A STUDY OF LANDFORM EVOLUTION AND ARCHAEOLOGICAL PRESERVATION AT 41HY165 SAN MARCOS, TEXAS

THESIS

Presented to the Graduate School of
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by

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ABSTRACT

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by

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Aquarena Center is an eco-tourism and research campus of Southwest Texas State University (SWT) located on Spring Lake, the headwater springs of the San Marcos River. Across this campus, numerous archaeological sites have been recorded These sites have produced a variety of temporally diagnostic stone tools, which have been the basis of a cultural historical approach of early archaeological excavations in and around the Spring Lake (Shiner 1983). This thesis uses a geoarchaeological approach to examine the landform evolution of site 41HY165 to clarify the interaction between cultural and geomorphic inputs on site formation processes. The geomorphic and archaeological data used for this research were collected in the 1996, 1997, and 1998 SWT archaeological field schools. The resulting geoarchaeological model of 41HY165 developed in this thesis concludes that early Holocene aggradation buried archaeological materials dating from the Late Paleoindian and Early Archaic periods, while erosion during the middle

Holocene removed sediments containing archaeological materials dating from the Middle Archaic period. Lastly, the resumption of slow aggradation and soil formation in the late Holocene preserved the archaeological record from the Late Archaic and Late Prehistoric periods.

CHAPTER I

INTRODUCTION

This thesis examines and interprets the landform evolution and archaeological preservation of site number 41HY165 (a Smithsonian trinomial designation for archaeological sites) located on the campus of Southwest Texas State University (SWT), San Marcos, Texas. The site lies at the confluence of Sink Creek and San Marcos River 100 meters south of the San Marcos Springs (Figure 1). These headwater springs, the second largest in Texas, are inundated by Spring Lake, a small man-made lake within the SWT Aquarena Center campus. Archaeological investigations in the area suggest the springs have a culture history of over 11,000 years (Shiner 1983; Garber et al 1983; Garber and Orloff 1984). This research uses a geoarchaeological approach to analyze data collected from the 1996-1998 Texas Archaeological Field Schools. This approach is multidisciplinary and integrates disciplines including geology, chemistry, biology, geography and anthropology. Geoarchaeological research records and analyzes geomorphic and soil data and relates them to archaeological data for the purpose of archaeological interpretation (Waters 1992). To assess archaeological preservation and interpret human occupation at 41HY165, the ability to determine whether archaeological assemblages are spatially discrete or palimpsests (of centuries or even millennia) of cultural debris is of great importance. Thus preservation is tied to the timing and nature

Figure 1. Location of Aquarena Center and Southwest Texas State University, San Marcos, Texas.

of depositional and erosional events that control landform evolution.These events, in turn, are controlled by environmental inputs including climate, geology, topography and biota.

Collins (1995) states that a problem exists with archaeological inquiry in Central Texas from the inadequate recognition of landform evolution. Numerous archaeological sites are recorded within Aquarena Center including 41HY37, 41HY147, 41HY160, and 41HY165 (Figure 2) but their geomorphic contexts have only recently been examined. Much of the previous research at Aquarena focused on developing a culture history based mainly on the presence of diagnostic projectile points. Recent studies have addressed questions of site formation process and archaeological preservation within the alluvial terraces where the majority of the archaeological record at Aquarena is preserved (Aarn and Kibler 1999; Goelz 1999).

The purpose of this research is to gain an understanding of archaeological preservation at 41HY165. This research synthesizes geomorphic, pedologic, radiometric, paleoenvironmental, and archaeological data to answer three fundamental questions of landform evolution and site formation 1) Based on stratigraphic data and archaeological materials, what is the geochronology and cultural chronology at the site? 2) How has the timing of depositional and erosional events at 41HY165 affected archaeological site formation and preservation? 3) How does the stratigraphy of 41HY165 compare to other sites at Aquarena as well as other sites in the region?

This thesis complements the existing research of the San Marcos Springs area and strives to make a contribution from which future studies can draw. This research may aid future archaeologists in developing a research design to examine specific cultural

Figure 2. Distribution of Archaeological Sites at Aquarena Center and Approximate Boundaries.

components at the site or use it to refine the geochronology and geoarchaeology of the site, Spring Lake area, and sites on alluvial landforms of the upper San Marcos River Valley.

CHAPTER II

ENVIRONMENTAL SETTING

The alluvial sediments and soils preserving archaeological materials at 41HY165 are the product of environmental processes. The relationship between geological, climatic, and biological processes on landform evolution and soil formation profoundly affect archaeological preservation (Waters 1992). This chapter presents an overview of the environmental setting as it pertains to landform evolution.

Location

41HY165 is located in southwestern Hays County in the city of San Marcos. The site is situated on an alluvial terrace of the lower Sink Creek at the confluence with headwater springs of the San Marcos River. The confluence and adjacent waterways are inundated by a small man-made lake known as Spring Lake. The site, which has an approximate area of 4,800 square meters, is located on the Balcones Fault Zone. A major physiographic and ecotonal divide, the fault zone lies between the eastern edge of the Edwards Plateau and the western edge of the Blackland Prairie (Woodruff and Abbott 1986). Faulting immediately north of 41HY165 forms a steep fault scarp and breeches the Edwards Aquifer forming one of the largest natural springs in Texas (Figure 3).

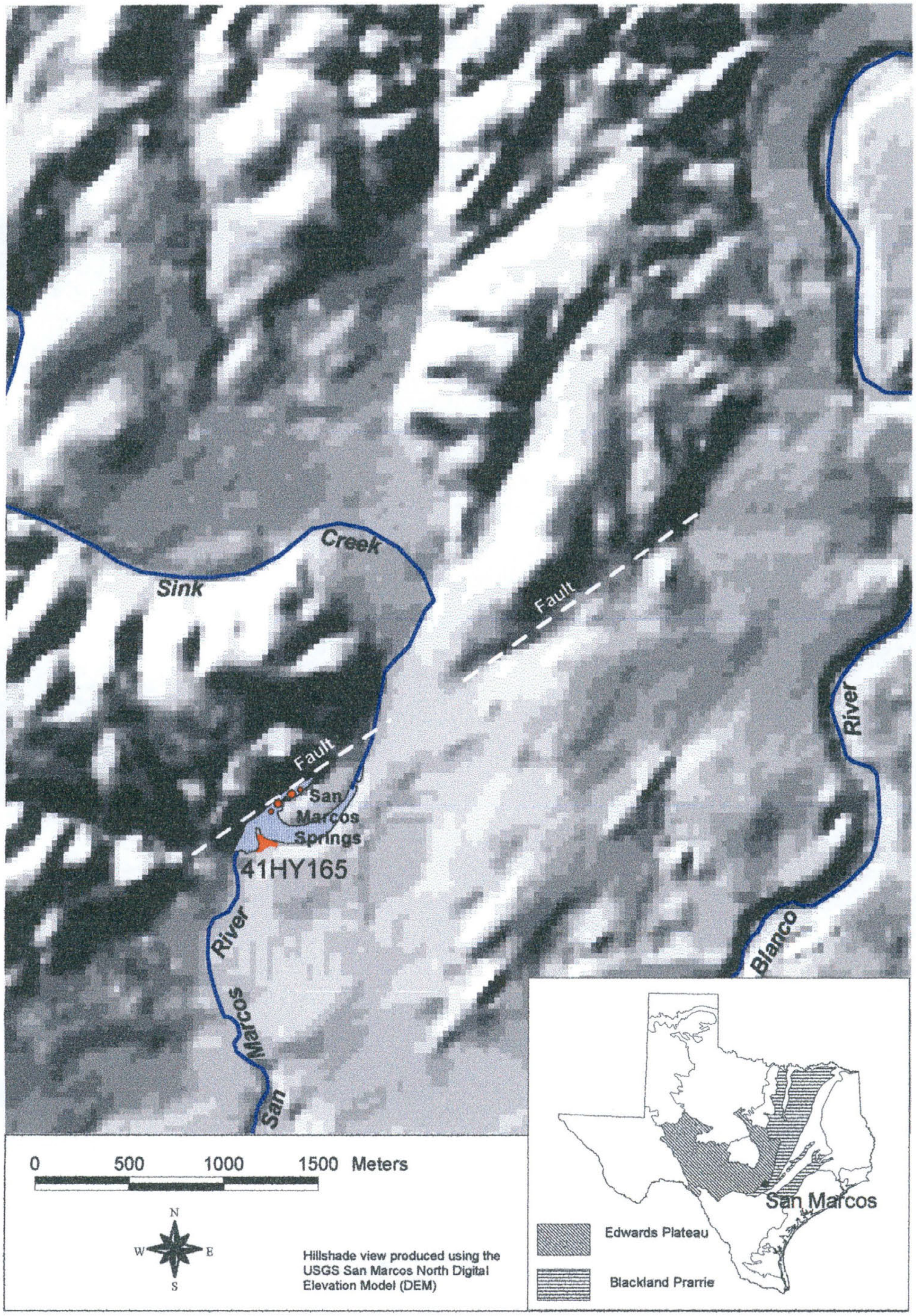


Figure 3. Physiographic Setting of 41HY165.

Modern Climate

The site area lies within a transitional zone between the humid subtropical Gulf Coastal Plain to the east and the semi-arid sub tropical Edwards Plateau to the west. The local climate is characterized by long, hot summers with high temperature averages of 35° C and short, mild winters with temperatures averaging 12° C (Bomar 1983; Woodruff and Abbott 1986). Precipitation averages 85 centimeters annually with two distinct wet periods. In late spring, the region experiences vigorous cold front squall lines. In late summer and fall, remnants of Gulf of Mexico hurricanes can produce prodigious rainfall totals and catastrophic flooding. Since 1901 there have been five precipitation events greater than 25 centimeters in 24 hours with the greatest occurring in 1998 when 40 centimeters fell on October 17 (Sands 1998). Winter precipitation is generally limited to frontal storms and is minimized by cold dry air masses holding warm moist air masses south and east of the escarpment (Bomar 1983).

Geology

In general, the surface geology in the vicinity of 41HY165 is the result of faulting associated with the Balcones Fault Zone and the dissection of the eastern Edwards Plateau immediately west. The fault zone was formed during the Miocene as the Gulf basin subsided and stressed Cretaceous limestone along a hinge in the buried Ouachita subcrop (Woodroff and Abbott 1986). A step fault exposes upthrown lower Cretaceous Del Rio Group overlying the porous Edwards limestone. Groundwater flowing through this permeable limestone has formed extensive solution channels and caverns that make up the Edwards Aquifer. Faulting north of the site breeches the aquifer which forms these artesian San Marcos Springs. Headward stream erosion of less resistant Cretaceous limestones, chalks and marls of the Navarro and Taylor Group, Austin Chalk, and Del Rio Group creates the highly dissected landscape of the Sink Creek watershed. Stream transport of boulders, cobbles, gravel, sand, silt and clay in the form of bed load and suspended load is the source of the sediments making up the lower Sink Creek floodplain mapped as Quaternary alluvium (Barnes 1979). These Pleistocene and Holocene sediments form the matrix from which the strata of 41HY165 and other sites at Aquarena Center are composed. Fluvial sediments in the Sink Creek floodplain at Aquarena center are known to be as deep as nine meters (Goelz 1999) and consist mostly of fine-grained silt and clay loams.

Soils

The soils at 41HY165 are mapped as the Oakalla series by the Soil Conservation Service. Oakalla soils are deep, well drained, and formed in calcareous loamy alluvium (Batte 1984). These soils are characterized by clay loam overlying an alluvium substrate and are frequently flooded. Oakalla Soils are vertisols which are characterized by poor horizonation caused by vertical mixing from cracking and swelling of expandable clay (Birkeland 1999). The resulting soil structure is characterized by large sub-angular blocky peds with clay-coated ped faces known as slickensides. Shrinking and swelling clays can be a problem in archaeological sites since cultural materials can be displaced through the soil profile (Collins 1995). An understanding of soil development (or pedogenesis) can aid archaeological interpretation by providing evidence of age, geomorphic context, and site formation history (Ferring 1992).

Hydrology

The San Marcos River, fed by the perennial San Marcos Springs, flows to the southeast across the upper coastal plain to its confluence with the Guadalupe River. The San Marcos Springs have a mean annual discharge of 17 cubic meters per second (cms) with a maximum discharge of 35 cms (June, 1975) and a minimum discharge of 5 cms (August, 1956) (Brune 1979). Tributaries of the San Marcos River include the Blanco River (its primary tributary), the Sink Creek, Sessoms Creek, Purgatory Creek, Willow Springs Creek, and numerous smaller tributary streams. Of these streams, Sink Creek is of particular importance to this research. The Sink Creek watershed, from which the alluvial sediments of 41HY165 originated, has a drainage area of approximately 121 square kilometers. Like many other streams in the region, the San Marcos River has experienced spectacular flooding. When discharges are calibrated to the location of the former United States Geologic Survey (USGS) gage at the I-35 bridge, there have been six floods greater than 1166 cms since 1921.

Flora and Fauna

The San Marcos Springs area lies between the Balcones Canyonlands and Blackland

Prairie vegetation regions as defined by Gould (1969). The Balcones Canyonlands west of 41HY165 are dominated by juniper-oak woodlands. To the east of the springs, the Blackland Prairie is characterized by gramgrass switchgrass grasslands, little bluestem-indian -grass tall grassland, silveanus dropseed tallgrass grasslands, and low flat woodlands along streams. Vegetation at 41HY165 can be considered southeastern riparian forest that is dominated by oak (*Quercus*), Pecan (*Carya illinoinensis*), Bald *Cyprus (Taxodium disticum)*, with an interspersed assemblage of hackberry (*Celtis laevigata)*, bushy bluestem (*Andrapogon glomeratus*), poison oak (*Rhus toxicodendron*), greenbriar (*Smilax bona-nox*), and other thorny vines.

The site 41HY165 lies just within the Texan biotic province as defined by Blair (1950). Across the San Marcos River (Spring Lake), the Balconian biotic province can be found 200 meters away from the site. A diversity of mammals, birds, reptiles, and amphibians occur or have historically occurred within this transition zone between biotic provinces; their distribution and densities are mainly dependent upon the local vegetation community and available water resources. Common mammals in the area include white-tailed deer (*Odocoilious virginianus*), opossum (*Didelphis virginiana*), armadillo (*Dasypus novemcinctus*), eastern cottontail (*Sylvilagus floridanus*), gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitus*). Bison (*Bison bison*) were present in the area during prehistoric times. Of these animals listed, the remains of white-tailed deer, bison, wild turkey, and rabbit have been identified from the faunal assemblage of 41HY165 (Giesecke, 1998) though the analysis at this time is currently ongoing. Shiner (1984) reports mammoth (cf. *Mammuthus jeffersoni*), Mastodon (*Mammut americanus.*), and bison remains recovered from 41HY147 in early stratigraphic context.

Paleoclimate

Since climate is one of the primary factors affecting depositional events that can preserve or destroy deposits containing archaeological materials, an understanding of paleoclimatic change is necessary for geoarchaeological interpretation. The temporal relationship between paleoenvironmental change and the regional cultural chronology is represented in Figure 4. The paleoclimate of the region has been examined by soil and geomorphic studies of numerous central Texas streams (Baker and Penteado-Orellana 1977; Blum and Valastro 1989), through the interpretation of palynological evidence (Holloway and Bryant 1984; Bousman 1998), and through paleontological evidence (Lundelius 1967; Dillehay 1974; Toomey 1993).

The period of paleoclimate change relevant to archaeological research in Central Texas spans from the late Pleistocene through the Holocene Epochs. Beginning with a period from 12,000 to 11,000 B.P. near the end of the late Pleistocene, a xeric interval referred to as the Clovis Drought (Haynes 1991) is inferred from geomorphic and paleontological data. Fairbanks (1989) hypothesized that Gulf coastal high pressure systems were caused by cold glacial meltwater resulting in inhibited moisture movement onto land and a cooler dryer climate. The following period, dating roughly to 11,000-8000 B.P. (Terminal Pleistocene/ early Holocene), exhibits a shift toward a more mesic climate as suggested by an increase in arboreal bog pollen columns from Boriak Bog in Central Texas (Bousman 1998). Also supporting an early Holocene mesic interval is the

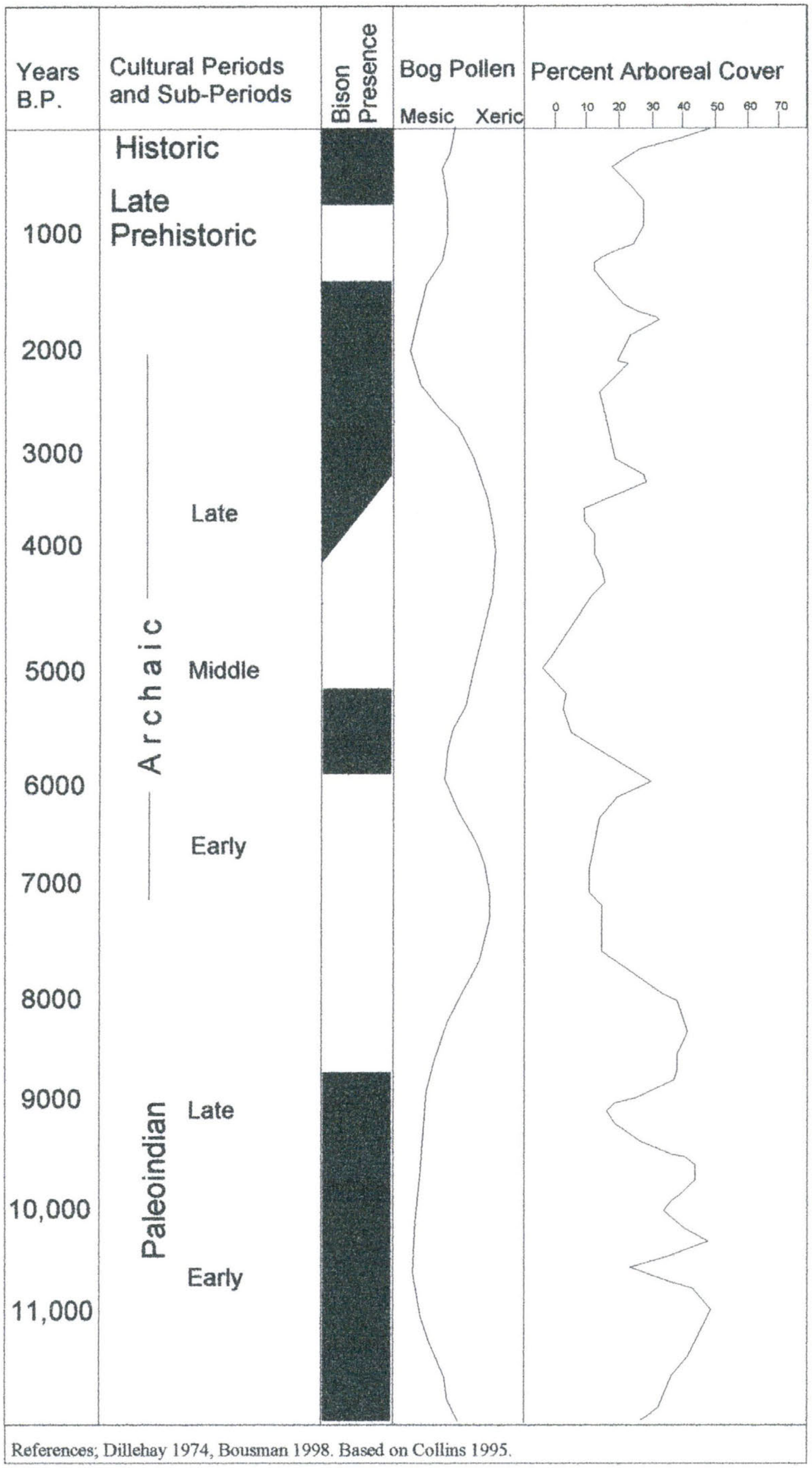


Figure 4. Cultural and Paleoclimatic Chronology of the Region.

paleontological evidence of a corresponding bison presence period (Dillehay 1974) and geomorphic data at numerous Central Texas alluvial terraces (Holliday 1992).

The middle Holocene, which dates from approximately 8000 to 4000B.P., is marked by a prolonged though variable xeric interval which has also been referred to as the Altithermal. Geologic evidence supporting the dry conditions of the middle Holocene include channel incision, surface stability, soil development, and erosion (Holliday 1992; Collins 1995). Dillehay (1974) notes a period of absence of *Bison* during the period from 7000B.P. to 4500B.P. and accounts for the absence period through middle Holocene climate change that reduced populations and shifted ranges. However, a brief period of bison presence and increased arboreal pollen at 6000 B.P. (Bousman 1998) (see Figure 4) suggest a brief reprieve from this prolonged dry interval. Other paleontological data supporting a middle Holocene xeric interval is presented by Toomey (1993) who compares the occurrences of environmentally sensitive least and desert shrews. Pollen data from Boriak bog also supports a middle Holocene drought.

Climate during the late Holocene (4000 to 1000B.P.) appears to have reverted back to more mesic conditions based on geomorphic data showing resumption of aggradation of point bars (Blum and Valastro 1989). Pollen evidence supports a wet late Holocene climate with increased aboreal pollen (Bousman 1994). Bison are also present again in the region as well as an increase in the presence of the least shrew which also indicates increased regional precipitation (Dillehay 1974; Toomey 1993). The past 1000 years have been marked by the return of more xeric conditions as supported by Hall's Cave microfauna (Toomey 1993) and arboreal pollen of Weakly Bog, central Texas.

CHAPTER III

CULTURAL SETTING

The culture history of the central Texas region relevant to the research area is presented to provide an overview of known prehistoric groups known to have occupied the area of San Marcos Springs. From what can be synthesized from the archaeological research in the region over the past century (Prewitt 1981, 1985; Black 1989; and Collins 1995), the prehistoric cultures of central Texas were organized into small bands and, for the most part, practiced hunter-gather subsistence up to Historic times. These ancient peoples are now only represented by the refuse they left behind which includes stone tools, flaking debris from stone tool production, burned rock from various hearth and/or cooking features, and disarticulated and fractured animal bone.

Distinctive artifact styles such as stone projectile points are often used as relative chronological indicators (i.e., index fossils). Typological frameworks established by Kelly (1947), and Suhm, Krieger, and Jelks (1954) are based on specimens recovered from hundreds of excavated sites throughout Texas and the United States. These stylistically diverse diagnostic types are often used as temporal and cultural markers (Figure 5) and have been the basis of establishing a central Texas archaeological chronology (Prewitt 1981, 1985; and Collins 1995). Arguing that stylistic variability in diagnostic artifact forms are in themselves insufficient to distinguish cultural change, recent refinement by Johnson and Goode (1994) makes extensive use of radiocarbon

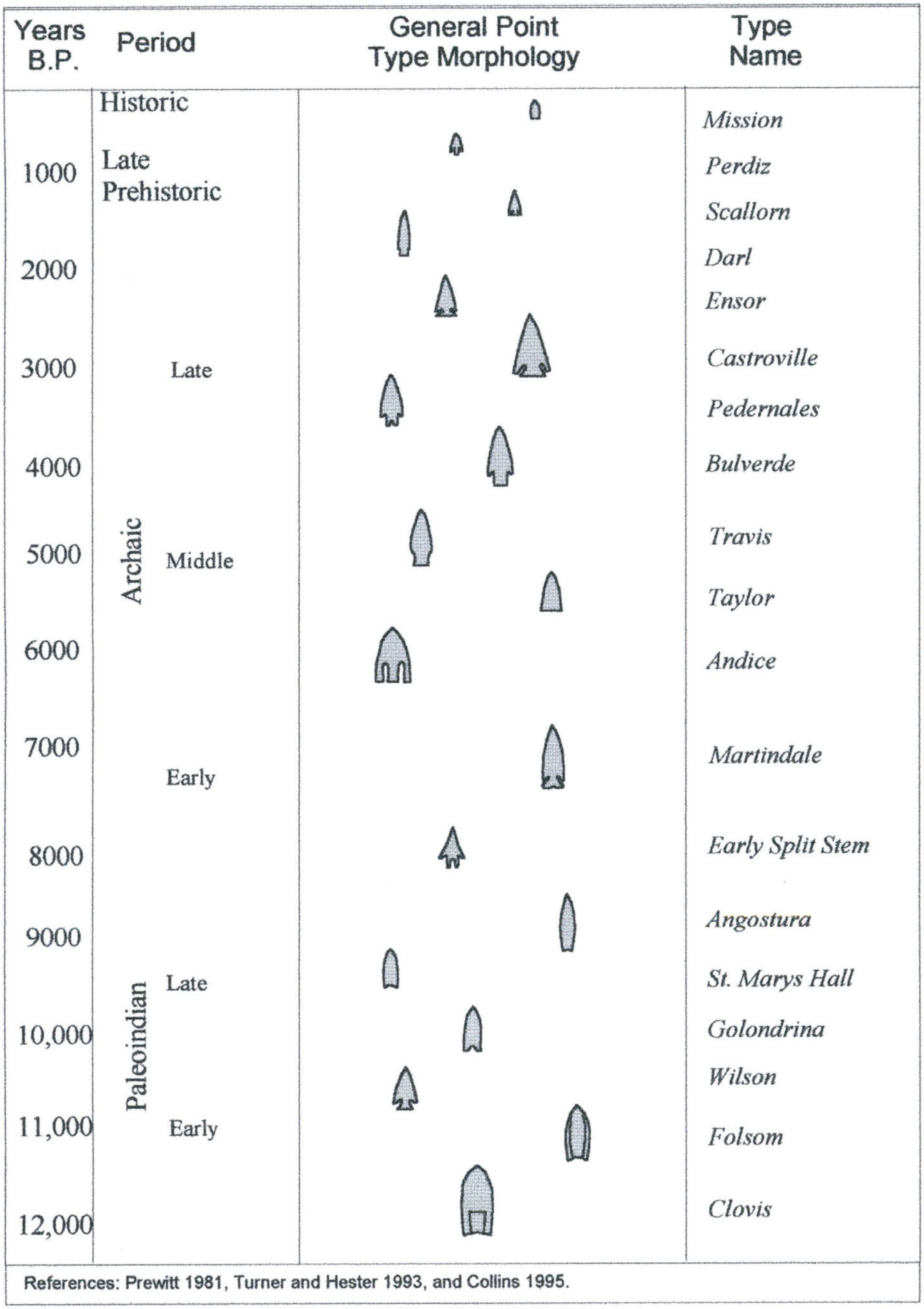


Figure 5. Cultural Chronology with Diagnostic Point Types.

dating accounting for paleoclimatic influences in an attempt to refine the central Texas archaeological chronology.

The culture history of Central Texas has been divided into four general periods: Paleoindian, Archaic, Late Prehistoric, and Historic (Suhm and Jelks 1954; Prewitt 1981; Johnson and Goode 1994; Collins 1995). The archaeological excavations at 41HY165 recovered materials from all four of these periods. These periods are divided into subperiods based on changes in the archaeological and paleoenvironmental record.

The Paleoindian Period

The Paleoindian period represents the first known human occupation of the area and dates from 11,500 to 8800 BP. During the terminal Pleistocene, the Paleoindian period is noted for its association with the hunting of megafauna and high mobility. Recent inquiries into Paleoindian subsistence have revealed greater reliance on smaller game and plant resources (Meltzer 1993). This period is divided into two subperiods; Early Paleoindian and Late Paleoindian

The Early Paleoindian period in central Texas dates from approximately 11,500 to 9,500 BP. (Collins 1995). This subperiod of prehistory is represented by three general cultural traditions defined by subsistence and tool technology; Clovis, Folsom, and Plainview. The first well documented large-scale intrusion of people to enter North America via the Bering land bridge is known as the Clovis culture. Named after the famous site on Blackwater Draw near the town of Clovis, New Mexico, the Clovis technological complex is represented archaeologically by distinctive fluted stone points and association with extinct Pleistocene mammals including mammoth (*Elephas columbi*), bison (*Bison antiquus*), camel (*Camelops sp.*) and Pleistocene horse (*Equus*). Though Clovis materials are found over a wide range of North America, there is a paucity of Clovis sites having materials *in situ* (direct association in a primary depositional setting) with stratigraphic integrity (Haynes 1993). Tèn of these sites reviewed by C. Vance Haynes (1993) have yielded radiocarbon dates which range in age from 11,650 years B.P. at the Agate Basin site in Wyoming to 10,500 B.P. at the Vail site in Maine.

Toward the end of the Pleistocene, changing climate and possibly human hunting pressure (Haynes1991) caused the abrupt extinction of the Pleistocene megafauna with the exception of *Bison antiquus*. This change is evident in the faunal assemblages of Folsom and Plainview complex sites including Blackwater Draw (Hester 1972), Lubbock Lake (Johnson and Holliday 1980), and Wilson Leonard (Collins et al 1993). Mesic conditions and vast Great Plains grasslands supported an abundance of the now extinct form of bison. It appears Folsom and Plainview peoples tracked bison over great distances as evidenced by lithic sourcing and technological organization (Hoffman 1991). Radiocarbon dates for Folsom sites range from 10,900 B.P. at Indian Creek, Montana to 10,200 B.P. at the Hanson site in Wyoming (Haynes 1993). The Plainview bison kill/butchering component at the Lubbock Lake Site (41LU1) is radiocarbon dated as being post-Folsom at 9,900 B.P. (Johnson and Holliday 1980). Unfluted lanceolate Paleoindian points similar to *Plainview* from the northern Great Plains (referred to as "*Goshen*") dating to approximately 11,000 B.P. (Frison 1993) obfuscates clear chronological affiliation of unfluted point traditions.

Late Paleoindian sites and associated artifacts are dated from 9500 B.P. to 8800 B.P. This subperiod is marked by changes in site frequency and artifact density with these sites being more numerous and containing higher artifact densities. Diagnostic tool types associated with the late Paleoindian subperiod recovered at San Marcos Springs and other Eastern Edwards Plateau sites include *San Patrice* and *Big Sandy*, *St. Marys Hall*, *Barber* and *Golondrina* (Shiner 1983; Collins 1995). Though the *San Patrice* and *Big Sandy* types are more common in the Southeastern United States, the presence of these types along the eastern plateau margin represents the western extent of those technological traditions (Patterson 1989).

The Archaic Period

The Archaic period, which lasted from 8800 B.P. -1200 B.P., is the longest of the defined cultural periods and represents two-thirds of central Texas prehistory. This period, which represents a central Texas adaptation, is divided into three subperiods; Early, Middle, and Late Archaic. Marked changes in the material culture of the Archaic from the Paleoindian period include burned rock middens and ground stone indicative of a shift toward more intensified utilization of local flora and fauna (Collins 1995). The majority of the Archaic is marked by a prolonged drought ending by the Late Archaic subperiod with a change to a more mesic climate.

The Early Archaic dates from approximately 8800 - 6000 B.P. This subperiod is represented by four diagnostic tool traditions: *Angostura, Gower, Uvalde, and Martindale*. From data on Early Archaic site distribution, it appears that these sites occur typically along the eastern margin of the plateau (McKinney 1981; Collins, 1995). With more reliable water resources along the escarpment (i.e., Comal, San Marcos, and Barton Springs), the eastern plateau and its many springs may have proved more hospitable during these dryer times.

The Middle Archaic subperiod lasted from 6000 - 4000 B.P. and is represented by numerous diagnostics artifacts including *Andice*, *Bell*, *Early Triangular*, *Nolan*, and *Travis*. The Middle Archaic coincides with the onset of a xeric climatic interval which has been referred to as the middle Holocene Altithermal. This middle Holocene climatic interval is marked by extensive erosion or limited alluvial deposition. Erosion destroyed many of the Middle Archaic sites that would have formed on stream terraces. Surface stability allowed the other stream terraces to accumulate cultural debris into aggregates or palimpsests representing centuries or even millennia of occupation (Holliday 1992; Collins 1995).

The Late Archaic sub period is dated to 4000 - 1200 B.P. and is represented by a wide variety of diagnostic tool types including *Bulverde*, *Pedernales*, *Castorville*, *Fairland*, *Frio*, *Ensor*, and *Darl* (Collins 1995) The Late Archaic shows a shift to a mesic climatic interval and the resumption of aggradation of many stream terraces. Increased distribution and density of Late Archaic sites in central Texas may be attributed to population growth resulting from an increased resource base associated with increased precipitation.

The Late Prehistoric Period

The Late Prehistoric period spans 1200-500 B.P. marked by several notable technological changes including the introduction of the bow and arrow and ceramics. The climate shifted again to a xeric interval that increased in intensity throughout the period. In central Texas two subperiods or phases are recognized, Austin and Toyah. These subperiods are based on changes in artifact assemblages and subsistence practices (Prewitt 1981; Collins 1995).

The Austin subperiod is dated at approximately 1000 - 800 BP and is marked by the presence of *Scallorn* arrow points. Austin phase materials found in association with burned rock middens are not uncommon suggesting similar subsistence practices to earlier Archaic hunter-gathers (Collins 1995).

The Toyah subperiod which dates to approximately 800-500 BP. is characterized by plainware ceramics and *Perdız* arrow points. A shıft toward bison hunting is apparent with increased bison remains present in Toyah sites (Ricklis and Collins 1994). Lithic tools such as thin beveled bifaces and end scrapers are also present in Toyah sites (Prewitt 1985).

The Historic Period

The earliest historical documentation of San Marcos Springs was written by Spanish explorers of the Espanosa-Oliveres-Aguirre expedition in 1709 (Brune 1979). Accounts of San Marcos Springs "leaping, sparkling waters" and numerous Indian tribes including the Lipans, Comanche, and Caddo were recorded by Spanish missionaries (Shiner 1983) In 1755, the Spanish moved the San Xavier Mission from Milam County to San Marcos but later moved it again to Comal County in 1757 due to drought conditions. Near the same site, the Spanish governor of Texas Manuel Antonio Cordero y Bustamante sponsored the construction of a new settlement, San Marcos de Neve in 1808. The site was abandoned in 1812 due to floods and Indian raids.

Anglo settlement of the area began some time around the mid 1840s by Thomas G. McGehee, William W. Moon, General Edward Burleson, and later by members of John C. Hays' company of Texas Rangers. A written account by early Anglo settlers is provided in a brief historic synopsis of San Marcos Springs by Brune (1979). In this account, the springs are described as bubbling up as high as three feet in a channel roughly 40 yards wide. The springs were inundated in 1849 with the construction of an earthen dam by General Edward Burleson that created Spring Lake and provided hydro-power to operate a gristmill (Shiner 1983).

CHAPTER IV

PREVIOUS RESEARCH

Previous Research at Aquarena Center

With such an extensive history, numerous archaeological research projects have been conducted in the San Marcos Springs area. A brief archaeological history of the Spring Lake area is presented to better understand the archaeological context of the area and to provide data for inter-site comparison and contrast. Initial archaeological investigations by Southern Methodist University (SMU) and SWT were exploratory and academic in nature. Recently, archaeological investigations have been initiated by proposed development in compliance with state and federal antiquities protection laws. These recent studies have had greater geoarchaeological emphasis while earlier work concentrated on developing a culture history of the area. The culmination of stratigraphic data from soil profiles recorded by these investigations has proven helpful for geomorphic interpretation and are presented later in this study.

Of the most notable investigations in the area, the work of the Late Dr. Joel Shiner of SMU concentrated on two underwater sites, 41HY161 in the San Marcos River and 41HY147 in Spring Lake. In 1978, Dr. Shiner began work on the Icehouse site (41HY161) just below the Spring Lake dam (Shiner 1979). He later focused primarily on a locality within Spring Lake (41HY147) which yielded a diverse array of diagnostic

Paleoindian, Archaic, Late Prehistoric, and Historic artifacts (Takac 1991).

Shiner worked on the Terrace locality (41HY147) until his death in 1988. Shiner (1983) provides a brief description of the stratigraphy, noting three stratigraphic units. The upper unit is described as a dark gray clay layer 20-30 centimeters thick associated with shouldered Archaic projectile points. The second unit is a red sand 10-20 centimeters in thickness associated with shouldered projectile points of Archaic age as well as Paleoindian lanceolate projectile point forms. The third unit is described as a red clay layer 30-40 centimeters in thickness associated with lanceolate projectile points of Paleoindian age (including *Clovis, Folsom,* and *Plainview*) and fossil bones and teeth of Pleistocene megafauna. Materials from Shiner's excavations are currently curated at the archaeological field laboratory of SWT Aquarena Center.

Paul Takac, a graduate student at SMU, resumed the work on the Terrace locality from 1991 through 1993. Takac's research focused on trying to collect stratigraphic data from the site. His intention was to create a series of stepped walls that would be more stable underwater than a vertical wall and allow for profiling of the site. Unfortunately, Takac discontinued the project in 1993.

Dr. James Garber, professor of anthropology at SWT, has been conducting archaeological investigations around the San Marcos Springs since 1982. His investigations of terrestrial localities around the park include 41HY160, 41HY37, and 41HY165.

Garber's 1982 excavations at 41HY160 (Garber et al. 1983), in association with the SWT Texas Archaeological Field School, revealed a multi-component site yielding cultural material throughout 2.4 meters of Sink Creek alluvium. From profiles recorded from excavation units 1 and 10, Garber et al. (1983) notes two basic color distinctions between strata. The upper 80 centimeters were recorded as a very dark gray clay loam. The lower 160 centimeters of the profile examined is described as a dark reddish brown clay loam. Temporally diagnostic projectile point types recovered from 41HY160 include *Golondrina*, *Nolan*, *Pedernales*, *Castroville*, *Frio*, *Darl*, *Scallorn*, and *Perdiz* and suggest multiple occupations spanning from the Paleoindian to Late Prehistoric periods. Depth ranges of diagnostic artifacts are provided and suggest a fair degree of vertical segregation although some translocation of artifacts was suspected (Garber et al. 1983). In general, Late Prehistoric arrow points occurred from 0 to 20 centimeters below surface (cmbs), Late Archaic points were recovered from 10 to 50 cmbs and points identified as Middle Archaic were recovered from 70 to 190 cmbs. Two reported Paleoindian points were found at 40 cmbs and 80 cmbs in an area of probable dredge spoil.

In 1983, Garber conducted excavations at an adjacent site 41HY37 (Garber and Orloff, 1984). The archaeological testing of this site yielded lithic tools dating from the Early Archaic to Late Archaic subperiods including *Clear Fork*, *Pedernales*, *Frio*, and *Edgewood.* Unlike 41HY160, all of the diagnostic points were found lying on the upland limestone surface and within the thin soils. These soils ranging from 8 to 40 centimeters thick were encountered and found to contain stone tools and flaking debris.

In 1988 David Driver conducted the SWT Archaeological Field School at Spring Lake in association with Garber. Driver recorded and tested site 41HY165 which is located at the confluence of Sink Creek and the headwaters of the San Marcos River. Unfortunately, the results of the investigations were not published but the site was recorded at the Texas Archaeological Research Laboratory and was numbered.

In 1997, a proposed parking lot near Sessoms Creek and the San Marcos River confluence on site 41HY161 necessitated some limited archaeological investigations of the proposed impact area by the Center for Archaeological Research (CAR) of the University of Texas at San Antonio (Ford and Lyle 1998). These investigations reported that substantial historic disturbance of the upper 40 centimeters of the soil profile was present in the project area. Beneath the disturbed materials a dark grayish-brown clay loam "native A horizon" overlying a orange-red clay loam is described. No diagnostic artifacts were recovered in the testing although glass, metal, bone, and chipped stone flaking debris were recovered.

In 1998, archaeological testing was once again conducted on 41HY161 by CAR in association with a water line proposed by SWT. The author, who was invited by Anthony Lyle and Chris Harrel of CAR to visit the site, was shown Early Archaic split stemmed projectile points associated with a highly oxidized reddish-brown alluvial sediment laying beneath 50 centimeters of a black to dark brown clay loam. Below the oxidized sediment, a buried soil or paleosol was noted at approximately one meter below ground surface before excavations were forced to stop by contractual constraints. Organic material from the paleosol was dated to 1000 B.P. and probably reflects contamination (Bousman personal communication).

In 1999, John Arnn and Karl Kibler of Prewitt and Associates Incorporated, conducted archaeological testing and a geomorphic assessment of 41HY37 in preparation for a proposed water pipeline. These investigations were focused along the colluvial toe-slope of 41HY37 and showed over twice the sedimentation that was recorded by Garber (1984) on the upland portion of the site. Soil profiles taken from five backhoe trenches revealed

25 to 50 centimeters of disturbed fill on top of 50 to 80 centimeters of dark gray silty loam with dispersed gravel overlying 35 to 70 centimeters of brown gravelly silt loam on top of weathered limestone bedrock. Only one temporally diagnostic artifact dating to the Late Archaic (a *Frio* point) was recovered from the lower portion of the profile.

In preparation for potential limited development by Texas Parks and Wildlife Department (TPWD), core sampling was conducted in 1999 by Prewitt and Associates Incorporated. Thirty cores were placed across the west terrace of the lower Sink Creek on which Aquarena Center is located. The cores were drilled by Trinity Engineering Testing Corporation and were interpreted by Melinda Goelz (1999) of Corrigan Consulting. The core sampling was conducted to better assess the structural geology of several potential sites for the proposed Texas River Center. The core samples investigations revealed nearly 9 meters of alluvium are present in the central part of the park on which 41HY160 is located.

Goelz describes two stratigraphic units consisting of Unit I (late Pleistocene alluvium) and Unit II (early to late Holocene alluvium). Unit I was encountered at a depth of 8.7 to 5.5 meters below the modern ground surface and is described as a strong brown, silty clay loam which lies unconformably over Cretaceous Limestone bedrock. Unit I yielded a radiocarbon assay of 11,470 $^{+}$/- 100 years B.P. from bulk sediment samples recovered at a depth of 8.5 meters (Goelz 1999). Unit II was found from 0 to 5.5 meters and consists of a dark brown, silty clay loam. Soil development was noted in the upper meter of the stratigraphic Unit II as well as a paleosol encountered at 2.4 to 1.8 meters. A radiocarbon assay of organic matter from bulk sediments from the paleosol yielded a date of 3660 $^{+}$/- 50 years B P.

Regional Geoarchaeological and Geomorphic Investigations

A literature review of archaeological and geomorphological studies in the eastern Edwards Plateau and southern Great Plains was conducted to develop a regional perspective of Holocene alluvial sequences. Six archaeological sites and two geomorphic studies were selected (Figure 6) to examine regional trends in deposition, erosion, and soil formation. These projects include the archaeological excavations of sites 41BX323 (Houk et al 1999), 41HY261 (Cargill and Brown 1997), 41HY202/41HY209 (Ricklis and Collins 1994), 41WM235 (Holliday 1992) and 41LU1 (Holliday 1992) and geomorphological studies of the Cowhouse Creek, central Texas (Nordt 1992; Abbott 1994a).

41BX323

In 1998 and 1999 San Antonio Water Systems funded archaeological investigations at 41BX323 to mitigate impact to the site by a recycled water pipeline that had to be routed through a portion of the site. 41BX323 is located in Brackenridge Park on an alluvial terrace of the San Antonio River. Archaeologically, the site has multiple cultural components dating from the Late Paleoindian to Historic periods (Houk et al. 1999).

Nordt (1999) identifies three stratigraphic units at the site that date from the late Pleistocene, early Holocene, and late Holocene designated as Units 1-3 respectively. The alluvial sediments comprising Unit 1 ranges from one to three meters in thickness. This clay loam is yellowish brown in color with pronounced pedogenic calcium carbonate development. The proposed late Pleistocene age (18,000 B.P.) of Unit 1

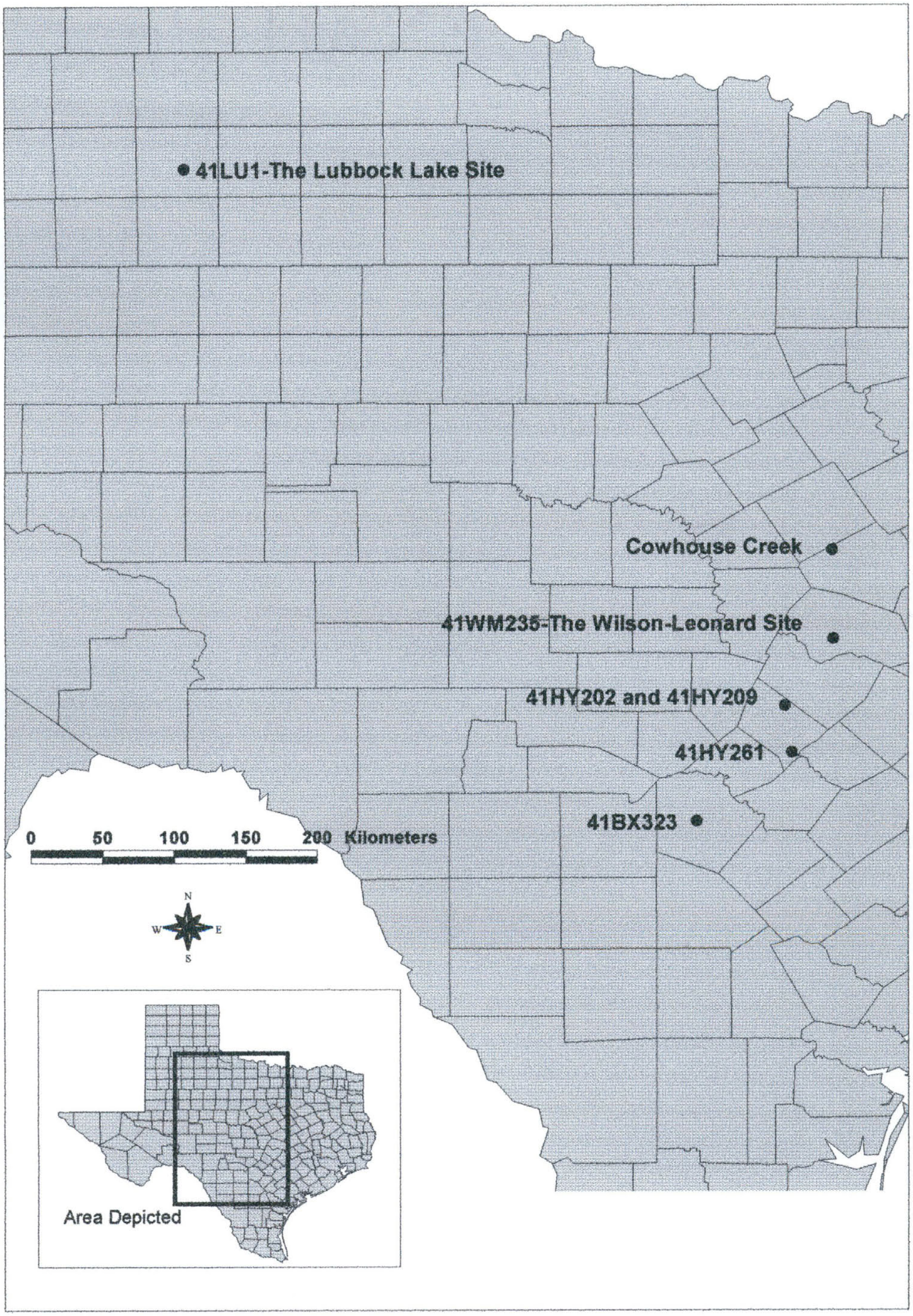


Figure 6. Distribution of Archaeological Sites used for Regional Comparison.

(Nordt 1999) predates the known presence of humans in the area. Unit 2, which lays unconformably over Unit 1, is a brown to dark gray clay loam. This alluvial fill is nearly 3 meters in thickness at the T1 terrace and pinches out in a lateral unconformity by the time it reaches the T2 terrace. Unit 2 is associated with the oldest diagnostic projectile point forms of Early Archaic and Late Paleoindian age including *Martindale* and *Victoria*. Finally, Unit 3 is the uppermost alluvial unit and ranges in thickness from 35 to 72 centimeters in thickness and consists of a dark gray clay loam. Diagnostic projectile points of Late Archaic age were recovered from the lower half of Unit 3 including *Pedernales*, *Castroville*, *Marcos*, *Fairland*, and *Ensor*. The upper portion of the profile yielded Late Prehistoric arrow points including *Scallorn*, and *Perdiz*.

41HY261-The Crook's Park Site

Site 41HY261 is located on the an alluvial terrace of the San Marcos River 200 meters west of the Interstate Highway I-35 crossing. The archaeological testing of 41HY261 was conducted in March 1997 by CAR to determine the site's eligibility as a State Archaeological Landmark (SAL) and to the National Register of Historic Places (NRHP) in accordance with state and federal antiquities laws. The testing revealed multiple occupations at the site spanning approximately 5000 years and was determined SAL and NRHP eligible based on the presence of extensive subsurface deposits.

Cargill and Brown (1997) describe two general strata at the site both consisting of 30 to 75 centimeters of a dark brown silty clay loam overlying a yellowish-red silty clay excavated to depth of 150 centimeters below surface (cmbs). Diagnostic artifacts from the Late Archaic to Historic periods were recovered from the dark brown clay loam No diagnostic artifacts were recovered from the underlying red silty clay although a peak in chipped stone flaking debris was noted from 80 to 100 cmbs.

41HY202 and 41HY209

In 1991, the Texas Archaeological Research Laboratory (TARL) of the University of Texas at Austin conducted archaeological investigations at 41HY202 and 41HY209 on the eastern margin of the Edwards Plateau, Hays County, Texas. These investigations were conducted for the Texas Department of Transportation (TxDOT) to mitigate impacts caused by the proposed construction of a bridge across the Mustang Branch and Brushy Creek associated with the construction of FM1626 six miles west of Buda, Texas. The sites are located on the Mustang Branch, an abandoned meander bend of Onion Creek, and the adjacent upland. 41HY202 is located on a late Pleistocene terrace that lies 15 meters above the modern bed of the Onion Creek and is described by Abbott (1994b) as having two general stratigraphic units. Unit 1 is described as consisting of Pleistocene gravels and massive calcareous sands and loams. Unit 2 is described as a thin veneer of overbank alluvium of early to middle Holocene age containing artifacts dating to the Early Archaic and Middle Archaic. Unit 2 has moderate soil development exhibiting an A-Bk-C horizon sequence.

41HY209 is located on the floodplain of the Mustang Branch. This T1 terrace consists of middle and late Holocene sediments divided into three stratigraphic units by Abbott (1994b). Unit 3, the basal unit, is 50 centimeters thick and is composed of angular limestone gravel cemented by calcium carbonate. Unit 2 consists of a meter of thick dark brown clay loam with a medium prismatic structure. From this stratum, artifacts of Late Archaic age were recovered. Unit 3 consists of 90 centimeters of a very dark gray to black clay loam containing two Late Prehistoric components. Unit 3 exhibits a granular structure in the upper 60 centimeters becoming sub-angular blocky in the lower 30 centimeters of the unit.

41WM235-The Wilson Leonard Site

The Wilson Leonard site (41WM235) is located on the northeastern margin of the Edwards Plateau on an alluvial terrace of Spanish Oak Creek in Williamson County, Texas. The Wilson Leonard site was originally excavated in 1985 due to the construction of a bridge associated with the expansion of FM 1431 five miles east of Cedar Park, Texas. The Wilson Leonard site is a stratified multi-component site containing cultural materials from the Paleoindian to Late Prehistoric periods within 6.5 meters of episodically deposited alluvium divided into six stratigraphic units with three associated soils (Holliday 1992). The strata proposed by Holliday are numbered from 1 to 6 (oldest to youngest).

The lower four strata (Units 1-4) were deposited sometime before the end of the Late Pleistocene until 9000 B P. These sediments and the Leanne Soil, which developed around 9500 B.P., contain the early Paleoindian record at the site including *Midland* (unfluted *Folsom*), *Wilson*, and *Plainview* type projectile points. Stratigraphic Unit 5 began accumulating sometime around 9000 B.P. but at a slower rate than Units 1-4 allowing pedogenesis to occur. The buried soil associated with the upper half of Unit 5 is called the Stiba Paleosol. During this time of surface stability, cultural materials including *Angostura* and *Gower* points accumulated for over a millenium. Initially, this amalgamation of artifacts gave a false impression that these materials were contemporaneous.

Unit 6 began accumulating around 6000 B.P until 4000B.P. when the Wilson paleosol began forming and continued into the Twentieth Century. This soil, designated the Wilson-Leonard soil, contains artifacts of Late Archaic and Late Prehistoric age. The slow rate of aggradation associated with the Wilson soil has resulted in poor vertical segregation of cultural materials deposited during the late Holocene.

Cowhouse Creek

Late Quaternary alluvial sequences of Cowhouse Creek, which flows through the Fort Hood Military Reservation in Coryell and Bell Counties, Texas, have been studied extensively by Nordt (1992). The Cowhouse Creek is a tributary of the Leon River and drains the southeastern portion of the Lampasas Cut-Plain Nordt proposes six stratigraphic units from the late Pleistocene through the late Holocene.

The oldest stratigraphic unit currently recognized in the Cowhouse Creek and tributary streams at Fort Hood is the Jackson Alluvium. This stratum is late Pleistocene in age and is found on the T2 terraces of Cowhouse Creek and larger streams. The Jackson Alluvium ranges from 2 to 4 meters in thickness and generally consist of reddish-orange coarse-grained channel gravel, loamy, sandy, and clayey sediments. A radiocarbon date from the Jackson Alluvium was dated to 15,000 ± 260 B.P. (Nordt 1992) which predates any known cultural occupation of the area.

The Georgetown Alluvium dates from the late Pleistocene through the early Holocene 12,000 B.P. to 8200 B.P. although only the terminal date for this range is based on radiocarbon assays (Abbott 1994a). The stratum is 2 to 5 meters in thickness and consists of fine well-sorted channel gravel underlying yellowish clayey and silty loams. Surface stabilization allowed pedogenesis to occur forming what is known as the Royalty Paleosol (Nordt 1992).

The Fort Hood Alluvium dates from approximately 8000 B.P. to 4500 B.P. and consists of 10 meters of clay loam overbank deposits overlying 1 to 2 meters of channel gravel. Soils in the Fort Hood Alluvium are generally thick and have A-Bw-Bk-C profiles and range in color from reddish-brown to brown (Abbott 1994a).

The West Range Alluvium is divided into two halves with a lower coarse-grained lower portion dating from 4300 B.P. to 2400 B.P. and an upper fine-grained member deposited from 2800 B.P. to 600 B.P. (Abbott 1994a). This stratigraphic unit is associated with the T1 terraces of the Cowhouse and tributary streams and has a thick cumulic dark brown soil with a A-Bk-C profile.

41LU1-The Lubbock Lake Site

The Lubbock Lake Site (41LU1) is located on the Southern High Plains in the city limits of Lubbock, Texas. The site was formed in a meander of Yellowhouse draw where late Pleistocene and Holocene sediments and soils have been accumulating and developing for over 11,000 years (Holliday and Allen 1987). The site was discovered in 1936 when workers at a Works Progress Administration (WPA) excavation to rejuvenate the local springs found archaeological materials in the dredge spoil. Initial archaeological investigations ensued in 1939 and numerous subsequent investigations followed and demonstrated a continuous occupation of the site from the Early

Paleoindian (Clovis) period through the Historic period (Holliday 1987).

Holliday and Allen (1987) describe the archaeological geology (or geoarchaeology) of the Lubbock Lake Site identifying five stratigraphic units and five associated soils. The strata are numbered 1 to 5 from oldest to youngest. The draw began filling with alluvial sediments of Units 1 and 2 from 11,200 B.P. to 8500 B.P. From 8500 B.P. to 6400 B.P., the Firstview soil (named because of its association with lanceolate *Firstview* points) formed in an environment of slowed sedimentation. From 6400 B.P. to 4500 B.P. Units 3 and 4, consisting of marsh sediments and wind blown (eolian) sediments, deposited nearly four additional meters of fine-grained sediments. From 6000 to 5000 B.P., deposition again slowed and another soil began forming designated the Yellowhouse soil. From 4500 B.P. to the present, three soils were formed during the slow deposition of Unit 5. These soils include the Lubbock Lake soil (4000B.P. to 2000B.P.), the Apache soil (1000B.P.), and the historic Singer soil.

Through examination of sedimentation and soil development at the archaeological sites discussed, several trends become apparent. Similarities in the timing of sedimentation and soil formation events between these sites are noted throughout the Holocene. Three general trends of alluvial landform evolution are seen. Alluvial sequences show Early Holocene flood plain aggradation, Middle Holocene flood plain abandonment, soil formation, and channel incision, with a resumption of flood plain aggradation in the Late Holocene. Shorter duration or less pronounced trends are seen within the Holocene marked by paleosols, aggradation, and erosion.

CHAPTER V

METHODS

The focus of this thesis is oriented toward examining the interaction between landform evolution and archaeological site formation. The methods for collecting both geomorphic and archaeological data for analysis are presented in this chapter.

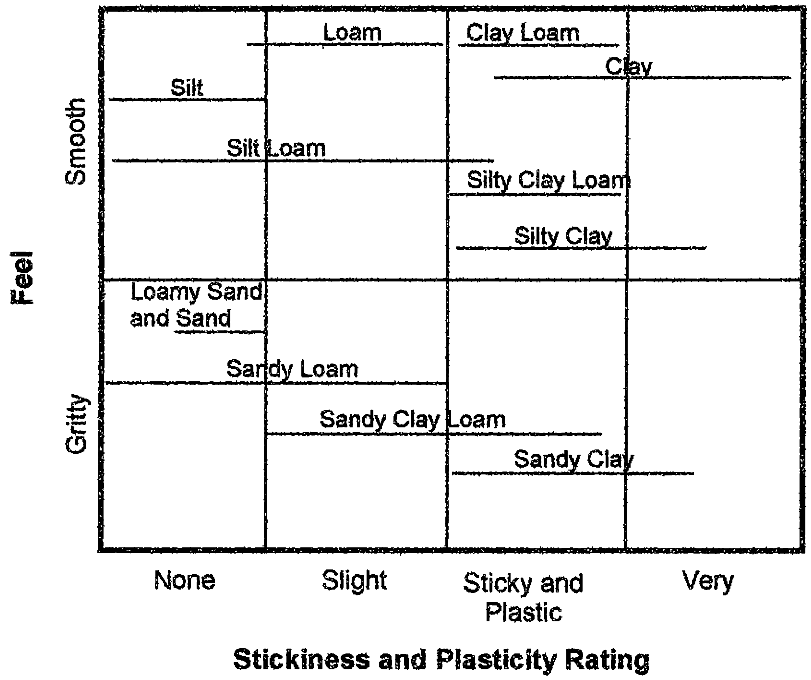
Geoarchaeological Methods

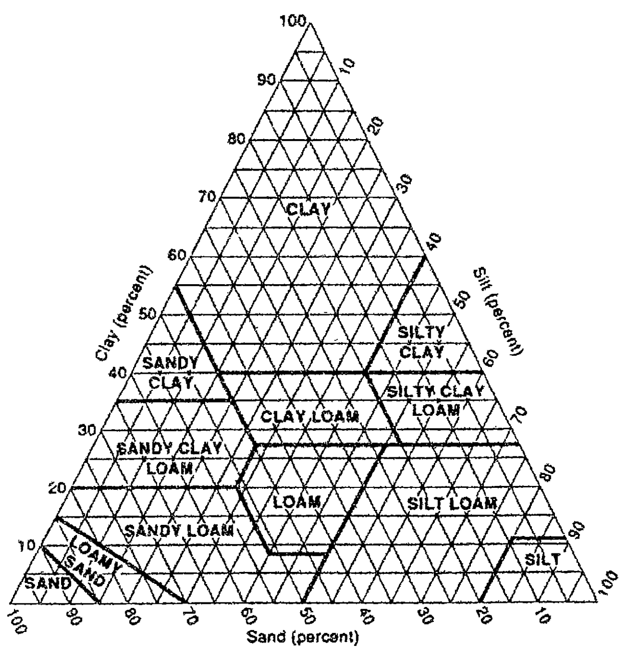
The methods for the geoarchaeological study of 41HY165 are structured to aid in the analysis of site geomorphic, stratigraphic, and pedologic data for the development of a site formation model. The geomorphic context of 41HY165 was described with the aid of a Geographic Information System (GIS) and digital maps (or coverages) of the San Marcos area available from the Texas Natural Resource Information System (TNRIS). Stratigraphic and soil profile descriptions recorded for this study were taken from excavation units 2, 3, 8, and 10 to provide a 60 meter cross section of the site. Sediments and soils were described using the variables of depth, color, texture, structure, boundary, consistence, presence of carbonates, and bioturbation. Once these variables were collected, lithostratigraphic designations were assigned based on conventions of the North American Stratigraphic Code (1983). Soil horizon designations, as defined by the Soil Survey Staff (1993), were used to identify soil development within the alluvial strata of the site. The methods for the collection of variables used in the sediment/soil descriptions are presented below.

Color was recorded using a Munsell soil color chart which quantifies field color observations of soil profiles. Munsell chart values are divided into hue, value, and chroma. Hue relates to the dominant color (i.e., 2.5YR is red, 10YR is brown, and 2.5Y is yellow). Value relates to lightness or darkness of the color and rated from 1 (dark) to 8 (light). Hue relates to the purity or strength of spectral color (Birkeland 1999) and is ranked from 1 (least vivid) to 8 (most vivid). Soil color can be an indication of organic material, leaching, the accumulation of carbonates or iron, and other soil processes

Texture is an important characteristic of a profile and variation can be used to interpret pedogenic history of a soil (Birkeland 1999). Texture of fine-grained alluvial sediments, such as those present at 41HY165, are analyzed and described according to the percentages of sand, silt, and clay. Numerous methods of texture analysis can be used to identify soil texture and include tactile field description, nested sieves, hydrometer, and pipette methods. Fiscal limitations of this study have limited texture analysis to the tactile field description as presented by Birkeland (1984). Texture description diagrams used in the soil analysis of the site are presented in Figure 7 and show the relationship between the qualitative description of sediment and the approximate quantitative percentage of sand, silt, and clay.

Variation in the arrangement of soil particles into secondary particles, units, or peds within a sediment profiles are described according to the Soil Survey Staff (1993). These soil structure descriptions may be useful in interpreting soil formation processes as influenced by biological and paleoclimatic inputs which in turn affect archaeological preservation.





TEXTURAL ABBREVIATIONS			
C	Clay	SCL	Sandy Clay Loam
CL	Clay Loam	SL	Sandy Loam
L	Loam	Si	Silt
LS	Loamy Sand	SiC	Silty Clay
S	Sand	SiCL	Silty Clay Loam
SC	Sandy Clay	SiL	Silt Loam

MODIFIER ABBREVIATIONS:	
vf	very fine
f	fine
co	coarse
vco	very coarse
g	gravelly

References. Birkeland 1999

Figure 7 Texture Diagrams used for Texture Analysis.

Stratigraphic boundaries are examined in this study to address development, deposition, and erosion of soils and sediments at the site. Stratigraphic boundaries between different soil horizons are differentiated and described on the basis of distinctness and form (Waters 1992). Distinctness is evaluated by differences between horizons which may include color, texture, and structure. The boundaries dividing soil horizons are then ranked as either abrupt (<2cm), clear (2-5cm), gradual (5-15 cm), or diffuse (>15 cm).

The presence of secondary calcium carbonate in the soil profile will be described as it occurs as filaments and/or nodules. Carbonates may be introduced by illuvial movement through the soil profile (accumulating at an impervious boundary) or by the fluctuation of the ground water table which may be saturated with calcium carbonate. Secondary carbonates can be an indicator of relict soils or a relative indicator of age.

Bioturbation of soils by flora and fauna must be considered in archaeological interpretation. Through the action of burrowing animals and plant roots, cultural materials can be translocated from one stratum or horizon to another chronologically and archaeologically different one. Examination of this phenomenon is especially important when using temporally diagnostic artifacts recovered from the site for relative dating of archaeological horizons or sedimentation rates. At 41HY165, bioturbation is not uncommon and, in many cases, can be identified by differences between soil color and texture. Root and animal burrow bioturbation was recorded. Those containing displaced archaeological materials were noted.

Archaeological Methods

Archaeological excavations at 41HY165 were conducted in association with the Southwest Texas State University Texas Archaeological Field School in the summers of 1996, 1997, and 1998. The field schools were directed by Mary K. Brown with myself acting as teaching assistant. Although 41HY165 was previously recorded and investigated during the Texas Archaeological Field School in 1988 by Dr. James Garber and David Driver of SWT, the limited scope of the work prompted a second examination of the site. The archaeological investigations conducted during the 1996, 1997, and 1998 field seasons had three primary goals. The first was to teach an archaeological field techniques course as well as involve the students in site evaluation and protection on their own campus. The second was to systematically identify cultural components at the site, assess their aerial extent and preservation, and evaluate future research potential. The third focused on protecting the site by recommending it for nomination as a State Archaeological Landmark (SAL) to the Texas Historical Commission.

Although 41HY165 had been previously recorded, to be thorough and as a class exercise, the site was redefined by a series of shovel tests at the beginning of the 1996 field school. Seven shovel tests were placed approximately 30-50 meters apart and excavated to depths ranging from 60 to 100 centimeters (depending on difficulty). Each shovel test was excavated in 20 centimeter intervals and screened through 1/4 inch mesh. The distribution and results of these shovel tests are presented in Figure 8a.

Placement of the excavation units was based on the results of the shovel testing (Figure 8b). Six units were initially placed during the 1996 field school. All units were

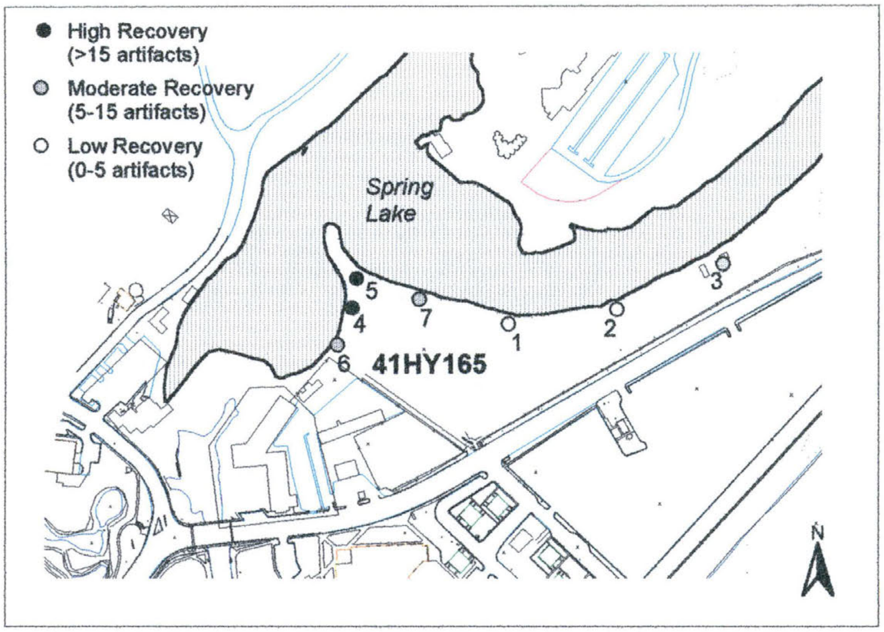


Figure 8a. Distribution and results of shovel tests at 41HY165.

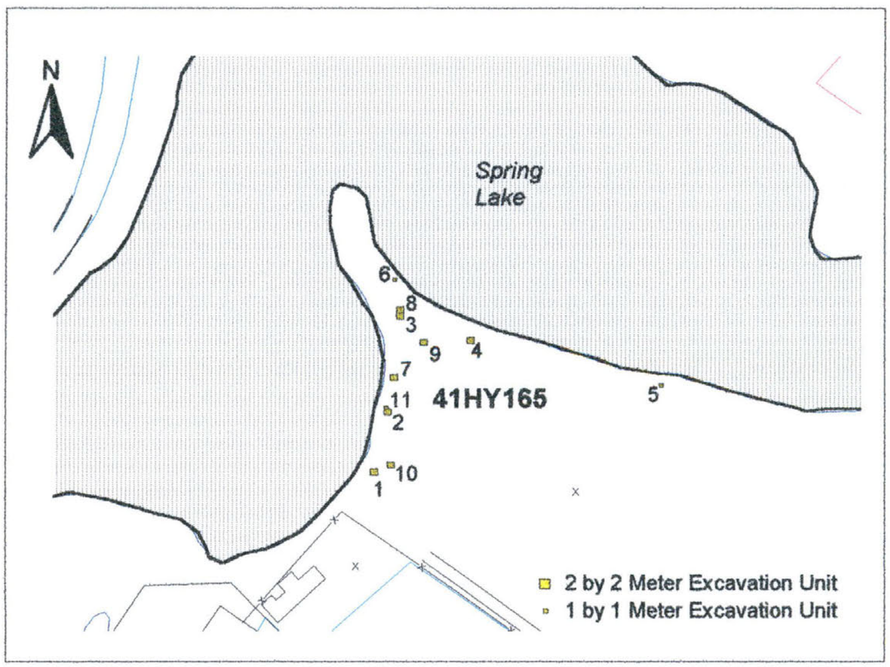


Figure 8b. Distribution of excavation units at 41HY165.

Figure 8 a and b. Distribution of Shovel Tests and Excavation Units at 41HY165.

oriented on magnetic north and all two-by-two meter units were divided into 4 one by one meter quadrants. Units 1, 2, 3, and 4 were two by two meters in size and Units 5 and 6 were only one-by-one meter in size. Excavation units 7 through 11 were added during the 1997 field school. Units 7 through 10 were two by two meters in size. Unit 8 was placed immediately north of unit 3 giving a four-by-two meter horizontal exposure and four meter linear soil profile. Unit 11 was only one-by-one meter in size and placed immediately north of the northwest quadrant of unit 2. No excavation units were added during the 1998 field season which focused on extending units 3 and 8 to greater depths.

Each one-by-one meter quadrant or excavation unit was excavated in 10 centimeter arbitrary levels. Levels were excavated by hand using trowels to allow greater control for finding artifacts in-situ (or their exact vertical and horizontal positions). The depth of features, lithic tools, and bone were measured in centimeters below ground surface (cmbs) using a line level and metal tape measure. Horizontal position was measured using a tape measure and recorded by hand drawing the specimen(s) or feature on graph paper for each unit and level. These data were then recorded on standardized level forms. The sediment excavated from each level was screened using 10 millimeter wire mesh. Lithic tools, debitage, and bone not found in-situ were recovered in the screen and bagged by unit and level. All archaeological materials recovered from the excavations were washed and catalogued. These materials are currently curated at the SWT Anthropology Field Lab.

The methods for the feature and artifact analysis are focused on gathering data to understand site formation and archaeological preservation at 41HY165 rather than a comprehensive artifact analysis oriented toward anthropological research questions such as subsistence and social organization. All temporally diagnostic projectile points from the site will be analyzed to maximize temporal control for developing a geochronology for the site. Archaeological features and artifacts used in the analysis are sampled from excavation units 2, 3, and 8. This allows for the examination of a representative sample of the archaeological artifact assemblage to be conducted without burdening the research with excessive and repetitive data. Features were sampled from excavation units 2 and 3 because they have the highest occurrence of features and best demonstrate superposition (where the most recent is at the top and oldest is on the bottom) of the different cultural occupations represented by these features. Lithic debitage and faunal material are sampled from the northeast quadrant of excavation unit 2 and the northwest quadrant of excavation unit 8 for an analysis of frequency distribution by 10 centimeter level

Archaeological features from 41HY165 are fairly representative of those found in the Central Texas region and include hearths, basins, and scatters composed of burned limestone which represent activity areas generally believed to be associated with cooking (Black 1989). Of the eighteen features encountered during the 1996 and 1997 excavations, eight were selected for analysis and integration into this thesis. Analysis of these features consists of describing the dimensions of the feature, artifacts that make up the feature, morphology of the feature, age of the feature, and the function of the feature (if possible).

Features that have no discernable shape or form and are only represented by a sharp increase in artifact frequency (i.e., lithic tools, debitage, and/or bone) are referred to in this thesis as archaeological zones. Two zones are described along with the eight features selected for analysis

Temporally diagnostic projectile points will be identified by their morphology and relevant technological characteristics from the evolving typological categories defined by Suhm, Krieger, and Jelks (1954), Prewitt (1981, 1985), and Turner and Hester (1993). Projectile point types can be good relative chronologic indicators since the recurrence of these types are well documented across the state and often from sites with good radiocarbon dating. However, the use of diagnostic projectile points as relative chronologic indicators should be conducted cautiously with the understanding that cultural materials can be translocated through the soil or sediment profile by bioturbation and pedogenic processes. Non-diagnostic lithic tools are not examined due to the cursory nature of the initial analysis. Given the subtleties and difficulty of lithic analysis the current tool counts are likely inaccurate. Lithic debitage, which occurs in greater frequency and much easier to identify, was examined instead of non-diagnostic lithic tools.

Lithic debitage from excavation units 2 and 8 was analyzed using the variables of frequency and elevation. Although this analysis seems simplistic, a frequency analysis should be sufficient to identify discrete cultural components or accumulations of materials (from several components on a stable surface) since technological aspects of the lithic assemblage are beyond the scope of this research.

Faunal remains were frequently encountered at 41HY165, and although a comprehensive analysis of the faunal assemblage has not been conducted, accurate counts of specimens by excavation unit and level are available. Like the debitage analysis, faunal material from excavation units 2 and 8 was analyzed by frequency and depth.

Since bison bone in the faunal assemblage was easily identifiable and can be related to climatic changes through time (Dillehay 1974), an examination of bison bone from the site was also conducted. These remains are presented by excavation unit, level, and later correlated with archaeological features and geologic strata.

Wood charcoal was also frequently encountered from 41HY165 during the 1996 and 1997 Texas Field Schools. These organic materials were found throughout the soil profile but were most common in the upper meter of deposits in association with burned rock features. Wood charcoal was chosen as the preferred material for radiocarbon dating rather than soil humates. Since older organics associated with the parent material may be introduced into alluvium and through illuvial processes, humate dating may yield older dates not truly representative of the actual age of a particular soil or sediment (Ferring 1992). When encountered in the field, datable carbon (generally wood charcoal) found in-situ was collected and stored.

CHAPTER VI

DATA AND ANALYSIS

This chapter presents analysis of the geomorphic data and archaeological materials recovered from 41HY165. This chapter is divided into three sections: The first section presents an analysis of the geomorphology, alluvial stratigraphy, and soils of 41HY165. The second section presents an analysis of selected archaeological features and materials including burned rock hearths and scatters, lithic tools and flaking debris, and faunal material. The final section integrates the previous sections from which a spatial analysis of the site is constructed.

Analysis of Site Geomorphology, Alluvial Stratigraphy, and Soils

The identification and the descriptive analysis of alluvial surfaces of the lower Sink Creek and headwaters of the San Marcos River were conducted using the San Marcos North United States Geological Survey (USGS) 7.5 minute topographic Digital Raster Graphic (DRG), and the USGS Digital Elevation Model (DEM). These alluvial surfaces are identified in both plan view and cross section (Figure 9a and b). Topographic contour lines were generated from the DEM using ArcView GIS. The shape and size of Spring Lake and the stream locations was digitized from the DRG.

As seen from the topographic map shown in Figure 9a, 41HY165 is located on the

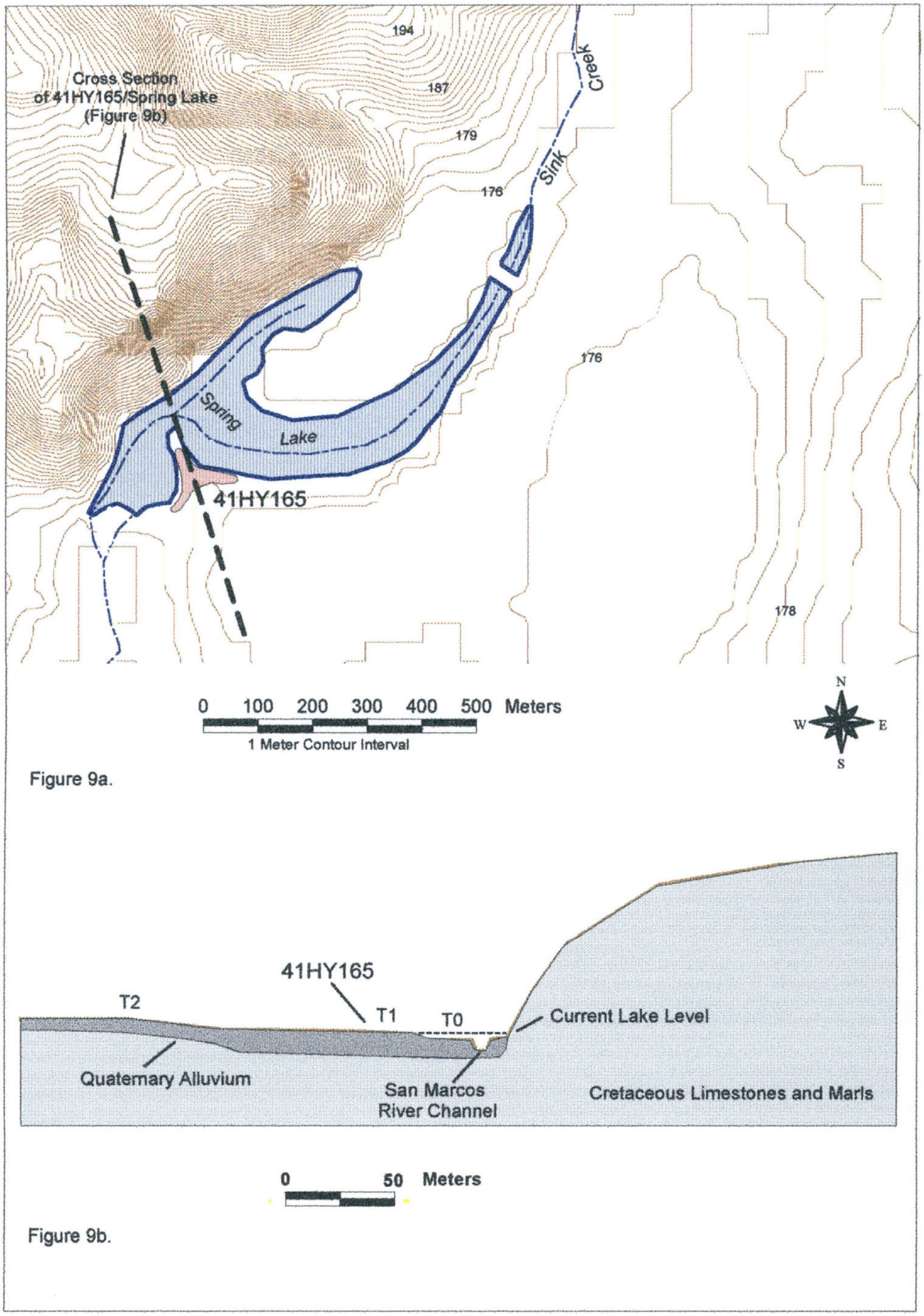


Figure 9 a and b. Topography and Cross Section of 41HY165 and Spring Lake.

south shore of Spring Lake at the inundated confluence of Sink Creek and the San Marcos River. The site lay on a point bar adjacent to paired alluvial terraces of the lower Sink Creek immediately to the east. The northern terrace is also an interfluve between the Sink Creek and headwater springs of the San Marcos River. The elevation of 41HY165 is approximately 176 meters above mean sea level or two meters above the current lake level.

A cross-section of the area constructed referencing the DRG and DEM (see Figure 9b) reveals the modern floodplain (T0) is currently inundated by the Spring Lake. 41HY165 is located on the abandoned floodplain terrace (T1) composed of Holocene alluvium. South of the site, is a third terrace (T2) higher in elevation and likely Pleistocene in age. The evolution of sedimentary construction of the T1 terrace is described in the analysis of the alluvial stratigraphy.

The alluvial stratigraphy at 41HY165 was analyzed using the recorded profile descriptions from excavation units 2 and 8 employing techniques outlined in the previous chapter. The strata defined are described as lithostratigraphic units according to North American Stratigraphic Code (1983) and given Roman numeral designations (Figure 10) starting with I at the bottom of the profile. Each stratigraphic unit represents a temporally discrete sediment package either being laid-down briefly by rapid deposition or long-term slow deposition. Differences in lithostrata are the product of changes in the depositional environment and may exhibit conformable or unconformable contacts with underlying and overlying stratigraphic units. Varying degrees of pedogenesis within these units are noted and discussed.

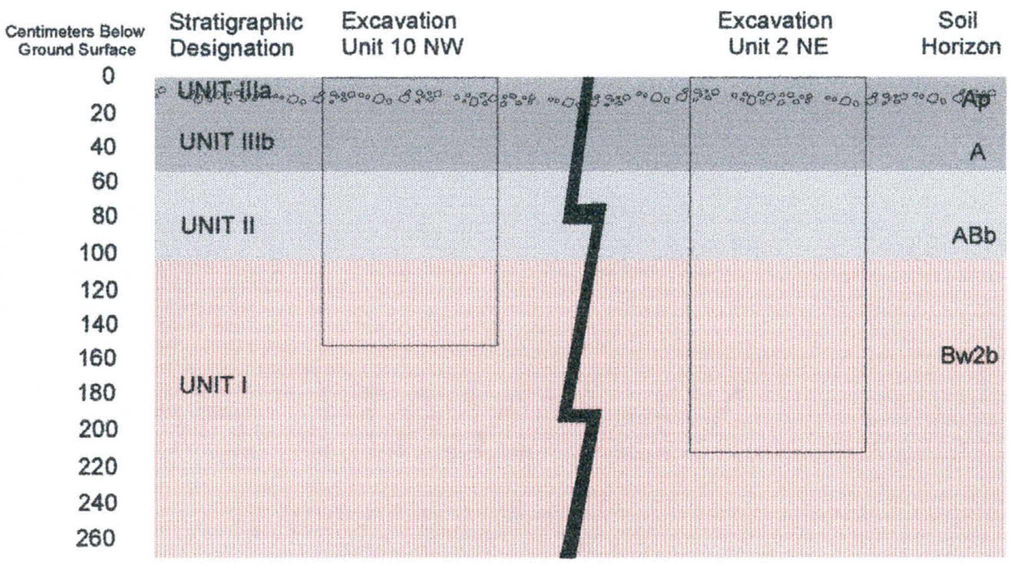


Figure 10a. Profiles of Excavation Units 2 and 10.

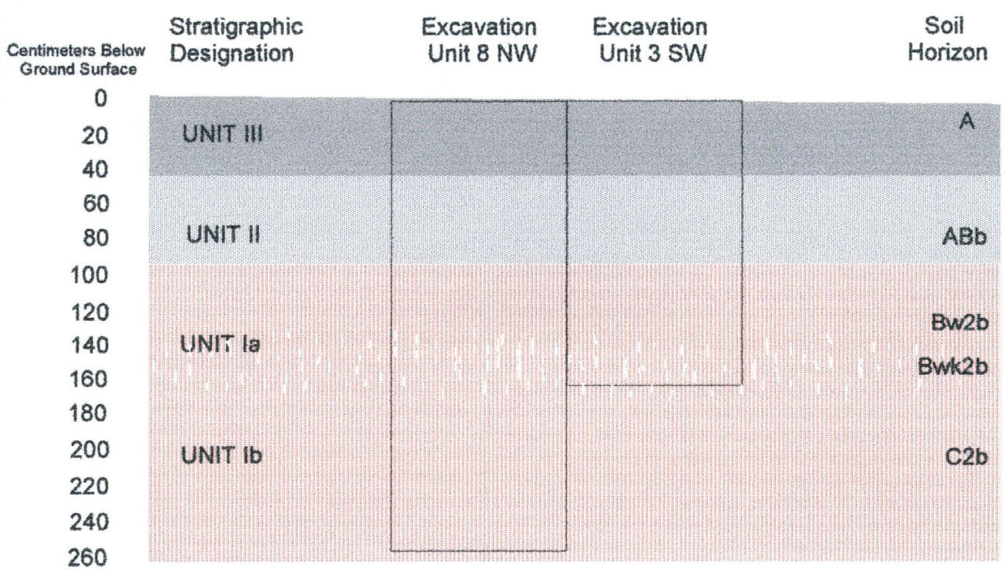


Figure 10b. Profiles of Excavation Units 3 and 8.

Figure 10 a and b. Stratigraphic Profiles of Excavation Units 2, 3, 8, and 10.

Profile Description of Excavation Units 2 and 10

Although excavation units 2 and 10 are approximately 15 meters apart, their profiles are nearly identical. To prevent redundancy, these profiles will be described together.

Unit IIIa (0-15 cmbs)

Unit IIIa begins at the ground surface and is approximately 15 cm in thickness. This unit is composed of historic fill material with an overlying thin humic soil. The upper 5-7 centimeters is a brown and dark brown (10YR4/3 and 10YR3/2) mixture of partially decomposed organic matter and loamy mineral fraction overlying an 8-10 cm thick layer of historic gravel fill material. The gravel is loose and poorly sorted, consisting of rounded to sub-rounded limestone fragments ranging from <1 - 5 cm in size. The gravel in Unit IIIa pinches out and disappears somewhere between excavation unit 7 and 8. Roots and rootlets are common and sediment filled animal burrows (krotovina) are few but present. The boundary with Unit IIIb is abrupt. An Ap horizon designation is given which is defined as a human modified soil.

Unit IIIb (15-50 cm)

Unit IIIb begins approximately 15 cm below ground surface (cmbs) and is 35 cm in thickness. This unit consists of a very dark brown (10YR2/2) silty clay loam with granular structure. The dry, granular structure of this stratum is the product of active bioturbation from roots, earthworms, and various burrowing arthropods and vertebrates (Birkeland 1999). Unit IIIb is dry, slightly hard, with common roots and rootlets and few krotovina. The lower boundary with Unit II is clear and smooth. Slow aggradation of the stratum has given way to soil formation. This dark organic soil is an A horizon which consists of humified organic mater with mineral fraction from overbank flooding.

Unit II (50-90 cm)

Unit II is found 50 cmbs and is approximately 40 cm in thickness. This stratum is a dark yellowish brown (10YR3/4) silty clay with moderate sub-angular blocky structure caused by the shrinking and swelling of clay. The peds are coarse and hard with clay coating on the faces. Roots and krotovina are few and the boundary with Unit I is clear and smooth. Since Unit II shows some degree of pedogenic alteration (in the form of illuvial clay) but still retains similarities with the overlying soil horizon, the unit is given an ABb horizon designation (shares the attributes of both an A and B horizon and is a buried soil).

Unit I (110-200 cm)

Unit I occurs at 110 cmbs and is greater than 90 cm in thickness. Unit I is a dark reddish brown 5YR3/4 silty clay loam with weak sub-angular blocky structure. Peds are medium and slightly hard becoming firm with depth and added moisture. Although roots and krotovina are few in this stratum, root molds filled with darker sediment (Unit II) are clearly visible. The clear boundary and abrupt change in color and texture from Unit II to Unit I marks an apparent unconformity. This stratum exhibits a buried Bw2b-C2b soil profile. The upper half of Unit I (110-160 cm) is designated as a Bw2b horizon due to the weak structure and lack of illuvial clay accumulation. The lower portion of Unit I consists of alluvial sediment unaltered by pedogenesis and is given a C2b horizon designation.

Profile Description of Excavation Unit 3 and 8

Like the profile description of excavation units 2 and 10, the descriptions of units 3 and 8 are presented as one since the units are immediately adjacent to one another and have nearly identical profiles. Unlike excavation units 2 and 10, the profile of excavation units 3 and 8 lack the historic fill (Unit IIIb). The remaining strata (Units I-III) are analogous.

Unit III (0-45 cm)

Unit III begins just below ground surface under a thin humic layer and is 45 cm in thickness. This unit consists of a very dark brown (10YR2/2) silty clay loam with granular structure. It is dry, slightly hard and friable, with abundant roots and rootlets. The lower boundary with Unit II is clear and smooth. The dark organic soil that has formed in this stratum is classified as an A horizon.

Unit II (45-95 cm)

Unit II is encountered at 45 cmbs and is approximately 50 cm in thickness. Unit III is a dark yellowish brown (10YR3/4) silty clay with moderate sub-angular blocky structure The peds are hard and firm with clay coating on the faces. Roots and krotovina are few, although several krotovina filled with displaced archaeological materials are noted. The lower boundary is clear and smooth. Since Unit II shows slight accumulation of illuvial clay but still retains similarities with the overlying soil horizon, the Unit is given an ABb horizon designation.

Unit Ia (95-170 cm)

Unit Ia occurs at 95 cmbs and is 75 cm thick and is a dark reddish brown (5YR3/4) silty loam with weak sub-angular blocky structure that is slightly hard. Roots and krotovina are few, with several krotovina filled with displaced archaeological materials and Unit II soil. At 130cm secondary carbonates form as films and small nodules and continue to a gradual lower boundary at 170cm. The clear boundary and abrupt change in color and texture from Unit II to Unit I marks an apparent unconformity. This stratum exhibits a Bw2b -Bwk2b soil profile. The upper half of Unit Ia (95-130 cm) is designated as a Bw2b horizon. The lower portion of Unit Ia (130-170) is given a Bwk2b horizon designation because of the development of pedogenic carbonates.

Unit Ib (170-280cm)

Unit Ib begins approximately 170 cmbs and continues to 280 cmbs (the deepest extent of the excavation). This unit consists of a reddish brown (5YR3/4) silty clay with moderate sub-angular blocky structure. The peds are coarse and friable with very few roots or krotovina present. Unit Ib consists of alluvial sediment unaltered by pedogenesis and is given a C2b horizon designation. Although the excavations only exposed this stratum to a depth of 280 cm, core sampling within Aquarena Center (Goelz 1999) suggests Unit Ib may continue to a depth of six to nine meters.

Archaeological Analysis

The 1996 and 1997 excavations at 41HY165 recorded and recovered a total of 18 features, 26 diagnostic projectile points, 998 lithic tools, 54,196 pieces of lithic debitage, and 6,906 faunal remains. As previously mentioned, the analysis of sampled archaeological materials from excavation units 2, 3, and 8 will focus on archaeological features, projectile points, lithic debitage, faunal remains, and wood charcoal.

The analysis of selected features and zones from excavation units 2 and 3 was conducted to examine the preservation and spatial segregation of archaeological components. The analysis of the diagnostics projectile points was conducted for the relative dating of features and strata. The examination of lithic debitage and faunal material was conducted to examine accumulations at various depths. Finally a single wood charcoal sample from a burned rock feature in excavation unit 3 was used for radiocarbon analysis to gain further chronological control.

Feature and Zone Descriptions

During the course of the excavations, eighteen archaeological features and four zones were recorded. These features include various clusters of burned limestone which represent hearths, burned rock dumps (discarded boiling stones), and burned rock scatters. These features are numbered by order of discovery and year of field season (i.e., 2/96). Eight features were selected for integration into this thesis to demonstrate site formation, superposition, and variability.

Zone 1/96

Zone 1 was encountered in excavation unit 2 level 1 and continued into the lower half of level 2 (5-20cm). The zone extends horizontally to excavation unit 10 to the south and pinches out by excavation unit 1. To the north, zone 1 extends to excavation unit 7 and disappears by excavation unit 8. In excavation unit 2 the zone consists of 97 historic artifacts including clear, brown, and solarized glass fragments, wire and square nails, and whiteware sherds. The exact number of each historic artifact type is currently unavailable since analysis of these materials is incomplete. The historic materials occurred most frequently in level two within and beneath the gravel.

Feature 2/96

Feature 2/96, uncovered in excavation unit 2, consists of a burned rock scatter with a cluster in the northeast quadrant (Figure 11a). The cluster, composed of sub-angular and angular pieces of limestone is approximately 75 x 75 centimeters in size. The feature is approximately 15cm in thickness appearing toward the bottom of level 3 (20-30 cmbd) and continuing through level 4 (30-40 cmbd). This feature is composed of 3 diagnostic projectile points, 35 lithic tools, 1791 pieces of lithic debitage, four ceramic fragments, 483 faunal remains, and 139 pieces of burned rock weighing 15.5 kg. The projectile points consist of two *Perdiz* arrow points and one *Scallorn* arrow point. Although lithic debitage was located across all four 1x1 meter quadrants, a cluster of lithic debitage is located in the southeast quadrant. The presence of abundant wood charcoal suggests there was burning which suggests a hearth function.

Feature 5/96

Feature 5/96, uncovered in excavation unit 2 levels 5 and 6, consisted of two limestone clusters (see Figure 11b). The first cluster, approximately 50 x 70 centimeters in size is located in the northwest quadrant and semi-circular in shape. The second cluster, is 60 x 65 centimeters in size and is irregularly ovate in shape was located between the southeast and southwest quadrants with the majority of the cluster in the former. The clusters are approximately 8-10 centimeters in thickness. This feature is composed of 1 diagnostic projectile point, 7 lithic tools, 689 pieces of lithic debitage, 45 faunal remains, and 36 pieces (15.5kg) of burned rock. The projectile point consists of a *Darl* dart point from level 5. Although a few pieces of charcoal are noted throughout level 6, the small piles of limestone are more consistent with a rock dump associated

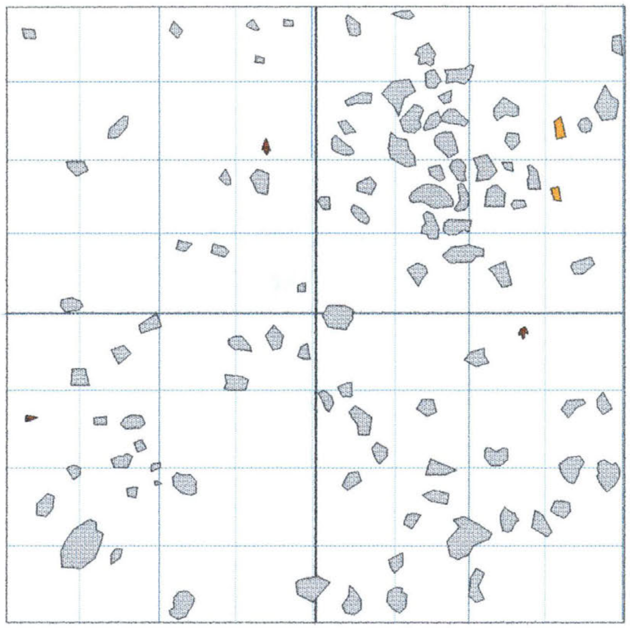


Figure 11a. Feature 2/96 (Unit 2 Levels 3 and 4).

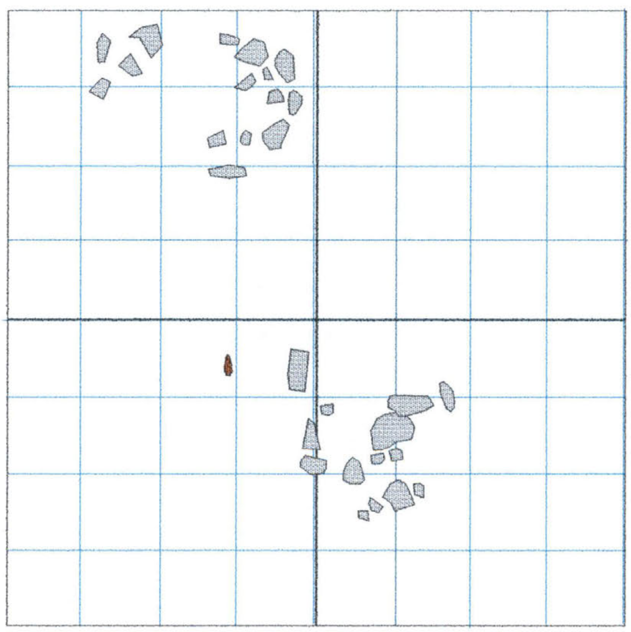


Figure 11b. Feature 5/96 (Unit 2 Level 6).

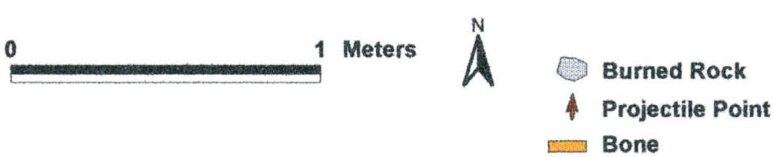


Figure 11 a and b. Burned Rock Features 2/96 and 5/96.

with hot stone boiling

Feature 7/96

Feature 7/96 was encountered in excavation unit 3 levels 10 and 11, and consists of a burned rock cluster in the northeast quadrant (Figure 12a). The cluster, composed of angular and sub-angular pieces of limestone is approximately 80 x 55 centimeters in size and ovate in shape. The feature is approximately 20cm in thickness appearing toward the top of level 10 and extending to the bottom of level 11(110 cmbd). This feature is composed of 1 projectile point, 4 lithic tools, 381 pieces of lithic debitage, 8 faunal remains, and 45 pieces of burned rock weighing 5 kg. The projectile point consists of a Morhiss-like dart point made of an olive gray chert with traces of asphaltum on the stem. Morhiss points, which often exhibit asphaltum on the stem, are less common in Central Texas and found mainly on the coastal plain along the lower Guadalupe River (Turner and Hester 1993). The amorphous shape of the cluster along with a lack of wood charcoal suggest a possible burned rock dump.

Feature 4/97

Feature 4/97, uncovered in excavation unit 3 levels 2 and 3, consists of a burned rock scatter with a cluster in the northeast quadrant (Figure 12b). The cluster, composed of angular and sub-angular pieces of limestone, is approximately 70 x 35 centimeters in size. The feature is approximately 15cm in thickness appearing in level 2 and continuing through level 3. This feature is composed of 1 diagnostic projectile point, 4 lithic tools, 361 pieces of lithic debitage, 44 faunal remains, and 32 pieces of burned rock weighing 3.5 kg. The projectile points consist of one *Perdiz* arrow point. The north profile of the northeast quadrant shows that the feature continues to the north. Although the presence

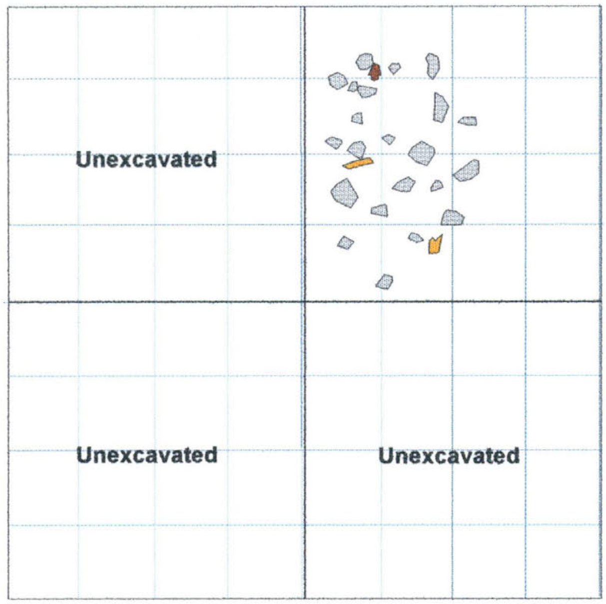


Figure 12a. Feature 7/96 (Unit 2 Levels 10 and 11).

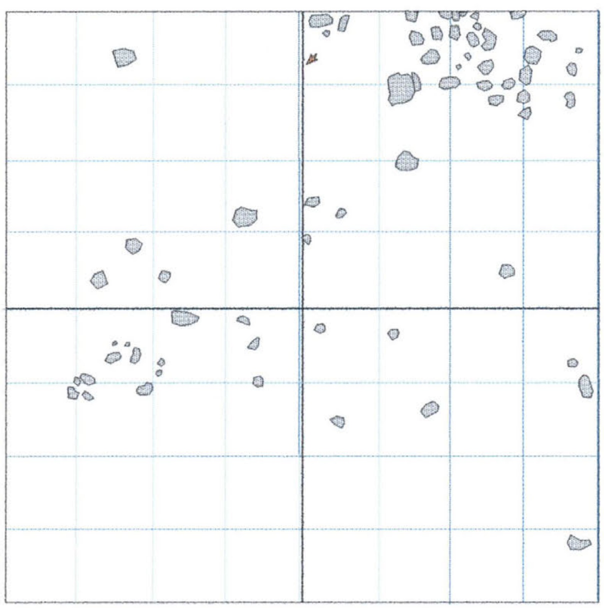


Figure 12b. Feature 4/97 (Unit 3 Levels 2 and 3).

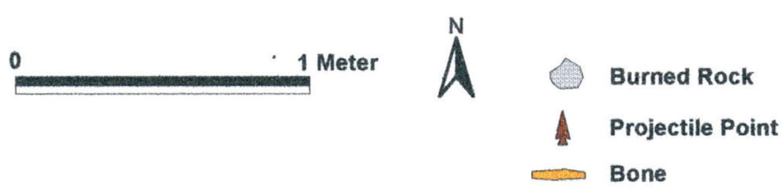


Figure 12 a and b. Burned Rock Features 7/96 and 4/97.

of wood charcoal is noted, the amorphous shape of the cluster along the remaining scattered burned rock precludes functional determination of the feature.

Feature 3a/96-6/97

Feature 3a/96-6/97, uncovered in excavation unit 3 levels 4 through 6, consists of a burned rock scatter with a cluster in the southwest quadrant (Figure 13a). The cluster, composed of angular and sub-angular pieces of limestone, is approximately 115 by 95 centimeters in size. The feature continued horizontally into the northwest quadrant of excavation unit 8. The feature measured approximately 20 cm in thickness appearing at 39 cmbd in level 4 and continued through level 6 (50-60 cmbd). This feature is composed of one diagnostic projectile point, 20 lithic tools, 1151 pieces of lithic debitage, 298 faunal remains, and 81 pieces of burned rock that weighs 5.5 kg. A *Marcos* point was recovered from Feature 3/96-6/97 at the bottom of level 4 excavation unit 8. The amorphous shape of the burned rock cluster and the remaining scatter precludes functional determination.

Feature 3b/96

Feature 3b/96, uncovered in excavation unit 3 levels 7 and 8, consists of a burned rock scatter with a cluster spanning the northeast and southeast quadrants (Figure 13b). The cluster, composed of angular and sub-angular pieces of limestone, is approximately 110 x 95 centimeters in size. The feature is approximately 20 cm in thickness appearing toward the top of level 7 (60-70 cmbd) through level 8 (70-80 cmbd). This feature is composed of 23 lithic tools, 1046 pieces of lithic debitage, 274 faunal remains, and 307 pieces of burned rock with a weight of 21.25 kg. The apparent basin-shaped morphology of the feature infers deliberate construction (which may have involved shallow excavation into

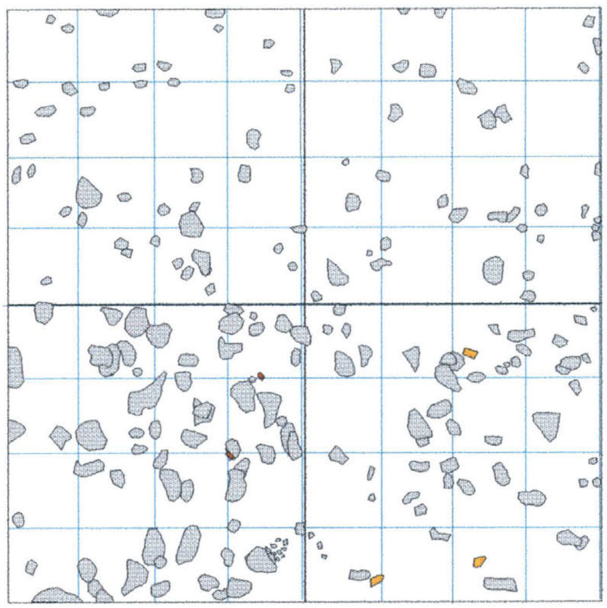


Figure 13a. Feature 3a/96-6/97 (Unit 3 Levels 5 and 6)

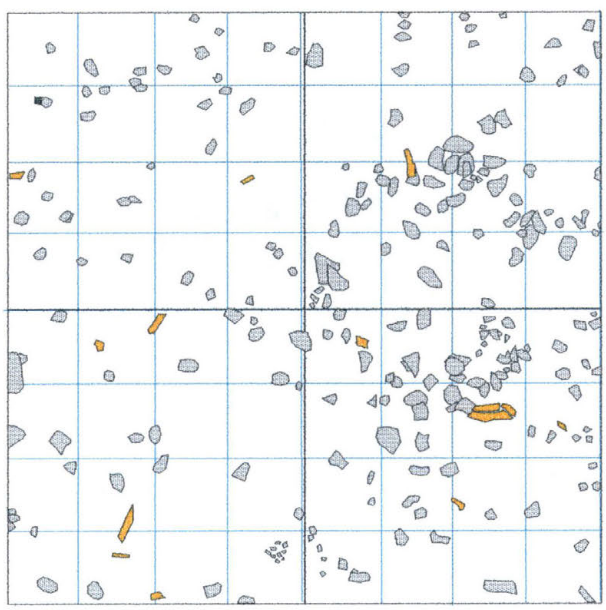


Figure 13b. Feature 3b/96 (Unit 3 Levels 7 and 8).

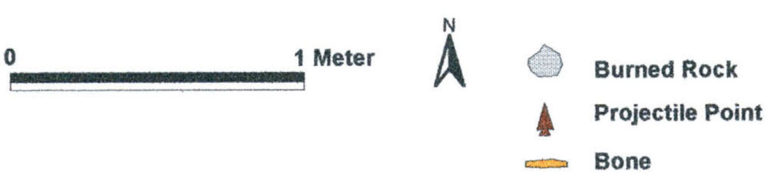


Figure 13 a and b. Burned Rock Features 3a/96-6/97 and 3b/96.

underlying strata) and suggests a hearth function as opposed to a dump.

Feature 3c/96

Feature 3c/96, uncovered in excavation unit 3 levels 8 and 9, consists of a burned rock scatter with a cluster in the northwest quadrant (Figure 14a). The cluster, which is composed of angular and sub-angular pieces of limestone, is approximately 75 x 90 centimeters in size The feature is approximately 15 cm in thickness appearing at the top of level 8 and continuing through the upper 5 centimeters of level 9. This feature is composed of one diagnostic projectile point, 12 lithic tools, 693 pieces of lithic debitage, 143 faunal remains, and 328 pieces of burned rock weighing 17.5 kg. The projectile points consist of one *Pedernales* dart point. The west profile of the northwest quadrant shows Feature 3c/96 continuing to the west. The basin-shaped morphology of the feature and presence of wood charcoal suggests a hearth function

Feature 11/97

Feature 11/97, uncovered in excavation unit 3 levels 10 and 11 (Figure 14b), consists of a dense burned rock scatter with two quasi-clusters between the northwest and southwest quadrants. The scatter is composed of angular and sub-angular pieces of limestone. The feature is approximately 20 cm in thickness, appearing at the top of level 10 and continuing through level 11 This feature is composed of 2 diagnostic projectile point, 15 lithic tools, 700 pieces of lithic debitage, 102 faunal remains, and 503 pieces of burned rock weighing 35 kg. The projectile points consist of one *Angostura* dart point and one *Golondrina* point. The ubiquitous nature of the scattered burned rock precludes functional determination of the feature.

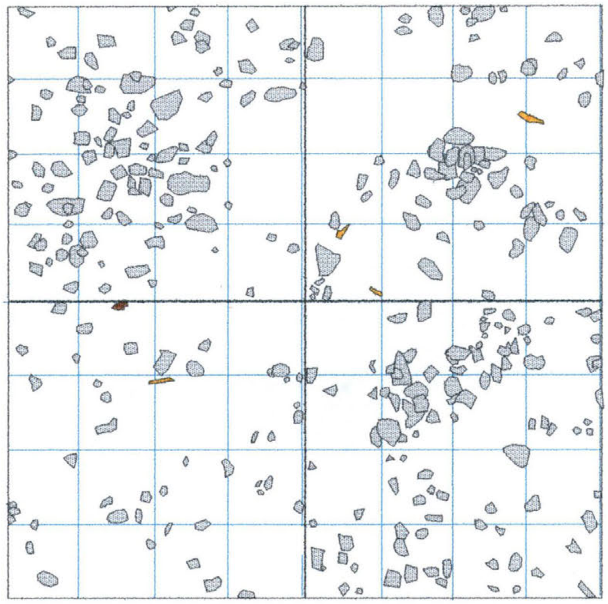


Figure 14a. Feature 3c/96 (Unit 3 Levels 8 and 9).

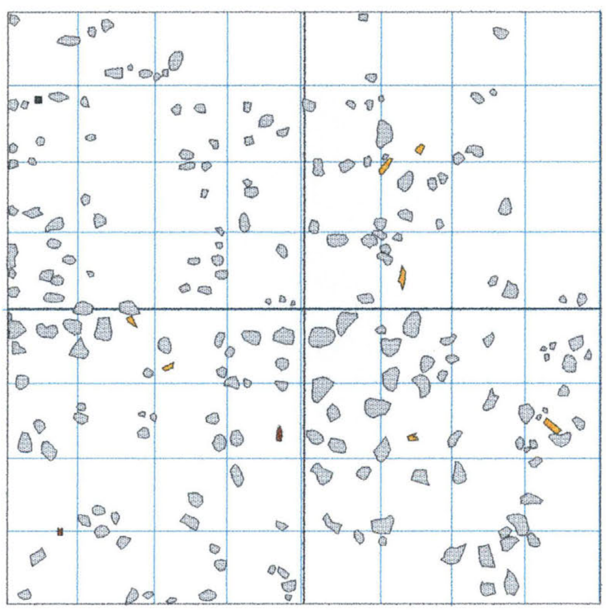


Figure 14a. Feature 11/97 (Unit 3 Level 10).

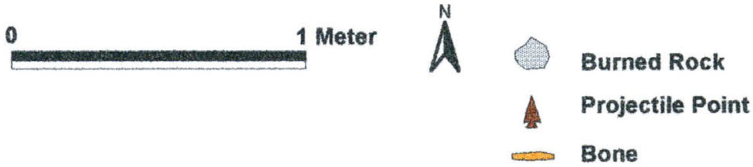


Figure 14 a and b. Burned Rock Features 3c/96 and 11/97.

Zone 1/97

Zone 1/97 was encountered in excavation unit units 3 and 8 from level 14 into the upper portion of level 15 (130-145 cmbs). The analysis of materials from this zone in excavation 3 is incomplete, hence the faunal and debitage counts from the northwest quadrant of excavation unit 8 are used. Zone 1/97 artifacts from excavation unit 8NW include 1 stemmed dart point, 169 chert flakes, and 48 bones and bone fragments. Secondary calcium carbonate is present on the surface of the lithic and bone artifacts recovered.

Analysis of Diagnostic Projectile Points

The analysis of temporally diagnostic projectile points was used to aid in the relative dating of soils and sediments at the site and will be important in developing an initial geochronology of 41HY165. A total of 26 projectile points (Table 1) are categorized into a typological and temporal framework (see Figure 5) as proposed by Suhm and Jelks (1963), Prewitt (1981 and 1985), and Turner and Hester (1993). The type characteristics and distribution of the specimens are briefly presented in this section. The established types are described by morphological and technological attributes that qualify its typological assignment and will be presented chronologically.

Type Descriptions

A total of 15 different diagnostic projectile point types were defined out of the 26 typable specimens examined. The descriptions and chronology are drawn largely from Suhm and Jelks (1954), Turner and Hester (1993), and Johnson and Goode (1994) and presented in the following section. All but one of the projectile points examined have been identified as being made of Edwards Chert. The non-Edwards specimen is an Ensor point from unit 7 level 4 made of petrified wood.

Excavation	Level	Type	Period	Years Before Present
3NW	2	Mission	Historic	Historic (18th
2NW	3	Perdiz	Late Prehistoric	300-700 B.P.
2SE	3	Perdiz	Late Prehistoric	300-700 B.P.
3NE	3	Perdiz	Late Prehistoric	300-700 B.P.
4SW	4	Perdiz	Late Prehistoric	300-700 B.P.
2NW	4	Scallorn	Late Prehistoric	600-1000 B.P.
2SW	5	Scallorn	Late Prehistoric	600-1000 B.P.
4NW	5	Scallorn (cf)	Late Prehistoric	600-1000 B.P.
3SW	3	Darl	Late Archaic II	1200-1800 B.P.
2SW	5	Darl	Late Archaic II	1200-1800 B.P.
3SW	4	Ensor	Late Archaic II	1400-1800 B.P.
3SW	4	Ensor	Late Archaic II	1400-1800 B.P.
7SW	4	Ensor	Late Archaic II	1400-1800 B.P.
8SE	8	Fairland	Late Archaic II	1400-1800 B.P.
8NW	4	Marcos	Late Archaic I	1800-2400 B.P.
10NW	6	Pedernales	Late Archaic I	2500-3500 B.P.
8SE	7	Pedernales	Late Archaic I	2500-3500 B.P.
8SE	8	Pedernales	Late Archaic I	2500-3500 B.P.
3SW	9	Pedernales	Late Archaic I	2500-3500 B.P.
2NE	10	Morhiss (cf)	Late Archaic I	2500-3500 B.P.
3SW	12	Nolan	Middle Archaic	4000-4600 B.P.
1SE	11	Travis	Middle Archaic	4000-4600 B.P.
3SW	9	Gower	Early Archaic	6500-7500 B.P.
3SW	10	Angostura (cf)	Early Archaic	7500-8800 B.P.
3SW	10	Golondrina	Late Paleoindian	8800-9100 B.P.
3SW	14	Early Stemmed	Late Paleoindian	9000-10000B.P.

Table 1. Diagnostic Projectile Points from 41HY165

Mission

This type is associated with historic Indians (possibly Lipan Apache) and dates to the seventeenth and eighteenth centuries A.D. *Mission* points are often associated with Spanish Mission sites (Turner and Hester 1993). They are small lanceolate points often minimally modified and shaped by expedient pressure flaking. A single *Mission* point (Figure 15a) was recovered from excavation unit 3 level 2.

a. b. c.

Selected arrow points recovered from 41HY165: a. *Mission* point from unit 3 level 2, b. *Perdiz* point from unit 2 lv 3, and c. *Scallorn* point from Unit 2 lv. 5.

d. e. f.

Selected Transitional Archaic points from 41HY165: d. *Darl* point from Unit 2 lv 6, e. *Ensor* point from unit 7 level 5, and f. *Fairland* point from unit 3 lv 7.

Figure 15. Diagnostic Arrow and Dart Points from 41HY165 (Actual Size).

Perdiz

Found across most of Texas, this arrow point type is noted by Suhm, Krieger, and Jelks (1954) as well as Turner and Hester (1993). *Perdiz* points are associated with the Toyah Phase of the Late Prehistoric Period (300 B.P. to 700 B.P.). This arrow point type exhibits a contracting stem, flared barbs, and are often unifacial (modified on one side only). Two *Perdiz* points were recovered from excavation units 2 level 3 (Figure 15b) in association with Feature 1/96, one from unit 3 level 3 in association with Feature 4/97, and one from unit 4 level 4.

Scallorn

This arrow point type is described as "Scallorn Stemmed" by Kelly (1947). *Scallorn* points are associated with the Austin phase (or interval) of the Late Prehistoric Period. These arrow points exhibit a triangular blade and corner notching which produces an expanding stem with a straight base. This point type dates to 600-1000 B.P. and has been found stratigraphically below *Perdiz* points at numerous sites including 41HY209 in Buda, Texas. Two *Scallorn* points were recovered from excavation unit 2 levels 4 and 5 (Figure 15c) and one from unit 4 level 5

Darl

This type was described by Miller and Jelks (1952) and Sorrow, Shaffer, and Ross (1967) from the Belton and Stillhouse Reservoirs, Bell County, Texas. *Darl* points are associated with the Late Archaic II (Johnson and Goode 1994) or Transitional Archaic (Turner and Hester 1993) and are dated from 1200 to 1800 B.P. This point type exhibits a parallel-sided to slightly expanding stem and a long narrow triangular blade which is often beveled. Two *Darl* specimens were recovered from excavation unit 3 level 3, and unit 2 level 5 (Figure 15d) with Feature 5/96

Ensor

"Ensor Stemmed" points are described by Miller and Jelks (1952) and Sorrow, Shaffer, and Ross (1967). *Ensor* points are associated with the Late Archaic II (Johnson and Goode 1994) or Transitional Archaic (Turner and Hester 1993). This dart point type dates from approximately 1400 to 1800 B.P. and exhibits an expanding stem, a triangular blade, and corner notches. Excavations at 41HY165 yielded three *Ensor* specimens. Two were recovered from excavation unit 3 level 4 and one was recovered from unit 7 level 4 (Figure 15e).

Fairland

Fairland points are described by Suhm, Krieger, and Jelks (1954) and Turner and Hester (1993). *Fairland* points are associated with the Late Archaic II (Johnson and Goode 1994) or Transitional Archaic (Turner and Hester 1993) and date from approximately 1400 to 1800 B P. These dart points exhibit a triangular blade, an expanding stem with a concave base, and pronounced basal thinning. Excavations at 41HY165 yielded a single specimen from excavation Unit 8 level 8 (Figure 15f).

Marcos

Marcos points are described by Suhm, Krieger, and Jelks (1954) and Turner and Hester (1993). This style is associated with the Late Archaic Period and dated to 1800 B.P. to 2400 B.P. These dart points exhibit a broad blade, deep corner notching, and an expanding stem with a slightly convex base. A single specimen was recovered from excavation unit 8 level 4 (Figure 16a).

a. b. c.

Selected Late and Middle Archaic points from 41HY165: a. *Marcos* point from unit 8 lv 6, b. *Pedernales* point from unit 10 lv 6, and c. *Nolan* point from unit 3 level 13.

d. e. f.

Selected Early Archaic and Late Paleoindian points from 41HY165: d. *Gower* point from unit 3 lv 9, e. *Golondrina* point from unit 3 lv 10, and f. *Early Stemmed* point from unit 3 level 14.

Figure 16. Diagnostic Dart Points from 41HY165 (Actual Size).

Pedernales

This distinctive type was defined by Kelley (1947) and later by Suhm, Krieger, and Jelks (1954). This type is associated with the Late Archaic Period and dates from 2500 B.P to 3500 B.P. *Pedernales* points are distinguished by a large triangular blade, a deeply notched stem, and pronounced basal thinnıng on one or both sides. Four *Pedernales* points were recovered from 41HY165. Two specimens were found in excavation unit 8 levels 7and 8, one specimen was recovered from unit 3 level 9, and one specimen was recovered from unit 10 level 6 (Figure 16b).

Morhıss

Morhıss points are described by Suhm, Krieger, and Jelks (1954) and Turner and Hester (1993). This type is associated with the Late Archaic Period and dates from 2500 B.P to 3500 B.P. *Morhıss* points are distinguished by a large triangular blade, pronounced shoulders, and a parallel-sided stem with a rounded base. Traces of asphaltum (used as a halfting adhesive) are often found on the stem. A single specimen was recovered from excavation unit 2 level 10. The specimen is damaged and can only be tentatively typed as a close facsimile although asphaltum is present on the stem.

Nolan

The *Nolan* type was described by Kelley (1947) and is associated with the late Middle Archaic. Prewitt (1981) dates the *Nolan* type between 4000 to 4600 B.P. This weak shouldered dart point has a characteristic beveled rectangular stem. A single *Nolan* specimen was found in excavation unit 3 level 13 (Figure 16c).

Travıs

Noted by Kelly (1947), these points are similar in outline to Nolan points having weak-shoulders dart points but no stem beveling. *Travis* points are roughly contemporaneous with *Nolan* dating to 4050-4650 B.P. (Turner and Hester 1993). One *Travis* point was recovered from excavation unit 1 level 11.

Gower

This dart point type is described by Suhm, Krieger, and Jelks (1954) and Turner and Hester (1993). *Gower* points are associated with the Early Archaic and have been dated to 6500 B.P. at the Wilson Leonard Site (Holliday 1995). These dart points are similar in shape to *Pedernales* but are smaller and do not exhibit the same attention to basal thinning. A single *Gower* point was recovered from excavation unit 3 level 9 (Figure 16d)

Angostura

This dart point type is described by Suhm, Krieger, and Jelks (1954) and Turner and Hester (1993). *Angostura* points are associated with the Early Archaic period and date to 7500 B.P. to 8800 B.P. These dart points are lanceolate in shape, often exhibit patterned pressure flaking (oblique transverse), and exhibit grinding on the hafting edges. A single specimen was recovered from excavation unit 3 level 10. This specimen is rather crudely manufactured and can only be tentatively typed as a close facsimile.

Golondrina

Golondrina points are noted by Word and Douglas (1970) for their early context at Baker's Cave. This type is associated with the Late Paleoindian period and dated to 8800 B.P. to 9100 B.P. These lanceolate dart points exhibit a deeply concave base which is slightly flared and basal edges are ground smooth (Turner and Hester 1993). A single *Golondrina* point was recovered from excavation unit 3 level 10 (figure 16e).

Early Stemmed

This type is described as by Turner and Hester (1993) referring to specimens noted by Sorrow, Shafer, and Ross (1967) and Weir (1985). *Early Stemmed* points are associated with the Late Paleoindian period and are dated to 9000 B.P. to 10000 B.P. The type is a somewhat ambiguous resembling several Archaic projectile point types. However, the majority of the *Early Stemmed* points exhibit pronounced stem grinding which is the case for the single specimen recovered from excavation unit 8 level 14 (Figure 16f).

Lithic Debitage Analysis

Analyses of lithic debitage can tell a great deal about lithic technology, raw material economy, subsistence, and mobility of prehistoric hunter-gathers. Numerous techniques have been used to examine these issues (Morrow 1997) and include metric analysis, flake classification, mass analysis, and raw material analysis. Metric analysis consists of measuring specific attributes of flakes (i.e., length, width, and thickness) often for statistical manipulation. Flake classification uses morphological categories to examine technological aspects of a population of lithic debitage. Mass analysis utilizes flake count of size grades (ie.,1/2",1/4", and 1/8") and overall weight of each size grade often comparing the results to experimentally generated populations representing specific technologies. Finally, raw material analysis is conducted using qualitative (i.e., color, texture and mineralogy) and quantitative techniques (i.e., neutron activation and mass spectrometry) to examine the movement of raw materials across the landscape.

Since a technological analysis is not necessary to ascertain an understanding of site formation process, a simple analysis of frequency distribution of lithic debitage from excavation units 2 and 8 was conducted. The analysis examines flake frequency by 10 centimeter level to identify accumulations (as peaks in frequency) of debitage. Frequency polygons generated with Microsoft Excel 97 revealed numerous peaks representing either a discrete occupation or a palimpsest of materials on a stable surface from multiple occupations. The differentiation between discrete occupation or palimpsest is addressed through correlation of debitage frequency with geomorphic and archaeological data presented in the interpretation section of this chapter.

Excavation Unit 2

A total of 1467 pieces of lithic debitage were recovered from the northeast quadrant of excavation unit 2. The frequency distribution of debitage from excavation unit 2 shown in Figure 17a, shows three peaks at levels 5 (n=229), 10 (n=157), and 13 (n=48).

Excavation Unit 8

A total of 1893 pieces of lithic debitage was recovered from the northwest quadrant of excavation unit 8. The frequency polygon shown in Figure 17b reveals a more dynamic distribution than the sample from Unit 2. Seven frequency peaks are observed and occur at levels 3 (n=309), 6 (n=148), 8 (n=159), 10 (n=112), 14 (n=169) 18 (n=44), and 22 (n=88).

Faunal Analysis

Like the debitage analysis, a simple frequency distribution of faunal material from excavation units 2 and 8 was conducted. The analysis examines bone frequency by 10 centimeter level to identify accumulations (as peaks in frequency) of faunal remains representing a single occupation or palimpsest. A subsequent examination of bison

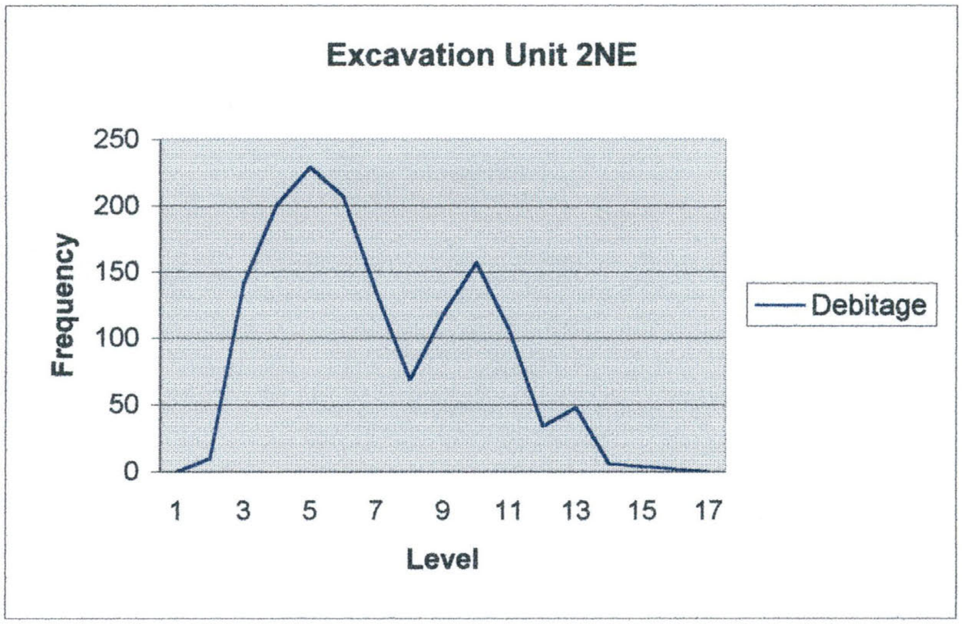


Figure 17a.

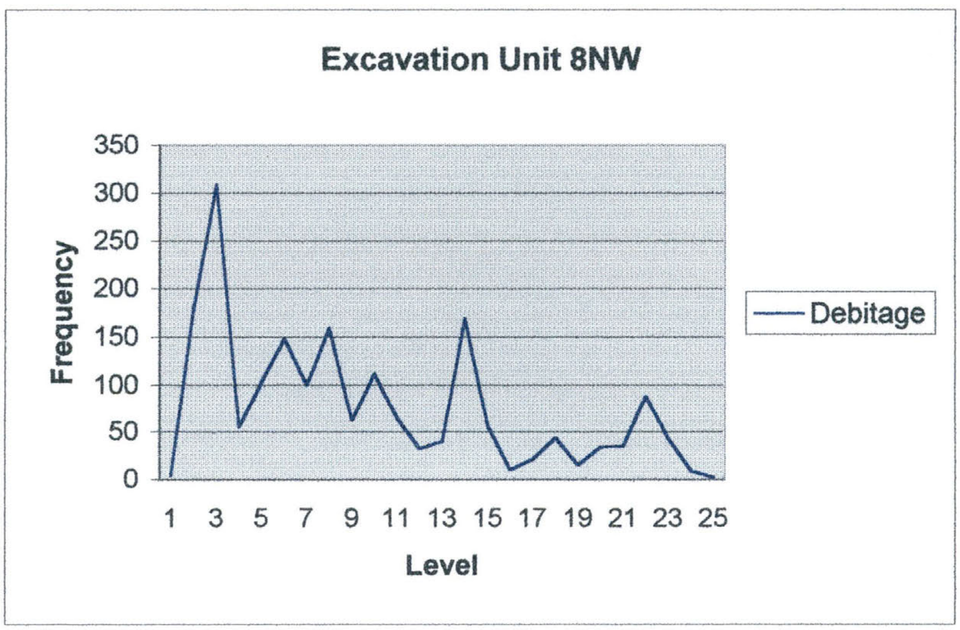


Figure 17b.

Figure 17a and b. Frequency Distribution of Sampled Debitage from Units 2NE and 8NW.

bone distribution was also conducted. As presented in Chapter 2, bison populations fluctuated through time and can be related to mesic climatic periods (see Figure 4).

Excavation Unit 2

A total of 97 bones and bone fragments were recovered from the northeast quadrant of excavation unit 2. The frequency polygon shown in Figure 18a reveals peaks at levels 4 (n=34) and 11 (n=5).

Excavation Unit 8

A total of 287 faunal remains were recovered from the northwest quadrant of excavation unit 8. The frequency polygon shown in Figure 18b reveals a similar dynamic distribution to the debitage sample with frequency peaks at level 3 (n=62), 6 (n=30), 10 (n=15), 14 (n=48) 18 (n=8).

Bison Remains

The presence of bison remains were examined in excavation units 2, 3, and 8 for comparison in the spatial analysis section with geomorphic and archaeological data already presented. The identification of bison remains was conducted by Giesecke (1998) and myself and presented in Table 2. The presence of these remains are used as gross chronological indicators based on the work of Dillehay (1974).

Radiocarbon Analysis of wood charcoal

To aid in the dating of cultural components and proposed stratigraphic units, radiocarbon analysis was utilized as an absolute dating method to be used with relative dates provided by the diagnostic projectile points. A single radiocarbon assay was run by Beta Analytic Incorporated using an accelerator mass spectrometer (AMS). The percentage of the unstable isotope ^{14}C present in the carbon sample was measured from

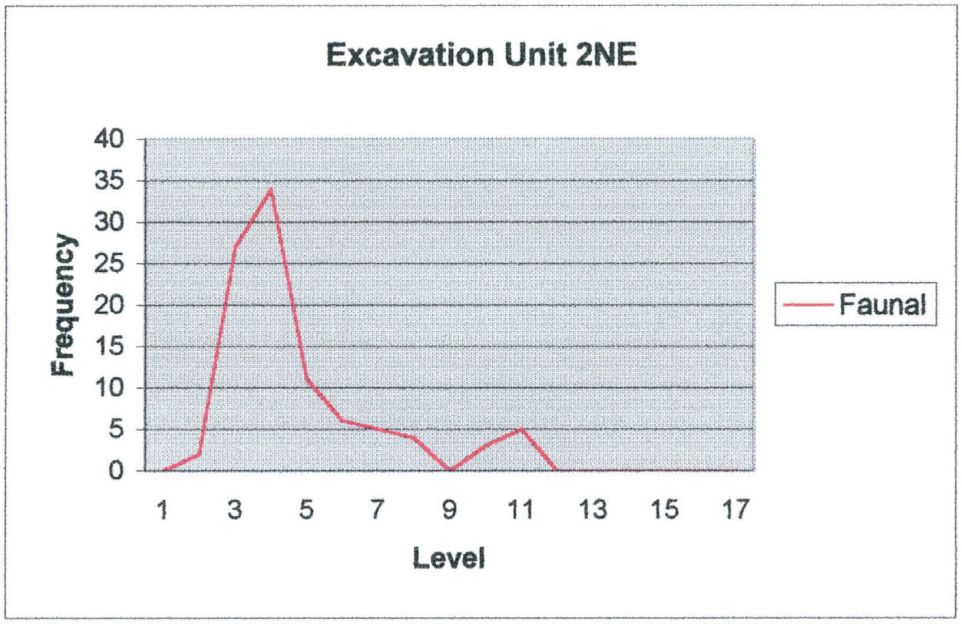


Figure 18a.

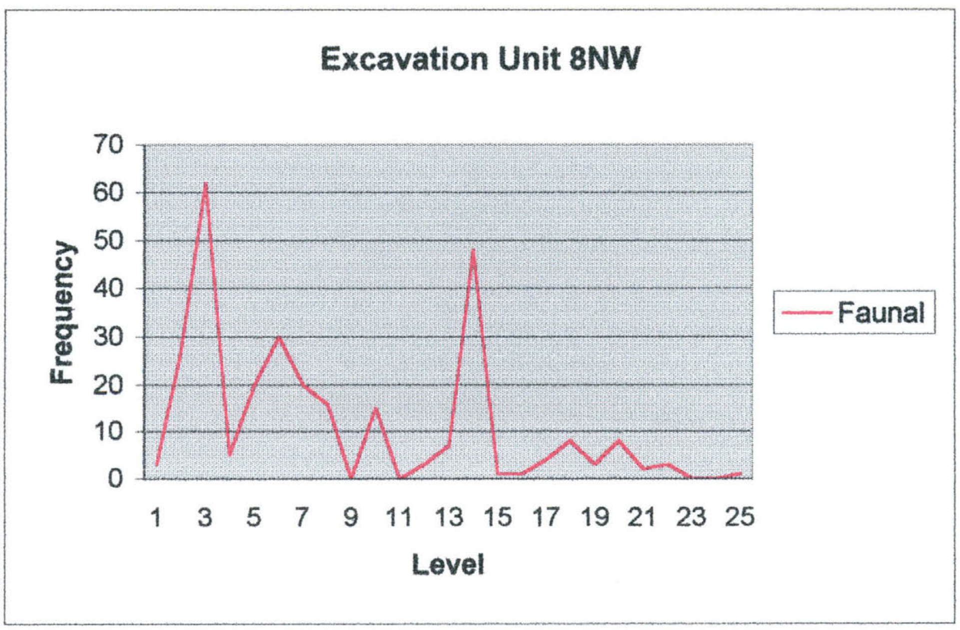


Figure 18b.

Figure 18a and b. Frequency Distribution of Faunal Material from Units 2NE and 8NW.

the total weight of the ^{12}C present in the sample. The age was calculated using the known decay rate of ^{14}C (referred to as half-life) which is 5568 years.

Excavation Unit	Level	Element	Condition
2 NE	3	tooth	Fragment
2 SW	3	tooth	Complete
3 NW	7	indet longbone	Fragment
3 SE	6	indet longbone	Fragment
3 SE	7	tibia	Fragment
3 SE	7	indet longbone	Fragment
8 NW	10	indet longbone	Fragment
8 NW	10	tooth	Fragment

Table 2. Bison Remains Recovered from Excavation Units 2, 3, and 8

The wood charcoal sample used was collected from excavation unit 8NW, level 9, Feature 3c. Wood charcoal was taken from feature context rather from non-feature sediment assuming the matrix of burned rock would be more resistant to bioturbation and contamination from displaced materials from overlying sediments. The conventional radiocarbon age (2 sigma or 95% probability) of sample # 117967 was measured at 2300 +/- 40 years B.P.

Spatial Analysis

A spatial analysis was conducted through correlation of the recorded horizontal and vertical positions of the stratigraphic and archaeological data collected and analyzed. This section examines two aspects of spatial relationship at 41HY165: 1). The position of diagnostic artifacts, bison bone, and radiocarbon data in relation to the proposed stratigraphic units. 2). The superposition of archaeological features and zones, lithic debitage, and faunal material within the strata The correlation of these data was achieved with 2-dimensional overlay using ArcView GIS. The interpretation of these relationships is presented in the following chapter.

The horizontal and vertical distribution of diagnostic artifacts, bison bone, and the radiocarbon sample, within the stratigraphic units of 41HY165 (Figure 19a and b) is critical for the interpretation of cultural and geochronology. A description of the distribution of these materials is presented by stratigraphic unit.

Unit III/IIIb

Late Prehistoric arrow points occur exclusively in stratigraphic Unit IIIb in the southern half of the site and in Unit III in the northern portion of the site. *Perdiz* points occur in level 3 in excavation units 2 and 3 and in level 4 excavation unit 4. *Scallorn* points were also recovered from excavation units 2 and 4 level 5, one level below *Perdiz* points. Transitional Archaic dart points are most common in lower Unit IIIb and Unit III with a single specimen recovered from level 8 Unit II. In Unit IIIb one *Darl* point was retrieved from level 5 of excavation unit 2 and in Unit III at the bottom of level 3 in excavation unit 3. Two *Ensor* points were recovered from level 4 excavation unit 3. A Late Archaic *Marcos* point was also found at the same level. Bison bone was recovered from Unit IIIb in excavation unit 2. Two bison teeth were unearthed in level 3 of the northeastern and southwestern quadrants of excavation unit 2.

Unit II

A single Transitional Archaic *Fairland* point was recovered well within Unit II from excavation unit 3 level 8. Late Archaic projectile points are the most common variety in Unit II with a total of 5 points. Four of these points are *Pedernales* points recovered from excavation units 3 (level 9), 8 (levels 7 and 8), and 10 (level 6). The remaining

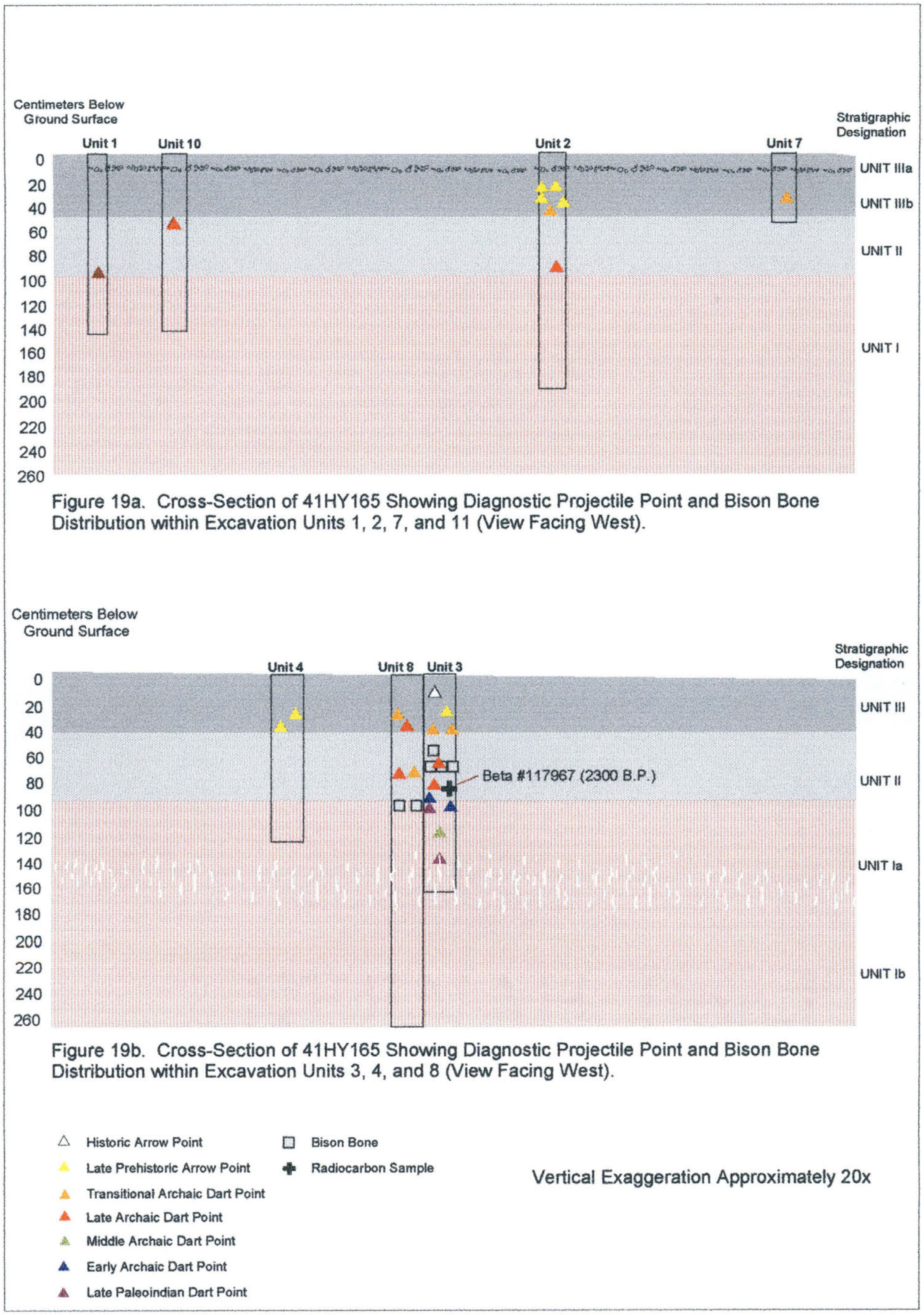


Figure 19a. Cross-Section of 41HY165 Showing Diagnostic Projectile Point and Bison Bone Distribution within Excavation Units 1, 2, 7, and 11 (View Facing West).

Figure 19b. Cross-Section of 41HY165 Showing Diagnostic Projectile Point and Bison Bone Distribution within Excavation Units 3, 4, and 8 (View Facing West).

Figure 19 a and b. Stratigraphic Profile showing Spatial Distribution of Diagnostic Projectile Points, Bison Bone, and Radiocarbon Sample.

Late Archaic point is a *Morhiss* from excavation unit 2 level 10. One Middle Archaic *Travis* dart point was recovered from excavation unit 1 level 11.

Unit II produced 50 percent of the total bison bone recovered from 41HY165. All of the bison bone from Unit II was found in excavation unit 3 and consisted of one longbone fragment from level 6, a tibia (reconstructed from spiral-fractured fragments) and two longbone fragments from level 7.

The only dated carbon sample from 41HY165 came from Unit II. The wood charcoal was collected from excavation unit 3, level 9, Feature 3b/97 (see Figures 19 and 20).

Unit Ia

Unit Ia yielded two Early Archaic points and two Paleoindian points. The Early Archaic points consisted of a *Gower* point and an *Angostura* point both from excavation unit 3 levels 9 and 10 respectively. The Paleoindian points were also recovered from excavation unit 3 and included a *Golondrina* point from level 10 and an *Early Stemmed* point from level 14. Unit Ia yielded two pieces of bison bone from excavation unit 3. Both specimens were recovered from level 10 and included a tooth and a longbone fragment.

An analysis of superposition of archaeological features and zones from 41HY165 are important for the interpretation of archaeological preservation. The relative position of recorded features and zones from 41HY165 is shown in cross section in Figure 20a and b. Faunal and debitage frequency is represented by a line graph scaled to the profiles to show the accumulation of materials throughout the profile and associations with archaeological features and zones. A descriptive analysis of these relationships, which will aid in the interpretation of site formation and archaeological preservation, is

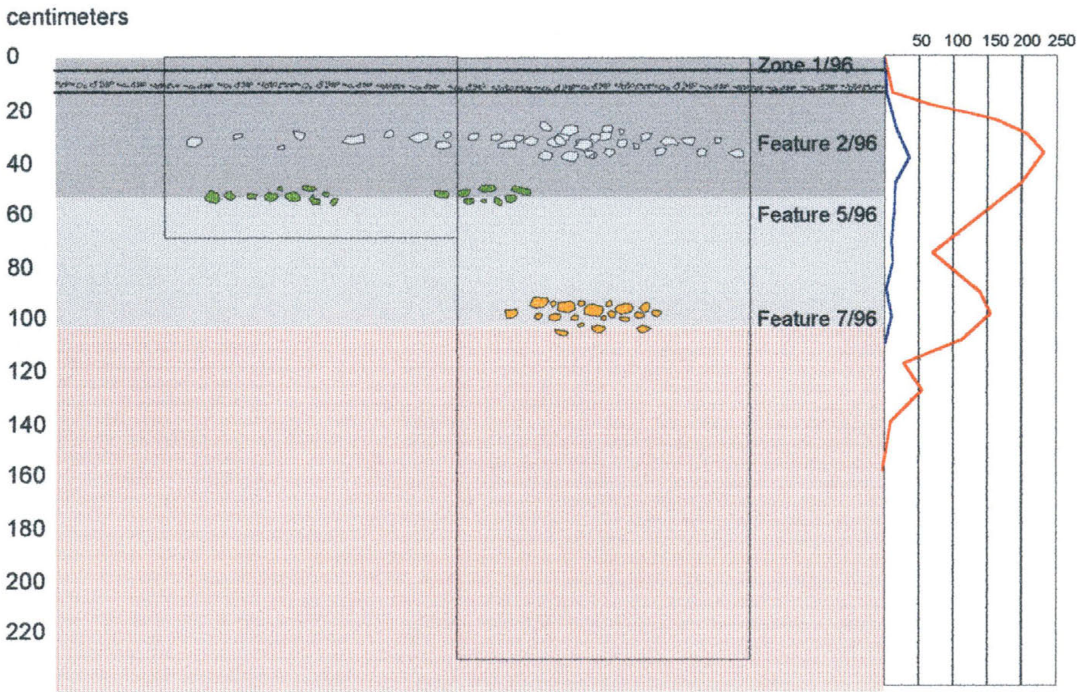


Figure 20a. Cross Section of Features 2/96, 5/96, and 7/96 with Faunal and Debitage Frequency.

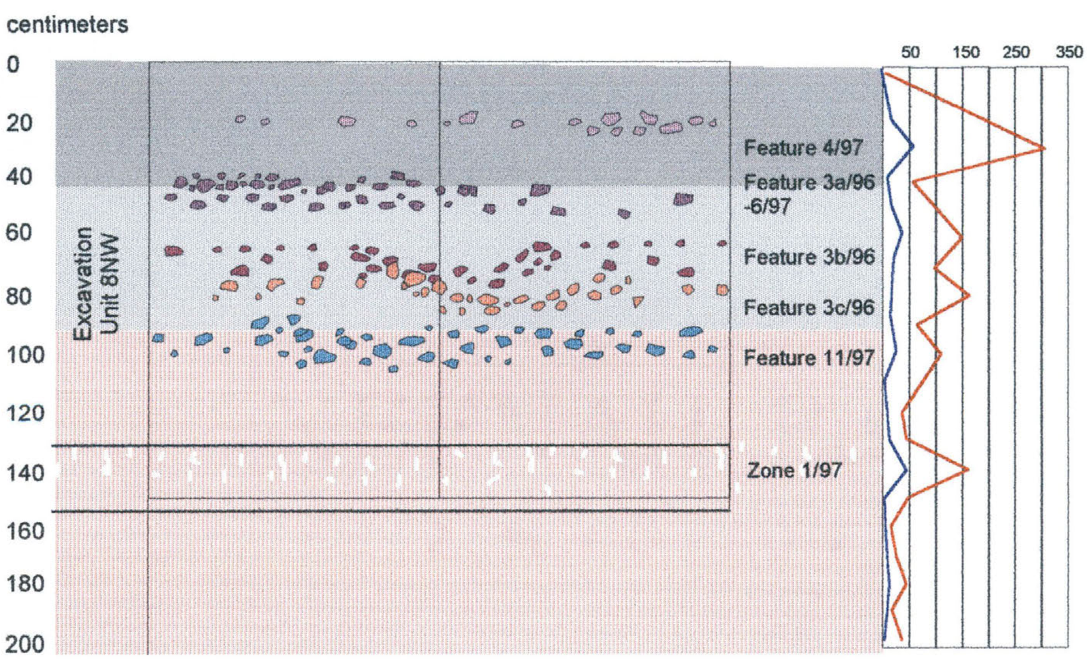


Figure 20b. Cross Section of Features 4/97, 3a/96-6/97, 3b/96 , 3c/96, and 11/97 with Faunal and Debitage Frequency (from adjacent Excavation Unit 8NE).

Figure 20a and b. Feature distribution of Excavation Units 2 and 3 showing debitage and faunal frequency.

presented by excavation unit.

Excavation Unit 2

The relative positions of three features and one zone encountered in excavation unit 2 (see Figure 20a) show three general patterns when related to the proposed strata. First, the historic scatter and gravel fill comprising Zone 1/96 is located within Unit IIIa with some historic artifacts occurring in the upper few centimeters of Unit IIIb Next, Feature 2/96 is located within Unit IIIb whereas Feature 5/96 is located at the Unit IIIb/II contact. Debitage frequency peaks at level 5 just below Feature 2/96 and above Feature 5/96. Faunal remains peak at level 4 in Feature 2/96 and decline slowly to the bottom of Unit IIIb and into Unit II. Lastly, Feature 7/96 is located within Unit II just above the Unit II/I contact. Debitage and faunal frequencies decline in Unit II until level 10 where a second peak in frequency occurs.

Excavation Unit 3

The distribution of five features and one zone uncovered in excavation unit 3 exhibits similarity to those seen in excavation unit 2 albeit more complex and dynamic. In stratigraphic Unit III, the uppermost feature from levels 2 and 3 of excavation unit 3 is Feature 4/97. Like excavation unit 2, debitage and faunal frequency peaks highest nearest the surface. Feature 3a/96-6/97 is located at the Unit III/II contact at levels 5 and 6 where debitage and faunal counts also show a second peak (see Figure 20b). Within Unit II, Feature 3b/96 was encountered at levels 7 and 8 and Feature 3c/96 at levels 8 and 9. Debitage frequency peaks at level 8 in the lower portion of Feature 3b/96 and upper portion of Feature 3c/96. Faunal remains decline in frequency in level 8 and do not show another synchronic peak with debitage. Features 11/97 and Zone 1/97 were encountered within Unit Ia. Feature 11/97 was found at levels 10 and 11 and Zone 1/97 was found at levels 14 and 15. Debitage frequency peaks are seen at level 10 in the upper portion of Feature 11/97 and level 14 upper portion of Zone 1/97. Faunal remains show similar increases in frequency at levels 10 and 14 with the more pronounced peak occurring at level 14.

CHAPTER VII

INTERPRETATION

This chapter presents an interpretation of analyzed archaeological and geomorphic data presented in the previous chapter. This interpretation is limited to three research questions presented in Chapter 1. To reiterate, the research questions are presented and addressed in the following order: 1) What is the geochronology and cultural chronology at 41HY165? 2) How has the timing of depositional and erosional events at 41HY165 affected archaeological site formation and preservation? 3) How does the stratigraphy of 41HY165 compare to other sites at San Marcos Springs and the central Texas region?

Geochronology and Cultural Chronology

A model for the geochronology at 41HY165 was developed using the stratigraphic profiles as well as chronometric and relative dating data provided in the archaeological analysis. The cultural chronology of 41HY165 is based on the analysis of features and artifacts presented in Chapter 6. The geologic and cultural histories of the site are presented together beginning with the most recent strata and occupation.

Unit IIIa (0-20 cm) 0-100 B.P./Historic

Unit IIIa, which consists of a gravel fill with a thin overlying organic soil, extends across the southeastern portion of 41HY165. The gravel portion of Unit IIIa is apparently a human generated (anthropogenic) fill of currently unknown function or origin. The overlying organic soil has been impacted from other human activities such as clearing along the Spring Lake margin, the construction of a softball field, and an apartment complex to the south and east (see Figure 2). Unit IIIa is dated by the historic debris found within the gravel which includes square nails and solarized glass. Although a thorough analysis of these materials has not yet been conducted, the materials are tentatively dated from the late 1800s to the early 1900s. Based on the abrupt boundary and tentative dates, this anthropogenic sediment lays unconformably on Unit IIIb representing approximately 200 years.

A single historic cultural component is currently recognized within Unit IIIa represented by historic materials recovered from Zone 1/96 (Figure see 20a). Although materials from Zone 1/96 extend into Unit IIIb (level 3), the presence of these materials might be the product of translocation by bioturbation. The granular structure of IIIa (and IIIb), which is the product of bioturbation, supports this premise.

Unit IIIb (20-50 cm) 300-1800 B.P./Late Prehistoric to Late Archaic

Unit IIIb is a late Holocene A horizon that extends across the southeastern portion of 41HY165. It is analogous to Unit III in the northwestern portion of the site. The age of Unit IIIb is dated by the Late Prehistoric arrow points recovered from the upper 20 centimeters and Late Archaic II diagnostic artifacts found within the lower 10 centimeters (see Figure 19a). Based on these diagnostics artifacts, the upper boundary of Unit IIIb dates to approximately 300 years B.P. and the lower boundary dates between 1400-1800 years B.P. which lays unconformably on the underlying Unit II.

Based on the materials recovered from the 1996 and 1997 field seasons, two cultural components are currently recognized from Unit IIIb consisting of Late Prehistoric and Late Archaic II features and artifacts (see Figure 20a). Late Prehistoric Feature 2/96 and associated *Perdiz* arrow points and bison remains tentatively place the cultural chronology of these materials to the Toyah subperiod (300-700 B.P.). A Scallorn arrow point recovered from level 5 immediately beneath Feature 2/96 (levels 3 and 4), as well as a peak in debitage frequency, suggests the presence of hunter-gathers of the Austin subperiod. The lower 10-15 cm of Unit IIIb, as seen in excavation units 2 and 4, yielded one Darl dart point, one Ensor dart point, and Feature 5/96. These materials are dated to the Late Archaic II subperiod (1200-1800 B.P.). Active bioturbation in Unit IIIb, as seen through the granular soil structure and common roots, introduces the likely possibility of some degree of translocation and mixing of cultural materials.

Unit III (0-45 cm) 0-1800 B.P /Historic to Late Archaic

Unit III is a late Holocene A horizon that extends across the northwestern portion of the site. The age of Unit III is dated by Historic and Late Prehistoric materials recovered from the upper 20 centimeters and Late Archaic II artifacts found within the lower 10 centimeters (see Figure 19b). The uppermost portion of Unit II is exposed at the surface and dates to historic times. The potential for soil erosion in the upper portion of Unit III is present based upon landscape position (toward the northern point of the site) and flood events of the past several decades. The lower boundary of Unit III, which lays unconformably above Unit II, dates somewhere between 1400-1800 years B.P.

Three archaeological periods and two cultural components are currently recognized from Unit III consisting of Historic, Late Prehistoric, and Late Archaic II features and artifacts (see Figure 20b). A single Mission point was recovered from the upper 20 cm of Unit III suggesting the presence of Historic period Native Americans at the site. However, the presence of a single arrow point does not represent a cultural component at the site. The Late Prehistoric period is represented by Feature 4/97 and an associated *Perdiz* arrow point tentatively placing the cultural chronology of these materials to the Toyah subperiod (300-700 B.P.). The lower 20 cm of Unit III, as seen in excavation units 3 and 8, yielded a *Darl* point, two *Ensor* points, and a *Marcos* point. These materials are dated to the Late Archaic II subperiod ranging from 1200-2400 B.P. The *Marcos* point is most likely associated with Feature 3a/96-6/97 which is found at the Unit III/II contact and continues into Unit II hence the 2400 year B.P. is probably representative of the upper two levels (levels 5 and 6) or 15 cm of Unit II. Like Unit IIIb, an age of 1400 to 1800 years B.P. seems a more likely age considering the interpretation of radiocarbon data presented in the following Unit II discussion

Unit II (45-110 cm) 1800-4600B.P./Late Archaic

Unit II is a late Holocene buried AB horizon that extends across the entire site. The once overlying A horizon was apparently truncated by erosion as seen by the clear boundary with Unit III rather than a gradual or diffuse boundary that would be expected in a cumulative soil. The age of Unit II is dated by Late Archaic II and Late Archaic I artifacts found throughout the strata (see Figure 19b). The upper portion of Unit II is difficult to date due to the paucity of diagnostic artifacts. The *Pedernales* point from excavation unit 10 level 6 is the uppermost diagnostic artifact clearly recovered from Unit II dating to 2500-3500 B.P. However, a more recent *Fairland* point (1400-1800 B.P.) was recovered from excavation unit 8 level 8. Given the amount of krotovina documented throughout Unit II, it is suspected that the *Fairland* specimen is displaced by an animal burrow from overlying sediments. The lower portion of Unit II, which lays unconformably above Unit Ia, is dated by the presence of three *Pedernales* points from levels 7, 8, and 9 in excavation units 3 and 8. A roughly contemporaneous *Morhiss* point (2500-3500 B.P.) was also recovered from excavation unit 2 level 10. A *Travis* projectile point was recovered from the bottom of Unit II in the far southwestern portion of the site (excavation unit 1 level 11) and suggests that the bottom of Unit II in that area of the site may be as old as 4000-4600 B.P Unlike stratigraphic Units III and I, Unit II has a single absolute date from excavation unit 3 in the northern portion of the site. A radiocarbon assay (Beta #117967), run from wood charcoal recovered from Feature 3c/96 level 9, was dated to 2300 +/-40 years B.P.

Unit II yielded materials from two archaeological subperiods representing two possible cultural components. The subperiods are represented by Late Archaic I and Late Archaic II features and artifacts (see Figure 20b). The Late Archaic I period is represented by Feature 3a/96-6/97 and an associated *Marcos* point. The lower 20 centimeters of Unit II in excavation unit 2 produced a *Morhiss* point (2500-3500 B.P.) and Feature 7/96 The lower 30 centimeters of Unit II, as seen in excavation units 3 and 8, yielded three *Pedernales* points (2500-3500 B.P.) and Features 3b/96 and 3c/96. These materials are dated to the Late Archaic II subperiod.

Unit Ia (95-170cm) 6500 B.P.- 9500 B.P./Early Archaic to Paleoindian

Unit Ia is an Early Holocene buried Bw-Bwk horizon that extends across the entire site. The once overlying A horizon is apparently truncated by erosion as seen by the clear boundary with Unit II rather than a gradual or diffuse boundary The age of Unit Ia is dated by Early Archaic and Paleoindian artifacts found throughout the strata (see Figure 19b). A Middle Archaic *Nolan* point (4000-4600 B.P.) recovered from excavation unit 3 level 12 is suspected to have been displaced by krotovina from either lower Unit II or the former A horizon of Unit Ia before it was eroded The upper 20 cm of Unit Ia produced a *Gower* point from excavation unit 3 level 9 (6500-7500 B.P.) and an Angostura point (7500-8800 B.P.) and *Golondrina* (8800-9100 B.P.) point from excavation unit 3 level 10. The lower portion of Unit Ia, which lays conformably above Unit Ia, is dated by a single ambiguous *Early Stemmed* projectile point (9000-10,000 B.P.) from level 14 in excavation unit 3. With some question as to the antiquity of the point, the more conservative estimate of 9500 B.P. is given for the bottom of Unit Ia

Unit Ia yielded materials from two archaeological subperiods representing three possible cultural components. The subperiods represented consist of Early Archaic and Late Paleoindian features and artifacts (see Figure 20b). The Early Archaic period (6000-8800 B.P.) is represented by Feature 11/97 (levels 10 and 11) and associated *Gower* (lower level 9) and *Angostura* points. A Late Paleoindian *Golondrina* point was also recovered from level 10. The lower 60 cm of Unit Ib, as seen in excavation units 3 yielded an atypical *Early Stemmed* point and Zone 1/97 (levels 14 and 15). These materials are dated to the Late Paleoindian subperiod (8800-9500 B P.).

Site Formation and Archaeological Preservation

An understanding of the timing and rate of sedimentation, soil formation, and erosion at 41HY165 is critical for the interpretation of site formation and archaeological preservation. The geochronology and cultural chronology of 41HY165 presented in the previous section will aid in the development of a site formation model and assessment of archaeological preservation. Since the interaction between site formation and archaeological preservation are so closely linked, they will be discussed together.

Site formation at 41HY165 is reconstructed by examining the interaction between landform evolution and accumulation of archaeological debris (Figure 21). Alluvial sedimentation at 41HY165 began sometime in the late Pleistocene although it is unclear, with chronological data currently available from the site, whether or not sediments of this age were encountered in the 2.5 meters profile exposed in excavation unit 8. The lower portion of stratigraphic Unit I exposed in excavation unit 2 and stratigraphic Unit Ib exposed in excavation unit 8 consist of fine-grained alluvial sediments that represent late Pleistocene to early Holocene aggradation. Considering that bedrock was not reached and the sediments continued past the extent of excavations, the rate of aggradation of lower Unit I and Unit Ib appears to have been rapid relative to overlying stratigraphic units. Further work, in the form of chronometric analyses, is needed to determine the actual rate of aggradation.

No archaeological features or zones were found in lower Unit I and Unit Ib although

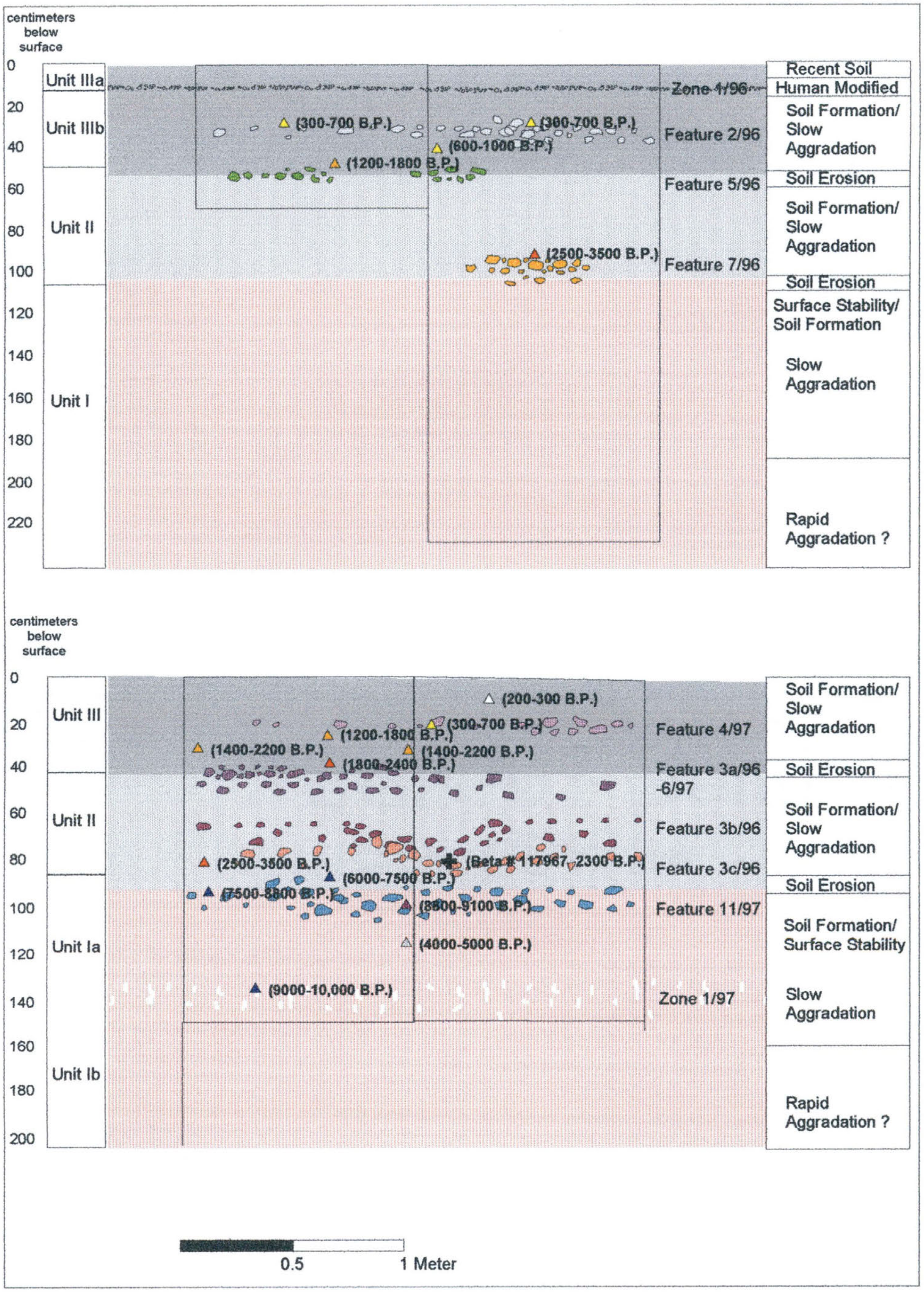


Figure 21a and b. Site Formation Model Using Diagnostic Artifact and Feature Distribution from Excavation Units 2 and 3 Related to Stratigraphic Units and Geomorphic Processes.

sparse lithic debitage was encountered. With such a scarcity of cultural materials, it is difficult to assess the archaeological preservation potential Theoretically, rapid fine-grained sedimentation is conducive to good archaeological preservation since occupation surfaces are buried quickly and multiple occupations are often well segregated by archaeologically sterile alluvium between occupation intervals (Ferring 1986).

Based on the temporally diagnostic artifacts recovered from Unit Ia, it appears aggradation of alluvial sediments continued through the early Holocene. The spatial segregation of Zone 1/97 from the overlying Feature 11/97 by 20 centimeters of alluvium suggests the cultural component represented by the zone has relatively good preservation. The estimated rate of aggradation from the top of Zone 1/97 to the bottom of Feature 11/97, based on the median age of the *Early Stemmed* point (9500 B.P.) and *Golondrına* point (8950 B.P.), is approximately 10 centimeters per 275 years. However, more chronometric data would be needed for greater accuracy and reliability.

In the upper portion of Unit 1a, the presence of Late Paleoindian to Early Archaic diagnostic artifacts (*Golondrına*, *Angostura*, and *Gower* points) within such close vertical proximity to one another (<20 centimeters) suggests surface stability. The proposition of a stable surface is supported by the weak pedogenic development of Unit Ia and the peak in debitage and faunal remains representing long-term artifact accumulation which is characteristic of the onset of the middle Holocene xeric interval (see Figure 4). Considering this type of landform stability, Feature 11/97 can be interpreted as a palimpsest of archaeological materials spanning over 2000 years. Hence, the archaeological preservation of discrete and isolated cultural components would be considered poor. The *Nolan* point recovered from excavation unit 3 level 12 was displaced by krotovina from either Unit II or the old Unit Ia A horizon before it was eroded away.

The absence of an A horizon in the upper portion of Unit Ia, an abrupt stratigraphic contact with the overlying Unit II, and the estimated age of the lower portion of Unit II, supports the premise that the Unit I/Ia and Unit II contact represents an erosional unconformity. Soil erosion resulting from prolonged drought has been documented from alluvial sequences throughout the southern Great Plains (Hall 1990). An erosional unconformity explains the absence of Middle Archaic materials dating from 4700-6400 B.P. at the site.

Based on the temporally diagnostic artifacts recovered from Unit II it appears aggradation of alluvial sediments resumed sometime in the early-late Holocene. Significant pedogenisis within Unit II suggests slow aggradation coupled with soil development The presence of a clear boundary with Unit III and IIIb suggests either erosion or a hiatus in soil formation. Using the median date for the *Travis* point (4300 B.P.) as representative of the lower boundary of Unit II (in the southwestern area of the site) and the median date for the *Marcos* point (2100 B.P.) as the representative of the upper boundary of Unit II acrosss the site, the estimated rate of aggradation is approximately 10 centimeters per 367 years. Again, more thorough chronometric analyses will need to be conducted to calculate sedimentation rates with greater reliability. The presence of numerous *Pedernales* points at and above the lower Unit II boundary suggests a greater unconformity with Unit Ia in the northwestern portion of the site than in the southwestern. This presents the possibility that the northern portion of the site may have been prone to erosion from late-middle Holocene flash flood events although more intensive geomorphic studies would be needed to support this proposition

With such slow aggradation, the preservation of Features 3a/96-6/97, 3b/96, and 3c/96 is moderate to poor. Feature 3a/96-6/97 has only slightly better spatial segregation from 4/97 and 3b/96 than Features 3b/96 and 3c/96 which show overlap (see Figures 13b, 14a, and 21) and have greater potential for mixing of cultural materials due to proximity, pedogenic processes, and krotovina. Frequency peaks in lithic debitage and faunal material at levels 6 and 8 suggests two components with limited segregation with Feature 3a/96-6/97 represented by the upper peak and both Features 3b/96 and 3c/96 representing the lower peak. A Late Archaic II *Fairland* point recovered from Unit II excavation unit 8 level 8 is suspected to have been displaced by krotovina.

Unit III and IIIb are late Holocene soils which, like Unit II, exhibit slow aggradation coupled with soil development. The presence of a clear boundary between Unit IIIb with overlying Unit IIIa is the result of historic human modification. Using the median date for the *Ensor* type (1600 B.P.) as representative of the lower boundary of Unit IIIb and the median date for the *Perdiz* arrow points (500 B.P.) as the representative of the upper boundary of Unit IIIb in the southern portion of the site, the estimated rate of aggradation is approximately 10 centimeters per 550 years. The rate of Unit III, in the northern portion of the site, based on the median date of *Ensor* points (1600 B.P.) from excavation unit 3 level 4 and the historic *Mission* arrow point (250 B.P.) from level 2 of the same excavation unit is approximately 10 centimeters per 675 years. This rate is more consistent with data provided by alluvial sequences from the southern Great Plains that demonstrate significantly slowed rates of aggradation beginning around 2000 B.P. (Hall 1990). Once again, thorough chronometric analyses are needed to state this with greater reliability.

As a result of slow aggradation, the preservation of Features 2/96, 5/96, and 4/97 is moderate to poor. Even though Feature 2/96 has moderate spatial segregation from Feature 5/96, the presence of *Scallorn* arrow points immediately beneath *Perdiz* arrow points and bison remains associated with Feature 2/96 could indicate a palimpsest of materials from the Austin and Toyah subperiods of the Late Prehistoric. The accumulation of lithic debitage throughout Unit IIIb and the peak in frequency noted at level 5 also suggests a palimpsest of cultural materials. Again, proximity, pedogenic processes, and krotovina serve as the catalyst for the displacement of cultural materials through the profile.

Unit IIIa is a historic anthropogenic sedimentary unit that extends across the southwestern portion of the site. The abrupt boundary with the underlying Unit IIIb and the gravel fill of lower unit IIIa marks an unconformity of approximately 200 to 400 years based on the estimated age of Feature 2/96 and the historic fill. The five to seven centimeter A horizon above the gravel fill (Zone 1/96) has accumulated in the past 80-100 years. Further analysis is needed to date historic materials from lower Unit IIIa for tighter chronological control

Archaeological preservation within Unit IIIb is considered moderate to poor due to the lacking sedimentary segregation from underlying cultural manifestations like Feature 2/96. The concentration of Zone 1/96 materials within the upper two levels of the soil profile and the fact that it is the uppermost cultural component, makes the zone relatively easy to identify and isolate. However, proximity to underlying Late Prehistoric materials, pedogenic processes, and krotovina contribute to mixing of Historic and Late Prehistoric artifacts immediately below the lower boundary of Unit IIIa.

Local and Regional Context

An examination of 41HY165 in a local and regional context is presented in this section. Soil profiles from four sites in the immediate vicinity of Spring Lake are compared and contrasted to show variability in sedimentation across different landforms of the lower Sink Creek and headwaters of the San Marcos River. An examination of alluvial sequences from six localities across Texas is conducted to examine regional trends in sedimentation, soil formation, and erosion.

Local Context

When examined in the context of other sites in the San Marcos Springs area, 41HY165 exhibits significant similarities and differences in landform evolution and archaeological site formation. A correlation of compiled soil horizons recorded from the San Marcos Springs area (Figure 22) is incorporated to address some of these similarities and differences in deposition and depositional setting from which inferences can be made about archaeological preservation.

Late Holocene sedimentation in the area is represented by stratigraphic Unit III and Unit II at 41HY165, and is observed at all the San Marcos Springs sites. These sediments, which exhibit weak to moderate soil formation, vary in thickness with the thicker deposits located on the flood plain on the southeastern margin of Sink Creek and between Sink Creek and the escarpment. The thinner deposits occur on colluvial toe

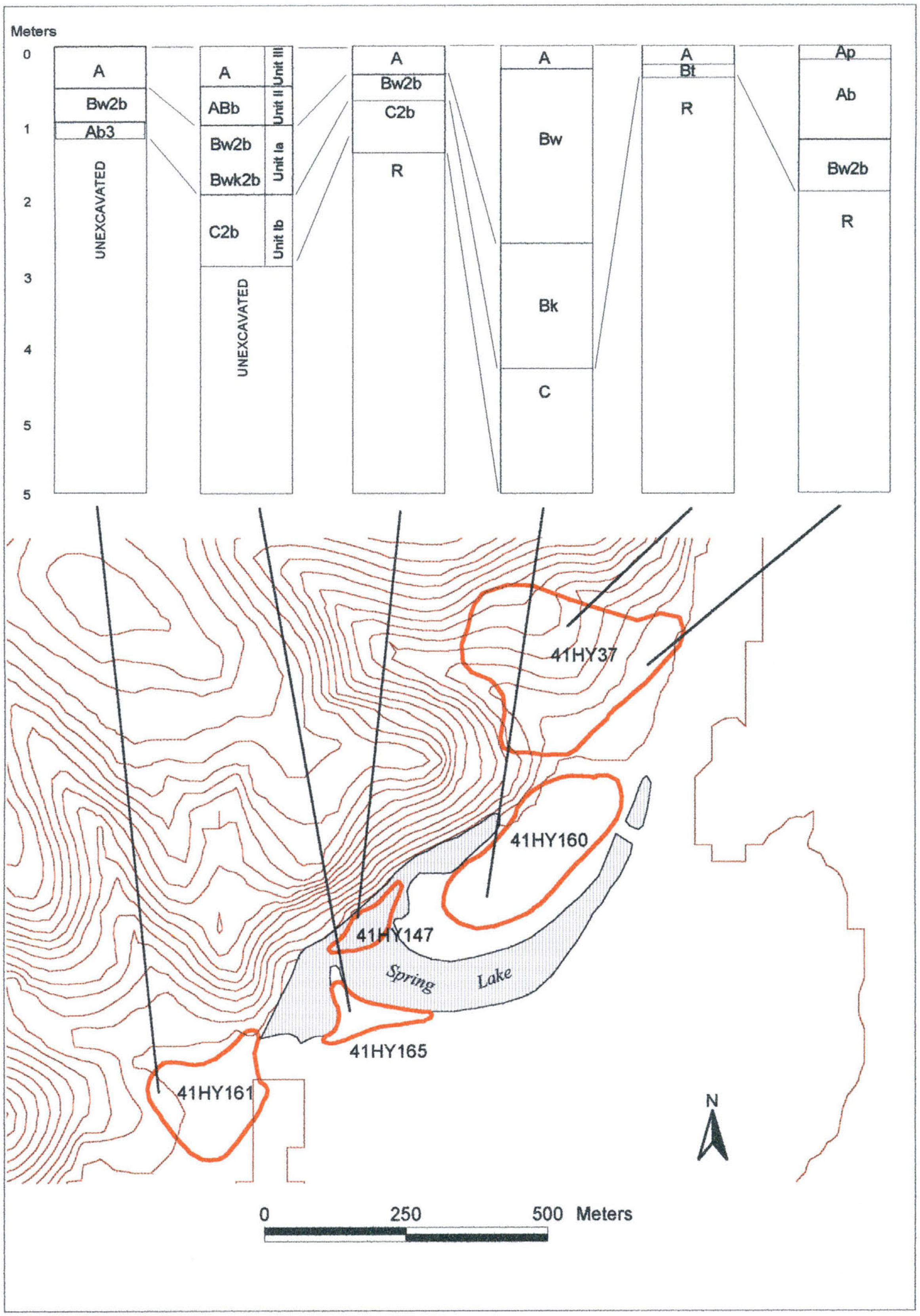


Figure 22. Compiled Soil Profiles from Archaeological Sites in the Spring Lake Area.

slopes and upland bedrock surfaces of the northwestern valley margin Based on the site formation model proposed for 41HY165 and data provided by the previous investigations, cultural materials dating to the Late Prehistoric and Late Archaic are associated with this depositional unit across the park. In regard to archaeological preservation, thicker alluvial soils have greater potential for spatially segregating archaeological materials than thin colluvial and upland soils which tend to compress or amalgamate materials over time.

The uncomformable contact between Unit II and the underlying early Holocene sediments of Unit I documented at 41HY165 is also observed at 41HY161 and is suspected at the toe-slope of 41HY37 based on profiles and archaeological materials reported from these sites (Arnn and Kibler 1999). Geolz (1999) records no unconformity at 41HY160 based on sediment cores and concludes the profile represents continuous deposition. Based on this evidence, it would appear that depositional and/or erosional unconformities may be associated with depositional settings on the valley margin and alluvial terraces located above the flood plain. Certainly, further work in the area is needed to clarify the presence, timing, and extent of a middle Holocene unconformity

The reddish brown silty loam described as Unit Ia at 41HY165 is quite distinctive and is documented across the entire park except in the upland portion of 41HY37 (Garber et al 1983, Shiner 1983, Garber and Orloff 1984, Arnn and Kibler 1999, and Geolz 1999). This alluvial unit exhibits weakly developed Bw and Bwk horizons at all sites but 41HY160 which exhibits a moderately developed Bk horizon. Based on the model proposed at 41HY165, this unit is estimated to be early Holocene in age and contains diagnostic cultural materials of the Early Archaic to Late Paleoindian periods. This proposition is supported by profiles and recovered diagnostic artifacts from 41HY147, 41HY160, 41HY161, and 41HY165. The nature of archaeological preservation within this early Holocene alluvium is still unclear at the San Marcos Springs sites given the paucity of well documented controlled excavations. In this case, the well documented data from 41HY165 becomes important having demonstrated mixing of Early Archaic and Late Paleoindian cultural materials in the upper portion of Unit Ia (as aggradation slowed toward the terminal early Holocene) and greater spatial segregation in the lower portion of the strata (during rapid sedimentation in the early Holocene). However, the areas of greater sedimentation, namely 41HY160, may have the potential for spatial segregation of the cultural components mixed in Unit Ia at 41HY165. Further geomorphic and archaeological studies are needed to better understand archaeological preservation in these early Holocene sediments.

Finally, deposits of late Pleistocene Age have only been verified from 41HY160 by core sampling (Goelz 1999). At 8.5 meters below ground surface, a radiocarbon date of 11,470^{+}/-100 years B.P. was obtained from humates. At 41HY147, artifacts recovered by Dr. Joel Shiner between 1978 and 1983 included three *Clovis* points that date to the late Pleistocene approximately 11,200 years B.P. Unfortunately poor notes, recording, and mapping of artifact distributions and stratigraphic profiles calls into question the precise provenience of diagnostic projectile points. Shiner's description of finding a Clovis point(s) mixed with Paleoindian dart points, Archaic dart points, lithic debitage, and bone including mammoth, mastodon, and bison in a 20cm stratum (Shiner 1983) suggests Shiner was digging into re-deposited dredge spoil from dredging operations that dumped spoil into the long arm of Spring Lake made by Sink Creek which is referred to as the

"Slough" by Aquarena Center staff. Hence, more work will need to be conducted at 41HY147 to determine the cultural and geochronology. Unlike 41HY147 and 41HY160, at 41HY165 the deepest sediments encountered over the course of excavations yielded no diagnostic artifacts or radiocarbon dates although the position of the site relative to the floodplain and valley axis suggests the potential for late Pleistocene alluvium to be present. Further work will be needed to better understand the geochronology at the site.

Regional Context

The correlation of the proposed stratigraphy of 41HY165 with alluvial sequences from six localities on the eastern Edwards Plateau and Southern High Plains is conducted to examine the site within a regional context. In this context, 41HY165 reveals synchronous changes in alluvial deposition throughout the Holocene related to regional changes in climate as supported by pollen and paleontological data (Figure 23). In turn, these regional trends in alluvial sedimentation have a direct effect on archaeological preservation.

Of the sites examined in the regional comparison, alluvial sediments and cultural materials of late Pleistocene age are only positively identified at the Wilson Leonard Site (41WM235) and the Lubbock Lake site (41LU1). At both of these sites, the Early Paleoindian record is well preserved with spatial segregation and good integrity of *Clovis* and *Folsom* components.

The mesic interval of the early Holocene is marked by rapid alluvial aggradation as seen from 41HY165, 41WM235, Cowhouse Creek, and 41LU1. With the exception of a brief period of soil formation at approximately 9500 B.P. at the Wilson Leonard Site,

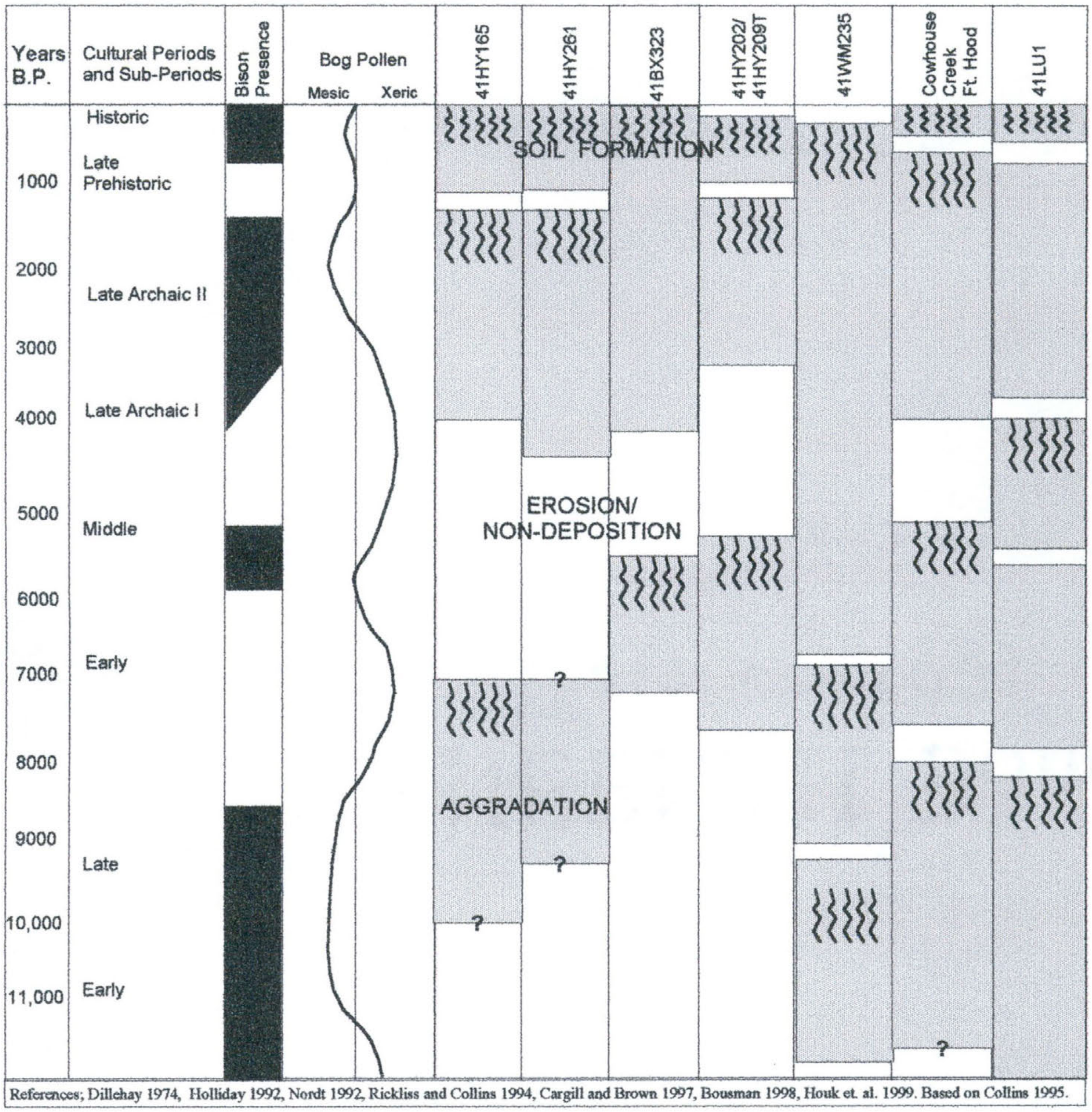


Figure 23. Cultural, Paleontological, and Paleoclimatic Chronology Correlated with Regional Alluvial Sequences.

the alluvial sedimentation continues through the early Holocene until the onset of the middle Holocene dry interval approximately 8500 B.P. when soil formation begins on stabilizing landforms. Archaeological preservation in the early Holocene sediments (of those sites that have the sediments and archaeological materials of this age) is generally good as seen from the *Wilson* cultural component at 41WM235 and the *Plainview* component from 41LU1.

The beginning of the middle Holocene is marked by soil formation as seen from three of the six regional sites examined. Documented middle Holocene soils from these sites include the Stiba paleosol from 41WM235, the Royalty Paleosol from Cowhouse Creek, and the Firstview paleosol at 41LU1. As the dry interval continued, surface stabilization and/or soil erosion is documented at all of the sites examined in the regional comparison. Those sites that did not have archaeological materials removed by erosion, as seen at 41HY165, have generally poor segregation of Early Archaic and Middle Archaic archaeological components resulting from the accumulation of archaeological materials on stable surfaces. A brief break in the dry interval between 6000 and 5000 B.P. is seen in aggradation at 41BX323 and 41HY202 preserving *Martindale* and *Andice* cultural components.

The late Holocene is characterized by the resumption of aggradation as seen in all the regional sites examined in the comparison. Alluvial sedimentation continued through the late Holocene until the onset of a dry interval around 1000 B.P. when soil formation began on stabilizing alluvial landforms. Archaeological preservation in late Holocene sediments varies widely from good to poor across the sites considered. Slow aggradation at 41HY165, 41HY261, 41BX323, 41WM235, and 41LU1 in the late Holocene, despite increased precipitation, may be explained by the increase in the elevation of these sites above their respective associated streams over the course of 7000 years and the resulting decrease in sedimentation from overbank flooding. With a lower rate of sedimentation, segregation between cultural occupations is decreased resulting in compression of the archaeological record. Aggradation is greater at 41HY209T and Cowhouse Creek resulting in better segregation and overall archaeological preservation.

CHAPTER VIII

SUMMARY AND CONCLUSION

The confluence of Sink Creek and the headwater springs of the San Marcos River has a dynamic cultural and alluvial history dating back to the late Pleistocene. Five archaeological sites have been recorded in the immediate vicinity of the San Marcos Springs and offer extensive data on the cultural and alluvial history of the area. Numerous archaeological projects conducted in the area over the past 22 years have produced a variety of temporally diagnostic stone tools, soil profiles, and a few radiocarbon dates. Of these sites, 41HY165 is the focus of this thesis which applies geoarchaeological methods to examine the archaeological and stratigraphic data to clarify the interaction between cultural and geomorphic inputs on site formation processes.

Archaeological and stratigraphic data collected during the 1996, 1997, and 1998 SWT archaeological field school are incorporated into this research and include features and artifacts consisting of burned rock hearths and scatters, diagnostic projectile points, and lithic debitage as well as detailed descriptions of stratigraphic profiles and soil horizons. The analysis of these data is correlated in a spatial analysis and interpreted to address research questions concerning cultural chronology, geochronology, and archaeological preservation. This analysis identified diagnostic projectile points dating from 9500 B.P. to 200 B.P. and three stratigraphic units. Published archaeological and stratigraphic data from four local and six regional archaeological sites were also utilized to address the local and regional context of 41HY165.

The proposed model of landform evolution and site formation at 41HY165 consists of two primary alluvial depositional events and three episodes of soil formation. Early Holocene alluvial sedimentation preserved archaeological materials of the late Paleoindian period and Early Archaic, while erosion during the middle Holocene removed sediments containing the Middle Archaic record creating an unconformity dating between 6500 to 4500 B.P. Finally, the resumption of slow aggradation and soil formation in the late Holocene preserved the Late Archaic and Late Prehistoric with a brief hiatus in soil formation and a possible erosional unconformity sometime between 2400 to 1400 B.P.

Archaeological preservation at 41HY165 varies with the stratigraphic unit. Unit Ia preserves two cultural components from the Late Paleoindian and Early Archaic periods with the lower component (Late Paleoindian) exhibiting good preservation and segregation from the upper component (Late Paleoindian and Early Archaic) which has poor preservation due to mixing of cultural materials on a slowly aggrading or stable surface. Preservation in Unit II is moderate to poor and consists of two Late Archaic components with only slight segregation between the components from upper to lower Unit II. Stratigraphic Units III and IIIb revealed two cultural components dating to the Late Archaic and Late Prehistoric with moderate to poor segregation. Unit IIIa is a human-deposited cap of gravel fill containing artifacts of early twentieth century age. With Unit IIIa lying unconformably over Unit IIIb, no sterile sediment segregates the Historic component of Unit IIIa and the Prehistoric component of Unit IIIb.

In the context of the San Marcos Springs area, 41HY165 was compared and contrasted with four other sites recorded in the immediate vicinity of the springs. Similarities in depositional units between sites are noted with variability in the presence or thickness of these strata related to site position on the landscape (see Figure 22). Two general patterns are apparent in regard to archaeological site formation across the park. Sites located in the deep alluvium of Sink Creek exhibit the greatest documented sedimentation and hence the best potential for burying and segregating archaeological materials over time. Sites located immediately northwest of Sink Creek and the San Marcos River on the upland surfaces (41HY37), Pleistocene terraces (41HY160), or colluvial toe-slopes (41HY37), appear to have greater stratigraphic compression and poorer preservation potential.

On a regional scale, the landform evolution and site formation model proposed for 41HY165 is quite similar to six alluvial sequences examined from archaeological sites from the eastern Edwards Plateau and the Southern High Plains. Similarities in the timing of depositional and erosional events that affect landform evolution and site formation are likely related to regional changes in climate. A mesic early Holocene resulted in aggradation of alluvial floodplain terraces burying archaeological materials of Paleoindian age. A middle Holocene xeric interval resulted in soil formation and/or erosion allowing thousands of years of Early Archaic and Middle Archaic archaeological materials to accumulate on a stable surface or be removed from the record. The return to increased precipitation and the resumption of aggradation during the late Holocene buried archaeological materials from the Late Archaic to the Late Prehistoric.

Although the landform evolution and site formation model proposed in this thesis appears to be consistent with local and regional archaeological sites and alluvial sequences, a number of retrospective conclusions are presented. Foremost of these conclusions is that more radiocarbon dating is needed to clarify numerous ambiguities in the geochronology. Notably, the absolute age (as opposed to relative age) of Unit I as well as the age and duration of the unconformities proposed at the Unit III/II and II/I contacts are lacking and could refine the proposed chronology considerably.

The accuracy of the methods utilized for vertical and horizontal data collection lack precision. In sites such as 41HY165, where certain archaeological components have minimal segregation from one another, more precise methods in the recording of spatial data are needed and should be utilized. The use of a transit, theodolite, total digital station, or survey grade differential GPS would certainly provide greater accuracy in data recording.

Lastly, the delineation of 41HY165, as well as the other sites examined in the San Marcos Springs area, are approximations at best and need refinement in order to effectively manage the cultural resources on SWT property. With increased rapid urban development of the central Texas region, sites such as those found at the Aquarena Center campus are becoming increasingly rare and even threatened. The preservation and effective management of these sites is a challenge for SWT and the faculty, staff, and students of today and the future. It is my hope that this research has made a contribution that can be utilized for the purpose of management as well as future research.

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