at 60 cmbs in the top of the A horizon. Individual artifact descriptions and functional interpretations are presented below (see section 9.7.3.2 Chipped Stone Tools), accompanied by the results of high-powered use-wear analysis that were conducted on all eight pieces.

Feature 6 is interpreted as a tool kit used by the inhabitants, and then cached towards the margin of the campsite for future retrieval. Such caching behavior probably represents the occupants' intention to return to this specific locality.

9.7.2.5 Feature 7

This was an ash filled basin/pit with ash smearing near the top. This feature was partially bisected in a northwesterly to southeasterly line by the backhoe during the stripping process. Following its exposure, a sample of the ash was collected. The stripping may have removed the upper few centimeters of the northeastern section. Feature 7 was in the western part of N486 E492 and extended some into E493, nearly 2 m southwest of ash Feature 1. The southwestern side of the stripped edge became the bisection line through this feature. The top of the ash appeared at 69 cmbs and revealed an irregular ashy matrix over an area 65 to 70 east to west by some 40 cm north to south with roughly three lobes of ashy matrix that extended southward beyond the central area (Figure 9-35). The top of what eventually turned out to be a basin, measured roughly 45 cm across, whereas the middle of the basin extended 7 cm deep. The detected ashy matrix reveals a nearly circular basin. The basin was filled with mostly a whitish (5YR 8/2) ashy mixture underlined by a very dark grayish brown (10YR 3/2) stained matrix with small (less than 1 cm in diameter) specks of yellowish red spots (5YR 5/6) and tiny charcoal flecks and chunks (Figure 9-36). The ash filled basin appeared partially outlined by dark grayish to a very dark gray to black (10YR 2/1) lens 1 to 3 cm thick. A brown (10YR 5/3) sandy loam that contained flecks of charcoal was above and below the ash. The three lobes of ashy matrix at the top of the basin were very thin and difficult to discern. These lobes may have resulted from cleaning out of ash and charcoal laden matrix from the basin during the occupation. It is possible that the backhoe stripping caused some of the dispersion of the ashy matrix, though this is unlikely given that the mechanical stripping actually occurred in the opposite direction from the lobes.

The heavy fraction (40.8 g) from 18.25 liters of floated matrix (#371-004-1, #372-004-1&2, #373-004-1,and #546-004-1) from Feature 7 yielded three tiny pieces of lithic debitage, 73 tiny pieces of charcoal, two tiny unburned bone fragments, two burned seeds, and one unburned hackberry seed. The light fraction (61.7 g) from this same sample yielded many tiny rootlets, and insect parts along with some tiny charcoal pieces. The charcoal included mesquite (*N* = 25+) and indeterminate species (*N* = 16; Appendix N). Feature 7 is interpreted as an *in situ* basin shaped heating element that was allowed to burn completely out creating the mostly ashy fill with a thin charcoal laden matrix lining the basin. If the thin lobes of ashy matrix to the southwestern side of the basin reflect cleanouts, then this basin appears to have been cleaned out more than once during the occupation. The tiny lithic debitage pieces were from the very top and may include pieces from immediately adjacent the actual basin on the eastern side. As noted previously, this could indicate that someone was flint knapping while sitting next to this heating element. The ash dump Feature 1 also yielded tiny microdebitage in the ashy matrix. It is likely that the ash in Feature 1 was cleaned out of this heating element.

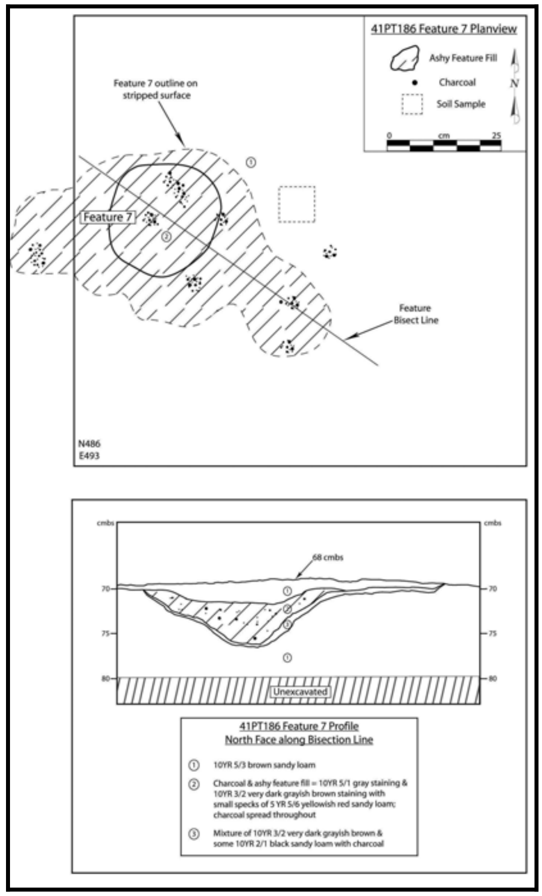

Figure 9-35. Plan Map and Profile of Feature 7, In Situ Basin Heating Element.

Figure 9-36. Close-Up Profile of Ash and Charcoal Fill in Basin Heating Element Feature 7.

9.7.2.6 Feature 8

This was an ash and charcoal filled basin/pit in N488 E489 and E490 along the very western edge of the stripped block. Feature 8 was about 250 cm northwest of the ash filled basin/pit Feature 7 and some 450 cm west of ash dump Feature 1. The ashy matrix was observed during the backhoe stripping. The stripping encountered ash at 63 cmbs along the southern end with the northern end stripped to roughly 73 cmbs. The excavated basin appeared to have been approximately 50 cm in diameter, some 12 cm deep, with a general bowl shaped outline (Figure 9-37). No burned rocks were present. Most of the outer basin margins exhibited a dark yellowish brown (10YR 3/4) oxidized and hardened loam. This basin was filled with a patchy mixture of gray (10YR 5/1) and pale brown (10YR 6/3) ash with charcoal flecks and chunks, and strong brown (7.5YR 5/6) sandy loam below the ashy fill (Figures 9-38 and 9-39). The feature was bisected twice, one generally north to south along the western boundary of unit N488 E490 and again east to west through an arbitrary northern section of partial unit N488 E489.

The heavy fraction (115.7 g) from 25.9 liters of floated matrix (#405-004-1&2 and #407-004-1 from Feature 8 yielded 126 tiny pieces of lithic debitage, 107 tiny pieces of charcoal, 26 tiny burned or oxidized clay particles, and three tiny bone fragments. The light fraction (48.1 g) yielded many tiny rootlets, insect parts, plus wood charcoal. The woods present include cottonwood/willow (*N* = 24), sand plum/mountain mahogany type (*N* = 27), and roots (*N* = 22; Appendix N). Again no burned seeds, nuts, or other plant parts were present.

Feature 8 is interpreted as an *in situ*, basin shaped heating element that was allowed to burn completely out, allowing the fill to be dominated by ashy, oxidized matrix with tiny pieces of charcoal. The fire was sufficiently intense to create patches of oxidized soil observed near the margins of the basin. The high frequency of lithic debitage in the matrix indicates that flint knapping took place immediately next to his feature with the tiny flakes falling into this heating element. Alternatively, the flakes may have been discarded into the fire as a means of disposal, though this seems less likely as there should have been a wider range of flake sizes represented if disposal of knapping waste is represented.

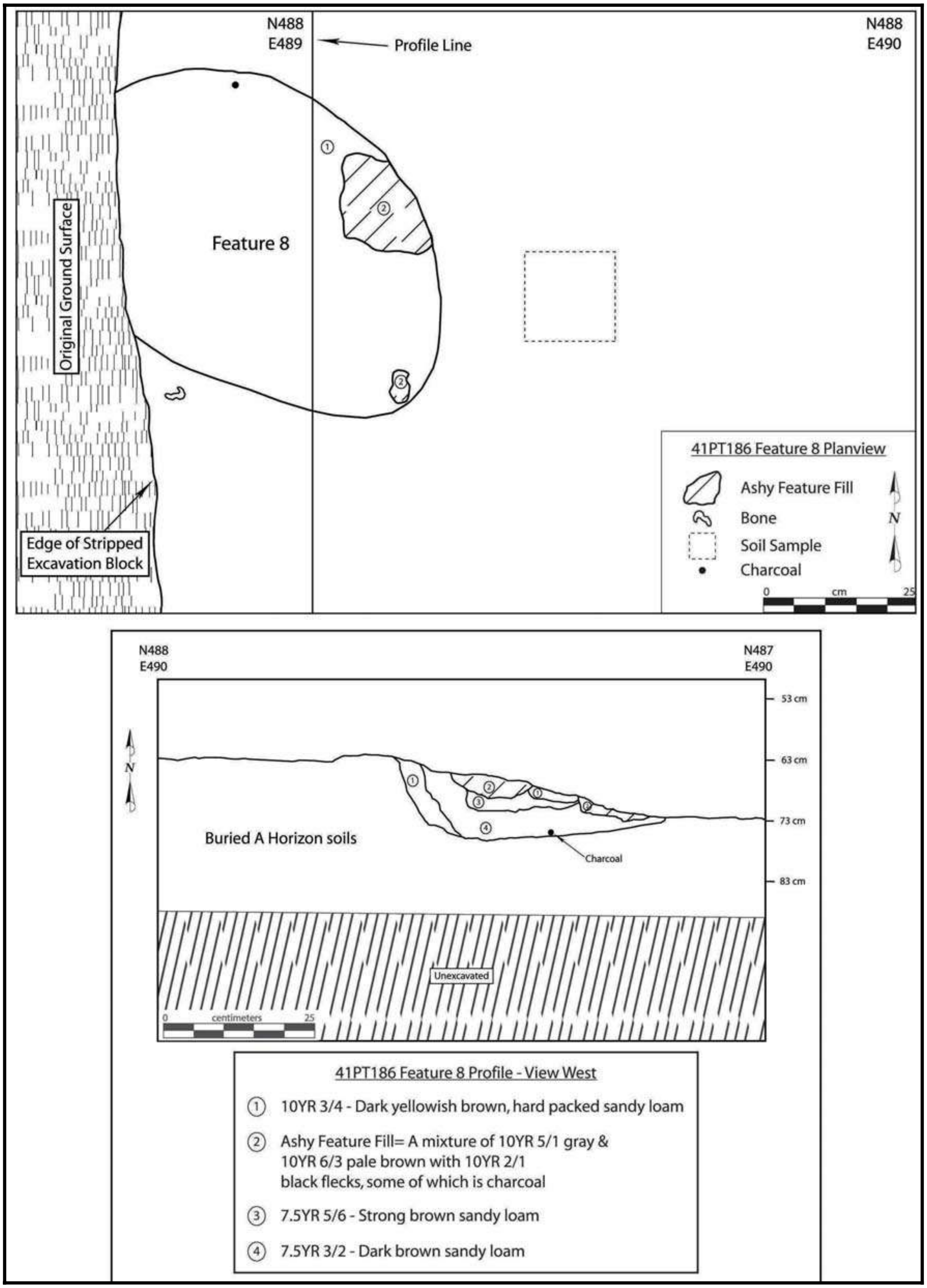

Figure 9-37. Plan Map and Profile of Feature 8, In situ Basin Heating Element.

Figure 9-38. Plan View of Eastern Half of Feature 8 that Exhibits a Mixture of Ash, Charcoal and Oxidation Stain in Buried A at Western Edge of Excavation Block, 41PT186.

Figure 9-39. Profiles of Ash, Oxidation, and Charcoal Fill Within Basin Heating Element Feature 8, 41PT186.

9.7.2.7 Discussion of Features

The identification of only five features in an excavated area of 144 m^2 is quite low. However, it is their spatial relationship between each other and other cultural debris that is significant (Figure 9-40). Four of the five relate to heating, with one a cache. Two (Features 7 and 8) of the four are considered intact basin heating elements primarily filled with ashy matrix with organic stained sediments, and limited charcoal.

Microdebitage was recovered from all three features and indicates that either knapping activities occurred close enough to these that tiny pieces fell into the heating elements accidentally or that skins that contained debitage were purposely dumped into the heating elements as a means of camp maintenance. At least one heating element was cleaned out, with the accumulated ashy matrix discarded as Feature 1. Those that conducted the cleaning did not go far to dump the unwanted ash from the *in situ* feature(s). They did discard the ash towards the back side of the terrace. The presence of the lithic debitage in the three features also ties these three heat related features together in time. Feature 5, a small, dark stained amorphous area just to the southwest of Feature 7 may be related to Feature 7, but it is unclear.

Unfortunately macrobotanical recovery from the heat related Features 1, 7, and 8 is quite poor. Charcoal from each feature weighed less than 2.5 g. Although the recovered charcoal was limited in frequency and the pieces are quite small, at least three wood types were identified. These include cottonwood/willow (N = 53), most likely a combination of cottonwood and willow as they are present today, mesquite (N = 27+), and sand plum/mountain mahogany type (N = 27; with sand plum the most probable as it is growing in the immediate vicinity today), and indeterminate pieces (N = 29). The recovery of tiny rootlets, insect parts, uncharred seeds, and other uncharred plant parts in the floated samples indicate various disturbances. All three features lacked charred seeds, nuts, or berry pits that might indicate specific plant food resources. The lack of plant food remains may indicate that these features were used strictly for heat or for cooking meat. The faunal assemblage at this campsite indicates that meat of bison and deer was present, and potentially these meats were cooked over Feature 7 or 8. This cluster of three and possibly four heat related features at the southern end of the block reflects at least one task or use area.

Feature 6 was a cache of stone tools. It was towards the front of the terrace, but only 4 m

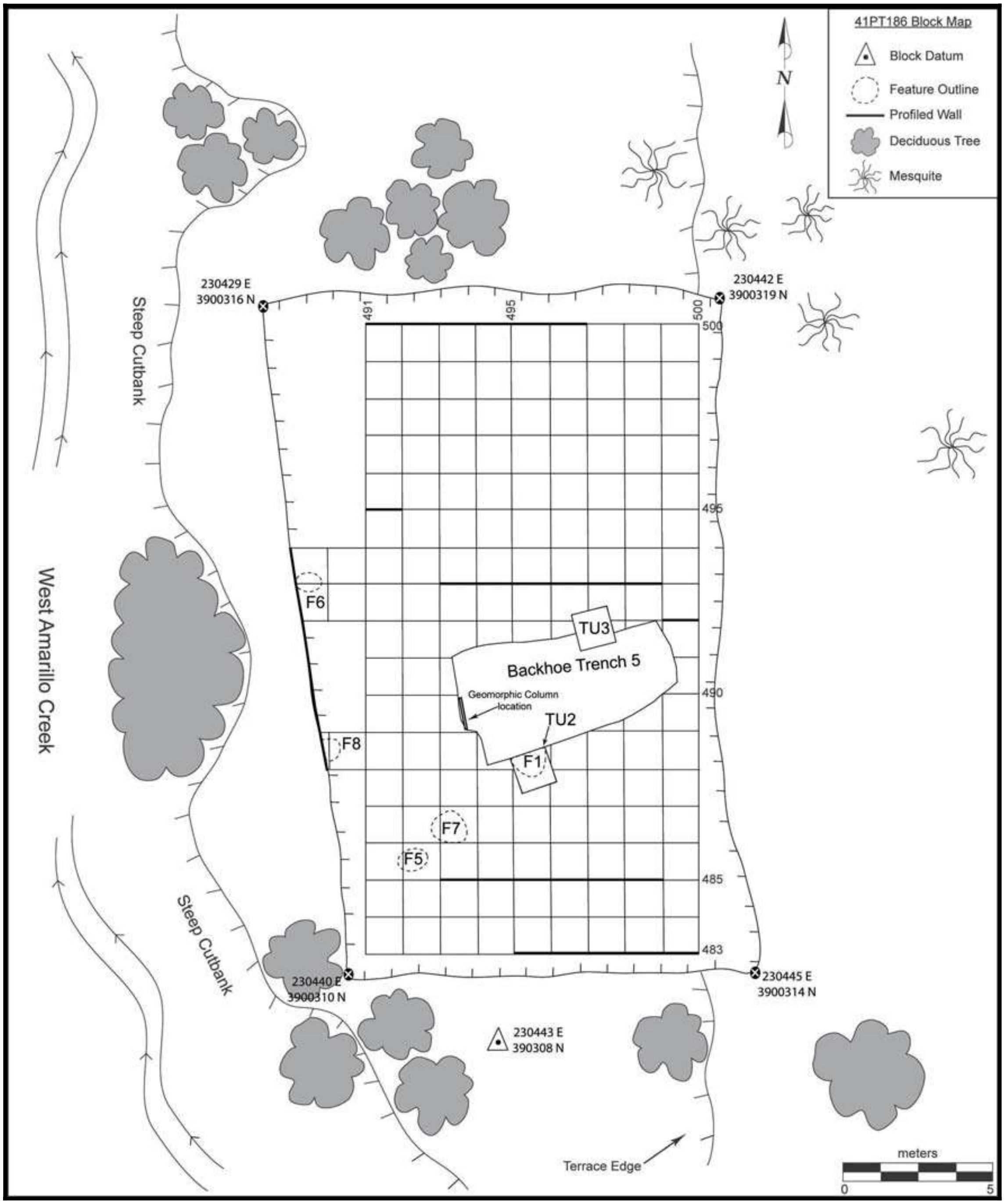

Figure 9-40. Horizontal Distribution of Five Identified Cultural Features in the Excavation Block.

north of heating element Feature 8. Since so few caches have been located in previous campsites it is not clear if this placement is common. In comparison to the discarded ash dump (Feature 1) it was in the opposite direction, towards the front of the terrace. It was at least a few meters from any other feature, which sets it apart form the other identifiable activities. No clear evidence of a marker was present to help relocate this cache. Its presence is unusual, but its placement is unclear.

Further discussions concerning the horizontal distribution of these features and other cultural materials will be elaborated upon in section 9.9.3 below.

9.7.3 The Artifact Assemblage

The 144 m^2 hand excavations in the excavation block yielded low to moderate frequencies of cultural debris (*N* = 863). This total encompasses a variety of classes of material and includes 212 pieces of lithic debitage from the 6.4 mm screening, nine items classified as chipped stone tools, which include four formal scrapers, two edge-modified flakes and two unmodified flakes from Feature 6 (the cache), two other tiny scraper fragments (#409-10 and #501-10), and at least three edge-modified flakes (#360-010, #425-010 and #482-010). Besides the chipped stone tools, one core (#462-001), one tested cobble (#516-001), one tiny unidentifiable mussel shell fragment (#444-006) were recovered. Twelve burned rocks, 395 pieces of bone, 53 pieces of charcoal, and one historic tinkler cone were also recovered. In one area, tiny lithic debitage was encountered, so to capture that microdebitage we switched collection strategies and screened 12 m^2 in that one area with nested screens. This strategy paid dividends as another 156 pieces of lithic microdebitage was collected from a 3.2 mm screen. Each of these classes is presented and discussed by category below.

9.7.3.1 Lithic Debitage (*N* = 212)

Debitage is defined as any lithic specimen formed in the act of lithic tool production or reworking. This class includes complete or fragmented flakes, angular shatter, indeterminate pieces, and exhausted cores. In the discussion below, the lithic debitage assemblage is examined in an attempt to discern what kinds of tool manufacturing, reduction, and resharpening activities may have occurred within the excavation block. To facilitate this line of investigation, various flake characteristics were examined to provide clues to the overall reduction trends that may be represented. Once the different types of flakes are presented the horizontal distribution of lithic debitage will be examined to identify discrete human behaviors.

Throughout this section, specimens bearing striking platforms are referred to as flakes, specimens devoid of striking platforms, but retain other flake characteristics distal flake fragments, and pieces that do not retain flake characteristics are considered angular/blocky debris or nonflakes. Issues regarding reduction techniques are addressed through the examination of the proximal or platform bearing portion of the flake. Furthermore, the discussions refer to the flakes and their relationship to the *objective piece*. Specifically, the objective piece is the chert nodule/cobble or tool from which the debris originated. The 212 pieces of lithic debitage from the 6.4 mm screen represents 24.6 percent of the total cultural materials recovered from the excavation block.

Debitage Size

The majority (88 percent, *N* = 186) of debitage recovered from the 6.4 mm screening from the excavation block was between the 12.8 mm and 6.4 mm size (Figure 9-41). A much smaller percentage (10 percent, *N* = 21)) was less than 6.4 mm even though it was captured in the 6.4 mm screen. Only 2 percent (*N* = 4) of the debitage assemblage represents pieces greater than 12.8 mm. This trend of relatively small size in the debitage indicates three possibilities: 1) initial reduction of large pieces of cores or large tools occurred

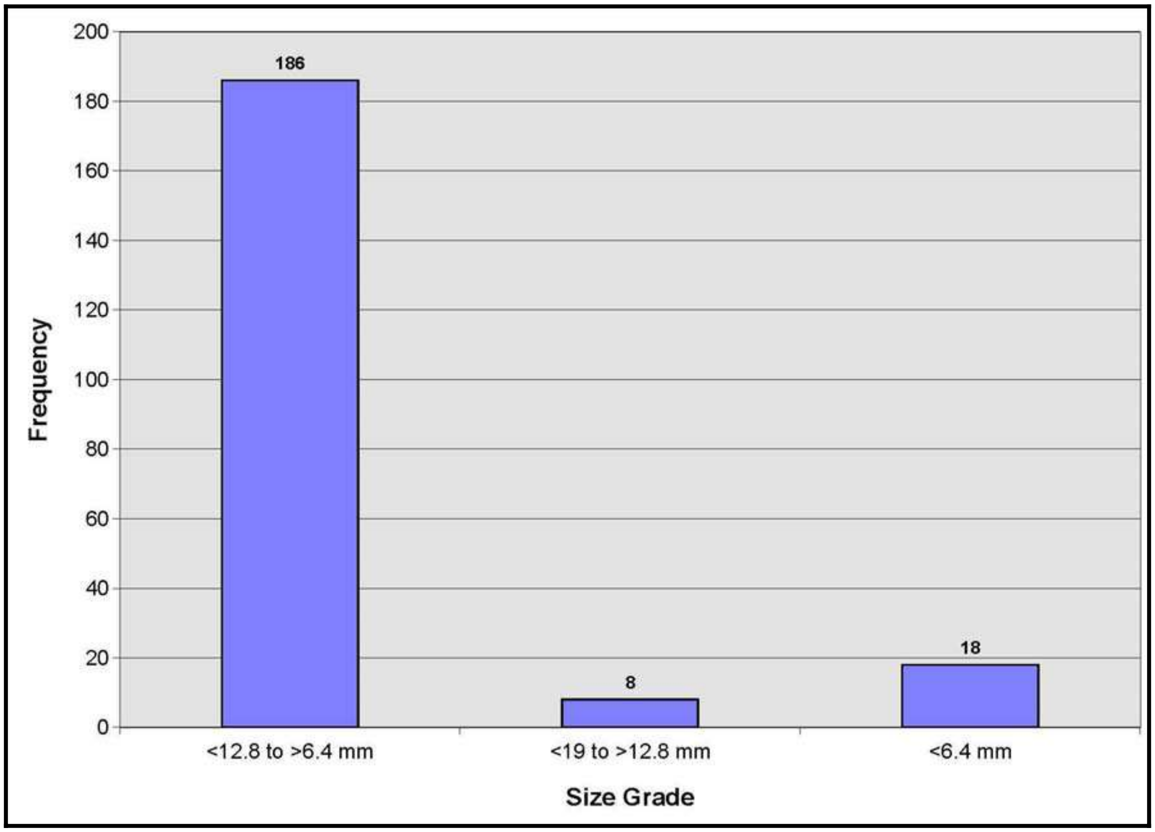

Figure 9-41. The Frequency of Debitage Size Categories from the Excavation Block.

off site; 2) this same reduction of large pieces occurred beyond the limited of the block excavation; or 3) only small objective pieces such as small flakes or small tools were targeted here. The latter is the most likely possibility with finished tool less than 12.8 mm resharpened or small tools/flakes were manufactured.

Debitage Morphology

The assemblage was divided into several morphological groups, which include shatter/angular debris, proximal flakes, complete flakes, and distal flakes. A breakdown of these morphological groups is visually presented in Figure 9-42. Just over half of the assemblage (57.5 percent; *N* = 122) had proximal flake parts present that exhibit platforms and bulbs of percussion, for further examination.

Figure 9-43 shows a preponderance of flakes (70.5 percent; *N* = 86) representing the soft hammer reduction strategy. Pressure flaking is represented in 22 percent (*N* = 27) of the flake population. The threshold between soft hammer and pressure was sometimes blurred given that both contain diffuse bulbs of percussion. In those instances, flake size was used as the deciding factor (i.e., >6.4 mm reduction equals soft hammer). The remainder of the assemblage (7 percent; *N* = 9) represents flakes possessing large bulbs of percussion characteristic of hard hammer reduction.

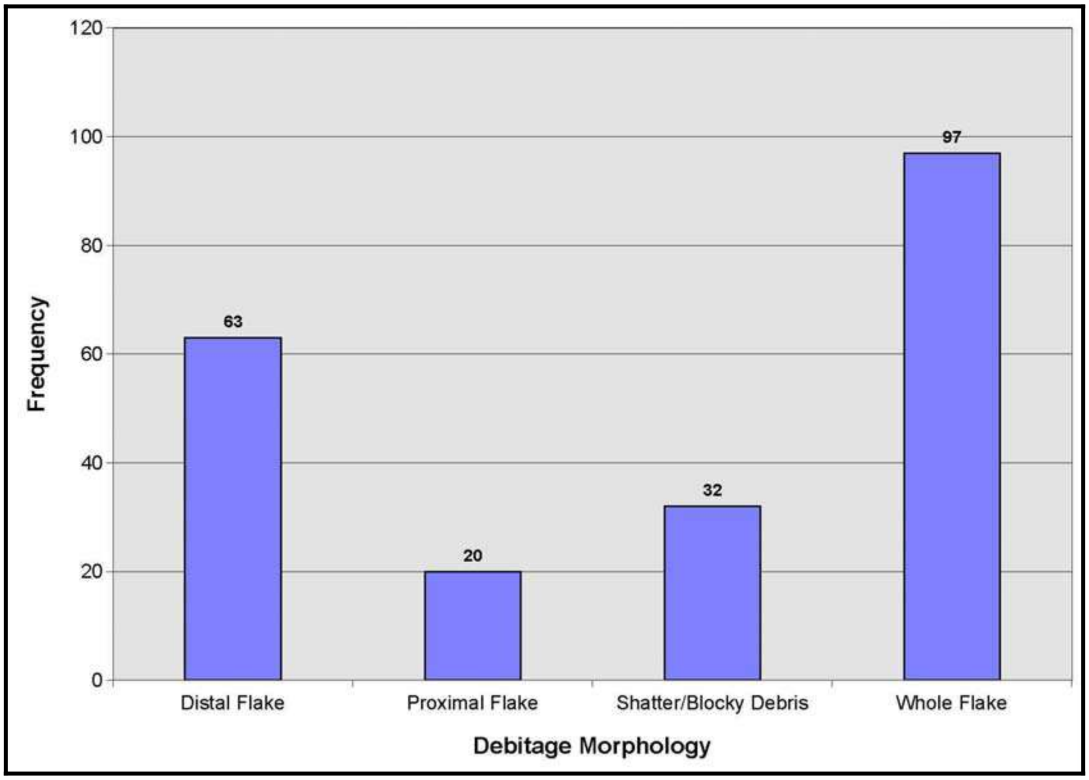

Figure 9-42. Frequency of Debitage Flake Morphology from Excavation Block.

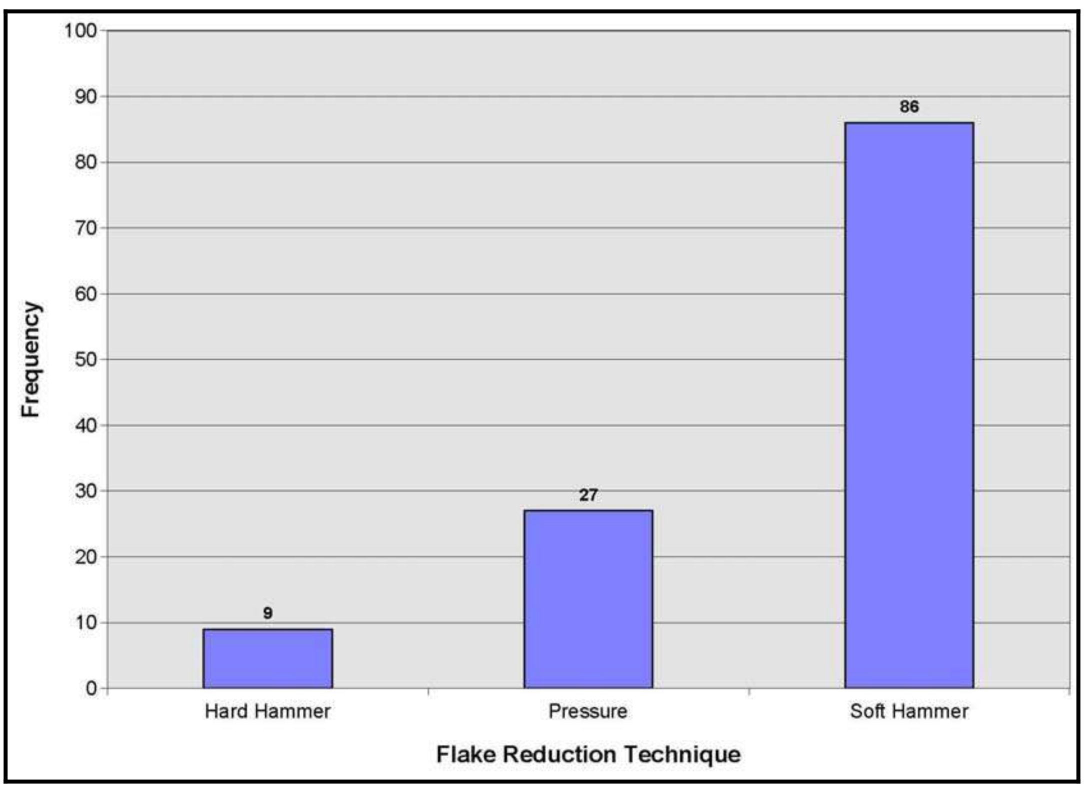

Figure 9-43. Frequency of Flakes by Reduction Technique.

The platform attributes show that about 60 percent (*N* = 63) of the discernable flake platforms are flat, which equate with unifacial reduction pieces. About 22 percent (*N* = 16) have crushed platforms, which tend to be more common with soft hammer percussion (Figure 9-44). The remaining 18 percent exhibit multifaceted platforms common with biface thinning.

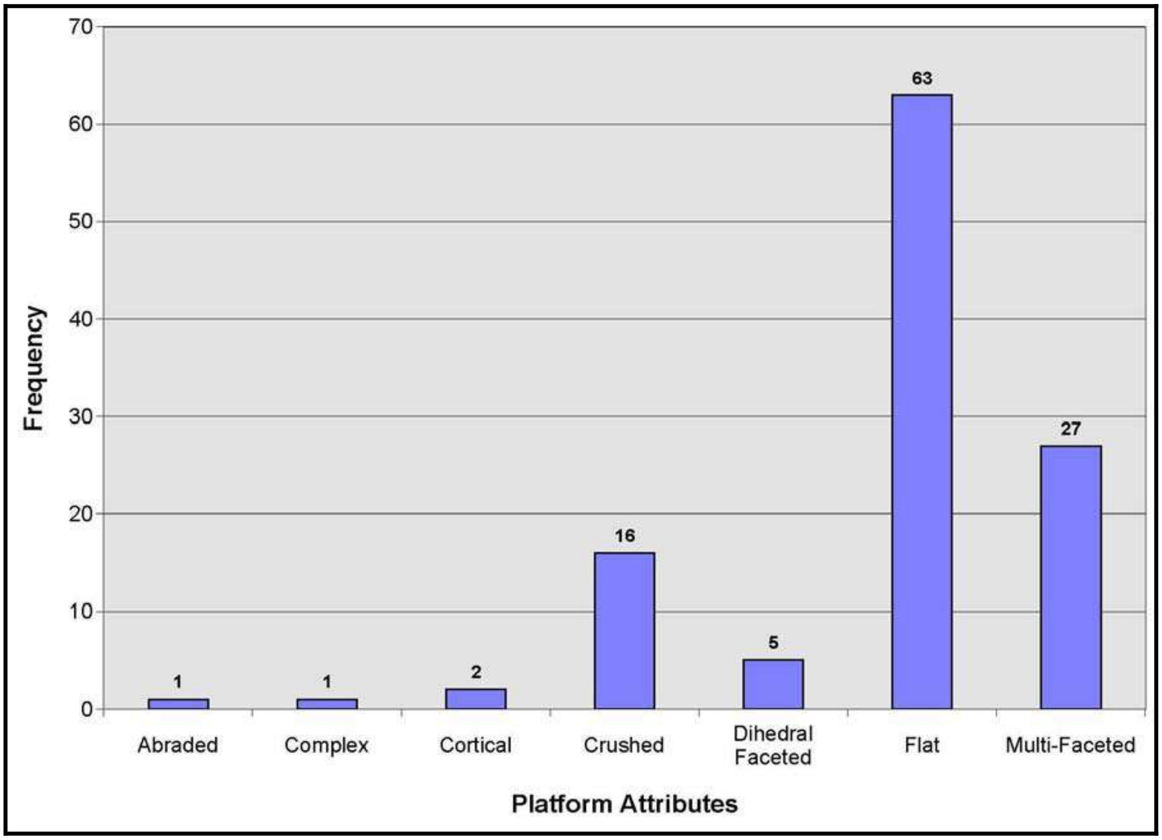

Figure 9-44. Frequency of Platform Attributes on Debitage from Excavation Block.

Core Reduction and Tool Edge-Preparation Flakes

It is evident by the dominant group of flat or single faceted platform flakes that unifacial reduction and/or tool edge preparation was carried out (Figure 9-45). Specifically, flat platforms indicate that flakes were detached from nonbifacial tools (Andrefsky 2000:94). The flat platform originated from an objective piece with at least one flat side from which the flake was struck or a flake blank. Facetting is an effective way to remove irregularities on a platform surface. It also increases the exterior platform angle to aid in more successful flake termination from the objective.

Biface Thinning Flakes

Figure 9-45 shows the frequency of the complete and proximal flakes recovered from the excavation block assemblage by platform characteristics (small bulbs of percussion, small flake curvature) that indicate the use of a soft hammer precursor (i.e., a billet fashioned from wood or antler). In most cases, soft hammer percussion was most advantageous in the thinning, flattening and shaping of bifaces (Whittaker

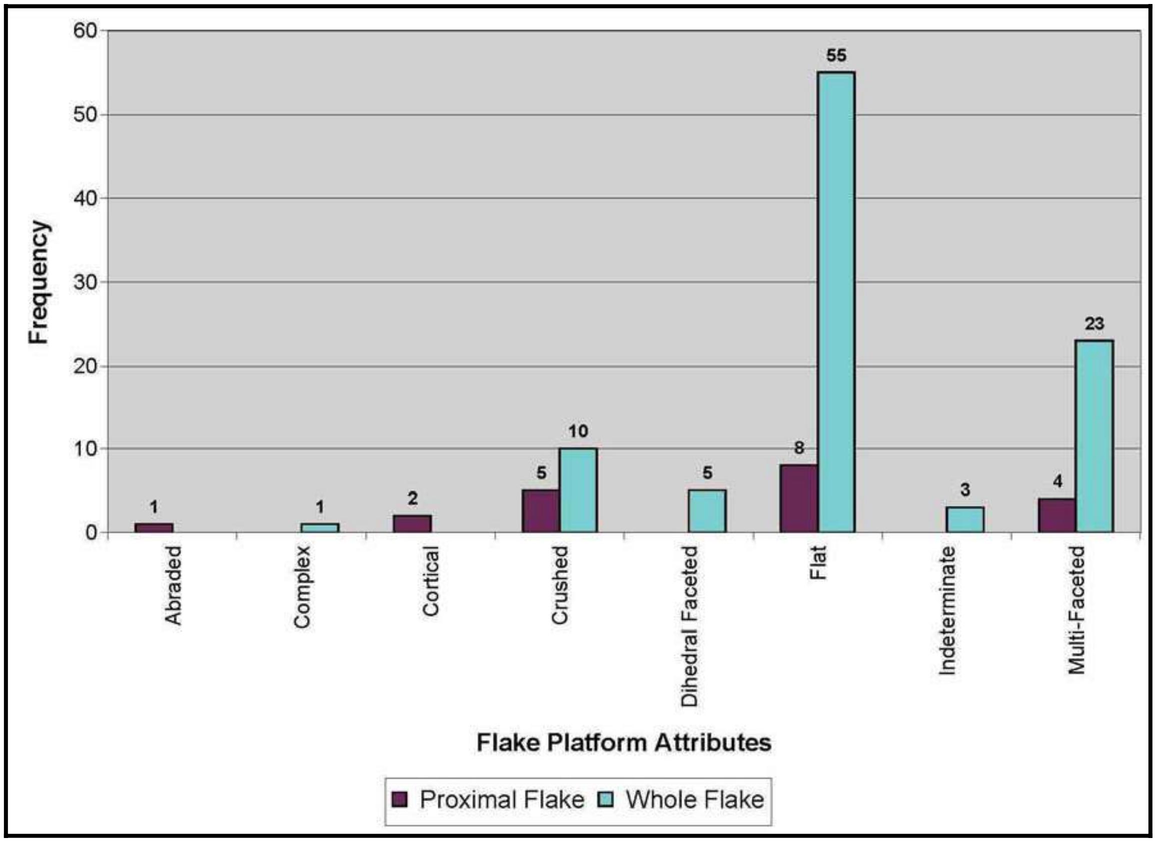

Figure 9-45. Frequency of Platform Attributes form Excavation Block.

1994:185). Soft hammer percussion flakes generally equate to biface shaping/reduction activities, then approximately 40 to 45 percent of the flakes with platforms intact represent biface thinning activities (see Figure 9-46). It must be noted, however, that the knappers were more than likely using soft hammer percussion for more than late stage thinning. Crushed platforms, often associated with soft hammer percussion, are a good example of this fact. Platform crushing often occurs when the distribution of force, or load application, by the billet is passed on to the objective piece at an angle that approaches 90 degrees. Figure 9-46 shows a series of biface thinning flakes removed in succession from an Alibates piece all from the same unit and level (N496 E495).

Figure 9-46. Cluster of Alibates Flakes that were Refit in Laboratory. (scale in cm)

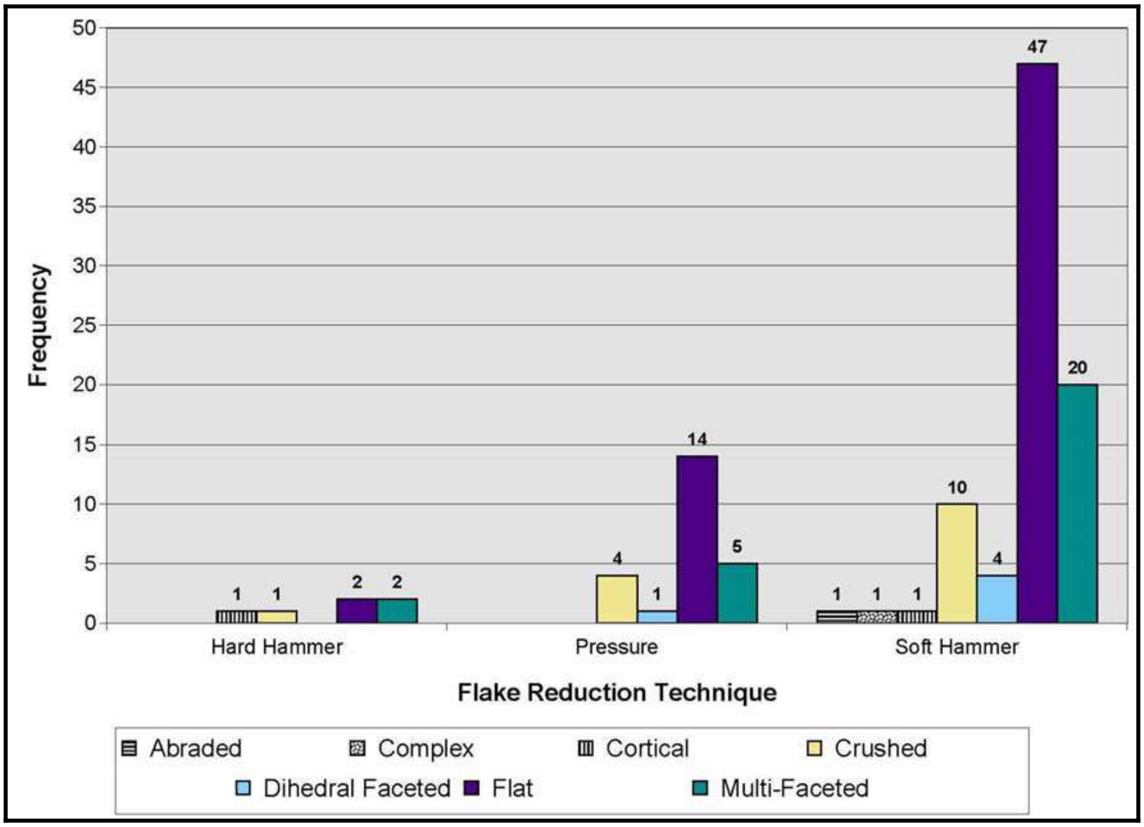

Figure 9-47. Frequency and Flake Reduction Techniques

The frequency of flake platforms sorted into flake reduction types, documents that the majority of flakes have flat platforms, and this could represent unifacial tool production at the site (see Figure 9-47). This is further corroborated by the tool assemblage inventory, which is predominately unifacial and flake tools (see Section 9.7.1, this chapter).

Microdebitage

Twelve units in the northern part of the excavation block were subjected to 3.2 mm screening in addition to the 6.4 mm screening. As a result, this microdebitage is characterized separately to avoid misleading comparative data sets due to this recovery technique. These 12 units yielded 156 pieces of less than 6.4 mm debris (Figure 9-48). The ratio of nonplatform bearing to platform bearing debitage is approximately 3:1 meaning that most flakes were broken fragments (Figure 9-49). Those with platforms (*N* = 48; 99 percent) are pressure flakes (Figure 9-50). Pressure flakes are generally smaller, thinner, and lighter than flakes driven off via percussion (Ahler 1989:91; Root 1992:87). The recovery of pressure flakes in this assemblage reflects tool edge-preparation and/or tool edge-resharpening activities.

Figure 9-48. Example of Microdebitage from 3.2 mm Screening. (scale in cm)

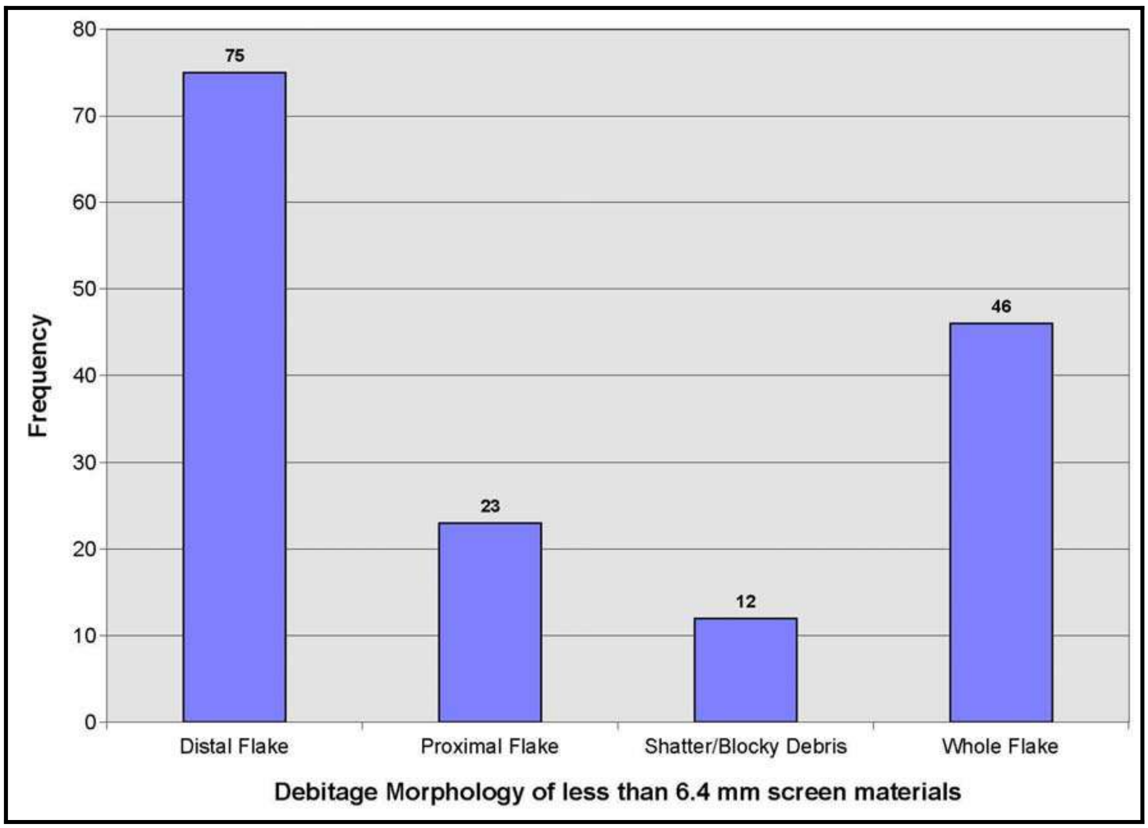

Figure 9-49. Flake Morphology of Microdebitage.

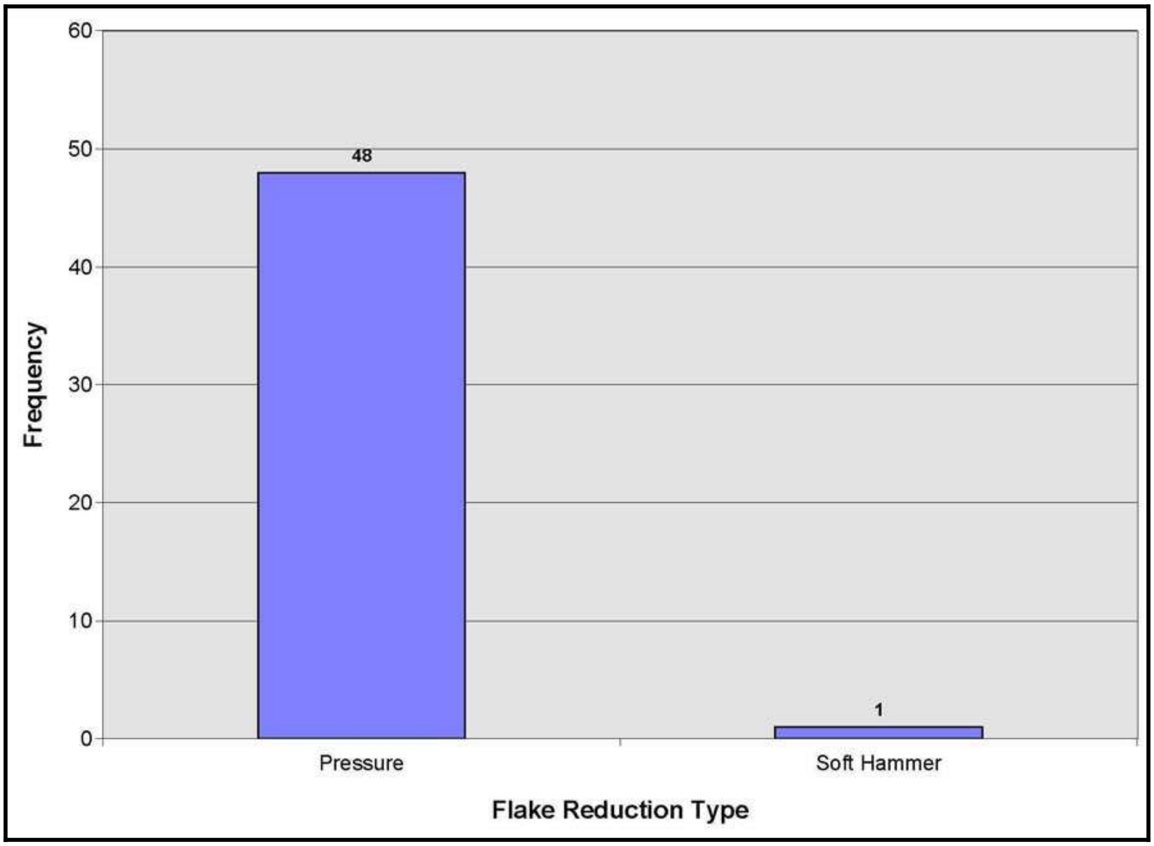

Figure 9-50. Flake Reduction Type of Microdebitage.

The majority of the identified platforms (*N* = 46; 66 percent) were classified as flat faceted platforms (Figure 9-51). This is a similar trend identified in the larger pieces, and indicates working on unifacial tools or flake edge modifications. The few crushed platforms (*N* = 22) were observed meaning that soft hammers were in use. Only one multifaceted (dihedral) platform was identified among the microdebitage. The paucity of multifaceted platforms supports the assertion that bifacial reduction was not conducted within the confines of the excavation block (Figure 9-52).

Unifacial Reduction Flakes

Four flakes from a 10 cm thick level in N497 E495 and N496 E495 are of the same Alibates material and likely removed from the same objective piece. These are all tertiary flakes. Each flake is noticeably curved to greater degree than others of that size (12.8 mm to 6.4 mm) and denotes a steep flaking surface. The termination of each flake is a broad, flat, dorsal facet (Figure 9-53).

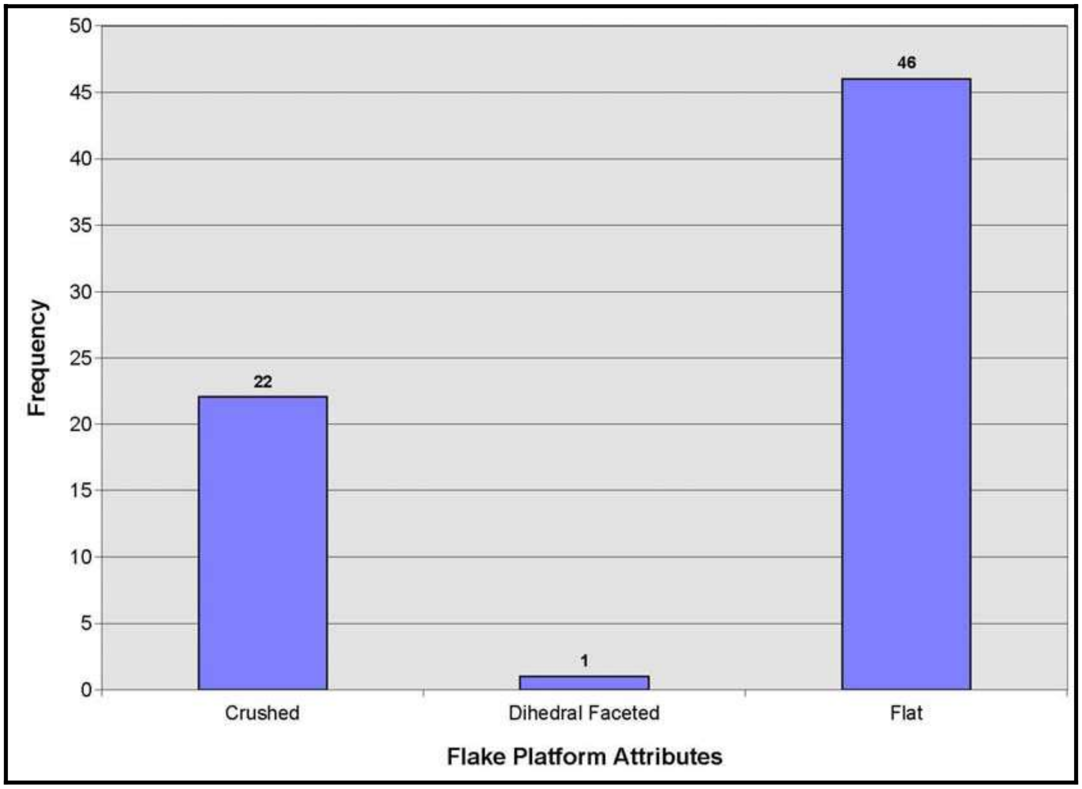

Figure 9-51. Flake Platform Attributes of Debitage Less Than 6.4 mm.

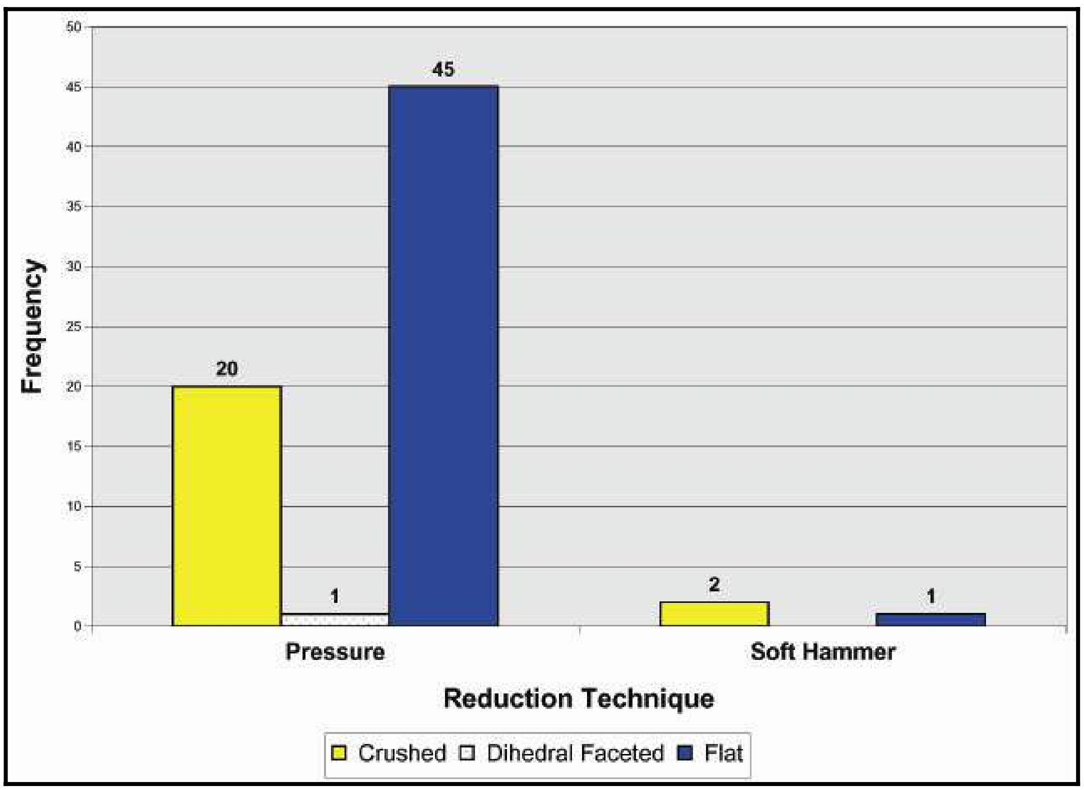

Figure 9-52. Flake Platform Attributes Sorted by Reduction Flake Type.

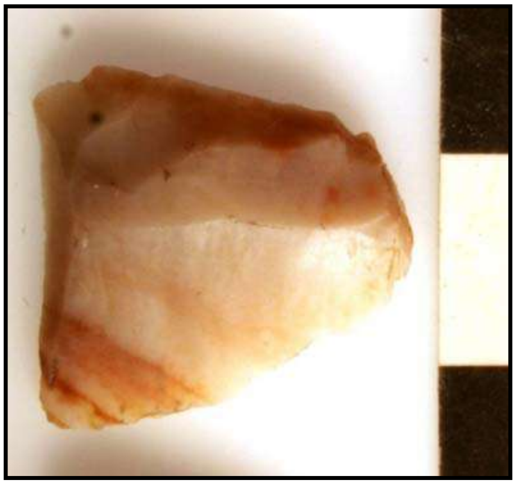

Figure 9-53. Unifacial Reduction Flake (#498-001-2) that Exhibits a Flat Dorsal Facet on Distal Flake End.

(Note Abrupt Change in Direction at Left Edge (distal end) of the Flake. [scale in cm]).

These four flakes are unlike other flakes of this size. Their platforms are flat indicating a flat ventral surface on the objective pieces. Each displays an acute edge angle. Together they represent a series of flakes removed from the face of an objective piece denoted by unidirectional overlapping scars on the dorsal side of the flake. Figure 9-54 shows an end scraper with a steep distal end and lateral edges from which unifacial flakes that are described about would have been removed from.

Lithic Material Usage

The extensive and near sole use of Alibates is obvious in the debitage assemblage as 90 percent of the debitage was identified as Alibates (Figure 9-55). Other material types are present, but in very low frequencies and in very small pieces. For example, two pressure flakes, one of Edwards chert and one of chalcedony, were recovered from the northern portion of the excavation block. This indicates that at least two tools were from these other materials. Although those specific tools were not discarded here, their presence and the reworking of those tools is indicated by these two flakes. A few flakes of Tecovas, opalite, silicified dolomite, and quartzite were identified and indicate that those material types were also present.

Figure 9-54. Unifacial Scraper (#446-013) Recovered from the Excavation Block that Would Have Yielded Unifacial Reduction Flakes like the One Shown in Figure 9-53 when Forming the Distal End (far right) or steep lateral Edges.

The horizontal distribution of the nonAlibates materials is depicted in Figure 9-56. These pieces are widely distributed with only a few of units that yielded more than one piece of any one material. This indicates that no one specific spot represented the place where one or more of these other materials were worked. The four pieces along the very eastern margin of the block were all along the base of the higher terrace. This position places those pieces in questionable context as there is a chance that these may be in disturbed context.

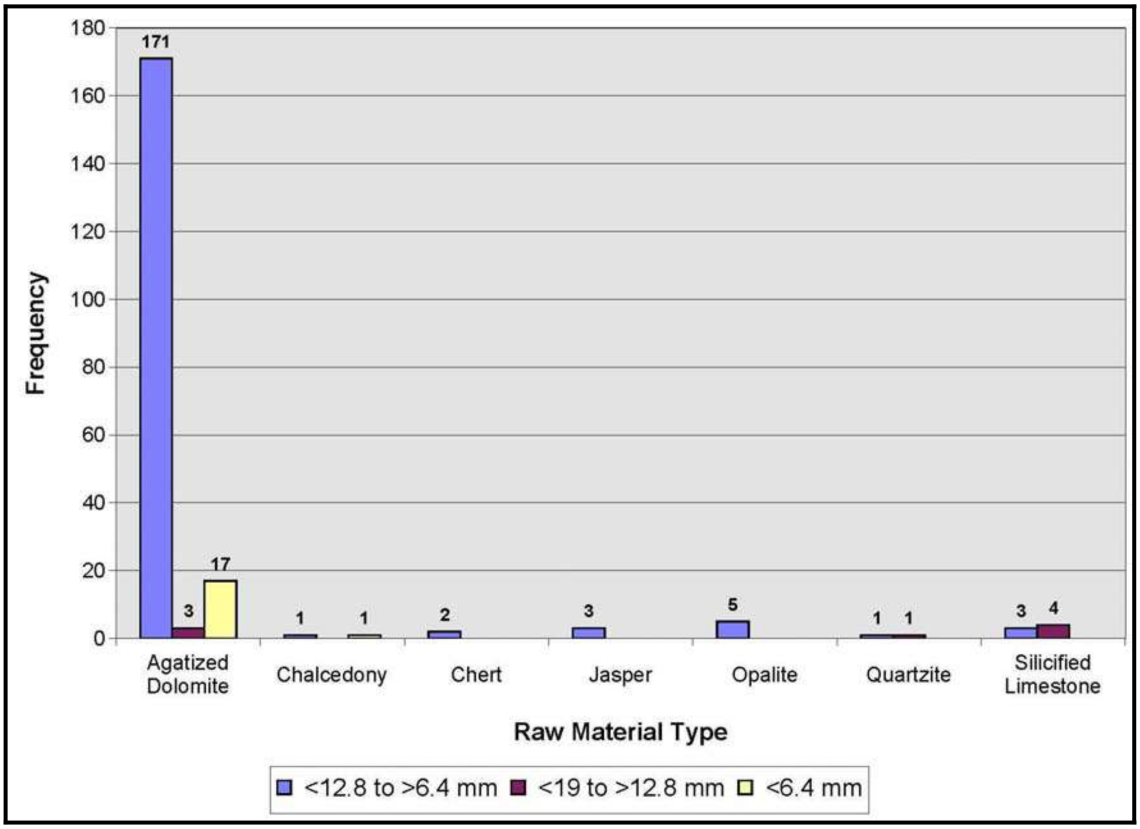

Figure 9-55. Frequency of Flake Size by Raw Material from Excavation Block.

Other Lithic Debris (N = 2)

One core (#462-001) was recovered. It is nearly 50 mm long and fashioned from a blocky chunk of opalite (20 g). It is a multidirectional or amorphous core with very few actual flake scars and little uniformity in flake scar orientation. One face appears to have been broken, whereas the remaining core facets are flake scars. Opalite has numerous internal fractures and is generally of poor quality leaving some doubt as to the actual flake removal from this piece. This core was from N495 E491 along the very eastern edge of the excavations and at the leading edge of the higher alluvial terrace. With the over whelming majority of lithic debitage recovered from the block being the high quality Alibates, it is possible that this piece did not served as a core. It may even be intrusive to this occupation.

One tested cobble (#516-001) was recovered. It also came from the far northeastern corner in N498 E499 and at the base of the higher terrace. The large nodular fragment (496 g) is a dolomite clast that has one large flake removed from one entire face. The other three faces appear in their natural state. One of the natural faces has at least two moderate size flake scars from the same edge, which appear quite old. Given the hardness of the material, it is likely that the flakes were removed with a large heavy hammerstone. Again, dolomite flakes from the excavation block are quite sparse and this tested cobble could be intrusive to this campsite.

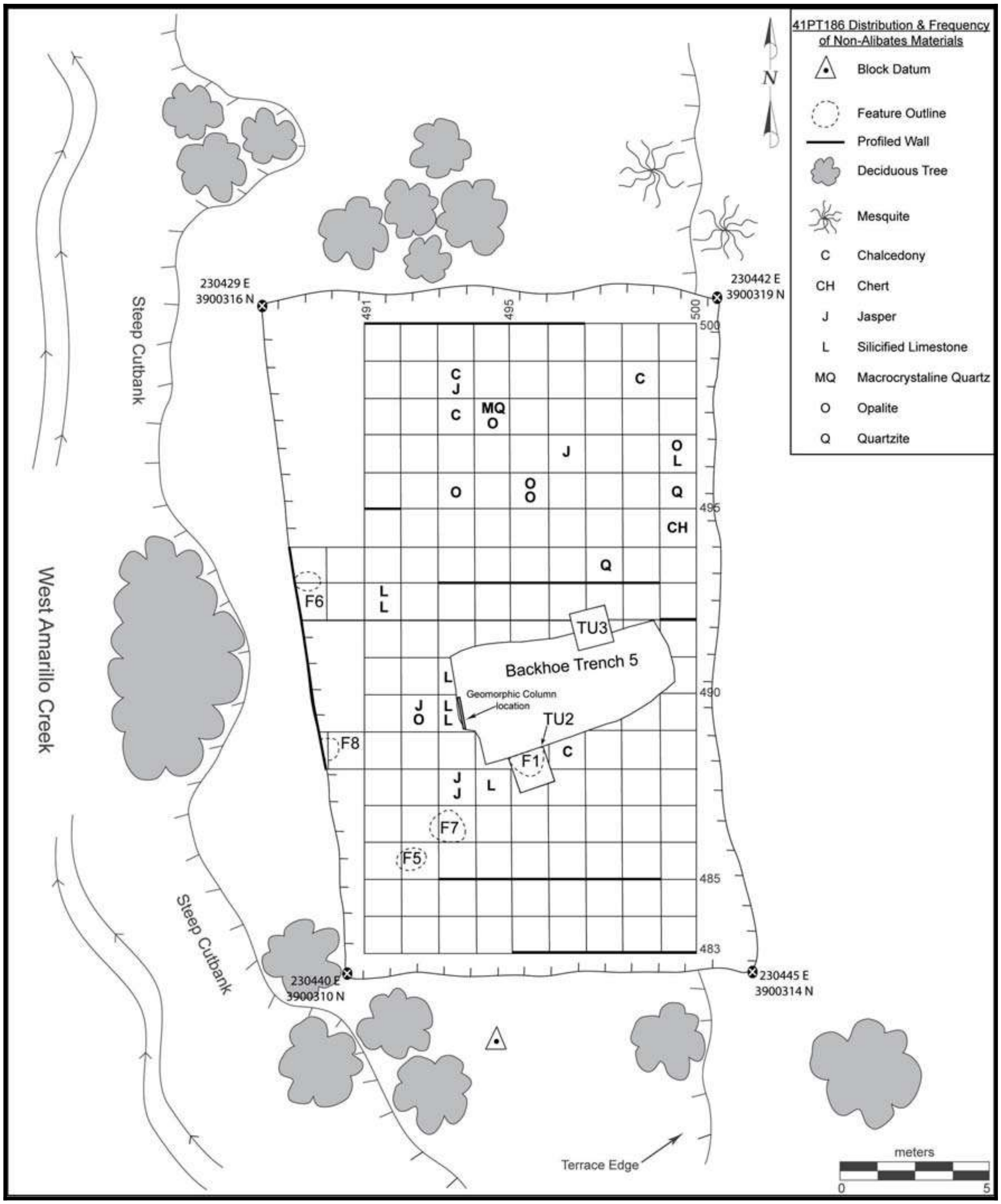

Figure 9-56. Horizontal Distribution of NonAlibates Materials from Excavation Block.

the very back edge of the terrace edge and in a situation that might have allowed cultural materials from another camping episode to have been displaced to this spot. They are not associated with any other tools or lithic debitage and therefore their direct association with the Protohistoric episode can be questioned. If they were part of this occupation, then they reflect knapping activities that were not directed towards the high quality Alibates as in the rest of the excavation block. This would indicate a separate and discrete activity off to the very margins of the rest of the camp.

Horizontal Patterning of Lithic Debris

The horizontal distribution of the lithic debitage was not randomly scattered across the entire block (Figure 9-57). Overall the debitage was sparse (*N* = 212) and recovered from only 47 units (32.6 percent). It accounts for only 24.6 percent of the total cultural assemblage from this block. The distribution of flakes with multifaceted platforms (*N* = 27), those that indicate probably detachment from bifaces are restricted to 15 units or 33 percent of the units that yielded debitage (Figure 9-58). The majority (*N* = 14) of the multifaceted platform flakes were in one unit (N497 E495). This indicates that at least one bifacial tool was worked at that spot. The wide distribution also indicates the likely hood that other bifaces were reduced and/or resharpened with at least one between Features 1 and 7.

The horizontal distribution of the flakes with flat platforms was very similar to that of the multifaceted flakes. Two units (N496 and N497 and E493) in the northern part of the block yielded the majority of these flakes (*N* = 49). Although a few were concentrated in five units in the southern part of the block east and north of heating element Feature 7 (Figure 9-59). At least two objective pieces were worked in these two different areas.

The debitage was primarily concentrated in two specific areas, one toward the northern end of the excavated block and one immediately east of Feature 7 (Figure 9-60). The northern area is labeled Lithic Concentrations #1, whereas the southern area is labeled Lithic Concentrations #2.

Lithic Concentration #1 was observed within a 6 unit area (Units N495 to N497 and E494 to E496). It was the larger of the two and contained 130 pieces from the 6.4 mm screen. Three of the six units were subjected to 3.2 mm screening, which yielded 115 pieces of microdebitage. The microdebitage is not included in this discussion since fine-screening was not consistence across the entire concentration or across the block. The 130 pieces recovered from the 6.44 screen include 62 complete flakes, 52 distal fragments, eight proximal fragments, and eight pieces of shatter/blocky debris.

Nearly 80 percent of the debitage was between 6.4 and 12.8 mm (Figure 9-61) with 19.2 percent less than 6.4 mm. The small size of the recovered debris is a reflection of the size of the objective piece. Furthermore, the objective piece(s) are thought to have been initially reduced elsewhere as no cortex is evident on any of the debris. It is also possible that the lack of cortex indicates the raw material may have originally been blocky pieces that lacked rounded cortex from water rounding.

Platform attributes for 124 complete and proximal flakes in Lithic Concentration #1 are depicted in Figure 9-62. Flat platforms (*N* = 77) are most prominent (59 percent) and commonly produced in flake production during core reduction and unifacial tool shaping. Crushed platforms (*N* = 30) account for another 24 percent. These are often associated with soft hammer percussion and supports late stage finishing or resharpening of tools. The thirteen crushed platforms (account for only 10.5 percent, and are most often the result of biface trimming. It is not clear what the few dihedral and complex platforms represent. The platforms reflect that both hard and soft hammer techniques were employed in this knapping area.

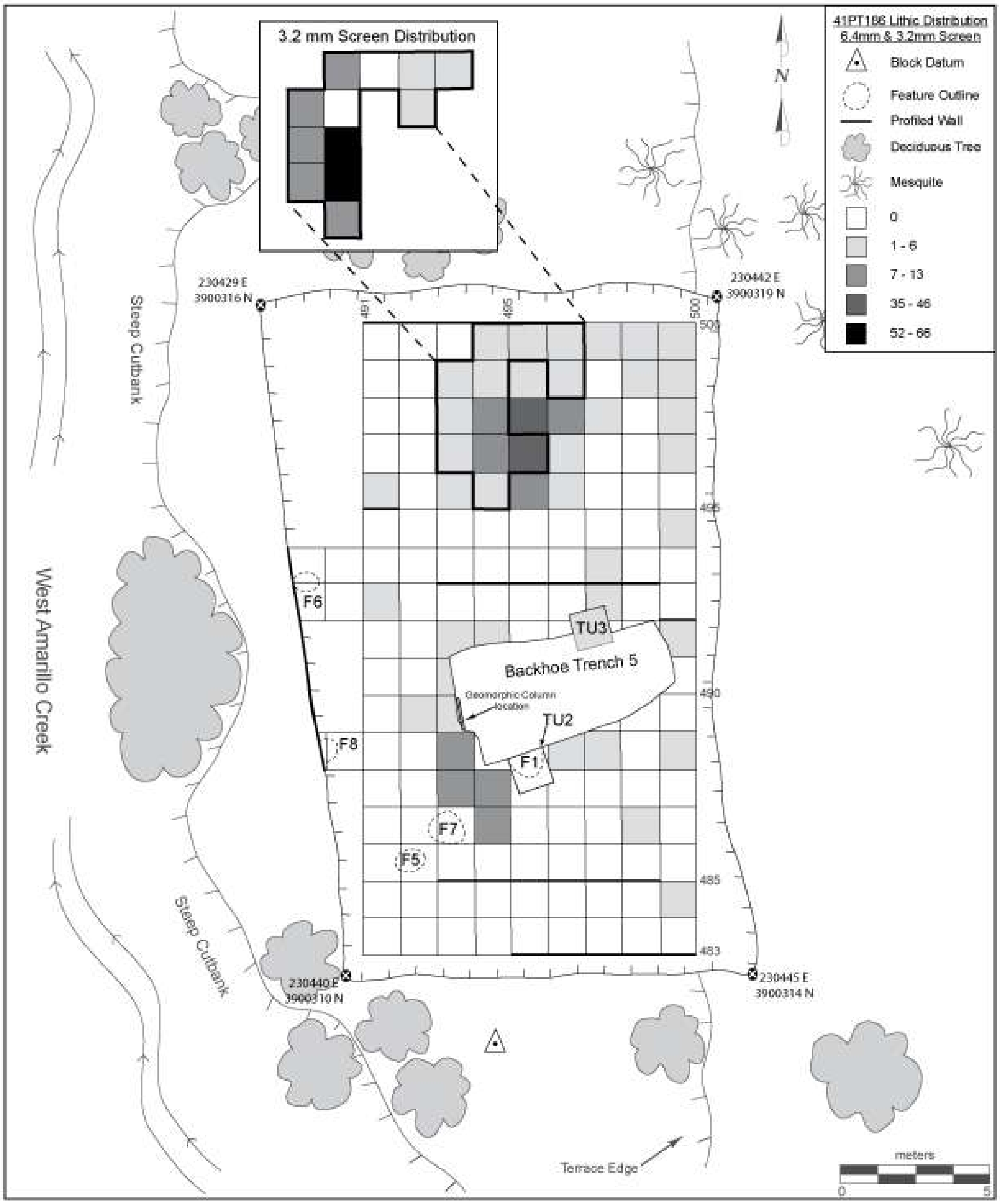

Figure 9-57. Horizontal Distribution of Lithic Debitage Across Excavation Block.

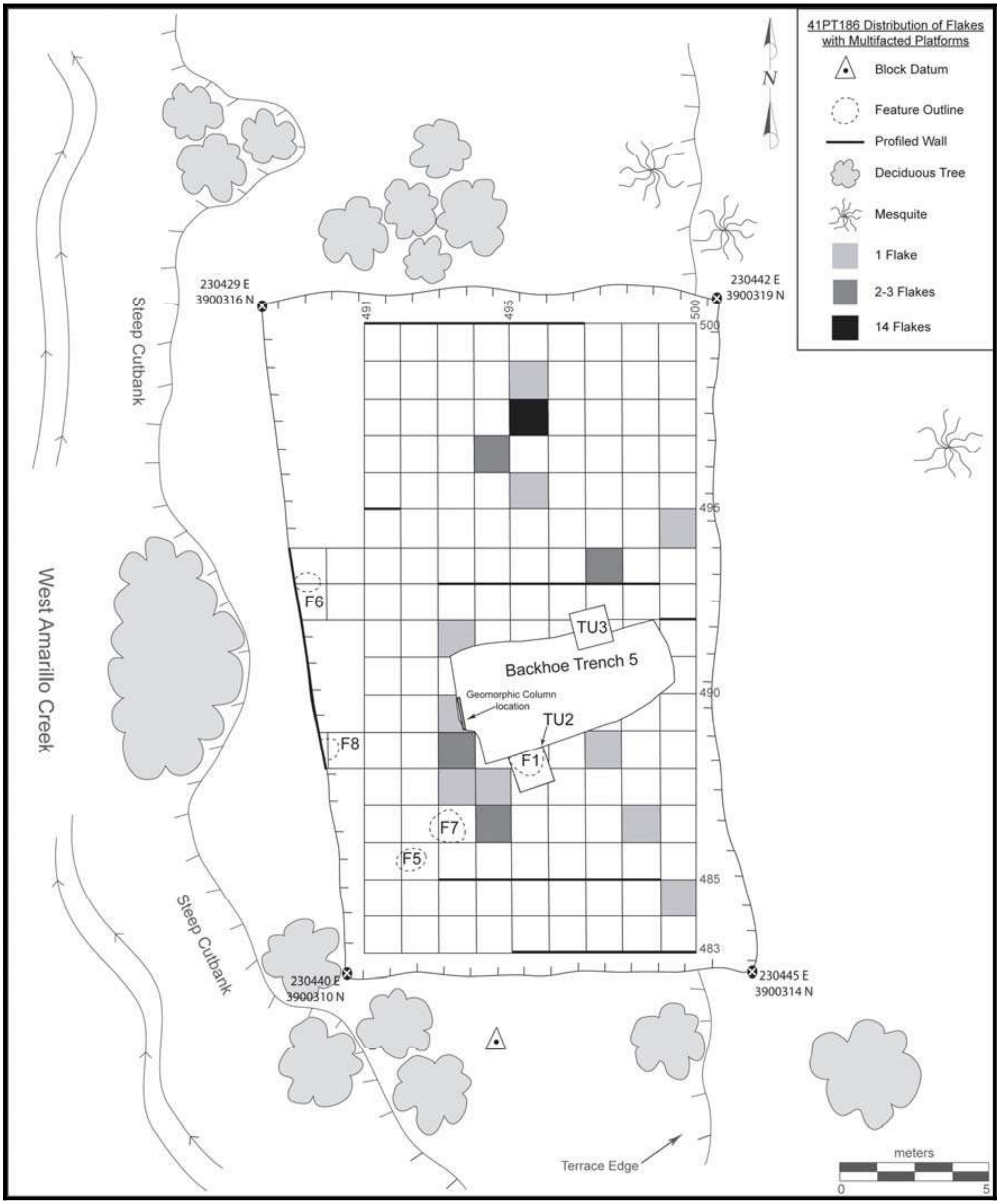

Figure 9-58. Horizontal Distribution of Multifaceted Platform Flakes Across Excavation Block.

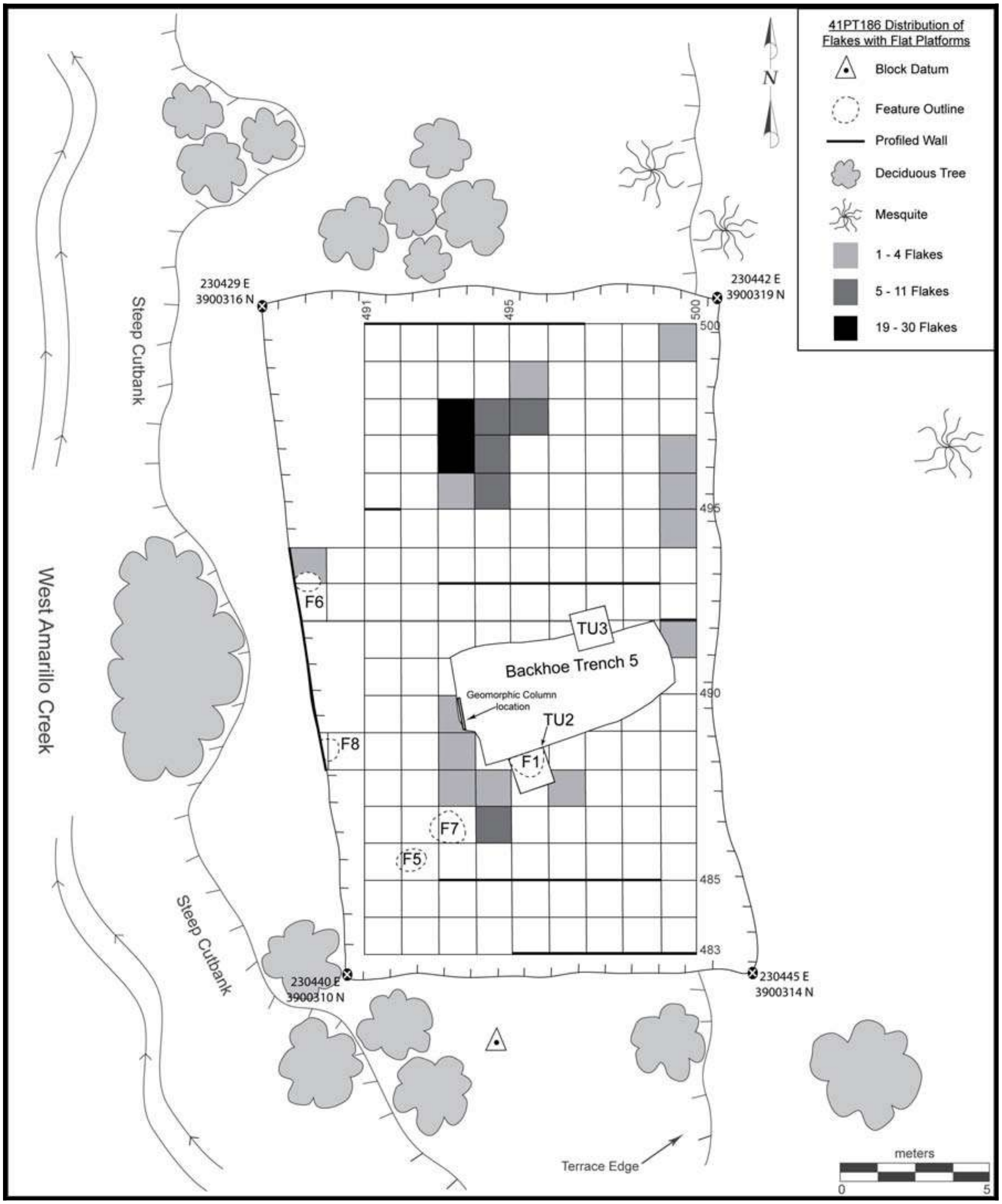

Figure 9-59. Horizontal Distribution of Flat Platform Flakes Across Excavation Block.

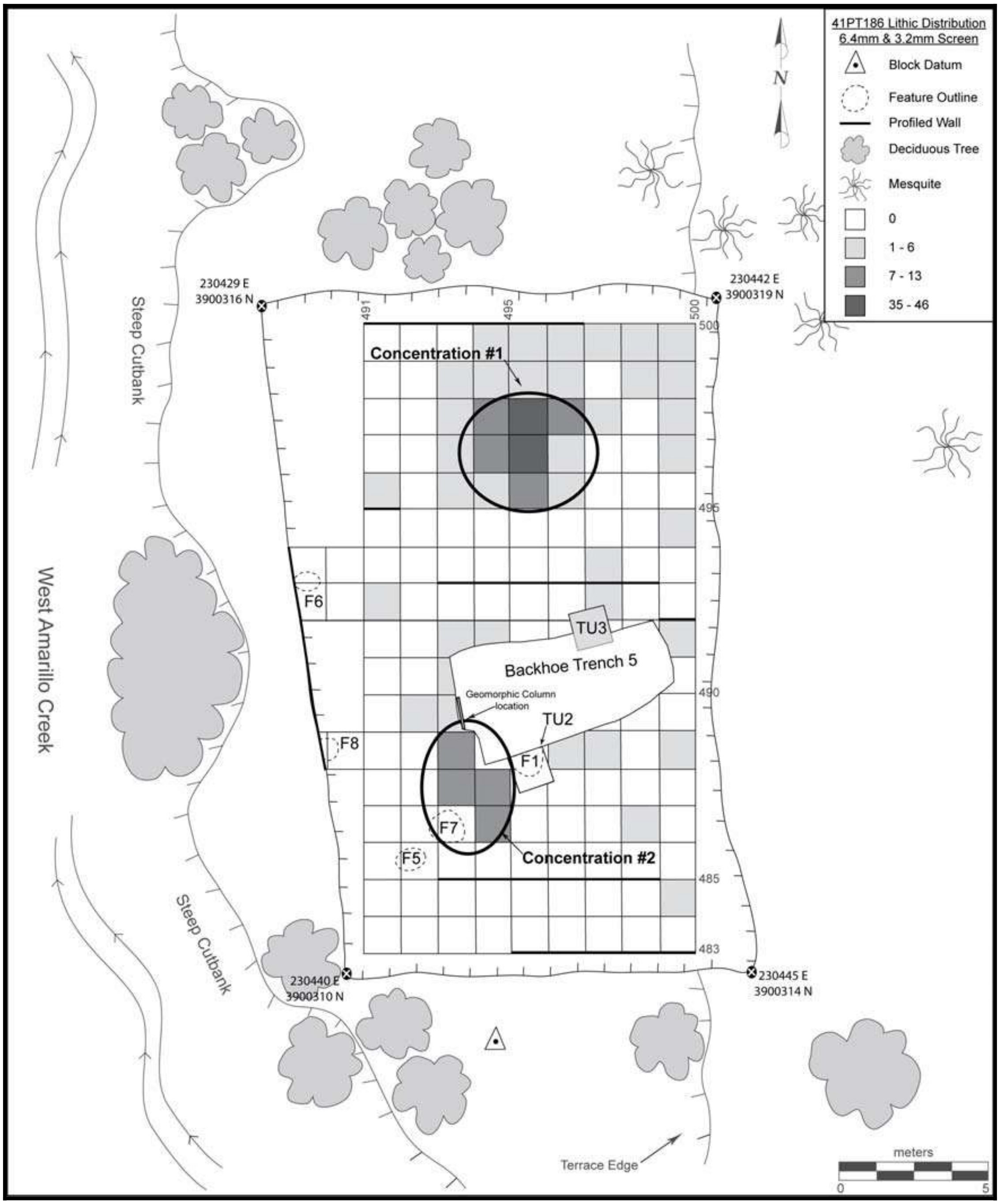

Figure 9-60. Location of Lithic Concentrations #1 and #2.

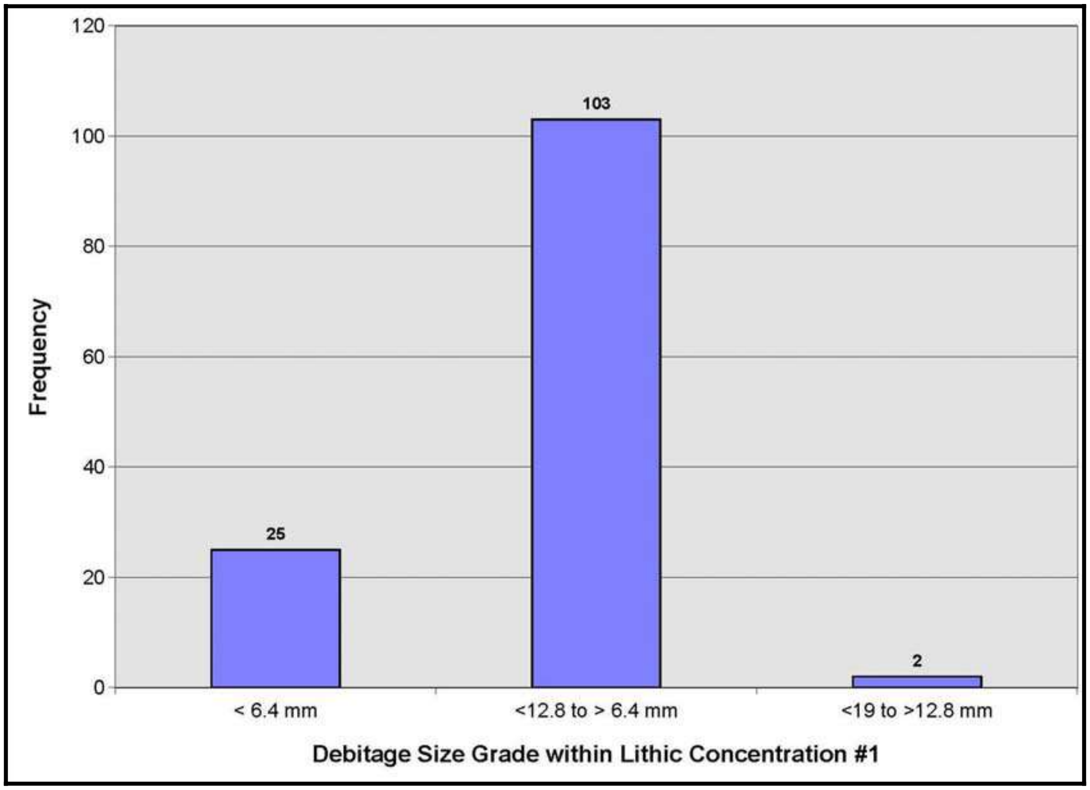

Figure 9-61. Frequency of Debitage Size in Lithic Concentration #1.

Alibates represents 98.5 percent of the material with the other 1.5 percent local opalite. The latter may represent the opportunistic use of locally available materials. The presence of two material types indicates a minimum of two objective pieces were modified at Lithic Concentration #1.

The size distribution of debitage, the preponderance (62 percent) of flat platforms implying soft hammer reduction (Figure 9-62) indicates the production and maintenance of unifacial tools as opposed to biface production occurred in Lithic Concentration #1. The microdebitage from this concentration also reflects late stage processing of tools, especially unifacial tools. The production of unifacial tools of Alibates corresponds to what we see in the cached tools of Feature 6 (the unifacial scrapers, edge-modified flake, and flake blanks). Indirectly, this links this knapping area to the cache implying they were related.

Lithic Concentration #2 encompassed an area slightly smaller and between Features 1 and 7 in the southern part of the block. Roughly four units (N486 to N489 and E493 to E495) contained 44 pieces of debitage. This area was not subjected to 3.2 mm screening and thus, no microdebitage was recovered. The debitage consists of 24 complete flakes, 10 pieces of shatter/blocky debris, nine distal flakes fragments, and one proximal flake fragment.

About 93 percent (*N* = 41) of the debris was between 12.8 mm and 6.4 mm (Figure 9-63). No flakes were larger than this size range and only 7 percent (*N* = 3) were smaller. The debitage size range reflects the general size of the objective piece(s) worked. The objective piece(s) were initially reduced elsewhere or the raw material did not have

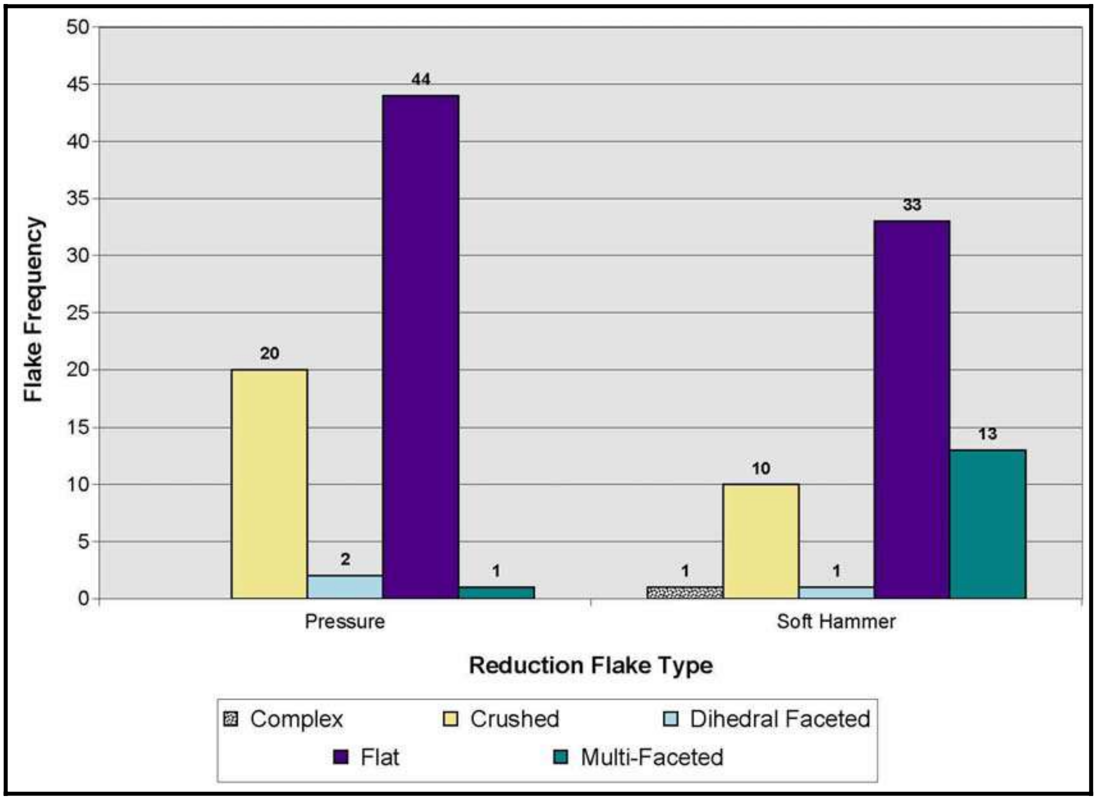

Figure 9-62. Frequency of Flake Platform Type within Lithic Concentration #1

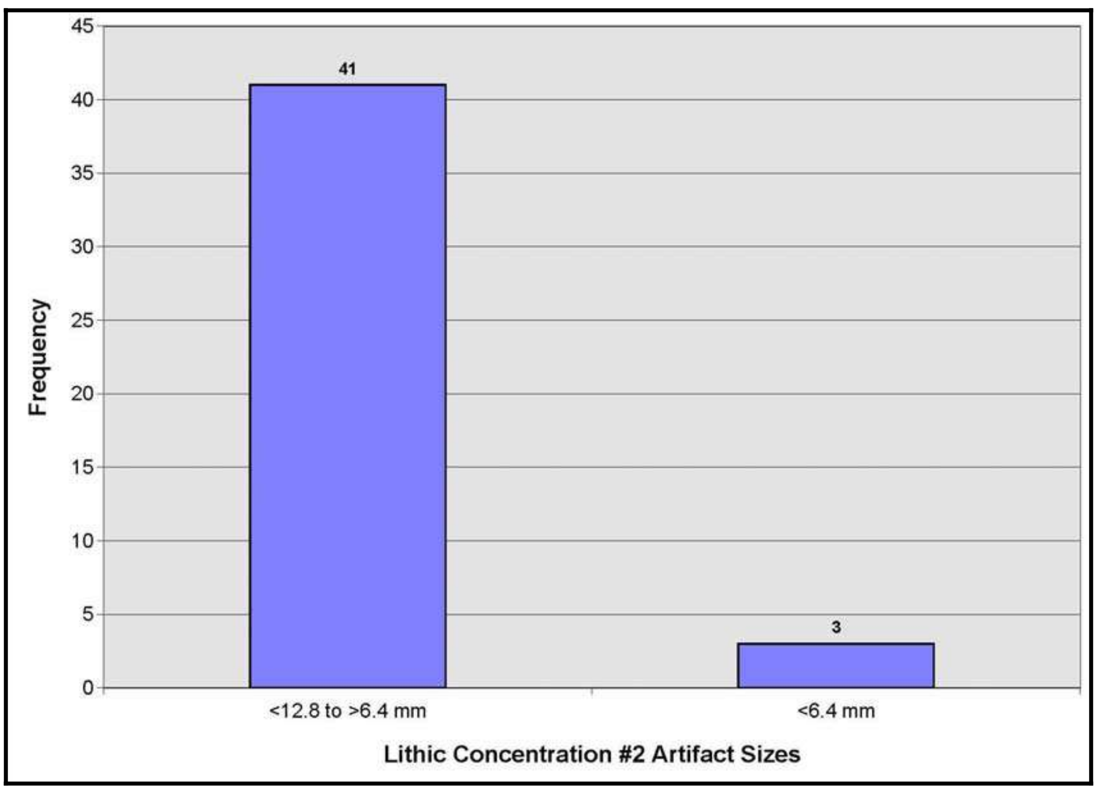

Figure 9-63. Frequency of Debitage Size in Lithic Concentration #2.

cortex as no cortex was evident on any of the debitage. Complete and proximal flakes (*N* = 25) account for nearly 57 percent of the debitage within Lithic Concentration #2.

Flat platform types are most prominent at 60 percent (Figure 9-64). These flat platforms are commonly produced in flake production from cores and/or unifacial tool shaping. The presence of a few crushed platforms, often associated with soft hammer techniques, may also support late stage tool finishing or resharpening. The multifaceted platforms imply that some (20 percent) bifacial work was conducted here.

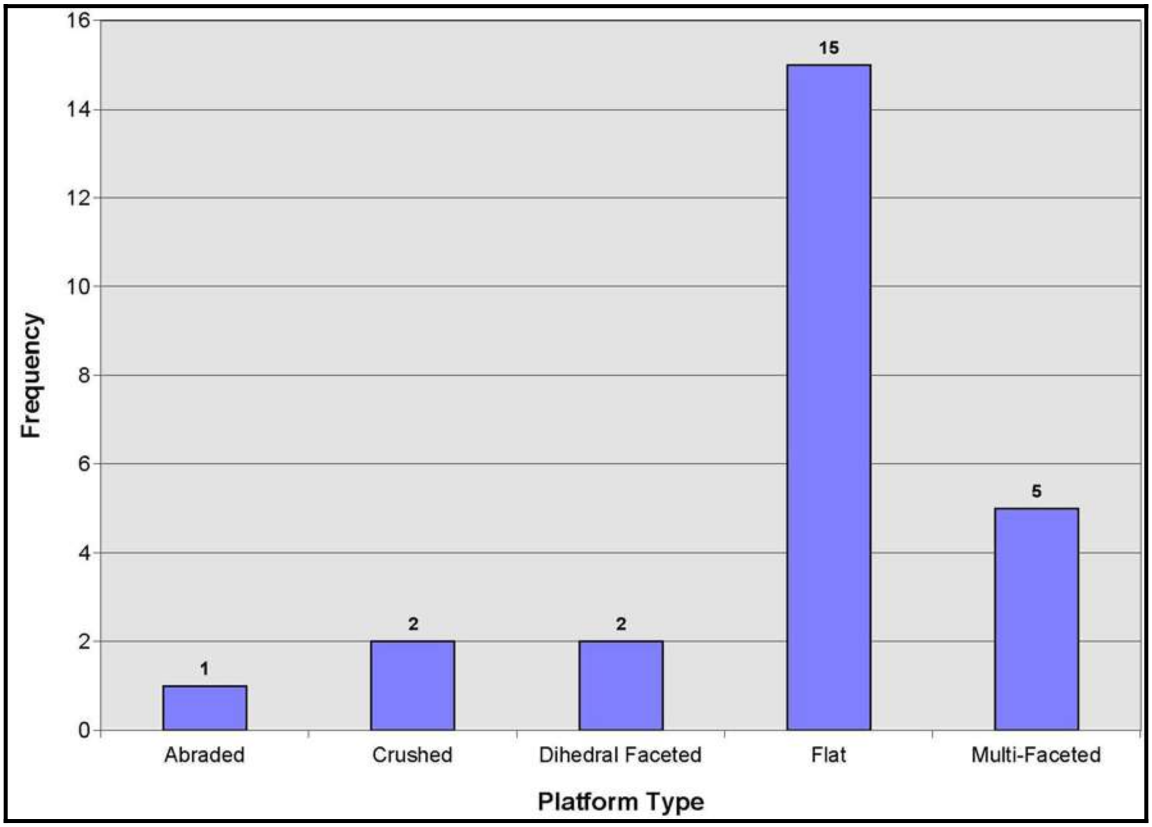

Figure 9-64. Frequency of Flake Platform Type in Lithic Concentration #2

Raw material frequencies within Lithic Concentration #2 (Figure 9-65) shows that nearly all of the material was Alibates (98 percent). The other materials, two pieces Tecovas Jasper and one silicified dolomite probably represent the opportunistic use of locally available materials to supplement Alibates material use. Overall, this indicates that a minimum of three objective pieces were modified in this concentration, probably in the creation of a minimum of three tools.

The small size of debris, flat platforms representing 60 percent and implying soft hammer reduction process, indicates that the production and/or maintenance of unifacial tools occurred in Lithic Concentration #2 adjacent to Feature 7. Again Alibates was the material most often worked, although at least two

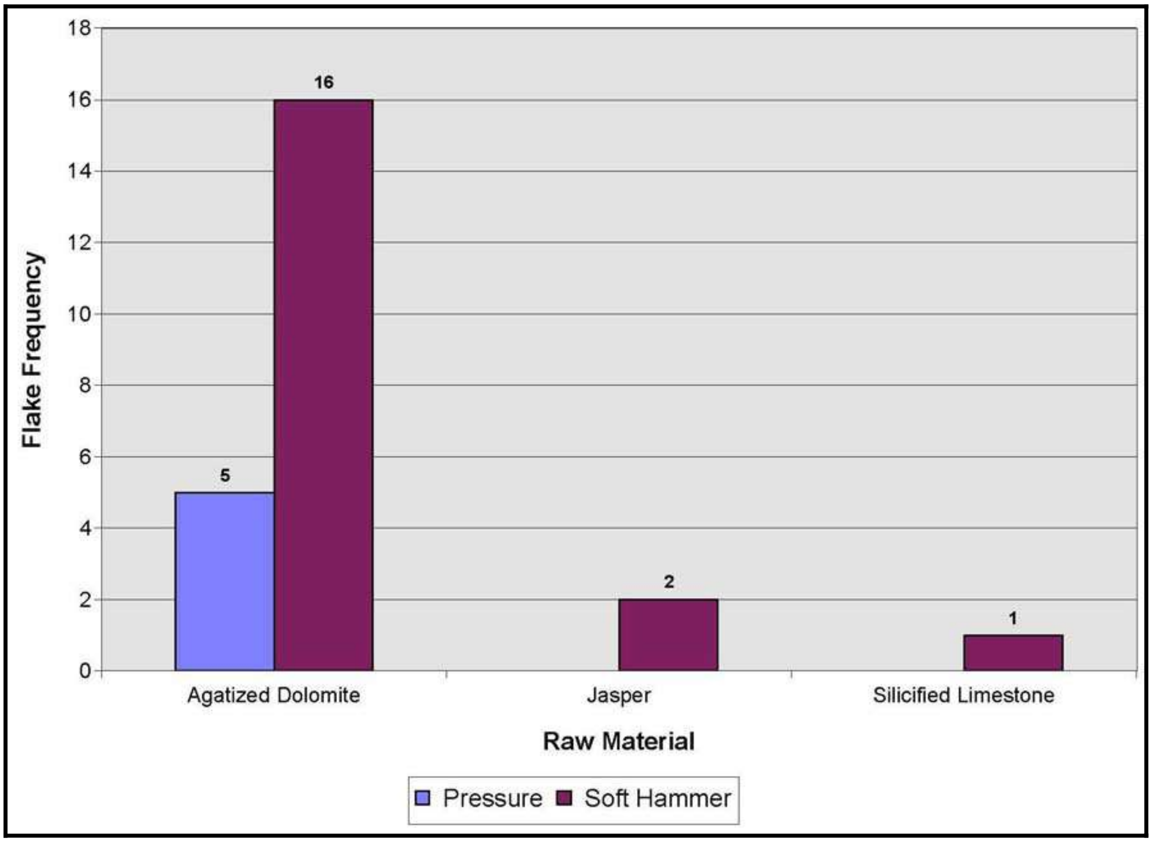

Figure 9-65. Frequency of Raw Material by Platform Type in Lithic Concentration #2

other tools of different materials were worked at this location. The knapping activity represented around Feature 7 again directly corresponds to the cached products in Feature 6. This indicates that Lithic Concentration #2 may also be directly related to the cached items.

9.7.3.2 Chipped Stone Tools

Only nine chipped stone tools were identified from the hand excavations across the 144 m^2 excavation block. These include two small end scraper fragments, four complete end and side scrapers from the cache, Feature 6, two edge-modified flakes from the cache, and three other informal stone tools classified as edge-modified flakes. Also discussed here are two apparently unworked flakes that were part of the cache. Each of these artifacts is described below beginning with the scrapers, followed by the edge-modified flakes, and the two apparent unworked flakes from the cache.

Scrapers

Scrapers were the most prevalent chipped stone tool recovered (66 percent of the total tools) from the excavation block at 41PT186. Four of the six scrapers were recovered in a cache of artifacts (Feature 6), whereas the two outside the cache were both broken fragments. These scrapers are briefly described below with metric and nonmetric measurements for these individual tools presented in Appendix Q.

Specimen #409-010 is a small edge fragment of a thin scraper or edge-modified flake from 66 to 80 cmbs in N488 E493. This fragment was manufactured on an

Alibates flake that is mostly a dark grayish brown (10YR 5/2) with dark reddish brown (5YR 3/4) banding (Figure 9-66). This fragment exhibits a flat unworked dorsal surface and mostly flat ventral surface with very steep lateral edge retouch along the very margin opposite the broken edge. This worked edge exhibits tiny hinge and step fractures and is part of a well worked and steep distal end. This piece was submitted to Dr. Hardy for high-powered use-wear functional analysis. He observed no residues or polish. He interprets the negative evidence as indicating this scraper fragment was unused (Appendix L).

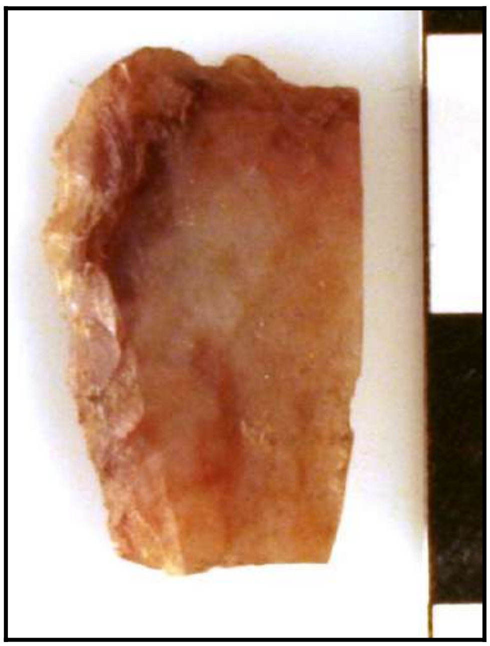

Figure 9-66. Scraper (#409-010) Fragment that Shows Worked Edge to the Left. (scale in cm)

Specimen #446-010 is a relatively large 69.5 mm long, 35 mm wide, and 17.8 mm thick, that weighs 53.5 g, and is a complete end and side scraper (Figure 9-67). A partially crushed and battered platform is present on the proximal end with a well formed and flaked distal end and lateral edges. The ventral surface exhibits a diffuse bulb of percussion near the proximal end with a relative flat remaining surface. The dorsal surface shows one medium size flake scar down the middle that terminated prior to reaching the distal end. This left a small high spot above the distal worked edge. The lateral edges are very steep with the right side extensively work and used. The left edge appears used, but not extensively worked. The left lateral edge juncture with the distal end on the dorsal surface exhibits two recent flake scars and crushed area from where the backhoe bucket nicked this tool during the scrapping. This scraper was at the top of the cache, ventral side up near the middle of the cache. It was manufactured from a light gray (10YR 7/2) to gray (2.5Y 7/1) dark banded Alibates.

Figure 9-67. Dorsal Surface of Unwashed Scraper #346-010. (Proximal End on Left with All Edges-modified).

This scraper was submitted to Dr. Hardy for functional analysis. He observed charred wood on the ventral surface of the distal end and hard, high silica polish plus striae, and possible starch grains on the dorsal surface of the distal end (Appendix L). He interprets the evidence as indicating this scraper was used to scrape charred wood.

Specimen #446-011 is a complete, rectangular end scraper with a wide and thick striking platform on the proximal end and a well formed and flaked distal end and lateral edges (Figure 9-68). This 52.7 mm long by 11.0 mm thick end and side scarper weighs 23.7 g, does not have a central arise along the dorsal surface with steep lateral edges. The ventral surface is relatively flat with a relatively diffuse bulb. A fresh flake scar is also on the ventral surface along the left lateral edge. The worked distal end is rounded and continues around the lateral edges with no obvious juncture. Multiple fresh, tiny flake scars are along the right lateral edge from impact by the backhoe bucket. This is a piece of Alibates.

Figure 9-68. Dorsal Surface of Unwashed Scraper #446-011.

This end scraper was submitted to Dr. Hardy for functional analysis. He observed hair, raphides, starch grains, and hard, high silica polish adhering to one edge (Appendix L). He interprets the evidence as indicating this scraper functioned to scrape both hides and hard, high silica plants. Dering (2003) believes that raphides, needle shaped calcium oxalate crystals, occur in a variety of Agavaceae including sotol, yucca, agave, and beargrass. Following Dr. Hardy's use-wear analysis this end scraper was sent for starch grain analysis. Seven lenticular grains of starch from Canadian wildrye (*Elymus canadensis*) grass were identified (Appendix F).

Specimen #446-012 is a complete, moderate size flake scraper that weighs 16.9 g. It was manufactured from a light bluish gray (Gel 2 7/5 PB) with bands of weak red (10YR 4/3). This complete flake exhibits a wide, narrow, single facetted platform that was ground on the dorsal side. The relatively thin distal end exhibits steep retouch and use-wear along a convex edge (Figure 9-69). Only a few previous flake scars are across the dorsal surface. The lateral edges are tapered with tiny use scars along the right, convex edge and irregular use scars on the relatively straight left lateral edge. The ventral surface lacks flake scars across the broad surface and is concaved with minimal bulb of percussion. Tiny flake scars are occasionally present along the edges of the ventral surface. This pieces was made on a piece of Alibates dominated by dark reddish brown (2.5YR 2.5/3) with light pale brown (10YR 8/2) bands throughout. This scraper was submitted for functional analysis. Dr. Hardy observed plant raphides and parenchyma residues coupled with hard, high silica polish along one edge (Appendix L). He interprets the evidence as indicating this scraper was used to scrap plants.

Figure 9-69. Dorsal Surface of Unwashed Flake Scraper #346-012 with Retouch along All Lateral Edges.

(Note: Platform at Top Left Corner)

Specimen #446-013 is a complete, ovate shaped end scraper that weighs 14.1 g. It has a platform on the proximal end and a well formed, steep, and flaked distal end (Figure 9-70). A single arris divides the dorsal surface, but not equally, as it is near the right lateral edge creating a steep right lateral edge and a tapered left lateral edge. Both lateral edges have been worked and appear used. The ventral surface is relatively smooth with a broad diffuse bulb of percussion just below the broad, thick striking platform with a slight concave area just before the distal end. Tiny flake scars are on the ventral side along the tapered left edge with hinge fractures on the steep right edge. This piece was along the northern edge of the cache and directly under another scraper. This scraper was made from a light bluish gray (gley 2 7/5PB) Alibates with weak reddish (10R 4/3) bands.

Figure 9-70. Dorsal Surface of Unwashed End Scraper #446-013 with Proximal End to the Left and Steep Worked End to Right.

It was also submitted for use-wear to determine its real function. Dr. Hardy observed hair fragments on the ventral and dorsal surfaces at the distal end. On the proximal half he observed raphides, wood fragments, and abraded ridges that indicate this scraper was hafted up to about its mid point. Thus, this hafted scraper was apparently used to scrap hides (Appendix L).

Specimen #501-010 is a small edge fragment (distal right corner) of a formal scraper from 100 to 110 cmbs in N497 E496. This tool was manufactured from an Alibates flake of grayish tan (10YR 5/1) (Figure 9-71). The piece exhibits an unworked, flat dorsal and ventral surface with no bulb or stress rings, and exhibits a very steep, well worked, and curved lateral edge.

Edge-Modified Flakes

Edge-modified flakes are those artifacts where one or more areas of flake scarring occur along margins. This scaring can be either regular/patterned or irregular across one or more edges, and generally does not significantly alter the overall shape of the flake. Five edge-modified flakes were recovered from the excavation block. Two were in the cache Feature 6 and are discussed below. The two edge-modified flakes from the Feature 6 cache ate described and discussed below. The metric and nonmetric measurements for all five edge-modified tools are presented in Appendix Q.

Figure 9-71. Dorsal View of Scraper Fragment (#501-010) With Worked Edge at Left. (scale in cm)

Specimen #446-014 is a large, 59 mm long by 10.2 mm thick that weighs 38.6 g, edge-modified flake from the cache (Figure 9-72). This scraper was made from a reddish brown (2.5YR 4/4) and white (10YR 8/1) piece of Alibates with very dusky red (10R 2.5/2) bands. Specimen #446-014 is a large, 59 mm long by 10.2 mm thick that weighs 38.6 g, edge-modified flake from the cache (Figure 9-72). This scraper was made from a reddish brown (2.5YR 4/4) and white (10YR 8/1) piece of Alibates with very dusky red (10R 2.5/2) bands. It exhibits no obvious platform at the broken proximal end, although the dorsal surface shows a thicker area near. No identifiable bulb is

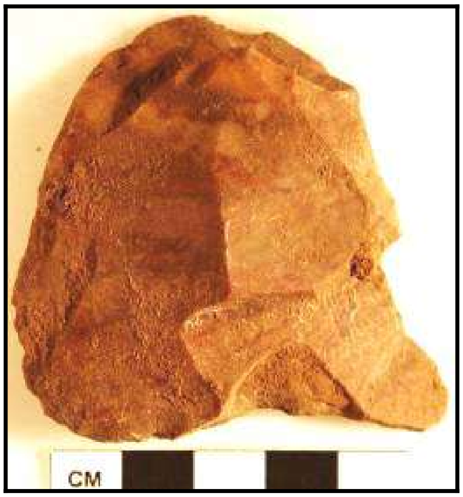

Figure 9-72. Dorsal Surface of Edge-Modified Flake #446-014. (Distal End at left, Retouch on Lower Left Corner, Right Corner Sent for INAA).

present on the ventral surface opposite where the missing platform. The distal end and most of the lateral edges are tapered with some small areas of broken edges. Limited edge-modification is present in at least four limited areas along the margins of this flake. These edges appear to have been used. The more or less central arris near the middle of the dorsal surface appears to be lightly abraded. This piece was near the center and the top piece in the cache. The smooth ventral surface exhibits a thin metallic line across its surface that indicates the backhoe bucket scraped it. The functional analysis performed by Dr. Hardy indicates this tool served to scrape plants as he observed plant fragments, raphides, and starch grain residues along with edge rounding and striae wear on at least one corner of this tool (Appendix L). The abraded central arris may be from bag wear or hafting. A small 1.2 g piece of this edge-modified flake (#446-014a) was removed and submitted to for INAA. The INAA (TRC476) indicates this is Alibates from the Quartermaster Formation (Appendix E).

Specimen #446-016 is a large, 50.7 mm long by 9.2 mm thick retouched flake that weighs 28.0 g. It was made from Alibates and was also from the cache. It exhibits a thick, broad, two facetted striking platform on the proximal end. The distal end is irregular with one partially worked edge and one small, steep edge with use scars, with a irregular concave area between (Figure 9-73). The right lateral edge expands outward and is tapered with some small minor flake scars towards the distal corner. The left lateral edge is very irregular with part of a previous platform still present. The dorsal surface along the left side exhibits previous flake scars orientated perpendicular to the flake axis that terminated near the mid line of this flake. The ventral surface exhibits a broad, diffuse bulb at the proximal end whereas the distal end has a concave edge. This was the lowest of the pieces at 68 cmbs and directly under one of the end scarpers. This Alibates retouched flake was a mottled reddish brown (10YR 4/4) to dark reddish brown (10YR 3/4) with white (10YR 8/1) mottles and bands. A 1.2 g piece off the left lateral edge (#446-016a) was removed and submitted for INAA. The INAA (TRC478) indicates this is a piece of Alibates (Appendix E).

Figure 9-73. Dorsal View of Edge-Modified Flake #446-016 from Feature 6 Cache. (Proximal End and Platform at Bottom)

Specimen #360-010 is a distal flake fragment from 90 to 100 cmbs in N484 E494. This partial flake exhibits use-wear along the left lateral edge that extends to the pointed distal end. The flake is mostly a dark reddish brown (2.5YR 3/4) with a yellowish brown (10YR 5/8) to brownish yellow (10YR 6/8) cortex across the dorsal surface. This cortical surface is very smooth indicating a water worn piece. Although not stripped this is an Alibates flake. The piece exhibits a smooth and slightly concave ventral surface with a tapered lateral edge that was used. Tiny use scars and slight wear occur along this once sharp lateral edge. The break appears as a snap indicating it was broken during use. This piece was submitted to Dr. Hardy for functional analysis. He observed plant tissue residues and hard, high silica polish adhering to one edge (Appendix L). He interprets the evidence as indicating this flake was used to cut hard, high silica plants.

Flakes

As mentioned above two large flakes were recovered within the lithic cache, Feature 6. These pieces are substantially larger than the majority of the lithic debitage assemblage recovered across the excavation block. Initially, these flakes were thought to be blanks to be modified into tools, but use-wear indicted they both had been used. Below is a brief description of the Feature 6 flakes.

Specimen #446-015 is a moderate size secondary sequence flake (16.5 g) with a left lateral corner/edge (Figure 9-74). Two pronounced striking platforms are still present at the proximal end. The platforms are roughly triangular, unprepared, and single faceted. The distal end generally tapers, but not to a thin edge. Relative small flake scars are visible on the dorsal surface between the platforms. The dorsal surface exhibits about one quarter of the surface with a smooth cortex. The left lateral corner is broken. The right lateral edge, partially covered in cortex, tapers. The ventral surface exhibits a pronounced bulb of percussion and concentric ripple lines. No obvious intentional flake scars are visible anywhere along the edges. This was a mottled piece of Alibates that is reddish brown (2.5YR 4/3) and white (10YR 8/1) with very dusky red (10R 2.5/2) bands. Functional analysis conducted by Dr. Hardy revealed hair and raphide residues coupled with soft polish that he interpreted as cutting hide and possibly plants (Appendix L). A 1.5 g piece of this flake (#446-015a) was submitted to for INAA. Results of INAA (TRC477) indicate this is a flake of Alibates from the Quartermaster Formation (Appendix E).

Figure 9-74. Dorsal View of Unmodified Sequence Flake #446-015 from Feature 6, Cache. (Proximal End and Platform on Left Side, Right Side Broken, White Area is Cortex)

Specimen #446-017 is a moderate size broken flake. It measures 51.7 mm long by 38.9 mm wide with a 6.3 mm thick bulb area and weighs 104 g. The flake appears to have split longitudinally through the bulb area at the time of impact (Figure 9-75). The left lateral edge is broken. The distal end terminates or is broken along a ripple mark. The right lateral edge tapers to a thin, sharp edge. The only apparent worked area is along the distal end with a few tiny scars. The dorsal surface is quite smooth, whereas ripple marks and the pronounced bulb are on the smooth ventral surface. This flake was below an end scraper at the northern edge Feature 6. This flake was identified as Alibates, with a creamy red (10R 4/4) and white (2.5Y 8/1) mottled color. A 1.6 g piece of this flake (#446-017a) was also submitted to for INAA.

Figure 9-75. Unwashed Broken Flake #446-017 from Feature 6 Cache.

Those results (TRC479) indicate this flake is Alibates (Appendix E). This flake was sent for use-wear analysis. Dr. Hardy observed raphides and starch grains along the jagged margins and interpreted this flake was used for cutting plants. Following that the flake was sent from starch grain analysis. Five grains of Canadian wildrye grass were identified, but no other starches were present (Appendix F).

Interestingly, the tool assemblage from the excavation block lacked projectile points and bifacial tools. However, the lithic debitage reflects the presence of probable bifacial tools through the identification of multifaceted flakes. Potentially bifacial tools were produced on site, but were curated upon site abandonment. If bifaces were not used extensively and thus not broken then they would not have been discarded. Our only clue to their possible presence is from the multifaceted flakes recovered from the two Lithic Concentration areas. The absence of projectile points might be from their total replacement by metal tools at this time, which could also account for the lack of bifacial tools.

The recovery of only a few artifacts outside Feature 6 cache, make interpreting their horizontal patterns difficult. The eight items in Feature 6 reflect the intentional caching of not only the formal end and side scrapers, but also the informal edge-modified flakes and two unmodified flakes. The cache was towards to the creek side (west or front) of the main camping area (Figure 9-76). It is not clear why that side was chosen. The two broken scarper fragments were widely separated. Specimen #409-010 was within the Lithic Concentration #2 next to heating element Feature 7 at the south end of the block. Apparently this was the location where retooling occurred. This broken scraper was discarded and one or more scrapers were made or refurbished. This retooling task occurred next to the heating element. The second broken scarper (#501-010) was within Lithic Concentration #1 at the north end. This location also served for retooling with the broken scraper discarded and new unifacial tools were made and/or refurbished here as indicated by the lithic debitage in this concentration. The two widely separated broken scrapers indicate that similar activities occurred at two separate places within the camp as the Lithic Concentrations #1 and #2 with broken scrapers are quite similar. This may reflect that two separate individuals performed these two tasks during this occupation. The one recognized and broken edge-modified flake (#360-010) was about 1.5 m southeast of heating element Feature 7. Because of its small size, and general proximity to Lithic Concentration #2 may have served in some retooling tasks and then was discarded in this area. Again this tool was probably used by someone tending to the heating elements. The use-wear analysis on this edge-modified tool revealed it was used in cutting hard, high silica plants, which may have been wood used in association with the adjacent heating elements or in the retooling of unifacial tools.

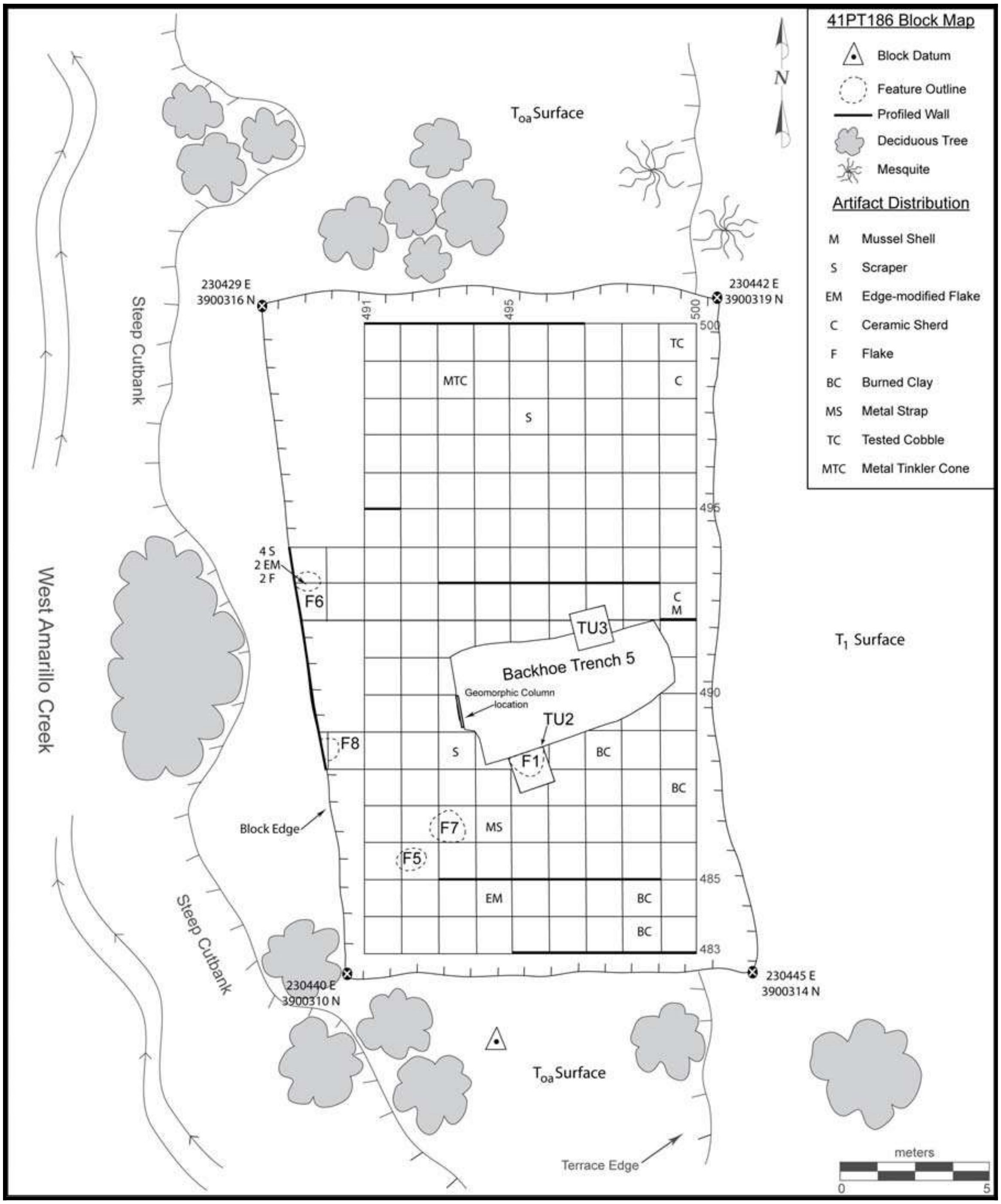

Figure 9-76. Horizontal Distribution of the Recovered Artifacts within Excavation Block.

Lithic Raw Material Acquisition and Use

The examination and identification of lithic raw material types used by the occupants is useful in interpreting group movement and resource selection patterns. The lithic debitage was initially sorted into material types based on visual and textural characteristics. This was relatively straightforward for coarse versus fine-grained materials (e.g., cherts versus quartzites) or those materials with distinctive color ranges (e.g., the grayish-blue of Edwards cherts). For those materials that had overlapping color ranges and similar fine-grained textures (i.e., Alibates dolomite and Tecovas jasper), visual sorting by raw material type was more difficult. To facilitate the sorting accuracy of the visual identifications 12 artifacts from the Protohistoric component were sent to the University of Missouri for INAA.

Specifically, eight flakes or parts of larger flakes (#461-001 = TRC472, #473-001 = TRC473, #482-001-1 = TRC474. #498-001 = TRC475, #503-001a = TRC480, #528-001 = TRC481, #533-001 = TRC482, and #537-001 = TRC483) were selected and submitted for INAA to determine their chemical composition and assignment to a particular geological formation. Six flakes fall clearly within the 90 percent confidence ellipse for the Quartermaster (Alibates) cherts. Two flakes TRC475 and TRC481 fall along the outside margin of the 90 percent confidence ellipse of the Quartermaster chert that moves them slightly toward the Tecovas ellipse (Appendix E, Figure E-6). All the submitted samples, which reflected the range of color and texture variations in the recovered assemblage, are chemically assigned to Alibates. At the time of submittal, all eight pieces were visually classified as Alibates. The visual identifications were supported by the chemical results.

Four tiny pieces (less than 2 g each) removed from the four scrapers from the cache (#446-014a = TRC476, #446-015a = TRC477, #446-016a = TRC478, and #446-017a = TRC479) were also submitted for INAA. The chemical results indicate that all four scrapers are chemically identified as Alibates of the Quartermaster Formation. They all fall within the 90 percent confidence ellipse (Appendix E, Figures E-6 and E-7). However, two of these scrapers (#446-015a = TRC477 and #446-017a = TRC479) had been visibly assigned to Tecovas prior to submission.

When the INAA results from these Protohistoric artifacts were assessed in conjunction with those samples/artifacts submitted from other sites and natural locations, it was calculated that TRC had an 80 percent accuracy rate in differentiating between Alibates Dolomite and Tecovas Jasper.

Based primarily upon our visual identifications, the debitage assemblage was composed of 92 percent Alibates silicified dolomite (Figure 9-77). Other materials represented include silicified dolomite (2 percent), Tecovas jasper (1 percent), Ogallala quartzite (less than 1 percent), opalite (less than 1 percent), and unidentifiable specimens (less than 1 percent).

Figure 9-77 also shows the debitage frequency of raw material classified by size category. Very few large flakes of Alibates were recovered from the excavation block. This may indicate that the majority of Alibates brought to this camp was in a reduced form such as flake blanks, thinned bifaces, or finished tools. The other infrequent materials present, also are in small sizes, as no large flakes of any other materials were recovered. This may reflect the casual collection or use of other various materials. Obviously large masses of the local material were not reduced or possibly present at this camp.

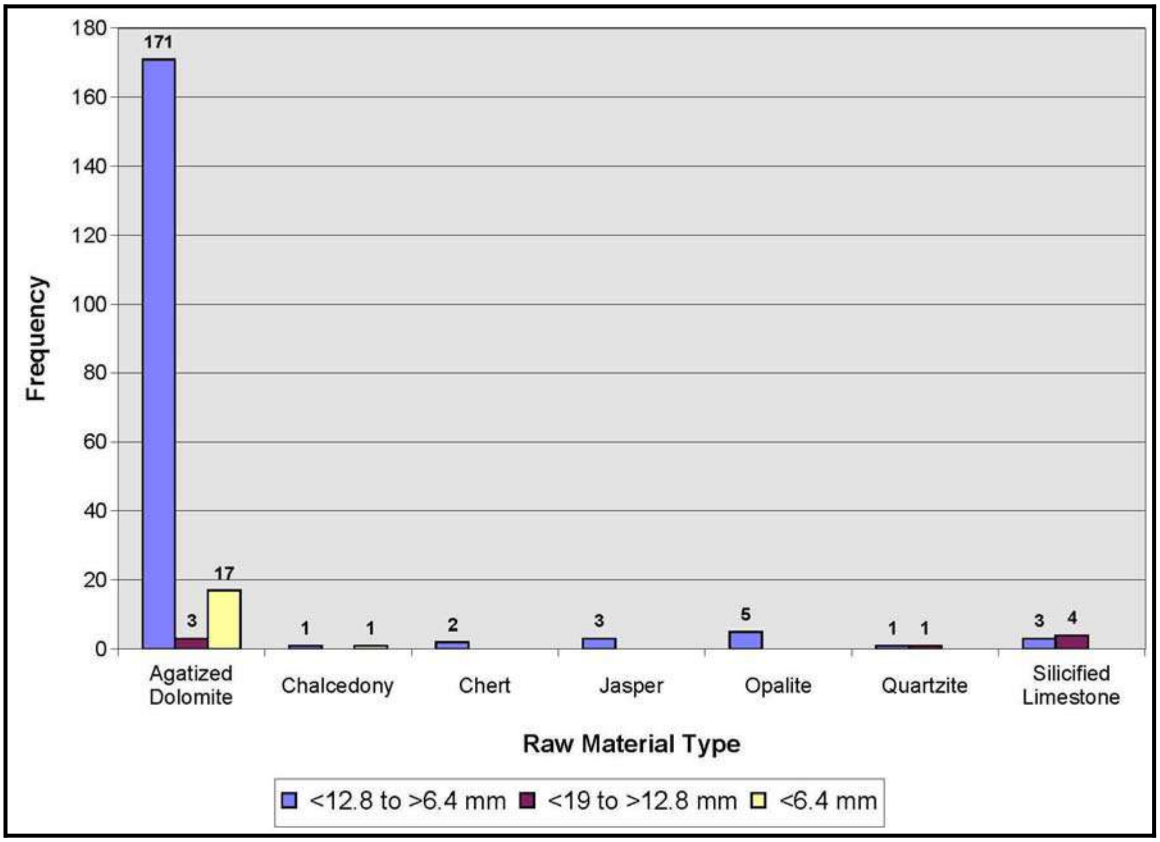

Figure 9-77. Bar Chart Showing Raw Material Distribution among Debitage from Excavation Block.

All nine chipped stone tools and 98 percent of the lithic debitage were of locally available Alibates. Most microdebitage reflects resharpening of Alibates tools, a high percentage of which apparently were steep edge unifaces, such as scrapers. The major known Alibates quarries are some 50 to 55 km to the north along either side of the Canadian River at Lake Meredith. A few pieces of poor grade local white opalite, one quartz crystal (#515-009), two pieces of Edwards chert (#460-001 and #473-001), and at least one piece of local Potter chert were identified in this Protohistoric assemblage. This Protohistoric group preferred the local Alibates material to manufacture their chipped stone tools over all other local and accessible materials.

It is clear that Alibates was the preferred material selected for and used in tool production activities. Plentiful high quality Alibates is within a day's walk from the campsite and is relatively easily accessible. However, considerable other raw material including Ogallala quartzite, dolomite, opalite, and Tecovas jasper were closer to this campsite. Although the quartzites and dolomite may not be as high quality as the Alibates, the Tecovas material may be close. A small outcrop of Tecovas is 27 km down stream at 41PT276. Therefore, it appears that Alibates was definitely selected for over the other locally available raw materials. This material was not traded for and in fact no nonlocal material was identified at all from this campsite.

This may indicate these Protohistoric occupants were local to this region and had first hand knowledge and experience with this one high quality tool stone resource. They definitely selected Alibates over the other locally available raw materials such as Tecovas and the various gravel sources.

9.7.3.3 Ceramic Sherd (*N* = 1)

One tiny body sherd (#443-008-1) was recovered from the occupation zone at 90 to 100 cmbs in N492 E499. It is only 14.4 mm long and ca. 5.7 mm thick, and weighs 1.0 g (Figure 9-78). It exhibited a smooth, light brown (7.5YR 6/4) exterior surface with a few light and dark sand grains exposed, a smooth, very dark brown (10YR 3/2) interior surface with very faint striations, or wiping and smoothing lines, plus a couple of exposed sand particles. The core was gray (10YR 5/1) and exhibited angular to subrounded quartz sand additives with many tiny pores. This sherd exhibited no curvature or special features. The entire sherd was first submitted to Dr. Perry for starch grain extraction, which was conducted through sontification, and left the sherd intact. The starch grain analysis revealed no starch grains (Appendix F).

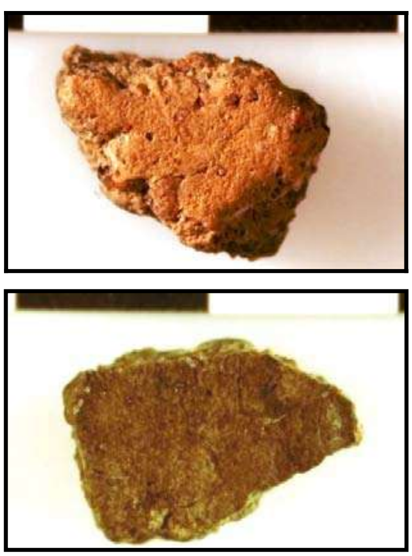

Figure 9-78. Plain Surface Body Sherd (#443-008-1), top is Exterior, Bottom is Interior. (scale in cm)

Following the starch grain extraction procedure the sherd was then submitted to Dr. Robinson for petrographic analysis of its constituents. This sherd was too small for normal thin sectioning and mounting. Therefore, one edge was crumbled, the matrix placed on a glass slide in a wet mount, and then viewed under a high-powered microscope. Dr. Robinson observed that quartz dominates the paste and clearly comprises the tempering agent. The quartz is coarse and medium-grained with subangular shapes. Direct comparison with natural gray sandstone from West Amarillo Creek valley floor revealed the local sandstone contained the same type of sand used in the paste. The quartz in the sherd was likely crushed and ground from natural local sandstone rock and added to the raw clay, or perhaps was collected from weathered portions of the sandstone areas. The sherd has a minor fraction of very fine biotite particles distributed through the paste. The biotite appears as small black specks. This ceramic specimen is strikingly similar to Paste Group 3, which was defined on a single sherd from this same site, 41PT186, but from a different context. The wet mounted particles lack Rock B, composed of quartz and biotite. It is thought that Rock B would be hard to distinguish from the rough paste texture or would be misidentified as quartz. Again, the lack of feldspar is the key in Paste Group 3, in a region where feldspar is common, though variable in its distribution (Appendix I). Although the sand grains are similar to those of the local sandstone, the lack of feldspar may reflect this sherd was manufactured outside this immediate region were feldspar is so common.

After the petrographic analysis, sherd #443-010 was sent to the Archaeometry Laboratory at the Missouri University Research Reactor for INA analysis to help determine where it was manufactured. INA indicates this sherd (TRC527) was manufactured from local clay sources with a close match with other Antelope Creek sherds from 41PT109, specifically in Meier's (2007) Group 4 (Appendix J). Her Group 4 was comprised of four sherds from 41PT109, three sherds from Landergin Mesa (41OL2), and nine sherds from Alibates Ruin 28 (Meier 2007). This sherd's chemistry is similar to that of other Antelope Creek sherds in the immediate region. The question then becomes a) whether or not the pot represented by this sherd was collected and curated by this Protohistoric population, b) if this Protohistoric group actually manufactured the vessel from the same materials as did the Antelope Creek potters, or c) the pertinent pot was introduced independently into this cultural deposit?

This sherd was at the very eastern edge of the excavation block at the very back edge of the lower terrace at the junction with the sloping edge of the higher terrace (Figure 9-76). This horizontal position is definitely off to the extreme side and away from all the other cultural artifacts and features within this one well defined occupation. The fact that only one tiny sherd was recovered places this piece in question. This coupled with the fact that it is nearly identical to the Antelope Creek phase ceramics creates a questionable association. Its context at the back edge of the terrace below the leading edge of the higher terrace and in a location of possible displacement indicates its probability for not being directly associated with the rest of the Protohistoric artifacts recovered. In other words, this sherd actually represents a displaced artifact from a different time period not represented in our Protohistoric occupation. At present, this sherd is not accepted as part of the Protohistoric assemblage.

9.7.3.4 Mussel Shell (*N* = 1)

A single mussel shell fragment (0.6 g) was recovered during hand excavations. This roughly 1.5 cm long fragment (#444-006) came from 100 to 110 cmbs in N492 E499. The piece exhibits four jagged and broken edges that lack obvious signs of utilization. No umbo is present that would facilitate species identification. However, one irregular edge exhibits a concave, notch-like configuration that might be part of a drilled hole, but the fractured area is very small and such an identification is tenuous, at best. It has a slightly concave ventral surface and possibly an exfoliated dorsal surface. If culturally modified, this mussel shell fragment may have functioned as an ornament or tool, and not part of the subsistence base. The lack of other mussel shells within the occupation and the fact that it was from the very back edge of this terrace would support a natural origin for this tiny piece. Thus, its horizontal position, along the very eastern margin of the terrace and at the back edge of the lower terrace puts into question its association with the other Protohistoric materials.

9.7.3.5 Burned Rocks (*N* = 12)

The lack of burned rocks here is surprising, given their abundances at other prehistoric hunter-gatherer sites in this region. Only 12 pieces were clearly classifiable as burned rocks. These consist mainly of pieces of dolomite, plus one small piece each of quartzite and sandstone (Table 9-6). Most pieces did not appear intensely burned, whereas some revealed a dark gray stain on the exterior instead of the more common dark interior. The pieces were most notable for their angular edges and not their discoloration. The angular edges are the reason most were considered burned rocks, as opposed to natural gravels which have rounded edges and lack discoloration.

Two burned rock samples, one dolomite (#470-003-1b) and one sandstone (#535-003-1b) were selected and sent for starch grain analysis. The dolomite piece (100 g) exhibits signs of having been heated and broken, thus representing a fragment of a larger rock. The sandstone piece (269 g) was nearly complete with some internal

Table 9-6. Protohistoric Burned Rock Data from Excavation Block.

Unit North/East	Depth (cmbs)	Size (cm) 0 to 4	4.1 to 9	9.1 to 15	Weight (g)	Material Type
485/ 497	100-110	1			25	Dolomite
495 495	80-90		1		102	Dolomite
499 498	80-90	1			29	quartzite
492 498	113	1			53	Dolomite
498 491	76	1			47	Dolomite
499 499	110-120	2			50	Dolomite
495 494	90		1		117	Dolomite
499 492	76		1		266	Dolomite
494 497	108			1	342	Dolomite
499 499	82			1	369	Sandstone
499 499	80-90	1			102	Dolomite

cracking and one crumbly edge, but limited discoloration. Each rock was split and one part was sent for analyses. The analysis yielded damaged starch grains and clearly gelatinized starch grains on one specimen (#470-003-1b; see Appendix F). The starch grain evidence indicates that this rock came in contact with heat, water, and starchy plants, resulting in the gelatinized grains. The dolomite pieces did not contain any identifiable plant remains.

The 12 burned rocks are widely distributed across this Protohistoric occupation (Figure 9-79). A single piece was south of the BT 5 and roughly 3 m east of the nearest heating element (Feature 7). Given that this was the only piece anywhere close to the clustered heating elements clearly indicates that burned rocks were not functional elements of those heating facilities. Four more pieces, all from different units, were north of BT 5 and apparently were not associated with any specific cluster of other materials. These scattered pieces form no apparent pattern and show no discernible association with other artifacts or ecofacts. Seven more pieces were found in the northeastern and the northwestern corners of the excavation block (Figure 9-79). Here again, they were not associated with any other cultural materials and they were off to the margins of the identified area of Protohistoric occupation. Their positions imply they were not part of the defined cooking/heating elements and their function unclear.

9.7.3.6 Other Artifacts

A few items (*N* = 7) that reflect a European/Euroamerican origin were recovered from this hand excavated targeted zone. Some items may or may not be directly associated with the collected sample of lithic artifacts. These items include five pieces of mostly clear glass, one with pressed designs and two thin, tiny fragments of metal sheeting.

One small (0.9 g) metal fragment (#506-009) was from 80 to 90 cmbs in N498 E493. This thin (less than 1 mm), rolled piece of either copper or brass (copper/zinc alloy) that forms an ovate shape and resembles a medial fragment of a tinkler cone (Figure 9-80). Both the proximal and distal ends appear to have been broken leaving angular and irregular edges. The exterior surface lacks obvious decorations, although multiple tiny, thin scratches or thin lines are microscopically visible across parts of the exterior surface. This broken piece measures 17.9 mm long by 9.0 mm wide, with the metal 0.4 to 0.5 mm thick. It is generally believed that tinkler cones were manufactured by Native Americans from fragments of various metal pieces such as utensils that have worn out, and pieces of those objects were salvaged and reworked. Small pieces were cut out and rolled into small cone shaped items that were sewed on clothing or worn in the hair as decorations and/or as "tinklers" for sound.

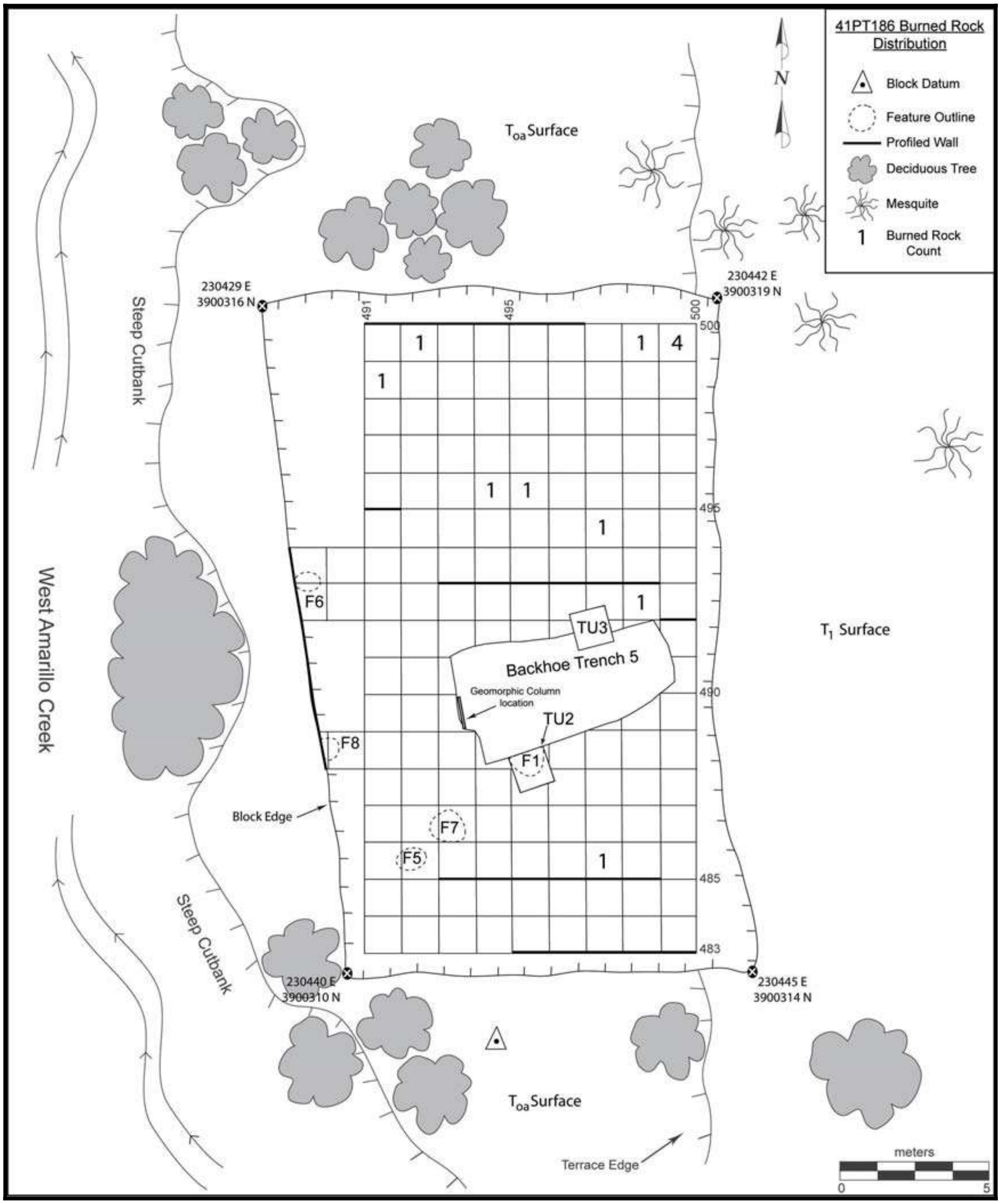

Figure 9-79. Horizontal Distribution of Burned Rocks within the Excavated Block.

Figure 9-80. Copper/Zinc Alloy Tinkler Cone (#506-009). (scale in cm)

The second small metal object (#374-009) came from 76 cmbs in N486 E494. This object was recovered form about 1 m east of heating element Feature 7. This tin object is complete, and is a flat, thin rectangular piece weighing 1.0 g with two tiny triangular tabs on each end (Figure 9-81). These two triangular tabs are assumed to have served to hold this small strap in place on an object. The piece measures 31.3 m long by 9.9 mm wide with the metal 0.4 mm thick. This piece was covered in an irregular coating of rust. Most of the rust was removed to better examine and identify this object. With most of the rust removed the stamped letters "DRUMMOND" became visible. Drummond was a tobacco manufacture in the late 1800s. This appears to be a tobacco tag of unknown origin. This object is considered intrusive to the Protohistoric occupation because it is less than 150 years old.

Only the tinkler cone was clearly within the occupation zone and its horizontal position appears to support it association with the other Protohistoric artifacts. The tinkler cone fragment was recovered from the western edge of the Lithic Concentration #1 at the northern end of the block. This position may indicate that the piece was dislodged from the clothing of the individual(s) that was responsible for the knapping activity in that area.

Figure 9-81. Thin, Rusted Metal Tobacco Tag with Triangular Extensions on Each End and Stamped Letters "DRUMMOND" Present (#374-009). (scale in cm)

9.7.3.7 Vertebrate Faunal Assemblage (*N* = 395)

The bone assemblage is quite limited with only 395 pieces. These include relatively few pieces of at least two bison, at least one mature and one immature animal. The majority of the assemblage is comprised of quite small, unidentifiable fragments with only a few articular ends and/or identifiable medial sections (*N* = 20, weighing 896.2 g). The elements identified as bison include rib fragments, 3rd phalanx, vertebrae, distal metapodial, proximal humerus, proximal tibia, pelvis fragments, and one complete maxillary tooth (Table 9-7). These identifiable elements reflect axial and appendicular parts of most of one bison, indicating that most of one entire carcass was brought to this location and further processed.

Table 9-7. Identifiable Bone Elements from Protohistoric Occupation in Excavation Block.

Catalog No.	Unit	Bison Element/Part	Weight (g)	Burned	Cut Marks	Surface Condition
261-002	TU 3	Complete left navicular cuboid	35	No	No	root etched, weathered
261-002	TU 3	Complete left cuneiform pes	6.5	No	No	root etched, weathered
261-002	TU 3	Complete 3rd phalanx	17.1	No	No	mostly intact
261-002	TU 3	Complete upper molar	9.5	No	No	mostly intact
261-002-1	TU 3	Medial immature right radius * and **	61.7	No	No	root etched, weathered
261-002-3	TU 3	Mature distal right metatarsal, female *	92.9	No	No	partially root etched
261-002-2	TU 3	Mature proximal left tibia, female *	180.1	No	No	rodent gnawed
386-002	N486 E499	Complete 3rd phalanx	27	No	No	intact
386-002	N486 E499	Proximal left humerus, 4 pieces	249	No	No	intact
394-002	N487 E494	Rib fragments, small	7.3	No	No	root etched, weathered
425-002	N491 E494	Scapula glenoid cavity fragment	7.9			root etched, weathered
438-002	N492 E496	right olecron & notch of ulna	69.6	No	No	slight root etching
453-002	N494 E494	Fragment of pelvis	50.1	No	No	root etched, weathered
455-002	N494 E495	Rib head and fragments	2	No	No	root etched, weathered
467-002	N495 E495	Rib fragments, small	5.2	No	No	root etched, weathered
513-002	N498 E498	Acetabulum fragment	26.1	No	No	mostly intact
519-002	N499 E492	Rib fragments	25.4	No	No	root etched, weathered
520-002	N499 E493	Articular facets of lumbar vertebrae	10.9	No	No	mostly intact
522-002	N499 E494	Rib fragments	8.9	No	No	root etched, weathered
522-002	N499 E494	Lumbar spines process	4	No	No	root etched, weathered
* element used for carbon and nitrogen isotope analyses			**896.2**			
** piece used for radiocarbo						

Catalog No.	Unit	Element/Part	Weight (g)	Burned	Cut Marks	Surface Condition
346-002	N483 E492	Deer, complete left calcanium, immature	13.5	No	No	root etched, weathered
346-002	N483 E492	Deer, complete left navicular cuboid	4.9	No	No	root etched, weathered
346-002	N483 E492	Deer, complete left cuneiform pes	0.9	No	No	root etched, weathered
358-002	N484 E492	Deer/antelope proximal left metatarsal	8.6	No	No	root etched, weathered
440-002	N492 E497	Deer/antelope medial metatarsal	3.6	No	No	root etched, weathered

A second bison, an immature animal, is represented by a single, right medial radius that is quite small and lacks the proximal and distal ends. The relatively narrow shaft and the size of the proximal end indicates that the epiphysis was not fused or present, further indicating that this individual was probably less than 1.3 years old (Bement and Basmajian 1996) when killed. The mature bison is represented by a proximal tibia (#261-002-2), proximal humerus (#386-002) and a distal metatarsal (#261-002-3). These three elements exhibit fused proximal and distal ends and based on the fusion rate indicate an animal more than 5.3 years old (Bement and Basmajian 1996). The distal metatarsal represents a female, based on comparative measurement data provided by Speth (1983: Figures 59 & 60 and Table 24). Therefore, the evidence indicates the presence of one mature female and one immature yearling bison.

This cow and calf may have been killed in the immediate vicinity of the site, thereby allowing for transport of the entire cow carcass back to camp for processing. The presence of only one element of the younger immature animal may reflect a completely different approach to processing that individual. It may indicate that the immature animal was specifically selected for more intensive processing. Potentially once the meat was removed the bones were broken open to extract the marrow, then further smashed into unrecognizable pieces to facilitate extraction of the bone grease. This type of extensive processing would account for the lack of other identifiable bones from this immature animal. Although the bones of the mature female were broken, probably to extract and consume the marrow, the fat rich ends of the proximal tibia and humerus were still mostly intact and recognizable. This fact indicates that these elements were not processed for their fat/grease. No specific elements such as fetal bones or immature teeth are represented to help identify the seasonality of this camp.

Also present were a few deer elements (*N* = 5, 31.5 g), including a left proximal metatarsal, calcanium, and navicular cuboid that potentially represent an articulated joint. The low frequency of deer elements may indicate that the carcass was not completely present. Alternatively, this may indicate that the deer elements represent something besides a food source i.e., the lower leg bones were to be used for tool production. These few deer elements may, therefore, not reflect the use of deer as part of the human subsistence base, at least at this particular campsite.

A few small identifiable rodent bones (*N* = 5, 4.6 g) were recovered. These include skull fragments, teeth, a right mandible section, a complete left humerus, and a partial right humerus.

These elements represent at least one plains pocket gopher (*Geomys*). Pocket gophers live in the ground and are common in sandy loam. Therefore, these rodent bones are believed to be part of this natural setting and not culturally deposited. The lack of any sign of burning, spiral fractures, or cut marks on these small bones supports this interpretation. Another small unidentifiable rodent (*N* = 16, 3.9 g) is represented by a partial mandible, partial humerus, radius, vertebrae, and pelvis, which probably represents a natural occurrence in these deposits. This gopher is then assumed not to be part of the subsistence base for this human population.

The limited representation of bison bones in the block excavation hinders the interpretations of the type of animal processing within this component. The majority of pieces are quite small, less than 5 cm, which severely limits the number of identifiable specimens. The small size of the pieces recovered, the extensive amount of rodent activity observed in these deposits, combined with the presence of bison bones in the overlying gravel lenses, creates uncertainty, if all the tiny fragments recovered were originally associated with the targeted Protohistoric occupation. It is quite possible that at least some of the tiny fragments were displaced from the zone above the cultural occupation. Some small fragments reveal intensive weathering and rounding as if they were redeposited and not in primary context. Part of the bone assemblage reveals that a few elements were intensively butchered and smashed. The small area encompassed by the cluster of larger, identifiable elements (primarily in TU 3) indicates one specific activity area were these bones were discarded. Since so few identifiable elements were recovered across a relatively broad excavated area, it is most likely that the primary bison processing of these two bison occurred nearby and not within this specific investigated block. The same may be the case for the deer that was represented.

The absence of burned pieces indicates that the bones with meat on them were not roasted and/or that once the meat was removed from the bones, the bones were not discarded into the nearby fires. The absence of cut marks is not surprising as many cultures remove the hide and meat from bones without leaving cut marks. It is also possible that these animals were stripped of their meat and cut up using metal tools. Metal cuts are very thin and may not have been recognizable and/or obliterated by the weathering and/or root etching process that occurred on most pieces. A few elements, such as the proximal tibia and the immature radius, reveal small rodent gnawing teeth marks, but it is unclear if this occurred at the time of this occupation or subsequent to site abandonment.

A number of mostly complete bison bones were discovered from the two gravel lenses roughly 20 cm above the targeted A horizon and Protohistoric occupation zone with some pieces collected for comparisons. The identified elements include multiple mature vertebrae fragments, a complete right tibia, a proximal right femur, a proximal left ulna, a complete left metatarsal, two complete left metacarpals, a complete cuneiform, a complete lunate, a complete cuneiform, a complete axis vertebra, a nearly complete right radius, a proximal right radius, a proximal left radius fragment, a proximal left scapula, multiple rib fragments, and pelvis fragments. At least two mature individuals are represented by these few elements. Many bones exhibit weathered and exfoliated surfaces, extensive drying cracks, light colored, and root etching. No elements were burned, exhibit butchered marks or spiral fractures, and represent bones unrelated to cultural occupation.

The bones directly associated with the cultural occupation zone were generally widely scattered with the exception of the cluster of bison bones in TU 3 on the northern side of BT 5 (Figure 9-82). The butchered deer elements were mostly clustered near the very southern edge of the block a couple of meters south of Features 5 and 7. These clustered elements include the proximal metatarsal and the carpals that could originally have been articulated with the metatarsal as part of the same limb. The one other identified deer element, a medial metatarsal, was just north of the bison bone cluster in TU 3. This latter element may be part of the same deer, which would indicates that these deer elements were directly associated with the Protohistoric occupation.

The clustered butchered bison elements in TU 3, which represent at least two animals, were discarded. These discarded elements included long bones that would have had major sections of meat attached to the bones, plus a few nonmeaty parts represented by the phalanges and carpals (Figure 9-83). The few other identifiable bones, mostly small rib fragments, at least one glenoid fossa of the scapula, an acetabulum from the pelvis, and a fragmented lumbar vertebra all reflect the axial skeleton of at least one carcass. These fragments were widely scattered around the outer margins of Lithic Concentration #1. It is not clear what this pattern may represent, but it may be that these small pieces represent a toss zone of bones with attached meat that served as snack food for those conducting the knapping activities.

A proximal humerus and a third phalange were in the very southeastern corner of the excavation, at the back edge of the lower terrace. This location would imply these elements were discarded in that area to get them out of the way of other activities. Thus, the general distribution of the majority of faunal remains reflects an intentional discard pattern, most likely by multiple individuals that were involved in at least two different tasks. It is important to note that this is considered a short term camping episode in which a discard pattern is detectable.

9.7.3.8 Charcoal (*N* = 53)

Charcoal lenses and concentrations were not detected anywhere within the excavation block, not even in the two identified heating elements (Features 7 and 8). Small chunks and flecks of charcoal (ca. 36 samples) were recovered from the margins of all three heating element features, plus scattered spots across the excavation block.

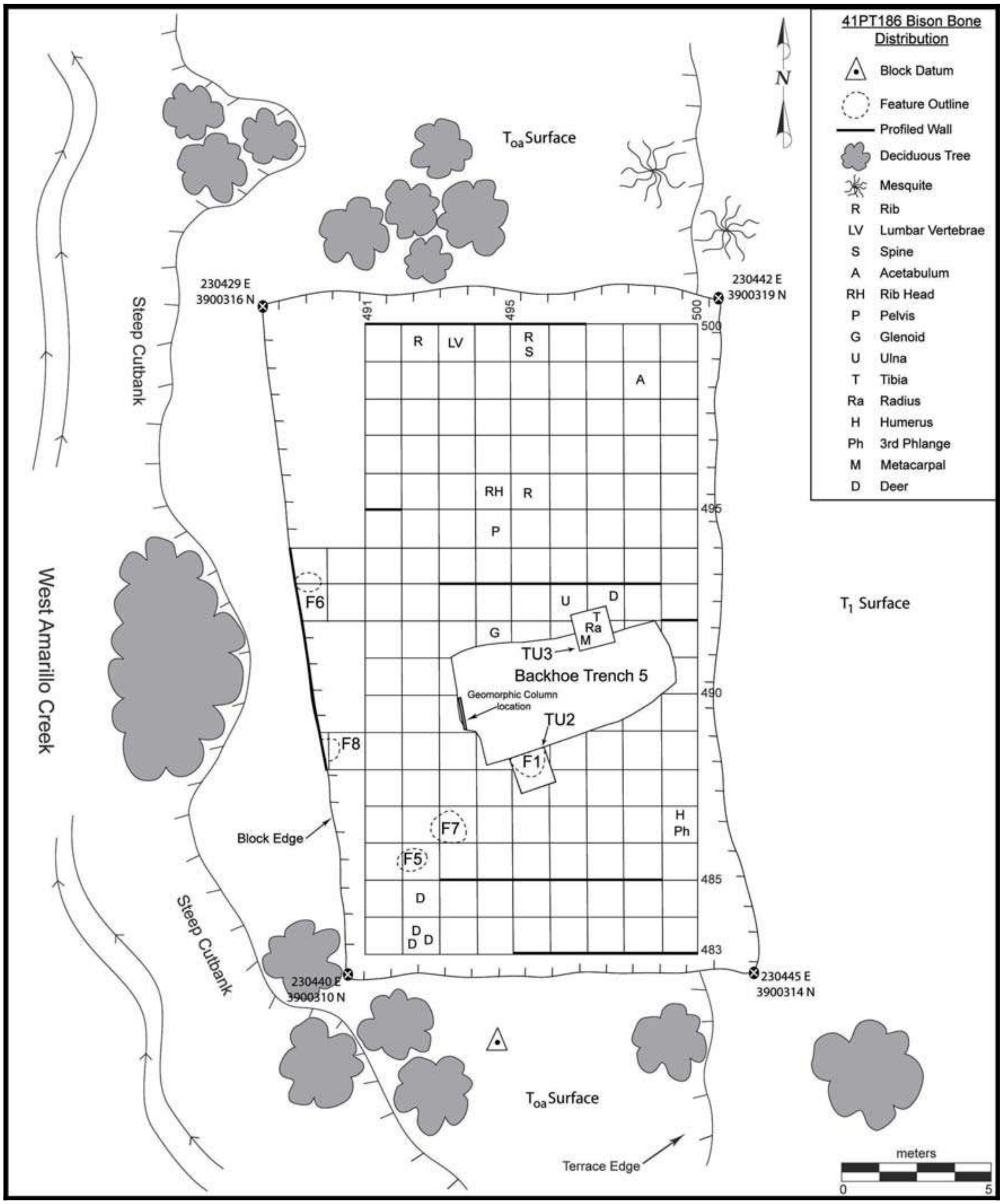

Figure 9-82. Horizontal Distribution of Bison Bones by Element in the Protohistoric Component.

Figure 9-83. Major Bison Elements Clustered in TU 3, Lower Left is the Immature Bison Radius.

Some 36 small charcoal samples were collected and placed in plastic vials during the Phase II block investigations. Most samples are tiny flecks with a few chunks up to 1 cm in diameter. Some charcoal samples were recovered from the screen, whereas others were found *in situ,* plotted and collected from those specific proveniences. In few instances, the charcoal sample was collected from throughout a 10 cm thick level. At least two piece plotted samples are from Feature 7, another two from Feature 8, and three samples came from around Feature 6.

Fifteen samples that contained larger pieces of charcoal were sent to Dr. Dering at the Shumla Archeobotanical Services for wood identification. These samples include 66 tiny charred pieces that weight less than 2.3 g. These pieces represent five wood taxon that include 28 cottonwood/willow pieces, 14 mesquite fragments, 11 sand plum pieces/mountain mahogany type, 10 unidentifiable pieces, and one juniper piece. The only nonwood and burned taxon is culm/stalk (N = 2) of the grass family Poaceae (Appendix N, Table N-5). Three different types of wood were identified from each of the three features examined and include mesquite from Feature 7, sand plum from Feature 8, and juniper next to Feature 6. All three taxon are in the immediate site area today. Since the charred grass culm/stalk was not recovered from a feature, its association with the cultural materials may be questioned.

9.7.4 Interpretations of the Results from the Block Excavations

This relatively limited cultural assemblage is interpreted to reflect a very short term camp (a few days at most) in which the Native American occupants resharpened a few stone tools, mainly unifaces, cached a few important scrapers and flakes for the future, killed and butchered at least one deer and two bison for food, and employed at least three heating elements. The lack of extensive burned rocks indicates that some other implements such as metal pots or ceramic vessels were used to cook their food. At the time period indicated by the three radiocarbon dates (ca. 200 to 300 B.P.), the Native populations in the region definitely had ceramic vessels and mostly likely had access to metal goods. The detected horizontal patterning reflected by the clear distribution of identified cultural tasks including animal butchering/processing, stone tool resharpening, and heating, indicates a highly intact occupation surface for this specific event. It also reflects specific use of space by task focused individuals or groups operating at the same time.

The ca. 20 cm thick, weakly developed and sandy A horizon (an A-C profile) indicates this Protohistoric occupation occurred at the end of a period of relative landscape stability at ca. 200 to 300 B.P. This buried soil or paleosol is traceable throughout the Landis Property. This paleosol is roughly the same time as the development of the weak, but prominent Apache Soil identified at the Lubbock Lake site in Lubbock, Texas (ca. 750 to 250 B.P., Holliday and Allen 1987). During this same period at Lubbock Lake the valley bottom marsh deposits were recognized and indicate that some water was present along the floor of Yellowhouse Draw.

At the Corral site, sediment gradually accumulated on this stable, mostly C_4 grass covered surface just prior to this cultural event. The sediment accumulation was slow enough just prior to the cultural occupation to allow the development of the A horizon that was minimally 15 cm thick. At the time of this Protohistoric event (ca. 200 to 300 B.P.), the broader regional environmental conditions were more arid compared to about 600 B.P. as the frequencies of the Chloridoid grasses increased by four times. The temperature was also warmer as indicated by the lower percentage of the Pooid grasses compared to 600 B.P. (Appendix D). The phytolith assemblage recovered from this buried A horizon is similar to the modern phytolith assemblage in the Lubbock region just to the south. Following that stable period and soon after the human occupation at ca. 200 to 300 B.P., at least a couple of high energy flood events occurred in this valley, as represented by two poorly sorted gravel lenses 10 to 15 cm above the buried soil. These two high energy flood events coupled with nearly a meter of deposits on top of the event may indicate a change in the local climate conditions and reflect general episodic events over the last few hundred years.

The following research issues and questions with some minor alterations were extracted from the initial research issues presented in the treatment plan (Quigg 2005) for the Landis Property and the final interim report following the Phase I data recovery effort (Quigg et al. 2008). These broad issues were pursued through general metric and nonmetric observations on a broad suite of recovered artifacts and carefully selected technical analyses.

9.7.4.1 Chronology and Cultural Affiliation Issues, and Discussions

The two previous radiocarbon dates of 210 and 230 B.P. the youngest on bison bone and the oldest on wood charcoal, obtained following the Phase I data recovery efforts (Quigg et al. 2008), plus another radiocarbon date on wood charcoal from Feature 8 of 290 B.P. clearly establishes an occupation with a 200 to 300 B.P. time period for this targeted, well defined occupation (Table 9-8). Given the possibility of old wood problems when radiocarbon dating small wood charcoal samples (see Smiley 1985 and Schiffer 1986) as was done here, the oldest age of 290 B.P. on wood charcoal is the least likely to reflect the specific age of the cultural event. The bison bone date of 210 B.P. is

assumed to be the most likely to be nearest the actual age of this specific event. If this reasoning is acceptable, then the age of this camp is projected to be close to 210-years old (or approximately A.D. 1740). If the wood charcoal radiocarbon date does not represent old wood used in the fires, then the occupation could be as old as 290 B.P. or A.D. 1660. The possible ca. 80 year difference is not much time, but cultural patterns and Native populations were changing and moving rapidly during this period across the Southern Plains.

Table 9-8. Radiocarbon Dates from 41PT186 in Potter County, Texas.

Provenience	Catalog No.	Feature No.	Depth (cmbs)	Material Dated *	Weight of Material (g)	Beta Lab No.	Measured Age	13C/12C Ratio (‰)	Conventional Age (B.P.)	2 Sigma Calibration Age
PT186, TU 1	FS 24.1		47	charcoal chunks		135418	80 ± 40	-14.7	80 ± 40	Cal AD 1680 to 1955
PT186, TU 3	261-002-1		118	1 immature bison radius	5	238317	100.8 0.5	-7.8	210 ± 40	Cal AD 1640 to 1950
PT186, BT 5-1	340-007-1	1	99	1 charcoal	0.1	235482	220 ± 40	-24.5	230 ± 40	Cal AD 1540 to 1950
PT186, 488/489	FS 643	8	75	1 charcoal	0.1	250879	370 ± 40	-29.6	290 ± 40	Cal AD 1480 to 1660
PT186, TU 1	FS 71.1		40	1 bison bone frag		138513	100 ± 40	-10.0	340 ± 40	Cal AD 1450 to 1620
PT186, BT 9-1	343-002-1		110-115	1 bison vertebrae		237020	350 ± 40	-9.9	600 ± 40	Cal AD 1290 to 1420
PT186, BT 9-1	343-004-2a	2	125	sediment	0.1	235485	1940 ± 40	-19.2	2040 ± 40	Cal 170 BC to AD 50
PT186, BT 9-2	343-004-2b		205	sediment Ab	0.1	235486	2160 ± 40	-25.5	2150 ± 40	Cal 360 BC to 280 BC
PT186, TU 6	302-007		180	1 charcoal in buried A	0.1	237021	NA	NA	2490 ± 40	Cal 780 to 410 BC
PT186, BT 6-1	341-004-1a		136-139	2Ab? sediment	0.1	235483	8240 ± 50	-22.7	8280 ± 50	Cal 7480 to 7170 BC
PT186, BT 6-2	341-004-2		264-268	3Bk sediment	0.1	235484	9560 ± 50	-22.0	9610 ± 50	Cal 9230 to 8800 BC

* bone dates were on collagen

The fragmentary tinkler cone of rolled sheet copper/brass support the radiocarbon dates as representing a Protohistoric period occupation here. Appendix C provides an elemental composition of this tinkler cone that determines it was produced from a copper/zinc alloy. Tinkler cones are known to have occurred at a number of Protohistoric sites on the Southern Plains, and a few examples are presented here. At least 13 brass tinkler cones were recovered from the Protohistoric Lasley Vore site near Tulsa, Oklahoma (Odell 2002, 2008). Feature 43 at Lasley Vore yielded a tinkler cone and adjusted radiocarbon date on nut shells of 175 ± 30 B.P. or A.D. 1775 (SMU 2217). Many other metal objects in association with chipped stone tools and Native ceramic sherds were recovered from that Native American site, as well (Odell 2002). European trade goods that include copper tinklers were recovered from the Bryson-Paddock (34KA5) that dates to ca. 250 to 300 B.P. (A.D. 1650 to 1700) and Deer Creek (34KA3) sites in northeastern Oklahoma (Leith 2008). Deer Creek was a location for French trading. A third example comes from site 25HN37 in Harlan County Reservoir in extreme south central Nebraska and assigned to the Dismal River complex where "jingles" made of sheet brass were found in the loose dirt of House VI (Gunnerson 1978:176). Dendrochronology places charcoal from 25HN37 in 227 B.P. (A.D. 1723). Site 25HN37 yielded a number of house structures with five vertical center posts, roasting pits, trash filled pits, prehistoric ceramics that are buff to black in color, bear smoothed to sharply stamped decorations confined to the lip, and have paste containing fine-to medium-sized particles of sand. This site also contained a variety of chipped stone artifacts, and sparse worked bone artifacts (Gunnerson 1978). The Vinson site (41LT1), a Norteño Focus Indian village in eastern Texas in Limestone County yielded at least eight tinkler cones along with a host of other metal goods. This was a historic Indian village, which has been attributed to the Wichita speaking groups. Based on all the diagnostic trade goods the site is thought to have been occupied between 190 and 150 B.P. (ca. A.D. 1760 and 1800) (Smith 1993).

If this metal tinkler cone was directly associated with this occupation as suspected, metal items had not totally replaced all uses of stone tools and ceramic vessels. Excavations at the Stansbury or Towash site (41-39B1-1) along the Brazos River a few kilometers southwest of Whitney, Texas yielded a very diverse assemblage of prehistoric and historic items with many metal goods that include some 15 brass tinkles or jingles (Stephenson 1970). The historic Native American occupation at Stansbury is attributed to the Tawakoni Indians that Althanase de Mézières encountered in 170 to 180 B.P. or A.D. 1770s (Jelks 1970). The Stone site (41ML38) referred to as "El Quiscat's Village" near the Brazos River near Waco, Texas also yielded many tinklers and other metal goods in association with chipped stone tools (Turner-Pearson 2008). The Stone site dates to roughly 170 to 180 B.P. (A.D. 1772-1779). These examples of tinker cones associated with Native American identified sites supports the conclusion that the occupation at the Corral site was a Protohistoric Native American camp.

The absence of chipped stone knives and projectile points is curious as these common tools are frequent at most sites. If stone scrapers, edge-modified flakes, and debris from these stone tools were present, then one normally would anticipate stone points and bifaces. However, other early to middle eighteenth century sites in central and east Texas have yielded similar disparities of chipped stone tools. As an example, hafted stone end scrapers (N = 620) clearly dominate the knives (N = 6) at the Womack site dated to around 1700 to 1720 (Harris et al. 1965). The same was true at the Gilbert site in northeastern Texas that was occupied around 1750, which yielded 27 knives and 418 end scrapers (Allen et al. 1967:197-206). In both the latter cases, metal knives were replacing the stone knives, whereas the hafted stone scrapers continued to be used. This was a reflection of the increased participation of these native groups in the fur trade.

With the presence of the two metal objects, and lack of these two specific stone tools, one assumes that these specific stone tools types were replaced by metal knives and projectile points. These would be the first tools in a prehistoric tool kit that would get replaced once the Natives obtained metal through European contact. These metal knives and points would also have been highly valued by the Natives and carefully curated, accounting for the absence of chipped stone bifaces and points from this camp.

The presence of chert flakes, chipped stone tools that include end and side scrapers (N = 6) and retouched flakes (N = 5), and a few burned rocks overwhelmingly supports a Native American occupation. The question of cultural affiliation is not clear or easily addressed. When the Spanish first arrived at the Pueblos in northern New Mexico in ca. 409 B.P. (A. D. 1542) at least two native groups, the Querechos and Teyas were trading there, and are thought to have occupied territories east of there on the Southern Plains. Currently, these groups cannot be identified archeologically. In discussing Apache sites, Donaldson and Welch (1991:99) state "generally there is little material and seldom anything distinctively Apache or otherwise diagnostic". Until we obtain a better understanding of the artifacts and their associated technologies, ethnic labeling of sites should be avoided.

If the one tiny plain surface ceramic sherd is directly associated with the Protohistoric occupation, its presence does not lend itself to a conclusive and positive identification and/or statement concerning the ceramic type or much concerning ceramic technology. The sherd's characteristics of a light brown exterior, dark brown interior surface with very faint striations with additives dominated by sand grains, is not diagnostic of one specific Native group. The local Protohistoric Tierra Blanca complex does include ceramic vessels such as micaceous tempered Perdido plain and/or Pueblo utility ware pottery, now assigned to the Tierra Blanca Plain type. Most Tierra Blanca complex sites typically have yielded abundant quantities of Southwestern trade wares, that include Rio Grande glaze ware shreds such as Glaze C and D (ca. A.D. 1425 to 1500) of the Intermediate Glaze period, and Pecos Glaze Polychromes (Glaze V), as well as obsidian artifacts, and marine shell jewelry. The presence of a single sherd with smoothed surfaces is not diagnostic of the Tierra Blanca complex as numerous groups in the region at that time had similar ceramic assemblages. The lack of features such as pits, and structures, stone circles, and roasting pits that were found at the Tierra Blanca site, indicates that the Protohistoric component at Corral site occupation is not a good candidate for assignment to the Tierra Blanca complex. The lack of storage pits and horticultural tools would indicate that the occupants at Corral site occupation were nomadic and not sedentary horticulturalists. Also, the lack of Southwestern trade items such as glazed Pueblo pottery, turquoise, Olivella shells, and obsidian does not link the occupants to Southwestern groups.

Sites assigned to the Protohistoric Garza complex (ca. 295 to 540 B.P. or A.D. 1410 to 1655) are identified primarily on the presence of the distinctive Garza and/or Lott arrow points with their distinctive small, "u" shaped basal notch. Currently, identified Garza sites are situated to the south, near Lubbock, Texas. The Tierra Blanca complex, currently identified mainly south of the Canadian River, lacks a diagnostic projectile point type or a specific diagnostic ceramic type.

The metal tinkler cone is also not diagnostic of any particular Native American group, with most groups in the region able to obtain and/or have access to metal objects during the Protohistoric period. This and other metal objects could occur in any number of Native American assemblages across a broad region of the southern Plains at that time. Therefore, it is not readily apparent which specific Protohistoric archeological complex, or native ethnic population, is represented at by this Protohistoric component at 41PT186. Based on our findings, however, we can conclude that this component was briefly occupied by either a group of mobile hunter-gatherers, or by a mobile task group linked to an unidentifiable, relatively sedentary horticultural community.

9.7.4.2 Subsistence and Food Resource Variability Issues and Discussions

Is there any evidence that nonlocal food resources, such as corn, were part of the subsistence base? Were domestic crops such as corn being exploited along this creek valley, or brought in from outside? Were these Protohistoric groups employing the horse and relying on the same subsistence resource, bison, as prehorse cultural groups?

At least three taxa are represented in the bone assemblage recovered from the block excavation. These include at least two bison, one deer, and one pocket gopher with the former two taxa part of the Protohistoric occupation. The two bison were definitely part of the subsistence base. It is assumed the two individual animals identified, a long yearling and the mature female, contributed at least meat and hides. The bones of the mature female reflect marrow extraction. The processing of the long yearling is open to various interpretations as the remains of that individual are nearly totally absence, with the exception of one radius shaft. It may be that this animal was more intensively processed through bone marrow extraction followed by bone grease and fat extraction. The smashing of the bones to extract the bone grease would have caused most elements to be unrecognizable and potentially only represented by very few elements. With only two bison represented, it is likely that these individuals reflect a small kill operation. The meat from one mature female (ca. 172 kg) and one yearling (ca. 105 kg) would definitely provide a food supply for a small group for a period of time.

The deer elements represented are also quite limited in number. It is not clear if these few leg elements represent meat for subsistence, or bones for tool production. The one burrowing gopher represented is believed to be part of the natural deposits and not culturally derived. The small mussel shell fragment is also not indicative of a food resource. The overall dearth of mussel shells from the broad excavation area does indicate that mussels were not a subsistence resource here.

If the occupants were horticulturalists then one might expect that this lower terrace area that was excavated, would have best served for growing crops, and that residential habitation would have been situated at a higher elevation on the T1 surface. The absence of horticultural tools such as tibia digging sticks, scapula holes, etc., and storage pits supports this campsite was occupied by mobile hunter-gatherers. Another possibility is the occupation represents a hunting task group from a horticultural community.

Starch grain analysis was conducted on a limited suite of five artifacts. This included a single chert flake (#446-17), one chert end and side scraper (#446-011), a Native ceramic sherd (#443-008), and two burned rocks (#470-003-1b and #535-003-1b). Burned rock #470-1b and both stone tools yielded starch grains. The starch grains on the burned rock include at least one that was damaged, indicating some sort of processing mechanism, plus a gelatinized grain, indicative of exposure to heat and water. The grains represent mostly wildrye grasses (Appendix F). The identification of two charred culm/stalk pieces from Poaceae grasses further supports cooking of grasses.

Starch grains were also observed on four of the 11 chipped stone tools (36 percent) subjected to use-wear analyses (Appendix L). Additionally, raphides and other plant tissues were observed on eight of the 11 stone tools examined during use-wear analysis, documenting the presence of plants that are normally archeologically invisible. Raphides are often found in plants of the Agavaceae family such as sotol, yucca, agave, and lechuguilla, indicating that at least some plants within this family were processed using the analyzed tools. Combined, the presence of starch grains, raphides, and other plant tissue are strong indicators Agavaceae plants were processed by at least some of the chipped stone tools represented. Further support that plants were part of the food resource base is the fact that damaged and gelatinized starch grains were recovered from one burned rock (Appendix L). This indicates that seeds were processed, and then they were cooked in hot water. The gelatinized starch grains form the burned rock supports that this rock was likely used in a stone boiling cooking activity.

The identification of butchered bison bones coupled with the observed microfossil plant remains on diverse artifacts strongly indicate that both plants and animals were included in the subsistence resources used by the inhabitants of this encampment. The presence of these two general products supports an interpretation that the inhabitances were hunter-gatherers in contrast to horticulturalists, at least at this particular site. If the occupants were a task group from a horticultural based community, this occupation may look the same. If this group had the horse at this time, it had not changed the subsistence base significantly, but it may have changed how those resources were acquired. Nothing in the findings from the diverse analyses indicates that these occupants were supplementing their subsistence base by trading for other food resources such as corn, beans, or squash from adjacent horticultural groups in the adjacent regions. The Protohistoric subsistence pattern at this specific time follows the long standing pattern for the prehistoric hunter-gatherers groups in this region.

9.7.4.3 Settlement and Community Pattern Issues and Discussions

Does the type and density of the artifact assemblage reflect the length of occupation or its makeup? Does the presence of well defined activity areas reflect a specific social structure or division of labor? What type of structures were present?

The five identified cultural features, combined with three unassigned clusters of materials (one bone and Lithic Concentrations #1 and #2), indicate multiple domestic activities. Features 1, 7, 8, and possibly Feature 5, indicate heating and, most likely, cooking tasks. Feature 1 is interpreted as an ash dump that contained tiny lithic debitage revealing that at least one cleaning of Features 7 and/or 8 occurred during the occupation. The lobes of white ash on two margins of Feature 7 also reflect cleaning out of the internal ashy deposits. Therefore, these observed cleanouts of two features would support an occupation that existed longer than one night. These three heat related features were clustered towards the southern end of the excavation block and their relatively close association reflects a general area used for heating. The small cluster of butchered bison bones, just over 3 m northeast of the ash dump, indicates that these may represent the animals from which meat was taken for processing in the heating/cooking events. The proximity of the clustered bison bones indicates that the individuals who created and maintained the heating elements may have also been those that removed the bison meat from the bones and discarded the bones. These activity areas were all in the southern half of the excavation block with working, walking and sitting space around the recognized clusters.

Tiny pieces of lithic debitage were recovered in heating elements Features 7 and 8, which supports that in situ knapping activities occurred at least next to Feature 7. An alternative explanation for the tiny debitage in Feature 7 would be that following knapping activities on a skin, the accumulated debitage was then dumped into the heating elements as a means of cleaning.

Tool knapping areas were identified by the two lithic debitage concentrations. Lithic Concentration #1 was some 5 m north of the bone cluster near the middle of the excavation block. This knapping area, away from the heating and food processing areas reflects another definable activity area, perhaps used by a single individual. The southern knapping area, Lithic Concentration #2, was next to heating element Feature 7 and may also reflect a single individual. This latter individual may have at the same time been tending to the fire. Whether or not these activity areas reflect tasks conducted by individuals of similar or different sexes is not clear. What is clear is that the horizontal distribution of the cultural remains across the excavation block definitely reflects patterning of specific tasks conducted by the occupants during a short term encampment.

The five identified cultural features combined with one bone and two lithic debitage concentrations appear reasonably intact and horizontally separated. These eight horizontally, well defined activity areas reflect specific, spatial relationships within a single short term Protohistoric encampment. They also reflect and define specific human behavioral patterns at this location. Features 7 and 8 were intact basin shaped heating elements only 3+ m apart towards the front part of the terrace. The ash dump, Feature 1, was 2 m northeast of Feature 7 and reflects the discard was nearby and towards the back of the terrace.

The very low frequency of formal chipped stone tools, tool classes, burned rocks, bones, and metal artifacts, coupled with the few well defined cultural features and horizontally well defined activity areas, indicate a relatively short term (only a few days at most) temporary camp. This site fits within Binford's (1980) "low bulk procurement" category, which are temporary locations represented by the processing of limited quantities of a resource. These are sites where tool use, exhaustion, and discard would be at a very low rate (Binford 1980:9). This is quite apparent here, and accounts for the overall low return.

At least five major identifiable tasks are represented within the excavation block. These tasks include bison meat and bone marrow extraction, chipped stone tool resharpening or maintenance, heating/cooking, cleaning/discarding, and caching of tools. Each task was horizontally well defined within the excavated block and indicates specific spatial divisions of tasks/activities, but in relatively close proximity to each other. It is not clear if these identified tasks relate to a social structure, division of space to conduct each task, or some undetected environmental influence (e.g., wind direction, smell, etc.). These spatially discrete activity areas across a relatively restricted area of 144 m2, supports the presence of a small group of people at this camp. The dominance of chipped stone scrapers with the apparent cooking and meat processing tasks implies this group included adult females. Male orientated tasks may be implied by the hunting of the bison and possibly the deer and the stone tool resharpening or maintenance, which are most often conducted by males. If these general associations are true, then the camp was inhabited by at least adult males and females. If both sexes are represented, then it is not too far fetched to believe that family units that included children and adults of different ages were present.

The site setting, on a small, low terrace along a creek surrounded by trees and bushes indicates that these family units occupied a sheltered area where necessities of life such as wood, water, and game resources were most abundant. However, this same setting might be interpreted as a good hiding place for a small group on the move and/or pursued by others. During this particular Protohistoric time (ca. 210 B.P. or A.D. 1740), various Europeans and Native American groups were scattered across the region. It might have been a very good place to carry out basic subsistence activities with the least risk of discovery by potentially unfriendly groups.

9.7.4.4 Exchange and Regional Interaction Patterns

What is the direction and intensity of contacts with other groups? What is the material being imported and or exported to the adjacent groups? What is the relative degree of isolation and self sufficiency of groups during the Protohistoric period? How dependent were the local inhabitants on nonlocal resources from adjacent areas? Are the group interactions conducted seasonally or year round?

The very limited nature of the recovered stone tool assemblage (six formal scrapers and five informal edge-modified tools) supports the inferred use of nonnative goods such as metal tools, even though such items were not recovered. The total absence of stone projectile points and bifaces, coupled with the near absence of edge-modified flakes and ceramic sherds, indirectly indicates that metal tools had replaced a significant part of the Native stone and ceramic assemblages. In fact, European guns may have replaced the Native bow and arrow altogether. Apparently, stone end scrapers were still used in hide working and plant processing. Metal tools, if present during this occupation, may not have been used for these specific tasks. Sharp metal knives potentially might cut or otherwise damage prized hides and there was no specific metal tool that would readily replace stone end scrapers.

Perkins et al. (2008) examine available archeological and ethnohistorical data concerning the Wichita and see a connection between changes in a few Protohistoric characteristics that may have resulted from growing French demand for hides. It was this demand for hide that may have caused the increase in production of hide scrapers during this Protohistoric period. It also may be the stimulus for the production of scrapers here at the Corral site and the importance for caching the scrapers found in Feature 6. Employing different lines of evidence Baugh (2008) examines Vehik's (2002) "conflict and prestige" model to explain the Wichita's political development during this period. Baugh's discussions help explain certain aspects of the social history.

The intensive use of local Alibates with a very minor use of local Tecovas quarry (N = 1) sources in the surrounding Canadian River valley for the manufacture of stone tools implies this was a local group familiar with the region and its resources. The extensive Alibates outcrops and quarries are about 56 km north of Amarillo. Two small pieces of Edwards chert (#460-001 and #473-001), a nonlocal high quality resource, were identified in this assemblage. The closest outcrop of Edwards chert is the Callahan Divide between Big Spring on the western end and Abilene, Texas, some 350+ km to the south southeast. Although the nonlocal material is very limited in frequency and size, these two pieces indicate a probable connection or interaction with groups towards the southeast.

The absence of nonlocal lithic tools and the near absence of nonlocal debitage indicate no apparent need for the acquisition of other tool stone. Obsidian is one lithic resource that has long been traded for out of north central New Mexico, but it is not identified from this Protohistoric assemblage. The preceding Antelope Creek phase in this same region traded extensively for obsidian from New Mexico. Baugh's (1984) Southern Plains macroeconomy refers to the total system of the Protohistoric Southern Plains societies participating in a regional exchange system with Southwestern societies. Baugh and Nelson (1987) state that obsidian found in western Oklahoma and the Texas Panhandle, and dating to after about A.D. 1450, arrived by an exchange system with an east to west orientation. The lack of other Southwestern trade items such as glazed Pueblo pottery, turquoise, and Olivella shells in the recovered assemblage also does not support interactions with eastern Puebloan groups. The lack of exotic artifacts obscures any clear picture of with whom this group may have interacted, or the geographic orientation of any such interaction.

If metal objects were in use at this Protohistoric occupation for specific tasks, as speculated, then contact and/or trade with Europeans was conducted to acquire these metal goods. However, the acquisition of those metal goods may have come through intermediaries that could have been other Native groups. Regional interaction may have been conducted by the people who occupied this component, but the apparent short term nature of their stay here did not leave behind clues that would clarify the nature of such activity.

9.7.4.5 Component Function/Intrasite Patterning Issues and Discussions

How many occupations are represented in the block excavation? Does the lack of stone tools, other than scrapers, affect or

alter interpretations of site function? Can we see the same intrasite patterning for all three time periods represented over that last ca. 3000 years? Is a single or specific activity represented or are multiple and diverse activities represented, as would indicate a more functionally diverse campsite?

The assessment and analyses of the various data sets that include vertical and horizontal patterning of the recovered materials and the nature and type of the natural deposits themselves all support that a single occupation/event is represented by the recovered assemblage from the block excavation. No overlapping features were present, the materials all came from the top of the buried A horizon, and excellent horizontal patterning was observed in the activity areas. The lack of overlapping activity areas and smearing of patterns is support for the single short term occupation. If multiple occupations had occurred on this buried A surface, the smearing effect of debris disposal/discard would most likely have masked the different activity areas and prevented their clear spatial definition.

The presence of multiple and diverse tasks/activities in a relatively restricted space (144 m2) supports a well structured, multifunctional general camp versus a single task specific occupation site. The five identified tasks include in situ heating/cooking, tool maintenance, debris discard, caching, and food processing. All are activities expected during a short term encampment. These tasks are considered basic and necessary for human existence at short term camps, with the exception of the cache of tools. The small stone tool cache is unique, and generally not thought of or associated with camp activities. Most stone tool caches that have been discovered and reported are most often isolated away from campsites (Miller 1993). This cache is also somewhat unique in that the type of items cached is dominated by scrapers and utilized flakes, and not bifaces (Miller 1993). One reported cache with scrapers consisted of 22 used end scrapers from 41RN169, a Late Prehistoric bison processing site in Runnels County some 480 km to the south (Treece 1993). The caching of stone tools implies an intention of returning to this specific location to retrieve cached items. Thus, we may infer that the site's inhabitants were a local group with sufficient knowledge of the immediate area that they could make their way back to this specific location to retrieve and reuse the cached items. The use-wear and residue analyses demonstrated that most of the eight items in the cache were used and functioned in a combination of scraping hides, wood, and plants, and cutting plants and hides. Interestingly, the plant associations out numbered the hide associations with cutting and scarping actions dominating.

9.7.4.6 Technological Issues: Traditional Verses Novel Approaches

An array of research questions relate to this topic. Questions such as: has the food cooking technology changed from earlier prehistoric times, and if so, how? Has the hunting technology changed with the introduction of European goods and/or the horse? Does the ceramic technology show change or has it been entirely replaced?

Does this component reflect the adaptation of new technologies, such as the use of metal and/or ceramics? If so, how is this reflected in the broader cultural assemblage and cultural adaptation? If not, is there any technological difference in comparison to the two earlier components investigated? It is assumed that the horse was in use at this time, so what affect does the horse have on the various technological aspects of the broader cultural assemblage? Has the prehistoric ceramic technology been totally replaced by this time? If not, was there a mixture of cooking technologies in

use here? Do any of the perceived technological changes correlate with perceived or documented changes in the paleoenvironment or do the resources shift? Does the cultural record reflect wholesale replacement of the technological patterns (i.e., local populations are displaced by new people), or are small segments of the total technological patterns replaced piecemeal (i.e., they reflect refinements and adjustments to changing situations)? Are the technological records sufficiently complete to reconstruct behaviors and social arrangements?

The presence of chipped stone tools (specifically, end scrapers and edge-modified flake tools) and lithic debitage indicates that aboriginal use of stone tool technology was still operative at this locale during this specific Protohistoric period. The long established technology of producing these two tool types continued, and yielded a group of six scrapers with a range of overall shapes, sizes, and manufacturing strategies. At least one of the end scrapers (#446-013) was hafted in a manner similar to those from the Late Archaic component 41PT185/C. The hafting allowed greater control and higher load rates to be applied. The application of higher loads placed on the end scrapers is evident in the two broken specimens, with at least one showing hard, high silica polish. The use-wear and microfossils on the hafted scraper documents it was used to scrape hides. Although functional interpretations have long assumed these classes of tools were used on hides, the use-wear analysis conducted on all six scrapers reveals a much greater ranger of materials that these were used on (Table 9-9). Plant tissues were far more prominent than animal products.

The two unmodified flakes from the cache reveal similar functions as the hafted end scrapers and represent a selection process of different tools for similar tasks. The relatively large size of these two flakes apparently allowed them to be hand held to perform their tasks.

The lithic debitage itself reflects a similar resharpening technique with small flakes detached from unifaces. The lithic debitage also reflects similar technological practices in the manufacturing process, with employment of both hard and soft hammer percussion, as well as pressure flaking. It appears that unidirectional core reduction was in use at this time. The absence of projectile points is also in accord with the absence of any evidence of notching flakes in the micro-debitage recovered.

Table 9-9. Tool Function Through High-Powered Use-Wear.

Artifacts By Period	Inferred Function										Contact Material and Observed Residues										
	Unknown	Scraping	Cutting	Boring/Drilling	Whittling	Hafted	Slicing	Pounding	Chopping		Plant Tissues	Polish	Bone	Hard, High Silica Plant	Wood	Animal Hair	Starch Grains	Raphides	Hide	Resin	Unknown
Protohistoric Tools																					
Scrapers	1	5									3			2	3	3	4	7	2		
Flake			2								2								1		
Edge-Modified Tools		1	2								2			1							

Although chipped stone tools were still in use and still being manufactured at this time, it is impossible to know with certainty, in the absence of any recovered metal tools, if such items (e.g., iron knives, points,) had been incorporated into the technological repertoire of native people in this area. Nonetheless, the complete absence of chipped stone projectile points and stone bifaces/knives does indicate that metal tools were, in fact, in use and had replaced their stone counterparts by this time. The recovery of a small metal artifact such as the tinkler cone, a type known to recur in Protohistoric contexts on the Southern Plains, indicates that the group that occupied this site had access to some European/Euro-American metal. So the inference that metal tools were also in use, and that this might account for the paucity of chipped stone tool forms, is reasonable.

Ceramic vessels often were used for cooking food over open fires. The three identified features (Features 1, 7, and 8) that relate to heating/cooking indicate some potential for use of pottery vessels. The absence of ceramic sherds from this Protohistoric component furthers supports the above interpretation that much of the prehistoric assemblage had been replaced by European metal goods. The single tiny sherd recovered was interpreted to be intrusive and not directly associated with the Protohistoric assemblage. If this is a correct assumption, then the absence of the long established aboriginal ceramic technology that one would expect for Native groups has also been replaced by metal goods. Again the negative evidence is only an indication that the ceramic assemblage has been replaced by metal goods. In general, however, if this group possessed and used metal pots, metal projectiles, and/or knives, those items would have been highly valued would have been removed from the site when the group abandoned this short term camp.

The infrequent and scattered burned rocks indicate that the prehistoric technology of cooking and/or heating with hot rocks was still an active part of the repertoire of cooking technology. However, the relatively low frequency of these items may again support the idea that metal pots were in use, thus curtailing the need for extensive use of hot rocks for cooking. The presence of burned rocks indicates that at least one prehistoric cooking/heating technology was still in use at this time. While it is hypothetically possible that the few burned rocks could have been used for a specific heating function other than cooking foods, starch grains found on two of the burned rocks (#470-003-1b and #535-003-1b) indicate they were used to cook wildrye grass seeds. Also, the gelatinized starch grain from one burned rock is the result of alteration by a combination heat and water that reflects cooking, most likely by boiling. Thus, the data also indicates the use of stone boiling, a traditional technique with roots deep in prehistory. In sum, then, it can be suggested that cooking may have been accomplished to a limited degree by the long held tradition of using hot rocks, as well as by use of the more or less novel technology of metal cooking vessels.

Despite the introduction of new technology, the selection of wood fuel followed established patterns. The three types of wood identified from the three features (Features 6, 7, and 8) are all local taxa, immediately available in the vicinity of the site. Mesquite was identified in Feature 7, sand plum from Feature 8, and juniper next to Feature 6. Although it appears that a single taxon is represented in each of the different features, the actual number of pieces present and identified is too few to indicate that a preferential selection process occurred.

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10.0 SITE 41PT245 – PAVILION SITE

J. Michael Quigg and Paul M. Matchen

10.1 NATURAL SETTING

This site has a setting similar to that of the Corral site, being situated on the right bank of a broad meander of West Amarillo Creek less than 2 km north of the Corral site (Figures 10-1 and 10-2). The creek bounds this meander on the south, west and north. Three constructional geomorphic surfaces are present. The majority of the site is underlain by the first terrace (T_1) surface, which forms a broad, relatively flat to gently westward sloping surface. A modern pavilion structure with a concrete foundation and a metal storage shed are both situated on the T_1 surface. This surface may have been leveled, or at least altered somewhat, in modern times, and is currently covered in short grasses. Due west of the pavilion, just across the bike trail, is a small arcuate shaped fragment of the upper floodplain (T_{0a}). This same surface is also present due north of the pavilion, but the scarp between it and the first terrace is much less pronounced than it is to the west of the pavilion. The lower T_{0b} surfaces are also covered in grasses with a few scattered and clumped elm and mesquite trees. The dirt road that enters the site from the northeast is cut into the colluvial slope that forms the eastern valley wall, and at least one small alluvial fan is present along the eastern side of the site. The margins of the creek are dominated by large cottonwood trees with at least one relatively large patch of plum bushes.

Figure 10-1. Northern End of Pavilion Site, 41PT245. (Note: Target area between backdirt from BT 20 towards right side of picture and trees to the south, view is west.)

This site was not identified during the 1999 surface survey (Haecker 1999). During Haecker's (2000) testing phase only limited investigations, one backhoe trench (TU 1) mechanically excavated into the T_1 deposits, one 1 by 1 m test unit (TU 2) hand excavated to 40 cmbs in the T_1 surface, and six shovel tests (STs 1 through 6) all dug into the T_1 surface, were conducted. A bone

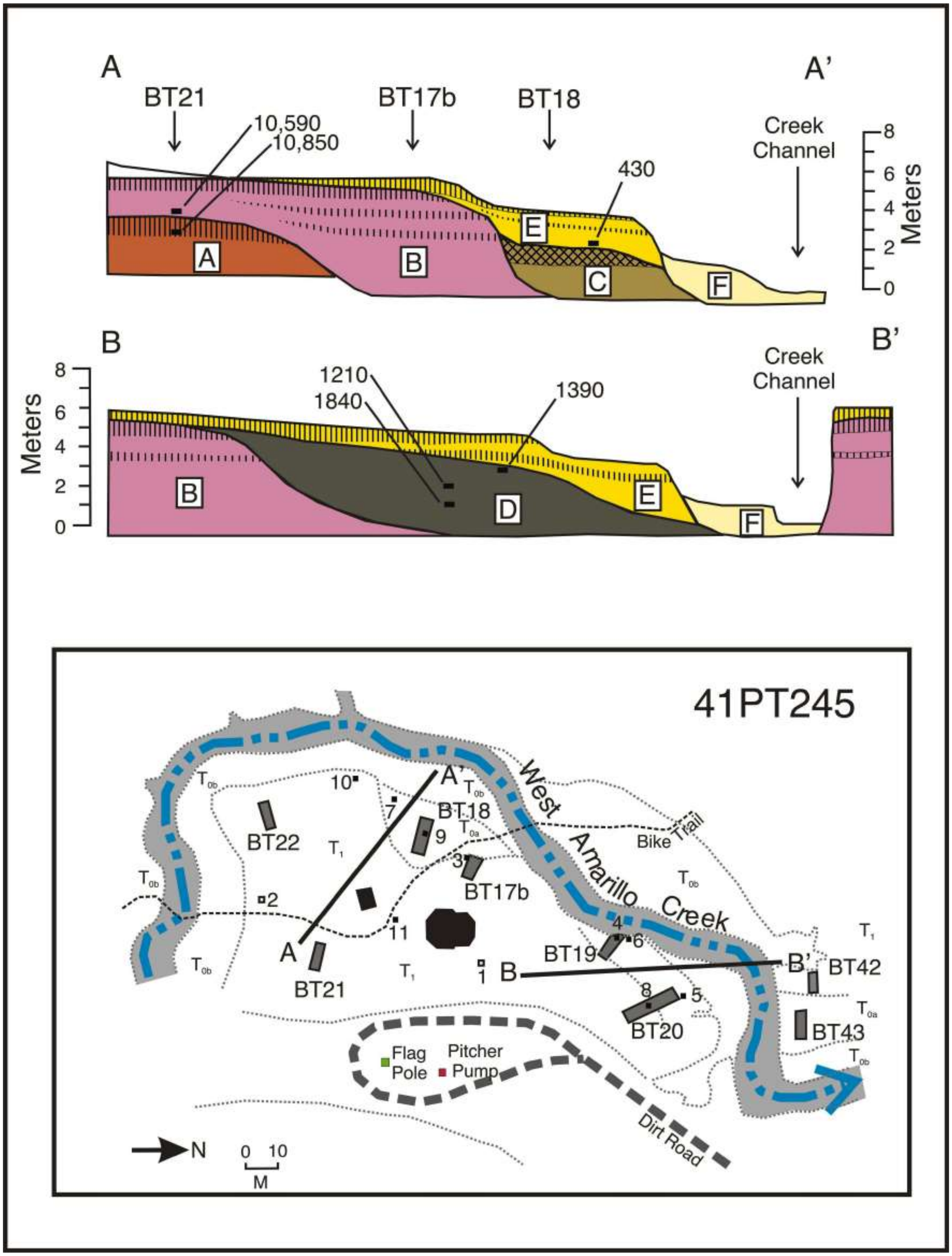

Figure 10-2. Schematic Cross Sections of Stratigraphy and Plan Map of the Pavilion Site, 41PT245.

fragment from 30 to 40 cmbs in TU 2 yielded a $\delta^{13}C$ adjusted radiocarbon date of 540 ± 40 B.P. (Beta-138512; Haecker 2000). Haecker (2000) recommended this site for further evaluation to determine its eligibility for listing on the NRHP and determining the nature and extent of the cultural deposits.

10.2 SUMMARY OF 2007 PHASE I INVESTIGATIONS

TRC excavated six backhoe trenches (BTs 17b through 22) across the projected site area, with a total combined trench length of nearly 62 m. Five trenches (BTs 17b through 20, and 22) were excavated in the most promising areas close to the creek or along the margin of the broad upper T_1 terrace (Figure 10-2). A sixth trench (BT 21) was placed back from the creek in the T_1 to sample the predicted older deposits and examine and document the stratigraphy in that setting.

Trench 17b was excavated immediately on the northern side of two burned rocks eroding out of the edge of the T_1 surface west of the Pavilion structure. The purpose of this trench was to examine that potential cultural feature (Feature 1). Backhoe trench 18 was excavated into the lower T_{0a} west of the Pavilion structure to sample that area. Trench 19 was excavated into the lower T_{0a} immediately south of clustered burned rocks (Feature 2) at about 130 cmbs to gain access to this deeper cultural material. BT 20, some 23 m north of BT 19, was excavated at the northern end of the lower T_{0a} surface. Trenches 20 and BT 21 were extensively sampled at roughly 10 cm intervals in vertical columns for subsequent analyses (Figure 10-3). A brown (10YR 4/3) silty loam (2Bk horizon) sediment sample, collected from 145 to 148 cmbs in BT 21, was radiocarbon dated. The sediment's organic fraction yielded a $\delta^{13}C$ adjusted radiocarbon date of 10,590 ± 40 B.P. (Beta-238320). Backhoe trench 22 was excavated towards the southern end of the site along the western margin of T_1 to sample that area overlooking the creek. Trench depths varied from 250 to 310 cmbs with safety steps/benches on one side of each trench. Trench lengths varied from 8 m long at BTs 17b and 21, to 19 m at Trench 20.

Figure 10-3. Backhoe Trench 20 that Shows Texture Column Samples at 10 cm Intervals.

Four trenches (BTs 17b through 20) revealed cultural materials in their side walls and showed promise for revealing intact and buried cultural components. Trench 17b revealed sparse cultural items in the 60 cm thick A horizon. At least one burned rock was observed at 55 to 60 cmbs near the bottom of the A horizon. Turbation was also visible in this sandy horizon. Backhoe trench 18 also exposed some cultural materials (Table 10-1). A thin 2 to 4 cm thick burned lens with charcoal chunks (Feature 3) was observed along the north wall at 155 to 160 cmbs and this lens extended horizontally for roughly 4 m. Backhoe trench 19 yielded at least 216 g of

Table 10-1. Cultural Materials Exposed in the Walls of Backhoe Trench 18, Pavilion Site.

Cultural Materials *	Depth (cmbs)	Trench Wall	Location in Trench
Chunk of coal	20	north	middle
Bone fragment	57	north	middle
Burned bulbs	70	north	middle
Glass fragment	105	north	middle
Bone fragment	127	end wall	east end
Charcoal lens	155-160	north	middle
9 Burned rocks	165	middle	middle
Burned rock	195	middle	middle

* At least two layers of burned rocks were present here

bone (#416-002) between 140 and 150 cmbs, with bison and deer represented, and a few small pieces of dolomite burned rocks and one quartzite burned rock (Tables 10-2 and 10-3). One bison long bone fragment than, and out of line with, other bison bone values, and is considered anomalous. At least eight scattered bone fragments were observed in the northern and southern walls of BT 20 concentrated towards the western end, generally between 80 and 110 cmbs (Tables 10-4 and 10-5). One bison long bone fragment (#417-002-1) from 180 cmbs was sent for radiocarbon dating, (#416-002-1a) was sent for stable isotope analysis, yielding a $\delta^{13}C$ value of -15.6‰ and a $\delta^{15}N$ value of 6.5‰ (Appendix H). The $\delta^{13}C$ value of -15.6‰ is more negative and yielded a $\delta^{13}C$ adjusted radiocarbon date of 1210 ± 40 B.P. (Beta-237022). One bone from roughly 90 cmbs at the western end of BT 20 appears to be part of carnivore skull fragment lacking dentition. Toward the middle of BT 20, there was a cluster of three bison thoracic vertebrae fragments (184 g; #417-002-1) at roughly 240 cmbs. Sediment (5Ab3 soil horizon, #417-004-2) from around the vertebrae yielded a $\delta^{13}C$ adjusted radiocarbon date of 1840 ± 40 B.P. (Beta-237023).

With bones and burned rocks observed in BTs 17b through 20, six hand excavation units (TUs 3, 4, 5, 6, 8, and 9) were excavated adjacent to the sides of these four trenches to further investigate these remains. Test Unit 3 was excavated from the surface to 50 cmbs next to off BT 17b and next to Feature 1 in anticipation of exposing more of that feature. Test Unit 4 was excavated from 100 to 160 cmbs inside BT 19 specifically to investigate Feature 2. Test

Table 10-2. Bison Bone Characteristics from BT 19, Pavilion Site.

Catalog No.	Bison Element/Part	Weight (g)	Burned	Cut Maraks	Surface Condition
416-002	7 partially complete, mature thoracic vertebrae bodies *	1018.2	No	No	root etched, rodent gnawed
416-002	5 mostly complete immature thoracic vertebrae bones and partial spines	794	No	No	root etched, rodent gnawed on spine edge
416-002	3 mature cervical vertebrae bodies	481.8	No	No	root etched,
416-002	1 rib head with medial section	67.2	No	No	root etched,
416-002	6 rib heads **	100.6	No	yes 3	root etched,
416-002	1 large complete axis	344.5	No	No	mostly intact
416-002	1 left distal humerus, butchered, male***	227.1	No	No	root etched
416-002	2 mandible sections with 3rd molar	698.9	No	No	partially root etched
416-002	1 left distal humerus, butchered	163.1	No	2 clusters	root etched

* = Piece radiocarbon dated to 600 ± 40 B.P. (Beta-237020)
** = One rib head submitted for carbon and nitrogen isotope analyses (see Appendix H)
*** = Sex determined by measurements from Speth 1983

Table 10-3. Cultural Materials Observed in the Walls of Backhoe Trench 19, Pavilion Site.

Cultural Materials *	Depth (cmbs)	Trench Wall	Location in Trench
Bone fragment (?pelvis)	84	south	east end
Bone fragment	108	south	near middle
Bone fragment	112	north	west end
Burned rock	115	south	west end
Bison long bone fragment	118	south	near middle
Bone fragment	127	south	west end
Distal bison tibia	132	south	near middle
Burned rock	138	south	near middle
Bison rib fragment	140	north	west end
Burned rock	170-180	north	west end
* Two closely spaced layers of bone were present here and they slope down			

Table 10-4. Cultural Materials Observed in Backhoe Trench 20, Pavilion Site.

Cultural Materials *	Depth (cmbs)	Trench Wall	Location in Trench
1 Bone fragment	57-60	west end	west end
Bison 3rd phalanx	83-85	north	west end
3 Bone fragments	85-90	south	west end
Bison rib fragment	90-95	north	west end
3 Bone fragments	90-95	west end	west end
Bone fragment	100-105	north	west end
Bone fragment	155-160	north	west end
Bone fragment	230-240	south	middle
* At least tw o, possibly three layers of bone w ere present here			

Table 10-5. Bison Bone Characteristics from BT 20, Pavilion Site.

Catalog No.	Bison Element/Part	Depth (cmbs)	Weight (g)	Burned	Cut Maraks	Surface Condition
417-002-2	M1, M2, M3 bison teeth, old	backdirt	86.1	No	No	weathered
417-002-3	4 bison vertebrae, mature	240	185	No	No	root etched,
417-002-1a*	bison long bone fragment	180	13	No	No	root etched
417-002-1b**	bison long bone fragment	180	17	No	No	root etched,
417-002-1	bison long bone fragments	180	38	No	No	root etched,
417-002-4	non-bison skull fragments	90	9.3	No	No	root etched,
* Bone radiocarbon dated to 1210 ± 40 B.P. (Beta-237022)						
** Sample submitted for carbon and nitrogen isotope analyses (Appendix H)						

Unit 8, inside BT 20, was initiated from the safety bench at 125 cmbs, and targeted the cluster of three bison thoracic vertebrae fragments at roughly 240 cmbs. Test Unit 9 was excavated inside BT 18 from approximately 50 to 180 cmbs to investigate burned rocks observed in the middle of the trench. This unit had to be stepped in three sections (9a, 9b, and 9c) to facilitate safe access to the deepest area inside the trench. Test Units 7, 10, and 11 were excavated to depths of 140, 90, and 90 cmbs respectively, in other selected areas across the main terrace. These units were placed to sample deposits of various ages, to identify horizontal and vertical extents, and to determine the density of the cultural remains.

Backhoe trench 22 penetrated through dark grayish brown (10YR 3/2 and 4/2) sandy sediments that exhibited cultural materials scattered above 115 cmbs. The 90 cm thick A horizon exposed at least one small rib fragment in the south wall at 90 cmbs, a small burned rock at 70 cmbs, and a second small rib fragment on the north wall at ca. 80 cmbs. Although cultural materials were present, considerable rodent activity was also visible in the trench walls. The cultural materials were thought to be Late Prehistoric in age based on their positions within the sandy A horizon.

10.3 STRATIGRAPHY

Five alluvial stratigraphic units are present at this 140+ m long site along the eastern margin of West Amarillo Creek (Figure 10-2; see Geoarcheological section above for more details on depositional units). At the eastern edge of the first terrace (T_1), BT 21 revealed the late Pleistocene Unit A (age greater than 11,000 B.P.) buried beneath the 185 cm thick veneer of Unit B. West of the Pavilion structure, Unit B thickens, to more than 3 m thick, and represents a period from approximately 10,700 too shortly after 8000 B.P. Unit B was then truncated or buried by the deposits under the T_{0b} surface.

The upper floodplain due west of the Pavilion structure is underlain by a truncated portion of Unit C at depth (dated to roughly 4000 to 2100 B.P.), which in turn is buried by roughly 2 m of Unit E (dated from 430 B.P. to present). Paradoxically, Unit D, the late Holocene marshy floodplain dated from roughly 1900 to 800 B.P., is missing completely in this part of the site, but it underlies an extensive area north of the Pavilion in the vicinity of BT 19 and 20. In the northern area along the margin of the creek channel, upwards of 3 m of Unit D lies beneath a thin (less than 1 m thick) veneer of sandy sediment, which is interpreted as Unit E. Several prehistoric occupations appear within Unit D in this northern section of the site.

10.4 ARCHEOLOGICAL RESULTS

During the initial site inspection in the fall of 2007, two sizable (11 to 12 cm in diameter) burned rocks about 10 cm apart were observed eroding out from the edge of the T_1 surface some 12 m west of the Pavilion structure. The two burned rocks, one a quartzite cobble and the other a chunk of caliche, appeared to represent a possible cultural feature that was designated Feature 1. No charcoal staining, pit fill, or other cultural materials were observed on this sloping and eroding edge. The two rocks were roughly 20 to 25 cmbs in a very dark grayish brown (10YR 3/2) sandy loam A horizon. A second cluster of three burned rocks associated with small bone fragments was observed farther north, again along the eroding edge of the T_0 surface next to the creek. This deeply buried cluster of cultural materials at 130 cmbs was designated as Feature 2.

Different parts of the late Holocene drape, Unit E, under the T_1 surface and above the much older depositional Unit B, were targeted by TUs 3, 10, and 11. These dispersed 1 by 1 m units were excavated to depths of 50, 140, and 90 cmbs respectively. TU 3 targeted an area immediately next to Feature 1 exposed by erosion of the lower part of Unit E, just above the Pleistocene deposits along the terrace edge. Test Unit 3 yielded 21 pieces of lithic debitage, 14 tiny ceramic sherds, and five small burned rocks (24.6 g) between 0 and 50 cmbs in the late Holocene drape. The lithic debitage was scattered throughout the top 40 cm, the shreds were in the top 20 cmbs, and the burned rocks were from 40 to 50 cmbs. No obvious indications of Feature 1 were detected in TU 3. The vertical distributions of the lithic debitage and sherds revealed no well defined cultural component in this dark homogenous drape.

Test Unit 10 was excavated from the surface to a depth of 140 cmbs along the western margin of the main T_1 surface. The top 10 cm yielded modern nails and decayed wood fragments, two small ceramic sherds, one piece of chert debitage, and six small unidentifiable bone fragments. From 10 to 40 cmbs were found some tiny mussel shell fragments (N = 6), unidentifiable bone fragments (N = 3), two chert and one obsidian flake, but no stone tools or indications of cultural features. Nearly 83 percent of the tiny bone fragments (N = 39, weighing 25.6 g) were below 70 cmbs, whereas all the lithic debitage and sherds were in the upper 40 cmbs. Rodent activity was observed throughout this unit. Again, no well defined cultural component was detected in this dark, sandy, and homogeneous matrix.

Test Unit 11 was excavated south of the Pavilion structure near the middle of this broad terrace. The 90 cm of excavated matrix yielded one piece of debitage at 40 to 50 cmbs. These three units were excavated into depositional Unit E, the dark sandy matrix of late Holocene age, and did not reveal a high density of cultural materials, formal tools, or recognizable cultural features. Although cultural materials were present in this deposit, the vertical distribution indicates this deposit has been turbated. Therefore, evidence for individual cultural events, if once present, could not be isolated or identified.

Late Holocene deposits designated as Units D and E, under the T_0 surface along the margins of the slightly higher T_1 surface, were investigated through hand excavated TUs 4 through 9. Below the T_0 surface and in these late Holocene deposits, cultural materials were scattered. These units contained sparse cultural materials as exposed in BTs 18, 19, and 20 (Figure 10-4). A bison long bone fragment (#417-002-1) from 180

cmbs at the western end of BT 20 yielded a δ^{13}C adjusted radiocarbon date of 1210 ± 40 B.P. (Beta-237022).

Test Units 4 and 4b, inside and at the very western end of BT 19, targeted a partially eroded burned rocks concentration (Feature 2) in the cutbank. These two units yielded 52 bone fragments, 18 burned rock pieces, eight pieces of lithic debitage, one edge-modified flake, and Feature 2, a hearth, from between 100 and 140 cmbs. The edge-modified flake was adjacent to Feature 2. It is a medial section of a 33 mm long tertiary flake (#347-010) of Tecovas jasper with patterned retouch along opposite edges on opposite sides.

Feature 2 was first observed eroding out from the T_0 edge at the western end of BT 19. The constituent burned rocks that formed this cluster, as well as those along the eroding slope, were collected. The remaining part of this burned rock cluster was targeted and hand excavated in TU 4 and the adjacent balk between TU 4 and the eroded edge. The excavation of Feature 2 revealed a concentration of 25 burned rocks that weighted 5339.4 g (Table 10-6). Tiny flecks of charcoal were found around and under some of the rocks, and a long rib section rested at the southern edge of the burned rocks. The matrix around and between the rocks was a dark brown (10YR 3/3) clayey loam. No color contrast was apparent between the soil inside and outside of the burned rock cluster. The clustered burned rocks (#348-003, #350-003, and #353-003) ranged in depth from 129 to 136

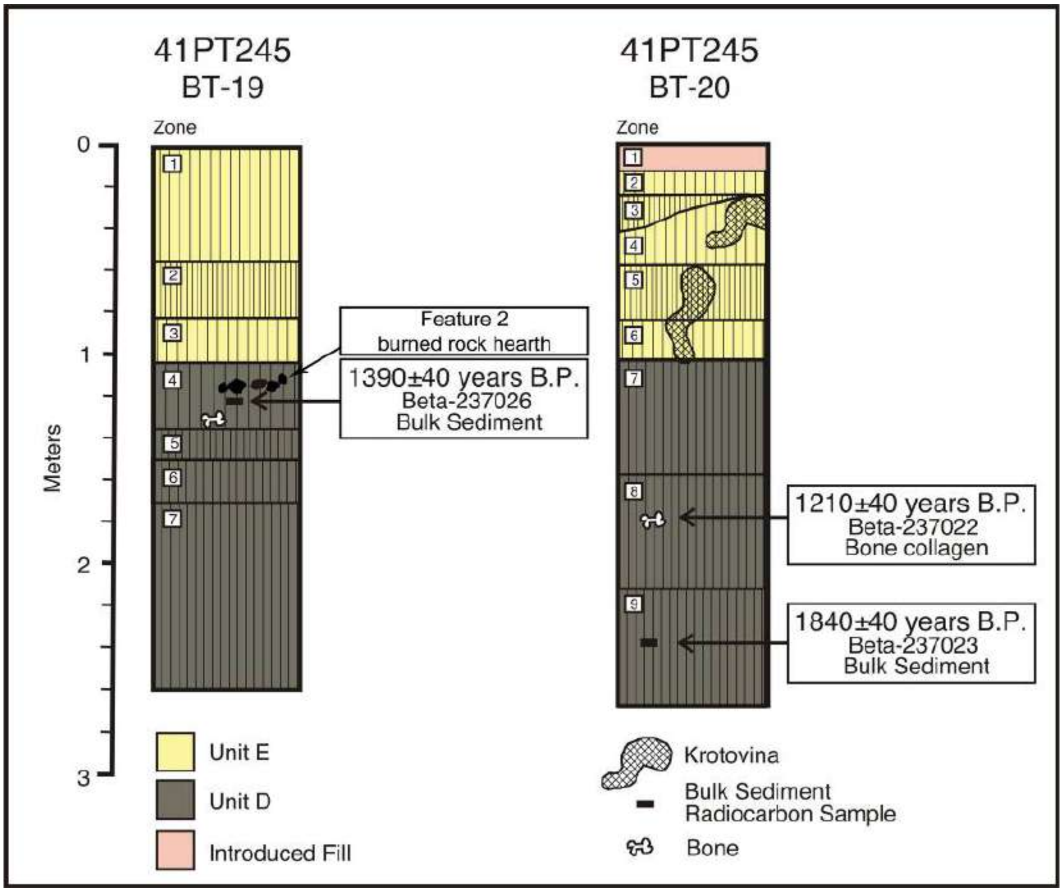

Figure 10-4. Schematic Stratigraphic Profiles of BTs 19 and 20 at 41PT245, Showing the Positions of the Radiocarbon Dates in Depositional Unit D.

Table 10-6. Burned Rock Characteristics from Feature 2.

Unit	Level	Cat. No.	Size (cm) and Weight (g)								Material Type [1]			Total Count	Total Wt. (g)
			0-4	Wt.	4.1-9	Wt.	9.1-15	Wt.	>15.1	Wt.	LS	SS	Qtz		
TU 4	12	346-003	1	14	2	120.7					2	1		**3**	**135**
TU 4	13	348-003	3	30.9							3			**3**	**31**
TU 4	14	350-003	1	13	1	107					2			**2**	**121**
TU 4-Bulk	14	353-003			3	388	2	1,126	1	1625	5		1	**6**	**3,139**
Cutbank		353-003	10	1457	7	3596					14	2	1	**17**	**5,053**
Totals			**15**	**1,516**	**13**	**4,212**	**2**	**1,126**	**1**	**1,625**	**26**	**3**	**2**	**31**	**8,479**

1. LS = limestone, SS = sandstone, Qtz = quartzite

cmbs (Figures 10-5 and 10-6). This cluster measured roughly 50 cm east to west and 30 cm north to south, although the feature was not totally excavated. Flecks of charcoal in dark sediment (#353-007) from just above one burned rock at 127 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon date of 1390 ± 40 B.P. (Beta-237026).

A bulk sediment sample (#348-004) with flecks of charcoal was collected from within

Figure 10-5. Feature 2 at Edge of the Cutbank (Left) and Adjacent to TU 4 (Right) Inside BT 19 at 41PT245. (Note: These 1390 B.P. burned rocks were used to boil large herbivore meat and wildrye grass seeds.)

5 cm of the top of the burned rocks. A second bulk sediment sample from 5 cm under the burned rocks (#350-004) between 125 and 130 cmbs was collected from the balk of TU 4. This sample (#348-004), consisting of 2.7 liters, was floated. The heavy fraction (85.9 g) yielded eight tiny pieces of lithic debitage, seven tiny bone pieces, and four tiny charcoal pieces. The light fraction (7.8 g) from this sample yielded sparse charcoal, tiny unburned black seeds, and many tiny rootlets. Sample #350-004, consisting of 5.4 liters from 134 to 140 cmbs, was also floated. The heavy fraction (332 g) yielded 30 tiny pieces of charcoal, 23 tiny bone fragments, 19 tiny burned rock fragments, and 19 tiny pieces of lithic debitage. Some 15 bone pieces were burned. The light fraction (6.6 g) yielded abundant charcoal, a few unburned black seeds, and many tiny rootlets. The tiny charcoal flecks were not identifiable (Appendix N).

Parts of four arbitrarily selected burned rocks (#353-003-1a, 2a, 3a, and 4a) from Feature 2 were subjected to lipid residue analyses. All four yielded interpretable lipid residues that indicate that large herbivore meat was processed using these four rocks. Sample #353-003-2a also yielded some plant residues (Appendix G). Parts of the first three rocks used for lipid analysis were also analyzed for starch grains (#353-003-1b, 2b, and 3b). All three samples yielded starch grains, with one burned rock (#353-003-2b) yielding gelatinized starch grains, two of which were identified as wildrye grass (*Elymus* sp.). Another burned rock (#353-003-3b) yielded a starch grain identified as Pooid grass. Two other burned rocks (#353-003-1b and 2b) also yielded unidentifiable plant tissues (Appendix F). The gelatinized starch grain indicates that heat and water were present and supports an interpretation these rocks were used to boil food. At least a combination of large herbivore meat and wildrye grass seeds was boiled using these rocks.

In TU 4, but outside the clustered rocks, were a young bison mandible, three bison rib fragments 50 cm to the south, two lithic flakes, one edge-modified flake, and other small unidentifiable fragmented bones adjacent to the rocks. One of the flakes is red Tecovas jasper. A total of 54 bone pieces weighing 107.8 g was in TU 4.

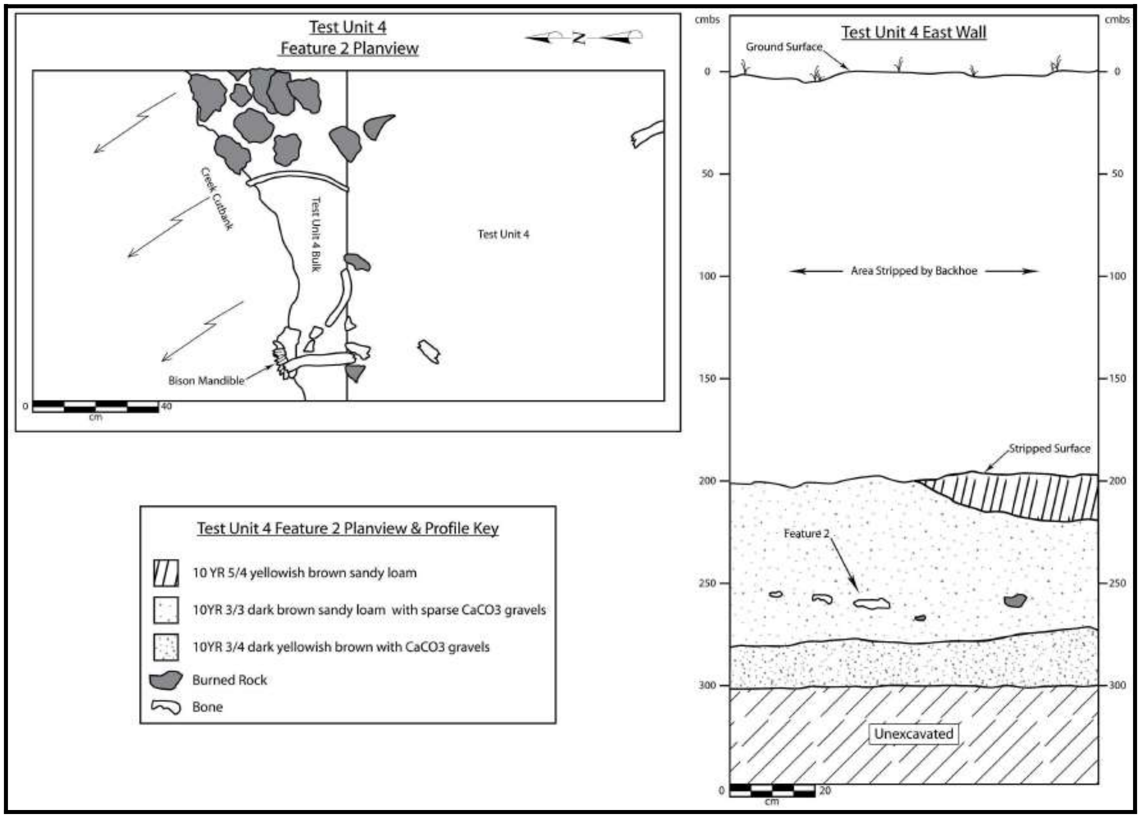

Figure 10-6. Plan and Profile of Feature 4.

These small fragments were in and around the clustered rocks. Most of the bone pieces exhibit root etched and weathered surfaces. One small (0.6 g), unburned turtle shell fragment (#353-002-2) was also adjacent to the clustered burned rocks.

The young bison mandible (#353-002-2) from 50 cm south of Feature 2 represents an animal roughly 4 to 5 months old (Figure 10-7). This interpretation is derived from the presence of a deciduous premolar (DP_4) that has erupted and has minimal wear on the highest cusps and first facet, plus a molar 1 that was erupted, but not quite to the level of DP_4, and is not worn. Molar 2 is only partially erupted. The age of this animal indicates an early fall (ca. September) kill, implying human occupation of the site at this time of year. A piece of this mandible (#353-002-2a) was sent for stable carbon and nitrogen isotope analysis.

The results of the carbon isotope analysis (-8.3‰) indicate this calf consumed approximately 80 percent C_4 grasses during

Figure 10-7. Close-up of 4 to 5 Month Old Bison Mandible (#353-002) from Feature 2, 41PT245. (scale in cm)

it short life. This figure is undoubtedly biased as this calf would still have been nursing. The nitrogen isotope value is 6.8‰ (Appendix H). The inside (tongue/lingual side) of this right mandible section exhibits three or four very thin, parallel lines that appear to be cut lines created by a very thin stone tool. If these are truly cut lines, then they would have resulted from cutting out the tongue.

Test Unit 5 was excavated in sandy to silty loam from the surface to 150 cmbs at the west end of BT 20 where bone fragments were exposed in the trench walls. The sediment became quite compact at roughly 80 to 90 cmbs. This unit yielded only 18 bone fragments scattered between 50 and 140 cmbs, with most fragments (*N* = 12) from between 90 and 110 cmbs. A nearly 20 cm long bison thoracic spine was uncovered at 60 cmbs. The apparent bone clustering (*N* = 12 weighing 230.3 g) between 90 and 110 contained one complete right bison metatarsal (#357-002) at 103 cmbs and implies a possible occupation zone at that depth. The metatarsal represents a small female bison based on the metric measurements of the proximal and distal ends (Table 10-7). This metatarsal was 15 to 20 cm higher than hearth Feature 2 at 125 to 130 cmbs and may represent a different deposits and the age obtained for Feature 2. This age may not be representative of the age of these deposits. Considerable rodent activity was observed in TU 5, which could occupation. However, this may also be the same occupation zone that slopes slightly in these homogeneous deposits. A small medial section of this same bison metatarsal (#357-002-1) yielded a $\delta^{13}C$ adjusted radiocarbon date of 160 ± 40 B.P. (Beta-237025). This 160 year old bone appears out of sequence with both the depth of account for the bone being displaced to this depth.

Test Unit 6, about 2 m north of TU 4, was excavated in mostly brown sandy loam with only slight color changes from the surface to 150 cmbs. This unit yielded three pieces of lithic debitage, 11 bone fragments (weighting 231.2 g), and some 46 tiny burned rocks fragments (weighting 124 g). Nearly all of the burned rock fragments (*N* = 44) were between 120 and 140 cmbs, a depth range that also yielded five bone fragments. The lithic debitage was scattered between 100 and 150 cmbs, though none was found between 120 and 140 cmbs. The larger burned rocks (#364-003 and #365-003) and bone fragments (#364-002 and #365-002) were between 128 and 137, indicating that this level was probably an occupation zone. The bones included at least one right distal metatarsal, a complete bison second phalanx, two bison rib fragments, small long bone fragments and some tiny bone scraps. The right distal metatarsal is that of a male, based on measurements compared with those provided by Speth (1983). Although the 20 cm thick zone between 120 to 140 cmbs yielded a relatively high concentration of butchered bison bones and numerous burned rocks, no stone tools or lithic debitage were recovered. This concentration of cultural materials was at the same level of hearth Feature 2 in TU 4.

Table 10-7. Metric Measurements on Bison Bones from Pavilion Site.

Catalog No.	Element Name	Unit	Depth (cmbs)	Side	Location and Measurement * (mm)	Gender
#357-002-1	Complete metatarsal	TU 5	98-103	Right	A=44.9, B=44.8, C=26.0, D=53.0, E=26.4, F=24.9, H=22.6,	Female
#346-002-1a	Distal metatarsal	TU 6	130	Right	D=68.3, E=32.5, F=30.9, H=25.8, J=36.4	Male

* = Measurements based on Speth 1983.

Metatarsal: A=greatest breath of proximal end; B=greatest depth of proximal end; C=greatest breath of articular facet of fused 2d-3d tarsal; D=greatest breath of distal end; E= breath of medial condyle; F=breath of lateral condyle; G= depth of medial trochlea; H=depth of lateral trochlea; J=depth of lateral sagittal ridge.

Test Unit 8 was excavated inside BT 20, beginning at the level of the safety bench approximately 125 cmbs and continued to 240 cmbs. This unit yielded 31 bone fragments weighing 40.7 g. These include 11 fragments of a bison rib from 109 cmbs, 13 fragments of a bison thoracic vertebrae from 114 cmbs, three unidentifiable fragments between 125 and 140 cmbs, and four bison thoracic vertebrae body fragments (#376-002) between 220 and 240 cmbs. No lithic debitage, stone tools, or burned rocks were recovered. This sparseness of materials reflects a vertical separation between bone specimens, probably indicative of at least two separate cultural events.

If the two accepted radiocarbon dates of 1210 and 1390 B.P. (the first on bone and the second on charcoal rich sediment from Feature 2) are from reliable contexts, they reveal at least two separate and stratified occupational episodes representing the Palo Duro complex or Woodland period. Limited cultural materials were found between 100 and 140 cmbs in BTs 19 and 20 and in TUs 4, 5, 6, and 8, apparently corroborating the interpretation that two distinct periods of occupation are represented. Currently, our interpretation is that a roughly 40 cm thick zone of cultural material, dating to ca. 1200 to 1400 B.P. and centered on BTs 19 and 20, has the potential to yield important information concerning at least two bison processing/camping events. The two accepted radiocarbon dates are roughly 180 radiocarbon years apart and represent a time period that has not been sufficiently studied in the region. A third occupation may be represented at roughly 240 cmbs in TU 8. A sample of organically enriched sediment (#417-004-2) from next to a cluster of bison vertebrae at 240 cmbs yielded a $\delta^{13}C$ adjusted radiocarbon age of 1840 ± 40 B.P. (Beta-237023). No lithic debitage or burned rocks were recovered from this depth in TU 8. No other cultural materials appeared at this level in the walls of BT 20. The bison bones from this one deep unit are very few and this scarcity indicate that this possible component is not sufficiently productive to warrant further investigation.

Toward the western end of the site and in the lower terrace, hand excavations of TU 9 were conducted inside BT 18. Unit 9 began at roughly 50 cmbs and continued to about 155 cmbs. At that point the unit was moved over and Unit 9b was excavated to 190 cmbs. In order to capture more of the possible occupation debris at this depth the unit was again moved and Unit 9c was dug in order to expand this excavation. These units revealed vertically stratified cultural events dominated by somewhat scattered burned rocks and a few tiny bone fragments (*N* = 6, weighing 3.5 g). The upper 150 cmbs or so appeared similar to the modern alluvial fill. This upper zone was a grayish brown (10YR 5/2) sandy loam with some coal chunks and glass fragments scattered near the top and in parts of the lower section, along the northern wall of the trench. Feature 3, 3 to 5 cm thick lens of charcoal and ash was first detected at roughly 140 cmbs. As hand excavations proceeded, the lens gently sloped downward to the west, and was completely gone by 147 cmbs in TU 9. This lens contained a few chunks of charcoal and charcoal stained matrix mixed with sandy loam matrix. No burned rocks or lithic debitage were recovered from this lens. This lens also appeared in the northern wall of BT 18 where it extended horizontally along the wall for at least 4 m. Here again, the lens did not contain any prehistoric cultural materials. Feature 3 is interpreted to represent a natural burn since it had no associated prehistoric materials.

Some 10 to 20 cm below Feature 3, in TU 9b at 156 to 168 cmbs a burned rock feature (Feature 4/5) was encountered. Feature 4/5 was initially identified as two small clusters of burned rocks (#387-003) about 40 to 50 cm apart with a couple of burned rocks and an a bison astragalus between the two clusters. A chunk of charcoal (#385-007) was under one burned rock in the more southern cluster. These items were distributed over an area roughly 90 by 200 cm (Figure 10-8). The complete, bison left astragalus (#385-002-1; 107 g) and one piece of chert debitage were in association with the burned rocks. The astragalus exhibits some minor rounding, as if water worn, but it also exhibits two small cut lines on one side to indicate it was culturally modified. Based on the metric measurements it represents a male bison. No diagnostic projectile points or ceramic shreds were discovered in association with the burned rocks. As Unit 9c was opened to the west to further explore this cluster of burned rocks, more burned rocks were encountered slightly down slope and these were also assigned to Feature 4/5. The burned rocks in Unit 9c were deeper, ranging in depth from 156 to 174 cmbs. These cultural rocks rested within a pale brown (10YR 6/3) silty clay loam that contained no charcoal or ash concentrations. The homogeneous color of the matrix and the slightly sloping surface make it difficult to determine if this was one or possibly two closely spaced occupation surfaces. A tiny piece of charcoal (#400-007) from 170 to 180 cmbs just below Feature 4/5 yielded a $\delta^{13}C$ adjusted radiocarbon age of 430 ± 40 B.P. (Beta-238318). This irregularly configured distribution of burned rock and the scattered bone fragments and charcoal chunks is interpreted to represent discard from cooking activity. Feature 4/5 occurred near the end of the Late Prehistoric or during first part of the Protohistoric period. The depth of this recent cultural event reveals the rapid deposition of sediment over the last 500 or so years in this valley.

Four burned rocks (#389-003-1a, 2a, 3a, and 4a) from Feature 4/5 were sampled for lipid residues to investigate what types of foods were cooked with these rocks. Insufficient lipids were recovered from all four rocks for residue identification (Appendix G). Parts of three of those same burned rocks (#389-003-1b, 3b, and 4b) were sampled for the presence of starch grains. One rock (#389-003-3b) yielded starch fragments, burned rock #389-003-1b yielded one unidentifiable starch grain, whereas the other two burned rocks (#389-003-3b and 4b) yielded unidentifiable plant tissues (Appendix F). Although no lipid residues were detected, the starch grain analysis revealed that plants were being cooked using these rocks.

Test Unit 7 was excavated from the surface to 140 cmbs at the southern end of the same low terrace in anticipation of finding additional evidence of the cultural components identified in TU 9. Test Unit 7 yielded very sparse cultural materials that included one chert flake (#369-001) between 30 and 40 cmbs, one tiny rib fragment (#372-002) between 110 and 120 cmbs, and 10 small pieces of charcoal vertically scattered throughout the profile from the surface to 120 cmbs. These items were in a heavily mottled pale brown (10YR 6/3) to dark grayish brown (10YR 4/2) silty sandy loam. The recovered materials are of questionable origin and too dispersed to reflect a discrete cultural component that would provide significant results if targeted.

10.5 THE ARTIFACTS

A single obsidian flake fragment (#403-001) was recovered from 20 to 30 cmbs in TU 10. This specimen was sent for XRF analysis, which determined that this obsidian originated in the Jemez Mountain region of northern New Mexico, specifically the Cerro Toledo Rhyolite source locale (Appendix C). This obsidian flake is from a mixed context in the Unit E deposits of the lower terrace. The age of Unit E is projected to be less than 430 B.P. and therefore, the obsidian flake may be of Protohistoric age.

Sixteen ceramic sherds were recovered from the Pavilion site, 13 from the top 20 cm in TU 3, one (#378-008-1) from 60 to 70 cmbs in TU 9, and two from 10 to 20 cmbs in TU 10. Surprisingly, not one single sherd exhibited a cordmarked exterior surface. Cordmarked exteriors dominate the ceramic

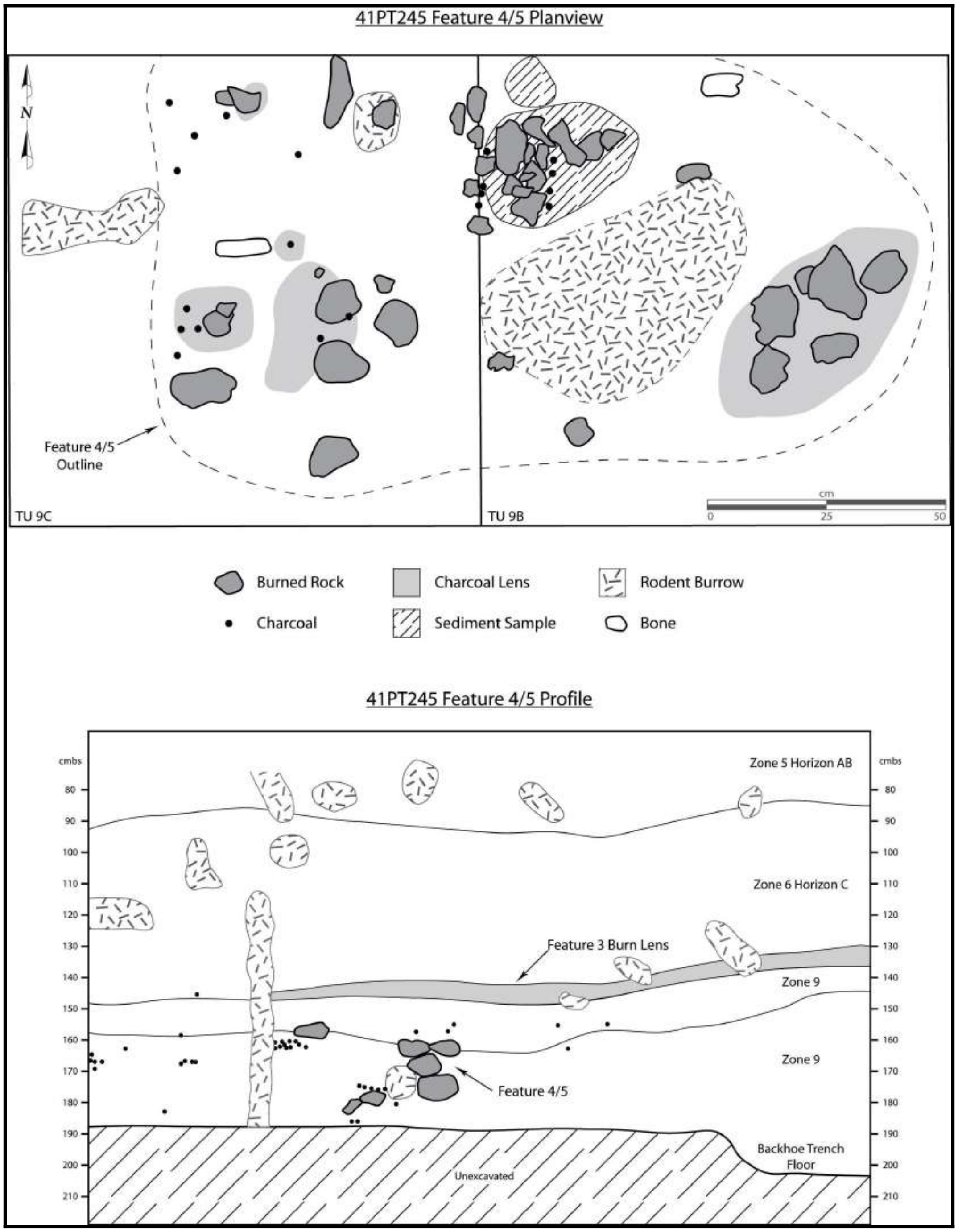

Figure 10-8. Plan View and Profile of Feature 4/5 that Shows Feature 3 in Wall at TU 9.

vessels form the Plains Village Antelope Creek period throughout this region between 750 and 450 B.P. (A.D. 1200 to 1500). All 16 sherds exhibit plain exterior surfaces and are relatively thin. These 16 sherds may represent at least three vessels based on visual characteristics, including one very thin walled vessel, one moderately thin walled vessel, and one redware vessel.

The very thin walled vessel is represented by a tiny rim sherd and at least 12 other similarly tiny body sherds, all from 0 to 20 cmbs in TU 13 (#340-008 and #341-008). These 12 sherds exhibit smooth plain exterior and interior surfaces (Figure 10-9). The body sherds exhibit very similar exteriors, interiors, and core colors with nearly identical thicknesses (Table 10-8).

Figure 10-9. Exteriors of Plain Sherds #340-008, Very Thin Walled Vessel.

The body sherds range from 14 to 26 mm in diameter and vary from 3.1 to 5.0 mm thick. The sherd colors are all the same, with grayish brown (2.5Y 5/2) exteriors, dark gray (2.5Y 4/1 interiors, and black (5Y 2.5/1) cores. The one tiny rim sherd (#341-008-2) is 12 mm long with a rounded, outward sloping and thinning lip with no visible decorations along the 6.5 mm of the rim edge. Two thin parallel lines, possibly the result of wiping are just below the rim in the slightly concave area below the lip. The top of the rim is 3.1 mm thick, and the lower edge of the sherd is 4.2 mm thick, thus revealing the lip is thinned relative to the rest of the vessel. One sherd (#340-008-1) was selected for INA analysis (TRC430), and two sherds (#340-008-2 and #340-008-3) were subjected to petrographic analysis. Body sherd #341-008-1 from the same provenience as those just mentioned may represent a different vessel as it exhibits an obviously contrasting dark exterior (Figure 10-10). This sherd was recovered from 10 to 20 cmbs in TU 3 along with those just discussed. It measured 26.5 mm long by 14.6 mm wide by 4.4 to 4.6 mm thick and weighed 2.3 g. This sherd is similar in thickness to the other 12 sherds with which it was found, but the dark exterior sets it apart. The dark reddish black (2.5YR 2.5/1) exterior appears polished on a flat, smooth surface. Tiny temper particles and possibly mica are visible on the exterior surface. The gray (7.5YR 5/1) interior is flat and bumpy with one longitudinal groove, probably from wiping. The black (2.5YR 2/1) core revealed moderate sized quartz temper, of various colors, up to 1.7 mm in size.

Figure 10-10. Dark Exterior of Body Sherd #341-008-1. (scale in cm)

The original sherd was broken into two pieces for two separate analyses. One piece (#341-008-1a) was subjected to lipid residue analysis. The extracted lipids indicate high fat content plant seeds/nuts with a trace of animal products, plus conifer products. The source of the conifer (likely juniper in this area) products is not known, but may have been resin from firewood (Appendix G). The other piece (#341-008-1b) was subjected to starch grain analysis. Unfortunately, this did not reveal any identifiable starchy residues (Appendix F). This latter piece (#341-008-1b) was returned and then subjected to INA analysis (#341-008-1 or TRC433).

The overall similarity in visual appearance of these 11 thin, plain sherds and the one polished black sherd is supported by INAA conducted on one body sherd from each visibly different group (#341-008-1a and #340-008-1). The INAA places the two sherds side by side in the bivariate plots (Appendix J, Figures J-1 and J-4, TRC430 and TRC433). The hierarchical cluster diagram also places them side by side (Appendix J, Figure J-2). Petrographic analysis on three sherds (#340-008-2, #340-008-3 and #341-008-1b) revealed very similar paste, which allowed assignment to the same paste group – Paste Group 1 (Appendix I). Paste Group I matrix is dark and of moderate density, that contains pore spaces in jagged strips. This paste group consists of tempering with Rock A (an unknown type), crushed granitic rock formed of quartz, microcline feldspar, and biotite. Fine-grained, subrounded and subangular quartz grains and fine lathes of biotite may have been resident in the original clay material. Orthoclase feldspar and pyroxene are incidental members of Paste Group 1 (Appendix I). Sherds in Paste Group I could have been manufactured locally, based on the compositional similarities with local sediments.

These 12 sherds from this one provenience appear to represent at least one and possibly two vessels. These sherds were from a mixed context near the surface of depositional Unit E, in a low alluvial terrace. No radiocarbon dates or other diagnostic artifacts were associated with the sherds. Therefore, they cannot be assigned to a particular archeological manifestation at this time. However, the sherds were in alluvial deposits that date to the Late Prehistoric or more likely the Protohistoric period.

The moderately thin walled vessel is represented by one sherd (#378-008-1) from between 60 and 70 cmbs in TU 9. This appears to be in a Protohistoric context dating to less than 430 B.P. based on the natural stratigraphic position of the alluvial matrix. Specimen #378-008-1 is also a tiny sherd that exhibits a polished/burnished dark gray (10YR 4/1) to black (10YR 2/1) exterior surface (Figure 10-11). This piece was sent for petrographic analysis. The

Figure 10-11. Exterior Surface of Moderately Thin Walled Sherd #378-008-1. (scale in cm)

sherd contained 34 percent temper and 13 percent pore space, and the remaining 53 percent was clay paste. The petrographic analyst assigned this sherd to Paste Group 2 (Appendix I) which exhibits moderately dense, dark matrix with jagged pore strips. Crushed granitic rock tempered the clay paste and contributed grains of quartz, feldspar and biotite to the mass. Paste Group 2 is distinguishable from Paste Group 1 in having ferric hematite particles in the matrix. These ferric particles may have been clay residents; their presence may mark the use of a clay source different from that of Group 1. Therefore, the clays used to manufacture this sherd are thought to be nonlocal in origin.

The third vessel is a redware, represented by one body sherd (#401-008-1) from 0 to 10 cmbs in TU 10, and again in a mixed/disturbed context. This single, relatively large sherd measured nearly 45 mm across, weighed 8.5 g, and exhibits a very slight curve. The thickness varies from 2.9 to 4.5 mm. It has a smooth, plain, and polished reddish (2.5YR 2.5/1) exterior that also has faint, thin wiping striations (Figure 10-12). The interior is a matt red (2.5YR

Figure 10-12. Exterior of Polished Redware Sherd #401-008-1. (scale in cm)

5/6), very smooth with very tiny mica particles visible. The core is a dark reddish gray (2.5YR 4/1) with abundant rounded quartz temper particles up to 2.9 mm in diameter. In profile, the gray core is bounded by a 1 mm thick red zone on both the interior and exterior. This sherd is identified as part of a redware vessel that has been smoothed and polished.

This redware sherd was carefully split into five pieces for multiple analyses, with one unwashed piece retained. The petrographic analysis indicates this sherd (#401-008-1e) contained 38 percent temper, 15 percent pore space, and 47 percent clay paste. The temper is dominated by quartz and was assigned to Paste Group 2 (Appendix I). Paste Group 2 exhibits moderately dense, dark matrix with jagged pore strips. Crushed granitic rock was used to temper the clay paste and contributed additional grains of quartz, feldspar and biotite to the mass (Appendix I: Figure I-4). Paste Group 2 is distinguished from Paste Group 1 in having ferric hematite particles in the matrix, and is considered to be of nonlocal manufacture. The ferric particles may have been resident within the clay and may mark the use of a clay source different from that of Group 1. This sherd and sherd #378-008-1 in Group 2 are quite similar and may have come from the same or similar ceramic vessels.

The lipid residue analysis on part of sherd #401-008-1a was interpreted to reflect moderately high fat content plant seeds/nuts with a trace of animal products (Appendix G). Another piece of #401-008-1b was subjected to starch grain analysis. The latter revealed a single, lenticular starch grain that is of Canadian wildrye grass (*Elymus canadensis*, Appendix F).

The INA analysis indicates that this sherd was not manufactured from the local clays included within this analysis (TRC 429; Appendix J). In the INAA, a hierarchical cluster diagram links this redware sherd with a corrugated sherd (#343-008-1b) from the Corral site (Appendix J). It is assumed that the corrugated ware was manufactured outside this immediate region and that the locally aberrant finishes on both sherds most likely reflect vessel production in the northern Pueblo region of New Mexico. The INAA supports that belief. Therefore, it is concluded that this redware sherd, the corrugated sherd, and probably the plain sherd #378-008-1 were not manufactured locally and probably represent imported Puebloan vessels.

A single edge-modified flake tool (#347-010) was recovered. It was from 120 to 130 cmbs in TU 4. The age and cultural associations of this artifact are unclear. This tool was manufactured from a high-quality piece of local Tecovas material that lacks flaws. A tiny area on the ventral surface has calcium carbonate attached. This edge-modified piece is roughly 80 percent of a distal flake with platform portion snapped off. It weighs 2.6 g, and measures 33.9 mm long, 16.5 mm wide and 4.9 mm thick. It exhibits a central ridge down the dorsal surface and tapers towards the distal end. The ventral surface is concave and lacks towards the distal end. The left lateral edge exhibits irregular tiny break areas interdispersed with some tiny retouch flake scars. This tool shows considerable use, and was most likely discarded following exhaustion of its use life.

Unfortunately, more diagnostic materials were not recovered with the ceramic sherds. These shreds provide information as to their construction process and their possible origin, but not their exact age. These are believed to very late in the time sequence based on their stratigraphic position in very late alluvium Unit E, most likely pertaining to the Protohistoric period, although that cannot be clearly demonstrated.

10.6 SITE INTEGRITY AS DETERMINED FROM PHASE I INVESTIGATIONS:

Across the major T_1 surface lies a relatively thin, roughly 50 cm thick, late Holocene drape (Unit E) overlying the late Pleistocene deposits (Units A and B). The thinness of this late Holocene deposit, combined with its extensive rodent disturbance, means that any cultural materials within this drape would be difficult to separate into meaningful temporal units. Therefore, much

Table 10-8. Metric and Nonmetric Observations on Ceramic Sherds from the Pavilion Site.

Unit	Depth (cmbs)	Pnum	Count	Ceramic Type	Sherd Type	Temper	Exterior Surface Finish	Interior Surface Finish	Exterior Color	Core Color	Interior Surface Color	Length (mm)	Width (mm)	Thickness (mm)	Analyses	Wt (g)
TU 3	0-10	340-008-1	1	Plainware	Body	Sand	Plain - polished	Smooth	10YR 5/2 grayish brown	10YR 2/1 black	10YR 4/2 dark grayish brown	20.55	16.50	3.16 - 3.47	INAA(TRC430)	1.8
TU 3	0-10	340-008-2	1	Plainware	Body	Sand VG=3	Plain - polished	Smooth	10YR 5/2 grayish brown	10YR 2/1 black	10YR 4/2 dark grayish brown	10.98	9.97	2.47 - 2.80	Petrographic	0.5
TU 3	0-10	340-008-3	1	Plainware	Body	Sand VG=3	Plain - polished	Smooth	10YR 5/2 grayish brown	10YR 2/2 very dark brown	10YR 5/1 gray	21.96	9.51	3.98	Petrographic	1.0
TU 3	0-10	340-008-4	1	Plainware	Body	Sand	Plain	Smooth	10YR 5/3 brown	10YR 2/1 black	10YR 3/2 very dark grayish brown	14.06	8.75 - 11.74	2.66 - 3.05	—	0.6
TU 3	0-10	340-008-5	1	Plainware	Body	Sand	Plain		10YR 5/3 brown	10YR 2/1 black	10YR 3/2 very dark grayish brown	13.86	6.65 - 9.03	2.57 - 2.85	—	0.4
TU 3	0-10	340-008-6	1	Plainware	Body	Sand	Plain	Smooth	10YR 4/1 dark gray	10YR 2/1 black	10YR 4/2 dark grayish brown	11.86	7.13 - 9.33	3.61	—	0.6
TU 3	10-20	341-008-1	1	Plainware	Body	Sand	Plain - polished	Smooth	Dark exterior - flat, smooth	—	Gray interior - flat, bumpy	26.5	14.6	4.40 - 5.00	1a=Lipid Residue, 1b=starch grain	2.3
TU 3	10-20	341-008-2	1	Plainware	Rim	Sand	Plain	Smooth	10YR 5/2 grayish brown	10YR 2/1 black	10YR 5/2 grayish brown	11.92	11.21	3.06 - 4.20	—	0.5
TU 3	10-20	341-008-3	1	Plainware	Body	Sand	Plain - polished	Smooth	2.5YR 2.5/1 reddish black	2.5 YR 2/1 black	7.5YR 5/1 gray	15.5	16.8	4.0-4.8	INAA(TRC433)	1.3
TU 3	10-20	341-008-4	1	Plainware	Body	Sand	Plain - polished	Smooth	10YR 4/1 dark gray	10YR 2/1 black	10YR 6/2 light brownish gray	10.61	9.19	3.14	—	0.3
TU 3	10-20	341-008-5	1	Plainware	Body	Sand	Plain	Smooth	10YR 5/3 brown	10YR 2/1 black	10YR 5/2 grayish brown	8.21	7.15	3.07	—	0.2
TU 3	10-20	341-008-6	1	Plainware	Body	Sand	Plain	Smooth	10YR 5/2 grayish brown	10YR 2/1 black	10YR 5/2 grayish brown	7.98	7.14	2.65	—	0.2
TU 9	60-70	378-008-1	1			Sand VG=2			5YR 4/1 - 2 dark gray to reddish gray	5YR 4/2 dark reddish gray	2.5YR 5/4 reddish brown	12.54 - 13.07	7.47 - 10.61	3.16	Petrographic	0.6
TU 10	0-10	401-008-1	1	Redware	Body	Sand VG=1	Plain - polished	Smooth	2.5YR 2.5/1 reddish black	2.5YR 2/1 black	7.5YR 5/1 gray	17.21	8.67	4.02	1a=Lipid Residue, 1b=starch grain, 1d=INAA(TRC429), 1e=petrographic	8.5
TU 10	0-10	401-008-2	1			Sand	Plain	Smooth	10YR 4/1 dark gray	10YR 2/1 black	10YR 5/2 grayish brown	9.09	11.95	5.14	—	0.8

cmbs = centimeters below surface, VG = Vessel Group, see Appendix I. INAA = Instrumental Neutron Activation Analysis, TRC430 = INAA lab no., mm = millimeters, g = grams of the broad upper T_1 surface underlying the Pavilion structure appears to have very limited potential for vertically distinguishable cultural deposits, making it a poor target for acquiring stratigraphically clear and chronologically meaningful information. The cultural materials recovered from such a context can only be interpreted in a generalized way. Consequently, this part of 41PT245 is not a recommended target for the Phase II data recovery.

Depositional Unit D, the late Holocene marshy floodplain dated from roughly 1900 to 800 B.P., dominates the deposits encountered in BTs 19 and 20 along the northwestern margin of the site underlying the T_0 surface. Unit D was sampled by TUs 4, 5, 6, and 8 revealing evidence for at least one, and possibly as many as three stratified cultural components. The apparent rapid deposition of Unit D, combined with the documented limited time frame between roughly 1200 and 1400 B.P. for the cultural occupation(s) between 120 and 140 cmbs, provide excellent context for the recovered cultural materials. Cultural events across the Southern High Plains during this time frame are not well represented in the archeological literature, and thus, little is currently known about this time period, which falls toward the end of the Palo Duro complex and at about the time of the Woodland occupations (Boyd 1997). The well known, but minimally reported Chalk Hollow site in adjacent Randall County (Wedel 1975) yielded an upper midden zone dated to this same period (Lintz 2002). The limited area at the northwestern end of 41PT245, between BTs 19 and 20 provides an opportunity to obtain information from good context concerning this time period with at least one occupation falling into this time frame. Therefore, the specific area around and between BTs 19 and 20 below the T_{0a} surface, between a depth of roughly 120 to 180 cmbs, was recommended for a block excavation during the Phase II data recovery effort.

10.7 2008 Data Recovery Phase II Investigations

As recommended in the final interim report (Quigg et al. 2008) and approved by BLM, the Phase II block investigation focused on one alluvial terrace (T_{0a}) dominated by depositional Unit D (roughly between 1900 and 800 B.P.) towards the northern end of 41PT245 (Figure 10-13). This location was immediately east of West Amarillo Creek. The Phase II excavation block was placed between previously excavated BTs 19 and 20 and the four 1 by 1 m test units (TUs 4 through 6 and 8) off the sides of BTs 19 and 20. During Phase I data recovery these trenches and units yielded scattered butchered bison bones within a clay loam that lacked any visual stratigraphic markers (Quigg et al. 2008). The upper levels contained one or two cultural occupations surfaces that and were radiocarbon dated following the 2007 investigations to 1210 and 1390 B.P. The latter date was obtained on a piece of charcoal from burned rock hearth, Feature 2, eroding from the cutbank at the western end of BT 19. Based on the two radiocarbon dates, the detected and proposed target zone appeared to represent Palo Duro or Woodland occupation(s). TRC proposed a single excavation block of roughly 140 to 160 m^2 between BTs 19 and 20 to investigate occupation(s) of the site during this time period.

Phase II data recovery efforts began by mechanically stripping the overburden from above the identified target zone to a projected target depth of 90 to 100 cmbs. An area approximately 20 m north to south by 7 to 15 m east to west (approximately 212 to 218 m^2) was mechanically stripped from the lower T_{0a} surface. The area stripped encompassed BT 20 towards the north end of the stripped surface, whereas the southern edge was about 7 m north of BT 19 within a clump of trees between the stripped block and BT 19. The floor of the stripped surface was slightly irregular and sloped up to the north some 35 to 55 cm.

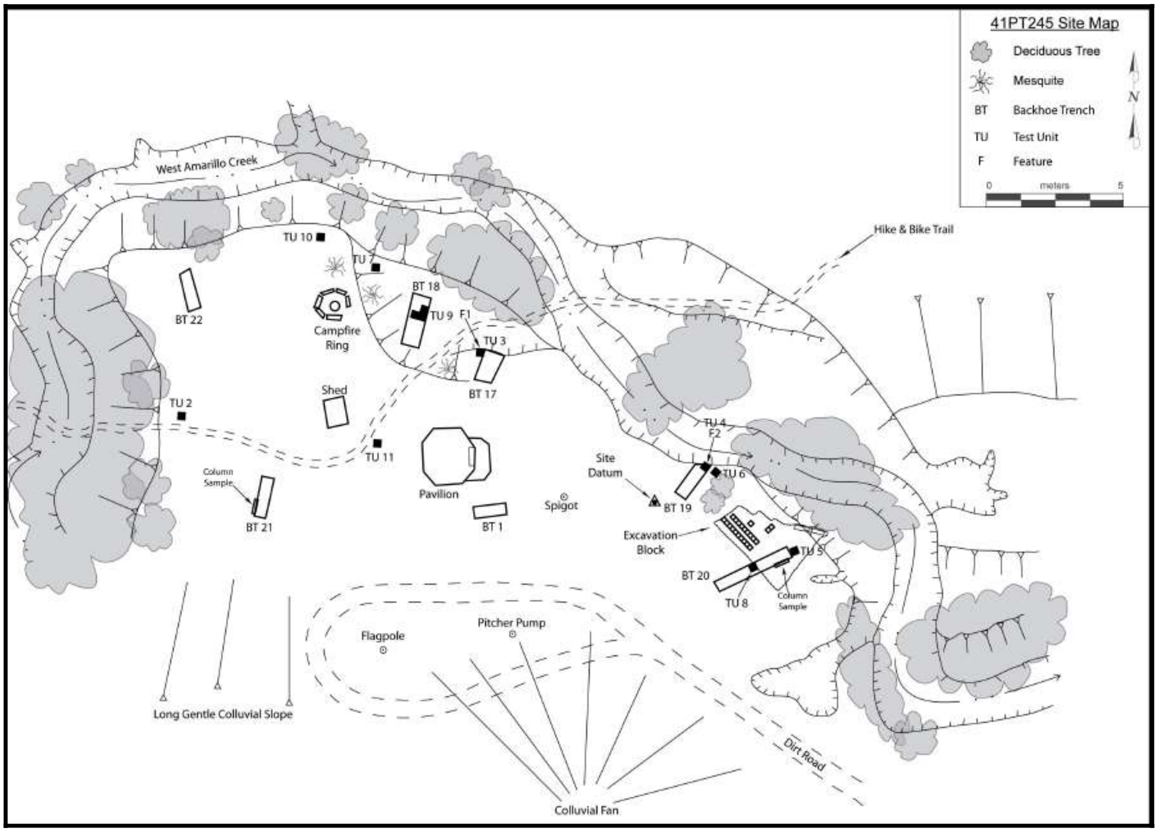

Figure 10-13. Overall Site Map of 41PT245, the Pavilion Site.

The southern end approached the target depth of 90 to 100 cmbs, whereas the northern end was closer to 35 cmbs. Our stripping did not go deep enough at the northern end. Consequently, a 7 m long backhoe trench was dug deeper from the floor of the stripped surface along the very northwestern edge of the block to determine if the targeted occupation zone was detectable below the stripped surface. This trench was dug at the same time the hand excavations began at the southeastern corner where the stripped surface had reached the targeted depth.

Within the stripped block, a 1 by 1 m grid system was established. An intense and diverse geophysical investigation that included use of a flux gradiometer, a conductivity meter, a magnetic susceptibility meter, and ground penetrating radar (GPR), was conducted across 210 m^2 of the stripped surface. We anticipated identifying a number of electronic anomalies that could be targeted through subsequent hand excavations. A number of anomalies were detected and the geophysical specialist marked those locations across the block prior to the beginning of the hand excavations.

The hand excavations began in the southeastern corner in two parallel, north to south rows of units with a 1 m wide separation between the two rows. As excavations expanded, two specific anomalies, #1 and #6, were targeted by hand units. The hand excavations, roughly from 100 to 140 cmbs, went through the projected target zone. Selected units were hand excavated to 150 cmbs. The excavated sediments, a silty clay loam deposit, were screened.

10.7.1 2008 Phase II Data Recovery Results

The geophysical specialist identified seven anomalies (numbered #1 through #7) across the electronically scanned 180 m^2 area (Figure 10-14). The identified electronic signals were not reflective of specific types of anomalies, with one exception. Backhoe trench 20 was electronically identified crossing diagonally across the northern end of the stripped block, but did not reveal a particularly unique or well defined signal. The vertical trench walls were not well defined by the signals. All seven geophysically identified anomalies were south of BT 20 and in a zone that ran diagonally across the block, southeast northwest. Hand excavations within the grid system focused on five (71 percent) of the seven most southerly anomalies. No cultural features were identified within the excavated depths at any of the marked positions of the electrically identified anomalies. Currently, it is not clear what caused the identified signals at the marked anomalies. It is possible that some cultural phenomenon may still lay much deeper or off to one side than what our hand excavations revealed. Anomaly #7 was left unexcavated, as this location generally coincided to a pedestal supporting a bone that was left in place during the stripping process.

A total of 22 hand excavated 1 by 1 m units that encompassed 90, 10 cm levels was completed (Figure 10-15). These units were excavated through the depth of the target zone in the southeastern corner of the stripped block. These hand excavations yielded very few cultural items and lacked any sign of a cultural feature. The new trench at the northwestern corner of the block revealed a single bison metapodial in the east wall of this 7 m long trench. Following these limited results, a decision was made to stop excavations at this block and move to one of the other selected blocks. The sparse recovery included a single piece of lithic debitage, 41 mostly

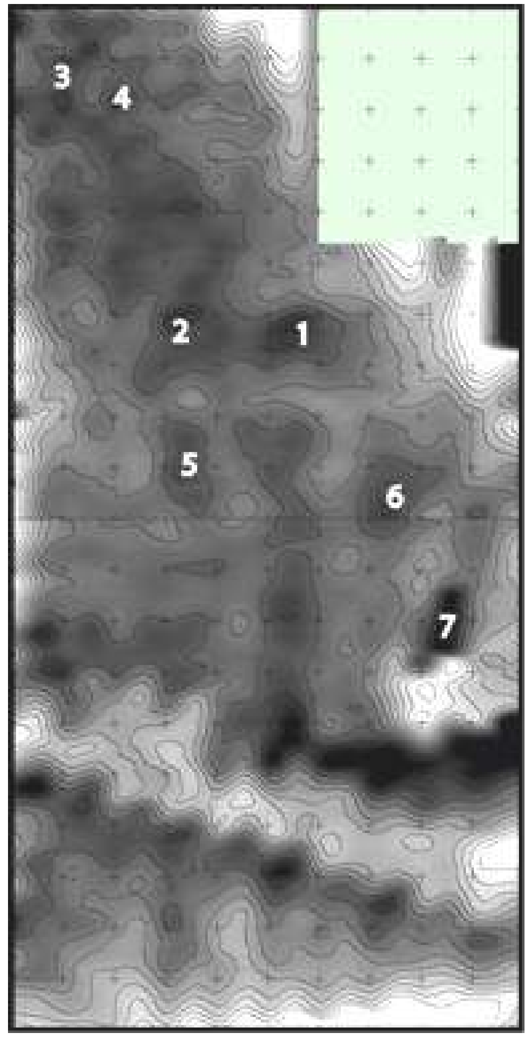

Figure 10-14. The Pavilion Site, 41PT245 Geophysical Results Identifying the Location of Seven Identified Anomalies. (Note: south is at the top of the picture)

tiny bone fragments that weigh 438.2 g, and eight tiny pieces (less than 4 cm in diameter)of burned rock. Thirty one, or 76 percent, of the bone pieces were less than 3 cm long. Only 10 of the 43 pieces were identified as representing bison (three long bone fragments, four pieces of ribs, two scapula fragments, and one sesamoid; weight = 370.7 g (Table 10-9). Most

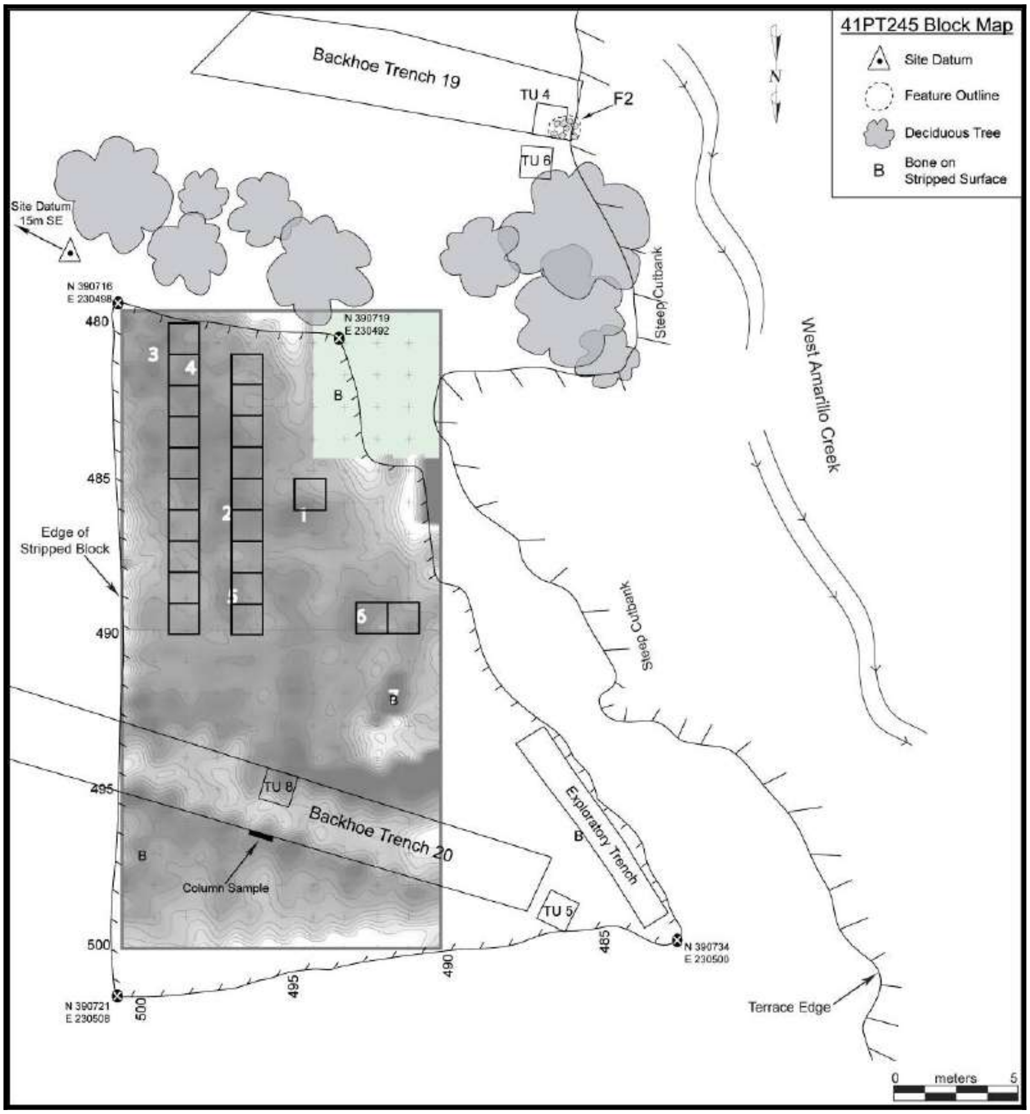

Figure 10-15. Excavation Block and Hand Excavated Units that Overlay Geophysical Map.
(Note: south is at top of map)

Table 10-9. Bison Bone Data from Excavation Block at Pavilion Site.

Unit	Depth (cmbs)	Catalog No.	Bison Element/Part	Weight (g)	Burned	Cut Marks	Surface Conditions
N496 E500	110	451-002-1	59 scapula fragments	42.1	No	No	root etched, calcium carbonate
N482 E493	80	452-002-1	43 scapula fragments, right	222.4	No	No	root etched,
N498 E492	70-80	446-002-1	25 rib shaft fragments	6.3	No	No	root etched,
N484 E496	130-140	429-002-1	8 rib head and shaft	28	No	No	root etched,
N486 E494	80-90	435-002-1	15 rib shaft fragments	10.3	No	No	mostly intact
N484 E498	100-110	431-002-1	1 sesamoid	8.1	No	No	complete

identifiable elements were represented by multiple fragments of that one element. With the lack of other taxon identified it is assumed that the other fragments may also represent bison, even though positive identification was not possible.

One long bone fragment (#433-002) from 110 cmbs in N485 E498 was a bone flake that exhibits a cone of percussion (Figure 10-16), indicating that the shaft had been intentionally impacted to break it open. One

Figure 10-16. Bison Bone Flake with Cone of Impact on Left Side.

rib head (#450-002) from the stripped surface at N492 E491 exhibits a cluster of some 20 very thin lines that are stone tool cut marks (Figures 10-17 and 10-18). These

Figure 10-17. Rib Head (#450-002) Showing Cluster of Thin Cut Lines from Sharp Stone Tool.

fine cut marks indicate that the tendons that attached the proximal rib to the vertebrae were cut to allow detachment of the rib from the vertebral column. A few of the long bone fragments exhibit spiral fractures indicating green bone breakage. The cut marks, impact fractures, and green bone breaks indicate that humans had butchered these bones and they were part of a cultural occupation. This meager bone assemblage indicates that a minimum of one male bison is represented.

Only eight burned rocks, weighing 215 g, were recovered and all were from N483 E496. They are small (less than 4 cm in diameter) chunks of dolomite. This was not a unit that contained a geophysical anomaly. These burned rocks were probably too small to have created an electronic signal.

The lack of significant numbers of cultural items from the first 22 m^2 of excavation, along with an absence of cultural items in the new trench at the opposite end of the stripped block lead to a decision to halt excavation of this block. Given that the block encompassed most of the remaining lower terrace along the very western and eroded edge of this lower terrace remnant, there was no option to expand or move the block. Therefore, this block was abandoned and work was redirected to the other two remaining blocks.

The research issues identified for the period of ca. 1200 to 1400 B.P., the Palo Duro and/or Woodland period or as some refer to the Late Prehistoric I period, are addressed below to the extent possible with the very limited data available. These data come from BTs 19 and 20, TUs 4, 5, 6, and 8, and the 22 units in the block excavation.

10.7.2 Chronology and Cultural Affiliation Issues

The one age of 1390 ± 40 B.P. from charcoal rich sediment in the hearth, Feature 2 combined with one assayed age on bison bone of 1210 ± 40 B.P., provides the absolute age range for this component that brackets some 200 years (Table 10-10). The age range encompasses two defined cultural patterns, the Palo Duro complex and the

Figure 10-18. Rib Shaft (#250-002) Exhibiting a Cluster of Thin Stone Tool Cut Lines and Root Etched Surface.

Woodland complex. However, given the dearth of diagnostic materials such as projectile points and an adequate sample of ceramics, it is impossible to define the cultural affiliation of the occupants in this area of the site during this time interval. The radiocarbon ages place occupation(s) around the middle range of the two named cultural manifestations and clearly prior to the later Plains Village complex that dates to after approximately 750 B.P.

In Boyd's synthesis of the region, the Lake Creek complex of the Plains Woodland tradition and the Palo Duro complex overlap in space and time in Potter County. Boyd (1995, 1997, and 2004) suggests that the more southern orientated Palo Duro complex had ties with Jornada Mogollon

Table 10-10. Radiocarbon Data from the Pavilion Site.

Provenience	Catalog No.	Feature No.	Depth (cmbs)	Material Dated *	Weight of Material (g)	Beta Lab No.	Measured Age	13C/12C Ratio (‰)	Conventional Age (B.P.)	2 Sigma Calibration Age
PT245, TU 5	357-002-1		98-103	1 bison bone	0.8	237025	101.6 ± 0.5	-7.5	160 ± 40	Cal AD 1660 to 1960
PT245, TU 9	400-007	4/5	170-180	1 charcoal	1	238318	430 ± 40	-24.7	430 ± 40	Cal AD 1420 to 1500
PT245, TU 2	FS 36.2		30-40	1 bone fragment		138512	300 ± 40	-10.3	540 ± 40	Cal AD 1310 to 1435
PT245, BT 20	417-002-1		180	1 bison bone		237022	970 ± 40	-10.2	1210 ± 40	Cal AD 690 to 900
PT245, TU 4	353-007	2	125-127	charcoal laidened sediment Ab	0.1	237026	1310 ± 40	-19.9	1390 ± 40	Cal AD 600 to 680
PT245, BT 20	417-004-2		240	sediment Ab	0.1	237023	1750 ± 40	-19.7	1840 ± 40	Cal AD 80 to 250
PT245, BT 21	418-004-2b		145-148	2Bk sediment	650	238320	10560 ± 40	-23.1	10590 ± 40	Cal 10840 to 10450 BC
PT245, BT 21	418-004-1		271-274	buried A sediment	467	238319	10770 ± 50	-19.9	10850 ± 50	Cal 10960 to 10610 BC

that extended northward up to the Canadian River in the Amarillo area.

The Lake Creek complex with linkages to the north and east, extended southward to near the headwaters of the Brazos River close to Plainview, Texas. Thus, it is probable that these two distinct, but contemporaneous archeological complexes overlapped within our study area. Nothing in our limited data base permits us to identify which of the complexes is represented at the Pavilion site. The Palo Duro complex is known to include campsites, base camps, rock shelters, and burials from the Canadian River southward. The Lake Creek complex is known mostly from open campsites distributed along the Canadian River and from there to the north and east. At this time, pottery is one of the key diagnostics of each of these two archeological assemblages. Palo Duro complex sites generally yield plain brownware pottery linked to the Jornada Mogollon tradition. The Woodland sites yield pottery bearing cordmarked exteriors. The complete lack of pottery from our block investigations of this time period has prevented assignment of this component to one of these two complexes. Both complexes may have had structures, but the Palo Duro complex sites exhibit pithouses, storage pits, backing hearths, etc. compared to less known wattle-and-daub surface structures presumed for the Woodland complex. Both complexes contain a variety of small corner-notched arrow point forms with assigned names such as Deadman's, Scallorn, and unnamed forms. The Woodland complex is currently poorly understood, and has few professionally excavated and radiocarbon dated sites with good context from the Texas Panhandle. The targeted area at 41PT245 cannot be linked with either the Palo Duro or the Woodland manifestations, due to the lack of diagnostic materials. We can assert, however, that the site was occupied at the time both of these cultural expressions were extant in the region, on the basis of our radiocarbon data.

10.7.3 Subsistence and Resource Variability Issues

Bones from at least two bison, one male and one female, and possibly one unidentified canid are identified in the faunal assemblage from this component, radiocarbon dated to 1200 to 1400 B.P. Bison are known to have been a prominent food resource for various Woodland complexes, but bison are poorly represented in the Palo Duro complex, where deer were the more significant animal food (Boyd 1995, 2004). Although one fragmented deer antler was recovered from BT 19, it had been shed, and thus could have been collected and used as a tool. The presence of this antler is not necessarily indicative of the occupants eating deer meat. Although the data are admittedly limited, they may support the tentative inference that the subsistence practices represented at this targeted component resemble those of the Woodland tradition more than they do those of the Palo Duro Complex.

Starch grain analysis on three burned rocks from hearth Feature 2 documented that grass seeds, specifically wildrye (*Elymus* sp.) were present. Moreover, the starch grains were gelatinized, indicating that water and heat were involved in their cooking. The lipid residue analysis on those same three burned rocks from hearth Feature 2 yielded results that are interpreted to reflect the cooking of mostly large herbivore meat and possibly plants. Thus, it appears that the food resources used by the site's occupants included large herbivore meat (i.e., bison), and wildrye grass seeds. These two technical analyses yielded no other indications of other food resources. The Pooid grass phytoliths observed on a burned rock during the starch grain analysis are believed to represent the natural background within the sediments at the site.

Based on one very young bison mandible from next to hearth Feature 2, the season of one of the occupations was early fall, as the dentition in the mandible represents a roughly 4 to 5 month old calf. The wildrye grass seeds may be considered an indication of this season, as well, since they ripen in the fall. On the other hand, since these seeds could have been stored, they do not necessarily represent the actual period of use. The identification of bison bones and wildrye grasses does indicate that the occupants of this targeted block were both hunters and gatherers. Both food resources were undoubtedly procured from within or near this valley.

10.7.4 Settlement and Community Pattern Issues

Both named complexes have yielded structures at other site localities, but the lack of structures here does not help to define cultural affiliation of this component. That is not to say that structures were not present here at one time, as they may have been removed by erosion, as much of this component has been. The Palo Duro populations are considered to have been semisedentary peoples who maintained some degree of residential mobility (Boyd 1995, 2004). Woodland populations also were residentially mobile. Therefore, the lack of structures is not surprising for either complex. The only feature identified in our excavation was a small, partially eroded burned rock cooking hearth. This type of feature is quite common in the region and through time, but possibly more common in Woodland sites than in Palo Duro sites. The specific setting of this component, a wooded and grass covered valley bottom with a small spring fed stream, may have been an ideal camping locality for people of either complex. The association of bison rib fragments and mandibles next to Feature 2 probably reflect bison butchering and cooking. It is not clear if these cultural items were in primary use context or if this represented a discard area. Generally, adult males are thought to have hunted and killed the meat, which alludes to the presence of adult males. Females and young children are generally tasked with gathering and preparing plant foods, and thus females were likely present as well. This activity around this one hearth most likely reflects the remains of a small hunting-and-gathering group composed of adult males and females and their children.

10.7.5 Exchange and Regional Interaction Patterns

The very meager lithic assemblage recovered reflects only the use of local Tecovas and Alibates tool stone resources. Both resources outcrop within a days' walk of here, so whatever archeological complex is represented, local stone was employed for the manufacture of at least some tools. The data indicates the use of the local area and its available resources. Of course, the lack of evidence for use of nonlocal resources may be more of a result of sample limitations than an absence of trade on the part of the site's prehistoric occupants.

10.7.6 Component Function/Intrasite Patterning Issues

Multiple test units were scattered across at least two major terraces of this broad site. The lowest terrace (T_{0a}), dissected into multiple small land forms, revealed evidence of sparse, but numerous and varied activities. The lower T_{0a} surface explored through BT 18 revealed small camping activities, undoubtedly multiple events, over the last few hundred years. The discarded and scattered burned rocks designated as Feature 4/5 may represent one relatively early Protohistoric event, whereas the few ceramic sherds near the surface in TU 7 may represent a more recent Protohistoric event. The presence of a redware sherd indicates some access to nonlocal pottery. The group responsible for that vessel and camping event may have been by a nonlocal group on the move during a time of high mobility when diverse Protohistoric groups moved through the area.

Just to the north of this low terrace and along the margin of the T_{0b} surface was a separate cultural component. Based on slight elevation differences in bison bone fragments in BTs 19 and 20, at least two closely spaced cultural surfaces were represented within this component. Each occupation can be assumed to represent the activities of a different group of people. However, highly fragmented bison bones associated with very limited lithic debitage and burned rocks were observed from each event. The only difference is the presence of the one burned rock hearth Feature 2 in the upper one. It appears that very similar tasks/activities were conducted at least two separate times during the relatively short period of a few hundred years. Although minimal evidence is represented here, the activities were focused upon killing and processing at least two bison and colleting grass seeds. It is not clear if the targeted block area was the margin of some more intensive processing area or just a very short term processing area where the short duration of the occupation did not allow for accumulation of quantities of cultural debris. The lack of stone tool resharpening flakes, and tools, plus a scarcity of debitage, indicates that the investigated locus may have been marginal to a butchering/processing area, rather than the primary focal point of activity.

10.7.7 Technological Issues

Only a few issues concerning technology can be addressed. The lack of any formal stone tools from the Pavilion site precludes discussion concerning the manufacture, use, and discard patterns of tools. The recovery of burned and fractured rocks in and around hearth Feature 2 demonstrates that the use of hot rocks was a technology used in food preparation (see Ellis 1997; Thoms 2008a, 2008b for discussions on hot rock cooking in general). The process involves collecting natural rocks, heating the rocks in an open fire, then placing the heated rocks in a container of water with the foods to be cooked. This does not rule out the possibility that ceramic vessels were used as well, but no ceramic sherds were recovered from the 1200 to 1400 B.P. activity area. Because gelatinized starch grains were detected on at least one burned rock from Feature 2, the cooking process is interpreted to indicate boiling with hot rocks. This was a common practice in most preindustrial cultures. It is not currently well represented in the Palo Duro complex, which may hint that the people that created this hearth were not affiliated with that complex.

The butchering technology directed towards the bison represented at the site is minimally reflected in the fragmented bison bones. The presence of diverse elements of the bison skeleton, which include a few metapodials, scapula fragments, sections of long bones, isolated teeth, thoracic vertebrae and spine processes, a second phalanx, and ribs, indicate that most, if not all, of the bison carcass was bought to this location for butchering and processing. The absence of any significant portion of the skeletal structure would imply that the bison(s) was/were killed some distance away and only selected parts brought to the site. The legs and ribs were undoubtedly disarticulated from other parts and the meat was stripped from these elements. Thin cut lines along at least one rib head and shaft indicate that sharp stone tools were used to deflesh the bones by cutting the meat and tendons away, possibly allowing for the disarticulation of the rib cage from the vertical column. The two thin cut lines on the back of the young bison mandible indicate that this element was separated from the tongue. With at least one complete metatarsal it does not appear that marrow was extracted from all the elements that yield this desired food. This element lacks meat, but does contain bone marrow and some bone grease. Once the meat was stripped from the bones it appears some bone scraps were discarded and/or burned. This is indicated by the presence of at least six small fragments burned to a black state. It is not clear if this was intentional burning.

11.0 SUMMARY

J. Michael Quigg

11.1 SUMMARY OF INVESTIGATIONS

Cultural resource investigations were necessitated by the transfer of nearly a one half section of federal property to the public. This 1.6 km long parcel is in the upper reaches of West Amarillo Creek, just west of Amarillo. The BLM was the federal agency responsible for oversight and direction of this investigation and the completion of the cultural resource work, with the data recovery facilitated through an open bid competition. The compliance process included a step wise approach that consisted of; 1) a surface survey (Haecker 1999), 2) site evaluations (Haecker 2000), and 3) a two phased (I and II) data recovery investigation, which incorporated geoarcheological efforts across the Landis Property (Quigg et al. 2008). The two phased data recovery investigations enabled the focus of time, effort, and money towards the most significant and informative locations within the broader archeological sites. Large horizontal block excavations implemented during Phase II yielded significant, but relatively sparse, cultural materials from two specific time periods. The earliest cultural occupations dated to a ca. 1000 year (ca. 1550 to 2550 B.P.) period during the Late Archaic and a single occupation at ca. 250 B.P. during the Protohistoric period. Excavation findings provide significant contributions to furthering the understanding of the local and regional prehistory for these two specific time periods. Both periods are currently poorly represented in the regional archeological literature, so these efforts greatly expanded the understanding of human activities and behaviors during these periods.

11.2 SUMMARY OF PHASE I DATA RECOVERY INVESTIGATIONS

Phase I data recovery investigations were conducted during the fall of 2007 by archeologists from TRC's Albuquerque and Austin offices, with work on three known prehistoric sites, 41PT185, 41PT186, and 41PT245, on the Landis Property. These archeological efforts were conducted in conjunction with geoarcheological investigations that focused on identifying the alluvial deposits across the alluvial landforms in the Landis Property. The geoarcheological work involved the mechanical excavation of 47 backhoe trenches, totaling 410 linear meters, across the valley within the project area. This consisted of 24 trenches (262 m) into the three known archeological sites. These subsurface windows into the alluvial deposits provided a means of identifying and interpreting the depositional history across the Landis Property. This property wide investigation documented a complex Holocene alluvial history in West Amarillo Creek Valley, which contains scattered cultural occupations that occurred intermittently over time. The geoarcheologist identified six Holocene alluvial units (labeled A through F) in deposits that were as much as 6 m thick. A suite of 51 radiocarbon dates (Table 11-1) from various depositional units and cultural occupations established the general timing of each depositional unit, and specific timing of archeological occupation encased in those deposits. Alluvial deposits between ca. 8200 and 4200 B.P. are missing from the depositional record in this part of the valley. Therefore, cultural materials relating to this ca. 4,000 year long period during the middle Holocene were not encountered within this specific section of the valley. At the sites investigated, no cultural materials older than 3000 B.P. were identified. The geoarcheological information has contributed significantly to the understanding of the age, context, and integrity of the archeological occupations it has also

Table 11-1. All Radiocarbon Dates and Data from the Landis Property, West Amarillo Creek in Potter County, Texas.

Provenience	Catalog #	Feature No.	Depth (cmbs)	Material Dated *	Weight of Material (g)	Beta Lab No.	Measured Age	13C/12C Ratio (‰)	Conventional Age (B.P.)	2 Sigma Calibration Age
PT186, TU 1	FS 24.1		47	charcoal chunks		135418	80 ± 40	-14.7	80 ± 40	Cal AD 1680 to 1955
PT245, TU 5	357-002-1		98-103	1 bison bone	0.8	237025	101.6 ± 0.5	-7.5	160 ± 40	Cal AD 1660 to 1960
PT186, TU 3	261-002-1		118	1 immature bison radius	5	238317	100.8 0.5	-7.8	210 ± 40	Cal AD 1640 to 1950
PT186, BT 5-1	340-007-1	1	99	1 charcoal	0.1	235482	220 ± 40	-24.5	230 ± 40	Cal AD 1540 to 1950
PT186, 488/489	FS 643	8	75	1 charcoal	0.1	250879	370 ± 40	-29.6	290 ± 40	Cal AD 1480 to 1660
PT186, TU 1	FS 71.1		40	1 bison bone frag		138513	100 ± 40	-10.0	340 ± 40	Cal AD 1450 to 1620
PT245, TU 9	400-007	4/5	170-180	1 charcoal	1	238318	430 ± 40	-24.7	430 ± 40	Cal AD 1420 to 1500
PT245, TU 2	FS 36.2		30-40	1 bone fragment		138512	300 ± 40	-10.3	540 ± 40	Cal AD 1310 to 1435
PT186, BT 9-1	343-002-1		110-115	1 bison vertebrae		237020	350 ± 40	-9.9	600 ± 40	Cal AD 1290 to 1420
PT185/C, BT 36	BT 36-M-4		282	charcoal	0.1	239652	750 ± 40	-25.1	750 ± 40	Cal AD 1220 to 1290
PT185/C, BT 36	BT 36-M-5		265-268	charcoal	0.1	239653	860 ± 40	-25.3	860 ± 40	Cal AD 1040 to 1260
PT245, BT 20	417-002-1		180	1 bison bone		237022	970 ± 40	-10.2	1210 ± 40	Cal AD 690 to 900
PT185/C, BT 36	263-86		178-186	7 shells, *Gyraulios parvus*	0.1	261753	820 ± 40	-5.1	1150 ± 40	Cal AD 780 to 80
PT185/C, BT 36	263--91		225-235	6 shells, *Planorbella* sp.	0.3	261754	890 ± 40	-8.0	1170 ± 40	Cal AD 770 to 980
PT185/C, BT 36	263-004-109		185	2Bk sediment	300.0	255835	1320 ± 40	-20.6	1390 ± 40	Cal AD 600 to 680
PT245, TU 4	353-007	2	125-127	charcoal laidened sediment Ab	0.1	237026	1310 ± 40	-19.9	1390 ± 40	Cal AD 600 to 680
PT185/C, BT 36	BT 36-M-3		334-336	clay sediment	43.0	239651	1320 ± 40	-18.5	1430 ± 40	Cal AD 560 to 660
PT185/C, 119/103	1174- A	15	47	1 bison bone frag	27.0	257845	1290 ± 40	-8.5	1560 ± 40	Cal AD 410 to 590
PT185/C, 115/96	914-2-1a		70-80	1 distal bison radius	14.0	264922	1310 ± 40	-8.9	1570 ± 40	Cal AD 410 to 580
PT185/C, 104/105	FS XX	8	41-50	1 charcoal	0.1	250877	1590 ± 40	-22.4	1630 ± 40	Cal AD 340 to 540
PT185/C, 118/103	FS 1322	15	38	1 proximal bison radius	27.0	253240	1500 ± 40	-10.3	1740 ± 40	Cal AD 220 to 400
PT245, BT 20	417-004-2		240	sediment Ab	0.1	237023	1750 ± 40	-19.7	1840 ± 40	Cal AD 80 to 250
PT185/C, BT 36	BT 36-M-1		485-490	3Cg Clay sediment		241070	1930 ± 40	-27.3	1890 ± 40	Cal AD 30 to 230
PT187, TU 2	FS 43.2		0-5	mussel shell frag		135419	1620 ± 30	-6.5	1920 ± 30	Cal AD 30 to 135
PT185/C, 120/100	1224-2-1a		52	1 bison distal radius	10.8	264925	1750 ± 40	-9.0	2010 ± 40	Cal 100 BC to AD 70
PT186, BT 9-1	343-004-2a	2	125	sediment	0.1	235485	1940 ± 40	-19.2	2040 ± 40	Cal 170 BC to AD 50
PT185/A, TU 1	FS 16.1 or 19.5	1	10	1 bison bone frag		135417	1890 ± 40	-10.1	2130 ± 40	Cal 350 to 50 BC
PT186, BT 9-2	343-004-2b		205	sediment Ab	0.1	235486	2160 ± 40	-25.5	2150 ± 40	Cal 360 to 280 BC
BT 1-3, Zone 25	1-004-1a		310-315	buried A sediment	492	238307	2110 ± 40	-20.8	2180 ± 40	Cal 370 to 110 BC
PT185/C, 120/108	1247-2-1a		40-50	1 proximal metacarpal	15.5	264924	2020 ± 40	-11.4	2240 ± 40	Cal 390 to 200 BC
BT 40, Zone 6	10-004-1		210-215	buried A sediment	394	238310	2200 ± 40	-22.0	2250 ± 40	Cal 400 to 200 BC
PT185/C, 104/115	493-002-1	9d	41	bison long bone frag.	33	255837	2010 ± 40	-10.3	2250 ± 40	Cal 400 to 200 BC
PT185/C, BT 35-1	262-002-1		60	1 bison metapodial		237024	2000 ± 40	-8.7	2270 ± 40	Cal 400 to 340 BC
PT185/C, 100/104	279-002-1a		40-50	bison long bone frag	11.9	255836	2020 ± 40	-7.5	2310 ± 40	Cal 410 to 360 BC
PT185/C, TU 22	210-002-1		70-80	1 bison metacarpal	13	238315	2130 ± 40	-10.9	2360 ± 40	Cal 520 to 380 BC
PT185/C, TU 26	236-002-1		97-102	1 bison radius	15	238316	2160 ± 40	-9.2	2420 ± 40	Cal 750 to 400 BC
PT186, TU 6	302-007		180	1 charcoal in buried A	0.1	237021	NA	NA	2490 ± 40	Cal 780 to 410 BC
PT185/C, 117/95	1027-2-1a	17	95	1 bison skull + horn core	37.3	264923	2250 ± 40	-8.9	2510 ± 40	Cal 790 to 510 BC
PT185/C, 112/104	FS 1049		92	distal bison radius	52.0	253239	2270 ± 40	-8.8	2540 ± 40	Cal 800 to 720 BC
PT185/A, BT 27	266-002-1a		68	1 bison bone	23	238312	2450 ± 40	-13.7	2640 ± 40	Cal 840 to 780 BC
PT185/A, TU 15	157-002		75	1 bison distal tibia	11	238314	2450 ± 40	-8.8	2720 ± 40	Cal 930 to 800 BC
PT185/C, BT 36	263-97b		385-395	4 tiny bivalves	0.1	261755	2240 ± 40	-6.8	2540 ± 40	Cal 800-540 BC
PT185/C, 104/101	FS 630		76	1 charcoal	0.3	250878	2850 ± 40	-23.0	2850 ± 40	Cal 1120 to 910 BC
PT185/A, BT 27	266-002-1b		145	1 bison navicular	14	238313	2700 ± 40	-10.6	2940 ± 40	Cal 1280 to 1010 BC
BT 40, Zone 14	10-004-2		445-448	5AC sediment -mud	472	238311	4290 ± 40	-22.4	4330 ± 40	Cal 3020 to 2890 BC
PT185/C, BT 36	"N"		510	sediment	470	253238	4400 ± 40	-23.1	4330 ± 40	Cal 2920 to 3330 BC
PT186, BT 6-1	341-004-1a		136-139	2Ab? sediment	0.1	235483	8240 ± 50	-22.7	8280 ± 50	Cal 7480 to 7170 BC
PT186, BT 6-2	341-004-2		264-268	3Bk sediment	0.1	235484	9560 ± 50	-22.0	9610 ± 50	Cal 9230 to 8800 BC
PT245, BT 21	418-004-2b		145-148	2Bk sediment	650	238320	10560 ± 40	-23.1	10590 ± 40	Cal 10840 to 10450 BC
BT 11, Zone 26	5-004-1a		153-158	buried A sediment	450	238309	10590 ± 70	-16.2	10730 ± 70	Cal 10920 to 10700 BC
PT245, BT 21	418-004-1		271-274	buried A sediment	467	238319	10770 ± 50	-19.9	10850 ± 50	Cal 10960 to 10610 BC

* bone dates were on collagen

contributed to the regional depositional history in the broader Texas Panhandle.

The Phase I archeological effort included hand excavation and screening of 46.9 m^3 from forty ne 1 by 1 m test units across four localities in sites 41PT185 (Loci A, B, and C), 41PT186, and 41PT245. At site 41PT185, Locus A, seven backhoe trenches totaling 70 linear meters combined with 11 test units totaling 11.6 m^3 were completed. The average density was 42.3 artifacts/m^2. At Locus B, two trenches, totaling 14.5 linear meters long, were completed, but no hand excavations were undertaken. At Locus C, four trenches, totaling 52 linear meters, combined with 13 test units totaling 13.5 m^3 were employed. The average artifact density was 21.9 artifacts/m^2. At 41PT186, five trenches totaling 64 linear meters and eight test units encompassing 10.8 m^3 were excavated. During Phase I this site yielded 1,011 artifacts from the hand excavations for an average density of 93.5 artifacts/m^2. At 41PT245, the Pavilion site, six trenches totaling 62 linear meters and nine test units that encompassed 11.0 m^3 were excavated across multiple terraces. Limited cultural materials were recovered (29.3 artifacts/m^2) during Phase I.

That goal of Phase I was to identify specific locations, within the three archeological sites, that contained the greatest potential to yield significant cultural information to address the stated research questions and address broader issues proposed in the Treatment Plan for the three sites (Quigg 2005). The information necessary to locate and broadly assess archeological sites 41PT185 (including Loci A, B and C), 41PT186 and 41PT245 was derived from the combined results of the mechanically created subsurface windows into Holocene alluvial deposits, the artifacts and their contexts recovered during hand excavations, subsequent data analyses, and the suite of geoarcheological data recovered. All these contributed to the information concerning age of the deposits, context of materials, and component clarity. These results accomplished the stated goals of the Phase I data recovery program.

The combined and integrated archeological and geoarcheological field efforts documented complex natural stratigraphy across the broad site areas. The archeological assessment/testing allowed identification of multiple cultural occupations, both in stratified and nonstratified contexts. The Phase I investigations identified multiple components at each locality with horizontal and vertical differences, and discrete cultural components isolated in certain parts of each site. These efforts determined that different areas within each site contained various quantities of cultural materials in different contexts, and with varying degrees of integrity. Within each investigated site, specific areas were determined to have low potential to contribute significant information to the archeological record. This was because of one or more characteristics that included minimally poor context and integrity, or very limited cultural remains. In contrast, limited areas within each site yielded high potential areas with reasonably good context that had the potential to contribute significant information to the available knowledge concerning defined cultural periods. These periods have historically not been well represented or documented by archeological efforts across the Texas Panhandle.

Bison bones were the most frequent cultural material recovered from these sites (N = 1,165) (Table 11-2). The presence of bison bones in many of the excavation units indicates that bone preservation was relatively good in these sites. An estimated one dozen nonbison elements, including deer, turtle, and dog were recognized. Bison bones were radiocarbon dated from ca. 3000 to 220 B.P. All components targeted for Phase II data recovery yielded bison bones and potentially, considerable quantities of these bones were anticipated. The presence of bones would allow for subsistence practices to be identified. The seasonal use of occupation sites may be individuals were preserved and recoverable. Butchering practices and food production activities (bone marrow and bone grease extraction) might also be detected.

Table 11-2. Summary of Phase I Artifact Recovery During Phase I Excavations at the Investigated Sites on Landis Property.

Artifact Totals for Sites/Localities Investigated					
Artifact Class	Site & Locality				
	41PT185		41PT186	41PT245	Total
	Locus A	Locus C			
Arrow Points		1			**1**
Dart Points	1	2			**3**
Bifaces	2	2	4		**8**
Unifaces			1		**1**
Scrapers				1	**1**
Edge-modified Flakes	6	5	11	2	**24**
Ground Stone Tools	4		10		**14**
Misc. Lithic Tools				1	**1**
Cores	2				**2**
Tested Cobbles	1				**1**
Lithic Debitage	235	95	170	46	**546**
Ceramics			2	15	**17**
Bones	103	114	784	164	**1,165**
Total Features	2	2	1	1	**6**
Burned Rock Clusters		1			**1**
Hearths	1	1		1	**3**
Ash Dumps			1		**1**
Other	1				**1**
Burned Rocks	130	71	27	60	**288**
Charcoal Samples	4		2	31	**37**
Mussel Shell					**0**
Total Assemblage	**491**	**295**	**1,011**	**322**	**2,119**
Area Investigated (m2)	**11.6**	**13.5**	**10.8**	**11.0**	**46.9**
Average Density of Artifacts	**42.3**	**21.9**	**93.5**	**29.3**	**45.2**

Lithic debitage was the second most frequent (*N* = 546) class of material recovered. This class reflects the production and reworking of chipped stone tools. The majority of lithic debitage represents late stage tool production and resharpening, with almost no core reduction and very limited early stage biface reduction. This skewed representation may indicate that these investigated sites were relatively short term camps where animal processing and food preparation were the major activities and stone working revolved around tool maintenance activities. Nearly all lithic material types represent locally available Alibates, Tecovas jasper, plus quartzites and other coarse-grained materials. Nonlocal obsidian from northcentral New Mexico was present in very limited quantities at all three sites. Fifty six percent of the nine obsidian flakes was from the Late Archaic component at 41PT185/C. The remaining 44 percent was from mixed deposits with questionable age associations, with 34 percent from 41PT186 and another 11 percent from 41PT245. The visible identifications of different types of lithic materials, combined with knowledge of their original source locations, provide information to address the movements and/or exchange/trade patterns of the populations represented. The lithic debitage also allows one to address stone tool technologies and contributes to understanding site function.

The third most frequent class of recovered material was burned rocks (*N* = 288), which is relatively low in comparison to many other hunter-gatherer assemblages. Most burned rocks represents locally available stone, including quartzites, caliche, sandstones, and dolomite. Some pieces exhibited different breakage patterns, which may reflect various heating and/or cooling processes, such as stone boiling versus baking or broiling. It is assumed that most burned rocks were used in cooking. This assumption has been verified through starch grain analyses in which gelatinized starch grains were identified on nearly 30 percent of the analyzed burned rocks indicating cooking with heat and water. The low frequency of burned rocks may reflect the limited amount of cooking in the areas tested and/or the limited time spent at each site. However, four well defined burned rock features, one at 41PT245, one at 41PT185 Locus A, and two at 41PT185 Locus C, were encountered and represent cooking activities. The presence of features and the burned rocks will contribute to our understanding of various cooking technologies, help to establish site function, allow detailed analyses (through lipid residue and starch grain) to address subsistence issues, and help explore intrasite patterns and human behaviors as addressed in the treatment plan (Quigg 2005).

Formal and informal chipped stone tools (i.e., four projectile points, eight bifaces, one uniface/scraper, 24 edge-modified flakes) were quite sparse from the Phase I investigations. The relatively high frequency of bifaces supports the interpretation that animal processing was a major task conducted at these locations. Only one probable arrow point fragment and three Late Archaic dart point fragments were recognized. The projectile point styles represent Late Archaic and Late Prehistoric occupations. The occurrence of diagnostic projectile points allows for assignment of components to time periods and cultural patterns. The presence of tools permits identification of site activities and contributes to a broader understanding of the kinds of human behavior represented.

The ground stone tool sample was relatively abundant (*N* = 14), but this may be misleading. Most ground stone artifacts were in direct association with burned rocks and may be misidentified and/or were recycled as burned rocks. Nearly all ground stone pieces were from mixed contexts and cannot be assigned to specific time periods or assigned to a specific cultural component. However, their presence contributes to our understanding of food processing activities and potentially helps to identify the foods that were processed.

Other time diagnostic artifacts include ceramics. A total of 17 tiny ceramic sherds were recovered from 41PT186 and 41PT245. Most were recovered from mixed contexts on or near the surface. Although some sherds were identified as to a general ware (i.e., cordmarked, redware, etc.), most could not be assigned to a specific cultural group or complex based on visual inspection. These time sensitive artifacts are generally thought to represent different cultural groups over the last 1,500 years. Their recovery may contribute to help identify the foods processed, b) if determined to be of nonlocal origin, to help understand directional patterns of trade/exchange, and c) to aid in identifying which specific cultural groups are represented at these three sites.

Unfortunately, very little charcoal or other macrobotanical remains were recovered (*N* = 37). When organic material was recognized, specifically charcoal, it was collected and counted. All pieces are small fragments and limited in frequency, reflecting poor preservation. Although small, these pieces provided a few radiocarbon dates that have contributed to documenting the timing of cultural occupations and natural events. The limited recovery of macrobotanical remains indicates that definition of subsistence patterns at these sites will have to rely on other means.

The types and quantities of cultural materials recovered are biased by the investigative techniques employed. The excavation of small vertical sample units to explore broad areas of hunter-gatherer camps does not provide interpretable cultural assemblages, given that these small units only capture small samples of the projected broad, horizontal occupational surfaces. Our strategy was to vertically locate cultural occupations which contained good context and integrity. Therefore, we tried to avoid most areas with compressed stratigraphy in which palimpsest occupations would occur, with greater likelihood of mixed cultural materials representing more than a single occupation. These were avoided where possible in favor of locations with better context. The general low frequency of such locations is a reflection of the limited number of hand excavation units that targeted a discrete time frame and is viewed as quite normal for the investigation of hunter-gatherer camps. The recovered cultural assemblages are quite typical of relatively short term camps by mobile hunter-gatherers, who focused on hunting bison and food preparation at these camps during the last 3,000 years.

Through Phase I efforts, three specific areas/components within these three broader archeological sites exhibited moderate to high potential to yield important information to address specific research questions concerning human activities. These three areas have the potential to contribute to our understanding of the poorly investigated Texas Panhandle region during narrow time frames over the last 3,000 years. Furthermore, they warranted the implementation of intensive data recovery investigations through large continuous block excavations that target materials believed to represent very restricted time periods.

Three separate localized and high-potential areas were recommended for Phase II data recovery efforts, with hand excavations in large contiguous blocks at each locality encompassing total areas ranging between 370 and 430 m^2. All three target areas contain significant quantities of bison bone associated with evidence of camping activities in the forms of small intact thermal features, scattered lithic debitage, and occasional stone tools. It was also recommended that flexibility be built into the field effort (i.e., the numbers of square meters excavated) directed toward each target so that if one area stopped yielding important information and significant data returns, efforts might be shifted to the other target areas.

11.3 SUMMARY OF PHASE II DATA RECOVERY INVESTIGATIONS

Archeologists with BLM concurred with the recommendations as put forward in the Final Interim Report (Quigg et al. 2008). The recommendations called for geophysical investigations using multiple instruments across three mechanically stripped, specifically selected target areas, one at each site. The plan was to first remove the overburden from the selected target areas with a backhoe, and then conduct the geophysical investigations across each of the three stripped blocks before hand excavations. Following the geophysical investigations, hand excavations were to be conducted in continuous blocks to sample large horizontal areas across the targeted occupational surfaces to address human behaviors.

Subsequently, the BLM solicited proposals to conduct the recommended and approved Phase II data recovery program. TRC was awarded the contract in late summer of 2008 for this final step in the process of preserving the fragile and limited prehistoric record in this region. TRC performed the required Phase II step in the fall of 2008, with the majority of data analyses and report writing conducted through December 2009.

The Phase II investigations targeted three specific localities, one in each of the three sites. The target blocks included a relatively shallow Late Archaic component at Locus C at 41PT185 (41PT185/C) that was radiocarbon dated to ca. 2200 to 2400 B.P. A deeply buried and sealed Protohistoric component in a low alluvial terrace (T_{0a}) at 41PT186, radiocarbon dated to 210 and 230 B.P., was targeted The third target block, containing a 1200 to 1500 B.P. component at 41PT245 was unidentified as to a specific cultural affiliation. Each targeted locality appeared to have good to excellent context, and to contain a cultural assemblage that represents a distinct time period. Although each appeared to have excellent context, the cultural material remains proved to be relatively sparse in each case.

Phase II investigations were initiated at the specific target location at the northern end of 41PT245, just south of Bt 21. The target area was first mechanically stripped of sterile overburden from above the selected target zone at ca. 90 cmbs. That stripped surface was then investigated with multiple pieces of geophysical equipment in order to detect buried cultural features that might be targeted by hand excavations. Following the geophysical work, hand excavations within the block were initiated along the southeastern quadrant. The initial 22 units yielded extremely sparse cultural remains, no identifiable cultural features, and no diagnostic artifacts. Due to this low yield in cultural materials, a decision was made to terminate the efforts at this block. The remaining field effort recommended for this block was redirected to the two other target blocks on sites 41PT185/C and 41PT186. Site 41PT186 thus received more effort than was originally recommended. Table 11-3 summarizes the data recovered across 41PT245.

At 41PT185/C, the Pipeline site, the target area was also mechanically stripped of overburden from above the target zone near 90 cmbs. The stripped surface ended up at variable depths as during the stripping process, quantities of burned rocks were encountered at higher elevations across much of the western side. The stripped surface was then investigated with multiple pieces of geophysical equipment to potentially detect buried cultural features. In attempting to follow the detected burned rock concentrations across the northwestern corner, the western and northern sides of the initial block were expanded partway through the hand investigations. That expansion area was not investigated with the geophysical equipment. In the end, a large "L" shaped excavation block of 285 m^2 was completed at 41PT185/C. Inside this block, and mostly between ca. 40 and 80 cmbs, at least two Late Archaic occupations were recognized. Although two occupations were detected and radiocarbon dated in this block, the homogenous dark colored sediments combined with the noticeable turbation activity, prevented the separation of the recovered materials into two distinct assemblages. The recovered materials were analyzed as a single component within a restricted radiocarbon dated time frame of some 1,000 years. This Late Archaic component yielded valuable information concerning human activities at campsites for the Panhandle region.

Table 11-3. Summary of Artifact Distribution Across the Three Target Blocks Excavated During Phase II Data Recovery on Landis Property

Artifact Totals for Excavated Blocks				
Artifact Class	Phase II Excavations			
	41PT185/C Block	41PT186 Block	41PT245 Block	Total
Arrow Points	2		-	**2**
Dart Points	21		-	**19**
Bifaces	21	-	-	**21**
Drills	1	-	-	**1**
Unifaces	1	-	-	**1**
Scrapers	8	6	-	**14**
Edge-modified Flakes	74	5	1	**80**
Ground Stone Tools	-	-	-	
Manos	1	-	-	**1**
Metate Fragments	10	-	-	**10**
Misc. Lithic Tools	-	-	-	
Hammers	2	-	-	**2**
Choppers	5	-	-	**5**
Cores		1	-	**1**
Tested Cobbles	1	1	-	**2**
Lithic Debitage	2507	212	1	**2,746**
Microdebitage	-	156 *	-	**198**
Ceramics	2	1	-	**3**
Bones	5,337	395	41	**5,773**
Total Features				
Burned Rock Clusters	16	-	-	**16**
Heating Elements	5	2	-	**7**
Ash Dumps	-	1	-	**1**
Other	1	2		**3**
Burned Rocks	4286	27	8	**4321**
Charcoal Samples	76	53	-	**129**
Mussel Shell	4	1	-	**5**
Total Assemblage	**12,381**	**863**	**51**	**13,295**
Area Investigated (m2)	**285**	**144**	**22**	**451**
Average Density of Artifacts	43.4	**6.0**	**2.3**	**29.5**

* Only 12/m2 sampled with 3.2 mm screens.

At the Corral site (41PT186), Phase II data recovery investigations sampled one low terrace (T_{0a}) through a continuous block excavation of 144 m^2 that targeted a ca. 80 to 90 cm deep buried Protohistoric component. The component of this rarely recognized period rested on top of a buried A horizon soil. Soon after the site occupants abandoned this terrace, the occupation debris was rapidly buried by low energy alluvial fines, thereby sealing the contents and providing an intact context in a "Pompeii-like" setting. The target block at 41PT186 focused on this well preserved and

and TUs 2 and 3, and created a void of data inside the larger block excavation. Again, the nearly 70 to 90 cm of sterile deposits above the target occupation was mechanically removed. The subsequent investigations totaled 144 hand excavated units that included TUs 2 and 3 within this block. No other areas in this site were investigated during the Phase II work.

11.4 SUMMARY OF PHASE II ARCHEOLOGICAL RESULTS

Table 11-3 provides a summary of the artifacts recovered from each excavated block and the few adjoining TUs excavated during Phase I. The following discussion begins with the Late Archaic assemblage recovered from 41PT185/C. This will be followed by the presentation of results from the Protohistoric component at 41PT186. The target block at 41PT245 was essentially devoid of cultural materials and will not be discussed.

At 41PT185/C, 14 radiocarbon assays were obtained on materials associated with the target zone. Twelve dates on bone and two on charcoal document the presence of at least two, closely spaced (vertically and horizontally) Late Archaic occupations during a ca. 1,000 year period from ca. 1550 to 2550 B.P. (Figure 11-1). The youngest occupation is dated to a ca. 200 year period between ca. 1550 and 1750 B.P. The majority of cultural materials associated with this age were concentrated across the northern end of the excavation block. Whereas the older occupation, a ca. 300 year period dated between ca. 2240 and 2540 B.P. was primarily across the southern and eastern ends of the block. In a few instances, vertical differences in a few cultural features were detected, which indicate there were at least two closely spaced Late Archaic occupations. During the horizontal excavations only limited overlap appeared to have occurred stratigraphically and horizontally, but for the most part the limited deposition of sediment

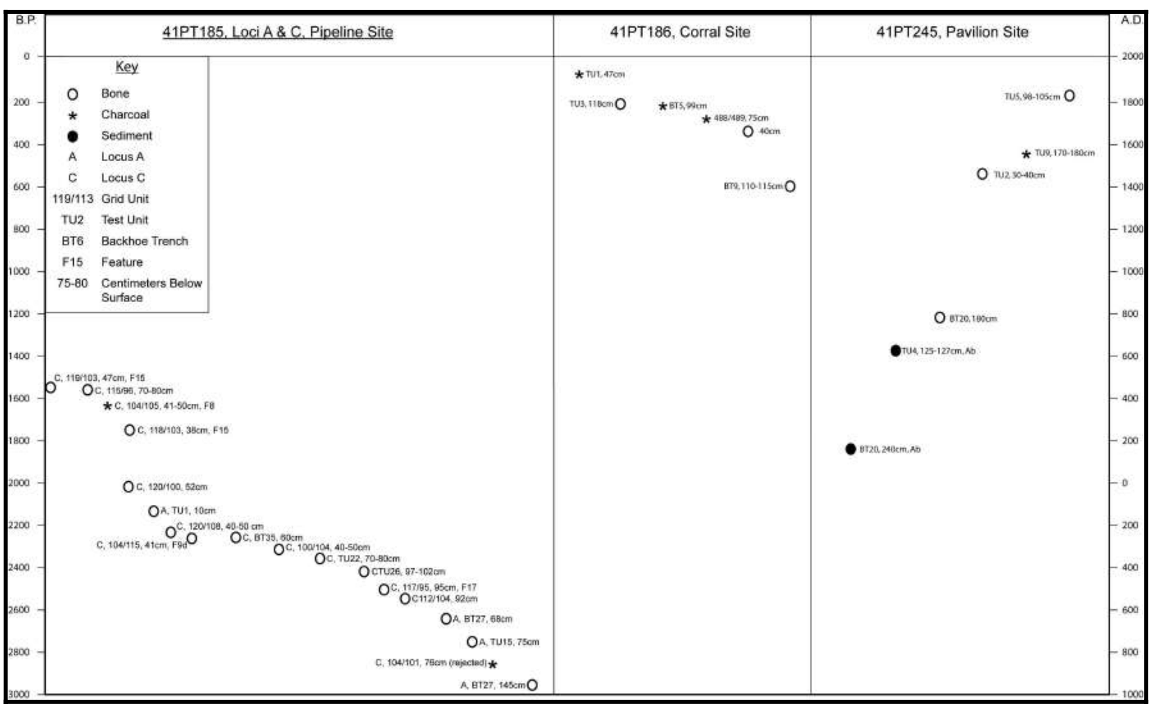

Figure 11-1. Plot of Radiocarbon Dates Derived from the Three Archeological Sites in the Landis Property.

between these two occupations was not sufficient in quantity, nor with sufficient color distinctions, or color to allow for the detection of two distinct components.

The sloping stratigraphy and homogenous sediments, combined with obvious turbation and limited deposition during this period, contributed to our inability to recognize and follow the individual occupations in the field. In the final analysis, it was not possible to separate the two closely spaced Late Archaic occupations into separate identifiable assemblages. Therefore, cultural materials were analyzed as representing one Late Archaic component dating to between 1550 and 2550 B.P. The cultural features were sufficiently defined horizontally and vertically that most were assigned to one of the two occupations.

Although two separate cultural occupations were recognized by limited vertical separation in the identified features and the two clusters of multiple radiocarbon dates, differences in the stone tool assemblage, the faunal assemblage, the features types, and the data extracted from technical analyses, all indicate closely similar camping activities, subsistence tasks, and human behavioral patterns. The Late Archaic assemblage yielded quantities of faunal remains, moderate frequencies of burned rocks, both scattered and in features, and limited, but diverse, chipped and ground stone tools. These reflect bison killing with intensive bone processing, combined with considerable cooking and other general camping activities.

Two technical analyses, lipid residue on a suite of burned rocks (*N* = 45) combined with starch grain analysis on burned rocks (*N* = 41) targeted 18 different cultural features. These features represent both identified occupations. The technical analyses reflect extensive cooking of wildrye grass seeds, and a near absence of the cooking of large herbivore meat. Wildrye grass was also detected in the ground stone tool assemblage, as reflected by wildrye starch grains on a hammerstone, a mano, and seven metate fragments used to process seeds. In contrast with most hunter-gatherer sites where the plant gathering aspect is only postulated, the specific plant gathered, processed, and cooked were positively identified here.

Combined, the detection and identification of altered wildrye (*Elymus* sp) starch grains on pounding and grinding tools, with gelatinized grains detected on the cooking rocks, supports the intensity and focus of these groups on plant resources. This detection and specific plant identification is a highly significant contribution to the prehistory of these Late Archaic occupations and to the broader region in general.

Wildrye (*Elymus* sp) grass seeds were gathered, processed, and cooked, together with large quantities of bison meat, bone marrow, and bone grease, which was also procured, processed and presumably eaten. The minimum number of 13 bison undoubtedly provided more fresh meat than could have been consumed immediately by these groups. Thus, it is postulated that much of the bison meat was stored for later use. Not only was meat extracted, bone marrow and bone grease were also extracted from the bison bones. It is likely these two fatty substances were combined with the meat to create a pemmican product as a means of long term storage of this food supply. Interestingly, the lipid residue analysis detected only minor amounts lipids associated with large herbivore meat in the cooking rocks. This supports the idea that much of the meat was consumed raw, dried, or used to make pemmican. It also reflects selective food processing and cooking of the different food resources.

Not only was the basic necessity of life, food, detected at 41PT185/C, but trade with neighboring groups was also recognized. The presence of rare obsidian (*N* = 10) from northcentral New Mexico in this Late Archaic assemblage is a direct indication of how early an east to west trade pattern occurred. It is also interesting that three different obsidian outcrops were represented in this very limited sample. In addition to this east to west interaction, a north to south interaction was also evident. The presence, although minor, of Edwards chert from the southeast in central Texas also reveals trade or contact with groups in that direction. Obviously, these Late Archaic hunter-gatherers were involved in trade/contact with their neighbors. How this influenced the prehistoric lifeway is not fully clear. The Late Archaic populations that occupied 41PT185/C relied extensively on, and had ready access to, quantities of local tool stone resources. This is evident in the form of both quantities of Alibates and Tecovas in the assemblage. The source for these high quality tool stones were within 17 km of this camp. Consequently, the apparent Late Archaic trade in which nonlocal tool stone was acquired from the southeast or west was definitely not done out of necessity. This trade reflects a peaceful interaction (mutualism) with their neighbors for other reasons. What was exchanged is not yet clear. The abundance of bison products, which were just acquired, may be one resource that was exchanged, as it is possible that some of the postulated surplus of bison meat was used as a trading commodity.

It can be inferred that local use of Alibates was prominent in this valley throughout the last ca. 2,500 years, as the Protohistoric groups at 41PT186 also relied extensively on this tool stone. The identified lithic materials establish a consistent use pattern that employed local lithic resources. While initially sorting the archeological materials into material type categories, the color combinations, color patterns, and preconceived characteristics of two major tool stone types, Tecovas and Alibates, became blurred. Positive assignment of individual pieces into one of these types was quite difficult. Subsequent recognition of the differences between these two high quality tool stones was aided considerably through INA analysis. A suite of 58 individual source samples from 11 local and regional outcrops included 25 pieces Alibates, 30 pieces of Tecovas, and two Baldy Hill samples, and one unknown piece. The INA results clearly document separate chemical signatures for Tecovas and Alibates. This in itself is a significant contribution to the region and will facilitate a clearer understanding of the uses of these to visually similar materials and look-alikes in the future.

Following the INA analysis, it was determined that we had visually misidentified ca. 38 percent of the submitted archeological assemblage. Most misidentified pieces were due to the confusion between Tecovas and Alibates. As indicated by these results, the INA is a more reliable tool for correct identification of Tecovas versus Alibates.

The basic hunter-gatherer stone tool assemblage, (i.e., projectile points, bifaces, end and side scrapers, drills) was recovered at 41PT185/C, although in limited quantities. One unusual discovery was a nearly complete corner-tang knife. Although widely known from the Late Archaic time period, few have been recovered from good buried contexts or excavated from campsites, as opposed to human burials. Not only was its presence significant, but its context under a relatively large unmodified rock near the middle of the excavation, indicates that this rare and unique chipped stone tool had special importance to an individual who had plans to return to this specific spot to retrieve it. High-power use-wear on this corner-tang knife detected the usual function of cutting soft and hard tissue. Starch grain analysis confirmed that it was not used to process starchy plants, such as wildrye grass.

The occupants at 41PT185/C (Pipeline site) were highly selective in their choice of woods for use in their fires, specifically to heat the rocks used in the cooking process. Lipid residue analysis detected the biomarker dehydroabietic acid, derived from conifer products, on 69 percent of the burned rocks. This indicates that wood from juniper trees was mostly selected and used as firewood. This is supported by the identification of mostly juniper (52 percent), plus some mesquite wood (16 percent), in the analyzed charcoal samples. Both woods were readily available in the immediate vicinity of the camp, but the occupants also had access to two or three other species including cottonwood, hackberry, and plum. A clear selection pattern is thus identified.

The target block at the Corral site (41PT186) yielded a well defined, single occupation. Three radiocarbon dates of 210, 230, and 290 B.P., which were obtained on charcoal and bison bone recovered from the occupation zone, document a use period between ca. 200 and 300 B.P. The two oldest dates were on charcoal, whereas the youngest was on a single bison bone. Due to the potential of old wood having been used in fires, the bison bone date may be the most accurate indicator of the time of this occupation.

The limited recovered cultural assemblage yielded lithic debitage, a cache of chipped stone tools, two heating elements, one ash dump, a few scattered burned rocks, and a cluster of butchered bison bones. The remains support the interpretation that this occupation was inhabited by Native Americans. The absence of chipped stone projectile points, bifaces, and pottery indicates that these specific artifact classes probably had been replaced by metal tools by this time. In support of the inference of a contact period occupation, a metal tinkler cone from the occupation zone indicates either direct or indirect contact by these Native occupants with Europeans/Euro Americans.

This cultural occupation yielded a rare artifact cache that consisted of eight items, including four end and side scrapers, two edge-modified flakes, and two unworked flakes, all of which reveal use-wear. All eight items were fashioned from Alibates. Use-wear analysis documented that two scrapers were used to scrape hides and plants, another was used to scrape only plants, and one was used to scrape charred wood. One edge-modified flake was used in cutting hard, high silica plants and the other was used to scrape plants. One unmodified flake was used on plants, whereas the other was used in cutting both hide and plants. Even though these tools were used, the inhabitants considered them valuable enough to cache in anticipation of returning to this site and using these artifacts again. It is unclear why such easily manufactured artifacts would have been considered worth caching, especially given that they had been used and the tool stone was readily accessible. This caching behavior indicates that this location was deemed worthy of re occupation at a later date.

The sparse artifact assemblage reflects a very short term, single occupation. Based on the few formal end and side scrapers, informal edge-modified flakes, and lithic debitage, combined with the heating elements and butchered bison bones, this campsite was occupied by a small group that likely included males and females, and probably represented a family unit. One might argue that the lack of formal bifaces and projectile points at this camp lacked adult males, which are often associated with these classes of tools. If adult males were absent from this camp, it might help explain the selection of this well hidden camp on a small, low creek terrace surrounded by trees. However, since bison bones were present, and hunting is generally conducted by males, then males were likely present.

At this short term camp, the occupants used and refurbished end and side scrapers made from flake blanks and killed and ate meat from minimally two bison. The two identified heating elements occurred in the southern part of the excavation block, with Feature 8 nearest the terrace edge, and Feature 7 a few meters east of the edge. An elongated north to south knapping area was on the immediate eastern side of heating element Feature 7. This concentration (Concentration #2) of 44 pieces of debitage (less than 12.8 mm long) reflects mostly uniface shaping and/or resharpening activities, which included a broken end scraper. The debitage indicates that minimally three objects were worked in that area. Another meter or so further east was a 1 m wide discard pile of ash (Feature 1) that contained tiny lithic debitage from Feature 7. About 3 m northeast of that ash was a small cluster of discarded bison bones. The discarded ash and bison bones were towards the back of the terrace. A second larger debitage concentration (Concentration #1) reflects another knapping activity area near the middle of the northern end. This north to south elongated debris concentration of 156 flakes also reflects mostly uniface refurbishing and another broken end scraper. Microdebitage (less than 6.4 mm in size) detected in Lithic Concentration #1 indicates that the activity was probably *in situ*. Minimally, two individuals conducted knapping activities, with one seated next to a heating element. The rare artifact cache along the front edge of the terrace was 4 m north of heating element Feature 8.

The cultural debris indicates heating in two areas, two individuals knapping in different areas, discard of excessive ash from one heating element, the discard of bison bones, and the caching of chipped stone tools all occurred at this campsite. This distinctive horizontal patterning of well defined task/activity areas reflects specific and various human behaviors, which are not often observed in hunter-gatherer campsites of any age.

The lithic types identified reflect a dominance of local Alibates, with sparse Tecovas, even through outcrops of Tecovas are more numerous and more frequent in the immediate area. No nonlocal materials were identified. This reliance on local Alibates supports the interpretation that the occupants were a local population centered here in the panhandle. Unfortunately, the recovered cultural assemblage is too limited in terms of quantity and diversity, and diagnostic artifacts to provide clear clues as to what cultural group the occupants might represent. Therefore, no assignment to an ethnographic group has been attempted.

Also at the Corral site, but outside the Protohistoric block excavation, the Phase I data recovery program yielded a few pieces of pottery. One tiny sherd was visually classified as a brown corrugated piece (#343-008-1). However, petrographic analysis yielded a composition that set it apart from other sherds and it was assigned to a local paste group (Paste Group 3). The observed temper also indicate that this sherd was manufactured locally. INA analysis on this same sherd (TRC431) supports a local manufacture. Therefore, the visible identification of a corrugated exterior appears incorrect, as corrugated exteriors are not known locally.

The high frequency of bison bones observed in BTs 8 and 9 and recovered from TUs 7 through 9 at the western end of the Corral site indicate a possible kill area. The cultural artifacts from that area consist of a couple of plain, tiny sherds, an Alibates arrow point tip, and an Alibates end scraper. These are all similar to traits of the known Antelope Creek assemblage. If this association is correct, then this probable bison kill relates to the Antelope Creek phase at the western end of this site.

Multiple camps from various time periods, but no earlier than ca. 3,500 to 3,000 years old, comprise the rest of the broader Corral site. The central part of the Corral site appears to exhibit relatively shallow alluvial deposits that contain mixed cultural materials. Only the two lower terrace settings, one of which was targeted, have reasonably intact cultural materials. The cultural materials in both lower terraces are attributed to occupations during the last 1,000 years.

At the Pavilion site (41PT245), no diagnostic projectile points were recovered from any context, although a few small ceramic sherds were recovered from two test units in the lower terrace (T_0). The different alluvial terraces yielded cultural materials that represent different ages in widely different contexts. The extensive main terrace (T_1) revealed less than 60 cm of Holocene deposits representing the last ca. 10,000 years, with cultural materials in apparently mixed contexts. The two horizontally separate lower terraces (T_0) exhibited much deeper deposits (>1.5 m) with better context, but these deposits yielded sparse cultural materials that were horizontally and vertically dispersed. The target block in the T_{0a} failed to yield the ca. 1200 to 1400 B.P. age cultural materials anticipated. Consequently, few materials are present by which to discuss this 200 year period.

All the cultural materials encountered at the Pavilion site represent short term occupations over the last ca. 1,200 to 1,500 years. Minimally two time periods are identified. The oldest is the Palo Duro/Woodland period directly radiocarbon dated to between ca. 1200 and 1400 B.P., which was the target of the Phase II block excavation. This included a small, partially intact burned rock cluster (Feature 2) that yielded butchered bison bones, burned rocks, and tiny charcoal pieces. Lipid residue analysis indicates that the burned rocks were employed to cook large herbivore meat, whereas the starch grain analysis on the same burned rocks indicates that wildrye grass was also cooked. Based on a single young bison mandible in association with Feature 2, this occupation occurred during the fall.

A later occupation in Protohistoric times was documented by a radiocarbon date of ca. 430 B.P. The sparse material associated with this date was deeply buried in the lower terrace (T_{0a}) deposits. No diagnostic artifacts and few cultural materials other than burned rocks (Feature 4/5) were recovered from this occupation. Both radiocarbon dated components reflect similar cultural activities, in that bison appear to have been the prominent meat resource and cooking was the most visible activity. Stone tool production and waste products were extremely limited in both components.

The few ceramic sherds from various contexts at 41PT245 reflect Late Prehistoric or Protohistoric periods. Five sherds, three with plain gray exteriors, one with a plain red exterior (#401-008-1), and one with a plain black exterior (#378-008-1), were assigned to two different paste groups (1 and 2). The three gray sherds in Paste Group 1 were thought to have been manufactured locally. INA analysis on these same sherds supports their local manufacture, but they were not from any of Meier's (2007) previously identified Antelope Creek localities. Both the black and red exterior sherds were assigned to Paste Group 2 and thought to have been manufactured outside this region. The INA analysis on the red exterior sherd did not match up with any of the previously identified Antelope Creek sherds or source areas, thereby indicating a nonlocal manufacture. Interestingly, the INAA on some of the natural clays examined indicates that some of Meier's (2007) previously analyzed Antelope Creek pottery was manufactured from these local clays.

Overall, the Pavilion site yielded relatively limited cultural materials dispersed across multiple terraces in various contexts. At least two time periods are represented during the last ca. 1,800 years. The cultural materials within the broad upper terrace appeared mixed and represent palimpsest occupations, undoubtedly during multiple periods.

11.4.1 Environmental Issues

By Charles D. Frederick and J. Michael Quigg

11.4.1.1 Introduction

An alluvial stratigraphic study of the upper reaches of West Amarillo Creek was conducted by Frederick (2008). Through the excavation of 47 backhoe trenches, six distinct alluvial deposits were identified. These range in age from modern to Late Pleistocene.

Only one of these deposits, Unit D, with a general age range from ca. 1900 to 430 B.P., preserved microfossil remains with the potential to yield a good paleoenvironmental record. The best and most complete exposure observed was in BT 36.

Trench 36 was excavated immediately adjacent to site 41PT185/C, and yielded a surprisingly deep exposure within which four allostratigraphic units were ultimately identified (see bottom right corner of Figure 11-2 for a schematic illustration of the alluvial allostratigraphic units identified within the trench). Within the trench Unit D was inset into Unit B and draped the eroded remnants of Unit C. The top of Unit D was subsequently truncated during an incision event that precedes deposition of Unit E, and was draped by an eastward thickening wedge of this deposit. Although basin wide trenching in the early stages of the project encountered many fragments of Unit D, BT 36 revealed a nearly complete image of this deposit that bisected the channel axis, providing an image of how the channel and immediately adjacent floodplain evolved throughout the period of Unit D deposition.

When BT 36 was first excavated, a series of six monoliths (50 cm long aluminum trays of sediment carved from the trench wall) were collected and a basic sketch of the stratigraphy revealed by the trench was made. Monoliths were employed because the deposits were very stratified and the monoliths could be described in more detail and at a slower pace in the lab than was possible in the field. A series of feasibility samples, designed to explore the potential for diatom, pollen, ostracod and phytolith preservation, were collected from the monoliths and submitted for assessment. A suite of 29 sediment samples were analyzed from the monoliths to characterize the lithology of Unit D in a fashion that was comparable to the other allostratigraphic units within the West Amarillo Creek valley.

Upon receiving favorable results from the feasibility studies and obtaining permission from the BLM to conduct a detailed paleoenvironmental study of the deposits, the trench was reopened in December 2008. The newly cut trench was almost the same as the original, but the eastern end of the south wall was cut back slightly more than the original trench, which removed all traces of the location of Monoliths 1 and 2. West of Monolith 2, the original trench wall was exposed intact and the locations of monoliths 3, 4, 5 and 6 were easily identified. The newly reopened BT 36 also differed from the original trench in that the west end was cut deeper and revealed an exposure of the bounding unconformity between Units D and B, as well as exposing a significant portion of a channel deposit associated with Unit B, which had not been observed up to this point.

Upon completion of the newly reexcavated BT 36, a suite of 21 samples was collected for pollen, ostracod, diatom and phytolith analysis, and a second suite of bulk sediment samples was collected to fill gaps in the sampling specifically between monoliths 2 and 3 and above Monolith 6.

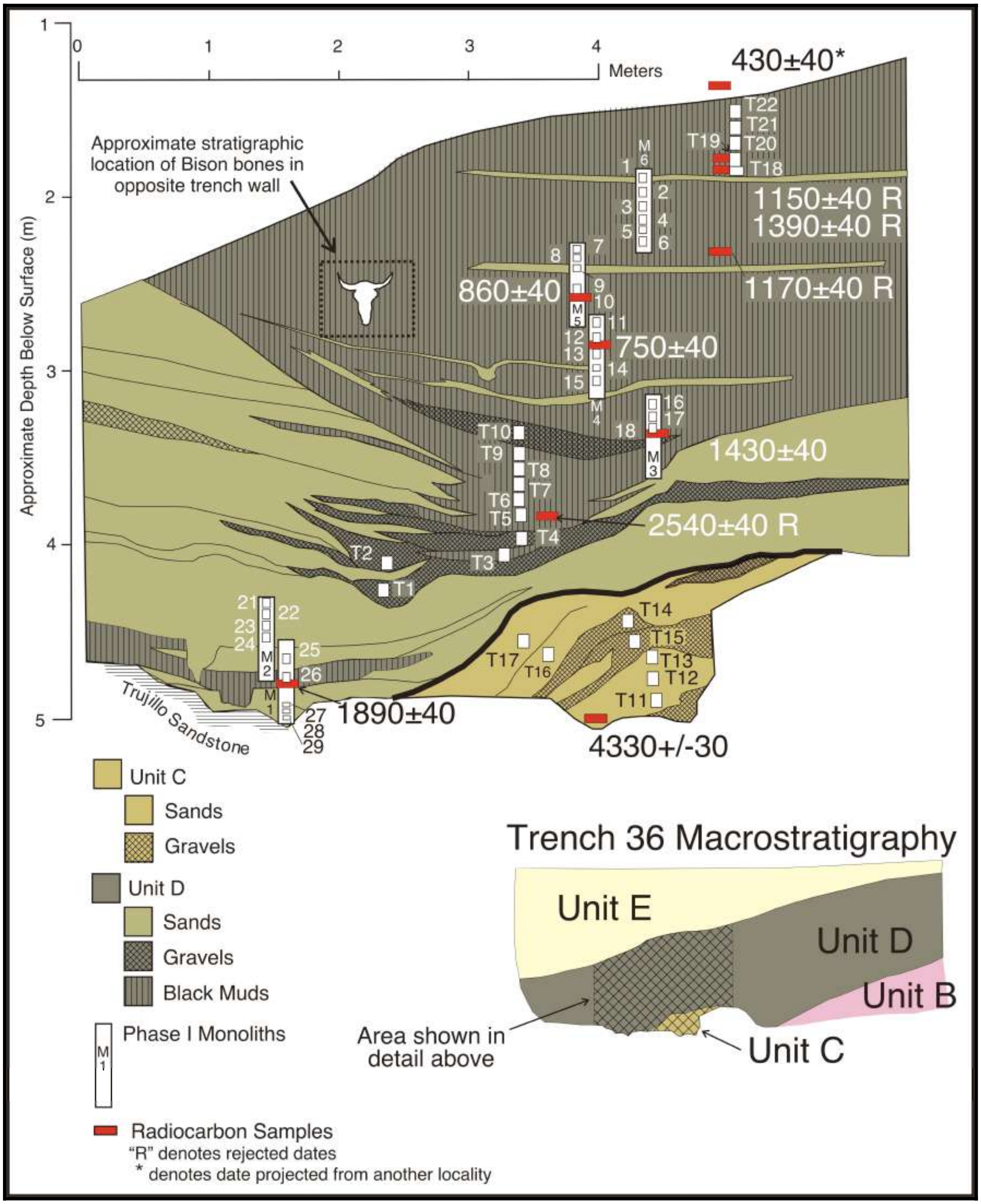

Figure 11-2. Expanded View of the Portion of BT 36 that was Sampled for Paleoenvironmental Analysis.

(Note: shows the location of the bulk soil/sediment samples used in the paleoenvironmental study. The white rectangles are monolith samples collected during the first phase of work at BT 36, and the smaller white boxes denote the location of samples collected from within the monoliths during that phase of work. White boxes with a "T" prefix denote samples collected during the second phase of investigations at BT 36).

Figure 11-3 shows the depth location of the samples used for the paleoenvironmental investigations with respect to the samples used to document the lithostratigraphy. In an ideal world the same samples would be used for all analyses, but given the two phase nature of the fieldwork and the fact that we had already invested in the lithostratigraphy during the first phase of investigation, the two sample groups are somewhat different, with the lithostratigraphic sample set having a much higher stratigraphic resolution.

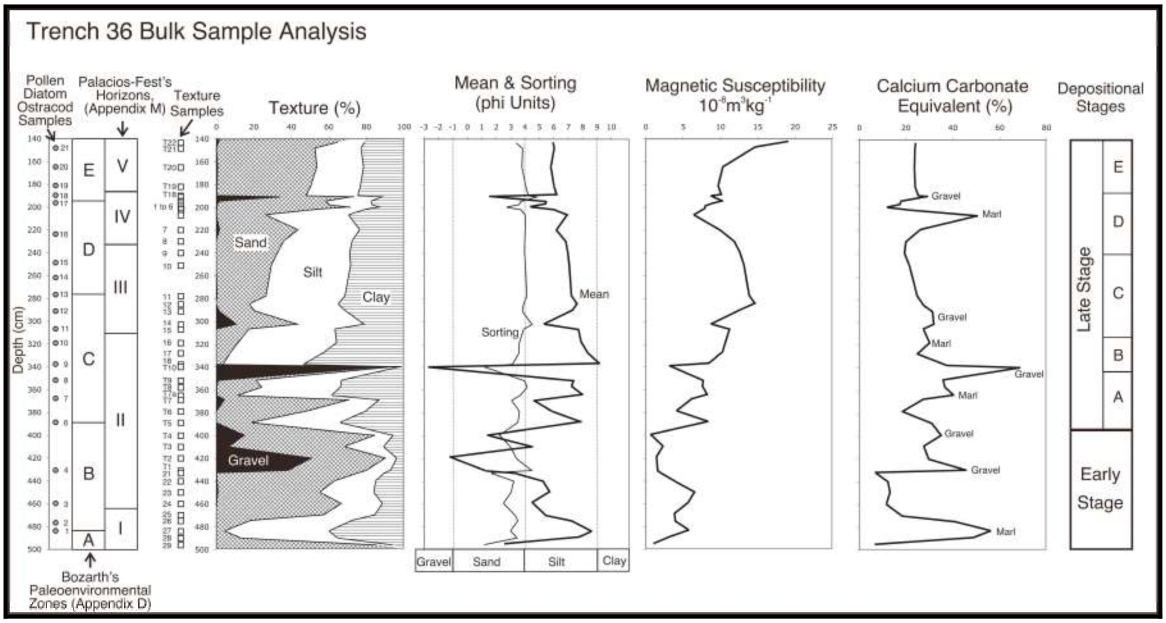

Figure 11-3. Plot of the Results of the Physical Analysis of Bulk Soil-Sediment Samples from BT 36, with Respect to the Samples Collected for Paleoenvironmental Analysis.

(Note: Left side of the diagram shows the relative locations of the two sample groups and the interpretive zones employed by Bozarth [Appendix D] and Palacios-Fest [Appendix M]. The far right side shows the lithologically based interpretive zones used in the discussion in this section.)

The specialists' technical results are presented individually by Bozarth (Appendix D), Winsborough (Appendix P), and Palacios-Fest (Appendix M). Figure 11-3 also shows the analytical units employed by two of the three specialists in their discussion of the data, so these can be readily linked to the physical deposits.

The following discussion summarizes the results of the specialist studies in light of the lithostratigraphy of Unit D. The results of the paleoenvironmental work have yielded a diverse set of information relevant to the conditions in the upper reaches of West Amarillo Creek during the period between 1900 and ca. 430 B.P. As might be expected, we do not completely agree with some of the inferences advanced by these experts, and the summation that follows compiles what we believe to be the most relevant and accurate information obtained from these studies. The reports of each specialist are provided so the reader can judge for him/herself.

11.4.1.2 Pre 1900 B.P. Events

The humid conditions inferred from Unit D appear to have started sometime before 2250 B.P, in the late stages of alluvial Unit C deposition. It was after this time that marl formed on the valley floor. Sometime between 2250 and 1900 B.P. the West

Amarillo Creek channel was incised about 3 to 4 m and created a new floodplain within which Unit D was subsequently deposited.

11.4.1.2.1 Unit D Paleoenvironmental Record

Lithostratigraphy

The deposits of Unit D, as revealed in BT 36, were complex. The sediment comprising this deposit included four distinct lithofacies; 1) dark colored muds, 2) sands, 3) gravels, and 4) marls. The stratigraphic distributions of these deposits are depicted in different fashions on Figures 11-2 and 11-3.

Dark colored (black or very dark grayish brown) muds were one of the diagnostic lithological attributes of Unit D throughout the valley, and although these sediments were seemingly similar in texture everywhere, they in fact exhibited a wide range of textures spanning sandy clay loam to silty clay loam and silty clay. The calcium carbonate content of the muds generally ranged between 20 and 30 percent, and toward the top of Unit D limited amounts of matrix supported gravel was common. The sands within Unit D were generally sandy loams and moderately to poorly sorted, and not very calcareous, with carbonate contents that ranged between 5 and 15 percent. The gravels were visually dominated in exposures by white limestone clasts, but these coarse deposits generally had a significant sand component (textures of very gravelly sandy loam to very gravelly loamy sands were most common). The gravels often exhibited high calcium carbonate content owing to the dominant gravel sized clast being reworked calcium carbonate nodules eroded from the Ogallala Formation (which at first glance appeared to be limestone) and are denoted on the calcium carbonate equivalent panel on Figure 11-3 to permit distinguishing them from marls. Most gravelly deposits were moderately to very poorly sorted and consisted of thin lenses situated in the center of the ancient channel. Overall, gravel was an uncommon constituent of the Unit D channels, which was especially apparent when channels of different age were compared. The marls consisted of white, brown or dark gray muds (typically silty clay loam or clay loam) that had a significant component of chemically and biogenically precipitated calcium carbonate. The most common biogenic source of calcium carbonate was the charophytes, which are wetland plants that fix calcium carbonate around their oospores, which are called gyrogonites. Palacios-Fest (Appendix M) identified three species of charophytes within the deposits of Unit D, which are more widely distributed than the marls, which show up visually within the deposits.

In general terms, the channel of West Amarillo Creek during the period of Unit D deposition alternated between periods of ponding, during which dark colored muds and marls were deposited, to periods of stream flow and flooding, which were represented by sand and gravels. The temporal trends in deposition were clearly complex, but at a general level the deposits documented within BT 36 can be divided into two major depositional stages, here termed early and late. The boundary between these two phases of activity is arbitrarily defined around 395 cmbs, slightly below the last major flood gravel. The Early Stage deposits represent a period when the channel of West Amarillo Creek was actively flowing, and occasionally flooding, which occurred between ca. 1900 and shortly before 1430 B.P. Brief periods of ponding occurred as well, but were much less common than in the Late Stage. The coarse-textured deposits shown on Figure 11-2 clearly show the depth and breadth of the channel floor during the Early Stage of Unit D, which typically appears to be about 50 cm deep and 2 to 3 m wide.

From slightly before 1430 B.P. and persisting no later than 430 B.P. West

Amarillo Creek was more often ponded or marshy, resembling a cienega or wet meadow, and exhibiting little evidence of a true channel. The channel form at ca. 1900 B.P., as indicated by the occasional coarse (sandy) beds which drape the channel, started off fairly concave and gradually flattened out through the Late Stage, ultimately ending as a broad, shallow pan-like surface toward the end of Unit D sedimentation. The deposits toward the top of this interval appear to represent damp, drying and sandy conditions, rather than a wet and marshy situation. Radiocarbon dates from the Late Stage are highly erratic, and the ca. 430 B.P. date used as the upper bracketing age for this period was the oldest radiocarbon age from Unit E. The deposition that followed Unit D sedimentation was preceded by a phase of channel trenching. The muddy sediments of the latter half of the Late Stage clearly became coarser textured through time, but in a very incremental manner that indicates a gradual drying of the landscape throughout this period. This data is consistent with the stable carbon isotopic record from these deposits, which indicates that the vegetation in the West Amarillo Creek catchment shifted from about 35 to 40 percent C_4 plants to around 65 to 75 percent C_4 plants during the latter stages of Unit D sedimentation.

Given the widely divergent radiocarbon ages obtained from these deposits, we are not confident that sedimentation rates calculated from our preferred radiocarbon ages are meaningful or even accurate, so speculation concerning variations in sedimentation rate is problematic.

Microfossil Preservation and Concentration

Figure 11-4 compares measures of microfossil ubiquity/concentration with the lithology and close examination of this diagram reveals several trends. Before discussing these trends, it is worth examining the significance of these measures. The concentrations or ubiquity of these microfossils are generally related to three main factors: 1) the suitability of the environment for the animal/plant in question, 2) the sedimentation rate, and 3) taphonomic factors that affect the preservation of each microfossil. The microfossils documented from these deposits are composed of three different materials (calcium carbonate [e.g. ostracodes, charophytes, and mollusks] opaline silica [e.g. diatoms and phytoliths], and sporopollenin and cellulose [pollen]) and as such are likely to exhibit different postdepositional biases.

Environmental suitability is applicable to plants and animals, preserved in these deposits, which lived in the creek. When conditions were favorable, the abundance generally increased unless some other mitigating factor was present (such as a predator). This is perhaps most notable with the diatoms, which are prone to tremendous increases in population (called blooms) given optimal conditions. The depth distributions of the ostracodes, diatoms, mollusks and charophytes most likely represent past periods when environmental conditions were most favorable to these plants and animals.

Sedimentation rate is often viewed as a controlling factor in paleobiological studies, with high sedimentation rates favoring low fossil abundance and low sedimentation rates resulting in high fossil abundance (Martin 1999). Bozarth (Appendix D) directly interprets the phytolith concentration in these terms, but if this were the controlling factor in fossil abundance, one would expect similar trends for all of the proxy records shown on Figure 11-4. The fact that the fossil concentration is significantly different among the six different fossil groups indicates that this was not the controlling factor.

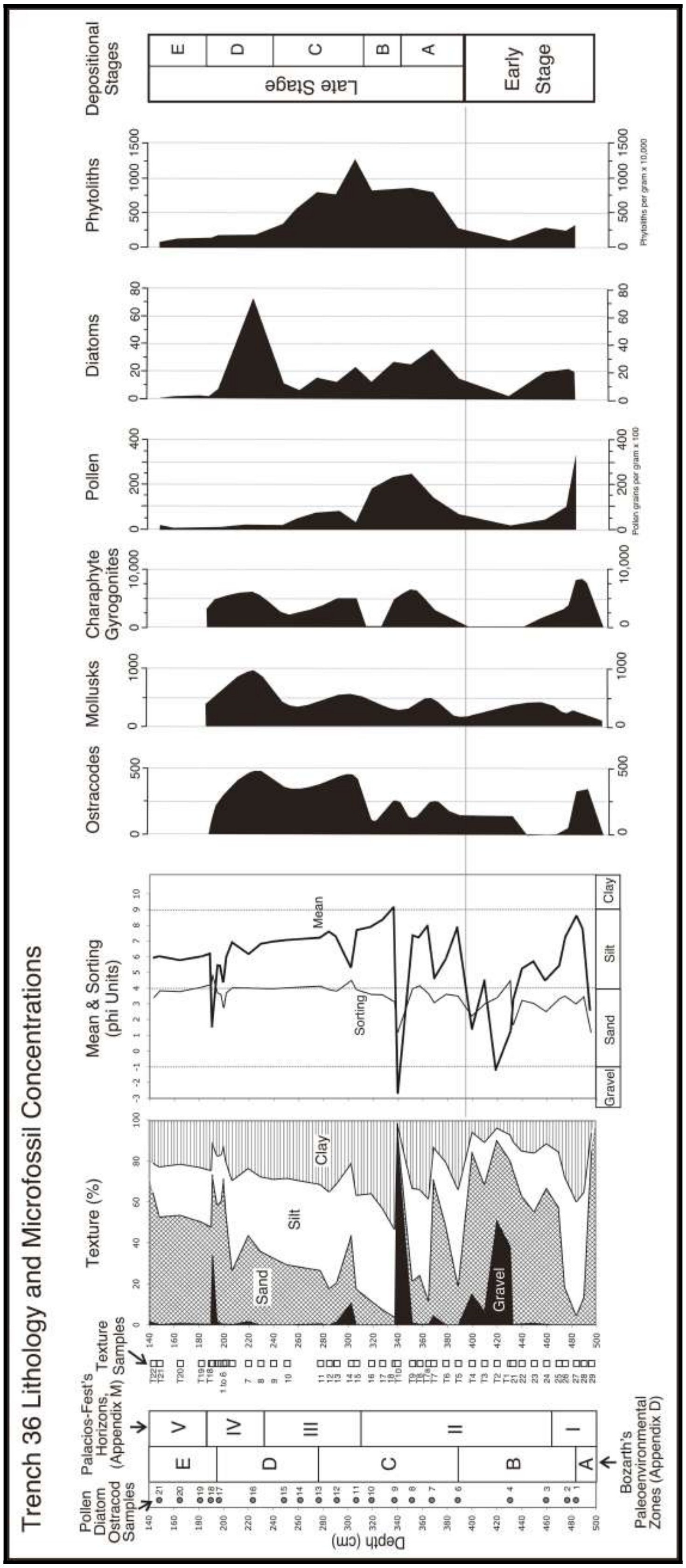

Figure 11-4. Plot Showing the Lithology within BT 36 with Respect to the Microfossil.

(Note: Concentrations for Pollen, Diatoms, and Phytoliths; [Bozarth, Appendix D] and Total Microfossil Populations for Ostracods, Mollusks, and Charaphyte Gyrogonites; [Palacios-Fest, Appendix M]).

Postdepositional taphonomic processes may have also strongly affected the microfossil preservation and abundance. All of these microfossils were subject to differential preservation depending upon the degree of transportation and chemical/edaphic history of the deposit. For instance, carbonates present near the ground surface are commonly dissolved by meteoric (rain) water and this calcium carbonate is later precipitated at depth in the form of pedogenic calcium carbonate. This process is generally slow, but could dramatically alter the preservation of these kinds of microfossils. Opaline silica is prone to dissolution under specific chemical conditions such as elevated temperature, pH and salinity, as well as attack from bacteria (Roubeix et al. 2008), and sporopollenin is generally best preserved in acid pH and poorly preserved in alkaline sediments.

The carbonate microfossils and the diatoms appear to reflect variations in environmental suitability, but the pollen and phytolith distributions are somewhat similar to each other, and clearly dissimilar to the carbonate microfossils. It is not clear what processes were affecting these distributions, but it was unlikely the sedimentation rate as Bozarth (Appendix D) indicates, or this pattern would have also occurred across all of the microfossil records. It is clear among all of the microfossil records that preservation is lowest among the sandy channel sediments at the end of the Early Stage deposits when sedimentation rates were likely high and physical abrasion also prominent. But it is possible that the high concentrations of pollen and diatoms in the more ponded facies of the sequence (the finer grained sections) were a taphonomic artifact.

As a final note, the validity of using the change in abundance of pollen transported to this area from long distance, such as pine, as an index for climatic changes in the long distance source are considered problematic. Trap studies of modern pollen on the Southern Great Plains (e.g., Hoyt 2000; Hall 1990b) have shown that pine is often carried long distances and the factors controlling its abundance in records are related more too taphonomic processes than to the abundance of pine trees in the source area. The nearest pines to this study area are on the western escarpment of the Southern High Plains, and the southern Rocky Mountains to the west (Hoyt 2000:691) and it is impossible to determine from which source(s) the pine pollen in question originated.

Paleoenvironmental Trends

The following discussion attempts to integrate all of the paleoenvironmental records obtained from BT 36, in order to obtain a more comprehensive image of late Holocene environmental change in the upper reaches of the West Amarillo Creek valley during deposition of Unit D.

The Early Stage (ca. 1900 to 1430 B.P.)

The initial deposits of Unit D immediately followed a period of channel entrenchment when the stream carried a high sediment load. These deposits rest directly upon Trujillo Sandstone bedrock. Whereas the first sediments were quite sandy, they were followed by the development of a pond/marsh that includes a prominent marly bed. Both the diatoms and the ostracods indicate that this early wetland contained a fluctuating level of moderately alkaline shallow water with emergent vegetation, such as the cattail and sedges and willow trees that lined the banks. The snail fauna of this early pond was primarily terrestrial, which is at odds with the clear evidence of wetland conditions. This may be indicative of either periodic drying, as indicated by the some diatoms that are tolerant of elevated salinity and drying, or influx from the uplands following a prolonged period of erosional instability during the period of channel entrenchment that followed deposition of Unit C.

The wetland near the base of the Early Stage deposits was followed by a phase of stream deposited sand, which was periodically interrupted by larger magnitude floods after 1890 B.P. This part of the deposit, which spans from ca. 400 to 475 cmbs in the sampled section, appears to have been more representative of a sandy to muddy stream bottom containing occasionally eutrophic, organically polluted water with moderate to elevated salinity. A complex suite of microenvironments ranging from sandy mud flats to small pools with a limited amount of emergent vegetation of variable height (grasses and cattail) is indicated. Pollen from this deposit indicates that the stream was still bordered by willows and that these may have expanded during this period onto the exposed but moist stream bed. Phytoliths from this deposit indicate that drier conditions prevailed at this time. A series of larger magnitude floods ended the Early Stage deposits when several beds of very gravelly sandy loam to loamy sand were deposited by the stream.

The Late Stage (ca. 1430 to 430 B.P.)

In the field, the Late Stage deposits were divisible into five muddy segments, separated by flood deposits (shown on Figures 11-2 and 11-5), and these segments are designated A through E (see Figure 11-4). Late Stage Segment A, from 390 to 340 cmbs, was marked by increasingly wet conditions, whereas the upper four segments (B to E) of the Late Stage deposits, which comprised the upper 2 m of the section between 340 and 140 cmbs, showed a gradual decrease in wetland conditions through time. In particular, although the muds in this period were visually similar, the deposits became increasingly sandy, and toward the end of the sequence include gravel fragments which are interpreted as represent a gradual decrease in effective vegetation throughout the latter stages of Unit D deposition.

Segment A (400 to 338 cmbs; Pollen, Ostracod and Diatom Samples 6, 7 and 8)

Shortly before 1430 B.P., the conditions on the floor of West Amarillo Creek abruptly became more aquatic, possibly reflecting a sustained base flow during a period of enhanced precipitation. The sediments became dominated by dark colored muds (silty clay loam and clay loam) with a single sandy interbed. Somewhat surprisingly, the pollen from this period indicates less aquatic, drier conditions, as willow and cattail were initially present, but were then replaced by cottonwood and oak. A damp environment, however, is indicted by the presence of sedge pollen and moss spores. Ostracods and charophytes within this deposit indicate that the water initially had low salinity and high alkalinity and became more saline and less alkaline immediately before the flood deposition that ended this segment. The mollusks throughout this period were predominantly aquatic. The diatom assemblage is mixed, being initially characterized by diatoms associated with muds exposed to the sun as well as diatoms favoring water with substantial nutrient levels (high phosphorous and nitrogen), which probably represent conditions present over multiple seasons. This assemblage was followed by a more diverse suite of algae that represent a mosaic of environments ranging from deep, clear water to shallow water with emergent vegetation.

Segment B (338 to 310 cmbs; Pollen, Ostracod and Diatom Samples 9 and 10)

A major flood occurred immediately before 1430 B.P, after which the channel of West Amarillo Creek was once again dominated by the deposition of dark colored muds. At the start of this period the water was shallow and clear and had low salinity and low alkalinity. Emergent vegetation, such as cattails and sedges, was initially present, but pollen from these plants disappeared. The absence of their pollen indicates that these plants were not present in addition to

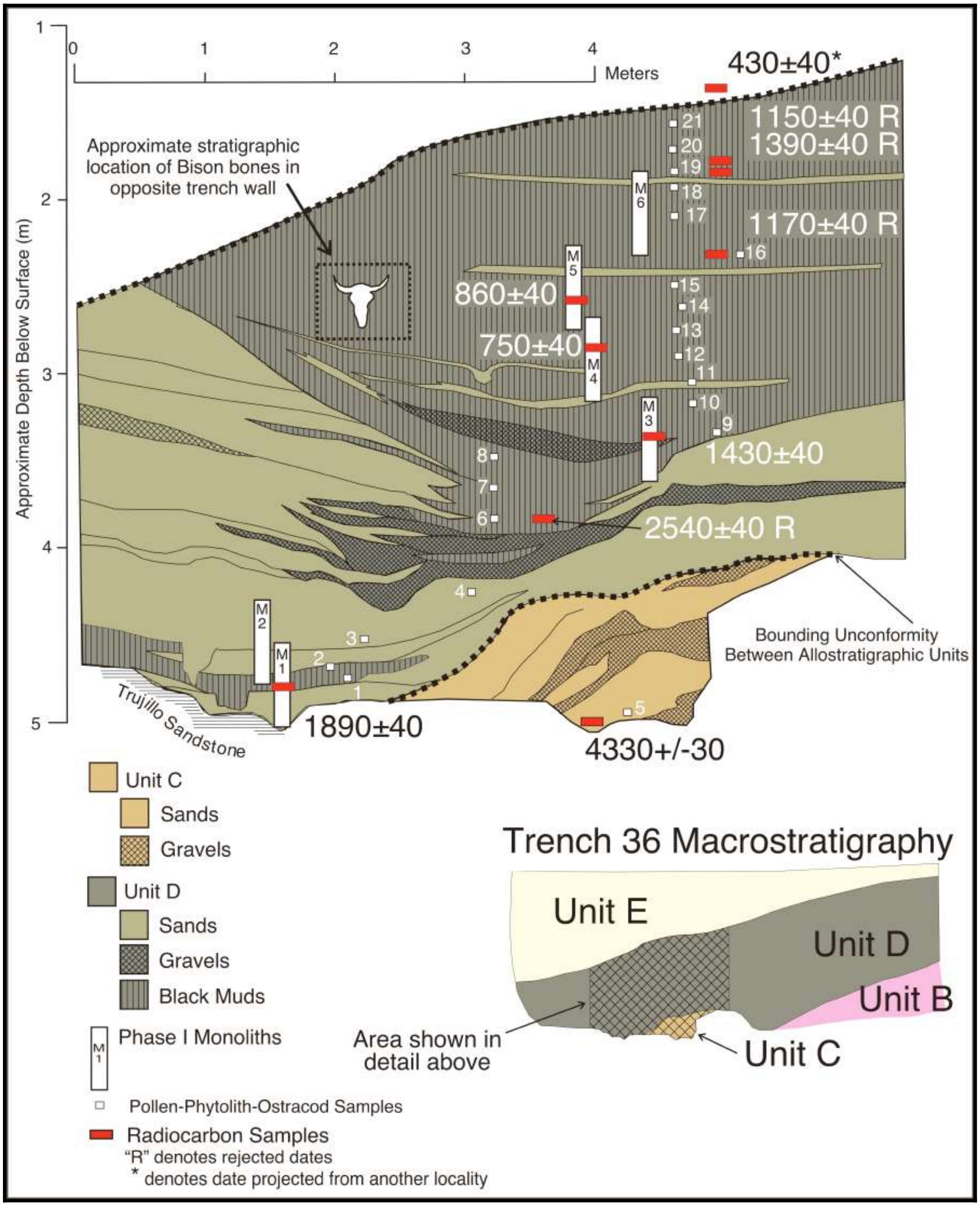

Figure 11-5. Expanded View of the Portion of BT 36 that was Sampled for Paleoenvironmental Analysis.

(Note: Shows the location of the pollen, ostracod, snail, and diatom samples used in the paleoenvironmental study).

absence of submerged vegetation such as the charophyte *Nitella flexis*. The stream was bordered, at least in places, by cottonwoods. The phytoliths in this deposit are abundant, but the significance of this is not clear.

Segment C (310 to 240 cmbs; Pollen, Ostracod and Diatom Samples 11, 12, 13, 14 and 15)

The conditions that prevailed during the deposition of Segment C were predominantly aquatic, with shallower water at the beginning and end of the segment and a period of deeper ponding in the middle. The pollen analysis indicates that the valley floor was rimmed with cottonwoods and lesser amounts of oak, at least initially, and that these taxa declined in abundance throughout Segment C. The dominant wetland taxa were sedges and ferns early on and later ragweed (*Ambrosia*). Somewhat surprisingly, however, the pollen analysis indicates that primarily drier conditions prevailed throughout this period. This is somewhat at odds with clear evidence of wetland from the other paleoenvironmental proxies, which clearly indicate aquatic conditions prevailed on the valley floor. The water throughout Segment C was moderately to highly alkaline, neutral to saline, with the most saline conditions occurring at the end when the diatoms indicate that the emergent vegetation may have been low, salt tolerant grasses and sedges.

Segment D (240 to 190 cmbs; Pollen, Ostracod and Diatom Samples 16, 17 and 18)

During deposition of Segment D, the floor of West Amarillo Creek started off with a dominantly aquatic habitat and ended as a flashy stream, which lacked significant wetland attributes. In the early part of this segment the deposits were clearly aquatic, and resulted in deposits that were nearly pure diatomite. The water was moderately alkaline and supported an aquatic snail fauna. The ostracods and diatoms conflict on the water salinity, with the ostracods indicting nearly freshwater conditions, but some of the diatoms present are clearly halophilic and indicate, if not saline water, a rim of evaporative salts that may have been present around the desiccated channel floor. Although some moss spores were identified during the pollen analysis, the overall trend in the pollen and phytoliths indicates that a warmer and drier climate prevailed during the early and middle parts of this segment's deposition. The aquatic conditions persisted through the middle of the segment, but declined toward the end when the deposits became considerably sandier. The diatom diversity and ubiquity decreased significantly and indicate a flashy, muddy drying stream with somewhat saline water. The pollen and phytoliths indicate that the climate at the end of Segment D was cooler and moister than before.

Segment E (140 to 190 cmbs; Pollen and Diatom Samples 19, 20 and 21)

The uppermost segment of the Late Stage exhibited evidence of increasingly dry conditions on the valley floor and in the basin. Throughout Segment E, the pollen and phytolith analyses indicate a warmer and drier climate. This is noted in increased amounts of low spine Asteracea, *Brassica* and grasses, and a slight increase in cottonwood at the start of this period. The diatom analysis noted the presence of low diversity floras that were dominated by taxa that tolerate moderately saline water, and periodically dry conditions.

11.4.1.2.2 Summary

The results of this multidisciplinary paleoenvironmental analysis of the Unit D deposits provide a relatively detailed reconstruction of changing conditions on the West Amarillo Creek valley floor during the period between ca. 1900 B.P. and sometime between 800 and 430 B.P. During the initial phase of Unit D deposition, the creek alternated between a flowing stream with a sandy channel, and a periodically dry pond/marsh. The stream was bordered by willows and cattails, and sedges grew in and around the channel. Sometime shortly before 1430 B.P., a more persistent wetland became established and varied between a marshy wet meadow and periodic conditions wherein deeper pools and ponding prevailed. This pattern persisted throughout most of the period of Unit D deposition. Around this time cottonwoods and limited amounts of oak trees replaced willows as the dominant galleria forest, and sedges, ferns and moss appeared more commonly than cattails. During the shallow water phases the water conditions were occasionally nutrient rich and organically polluted (most likely by bison and other wildlife), whereas the deeper water periods generally had clear and moderately alkaline conditions. Both the salinity and the alkalinity conditions varied throughout this period. Toward the end of end this period (sometime after 800 B.P., but before 430 B.P.) the water levels declined, and the valley floor shifted to a sandy stream bottom that was often dry, but occasionally supported isolated marshy areas that were fringed with evaporitic salts during the dry season.

The broad image of paleoclimatic change portrayed by the phytolith record (the temperature and aridity indices) is in good general agreement with the stable carbon isotopic record, as well as the depositional lithology. These data indicate that the Early Stage was characterized by a cool and moist climate that was gradually followed by increasingly warm, dry conditions until close to the very end of the Unit D record, when a subtle trend to cooler and moister conditions may have triggered the incision of the creek channel prior to the deposition of Unit E.

11.4.1.2.3 Regional Implications

When viewed in a regional context, the paleoenvironmental record obtained from West Amarillo Creek shares prominent attributes with work done in Oklahoma and around the margins of the Southern High Plains. However, in some aspects it is strikingly different from the extensive body of data available for the Southern High Plains in particular.

The longest and most widely applicable proxy record obtained from West Amarillo Creek is the stable carbon isotopic data on bulk organic matter, and this record is available for all of the alluvial deposits in the valley. These data indicate incrementally more mesic conditions from ca. 4000 B.P. to around 1900 B.P. This gradual decline in the proportion of more xerophytic C_4 vegetation is followed by a period of about 400 years when more moist conditions which prevailed until slightly before 1500 B.P., after which the landscape quickly became more arid once again. The latter 400 year interval reached similar values present in the valley at 4000 B.P., and around 1500 B.P. The shift from a C_3 dominated assemblage to a C_4 dominated one occurs relatively rapidly in this record, especially in comparison to the gradual onset of more mesic conditions. In the period after 1500 B.P., the stable carbon isotopic record oscillates around -18‰ on a roughly 500 year cycle, with peaks in more xerophytic vegetation occurring around 1150, 700, and 350 B.P.

Unfortunately, no other paleoecological proxy records exhibit suitable preservation that can provide comparable records across multiple alluvial fills in the West Amarillo Creek depositional sequence. Unit D, however, exhibits exceptional preservation of multiple paleoenvironmental records. These proxy records support the general trends of the stable carbon isotopic record, although with considerably more detail and environmental nuance. For instance, the diatoms, ostracodes and mollusks record wet conditions on the valley floor for most of the period of Unit D deposition, with perhaps the wettest conditions occurring slightly after 1430 B.P., when the stable carbon isotopes indicate the regional vegetation was once again fairly arid conditions (C_4 plants). This apparent contrast is supported by the aridity index obtained from the phytoliths, which indicates moist conditions early in the Unit D record and gradually more arid conditions throughout the latter half of Unit D deposition. The lithology of Unit D also supports this general trend, with the texture of Unit D coarsening very gradually in the period after 1430 B.P. The persistence of mesic conditions on the valley floor, while the regional (or basin) vegetation was once again more xerophytic, is probably due to a lag in the discharge of emergent groundwater from the High Plains aquifer along the valley floor. This trend appears to have diminished at the end of Unit D deposition after which the stream once again incises. The coarsening of the alluvium within West Amarillo Creek during the deposition of Unit E, which begins to aggrade around 450 B.P., indicates a less effective vegetation cover is present, signaling a return to somewhat drier conditions.

This trajectory of Late Holocene environmental change is at once familiar and not, finding similarity in some paleoenvironmental records in the surrounding landscapes, but not others. The following section examines late Holocene environmental change on the High Plains north of the Canadian River, on the Southern High Plains (or Llano Estacado) south of West Amarillo Creek, and on the Rolling Plains east of the Llano Estacado.

High Plains (North of the Canadian River)

Paleoenvironmental studies from the High Plains immediately north of the Canadian River in Texas are uncommon. The record closest to this work is a suite of studies that occurred on Palo Duro Creek, a tributary of the North Canadian River in Hansford County, Texas (Frederick 1993; Caran 1989) prior to construction of a dam on that stream. In that area, a prominent phase of alternating fluvial and wetland (marsh/pond) deposition occurred in the late Holocene between 3880 and ca. 1440 B.P., after which the channel incised and resumed alluvial sedimentation around 1240 B.P., continuing until sometime after 900 B.P. The latter phase of alluviation appears to have occurred in tandem with renewed slope and fan activity that began after ca. 1500 B.P. and eolian sedimentation that occurred after 1000 B.P. Both the onset of mesic conditions and segue into more arid conditions appear to occur somewhat earlier in the Palo Duro Creek record than is documented here for West Amarillo Creek.

Late Holocene wetland sedimentation in northeast New Mexico and the western Oklahoma panhandle have also been documented in a limited fashion by Dalquest et al. (1990), who radiocarbon dated such deposits on Carrizozo Creek (3860 B.P.; shell), a small unnamed tributary of the Cimarron River on the Leighton Ranch (3770 B.P., charcoal), and Tesesquite Arroyo on the 101 Ranch (2630 B.P.; mollusk shell). Dalquest et al. (1990) interpret all of these exposures as beaver dams, but the lack of more comprehensive stratigraphic work, and the apparent regional correlation with the Palo Duro Creek record calls this interpretation into question.

Using a slightly larger frame of reference, Forman et al. (2001:20; Figure 13) plot the chronology of eolian activity in dune fields and associated loess deposits. They present a figure for the Southern Plains that shows a prominent absence in eolian activity between approximately 2300 and 1500 B.P. The nearest localities that exhibited eolian sedimentation between 1500 and ca. 1000 B.P. are in eastern Colorado, the Great Bend Sand Prairie, central Kansas, and Nebraska. Eolian activity was detected during this apparently quiescent period much further north (Nebraska Sand Hills, Wyoming, and Canada). Multiple localities record a resumption of eolian activity around 1000 B.P. and the concordance of eolian deposition is interpreted as a period of regional aridity.

Southern High Plains (or Llano Estacado)

The most extensively studied landscape in proximity to this project is unquestionably the Southern High Plains. Amarillo sits on the northern periphery of the Southern High Plains, which is separated from the Great Plains by the Canadian River valley (often referred to as the Canadian Breaks). Over the last 20 years Vance Holliday and colleagues have systematically examined most of the dynamic depositional settings in this landscape, which include small streams or draws (Holliday 1995); small ephemeral playas (Holliday 2008), and eolian sand sheets and dunes (Holliday 2001), leaving only the large saline lakes or *salinas* as relatively unexplored. The late Quaternary depositional record of this landscape, viewed together, provides a solid framework upon which to examine the environmental changes documented for West Amarillo Creek. In general terms, the period of apparently more moist conditions observed in Unit D in West Amarillo Creek, between roughly 2000 and 1000 B.P. is conspicuously absent from the depositional record of the Southern High Plains, but the return of more arid conditions around 1000 B.P. in West Amarillo creek is observed across the Llano Estacado.

Draws

Although there are numerous site specific studies of the sediments in the draws on the Southern High plains (e.g., Sellards et al. 1947; Johnson 1987; Holliday 1985; Haynes 1995; Frederick 1994; to name but a few) the most comprehensive summary of the draw deposits is Holliday's 1995 memoir, which summarizes stratigraphic work on the draws across the region. In this work Holliday posits a five member stratigraphic sequence for the younger valley fills within the draws, and within any single stratigraphic member multiple depositional facies are generally present. For the latter half of the Holocene, Holliday (1995:32; Figure 19) reports eolian sedimentation dominating between 7000 and 4500 B.P. (stratum 4s), followed by nondeposition and soil formation in most draws up to the present day, with a few draws exhibiting localized marsh or palustrine settings in the last 4,000 years, and eolian deposition in the last 3,000 years. All deposits in the late Holocene are considered by Holliday to be stratum 5. An organic rich muddy deposit (stratum 5m) is identified as the most common facies (Holliday 1995:41) during this period and it is reported to be more of a cumulic soil welded to the top of stratum 4 than a discrete marsh deposit. There are no studies that have attempted to examine the chronological or depositional details of this late Holocene palustrine deposit.

Eolian Sands

Holliday (2001) presents a summary of Holocene and Late Pleistocene eolian activity on the Southern High Plains compiled from a regional study. He found that the period between 2000 and 1000 B.P. is perhaps the period with the least active eolian sedimentation. This is followed by widespread regional evidence for dune activation after 1000 B.P. However, in the aggregate it is stated to be younger than 1500 B.P. (refer to Holliday 2001:97; Figure 5). This apparent gap in eolian activity is similar to that observed in the regional plot in Forman et al. (2001). Although Holliday (2001:105) states,

> the absence of substantial amounts of dune sand or sheet sand dating to the period 5000 to 1500 B.P. and abundant evidence for multiple periods of eolian sedimentation after 1500 cal yr B.P. suggest that the landscape of the Southern High Plains was largely stable from the end of the Middle

Holocene until <2 k.y. ago. Although there were episodes of eolian sedimentation 5000 to 1500 B.P., and some deposits have been removed by erosion <1500 cal yr B.P., the data from the draws (Holliday 1995) support this interpretation.

Playas and Playa Lunettes

The late Pleistocene and Holocene depositional record of the ephemeral playa lakes that dot the Southern High Plains has been examined by Hvorka (1997), but extensive dating of multiple playa deposits has only recently been accomplished by Holliday et al. (2008). In a study that documented the stratigraphy and geochronology of 30 playas across the Southern High Plains, Holliday et al. (2008) record more rapid sedimentation and the accumulation of black clay between 4000 and 2000 B.P. from which they infer more moist conditions. These deposits are often observed buried by eolian sands starting around 1300 B.P.

The leeward clay dunes or lunettes associated with playas offer perhaps a more sensitive indicator to alternating arid humid conditions than the playa deposits themselves. These dunes are formed by eolian deflation of desiccated mud curls from the floor of dry playas, and attendant accumulation as dunes along the fringe vegetation. Periods of dune growth are generally arid, when mud flats are exposed to drying, whereas more mesic periods are represented in clay dune lithological sequences by periods of soil formation. Frederick (1994; 1998) reported the results of radiocarbon dating a lunette formed on the eastern side of a small playa on the floor of Sulphur Springs Draw that exhibited three depositional cycles. The first occurred prior to ca. 3200 B.P., based upon a radiocarbon date on a buried soil formed at the top of this eolian deposit. The second phase of eolian aggradation occurred after 3200 B.P., but before 970 B.P., and added about 1.2 m of sediment to the dune. The third phase followed 970 B.P. after which the dune aggraded approximately 2 m in a punctuated fashion. The third phase of the Sulphur Springs Draw lunette clearly correlates with the widespread arid conditions inferred for eolian systems across the Great Plains in the last millennium. The second phase may also, but the available geochronology is too imprecise to be certain. Regardless, the minimal amount of clay dune growth between 3000 and 1000 B.P. indicates that this was a fairly stable (mesic) period on the adjacent playa.

Rolling Plains

A number of studies of Holocene geomorphic activity are available from the Rolling Plains, which lie along the east side of the Southern High Plains. Although a few of these studies provide paleoecological records (e.g., Hall and Lintz 1984; Hall 1982), most, like the studies from the Southern High Plains, do not. Rather they provide chronological records of erosion and sedimentation.

Several studies from the Osage Plains of central Oklahoma record a period of moist conditions between 2000 and 1000 B.P. For instance, in west to central Oklahoma Hall and Lintz (1984) reported that the environment of Carnegie Canyon was drier than today around 3200 to 2600 B.P., and became more moist between 1950 and 1000 B.P. when a rising water table was at or near the valley floor. The local environment returned to drier conditions around 1000 B.P. A similar trajectory of environmental change is argued for the same period by Hall (1982) on the basis of pollen, molluscan and micromamalian faunal data.

The onset of drier conditions around a 1000 B.P. is well documented by a regional resumption of eolian activity and appears to be accompanied by stream channel incision. Southeast of Lubbock at Boren Shelter, near modern Lake Alan Henry, Kibler (in Boyd et al. 1994:215-220) noted an increase in externally derived eolian sand that entered the rock shelter after 950 B.P. Brady (1989; Foreman et al. 2001) examined the chronology of eolian dunes superimposed on alluvial terraces of the Cimarron River in west to central Oklahoma and found that the most recent phase of dune activity began after 1200 B.P. based upon a radiocarbon date on a buried soil. More recently Lepper and Scott (2005) used optically stimulated luminescence dating and radiocarbon dating to narrow the age bracket for this period of eolian sedimentation to slightly before 880 B.P. and shortly after 770 B.P. Hall (1990) noted that there appears to be a regional period of stream channel entrenchment around 1000 B.P. and that synchronous changes of this nature in fluvial environments are typically thought to be indicative of a climatic stimulus, in this particular case, a shift from more humid to a more arid climate.

Abbott (1990) posited the presence of four geomorphic phases for the Double Mountain Fork of the Brazos River, three of which were in the latter half of the Holocene. Phase II was a period of catastrophic stripping that began during the early Holocene and continued until around 3000 B.P. After which aggradation of the Double Mountain Fork and its tributaries began and continued until around 1100 B.P. Following aggradation, around 1000 B.P. a phase of stream incision, alluvial fan deposition, and dune activation ensued, from which Abbott inferred the establishment of more arid conditions.

Boyd's (1997b:228) summary of late Holocene paleoenvironmental conditions for a 250 km radius around Lake Alan Henry found that arid conditions in the middle Holocene gave way to a more mesic climate between 2,000 and 1,000 years ago, that was followed by more arid conditions. In regards to the mesic interval, Boyd concluded that there is, limited regional geomorphic and faunal (i.e., prairie vole) evidence indicating that conditions between 2000 and 1000 B.P. may have been wetter than today. Circumstantial archeological evidence supports this inference, but more paleoenvironmental and archeological data are sorely needed. Unlike drying trends, the mesic periods may be less visible in the paleoenvironmental record and supporting data may be difficult to obtain. Boyd found considerable support for the establishment of drier conditions in the Panhandle Plains region around 1000 B.P.

Paleoenvironmental Summary

The multidisciplinary paleoenvironmental record obtained from Unit D within West Amarillo Creek clearly documents the presence of more humid conditions on the basin floor, but also in the catchment between approximately 2000 and 1500 B.P. The fact that pond and marsh habitats persisted after the basin vegetation became more xerophytic (between 1500 and about 800 B.P.; Unit D Late Stage deposits) is interpreted as a lag in system response, with climate changing more rapidly than the water table. Emergent groundwater appears to have supported wetland conditions well after the climate had shifted to a more arid state. The geomorphic system responded to this shift sometime between 800 and 450 B.P., and did so by channel entrenchment and a coarsening of the sediment load. This general response is typical for this period (cf., Hall 1990). Although, in the West Amarillo Creek record, the event is poorly dated, given that radiocarbon ages from the Late Stage Unit D deposits are imprecise and conflicting.

It seems somewhat paradoxical that the extensive paleoenvironmental record for the Southern High Plains immediately south of our study area provides few hints of a moist period between 2000 and 1000 B.P. Perhaps it is the position of the West Amarillo Creek valley well below the Ogallala caprock that lends it to be more sensitive to periods of ground water discharge from the High Plains

Aquifer. Holliday's (1995, 200; Holliday et al. 2008) work on the High Plains surface is presumably in a location where only very high water tables will exhibit significant geomorphic influence. With time, perhaps studies of streams along the margins of the Llano Estacado, in landscape positions like West Amarillo Creek, will be shown to be better indicators of mesic periods when ground water tables are elevated.

11.4.1.3 The Carbon Isotope Evidence from Bison Bones

To expand the paleoenvironmental discussion to the broader plains grasslands beyond the immediate confines of West Amarillo Creek valley, we examined bison diet as proxy evidence for the type of grassland community present through the years. The assumption was that the bison diet reflects the general C_3 and C_4 isotopic grasses present across the open grasslands where bison spent their time feeding. Bison are generalist in their feeding behavior and will consume whatever C_3 and C_4 grasses are available (Martin et al. 1951; Penden et al. 1974; Penden 1976). Central Plains bison from the Pawnee Grassland of northeastern Colorado are known to consume 80 to 85 percent warm season C_4 grasses, comprised mostly of drought resistant buffalo, grama, dropseed, and bluestem grasses (Penden et al. 1974; Penden 1976). The isotopic value derived from their bones is a broad indicator of what animals consumed over their lifetimes (Steinhouse and Baxter 1979), although the retained enrichment might only be for the last ca. 5 to 10 years of the animal's life (Stafford 1984:113-114). The general grassland composition should be reflected in the bison bone chemistry, specifically, stable carbon isotopes. The bison represented in West Amarillo Creek campsites consumed primarily grasses from the broader grassland communities surrounding the valley. They ate primarily C_3 and C_4 grasses that were available, and those C_3 and C_4 grass isotope signatures are recorded in their bones. Were a bison to eat only C_4 grasses, their bone collagen $\delta^{13}C$ value would average about -7.5‰ compared to a diet of only C_3 grasses that would average -21.5‰. These obtained isotopic values account for a fractionation affect of +5.0‰ that occurred between the dietary input from the plant consumed and what is retained in the bone collagen (Vogel 1978; Chisholm et al. 1986).

Teeri and Stowe (1976) established the amount of C_4 biomass in a plant community is temperature dependent. This is because as temperature increases and precipitation decreases, the C_4 grasses become more abundant in terms of biomass creating a more xeric (drier) grassland community. As C_4 grasses became more abundant, bison would undoubtedly consume additional C_4 grasses, which should signal an increase towards a more positive value in the C_4 isotopic signature in bison bones. If we examine the change from one general time period to another, the documented isotopic values should reflect whatever changes occurred in the grasslands biomass in the region over time.

To examine possible changes over time, stable carbon and nitrogen isotope values were extracted from 20 samples of bison bone collagen that represent 20 individual bison pertaining to the four general time periods represented over the last ca. 3,000 years in this project area (Figure 11-6, Appendix H). Bison bone collagen resists postmortem environmental exchange and digenetic degradation, so the obtained isotopic value derived from collagen will be an isotopic signature of the diet (Brumstead 1984).

The Late Archaic period sample was supplemented by $\delta^{13}C$ values derived from radiocarbon assays on bison bone collagen during the dating process. The Late Archaic, from ca. 1550 to 2750 B.P., yielded an average $\delta^{13}C$ value of -9.49‰ from 16 bone samples, reflecting roughly an 89

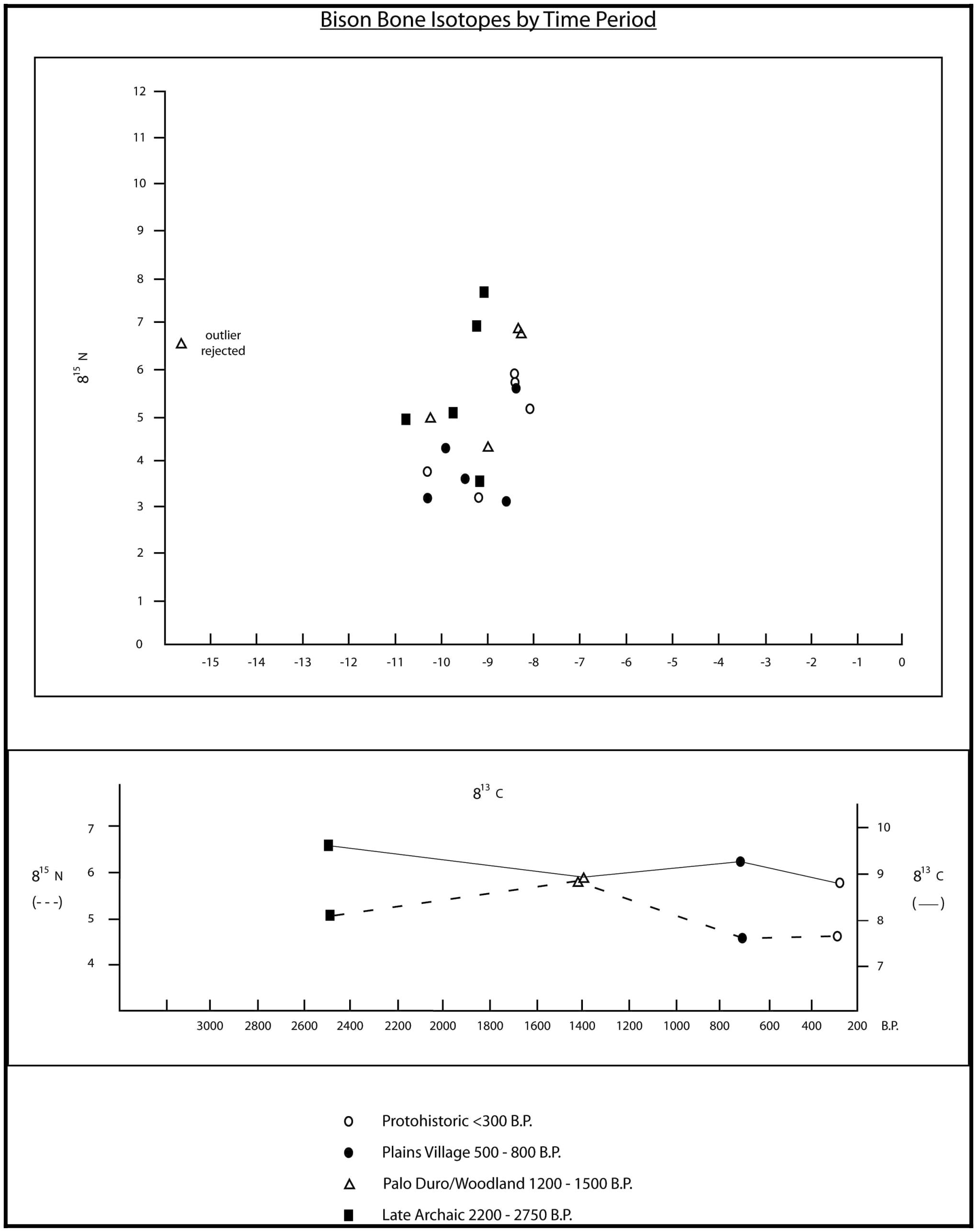

Figure 11-6. Graphs of the Carbon and Nitrogen Isotopic from Bison Bone Collagen Samples.

percent consumption of C_4 plants. The radiocarbon dates are used here to narrow down this nearly 1200 year long period into shorter time increments. The isotope values documented in these shorter periods reflect fluctuations over this same period. During the earliest 210 year, period from ca. 2510 to 2720 B.P., three $\delta^{13}C$ values average –8.83‰., which reflect a relatively xeric period with roughly 90 percent C_4 consumption. For the next 110 year period, from ca. 2310 to 2420 B.P., three bone $\delta^{13}C$ values average -9.2‰, which reflect a slight increase in C_3 plants. During the next 260 year period (from ca. 2010 to 2270 B.P.) five bone $\delta^{13}C$ values average -9.9‰, reflecting a continuing trend of increase in

C_3 plants. For the next 190 year period, from ca. 1550 to 1840 B.P., three bone $\delta^{13}C$ values average -9.23‰ revealing a slight increase of C_4 plants. The average $\delta^{13}C$ value detected for each period potentially reflects minor changes in the broader grassland composition in terms of the percentages of the C_3 and C_4 grasses.

The subsequent five Palo Duro/Woodland period samples dated between ca. 1200 and 1400 B.P. yielded an average $\delta^{13}C$ value of -8.95‰. If these average isotopic values reflect the true past grassland composition, then the surrounding grassland became slightly more positive (drier), documenting an increase of C_4 grasses from the previous period, ca. 2750 B.P. to the 1550 B.P. The five bison bones representing the Antelope Creek phase of the Plains Village period, ca. 500 to 800 B.P., yielded an average $\delta^{13}C$ value of -9.34‰. This indicates the grassland community changed again with a decrease of slightly 0.39‰ that reflects an increase in moisture that would support an increase in C_3 grasses. This reflects a return of the grassland community to close to what it was during periods in the Late Archaic.

During the Protohistoric period, between ca. 200 to 300 B.P., the five bison bone $\delta^{13}C$ values average -8.8‰. This indicates slightly drier conditions across the region, very similar to those during the period between ca. 1200 and 1400 B.P. This suite of bison bone isotope results document general periods of slight changes in grassland communities, or minimally, changes in bison grazing behaviors.

A broader suite of available bison bone isotopic results from radiocarbon dated contexts, which represent the last ca. 2,700 years across western and northern Texas and eastern New Mexico primarily document a broad range of $\delta^{13}C$ values ranging from about -7.5‰ through to -11.0‰, with a few outliers (Figure 11-7). Obvious isotopic changes across the broader regional grassland community are not clearly visible in this plotted data set. Bison bones identified to specific times reveal a range of C_3 and C_4 plants in such patterns that broad changes in the grassland biomass cannot be easily detected. Many factors may be influencing this lack of visible changes in the isotopic values from across the broader landscape. One factor is that the scale of the region involved, combined with the time involved, is too broad to detect the more subtle changes expected in the data. A second factor may be that the bison grazing pattern is not consistent enough to reveal the expected changes. A third possible factor may be that the preservation of bone collagen is not consistent within each bone to allow repeated isotopic values. A forth factor may be that the laboratory techniques are not sufficiently sensitive to consistently detect the small subtle changes. Also our sample sizes may be far too limited to reflect regional and/or chronological changes, given the possible variability in individual bison feeding behavior. Any or all these factors might be involved and additional research is required to resolve these issues.

Two of the three bison bone $\delta^{13}C$ values from the Certain site (34BR46) show significantly more negative $\delta^{13}C$ values, in the range of -13‰, than the sample from the Sanders site (41HF128), which yielded $\delta^{13}C$ values that average -8.1‰ (Figure 11-7). The Sanders site was radiocarbon dated to ca. 300 to 400 years older than the Certain site, but is ca. 140 km farther west. The very significant 4.9‰ difference in isotopic values undoubtedly reflects an increase in available C_3 grasses farther east. The east to west difference in $\delta^{13}C$ values corresponds to the known increase in C_3 plant grassland communities as one moves eastward from the short grass Plains to the mixed grass Prairies. Further support for this greater C_3 grass component farther east was also detected in the $\delta^{13}C$ value extracted from a modern bison bone from the Wichita Mountains towards central Oklahoma that yielded a $\delta^{13}C$ value of -13.5‰ (Quigg

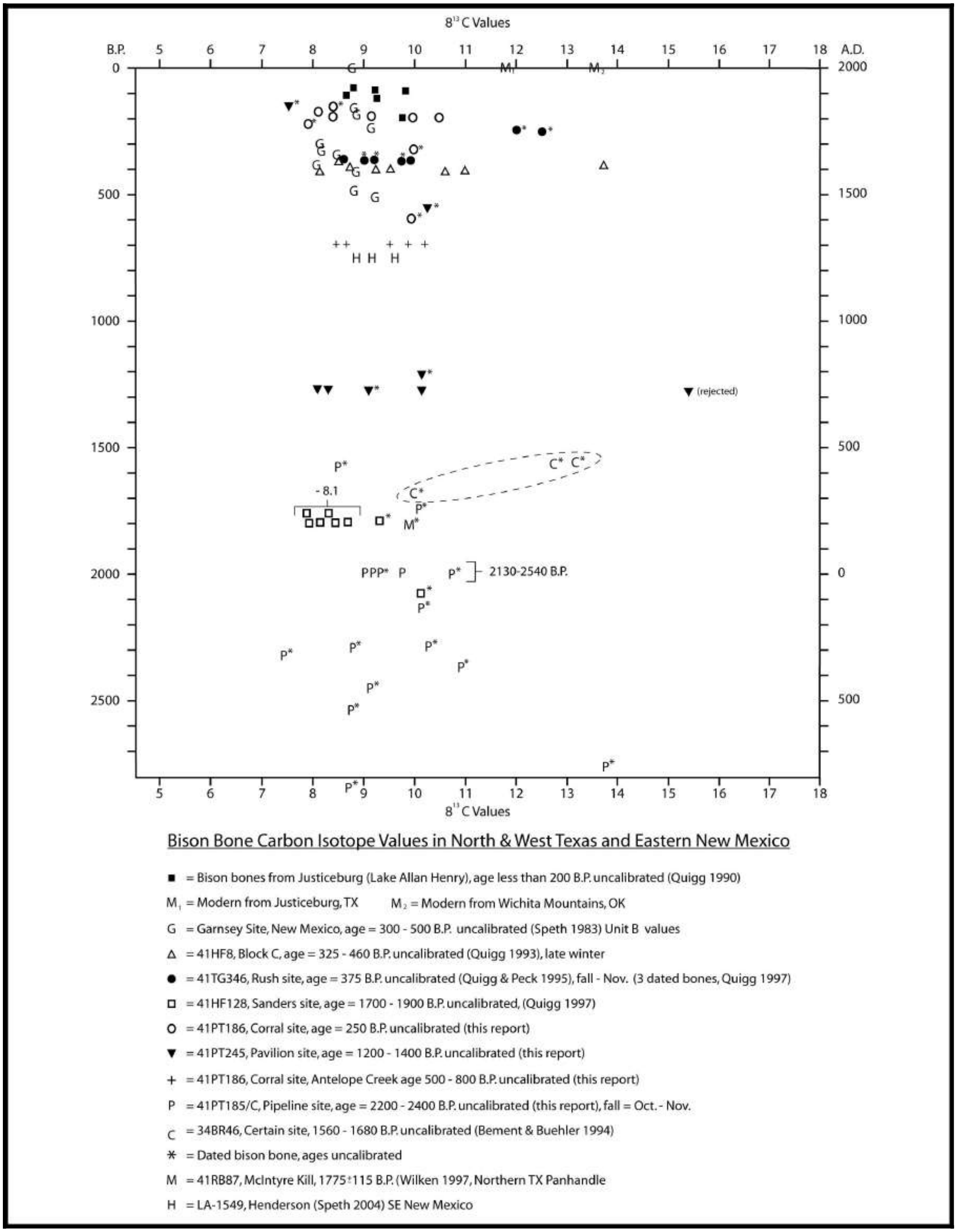

Figure 11-7. Compilation of Available Carbon Isotopic Results from Bison Bones from Across a Selected Region of the Southern Plains.

1997). This latter value reflects a nearly 57 percent consumption in C_4 grasses compared to nearly 95 percent consumption by the Sanders site bison.

If the relatively tight cluster of $\delta^{13}C$ values that average -8.1‰ from the Sanders site reflects a single bison herd killed at a single point in time, as is suspected, then the dispersed $\delta^{13}C$ values that range from -7.5 to -10.9‰ for the radiocarbon dated bones from the Pipeline site (41PT185/C) potentially reflect a bison population that was gathered from a broad region and dispatched at different times or potentially in a communal kill. This is just speculation, and additional data are required concerning the precision of laboratory processing, and a greater understanding of isotope variation within bison bones, are both needed to for more confident interpretations.

In the following sections, more general discussions are presented under the headings of broad research issues. Seven broad issues: chronology, subsistence, settlement patterns, exchange and interactions, technology, intrasite patterns, and social organization are addressed using the data gathered from the Landis Property.

11.4.2 Chronological and Cultural Affiliation Issues

Here, we summarize the cultural time periods identified across the 1.6 km long Landis Property. Four specific cultural periods were identified: the Protohistoric, the Late Prehistoric (probably including the Antelope Creek phase of the Plains Village period), the questionable Palo Duro/Woodland complex, and the Late Archaic period (Figure 11-8). The obtained absolute dates indicate that this limited section of West Amarillo Creek valley was favored by prehistoric populations on an ongoing, though intermittent, basis, probably seasonally over the last ca. 3,000 years. It should be noted that evidence for a ca. 4,000 year long time period between ca. 4200 and 8200 B.P. was not preserved in the alluvial deposits in this section of the valley, so that no human occupations for that period were represented. This ca. 4,000 year period is considered the hottest and driest period in the Holocene and is often defined as the Altithermal in the western United States (Antevs 1955). Each general time period is discussed below, beginning with the youngest and moving back through time.

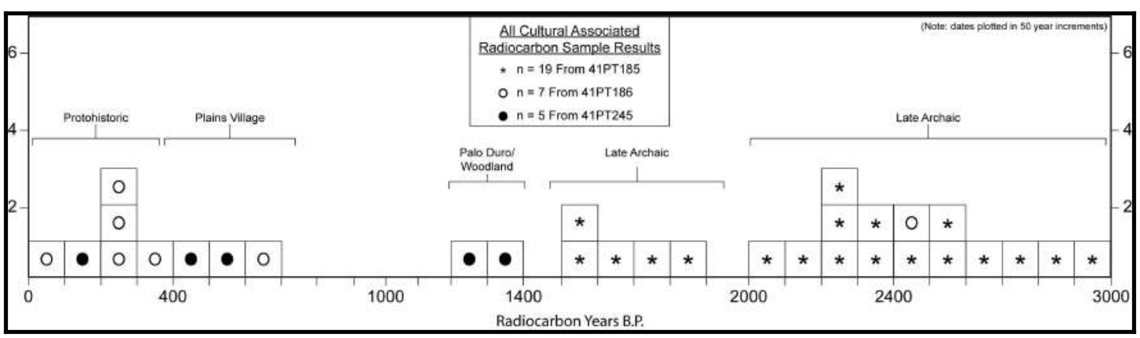

Figure 11-8. Summary of Radiocarbon Dates in 50 Year Intervals Derived from the Landis Property.

The most recent cultural occupation occurred during the Protohistoric period. Six radiocarbon dates fall within the last ca. 400 years and include a charcoal date of 430 B.P. from deeply buried Feature 4/5 at the Pavilion site. This date was associated with burned rocks (Feature 4/5) from two isolated test units into the lowest T_{0a}. Sparse cultural materials were recovered from around Feature 4/5 and they could not be assigned to a particular group or broaden our understanding of this period.

The Protohistoric period is represented by five radiocarbon dates from two separate contexts at the Corral site (see Table 11-1; Figures 11-8 and 11-9). The intensively excavated Protohistoric component at 41PT186 was radiocarbon dated by three samples to ca. 200 to 300 B.P. No diagnostic projectile points or ceramic sherds were directly associated with these dates. The absence of chipped stone projectile points and bifaces from this component may be attributed to the replacement of these classes of artifacts with European metal goods that included metal knives and firearms. One metal tinkler cone was associated with this occupation, indicating that the occupants of the site did have access to items of metal. One tiny, plain sherd, a few modern clear glass fragments and a metal tobacco tag from this Protohistoric context are considered intrusive to the Native occupation.

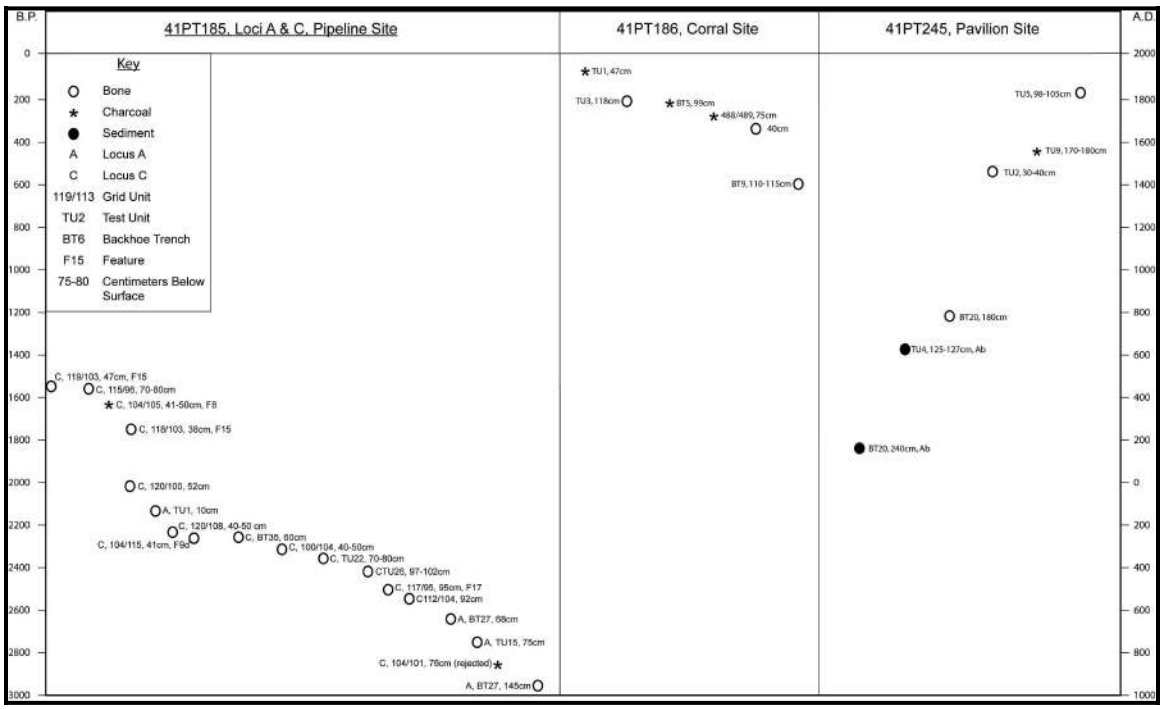

Figure 11-9. All Cultural Radiocarbon Dates from the Three Investigated Sites within the Landis Property.

Also at the Corral site, two dates, one on charcoal of 80 B.P. and a bison bone date of 340 B.P., were from mixed context next to the corral in the broad T_1. Mixing of cultural materials was apparent as these two dates were stratigraphically inverted. The mixed deposits prevent any clear understanding of the possible artifact associations with these two dates.

Five radiocarbon dates occur during the very significant Protohistoric period for the Southern Plains. This period experienced considerable cultural change manifested all across the region when Europeans began traveling through and establishing settlement or outposts along the margins of this region. These intruders caused significant cultural modifications to the Native lifeway and influenced Native peoples both socially and techno-economically. Natives became highly mobile once the horse was acquired and direct conflict between Native groups and the European intruders was intermittent and episodic.

The Protohistoric period is represented by scattered Native encampments in the archeological record across western Oklahoma and along the eastern Caprock Escarpment in Texas (i.e., Hofman 1984, 1989; T. Baugh 1986, 1992; Johnson 1992; Boyd 1997; Baugh and Perkins 2008). The two recognized Protohistoric occupations are quite significant because of their presence. This valley must have contained the necessary resources to provide basic needs of food, water, and shelter from enemies. However, limited cultural materials were recovered. The block excavations at the Corral site exposed a unique and excellent context. The cultural occupation was sealed soon after abandonment by mostly fine sediments, roughly 1 m below the surface. This highly desirable context allows for examination and interpretation of human behavior at this locale during the Protohistoric period. The sparse artifact assemblage, combined with the utilitarian nature of the assemblage, provides no substantial clues as to the cultural affiliation of the group(s) that camped at the Corral site. With considerable movement of Native populations during the Protohistoric period, this camp could have been occupied by any of several ethnographically identified groups.

A second use period was documented by two radiocarbon dates on bison bones associated with limited cultural debris, and lacked diagnostic chipped stone projectiles. This period represents the few hundred years between ca. 450 and 750 B.P. (see Figures 11-8 and 11-9). A bison bone from mixed context in an isolated test unit in the broad T_1 at the Pavilion site (41PT245) yielded a date of 540 B.P. A second date of 600 B.P. was obtained on a bison bone from the very western end of BT 9 at the Corral site (41PT186) where many bison bones were concentrated.

Sparse cultural materials (i.e., a broken beveled knife, a couple of Alibates end scrapers, a couple of cordmarked and plain ceramic shreds, and one or two unnotched unifacial arrow point fragments, Figure 11-10) from 41PT185/A and 41PT186 were attributed to this period. These few artifacts, combined with the two radiocarbon dates on bone, reflect the local Antelope Creek phase of the Plains Village period. This phase is described in the literature as representing a bison hunting and part time agricultural population that normally lived in permanent structures (Lintz 1978a, 1984, 1986, 1991;

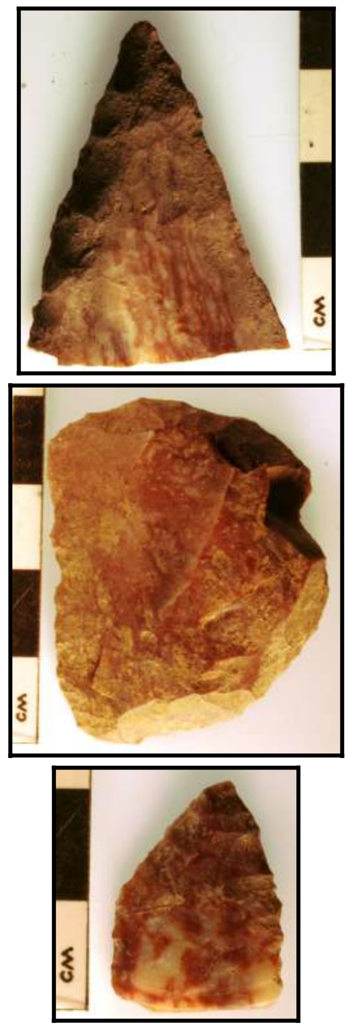

Figure 11-10. Alibates Beveled Knife (#41PT185/A, 1118-010, top), Alibates End Scraper (#41PT186 342-010, middle), and Unnotched Point Base (#41PT186, 326-010, bottom) Typical of Antelope Creek Phase Artifacts.

see Brooks 2004 for recent review). Within our project area, no house structures or cultigens were identified, making assignment to a specific cultural affiliation open to question. Antelope Creek houses and sites attributed to this phase are documented at the mouth of West Amarillo Creek all across the immediately surrounding region. It is, therefore, logical to infer that Antelope Creek people occupied this valley. The third use period, radiocarbon dated to between ca. 1200 and 1400 B.P., is again defined by very sparse camp/bison processing debris found towards the northern end of the Pavilion site (Figures see 11-8 and 11-9). A second possible limited activity locus was above the targeted Late Archaic component at 41PT185/C. At the Pavilion site, a minimum of two cultural occupations are represented by two radiocarbon dates of 1210 B.P. and 1390 B.P. and by two closely spaced, sparse layers of butchered bison bones. The very limited cultural debris included no diagnostic points or ceramic sherds directly associated with these two dates. Apparently, most associated materials had eroded away or were quite small. This limited ca. 200 year period may be related to either of two identified archeological manifestations, the Palo Duro or Woodland complexes. The lack of diagnostic artifacts prevents assignment to either manifestation.

At 41PT185/C, two small, different forms of untyped corner-notched arrow points, plus two tiny ceramic sherds (Figure 11-11), were recovered from just above the Late Archaic component. These artifacts may represent this time period. The smallest arrow point would fit within the poorly defined Woodland assemblages. The larger arrow point has some general resemblance to points recovered in Palo Duro assemblages. Their stratigraphic position above the well dated Late Archaic assemblages indicates the appropriate time period. However, the relatively limited understanding of the range of variation of point styles in the Palo Duro and Woodland assemblages makes positive assignment unrealistic. These artifacts were in a ca. 10 to 15 cm thick arbitrary excavation level, and one or more of these artifacts were potentially vertically displaced within the profile. It is not clear if these artifacts are representative of the same cultural group or even the same time period. The Palo Duro complex is better represented by sites further south of the Canadian River valley, but this complex is considered to have existed within this region (Boyd 1997).

Figure 11-11. Two Arrow Points (#1063-010 top and #1198-010 center) and Decorated Sherd (#915-8-001 bottom) from just above the Late Archaic Component at 41PT185/C.

Woodland occupations are not well represented in the region, creating difficulty in the general assignment of individual artifacts.

The fourth use period is best represented at the large excavation block at 41PT185/C. There, two clusters of absolute dates, one at ca. 2400 B.P. and the second at ca. 1600 B.P., document at least two Late Archaic occupations separated by around 800 years. (see Figures 11-8 and 11-9). This component yielded diagnostic corner-notched dart points and a corner-tang knife, which are congruent with the 14 radiocarbon dates. This component rests on top of, or in some instances just into, the ca. 8,000 year old light colored sediments of Unit B. Obviously a massive time incongruity exists between the very old sediments and the much younger Late Archaic occupations at this locality. Time, lack of deposition, and turbation account for the younger Late Archaic artifacts being in contact with the older Unit B sediments.

In addition to the intensively investigated Late Archaic component at 41PT185/C with its two occupations, at least four other Late Archaic occupations are represented across the Landis Property. Locus A at 41PT185 yielded three bison bone radiocarbon dates of 2490 B.P., 2640 B.P., and 2940 B.P. all of which are attributed to the Late Archaic period. These dated bones document the presence of bison during this period, although the lack of cultural materials directly associated with these dated bison bones leaves open the possibility they may not reflect human occupations. A corner-notched dart point from a rodent backdirt pile on the terrace surface at 41PT185/B also reflects use during the Late Archaic. At the Corral site (41PT186), two additional radiocarbon dates on bison bones, 2130 and 2490 B.P. support use of this area at that time. A radiocarbon date of 1840 B.P. on sediment directly associated with bison bones was obtained from the Pavilion site. The Late Archaic, dating from ca. 3000 to 1500 B.P., is represented at each investigated locality. These multiple dates and multiple occupations indicate more intensive use of this limited section of West Amarillo Creek valley than for any other time within the last 3,000 years.

Several Late Archaic sites in the broader region have been radiocarbon dated (Figure 11-12). Major excavations at the Sanders site (41HF128), a Late Archaic campsite/garbage dump in the northern end of the Texas Panhandle, was radiocarbon dated to 1700 to 1800 B.P., only slightly earlier than the younger cluster of dates from 41PT185/C. At the Sanders site, two bison bone collagen dates from that single occupation provide dates that average ca. 1943 B.P., which is some 133 years older than three charcoal derived dates at that same site (Quigg 1997). Of the six currently dated bison kill sites in the Texas Panhandle region; only Strong, with a date of 980 B.P., appears younger than 1000 B.P. All other dated bison kill sites in the Texas Panhandle document a use period that is older and associated with the Late Archaic. Four bison bone dates from the Certain site in western Oklahoma and two bone dates from the Twilla kill in the Texas Panhandle document an age range between ca. 1130 and 1440 B.P. Thus, seven bone dates from three sites are younger than ca. 1500 B.P., 13 radiocarbon dates from five sites fall between ca. 2000 and 1500 B.P., and another 12 dates from two sites occur between ca. 3000 and 2000 B.P.

The cluster of four uncorrected bone collagen dates that average 1395 ± 80 B.P. from the Certain site postdate a charcoal date (1730 ± 60 B.P.; Beta-66019) derived from a hearth directly above the uppermost bone bed in Trench C (Figure 11-12).

In southeastern Colorado the Late Archaic period is well represented by many sites dispersed throughout the Arkansas River Basin, with some 50 radiocarbon dates (Zier and Kalasz 1999). The obtained dates document a period of use of ca. 1,150 years, from ca. 3000 to 1850 B.P. Towards the

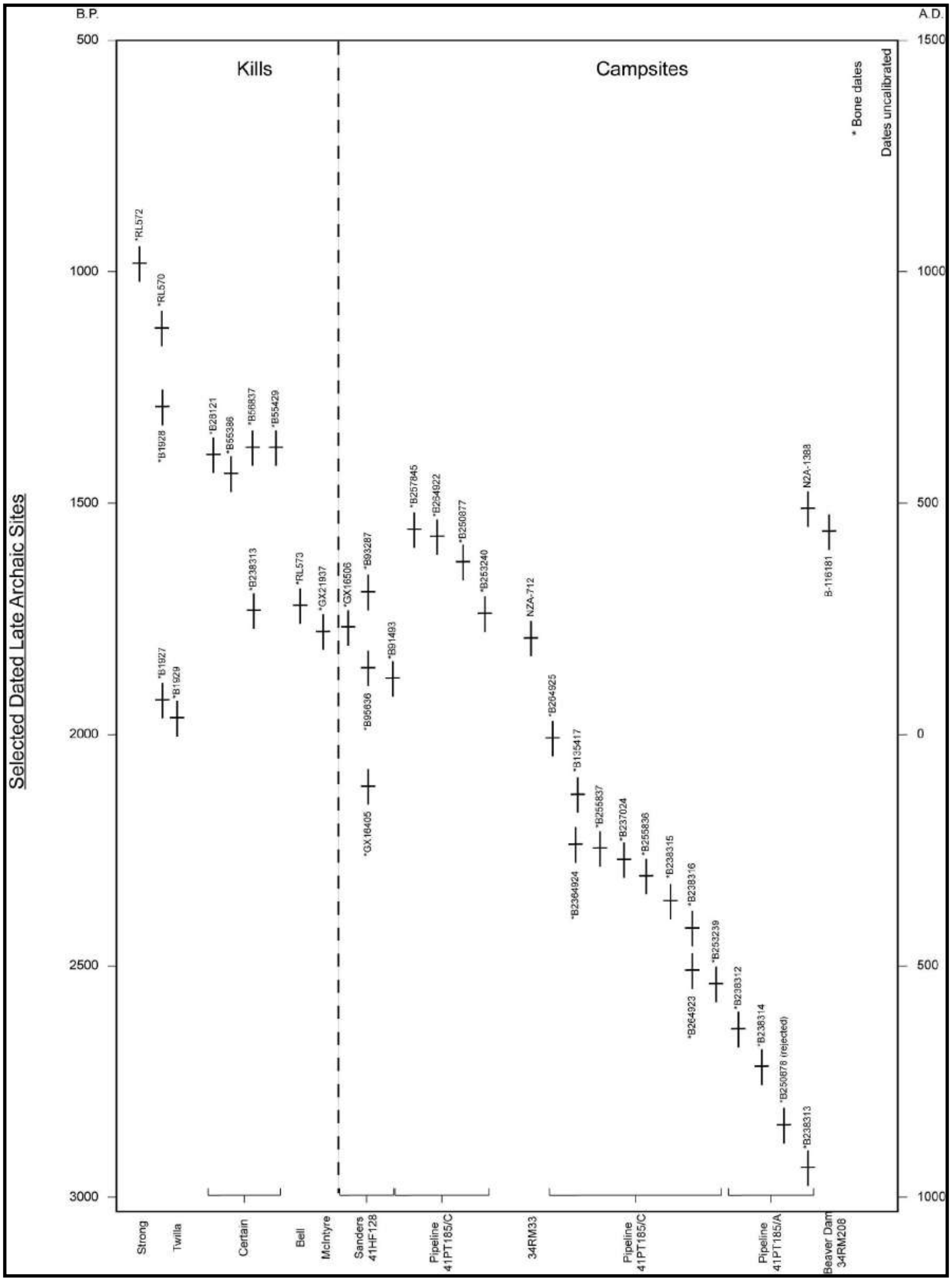

Figure 11-12. Graph of Radiocarbon Dates from Selected Late Archaic Sites in the Texas Panhandle Region and Western Oklahoma.

recent end of that range, the Late Prehistoric period begins in southeastern Colorado. This beginning is apparently much earlier than the beginning date of Late Prehistoric in the Texas Panhandle region, as indicated by the radiocarbon dates from bison kill sites and two well documented campsites. This Southern Plains region appears to have been occupied by mobile Late Archaic populations during a period from ca. 2940 to 980 B.P. Currently, all these dates are accepted for the Late Archaic, although some of the younger dates are possibly too recent and may eventually be found to be incorrect. Continued radiocarbon dating of buried occupations with good context will refine the timing of the Late Archaic across the Southern Plains.

11.4.3 Subsistence Issues within West Amarillo Creek Valley

For the most recent period of occupation, the Protohistoric, dated to between ca. 200 and 300 B.P., there is excellent preservation at the Corral site, 41PT186. The faunal assemblage was in good condition and the macrobotanical/charcoal was well preserved in several cultural features. The principal meat resource was bison (MNI = 2) and deer are represented, as well. No carbonized seeds, nuts, or other potential food resources were present in the macrobotanical assemblage, which indicates that these and similar foods may not have been favored. However, starch grain analysis on the burned rocks indicates that selected plant resources were also relied upon, specifically wildrye (*Elymus* sp.) grass seeds. The wildrye starch grains were both damaged by processing and gelatinized through cooking. The identification of bison and wildrye reflect a generalized hunting and gathering subsistence strategy, with focus on these two food resources. Additionally, use-wear analysis documented the presence of raphide phytoliths which are linked to various species of agave cactus. Although these plants were probably present, no evidence exists to indicate they were consumed. Just because raphides were present on some stone tools, does not indicate agave and similar plants were consumed as food.

During the slightly earlier Plains Village/Antelope Creek period, between ca. 500 and 800 B.P., bison appear to have been the dominant meat resource. Block excavations did not target this period, therefore the full range of food resources is unknown. It is known that other Plains Village sites in the broader region have yielded a variety of cultigens such as corn, beans, squash, and native plants (e.g., Green 1967; Keller 1975; Lintz 1984; Brooks 1994, 2004; Quigg and Smith 2005; Quigg et al. 2007).

Moving back in time to the third period of occupation, between ca. 1200 and 1400 B.P., of unidentified cultural affiliation, bison was still the favored meat resource, and wildrye (*Elymus* sp.) grass seeds were again part of the repertoire of plant resources employed. Large herbivore (i.e., bison) products were cooked with hot rocks, as demonstrated by the lipid residues from burned rocks in Feature 2 at 41PT245. These same burned rocks also yielded Canadian wildrye (*Elymus canadensis*) starch grains. Because of the very limited excavations relevant to this period, we have very limited evidence for interpretation, although it is clear that there was occupation within the project area at this time.

During the earliest period of human presence identified in the Landis Property, the Late Archaic, bison bones again dominated with deer and dog both present. Bison bones occurred in the components at 41PT185/A, 41PT185/C, and at 41PT245. The macrobotanical assemblage, in association with these Late Archaic camps, was nearly nonexistent, which is attributed to poor preservation. However, the starch analysis indicated that Canadian wildrye grass seeds were a significant native plant food resource. One unidentified starch grain extracted from a burned rock was identified as belonging to a root. Starch grains from grasses other than wildrye were also present, but remain unidentified. Large herbivore (i.e., bison) products were definitely cooked with hot rocks as demonstrated in Feature 11 at 41PT185/C.

Across the Texas Panhandle and into Oklahoma, bison were the primary animal resource documented during the period from ca. 1300 to 3000 B.P. (Hughes 1977, 1989; Bement and Buehler 1994; Quigg 1997, 1998; Buehler 1997; Kraft 2005a, 2005b). This is demonstrated by the radiocarbon dating at six identified sites where bison were the sole targeted animal. A minimum of four other bison kill sites (Finch, Hoover, R. O. Ranch, and Sitter) with large corner-notched dart points, have been identified along the eastern Caprock Escarpment in Texas, but lack radiocarbon dates (Hughes 1977, 1989), although the corner-notched dart points (except at R. O. Ranch) support placement in the Late Archaic. Even the excavated Late Archaic and radiocarbon dated campsites, such as the Pipeline and Sanders sites (Quigg 1997, 1998), document a near complete reliance on bison for meat during this period. The latter two campsites document bison processing during a minimum of two seasons, fall and spring. The majority of the multiple kills at the Certain site also occurred during the fall (Bement and Buehler 1994; Buehler 1997).

Although the identified Late Archaic kills and a few campsites have yielded bison remains, the numbers of bison at each site are relatively low in comparison to the much larger numbers from kill and camp sites on the plains north of central Colorado (i.e., Frison 1970, 1971, 1973, 1974, 1978a; Frison and Reher 1970; Fawcett 1987; Todd et al. 2001). The estimated number of animals for the kill sites along the eastern escarpment in Texas varies considerably from one report to another (Hughes 1977, 1989 and Fawcett 1987) with the highest frequency projected at ca. 50 animals at Twilla bison kill (Fawcett 1987). Twilla might contain as many as four separate kill events based on the four different radiocarbon dates obtained, which would indicate that each kill was relatively small. In the Southern Plains, most kills reflect relatively few animals, between ca. 3 and 35. The two intensively excavated campsites, Pipeline and Sanders, with sizeable excavated areas, 285 m^2 and 115 m^2 respectively, also yielded few bison with a MNI of 13 and 12 animals respectively. Apparently large bison herds were not present or humans targeted carefully selected groups of bison or possibly culled animals on a consistent basis to account for so few animals in the kill and camp sites in Texas. The current faunal evidence from southeastern Colorado does not support bison as the principle meat resource (Butler 1992, 1997; Zier and Kalasz 1999). There, deer dominated most faunal assemblages. This fact reflects major differences in subsistence within the Southern Plains, specifically from the Texas Panhandle region into southeastern Colorado.

The Beaver Dam site in Roger Mills County in western Oklahoma is the best example of other resources being procured by Late Archaic peoples. Feature 10 was a 30 cm deep pit hearth that contained charcoal, organically stained sediments, and a corner-notched dart point. Burned rocks, lithic debitage, and a bone bead were recovered from the area immediately surrounding the hearth. The faunal assemblage from Feature 10 yielded unidentifiable small mammal bones; however, an observed rodent disturbance may have contributed these small nonbison bones to this feature (Kraft 2005a).

Not only were bison procured for food, but evidence for native plant resources was detected at 41PT185/C. The Canadian wildrye (*Elymus canadensis*) starch grains from burned rocks, chipped and ground stone tools provide excellent evidence that these Late Archaic populations who occupied this section of West Amarillo

Creek also gathered native plants for food. The detection of damaged wildrye grass seeds on manos and metates clearly reveals that these seeds were ground and prepared. Also, the recognition of gelatinized wildrye starch grains on burned rocks clearly indicates that the grass seeds were used as food. For the Late Archaic especially, this is one of the few times that data analyses actually yielded evidence of the use of native plants for food. Another example was at Beaver Dam in western Oklahoma. Flotation of 7 liters from Feature 10 yielded 84 charred Chenopodium/Amaranthus seeds, 20 purslane (*Portulaca*) seeds, 10 barnyard grass (*Echinochloa*), one bulrush (*Scirpus* sp.), two marshelder (*Iva* sp.), nine muster (*Cruiferae*), one spikerush (*Eleocharis*) seed, and a couple of nutshells including one acorn shell (*Quercus* sp., Kraft 2005a). Site 41PT185/C and the Late Archaic component at the Beaver Dam site, provide two examples of well documented use of native plants for food in the Southern Plains. In the future, the processing of feature sediments by flotation, combined with starch grain analysis, should provide an even greater list of native plants used by these populations.

Optimal foraging theory suggests that selection of foods by hunter-gatherers is not directly dictated by abundance, but by cost and benefits (Winterhalder 1981:20-25). This is based on the caloric return weighted against cost of seeking, gathering, and processing. Although the cost figures for the seeking, gathering, and processing of wildrye seeds are not known, it is estimated to be quite high. Therefore, the sheer reliability, abundance, and storability may be benefits that outweighed the costs.

In general terms, the populations that occupied this part of the valley can be referred to as broad spectrum hunters-gathers-foragers that adapted to the specific valley conditions and resources. Here, the food resources most prominent were bison and wildrye grass seeds. What other food resource patches were sought and used throughout other seasons can only be determined through excavations of many more sites related to these same time periods in widely dispersed parts of the Southern Plains.

11.4.4 Settlement and Community Interactions

The Corral site excavation block yielded an excellent glimpse into human behavior during the Protohistoric period. Although the artifact assemblage was meager at best (*N* = 863 cultural items), the horizontal distribution of the cultural materials revealed specific and well defined activity areas. The two ash dominated heating elements (Features 7 and 8) were ca. 3 m apart towards the front part of the low terrace. A large discard pile of ash (Feature 1) was about 2 m east of heating element, Feature 7, with a localized knapping area (4 m^2) next to this same hearth. Towards the back of the terrace, some 6 to 7 m from the two heating elements, was a discarded pile of partially butchered bison bones that represent a minimum of two bison. At the northern end of the block was an irregular, ca. 2 m, elongated area where knapping activities, specifically production and rejuvenation of end scrapers, were undertaken. That area also yielded one broken scraper. Near the front of the terrace, and isolated from the other features, was a small 20 cm diameter cache of stone tools containing four finished and used end scrapers, two utilized flakes, and two large flakes with use-wear.

The horizontal distribution within this excellent context documents the clear separation of the heating elements, with obvious discard of ash and bones eastward toward the back of the terrace. Minimally, two individuals were involved in knapping activities during this one short term camp. These human behaviors were undoubtedly not unique to the Protohistoric occupants, but are not normally discernible in archeological sites where the imprints of repeated occupations generally overlap within palimpsest deposits. This type of specific patterning at campsites is what we hope to discover during excavation, but rarely is such a clear definition revealed.

For the second use period, ca. 450 to 750 B.P., very limited cultural remains were discovered. The majority of remains were bison bones immediately adjacent to the creek channel at the western end of the Corral site. That concentration of bison bones, many of which were skull parts, articulated sections of the vertebrae columns, and large, mostly intact leg elements, reflect a possible small kill area. A limited number of artifacts are attributed to this period within the Landis Property. Beyond this limited area, the broader region contains a considerable number of sites attributed to this Late Prehistoric period. Consequently, the populations representative of this period are known to have been present within the region. This restricted location inside the valley potentially served as an area where bison were procured and only limited camping activities were conducted.

The limited span of ca. 200 years identified for the period between ca. 1200 and 1400 B.P. left behind primarily scattered, butchered bison bones, though one heating element (Feature 2) was also present at the Pavilion site. At least one of the occupations occurred in the fall. The lack of recognized cultural artifacts associated with the bones may reflect a limited function processing site, as opposed to a camping locality. It is possible that camp related artifacts were present in the adjacent higher terrace, but were in mixed deposits and not recognized. The lack of recognized camp debris may also indicate that the groups camped elsewhere in the broader region and used this valley primarily as a hunting territory. This southern tributary to the Canadian River is near the postulated northern boundary of the Palo Duro Complex, as well as the southern extent of the more northern and eastern Woodland populations. This region may have served as an intermediate hunting area used sporadically by one or both populations.

During the Late Archaic period, ca. 1500 to 2500 B.P., groups repeatedly occupied this section of the West Amarillo Creek valley. Apparently all the resources necessary for a long term camp, such as wood, water, bison, and Canadian wildrye grass, were available to cause groups to return to this specific location on a somewhat regular basis. This general location was used during the fall on at least one, and probably two occasions. The repeated use of this limited section of the valley is not a unique occurrence during the Late Archaic in the Southern Plains. A limited area along the Rolling Red Bed Plains at the Dempsey Divide in Roger Mills County, Oklahoma has also revealed many Late Archaic sites (Thurmond 1991a; Kraft 2005a; Rebnegger 2006). Similar to West Amarillo Creek valley, wood, water, and food resources apparently were sufficiently abundant to draw groups there on a repeated basis. Feature 10 at the Beaver Dam site showed repeated use no less than five times (Kraft 2005a:19). This cluster of Late Archaic sites in Roger Mills County is ca. 32 km northwest of the Certain bison kill site. The latter includes six separate arroyos that contain bison bone bed deposits. Tooth eruption patterns of bison mandibles implicate that the Certain site was extensively used in the fall (Bement and Buehler 1994; Buehler 1997).

Thus, a picture of region wide settlement pattern is emerging for this general time period, a pattern that involved the reuse of protected valleys in the fall of the year. These settings provided abundant native plant resources as well as bison. These two food resources were presumably sufficiently available in the fall to provide surplus food supplies for the winter months ahead. It is not clear if the mobile bison were unavailable throughout the winter months, or just were not hunted during that period.

Currently, the data indicates that a high percentage of the known Late Archaic bison kill sites in the Southern Plains were occupied during the fall.

11.4.5 Exchange and Regional Interactions Patterns

In broad terms, direct evidence for trade/exchange is very limited during the Late Archaic, but is definitely present at 41PT185/C. By far, the majority of the lithic materials identified were of local Alibates and Tecovas with lesser quantities of local Ogallala gravels. Central Texas Edwards chert and New Mexico obsidian are the only two lithic materials recognized as items reflecting nonlocal lithic resources and thus, interactions with nonlocal populations. The obsidian from the mountains in north central New Mexico indicates east to west interactions, undoubtedly with groups who knew of, and had ready access to, the outcrops in the high mountains (Figure 11-13). The mere presence of a few biface thinning flakes of Alibates in the obsidian source areas in northcentral New Mexico does indicate that some trading or at least east to west movement of lithic materials occurred (Wiseman 1992).

A cluster of Late Archaic sites in Roger Mills County in Oklahoma also reveals a near total reliance on local lithic resources (Thurmond 1991a; Kraft 2005; Rebnegger 2006). There, Ogallala gravels outcrop in many localities across the Dempsey Divide and these materials were extensively used by Late Archaic groups. Ogallala quartzite was used to manufacture a broad suite of chipped stone tools, including projectile points and bifaces, gouges, and unifaces. Grinding slabs from the Beaver Dam site were made of sandstone (Kraft 2005a). As an example, over 90 percent of the debitage from 34RM507 represented Ogallala or other quartzites, whereas the nonlocal Alibates and Tecovas represented less than two percent (Rebnegger 2006). The presence of Alibates and Tecovas in western Oklahoma may further indicate east to west trade interactions. However, some of those nonlocal materials may have come from river gravels that washed downstream from the primary outcrops in the Texas Panhandle.

Extensive use of local quartzites, Potter chert, and even silicified wood were also documented in the projectile points recovered from the Late Archaic bison kill sites across the Rolling Red Bed Plains in the Texas Panhandle (Hughes 1977, 1989). Obviously, Late Archaic groups scattered across the Southern Plains relied heavily on local stone to manufacture their tool assemblage. Actual exchange or trading for nonlocal lithic resources appears to have been quite limited. It is possible that individual groups were so widely scattered that interactions were limited or that lithic resources were not the items of primary interest in extensive exchange.

Obsidian was also present at 41PT185/A and 41PT186, but the precise age(s) of those pieces is not clear. No obsidian was recovered from the extensively excavated Protohistoric component at the Corral site, which seems an anomaly. The Protohistoric Garza phase further south, and the Wheeler phase further east have yielded limited quantities and small percentages of obsidian from a minimum of seven sites (Baugh 1986). Obviously obsidian was exported onto the Southern Plains during Protohistoric times. In fact, during the earlier Plains Village period, obsidian was a major exchange item with relatively high frequencies of obsidian coming from central New Mexico (i.e., Lintz 1986; Brosowske 2005). The near absence of nonlocal tool stone in the assemblages reflects intensive focus on local chert resources. This may indicate that regional interactions were limited, or poor visibility/preservation of the goods exchanged. It may also imply that the exchange networks in place during the Late Archaic period were not well established and that exchange may not have occurred on

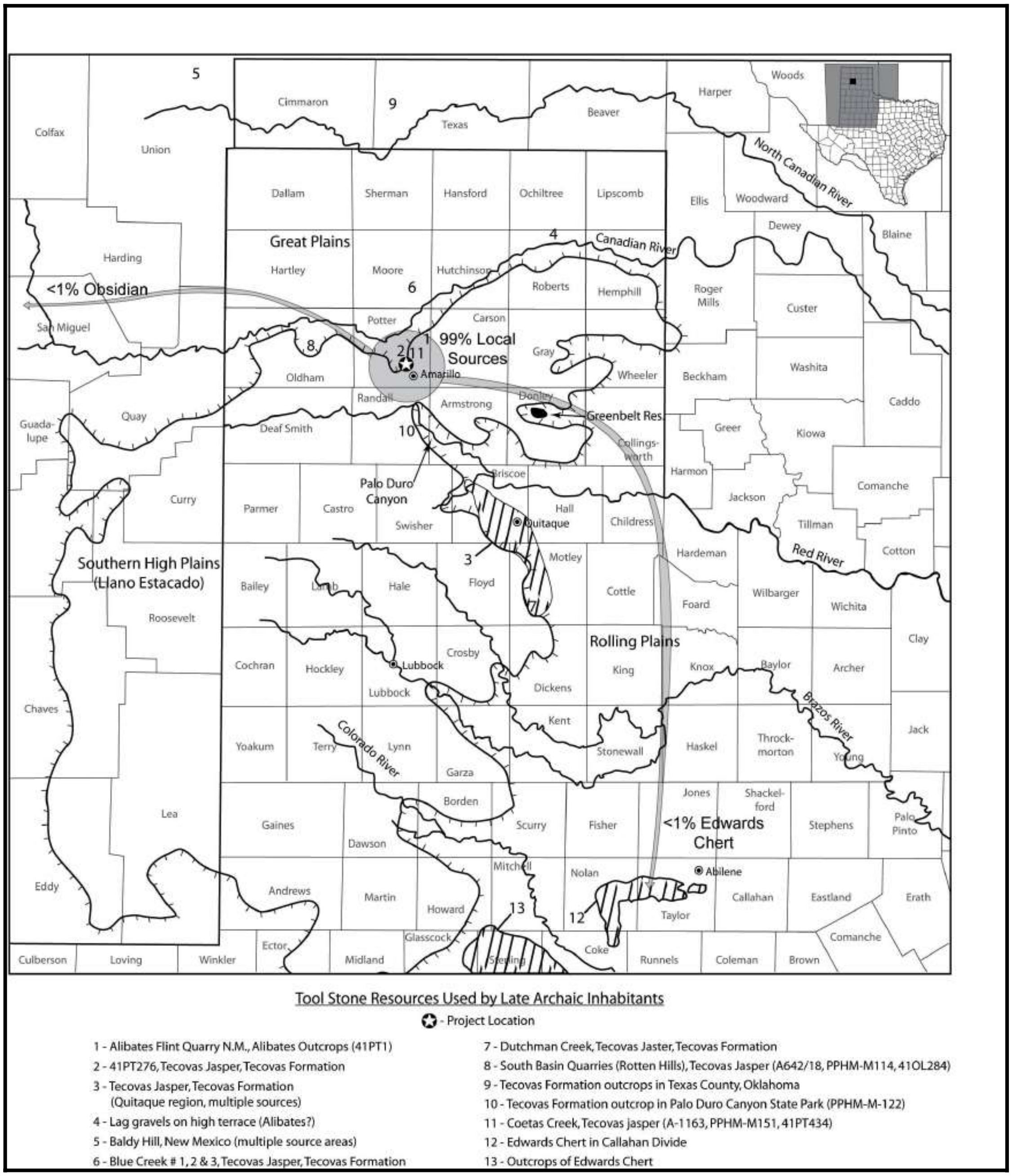

Figure 11-13. Quantities and Origins of Nonlocal Lithic Materials Recovered from the Landis Property.

a regular basis. Potentially, the encounters were more opportunistic than regular or planned events. Regardless of the quantities and kinds of materials, or how frequently exchange may have been, it is clear that some movement of goods did occur during the Late Archaic period in this region. In an article considering trade and economic specialization during the Late Prehistoric Plains period Vehik (1990) concludes that it is likely that researches have underestimated the complexity and variability of those systems. This is undoubtedly true, but until a much larger and more robust database for the various time periods becomes available, this important aspect of the past lifeway will be continually be understated.

Surprisingly, no nonlocal lithic materials were recovered from the Protohistoric component at the Corral site. Spielmann (1991) points out that trade relations are well documented ethnohistorically and played a major role in the adaptations of both Puebloan and Plains groups. Pueblo middens contain Plains lithics materials. Obsidian was one of the most common materials exchanged (Baugh and Terrell 1982). If the ethnohistoric data from the Historic period is any indication, nonperishable goods were also exchanged during the Protohistoric period. Speth (1991) and Spielmann (1982) indicate that Plains women married Pueblo men. Snow (1991) indicates that pueblo women were potentially residing in Wichita villages to the east in the Fourteenth Century. During the early contact period Europeans visiting the Southwest and Southern Plains observed numerous bison hide products in the northern Pueblos (Bolton 1916; Hammond and Rey 1940, 1966). It is not clear how far back in time this movement of bison hides to the west may have occurred. If the Late Archaic populations were exchanging goods (obsidian and possible Alibates) with Puebloans, bison hides would have been an ideal commodity to trade/exchange. In the ca. 200 to 300 year old Protohistoric occupation at the Corral site, hide scrapers were the only formal stone tool class ($N = 6$) recovered. During this period, these scrapers may have been important as part of the demand for hides by the Europeans (see Perkins et al. 2008 for in depth discussions).

The absence of ceramics, especially nonlocal ceramics, in the Protohistoric component at the Corral site is notable as well. The Protohistoric Tierra Blanca complex in this region has yielded Puebloan glazeware and redware pottery, plus corrugated and Faint-Striated sherds (Holden 1931; Spielmann 1982, 1983; Boyd 1997). There is some debate over exactly where the sherds were manufactured – locally by plains groups or by Puebloan peoples (see Boyd and Reese-Taylor 1993; Boyd 1997:372-373) as they question Habicht-Mauche's (1988) interpretations concerning who manufactured the pottery recovered. The fact that no pottery was recovered from the block excavation at the Corral site may further support the late radiocarbon dates of ca. 200 to 300 years old and the total replacement of clay vessels with metal containers by that time.

11.4.6 Technological Issues

11.4.6.1 Resource Procurement

Two principal food resources were identified as directly procured during the last ca. 3000 years for these investigated sites. Bison was the dominant animal resource targeted during all four time periods represented. However, relatively little information was extracted concerning the physical procurement procedures and/or method(s) involved in bison acquisition. Known Late Archaic bison kill sites have been identified along the Caprock escarpment of the Texas Panhandle and into western Oklahoma (Hughes 1977, 1989; Bement and Buehler 1994; Buehler 1997). Most Texas kill sites have been in arroyos, and in the case of the Certain site in Oklahoma, the multiple kills were clearly demonstrated to have occurred within and facilitated by deep, high walled arroyos (Bement and Buehler 1994). The use of arroyos goes back into Paleoindian times as is clearly demonstrated at Olsen-Chubbuck (Wheat 1972). Similar landforms are frequent along the eastern escarpment and all along the Canadian Breaks region across the Texas Panhandle, and even in many of the smaller valleys in the region. These landscapes would have facilitated the trapping of bison at most times in the past.

The Late Archaic populations obviously knew the landforms and the roaming bison well enough to plan, and conduct a successful kill operation employing the natural landscape. It is assumed that the killing events represented by the many bison bones recovered from the archeological sites in the West Amarillo Creek valley were likely the result of trapping bison in arroyos or in situations where steep sided cutbanks facilitated the controlling of the animals in order to easily dispatch them. The area has a few landforms or steep sided cliffs that might have allowed the killing of bison using a jump situation similar to those further north (i.e., Frison 1970, 1974, 1978a; Reeves 1978). Bison jumps and wooden corrals (i.e., Frison 1971) have not been identified in the region, although visibility may be the biggest factor influencing the absence of corrals in the Southern Plains.

The actual killing instruments were most likely darts delivered by atlatls. The wooden darts were tipped by stone points, which are the only parts that are archeologically visible. Three different corner-notched point forms were recovered from the Landis Property. Two were excavated from the Late Archaic component at 41PT185/C. At least two camping occupations were recognized in this component, but the two recognized point forms were mixed and neither can be assigned to one or the other of the two different occupations. All across the Southern Plains, it is apparent that a very broad range of corner-notched points were in use during the Late Archaic (see Chapter 3; Anderson 1989a, 1989b; Zier and Kalasz 1999). Currently, these slight hafting differences have not been subdivided into various types/varieties or otherwise formally named. Late Archaic point samples from across the Southern Plains have not been sufficiently large to provide researchers with statistically valid samples from good context to explore whether or not the Late Archaic assemblages can be subdivided into regional phases on the bases of diagnostic point types. Consequently, the assignment of the 41PT185/C points is into the general morphological category of Late Archaic corner-notched forms.

Only four projectile points (two complete and two short stem sections) were subjected to high-powered use-wear analysis. Three points lacked sufficient use-wear to indicate a specific function (Table 11-4). Three showed obvious wear on flake scar ridges

Table 11-4. Summary of Tool Function from Use-Wear Analysis.

Artifacts By Period	Inferred Function										Contact Material and Observed Residues										
	Unknown	Scraping	Cutting	Boring/Drilling	Whittling	Hafted	Slicing	Pounding	Chopping		Plant Tissues	Polish	Bone	Hard, High Silica Plant	Wood	Animal Hair	Starch Grains	Raphides	Hide	Resin	Unknown
Protohistoric Tools																					
Scrapers	1	5									3			2	3	3	4	7	2		
Flake			2								2								1		
Edge-Modified Tools		1	2								2			1							
Late Archaic Tools																					
Points	3					3					2	2								1	
Bifaces	2		2			2					3			2	4		1		1	1	1
Corner-tang Knife			1			1					1			1	1	1	1		1		
Scrapers	1	5									4	1	1	1	2	2	3		1		
Edge-Modified Tools	1	1					3				2	1		2	2		4			1	
Chopper								1	1		1			1	1		1				
Drill		1									1			1	1						

and were definitely hafted. One had resin and two also showed light polish on scar ridges. Based on the projectile point thicknesses, flaking patterns, and curvature, the Late Archaic specimens were mostly manufactured by means of bifacial reduction.

The adoption of the bow and arrow, whenever it occurred, denotes a major change in the stone tips used. With the smaller arrow shafts came the much smaller stone arrow points. In some areas the hafting or notching elements, such as corner-notching, still prevailed, especially in the Woodland period when small corner-notched points dominated. The small corner-notched point (#1198-101, see Figure 8-178)) from just above the Late Archaic component at 41PT185/C fits this style. Later in time, most arrow points exhibit very small notch elements on the sides and bases (i.e., Washita, Garza, and Harrell) or no notches at all (i.e., Fresno).

The projectile points are the most obvious artifact directly related to the procurement of animal resources. The overall numbers of points recovered are quite low for the ca. 475 m^2 area excavated. The Pavilion site failed to yield a single projectile from the nearly 33 m^2 excavation. The Corral site yielded nondiagnostic parts of three points, and no points from the 144 m^2 block excavation. 41PT185/A also failed to yield points. It was only at 41PT185/C where projectile points were recovered in any quantity. A total of 21 points were recovered from the nearly 300 m^2 excavated during Phase I and II. These sites are all considered to have been campsites, where retooling generally occurred, and apparently these populations were quite careful in keeping tack of their formal tools. Only 1 of 21 points is more or less complete. Site type is a critical factor in the recovery of projectiles, as kill sites yield great quantities. The overall frequency recovered is considered more related to the patterns of curation and discard of those tools than it is reflective the amount of actual hunting that was undertaken.

The technological evidence for the procurement of the grass seeds is not visible in the recovered tool assemblages. It is assumed that basketry was the primary equipment necessary for the collection of grass seeds; skin bags could have also been used (i.e., Geib and Jolie 2008). The high-power use-wear conducted on selected chipped stone tools did not isolate any particular chipped stone tool or class that showed clear and consistent evidence for cutting grass. If stone tools were used to cut grass, a separate nonchipped tool such as a sharp flake possibly served that particular function. It is also possible that bone tools were used in the collection of seeds, but no bone tools recovered from these sites seem to reflect that function. In most instances, the ethnographic literature does not mention the cutting of grass, just the collection of seeds.

In addition to food, tool stone procurement was a significant task that had to be conducted on a regular basis. No chipped, ground, or bone tools recovered were specifically determined to have functioned in the procurement of this necessary resource. Nearly 99 percent of the tool stone identified in the Landis Property sites was of local origin, regardless of the cultural period. Tecovas jasper and Alibates were the two most prominent materials identified in these assemblages, but Potter chert and quartzite gravels were also selected for limited use. The gravel sources (Ogallala gravels) are relatively frequent in the area and across the broader region. Currently, a large exposed gravel outcrop lies in the valley east of 41PT185, and this is likely one source from which cobbles were procured. Tecovas and Alibates materials are accessible in various outcrops in the general region. A Tecovas outcrop, 41PT275, is 27 km downstream and potentially served as a source. However, subsurface Tecovas and Alibates materials are considered better quality for use in crafting stone tools. To access the buried material, procurement would have been through hand dug quarry pits. Currently, quarry pits are known from the Tecovas outcrops at the Coetas Creek site (41PT434; Raab 2005) and 731 pits have been identified at the Alibates outcrop in the Alibates Flint Quarries National Monument (Katz and Katz 2004, 2005). The lack of any identifiable procurement tools indicates that much of the local materials must have been obtained without the major effort of digging for the buried materials.

Minimal research has been directed towards these known quarry pits and it is not known when the quarry pits at any of the local sites were first created. Few quarry pits and/or sites have been subjected to comprehensive excavations. A couple of examples from other regions indicate that some Late Archaic populations sought high quality stone to manufacture their chipped stone tools, and understood the extraction process. Trout Creek Pass quarry near Buena Vista, Colorado, west of the front range of the Rocky Mountains, has evidence of intensive Late Archaic use (Chambellan et al. 1984, cited in Zier and Kalasz 1999). At the northern end of the Plains, an archeological manifestation of the Late Archaic period known as Pelican Late with similar corner-notched dart points was known to involve quarrying of high-quality chert nodules from limestone deposits buried at the Schmidt Mine quarry (L. Davis personal communication 1971, Davis 1982). The latter mine is one of the more intensively investigated quarries in the Northwestern Plains.

Late Archaic populations that roamed the Southern Plains may have also sought high quality tool stone. As an example, the Late Archaic groups that camped at the Sanders site at ca. 1700 B.P. employed about 90 percent Alibates to manufacture their tools. The Sanders site, in the northern reaches of the Texas Panhandle, is ca. 100 km north of the known Alibates quarry (Quigg 1997). Apparently those peoples had just visited the Alibates quarries as they moved out onto the Plains to hunt bison. They did not use the local gravels for production of their tools. The use of the Alibates by the Sanders group may indicate that their territory included the Alibates source area, thus they had first hand knowledge of, and direct access to, that source. At 41PT185/C, Alibates again dominates the lithic assemblage in terms of both the formal tools and in the debitage. It is apparent that the Alibates quarry was visited and Alibates acquired prior to the establishment of this camp and the procurement of these two food resources. This is a repeated pattern that was detected in the Sanders site assemblage. In contrast, the Beaver Dam site (34RM208) in extreme western Oklahoma, and ca. 170 km east of the Alibates source area, used a high percentage of local Ogallala quartzite for most items, with Alibates represented by only one projectile point (Kraft 2005a).

The occasional acquisition of nonlocal obsidian from central New Mexico and Edwards chert from central Texas may be examples of casual contact and trading with nonlocal populations. Some Late Archaic populations had access to, and did use, high quality local materials (i.e., Alibates and Tecovas), they also obtained nonlocal high quality materials from outside the region through trade and/or exchange. Therefore, lithic resource procurement focused primarily on locally available materials, undeterred by the texture, with very limited acquisition of high quality nonlocal lithic materials. This type of procurement strategy may be imbedded into the seasonal round and reflect the local range of the Late Archaic populations and the knowledge of the local area. It also reflects their ability to manufacture chipped stone tools from a variety of tool stone, including the hard and more difficult to work Ogallala quartzites.

The ground stone industry was well represented only in the Late Archaic assemblage at 41PT185/C in the form of metate fragments. The stone for the metates was locally available and with minor shaping, the local natural sandstone provided the necessary raw material. Raw materials for manos and hammerstones were also immediately available in the form of various shapes of rounded quartzite cobbles from nearby gravel sources. Even though natural sandstone was in the vicinity, other tools often produced from this material such as abraders were not identified in any context. No imported materials for the ground stone industry were identified.

Bison bone was abundant in all time periods. This bone resource would have been available for the manufacture of many different types of bone tools. A well developed bone technology is not, however, evident at any sites in the Landis Property. Only a few simple bone tools were identified from all contexts. Therefore, it is apparent that the various groups had knowledge of this industry, but actual tools were scarce. Bone tools of various forms (i.e., awls, punches, antler billets, various expedient tools, and ulna hammers) were present at the Late Archaic Sanders site including what Quigg (1997, 1998) interpreted as gaming pieces. Bone beads have yet to be identified in these assemblages. Preservation and/or site type may be a factor contributing to the number and type of bone tools present at a given site.

The mussel shell industry is also not represented in the Landis Property sites. Very few natural mussel shells were encountered and thus, the apparent lack of procurement of shell to manufacture various shell tools and ornaments may reflect the limited availability of those resources.

Rocks used to transfer heat in various cooking activities (e.g., limestone, caliche, sandstone and quartzites) were undoubtedly procured locally. If fact, if quantities of natural rock was a desired resource for use in cooking activities, the selection of the campsite probably was influenced by the immediate access to necessary rock. No tools (i.e., large hammers, bone wedges, etc.) were recovered from these sites to indicate that procurement was from bedrock sources as opposed to surface outcrops. The creek bottom is generally devoid of large rounded cobbles, so these would have been procured from Ogallala gravels that are all along the valley slopes.

Wood used in campfires was also undoubtedly available in this valley throughout the last 3,000 years. Again, no formal or informal tools (i.e., axes, celts, large chipped stone wedges, etc.) were recovered to indicate large green trees were procured. The wood for fires was most likely collected from dried, dead trees and branches. Mesquite, cottonwood/willow type, and juniper were common woods burned in the fires (Appendix N). Mesquite and juniper are both hardwoods that would have served as good firewood to create long and hot fires. In fact, lipid residues from burned rocks identified dehydroabietic acid on many rocks, which supports the use of conifer (here junipers) for heating these rocks (Appendix G). This does not rule out the use of mesquite or other woods as this lipid biomarker was the only one detected on the rocks.

Other wood used for possible handles, traps, games, or other requirements probably came from small green wood, i.e., bushes. These unburned woods are invisible in the archeological record. Only certain kinds of stone tools might indicate the use of these woods. However, chipped stone gouges that have often been linked to woodworking were not recovered from these assemblages. The high-powered use-wear analysis on 31 arbitrary selected artifacts from these sites documented that at least 50 percent (12 of 24) of the tools with identified residues on them had wood fibers present (see Table 11-4). These tools included edge-modified flakes, a chopper, end and side scrapers, and bifaces.

11.4.6.2 Resource Consumption

Following procurement, most food resources required some preparation before consumption. In terms of bison, the meat and other parts of the animal were stripped from the bones. In most instances this was accomplished through the use of sharp stone tools, as some bones reveal thin cut lines. Cut marks on bones were observed in the Late Archaic, the Palo Duro/Woodland camps, and in the questionable Antelope Creek bison bones. The lack of cut marks on bones from the Protohistoric occupation may be just a sampling error. High-powered use-wear analysis documented that flakes, edge-modified flakes, and bifaces were all used in a slicing and/or cutting function during both the Protohistoric and Late Archaic periods (see Table 11-4).

In the case of the Late Archaic occupations, it is obvious that not just the meat was targeted, but also bone marrow and bone grease. The highly fractured bison bones at 41PT185/C indicate the intensive processing of the bones. Although no direct evidence exists for how the meat and bone marrow was consumed, some was likely consumed raw and immediately, and some was probably stored. The most efficient means of storing meat was drying/jerking and possibly the production of pemmican. The drying/jerking is not visible in the archeological record. The making of pemmican is indirectly indicated through the presence of smashed bones for the extraction of bone grease and specific types of cooking features. The production of pemmican includes pounding the dried meat and adding bone grease into one mass, and then storing in a skin bag. At 41PT185/C most meat did not appear to have been cooked by means of hot rocks. Lipid residue analysis on many burned rocks from most Late Archaic features did not detect large herbivore lipids. Yes, animal products were cooked by these rocks, but the products were something other than meat, possibly bone marrow and grease together with other foods.

Other than the Late Archaic camps, the archeological sites and periods investigated also yielded bison bones broken to extract marrow, but smashing bones to extract grease was not apparently targeted, at least not to the extent as in the Late Archaic component. This may reflect cultural biases or seasonal differences in the desire or need for bone grease.

The Canadian wildrye (*Elymus canadensis*) grass seeds procured during Late Archaic times were processed before consumption. The seeds were ground with the use of manos and metates as evident by the damaged wildrye starch grains from these tools. The ground stone industry is quite simple, consisting mostly of water worn cobbles of sandstone or quartzite employed as manos, plus grinding slabs or mutates. The manos do not appear to have been intentionally shaped, and some show evidence of use as hammers as well. The metate fragments most often consist of thin slabs of sandstone and reveal limited preparation. A few outer edges appear purposefully shaped as evident by limited flake scars of their margins. The worked surfaces are generally very shallow, with illdefined grinding margins and lacking deep basins or troughs. These shallow worked surfaces indicate limited grinding activities that may be related to limited seasonal use or single camp use followed by discard or recycling. A few pieces have the appearance of being recycled as burned rocks. Some metate fragments and manos have small peck marks on one or multiple surfaces. This is likely a means of roughing the surface to facilitate the grinding of seeds, etc.

The seeds were thus ground into flour that was then by heat and water through the use of the hot rocks. Cooking of the actual grass seeds is documented through the lipid residues and the gelatinized starch grains from burned rocks. Two types of analyses conducted on burned rock residues indicate that multiple foods were probably cooked at one time or burned rocks were used multiple times to cook different foods. Stone boiling is the most likely cooking technique. Boiling is one of the most often mentioned cooking techniques in the Plains ethnographic and historic literature (Schoolcraft 1851; Grinnell 1893; Wissler 1910; Mandelaum 1940; Ewers 1955; Driver 1972).

Burned rocks are often the dominant material class at open air sites in the Plains and elsewhere. Rocks for cooking and heating are generally readily available in most settings. After being procured, the rocks were most often heated in an open fire and then used to transfer heat for cooking foods and other activities. The near absence of burned rocks in the Protohistoric camp at 41PT186, as evident by the results from the large block excavation, indicate a major shift in the cooking strategy or that no cooking was accomplished there, though it is quite likely and apparent from other evidence that cooking did occur. Consequently, the technology of cooking likely changed from previous periods. During Protohistoric times, the use of hot rocks for cooking apparently stopped for the most part, and this strategy was replaced by the use of ceramic pots and/or metal kettles. Since neither kind of container was in evidence, the precise cooking technology cannot be identified.

At the Late Archaic component at 41PT185/C it is obvious that cooking with hot rocks was a significant activity. Some 4,300 burned rocks were encountered, accounting for 34.5 percent of the total materials from this component. These burned rocks were in identified cultural features (19 percent) and scattered (81 percent). The scattered rocks were generally smaller than those found within features. The small size of the scattered burned rocks is an indication that most of them were discarded following their use. Sixteen recognized features are considered clusters of discarded burned rocks from a use episode. Only five features are interpreted as *in situ* heating elements (Features 4, 8, 9a, 12, and 18). Based on feature shape, size, configuration, and burned rock analyses, two Features 8 and 12, may have served as cooking griddles. Feature 18 had a small basin that may have served as a small oven, whereas the other two served as open cooking elements. The large burned rock middens that are so common in central Texas and eastern Oklahoma were not identified. The cooking technology evidenced by the large central Texas middens or large earth ovens was not in operation at this campsite. Whether this technology was a function of the absence of particular foods, the season of occupation, or some other factor cannot be resolved until more excavations are conducted at other Late Archaic sites. Large oven technology is costly in terms of resources, time, and human energy. Dering (1999) suggests that an oven roughly 1.5 m in diameter requires 250 kg of rock, plus the gathering of the targeted food(s), which are generally low ranked resources that require considerable cooking time. These foods supply roughly 1,500 kcal per day for each person with a food yield that provides meager calories. Generally, the choice of low ranked resources indicates that high ranked resources are scarce or not available (Kelley 1995; Simms 1987). Groups that camped at the Landis Property had access to high ranked resources, the bison, and possibly the lower ranked wildrye grass seeds, were available and may be influencing why ovens were apparently not used.

The small burned rock features are similar to what is generally known for the Late Archaic period. However, they are not directly comparable to the 16 features at the Sanders site (Quigg 1997). There, only three burned rock features were identified, but the area excavated was outside the primary campsite making direct comparisons to 41PT185/C questionable. At the Sanders site all three burned rock features were considered dumps of discarded rocks used in cooking and were considered boiling stones.

Ultimately the shape, size and configuration of burned rock features, does not always clearly indicate what the rocks and features were used for. The lipid residues, combined with the starch grain analysis directed at the burned rocks, document that the rocks and features were used to cook foods. At the Late Archaic component the foods included, minimally, wildrye grass seeds and some animal products other than large herbivore meat, possibly bone grease and/or marrow.

The absence of pottery in Late Archaic components indicates that these sites and the populations that camped here were not using pottery in their cooking process. These groups may have heard about or even seen pottery, but apparently they had not incorporated it into their cooking technology. The Late Archaic component at the Sanders site in the northern Texas Panhandle did yield a single cordmarked sherd from excellent context (Quigg 1996, 1997). This indicates that some Late Archaic groups may have been in contact with populations with pottery and possibility knew about its existence. The Protohistoric component at the Corral site, surprisingly, did not yield pottery. The recent age of that component may be the major contributing factor as by this late date, ca. 200 to 300 B.P., metal may have replaced all use of clay pottery. The few sherds that were recovered from the rest of the Corral site were constructed of local and nonlocal clays that were tempered with different types of raw materials. Their exteriors varied considerably with some being plain, some polished red or black, some with cordmarkings and some with a possible corrugated exterior surface. Most of the interiors were wiped smooth, with some showing the wiping striations. These sherds were mostly from mixed contexts and limited information is available concerning their associations.

In ground storage of food or other resources was not apparent, as storage pits were not identified at any of the sites investigated. Storage pits are not known from other Late Archaic sites across the broader Southern Plains region (Quigg 1997; Boyd 1997; Zier and Kalasz 1999). This generally reflects on the mobility of the populations investigated, and supports the working assumption that short term camps were the norm for mobile hunter gatherers.

A ceramic industry was anticipated for at least two periods targeted by the block excavations, the blocks at the Corral and Pavilion sites. The 22 m^2 excavation block in the 1200 to 1400 B.P. component at the Pavilion site yielded no ceramic materials.

The targeted ca. 200 to 300 B.P. Protohistoric component at the Corral site yielded a single sherd that was interpreted to be intrusive and out of context. The less than three dozen sherds recovered from the project were mostly from mixed or questionable contexts dug during Phase I. The analysis of a few sherds indicates some were manufactured locally and some nonlocally. Insight into the construction technology of the tiny recovered sherds was mostly limited to identifying the constituents of the paste. Little can be said about construction except that most vessels were well manufactured with thin walls. A very thin walled vessel from the Pavilion site also had a very thin vertical lip. Two other sherds from different vessels at the Pavilion site had exteriors that had been intentionally decorated. One was a burnished red and the other a shinny black exterior. These types of exterior finishes, combined with the temper identified, represent wares from the Southwest rather than the eastern Woodlands traditions. Thus, at some point late in the chronological sequence, contact and or trade with groups in New Mexico occurred.

These two colored exterior sherds are not common in the region, although 129 sherds representing three vessels were recovered from the Protohistoric Headstream site and 207 sherds reflecting six vessels were recovered from the Longhorn site at Lake Allen Henry (Justiceburg Reservoir) southeast of Lubbock (Boyd and Peck 1992; Boyd 1997). In Texas, trade wares during the Protohistoric or early historic periods were generally plain utility wares with some glazewares present (i.e., Hofman 1989; Spielmann 1982; Hughes 1991; Boyd and Peck 1992; Boyd 1997). These Protohistoric sites at Lake Allen Henry do not fit well within the two archeological manifestations further north, the Garza and Tierra Blanca complexes. Both of the latter complexes are not defined adequately, as there is only limited information on their chronology, their relationship to each other, their geographic extents, or their cultural assemblages. A plain micaceous plainware is the key trait of the Tierra Blanca complex and the sherds from the Pavilion site are clearly not of this type. Much further research into the multiple ceramic assemblages is required to identify the ages, types, and associations of the Protohistoric and early Historic periods.

Following the acquisition of stone from different sources, the stone was then fashioned into various tools designed for specific and general activities. The lithic debitage assemblages at the two intensively investigated sites (41PT185/C and 41PT186) represent two distinct technological reduction strategies. The Late Archaic occupations at 41PT185/C show a prominent bifacial reduction technology, reflecting the production and maintenance of bifacial tools (e.g., projectile points, knives) as well as flake blank production and shaping in the fashioning of flake tools. Evidence points to soft hammer percussion and pressure flaking activities for a majority of the bifacial reduction efforts, though hard hammer percussion was implemented at considerably less frequent intervals. In addition, limited frequencies of cortex bearing specimens were recovered, indicating that much of the initial preparation of objective pieces occurred outside of the excavation block, or perhaps beyond the boundaries of the site. Bifacial reduction is limited to the higher quality (fine-grained) materials (Alibates and Tecovas), whereas flake blank production and modification involved both fine (Alibates and Tecovas) and coarse materials (i.e., Dakota and Ogallala quartzites, plus opalite). Although 41PT185/C has a diversity of material types, Alibates accounts for 66 percent of the formal tools manufactured and 76 percent of the debitage, indicating that it was the preferred medium for tool production. Alibates is not the most widely available, as it comes from one localized source area. The other two major lithic raw materials present, Tecovas and Quartzite, are widely available across the landscape, but were present in much more limited quantities. Tecovas accounts for 14 percent of the formal tools and only 4.9 percent of the debitage. On the other hand, various quartzites represent 16 percent of the formal tools and 9.8 percent of the debitage. Based on the ratios of the debitage to formal tools and the type of debitage represented, formal Tecovas and Quartzite tools were brought into this site as finished products. It is also clear that fine-grained materials were preferred, but these Late Archaic groups also demonstrate the ability to work coarse-grained quartzites as well.

Analysis of the Protohistoric lithic debitage from the block excavation at 41PT186 showed a predominance of flake blank modification into flake tools (scrapers and edge-modified flakes) and their use in bison processing activities. Most platform bearing debris exhibits flat platforms produced through load application characteristic of soft hammer percussion techniques, though pressure flaking was also common. There is almost no incidence of cortex bearing material or flakes exhibiting hard hammer percussion characteristics. This supports the assertion that materials were initially reduced offsite and brought to this location for shaping and eventual use. The lack of cortex may also reflect the use of nonwater worn and rounded cortex bearing cobbles, such as the layered bedrock Alibates and Tecovas. The occupants preferred using Alibates to all other available materials. There is little doubt that the tools, flakes and scrapers, recovered from the cache designated as Feature 6, were fashioned and maintained in this area.

It is apparent that local tool stone was the norm, through all time periods. A near absence of formal tools made from nonlocal tool stone is apparent through the 3,000 years represented in the Landis Property investigations.

11.4.7 Intrasite Behavioral Patterns

Human behavioral patterns, such as those represented by the horizontal distribution of cultural artifacts and features across the 144 m^2 block excavation at 41PT186, are rarely recognized in open campsites, especially those lacking structures. The excavation strategy of exposing broad horizontal areas, combined with the excellent context of this single occupation, contributed to the identification of these patterns. The five task areas identified reflect, minimally, bison bone discard, chipped stone tool resharpening or maintenance areas, heating/cooking areas, cleaning/discarding locations, and caching of artifacts. These primary tasks are suspected at most campsites, but not often detected and defined. The two heating and perhaps cooking hearths (Features 7 and 8) were a few meters apart at the southern end. Minimally, one person sat on the eastern side of the hearth, Feature 7, and knapped tools, using a soft hammer to create a unifacial tool or resharpened an Alibates scraper. A broken Alibates end scraper was on the northern edge of the clustered debitage. Tiny Alibates debitage from knapping entered the hearth (Feature 7) directly from the knapping activity or through intentional dumping of the debitage into the fire. Feature 7 was then cleaned out at least once, and the ashes and tiny flakes were dumped a meter or two further east in a discard location designated as Feature 1. This ash dump also yielded the same kind of tiny Alibates debitage that was found in hearth Feature 7. A second knapper was also present, but conducted his knapping ca. 7 m north, away from other recognized features or tasks areas.

Another intriguing human behavior was the caching of eight Alibates items (four scrapers, two large edge-modified flakes, and two large unmodified flakes), just below the occupation surface in a shallow pit toward the front edge of the terrace. The intentional caching by members of this group indicates they intended to return soon to this location and retrieve those items, thus implying redundancy of site occupation within a settlement system of limited mobility. No maker was detected to facilitate finding this exact spot in the future.

Patterns of human behaviors similar to those recognized in the excavation block at 41PT186 were searched for at 41PT185/C. The cultural features were again horizontally distributed across the excavation block, with minimal overprinting of the two identified camping episodes. Specific patterns were not as clearly isolable or recognizable, however. This probably reflects admixture of debris from more than a single occupation within a context of slow deposition of the sediments following site abandonment, and the subsequent turbation of those sediments over ca. 1,500 to 2,500 years. The nonfeature artifacts such as bison bones, stone tools, nonfeature burned rocks, and lithic debitage appeared randomly discarded and/or scattered after abandonment. The exception to this general rule was in the debitage distribution where two clusters were recognized and at least one bison bone discard area. These were relatively localized areas, 1 to 2 m in diameter, with one bone cluster in the southwestern corner 1.5 to 2 m east of a heating element, Feature 8. The main lithic cluster was in the northwestern corner of the excavation, ca. 4 to 5m east of discarded burned rocks, Feature 15. Patterns within the other various classes of materials were searched for, but no specific or recognizable patterns could be identified.

One interesting indicator of human behavior was the discovery of the cached corner-tang knife at 41PT185/C, which was found under a large unmodified rock. The deliberate caching of this single, unique used artifact apparently indicates that one individual thought he/she would return to this site to recover this important artifact.

11.4.8 Social and Political Issues

Socially, the two primary camps investigated at 41PT185/C indicate that small groups occupied these locations on a relatively short term basis, but the site nonetheless functioned as a base camp. The Protohistoric camp at 41PT186 apparently was a shorter occupation than that at 41PT185/C. Both campsites probably included small family units that conducted general tasks such as hunting, gathering, cooking, retooling, and camp maintenance. Both groups sought the local high quality tool stones, Alibates and Tecovas, to manufacture their chipped stone tools from. The near complete reliance on the local materials indicates these groups were quite familiar with the local environment and the sources of these raw materials.

During the Late Archaic, these Southern Plains hunter-gatherer groups interacted with other, probably more sedentary, groups to the west. This interaction is evident in the occurrence of obsidian from the mountains of northcentral New Mexico. It is also possible that the obsidian was passed along through down-the-line trading. The obsidian was not acquired from need, as the local Plains groups had relatively easy access to the local high quality materials such as Alibates and Tecovas. Thus, the acquisition of obsidian was related to something other than immediate technological necessity. A mutualistic exchange of goods and/or services took place, most likely on casual and informal bases. Such exchanges may have had a social or sociopolitical function of reinforcing/reaffirming existing relationships between the peoples involved.

It is not clear if the unique corner-tang knife from the Late Archaic campsite at 41PT185/C represents to a particular social or political status or identity. Since this artifact form is rare in most campsites, but has been recovered from a few selected burials, it may well relate to some unique status of an individual in the group. The corner-tang recovered here was manufactured of local Alibates and likely was manufactured within the region.

A partial burial of an adult male, perhaps of middle age, from the Beaver Dam site in Roger Mills County, Oklahoma yielded a complete lunate stone or atlatl weight, a nearly complete corner-notched dart point, and two complete ovoid biface knives (Thurmond 1991b; Kraft 2005a). All these stone artifacts were manufactured from local lithic types except possibly the lunate stone, which was of a fossiliferous material of unknown origin. The inclusion of those artifacts in that burial indicates a belief in the afterlife and the need for hunting equipment on the part of the deceased. The lack of similar mortuary data from Late Archaic burials in the region severely limits our ability to understand and reconstruct social and political structure of the groups involved. It is possible that the near absence of burials and the absence of cemeteries does convey something about their social structure or conditions. It may mean these mobile populations did not bury their dead.

11.4.9 Project Summary

The cultural resource investigations at the Landis Property began with the 1998 archeological survey (Haecker 1999), followed by the 1999 site assessment (Haecker 2000). Subsequently, as Haecker (2000) recommended, a detailed data recovery plan was prepared to guide the necessary next step, data recovery excavations, analyses, and reporting (Quigg 2005). Once the plan was accepted, it was implemented through a two phased (I and II) data recovery program in 2007 and 2008 at the three identified National Register Eligible archeological sites (41PT185, 41PT186, and 41PT245). The results of the fieldwork, combined with artifact descriptions and analyses presented in this technical report concerning those findings, and the publication of those findings with this report, has absolved the federal government of its cultural resource responsibilities in conjunction with the transfer of federal land to the private sector.

Combined, these investigations have contributed significant information concerning two specific time periods, the Late Archaic and the Protohistoric, within the Panhandle region. Although data recovery was conducted at very specific target locations within each of the three sites (41PT185, 41PT186, and 41PT245), some significant cultural resources may still remain buried at these sites and other locations across the Landis Property.

Cultural resource preservation should be considered when future land development activities that involve federal or state funds are planned that might encroach on these specific, and other, alluvial terraces across this Landis property. It is also possible that developers and/or agencies other than the private landowner may require easements on this property for construction activities. If so, the cultural resources still buried should be considered by those developers prior to any surface disturbance activities.

For those researchers interested in the cultural materials recovered from the Landis Property, the collected materials and the paper documentation of the excavations and analyses are curated at the Panhandle-Plains Historical Museum at Canyon, Texas. The database from Phases I and II is included on the attached disk, for the use of such researchers.

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12.0 RECOMMENDATIONS

No further recommendations concerning the cultural resources are necessary at this time. Those responsible for future development activities that include subsurface excavations and developments in the Landis Property should be aware that there is still potential for buried cultural materials and occupations that were not mitigated by this project. As good stewards of the land, if such developments are planned, it would be desirable to have a qualified archeologist conduct a subsurface survey and evaluation of the planned development areas prior to undertaking any disturbance.

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14.0 GLOSSARY OF TECHNICAL TERMS

A Horizon: The near surface horizon of a natural soil. This is a carbon rich soil horizon characterized by an accumulation of partially decomposed to decomposed organic matter and eluvial loss of constituents such as clays and carbonates, which tend to accumulate in the deeper B horizon. The A horizon represents the upper solum of a soil. Lower case letters with the upper case letter A indicate specific characteristics of that A horizon. An Ab designation indicates the A horizon is buried. An Ap designation indicates a disturbed or anthropically modified soil such as in a plow zone.

Accelerated Mass Spectrometry (AMS): Laboratory technique that separates and identifies ions based on their mass to charge ratios. This technique is used in radiocarbon dating tiny particles of carbon in organic remains and residues.

A.D.: Anno domini in Latin. "In the year of our Lord." For example, A.D. 1000 is 1000-years after Christ.

Aerophilous Habitats: An environment that has free oxygen or air. These can include damp soils, wet plants and rocks, marshes, wetlands and mudlands. This term is used in the discussion of phytoliths.

Agavaceae: A plant family name that refers to fiber, vascular bundle, or the central stem section that cannot be specifically identified as agave (*Agave*), yucca (*Yucca*) or sotol (*Dasylirion*).

Allostratigraphic Unit: Depositional unit made up of sediments dating to a similar period of deposition.

Alluvium: Clastic sediments, such as sand, silt, or clay deposited by a flowing stream, either in the channel or material deposited outside the channel during overbank flooding.

Anisotropic: The action of cross-polarization of light under a microscope as it passes through material. If the material causes any deviation in the transmission of light then the material will have illumination in the microscope in a pattern characteristic of the material and its properties. This term is used in the petrographic analysis of ceramic sherds.

Apatite: The nonorganic component of bone. This material may be radiocarbon dated, but is not the preferred standard as it is subjected to many more unknowns and decays over time.

Argillic Horizon: A soil horizon (Bt horizon) that exhibits significant enrichment in illuvial clay minerals or clay-sized particles. Such clays typically form grain coats, grain bridges, and ped-face coats of oriented clay that are visible in thin sections, and usually can be identified with a hand lens.

Atlatl: This is a short stick, roughly 40- to 60-cm-long, with a handle on one end and a groove or peg at the other end, used for throwing a dart shaft or light spear. It provides much greater leverage and force to the throw by extending the length of the arm. This was the primary instrument used to propel projectiles before the bow and arrow.

Autecology: The older term, autecology refers to the study of individual species in relation to the environment or, essentially, species ecology.

Azelaic acid: A chemical biomarker found in burned rock residue, which indicates the presence of seed oils.

B.C.: The abbreviation for Before Christ, as in contrast to A.D. or B.P.

Biface or Bifacial: A stone tool that has two distinct sides or faces, both of which have been worked and flaked. This may take the form of many shapes and sizes.

B Horizon: The lower solum of a natural soil. A B horizon is a mineral soil horizon characterized by an accumulation of constituents such as clays, carbonates or salts, or organic complexes that have been translocated from the A horizon. Common subordinates include lowercase letters such as *t*, which indicates accumulation of illuvial clays. The lowercase k indicates accumulation of carbonate. The lower case w indicates structural or color changes with no significant accumulations of alluvial material.

Bioclasts: These are tiny fossils particles within limestone that may belong to any invertebrate phylum. These were observed in the petrographic analysis of the pottery sherds.

Biosilicates: This is a general term to include various tiny hard bodies that contain silicon and are developed in plants such as phytoliths, diatoms, algal statospores, and sponge spicules.

Biotite: A dark-brown to black mica containing iron, potassium, and magnesium. This was observed in the ceramic sherds.

Bioturbation: The churning and mixing of sediments by living organisms, including burrowing rodents, insects, worms, and plant roots.

Biplot: A biplot is a special type of graph following from principal component analysis on which both the samples and elements are displayed. Examination of biplot from the principal component analysis of ceramic specimens often leads to identification of the analyzed elements responsible for differentiating groups of specimens from one another.

Bivariate Plot (Scatter Plot): A two-dimensional graph where the x-axis and y-axis symbolize a pair of measured or calculated variables. The points on a bivariate plot represent the position of individual samples. These graphs are used to recognize possible structure in a data set.

B.P.: An abbreviation for before present, which in radiocarbon dating is referenced to the standard year A.D. 1950, which is considered "present".

Burned Rock Dump: A loose cluster of heated rocks that exhibits no horizontal patterning to the positions of the rocks and lacks indications of *in situ* heating/burning, such as a prepared basin, lenses of charcoal or ash, and/or the absence of an oxidation rim. Scattered charcoal or other cultural items may be present between or around the burned rocks.

Cache: The deliberate placement or storage of artifacts in a tight grouping such as tools or pottery purposely placed for storage, generally in the ground. Caches are thought to represent storage with the intention of subsequently returning to retrieve the stored objects.

C Horizon: Weathered, but relatively unaltered parent material at the base of a soil profile. This term is roughly synonymous with subsoil, although the latter term is often used to encompass the lower B horizon.

Calcareous: Rocks, minerals, or sediment containing calcium carbonates.

Calcite: A common rock-forming mineral, calcium carbonate ($CaCO_3$). It is the principal mineral in limestone.

Caliche: A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche, normally white, occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

CAM Plants: A photosynthetic pathway for assimilating carbon dioxide into plants that can change from C_3-like to C_4-like plants depending on the diurnal (day or night) cycle. Most succulents such as cactus are crassulacean acid metabolism (CAM) plants. The carbon isotope values of most CAM plants in Texas such as *Agave lechuguilla* and *Opuntia englmannii*, are similar to the values in C_4 plants (see Eickmeier and Bender 1976).

Canonical Discriminant Analysis (CDA): This procedure finds axes (the number of categories -1 = k-1 canonical coordinates) that best separate the categories. These linear functions are uncorrelated and define, in effect, an optimal k-1 space through the n-dimensional cloud of data that best separates (the projections in that space of) the k groups.

C_3 Plants: A photosynthetic pathway that most trees and flowering bushes use to assimilate carbon dioxide into their systems. The average carbon isotope of C_3 matter is -26.5‰ with a range from about -24.0‰ to -34.0‰.

C_4 Plants: A photosynthetic pathway used by most arid (xeric) grasses and corn to assimilate carbon dioxide into their systems. The average carbon isotope of C_4 matter is -12.5‰ with a range of -6‰ to -19‰. These plants are more resistant to stress due to lack of water, but more susceptible to cold temperatures.

Carbonates: These are rock or mineral classes that include limestone, calcite, ooids, and bioclasts, and used in the petrographic analysis of the pottery sherds. The calcite staining in the thin-section preparation marked all these bodies with a carmine red color.

Cerro Toledo Rhyolite: A specific source of obsidian glass in the Jemez Mountains of north central New Mexico. Cerro Toledo Rhyolite is grouped with the Valle Grande Member obsidians within the Tewa Group due to similar magmatic origins. This obsidian comes from both the northern domes and from Rabbit Mountain, sometimes referred to as “Obsidian Ridge”. Size ranges from pea gravel to 16 cm in diameter. Cerro Toledo Rhyolite occurs throughout the Rio Grande alluvium all the way to Chihuahua, Mexico (Shackley 2005).

Chalcedony: A cryptocrystalline variety of quartz or chert. Chalcedony is often a component of other cherts. It may be translucent or semi-translucent, has a wax-like luster, and a white, pale blue, gray, blown, or black color.

Charophytes: These are small branching algae, normally living in carbonate-rich freshwater. Modern species prefer ponds and lakes, although they are occasionally found in running water, and have a partiality for somewhat brackish conditions such as freshly dug ditches in marshes near the sea.

Cheno-am: A term used in botanical classification that includes the plant family of Chenopodiaceae (goosefoot) and the genus *Amaranthus* (pigweed), with charred seeds that are indistinguishable from each other.

Clast: Any detrital particle of sediment created by the weathering and disintegration of a larger rock mass and transported by water, wind, or ice. Clasts also include discrete particulates created and deposited by volcanic action.

Clay: This is the mineral sediment particles less than 0.002 millimeters in diameter. As a soil textural class, soil mineral that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Cluster Analysis (CA): Clustering is the classification of objects into groups so that objects from the same cluster are more similar to each other than to objects from different clusters. Often similarity is defined according to a distance measure. Clustering is a common technique for statistical data analysis, which is used in many fields, including data mining, pattern recognition, image analysis and bioinformatics.

Collagen: The organic (protein) component of bone. It is this component that is usually radiocarbon dated by most laboratories.

Colluvium: Soil material, rock fragments, or both, moved by creep, slide, or local wash that is deposited at the base of steep slopes.

Complex: A group of sites dating from the same time period and that contain similar artifacts. This term expresses a relationship of common cultural or technological traits in assemblages within widespread geographic area.

Context: The association and position of artifacts, materials, and cultural features that are used by archeologists to interpret space, time, and culture.

Criterion of Abundance: If a large group of the specimens in a ceramic assemblage is represented by a single, homogenous, compositional fingerprint and the actual source of clay is unknown, then the criterion of abundance indicates that there is a high probability the group was produced locally or very near the site where it is most heavily represented.

Cumulic Soil: A soil formed in a setting experiencing relatively slow deposition, so that freshly introduced sediment is incorporated into the A horizon, leading to overthickening of the surface horizon. Cumulic soils are common in alluvial overbank and colluvial settings.

Curie Temperature: The temperature at which the magnetic properties of a substance change from ferromagnetic to paramagnetic. Magnetite has a Curie point of 580 degrees Celsius.

Dehydroabietic Acid: A chemical biomarker found in the residues of burned rocks, which indicates that conifer products (likely juniper here) are present. This resin would be from the firewood used to heat the rocks.

Dendrite: An oxide of manganese that has crystallized in a branching pattern as in the dark inclusions in moss agate.

Deposition: The accumulation of sediment or gravels laid down by natural agencies such as moving water, or artificial agencies such as dumping.

Detrital: Loose rock fragments or grains that have been worn away from the parent rock.

Diatoms: These are single-celled algae whose cellular contents are enclosed between two valves of silica that are preserved when the organism dies. Often diatoms are preserved in ponds and streams and important to stream ecology. Different taxa have differing tolerances for extremes of temperature, salinity, water depth, water clarity, and nutrient concentrations and respond rapidly to changes in the environment. These are useful in reconstructing aquatic paleoenvironments.

Discriminant Analysis (DA): This is used to predict group membership based on a linear combination of the interval variables. The procedure begins with a set of observations where both group membership and the values of the interval variables are known. The end result of the procedure is a model that allows prediction of group membership when only the interval variables are known. A second purpose of discriminant function analysis is an understanding of the data set, as a careful examination of the prediction model that results from the procedure can give insight into the relationship between group membership and the variables used to predict group membership.

Dolomite: A carbonate sedimentary rock consisting of more than 50 percent by weight of by areal percentage under the microscope of the mineral dolomite. Occurs in crystalline and noncrystalline forms, is clearly associated, and often interbedded, with limestone.

Effluent: This is the outflowing of water from a natural body of water, or from a man-made structure. Effluent is generally considered to be water pollution, such as the outflow from a sewage treatment facility or the wastewater discharge from industrial facilities.

El Rechuelos Rhyolite: An obsidian that is part of the Polvader Group, in the Jemez Mountains of north central New Mexico. It has been mistakenly called “Polvadera Peak” obsidian. It actually comes from a number of small domes south of Polvadera Peak. The largest nodules are close to 15 cm in diameter, but more common size range is from 1 to 5 cm. It is of extremely high quality (Shackley 2005).

Eluvial: The movement of materials such as clay or organic matter from a soil horizon by percolating water.

Eocene Epoch: The period of time between 37 and 58 million years ago, and a subdivision of the Tertiary Period of the Cenozoic era.

Eolian: Earthly particles moved by wind action and include sandy dunes, sand sheets, or loess deposits.

Erosional Uncomformity: A significant break or gap in the geological or depositional record, indicative of erosion of the older unit prior to renewed deposition.

Euclidean Distance: In mathematics, the Euclidean distance or Euclidean metric is the "ordinary" distance between two points that one would measure with a ruler, which can be proven by repeated application of the Pythagorean theorem. By using this formula as distance, Euclidean space becomes a metric space. The associated norm is called the Euclidean norm.

Eutrophic: Having waters rich in mineral and organic nutrients that promote a proliferation of plant life, especially algae, which reduces the dissolved oxygen content and often causes the extinction of other organisms. This is used in the discussion of diatoms.

Facies: A definable subdivision of a formal or informal stratigraphic unit.

Fatty Acids: The major constituents of fats and oils (lipids) that occur in nature in plants and animals. They are insoluble in water and relatively abundant compared to other classes of lipids. Fatty acids may be absorbed into porous archeological materials during cooking, including heated rocks and ceramics, or ground into manos, metates, or mortar holes.

Feature: In archeological terms it is used to identify a nonportable item or group of items produced by people, which requires documentation in the field, such as a house structure, a midden, heath, etc.

Feldspar: A group of aluminum silicate minerals that are the most common of any mineral group, making up about 60 percent of the earth’s crust. Feldspars are usually white or clear and translucent. Usually they possess cleavage in two directions.

Ferrous Iron: This is a common residual mineral in the form of hematite in the limestone of the Edwards Plateau. It is a red color. This was observed in the petrographic analysis of the pottery sherds.

Floodplain: A nearly level alluvial plain that borders a stream or river and is subject to periodic flooding.

Gas Chromatograph (GC): A highly technical measuring instrument that separates and measures the amount of elemental components of a specific sample by the measurement of light passed through gas at regulated temperatures, which allows the detection of fatty acids at the nonogram (1×10^{-9} g) level.

Gelatinization: In regards to starch grains this is a morphological change (distortion of the original) in the grain caused by the exposure to heat and water when starches are cooked.

Geomorphology: That part of geography concerned with the form and development of the landscape.

Geophytes: These are plants with below-ground parts such as bulbs (i.e., onions, camas, false garlic), tubers, and rhizomes that can be collected, cooked, and eaten.

Granite: A very hard igneous, plutonic rock in which quartz constitutes 10 to 50 percent of the feldsparic components.

Graticule: A device used in the microscope to measure the size of items under magnification.

Gyrogonites: These are the calcareous remains of the algae *Chara* and *Nitella*. These may be used to reconstruct the alkalinity, time of colonization, and paleohydraulics of a marsh. Charophytes normally live in carbonate-rich freshwater.

HCL: Hydrochloric acid, which is the solution of hydrogen chloride (HCl) in water. It is a highly corrosive, strong mineral acid and has major industrial uses.

Hematite: A blackish-red to brick-red mineral, Fe_2O_3, the chief ore of iron. This mineral is found naturally in the Trujillo Formation and is considered locally available.

Holocene: Geological time period spanning roughly the last 10,000-years before present. The Holocene is roughly equivalent to the Post-glacial period, and often referred to as the "Recent" period in geology. Many investigations consider the Holocene to be an *interstadial* in the ongoing Pleistocene epoch.

Horizon: A discrete, relatively uniform layer in a soil profile that is typically parallel with the surface and formed as the result of pedogenic process.

Humus: A dark, organic-rich material generally caused by the decay of organic material and is found in the soil.

Igneous: Rocks that are formed by the solidification of magma from volcanic activity or from molten magma, such as obsidian, rhyolite**,** basalt and granite. These are nonlocal to the area.

Illuvium: Material in a sediment profile that has moved downward into another soil horizon by water.

***In Situ*:** Something, generally referring to an artifact, in its original position that was placed or deposited within the landscape.

Integrity: This refers to the degree of intactness of archeological deposits, components, features, or artifacts for addressing a particular research question.

Instrumental Neutron Activation Analysis (INAA): This is a method of chemical analysis involving the exposure of samples to a neutron flux from a nuclear reactor without the use of chemical separation. The exposure to neutrons produces several short- and long-lived radioactive isotopes that emit characteristic gamma rays. The energy of the emitted gamma rays provides information to identify the constituent elements, while the intensity of the emitted radiation is proportional to the amount of the element present in the sample. Gamma-ray spectroscopy is performed at different levels after irradiation to measure isotopes with different half-lives. The method is particularly sensitive to a large number of trace elements, including the rare-earth elements, transition metals and others.

Iron Stain: These resemble a blood-red smear or splash on the matrix when using a cross polarized light in viewing a petrographic slide of a pottery sherd. The stained zone has irregular rounded shapes and commonly there are discontinuous zones or strips of several rounded iron stain smears. The source of the iron stain in the ceramic fabric is problematic.

Isotope: One of two or more forms of a chemical element, differentiated by the number of neutrons contained in the nucleus.

Isotropic: The behavior of cross-polarization of light as it passes through material, especially crystalline material. Having physical properties, as conductivity, elasticity, etc., that are the same regardless of the direction of measurement

Jasper: A dense, cryptocrystalline, opaque to slightly translucent variety of chert associated with iron oxide impurities that give the rock various colors. Most often red, but can be yellow, green, grayish-blue, brown or black.

Knapping: A term used to describe the manufacturing of prehistoric chipped stone tools using different techniques, such as pressure and/or percussion methods, to chip/flake a target mass of material to form a useful tool.

Krotovina: A discrete, anomalous area visible in plan or profile in a soil resulting from the infilling of a void (e.g., a burrow or root) with dissimilar sediment. Some investigators prefer to limit the term to animal burrows, preferring the term "root trace" for filling related to decayed roots. Some krotovina are obvious, whereas others are tiny and may only be identified in thin-sections.

Legume: A plant that produces a bean or seedpod in various forms consisting of one cell and/or two valves. Common legume plants across Texas include; mesquite, Texas ebony, various acacia, retama, *Dalea* sp., mimosa, and rattlebush.

Lipids: These are hydrophobic constituents of living tissues including fatty acids, alcohols, triacylglycerols, sterols, bile acids, and waxes. Lipids are present in tissues of all living organisms in varying proportions. They are insoluble in water, relatively easily extractable, and are readily amenable to separation and characterization.

Lithic: Means "of stone". This term is used by archeologists to refer to stone artifacts and the debris that result from the manufacture of stone artifacts.

Lithology: The scientific study and description of rocks, especially at the macroscopic level, in terms of their color, texture, and composition. The gross physical character of a rock or rock formation.

Lycopodium Spores: These are marker grains used in pollen analyses. Two tablets of 13,500 ± 500 spores are added to each sub-sample to permit calculation of pollen concentration values and provide an indicator for accidental destruction of pollen during the laboratory procedures.

Macrobotanical: These are remains of plant tissues, such as wood, charcoal, and seeds that one can see with the naked eye.

Mahalanobis Distance: In statistics, Mahalanobis distance is a distance measure introduced by P. C. Mahalanobis in 1936. It is based on correlations between variables by which different patterns can be identified and analyzed. It is a useful way of determining similarity of an unknown sample set to a known one. It differs from Euclidean distance in that it takes into account the correlations of the data set and is scale-invariant, i.e., not dependent on the scale of measurements.

M.A.S.C.A.: Museum of Applied Science Center for Archaeology, University Museum, University of Pennsylvania. One institution that has studied tree-ring calibrations of radiocarbon dates.

Manuport: An object, usually a rock, that was transported by humans to the place it was recovered, but its macroscopic appearance does not indicate it had been artificially altered to form a specific tool or other kind of artifact.

Marl: Here, marls consist of white, brown, or dart gray muds that are typically silty clay loam and clay loam that has a significant component of chemically and biogenically precipitated calcium carbonate.

Matrix: Refers to the sediments in which the artifacts at an archeological site are encased, or surrounds.

Mesic Condition: A relatively moist interval generally used in the context of climatic conditions.

Metate: A slab of rock in which vegetable matter is placed for the purpose of grinding. The natural surface becomes polished and a depression forms on the metate surface. The grinding stone is called a mano.

Microdebitage: Any stone or lithic material from the manufacture of stone tools that is less than 4.0 mm in diameter.

MNI: The minimum number of individuals represented in a given faunal or human osteological collection. This is determined by the largest number of any particular bone element representing a given species in a sample of bones.

Molar Solutions: A Molar (M) is a solution that contains one mole of solute in each liter of solution. A mole is the molecular weight expressed as grams. Therefore, 1 M = 1 g of molecular weight of solution per liter of solution.

Mollusks: These include bivalve clams, mussels (Pelecypoda), and univalve snails whelks and conches (Gastropoda). They are soft-bodied and unsegmented with a muscular foot, a head region, a visceral mass, and a fleshy mantle. The shell is comprised of proteins and crystalline calcium carbonate. Marine and freshwater species exist. The associations of mollusks in the sediments reflect the water quality, salinity, and streamflow.

Normal Solutions: A Normal (N) is a solution that contains one "gram equivalent weight" of solute per liter of solution. The gram equivalent weight is equal to the molecular weight expressed, as grams divided by the "valency" of the solution is the molecular weight expressed as grams.

Obsidian: A black or very dark-colored volcanic glass that has very sharp edges when fractured. Obsidian is usually of rhyolite composition characterized by conchoidal fracture. It is sometimes banded, and may contain microlites.

Opalite: An impure, colored variety of common opal that ranges may be white, creamy white, or pale white.

Ostracods: These are microscopic crustaceans characterized by a hinged bivalve shell made of calcite. They range in size from 0.5 to 2 mm. These are diverse and abundant in marine and fresh water environments. Two of the common ostracods in marshes include *Cypridopsis vidua* and *Cypridopsis okeechobei*.

Orthoclase: A colorless, white, creamy yellow, flesh-colored, reddish or grayish mineral of the alkali feldspar group. Common orthoclase is one of the most abundant rock-forming minerals and occurs in granites, acidic igneous rocks, and crystalline schists, and is usually perthitic.

Overbank Deposits: The deposition of fine silts and clay particles that are left on terrace tops and banks when water in a stream exceeds the capacity of the channel and drops the suspended sediments load in the lower energy environment. Overbank depositional processes usually cause minimal movement to large objects on the terrace surface.

Oxidation: A chemical process wherein oxygen is added to minerals or other compounds; weathering oxidizes minerals; burning wood and rusting metal are types of oxidation.

Paleoenvironment: Ancient or past environments.

Paleosol: Generally refers to a soil that developed an A horizon and was subsequently buried.

Palimpsest: Archeologically, refers to the inability to distinguish and separate material remains from repeated occupations by a succession of cultural events of different ages due to their deposition and intermixing over time on relatively stable surfaces. Some palimpsest assemblages are buried following a long period of exposure.

Palynology: The study of fossil palynomorphs (pollens and spores) that are produced by plants. Commonly used to reconstruct the floral communities in paleoenvironments.

Parenchyma Residues: The functional parts of an organ or the thin-walled cells of the ground plant.

Pedogenesis: The dynamic process of soil formation and development, which typically leads to the formation of a darkened, organic-rich A-horizon at or near the surface, and the downward movement of fine clays into, and/or the formation of carbonate nodules within, the underlying B horizons.

Permian: The seventh and last period of the Paleozoic Era in geologic time and before the Triassic period. A period of rock formation, specifically Alibates of the Quartermaster Formation.

pH: The standard numerical designation of acidity and alkalinity commonly used in reference to soils. A neutral pH value (as in distilled water) is 7.0. Lower and higher values are acidic and base, respectively.

Phase: A group of related archeological traits (e.g., artifacts, features) that contain similar cultural material and date to one relatively narrow time period.

Phytoliths: Tiny microscopic silica particles (plant stones) that develop within the cells of most plants. Dissolved silica is transported into growing plants through water and then deposited along cell walls as silica particles. Different kinds of plants and different parts of a plant develop phytoliths of distinctive shapes. After the plants die, the silica bodies become part of the mineral component of soils left in the ground.

Pleistocene: The first epoch, which along with the Holocene Epoch constitutes the Quaternary period, spanning the time between roughly 2.0 or 1.65 million years ago and 10,000-years ago. Characterized by repeated continental glaciations, the Pleistocene witnessed the evolution of modern humans.

Polyunsaturated Fatty Acids: Pertaining to long-chain carbon compounds (e.g., C18:2) like fats with multiple double bonds. These fats are very unstable and degrade very rapidly.

Pompeii-like Setting: Pompeii was an ancient Roman town which was very rapidly buried by volcanic ash during an eruption of a nearby volcano, Mount Vesuvius, preserving human remains, architecture and other cultural objects in their exact places at the time of the eruption.

Pressure Flaking: A method used to shape stone tools through the application of force by pushing rather than striking.

Principal Component Analysis (PCA): This is a pattern recognition technique used for reducing the dimensionality of multivariate data, similar to factor analysis. It uses all of the variables measured in a sample and calculates the variation among those variables.

Profile: A cross-sectional exposure of the sequence of horizons that make up a soil or a sequence of sedimentary deposits. It can be the result of either natural erosional downcutting or an artificial excavation.

Provenience: The specific vertical and horizontal location where an object is found.

Provenance Postulate: This states that chemical analysis can successfully trace artifacts to their source if the differences in chemical composition between different natural sources exceed, in some recognizable way, the differences observed within a given source.

Quarry: The location where lithic raw material is obtained from the earth or a bedrock exposure.

Quaternary: The second period, which along with the Tertiary Period, make up the Cenozoic Era, encompassing the Pleistocene and Holocene epochs; roughly the last 2.0 or 1.65 million years.

Raphides: Needle-shaped crystals in a plant cell, typically of calcium oxalate. These are often found in plants of the Agavaceae family such as sotol, yucca, agave, and lechuguilla. They are not diagnostic of any particular plant. Bohrer (1987) and Kwiatkowski (1992) believe that only agave contain these crystals. In contrast, Dering (2003) believes these occur in a variety of Agavaceae including sotol, yucca, agave, and beargrass.

Retouch: A technique of chipped stone artifact manufacture in which pressure flaking is used to detach small flakes to sharpen or otherwise modify the edge of a tool.

Rhyolite: A very fine-grained, extrusive igneous rock, same composition as granite.

Riparian Zone: The generally well-watered area along a stream course with trees, bushes, and grasses in contrast to the open prairies.

Root Etching: Thin, shallow lines or pits that are etched into the surfaces of bones by acids associated with plant roots that grow against the bone after the bone is deposited in the ground.

Sand: Rock or mineral fragments from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil/sediment textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Saprobity: This refers to the presence of biodegradable organic matter and low oxygen concentrations.

Saturated Fatty Acids: Each carbon in the chain is connected to its neighboring carbon by a single bond, which makes them relatively stable. The most abundant saturated fatty acids have chain-lengths of 14, 16, or 18 carbons. Mammal fats primarily consist of saturated fatty acids and are solid at room temperature.

Seasonality: The season of death of the animals killed at a campsite. This is often determined by the presence of fetal or neonatal bones (i.e., bison and deer), linked to a birthing period or the age of the animals determined by tooth eruption and wear patters.

Silt: A particle size that has a range from 0.06 mm to 0.002 mm. These are smaller than sand grains and larger than clay particles.

Siliceous: Pertaining to silica, as in silicon dioxide, the most common chemical constituent on earth, and the dominant component of chert and quartz.

Site Structure: The spatial distribution of features, artifacts, and debris across a single occupation (or within a component) of an archeological site. These distributions are used to reconstruct manufacturing, maintenance, processing, production, and disposal activities at specific loci, and the spatial ways prehistoric groups organized their space at a site.

Soapstone: A metamorphic rock of massive, schistose or interlaced fibrous texture, and soft, composed essentially of talc with varying amounts of micas, chlorite, amphibole, pyroxenes, and derived from the alteration of ferromagnesian silicate minerals.

Sodium Hydroxide (NaOH): Also known as lye and caustic soda, sodium hydroxide forms a strong alkaline solution when dissolved in a solvent such as water. However, only the hydroxide ion is basic. It is used in many industries, mostly as a strong chemical base. Pure sodium hydroxide is white.

Soil Horizon: A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons an upper case letter (i.e., A, B, C, R, and O) represents the major horizon. Lower case letters that follow the upper case letters represent subdivisions of the major horizons.

Soluble Inorganic Residues: These are silica gel residues that build up with moisture availability on the utilized edges of stone tools, and that form discrete microplates as tool use progresses. Impervious to most acids and strong bases, they were are quite commonly found during use-wear analysis of stone tools and are valuable indicators of tool use due to their long term stability, and affects on the microgemometry of a tool edge that indicate kinds of motion during use. They exhibit flow characteristics of a viscous liquid and desiccation cracks as they harden.

Spinulose Spheres: These are distinctive spheres produced in arboreal phytoliths, although only rarely, in the leaves of chinkapin oak (*Quercus muehlenbergii*), red oak (*Q. rubra*) and red oak (*Q. rubra*), as well as the endocarp of black walnut (*Juglans nigra*).

Stable Isotope: An isotope not subjected to radioactive decay, such as carbon (C^{13}), oxygen O^{18}, or nitrogen (N^{15}) isotopes. This contrasts with radioactive isotopes that decay over time.

Starch: Starch is produced by all green plants for energy storage and is a major food source for humans. Pure starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol. Starch can be used as a thickening, stiffening or gluing agent when dissolved in warm water, giving, for example, wheat paste. In photosynthesis, plants use light energy to produce glucose from carbon dioxide. The glucose is stored mainly in the form of starch granules. Toward the end of the growing season, starch accumulates in twigs of trees near the buds. Fruit, seeds, rhizomes, and tubers store starch to prepare for the next growing season.

Stratigraphy: The study of layering in rocks and/or sediments, and how the layers correlate to each other.

Terrace: In geologic terms, this is an old alluvial plain that is generally flat and borders a river, stream, lake, or sea.

Trace Elements: Chemical elements, such as zinc, manganese, and iron in soils and other materials, when present in extremely small amounts.

Trophic State Index: This refers to the presence of inorganic nutrients such as nitrogen, phosphorus, silica and carbon or in organic forms. This is a measure of the ecological potential of the aquatic environment to sustain species at different levels in the food chain.

Turbation: Disturbance to the natural matrix deposits generally caused by biological agents (burrowing rodents, insects, worms, and plant roots) and natural (soil creep, desiccation crack displacement, frost heaving, landslides, etc.) processes.

Ultraviolet Light: The wave-length of light above that usually detected by the human eye that fluoresces various kinds of minerals and emits distinctive colors. On this project, a multiband light source (UV light 254/366 nm Model UVGL-58 made in 1998) was used to investigate the visual fluorescence of culturally modified stones to help in identifying their source.

µm: This is the short-hand for a micron that is one millionth of a meter, or equivalently one thousandth of a millimeter. It can be written in scientific notation as 1×10^{-6} m, meaning $^{1}/_{1000000}$ m.

Unconformity: Stratigraphic term for a boundary or break created by a depositional hiatus. This separates younger strata from older strata and is usually caused by erosion.

Unsaturated Fatty Acids: These types of fatty acids contain at least one carbon-carbon double bond or point of unsaturation. That point of unsaturation is susceptible to additional reactions. Unsaturated fatty acids are the primary constituents of plant and fish oils and tend to be in liquid-state at room temperature. Their chain-lengths vary with a minimum of 12 carbons, but most common ones contain at least 18 carbons.

Use-wear: The high-powered microscopic evidence on a stone tool that was created from sustained use. The wear may appear as striations, tiny nicks, abrasive particles, polish, rounding, soluble inorganic residues, etc. The present study used magnification between 100x and 500x to observe wear and edge-modification on selected artifacts.

Uvalde Gravel: A gravel deposit throughout much of south and east Texas attributed to the late Miocene to early Pleistocene. The deposits are composed of pebbles, cobbles, and boulders of vein quartz, quartzite, chert, jasper, silicified wood, and limestone. The ultimate source of the lithology indicates the Llano Uplift, likely the Ogallala Formation (see Byrd 1971 for more details).

Valle Grande Rhyolite: An obsidian from the Jemez Mountains in northcentral New Mexico. -Along with Cerro Toledo Rhyolite, it is grouped within the Tewa Group due to similar magmatic origins. It is similar in appearance to the Cerro Toledo Rhyolite in that it is more vitreous and not granular. This material resulted from the most recent eruption in the caldera and does not erode out of the caldera (Shackley 2005).

Variance-covariance Matrix: This is the matrix of covariances between all pairs of measured variables in a study.

Vesiculate: Pollen grains that are full of air such as pine or spruce and easily dispersed by wind.

Voids: These are gaps, holes, pores, or spaces observed in pottery matrix when viewed under a microscope during petrographic analysis. They are often used as an indirect measure of vessel porosity.

Vug: A small cavity in a vein or rock, usually but not necessarily lined with crystals of a different mineral composition from the enclosing rock.

Vulnerability Index: A calculation made by dividing the mean vessel diameter (in wood) by the mean vessel density for wood sample. A higher vulnerability index results from the presence of fewer, but larger vessels in the wood, reflecting a condition indicating a wetter climate. A lower vulnerability index is a result of numerous but smaller vessels in the wood, a condition encouraged by low rainfall conditions.

Xeric Condition: A dry or relatively arid condition often in reference to climatic conditions.

Xylem Analysis: The study of the shape, size, and arrangement of cells in wood.

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