THE GEOLOGIC AND ARCHAEOLOGICAL HISTORY OF THE DICKIE CARR SITE 41PR26

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This thesis is an analysis and synthesis of the geologic and archaeological history of the Dickie Carr site, 41PR26, on Mill Creek in north central Texas. Included are analyses of the stratigraphy, sedimentary environments, and soils of the locality. A regional comparison is made with respect to the Late Quaternary geology of the upper Trinity River basin, Texas to interpret the geologic data. Two stratigraphic units were identified that record the Pleistocene-Holocene transition. The buried lower unit is comprised of terrace, floodplain, and channel deposits with extensive pedogenesis. The unit is Late Pleistocene in age and contains the remains of *Mammuthus columbi*. The upper stratigraphic unit is comprised of terrace and floodplain sediments with well-expressed pedogenesis. The unit is Early Holocene in age with Late Paleoindian and Late Archaic occupations. The archaeological components are compared and contrasted with documented sites from the Elm and East Forks of the Trinity River. The occupations are examined in a geoarchaeological context. The Late Paleoindian occupation is post-depositional and located in terrace deposits. The Late Archaic occupation is syndepositional and located in floodplain deposits.

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Many friends helped me with the Carr site project and I am grateful for their hard work and support. All are due hearty thanks, and I hope none are overlooked here, and apologize to any that I may have mistakenly omitted. Naturally, I must begin with thanks to my daughter Diana, son James, and adored Debra because this project changed my life and in the process theirs. Secondly, deep gratitude is given to Dickie Carr and family for graciously allowing the use of his property. Without his permission and his family's support the prehistory of the site would have been lost. I am most grateful to Dr. Reid Ferring for his direction, guidance, friendship, and most importantly patience while I struggled to complete this thesis. Special thanks are given to Jim Diffley for his expertise in the excavation of the mammoth and Alisa Winkler for her identification and age assessment of the mammoth.

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CHAPTER 1

INTRODUCTION

This thesis is a summary of investigations conducted at 41PR26, the Dickie Carr site, an archaeological-paleontological locality located in northeastern Parker County, Texas (Fig. 1.1). The Carr site contains Paleoindian Dalton, Plainview, younger archaeological materials, and a mammoth skeleton. The site is significant in that it is the only recorded Paleoindian site in Parker County, Texas, and archaeological research in the West Fork of the Trinity River basin is relatively non existent. Additionally, the mammoth is in an upland setting, which is unusual since most mammoth remains are associated with floodplain deposits. The upland setting of the mammoth and the presence of other Paleoindian occupations in close proximity presented the possibility that the mammoth may represent an older Paleoindian Clovis kill site. Investigations were conducted 1) to reconstruct the late Quaternary geologic history of the locality, 2) to establish the geologic contexts of the mammoth to test for natural deposition or cultural utilization, 3) to establish the geologic contexts of the several archaeological components, and 4) to assess site formation processes. In order to accomplish these goals, first the geologic setting is established including the geomorphology, stratigraphy, sedimentary environments, and soils. Second, the mammoth and the archaeological components are described and interpreted within the geologic context.

Physiographically, the site is located in north central Texas at the margin of the Rolling Plains and the Gulf Coastal Plain (Fenneman, 1931,1938). The Rolling Plains are underlain by Permian and Pennsylvanian sedimentary rocks that form gently rolling, broad, low relief plains dissected by southeasterly flowing rivers. Natural vegetation is dominated by mixed grass prairies with galleries of trees along rivers that include hardy xerophytic trees such as cottonwood and mesquite. The Gulf Coastal Plain within the study area is underlain by a broad belt of Cretaceous sedimentary rocks that exhibit differential resistance to erosion resulting in more varied and rugged topography than the Rolling Plains. A present vegetation community consists of a mosaic of mixed grass prairies, upland savannas, and riparian forests of oak and hickory (Hill, 1887, 1901, Blair, 1950).

Specifically, the Carr site is located in the Mill Creek valley, a tributary of Silver Creek within the West Fork Trinity River Drainage Basin. At a more local scale, the headwaters of Mill Creek originate in the Western Cross Timbers but the majority of the channel flows across the Fort Worth Prairie before reaching its confluence with Silver Creek. Thus, the channel crosses a transitional area or ecotone between two distinct physiographic regions. Similarly, the site occupies an ecotonal position since its location is at the boundary between the Western Cross Timbers and the Fort Worth Prairie. The site is on a heavily gullied gentle slope that faces east, overlooking Mill Creek at an elevation ranging from 740 to 720 feet above sea level (Fig. 1.2). Erosion of the gullies exposed large sub surface areas revealing artifacts and has been known to local collectors since the mid 1960s.

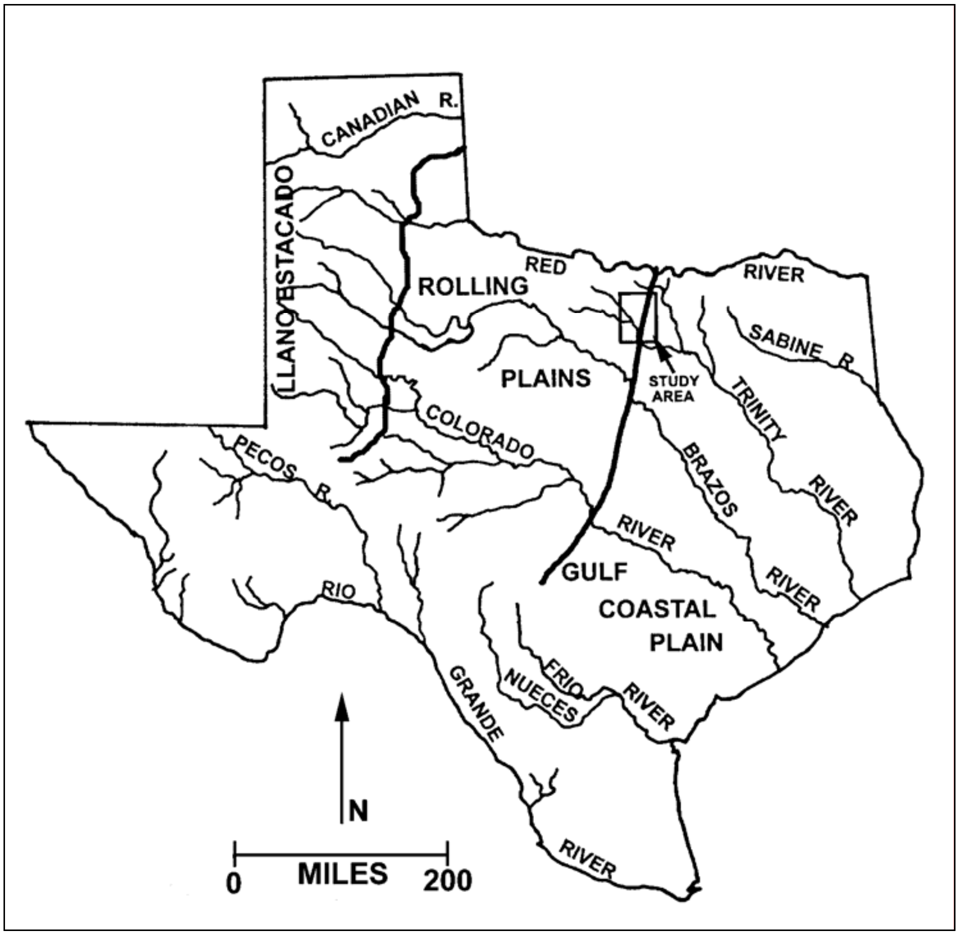


Figure 1.1 Map of Texas showing physiographic regions and study area. Note that the study area is transected by the boundary between the Rolling Plains and the Gulf Coastal Plains indicating its ecotonal position.

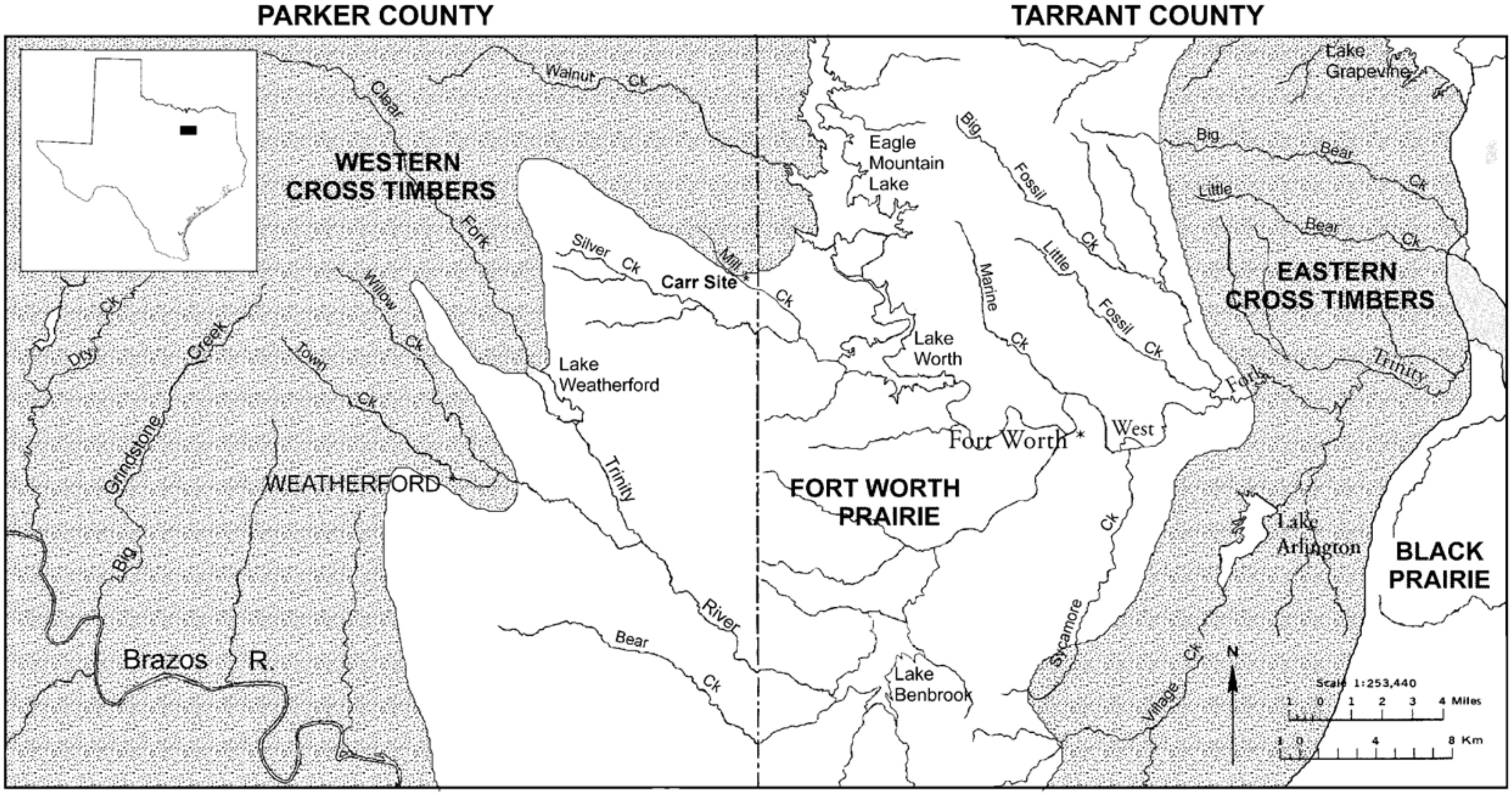


Figure 1.2 Map showing Tarrant and Parker Counties with location of the Carr site on Mill Creek a tributary of the West Fork of the Trinity. Note the ecotonal position of the site at the boundary between the Western Cross Timbers and the Fort Worth Prairie.

Climate

The climate of the study area can be characterized as humid and subtropical; the summers are hot, and the winters are usually mild. However, the area is distinguished by rapid changes in temperature, which shows marked extremes and wide fluctuations both daily and annually. It is not uncommon for droughts to occur during the summer, and in winter, freezing rain and limited snowfall does occur for short periods. Summer temperatures can reach above 37.7°C, and in winter temperatures well below freezing do occur. The mean daily winter minimum is 0°C and the mean daily summer maximum is 36°C. Winds are generally southerly throughout the year, and precipitation averages 81.05 centimeters annually. Precipitation is lowest in the winter months; in April and May rainfall is heavy, and thunderstorms are common. Summer months are usually dry and hot followed by increased precipitation in September (Bomar, 1983, Greenwade, Kelley, and Hyde, 1977, Fig. 1.3).

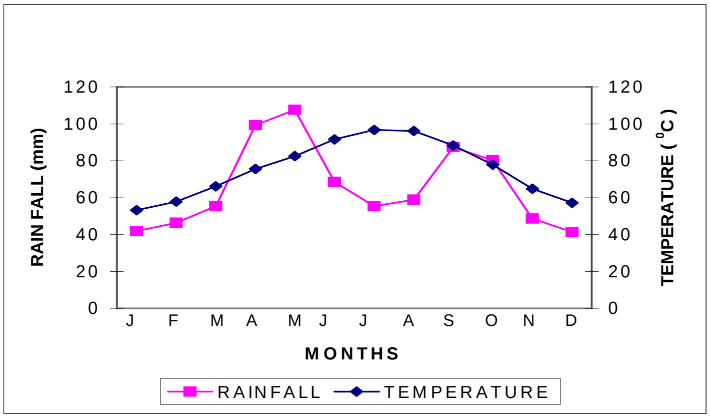


Figure 1.3 Average monthly rainfall and temperature for Parker County (data from Bomar, 1983).

Previous Research

Geology

R. T. Hill conducted the earliest investigations of the geology of Texas in 1887 and 1901. In these seminal studies, Hill described five natural provinces based primarily on differences in bedrock (Fig. 1.4). He noted that the hardness and dip in the underlying bedrock were the chief factors in variations in relief, in stream valley formation, in the formation of escarpments, and in the location of prairies. Considering the rivers of Texas, Hill noted that the Trinity was younger than the through-flowing rivers of the Red, Brazos, Colorado, Cimarron, and Canadian. Moreover, in his assessment he realized that these stream valleys recorded a remarkable geologic history that needed further exploration.

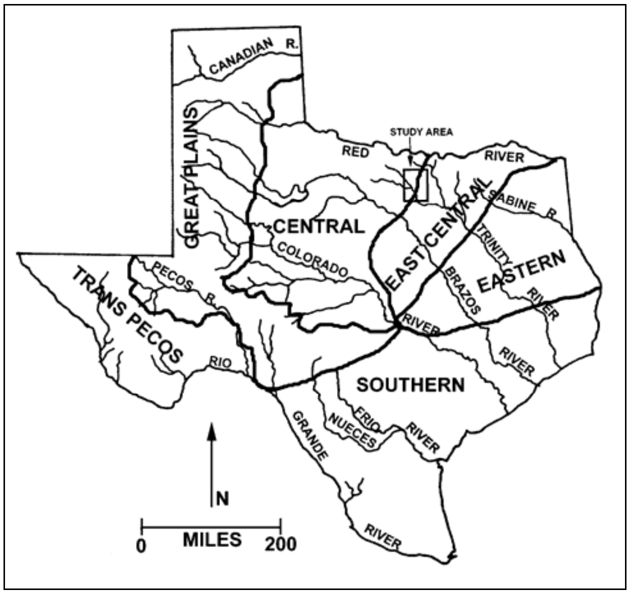


Figure 1.4 Hill's natural regions of Texas based primarily on bedrock controls. Note that Hill's Central and East Central Regions correlate with the Rolling Plains and Gulf Coastal Plains, respectively (adapted from Hill, 1901).

Faculty and students from Southern Methodist University have conducted the vast majority of research of the Upper Trinity River. Shuler (1918) was the first to note the importance of the alluvial terraces along the Trinity River near Dallas for construction materials and for their rich fossil record. Encouraged by Shuler, Lull (1921) published the first description of Pleistocene vertebrate fauna of the alluvial terraces in the Dallas area. Noting the presence of abundant proboscidean remains within the sandy terraces along the Trinity, Shuler (1934) speculated that these animals had been trapped in quicksand, and he noted the possibility of finding artifacts associated with these proboscidean remains. Additionally, Shuler (1935) defined the morphostratigraphy of the Dallas area terraces and compared them to other Texas rivers. He described three terraces above the current floodplain noting that the identification of the terraces could be made based on the three major soil types of Carter (1924).

Patillo (1940) described three terraces of the Elm Fork of the Trinity near Carrollton and correlated these terraces with those of Shuler's (1935) sequence on the Trinity River in Dallas. Further research of the Trinity was delayed until after World War II when there was a burst of research as returning veterans used the G.I. bill. During this period, a number of Southern Methodist University graduate students mapped terraces along the Trinity and its tributaries as part of their Masters studies. Taggart (1953) integrated this data into a five-terrace system for the Trinity based solely on topographic data from Dallas County.

Earlier, Stovall and McAnulty (1950) described a three-terrace system based on vertebrate paleontology, lithology, and stratigraphic position of terraces south of Dallas in Henderson County. These authors ambitiously attempted to correlate the terraces with glacial deposits to the north and with coastal formations to the south. While later research has not verified their correlations, their effort was the first and most extensive analysis of Quaternary geology and paleoenvironments in the Trinity Drainage Basin.

Later, W. W. Crook, Jr. proposed a new nomenclature for the Trinity terraces as a result of investigation of the Lewisville Lake archaeological site with R. K. Harris (Crook and Harris, 1955, 1957; 1958; Slaughter et al., 1962). The archaeological and paleontological community in the region quickly adopted this nomenclature. However, Crook's scheme used surfical archaeological data for dating sedimentary facies, and he used soil horizons as lithostratigraphic units to define alluvial stratigraphic units (Fig. 1.5). As a result of this approach, Crook's lithostratigraphic units are difficult to recognize in the field and dates for the terraces are erroneous (Ferring, 1986c).

Bob Slaughter, using Crook's geologic framework, led other investigations of the Quaternary geology of the Trinity. Primarily, Slaughter recovered vertebrate and invertebrate faunas from the "Hill" and "Shuler" formations of Crook's Pemberton Hill-Lewisville terrace. Slaughter labeled these faunas the Hill-Shuler Local Fauna and initially dated them to the Sangamon (Slaughter et al., 1962) based on radiocarbon dates and preliminary identification of *Bison alleni*. Slaughter and Ritchie (1963) examined fauna from the highest terrace of Clear Creek in Denton County, and included the faunal assemblage in the Hill-Shuler fauna. In a later publication, Slaughter (1966) included the Hill-Shuler fauna in the Moore Pit Local Fauna and reinterpreted his classification of the bison and other fauna as belonging primarily to the Wisconsin. Slaughter and Hoover (1963) investigated the alluvial deposits of the Sulpher River noting Pleistocene deposits and faunal remains in highly eroded cut banks. The faunal assemblage was named the Ben Franklin Local fauna, and a Late Wisconsin age was assigned based on radiocarbon dates. Molluscan faunas from Clear Creek and the Sulphur River examined by Cheatum and Allen (1963) showed environmental differences between the two assemblages.

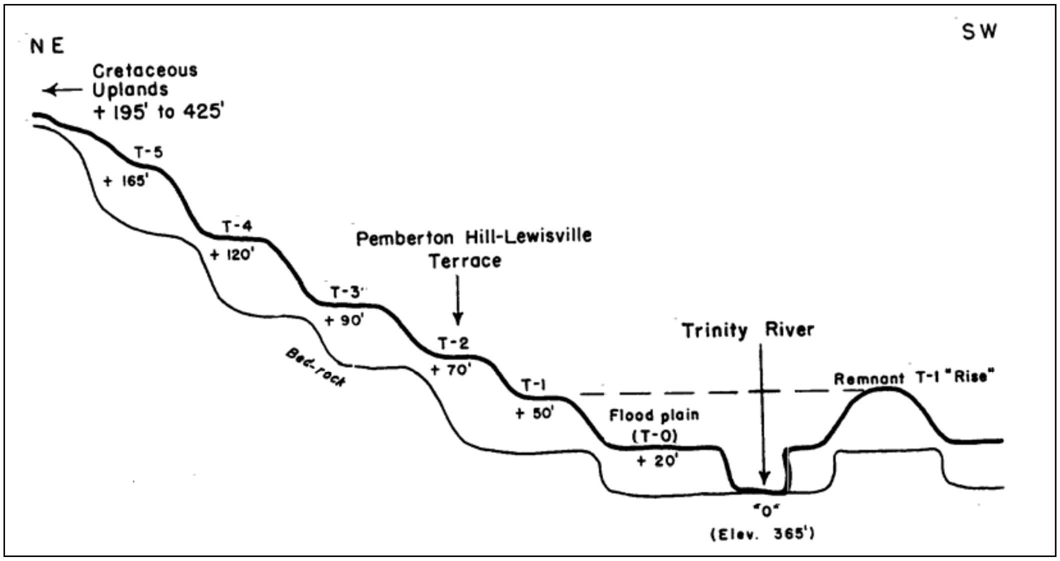


Figure 1.5 Topographic schematic showing Crook's stratigraphic sequence of alluvial terraces, Dallas, Texas. Crook introduced new binomial nomenclature with the first name indicating Dallas terrace and second name indicating comparable terrace on the Elm Fork of the Trinity (adapted from Slaughter, et al, 1962).

Thurmond (1967) began work on the East Fork of the Trinity River and described three terraces along this drainage. His was a balanced approach using topography, soil maps, subsurface data, and paleontologic evidence. Thurmond correlated his T-2 terrace with that of Crook's (1957) Pemberton Hill-Lewisville terrace (Fig. 1.5). Using a similar methodology, Willimon's (1972) work near Dallas noted three well-developed terraces along the Trinity. The majority of his research centered on the T-2 terrace with its rich Rancholabrean faunal record. Significantly, he used borehole data, detailed stratigraphic descriptions, and two molluscan local faunas to demonstrate that the T-1 terrace was aggraded from about 23 to 19 ka. In addition, he noted that there was a period of down cutting at 10 ka followed by rapid aggradation and a thick buried soil under the modern floodplain.

South of the study area, Pheasant (1982) examined the floodplain and terrace system of Richland and Chambers Creek, tributaries to the Trinity River. This work was based primarily on topographic height above the floodplain, lithology, and soil development. He noted that no buried soils were found on the terraces, but he identified two buried soils within the floodplain alluvium.

Ferring began extensive research in the Trinity River Basin in 1985. He continued the work on the Elm Fork and extended his research to the West Fork of the Trinity as far west as Fort Worth. Using borehole data, radiocarbon dating, and sedimentary analysis, he was able to revise and introduce new stratigraphic units (Ferring, 1986d, 1989a, 1990a,b, 1993). His research describes Trinity River terraces, their underlying alluvium, and soils that have developed in this alluvium. He describes four morphostratigraphic units based on geomorphic surfaces and bounding discontinuities: the Stewart Creek terraces, the Hickory Creek terraces, the Denton Creek terraces, and the floodplain. Additionally, six alloformations are described; three are associated with the terraces and three are linked to the floodplain (Fig. 1.6, 1.7).

In brief, Stewart Creek terraces are the highest and underlain by the Irving alluvium. These are strath terraces with gravel veneers and scattered terrace remnants underlain by alluvium. These are the least studied, but probably date to the Middle Pleistocene or Sangamon. In contrast, the Hickory Creek terrace is the most clearly expressed and studied terrace along the Elm Fork. This terrace is underlain by the Coppell Alloformation and is dominated by fine grained calcareous alluvium that suggests a prolonged period of aggradation/planation. Hickory Creek terraces are estimated to date to the middle Wisconsin, ca. 70 to 28 ka, with abandonment by valley incision about 30 ka leaving a broad flat terrace that is frequently matched on both sides of the valley. The lowest terraces are the Denton Creek terraces, which are discontinuous and complex, fill terraces underlain by the Carrollton Alloformation. The underlying sediments are sandy to loamy, upward fining, and usually non-calcareous. These facies suggest high energy, bed load braided streams during a period of rapid valley incision from 30 to 20 ka (Ferring, 1993b).

The floodplain registers a complex history underlain by at least three alloformations, two of which are buried. The Aubrey Alloformation is the oldest, which is composed of six to nine meters of sand and/or gravel with occasional beds of finer alluvium, marl, or lacustrine sediments. Sedimentary facies suggests a braided stream channel four to five times as large as today recording the last and deepest valley incision that began after abandonment of the Coppell floodplain. Radiocarbon dates bracket this formation to the terminal Pleistocene, 14.2 to 11.5 ka. Above the Aubrey Alloformation lies the Sanger Alloformation composed of a heterogeneous alluvium three to four meters thick. The dominant lithology appears to be fine-grained calcareous alluvium that indicates an aggrading valley with a meandering, suspended-load stream. This sediment package is dated to 11.5 to 4.5 ka. Finally, the Pilot Point Alloformation underlies the current floodplain surface away from the meander belts; near meander belts, it is buried under recent alluvium and contains the buried West Fork soil. Generally, these floodplain sediments are finer, having been deposited by a suspended load stream (Ferring, 1993b).

In sum, most Quaternary research of the Trinity River Basin was an outgrowth of lake construction for the Dallas-Fort Worth Metroplex. These efforts have concentrated mainly on the Elm Fork, the Trinity River section south of Dallas, and portions of the West Fork in Dallas and Tarrant County. The most recent research of the geologic history of the Upper Trinity River comes from investigations for the Corps of Engineers conducted by Ferring of the University of North Texas during the construction of Lake Ray Roberts (Ferring, 1986b; 1993). Since the West Fork drainage and its tributaries share the same climate and flow through similar

Cretaceous formations, some accurate conclusions and comparisons can be drawn from this research.

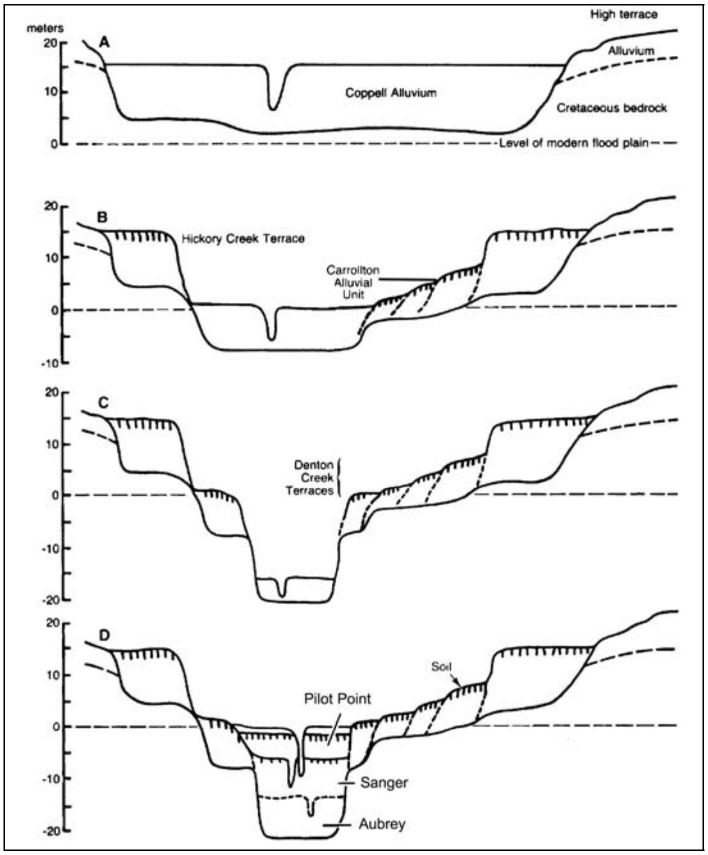


Figure 1.6 Ferring's (1993) evolution of the Trinity River terrace system. (A.) Aggradation of Coppell Alloformation sediments post deposition of older alluvium and formation of Stewart's Creek terraces, deposition ended ca. 30 ka. (B.) Genesis of Hickory Creek terraces with valley incision and deposition of Carrollton Alloformation sediments, ca. 30-22 ka. (C.) During last glacial maximum (ca. 22-15 ka) valley incision with deposition of Aubrey Alloformation. (D.) Early Holocene aggradation of Sanger Alloformation ca. 11-7.5 ka, middle Holocene pedogenesis ca. 7.5-4.5 ka, and late Holocene aggradation of Pilot Point Alloformation ca. 4.5-present (modified from Ferring, 1991, 1993)

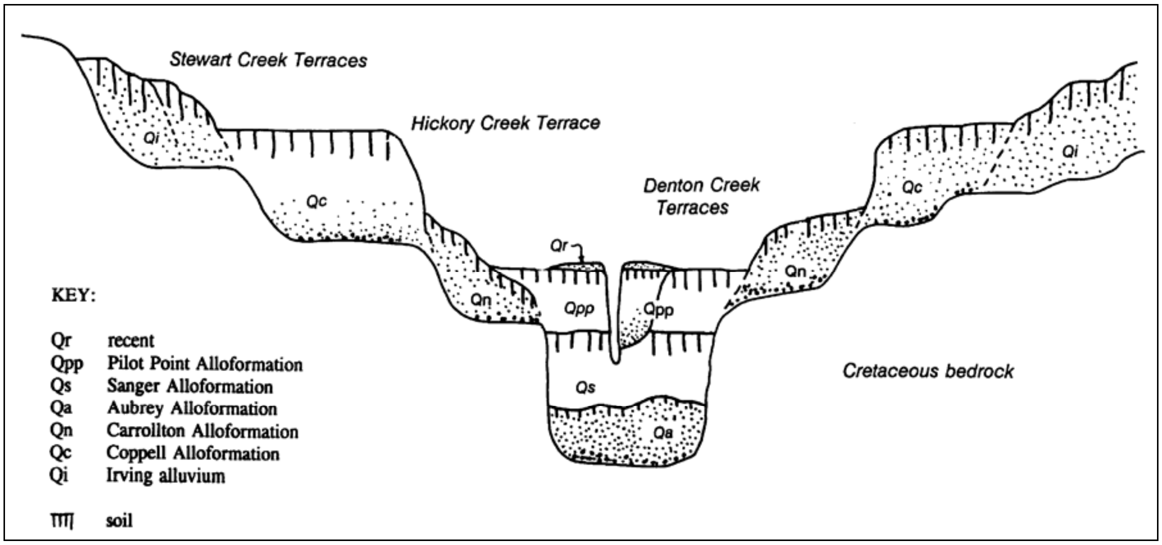


Figure 1.7 Schematic of geologic cross-section of the Upper Trinity River drainage from Ferring 1993b. Alloformations are named after local towns and terraces are named after local streams.

Late Quaternary Environments

Pollen Evidence

With the exception of the Aubrey Clovis site, there are no pollen records for the Upper Trinity River basin. The majority of fossil pollen evidence is from central, west, and southwest Texas and suggests a considerably cooler and more humid environment during the Pleistocene period than exists today (Bryant and Holloway, 1985). The Llano Estacado in west Texas provides evidence from playa lakes that shows an increase in conifer pollen of both spruce and pine in conjunction with a decrease in grass and herbaceous pollen. Early investigators suggested that this record might indicate a continuous conifer forest throughout much of west Texas (Hafsten, 1961; Oldfield and Schoewetter, 1975). However, Holliday (1987) challenges this interpretation. His review of the evidence noted questionable radiocarbon dates, differential preservation of pollen, and the lack of podzolization in late Quaternary soils. He concluded that late Pleistocene vegetation in west Texas was open grassland or grassland with some deciduous trees along drainages. Additionally, Hall’s (1992, 1995) analysis of unaltered pollen from White Lake lacustrine clay deposits (ca. 19-17 ka) indicates an *Artemisia* grassland on the High Plains during the full glacial interval. Similarly, pollen data from the Aubrey Clovis site in the Upper Trinity River basin registers grassland vegetation between 14.5 and 12 ka (Hall, 1991).

In central Texas, pollen evidence from Boriack Bog (Bryant, 1977a) contains an abundance of arboreal pollen indicating woodlands and parklands throughout central and east Texas. In contrast, the pollen record from Friesenhahn Cave, on the southeastern edge of the Edwards Plateau, contains higher percentages of grass pollen suggesting that south Texas was probably composed of grasslands and scrublands (Bryant and Holloway, 1985). More recently, Hall (1995) recovered pollen from lacustrine clays in Friesenhahn Cave (ca. 19.6-14 ka). His analysis of the pollen assemblage shows the Edwards Plateau to contain grasslands, high amounts of composites, and pinyon pines and deciduous trees in canyons and riparian zones.

North of the study area, Ferndale Bog contains sediments with well-preserved pollen from late Pleistocene to late Holocene. The bog, located in the Ouachita Mountains of southeast Oklahoma, was first examined by Albert (1981). Subsequently, Holloway and Ferring cored the bog in the same year (1981) obtaining deeper sediments (ca. 11.8-0.6 ka) with well-preserved pollen (Holloway, 1993). Their analysis revealed pollen assemblages dominated by low percentages of arboreal pollen and high grass with composites during the late Pleistocene (Fig. 1.8). The pollen assemblage suggests that the region is comparable to central Texas during the close of the Pleistocene with upland grasslands and arboreal elements in canyons and riparian zones. Comparable vegetation is reported at Domebo, Oklahoma by Wilson (1966), ca. 11.2 ka. At both sites late glacial assemblages contain high counts of grass and composites with low percentages of arboreal pollen.

Generally, the late Pleistocene and early Holocene pollen record at Ferndale Bog indicates a landscape dominated by grass and ambrosia (Holloway, 1993). However, dramatic vegetation shifts occurred during the early Holocene as prairie steppe vegetation yielded to an oak savanna. At Ferndale Bog (ca. 9 ka), grass and ambrosia decline as oak and composites began invading the post-glacial grasslands.

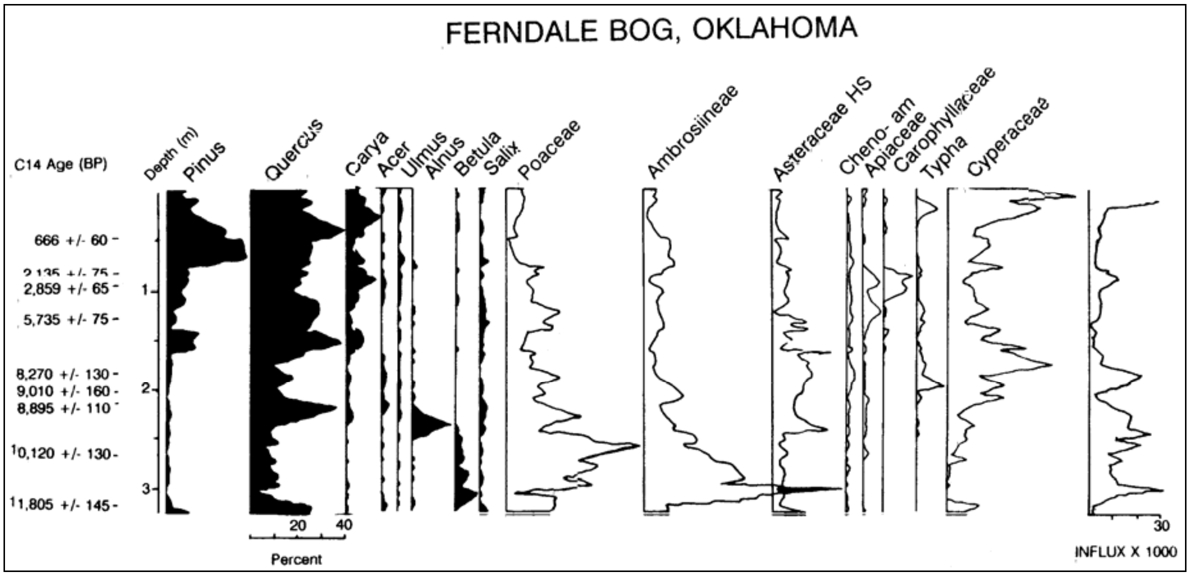


Figure 1.8 Pollen diagram from Ferndale Bog, Oklahoma showing changes in vegetation during the Holocene. Note high grass and ambrosia in early Holocene followed by low pollen influx during middle Holocene, and increase oak and pine in the late Holocene (modified from Ferring, 1993).

During the middle Holocene (ca. 6.5-5.5 ka), low pollen influx and higher grass pollen evidence a period of aridity. Similarly, at Boraick Bog, Bryant (1977, 1985) noted significant increases in grass pollen and low percentages of arboreal elements in the pollen record ca. 7.0 to 4.5 ka. Antev (1955) termed this arid period the Altithermal suggesting that it was both warmer and drier than present. He placed the Altithermal period directly in the middle Holocene, although middle Holocene climates are complex and highly variable both geographically and temporally. A variety of paleoclimatic models has been constructed based on different lines of evidence resulting in opposing temporal reconstructions (Ellis *et al*, 1995, Fig.1.9).

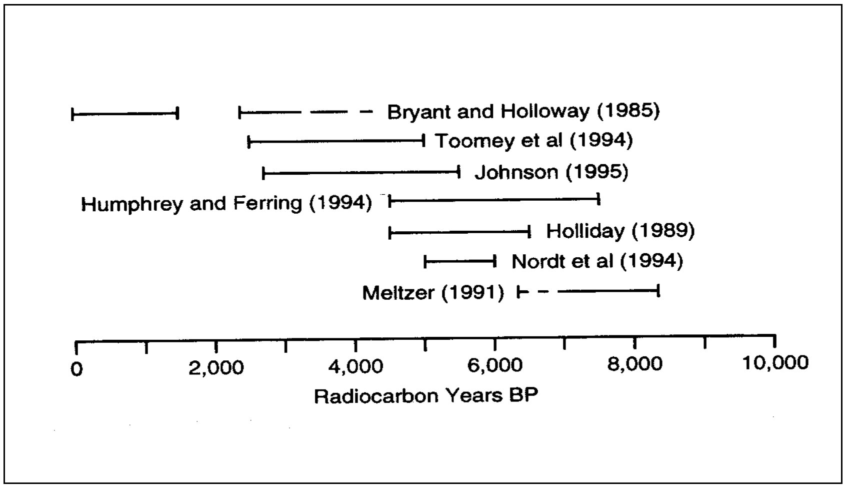


Figure 1.9 Graph of range of paleoclimatic models showing duration of Altithermal period from areas in and around central Texas. Note that different lines of evidence and geographic locations have yielded largely different temporal reconstructions (modified from Ellis, et al, 1995).

Despite these differences, a convergence of evidence supports Antev's conclusion that the Altithermal was a period of extreme aridity and harsh times (Meltzer, 1991). Following the drier middle Holocene period, the late Holocene pollen record at Ferndale Bog (ca 3 ka to present) shows a continued succession to a mixed oak-pine-hickory forest (Ferring, 1993b). At Boraick Bog, the late Holocene pollen record is truncated by draining and removal of peat in the twentieth century (Bryant, 1977). However, a study of Weakly Bog in Leon Co., Texas has provides pollen data from this period (Holloway, 1987). The pollen spectra from this site show a general increase in arboreal pollen through time. Thus, the evidence from Ferndale Bog and Weakly Bog implies that following the middle Holocene dry spell the climate became progressively moister through the late Holocene (Bousman, 1998).

Faunal Evidence

In his discussion of the geology of Dallas County, Shuler (1918) noted the presence of an abundance of fossil fauna from sand and gravel pits in the alluvium of the Trinity River near Dallas, Texas. Encouraged by Shuler, Lull (1921) examined these fossils assigning a Pleistocene age. Slaughter (1962, 1963b) considered these fossils to be Sangamon reflecting a climatic change from humid to more arid than today. In their study of mollusks, Cheatum and Allen (1963) supported Slaughter's interpretation of a drier Sangamon, but suggested that at the close of the Wisconsin glaciation, the climate was much moister than today. In his review of late Pleistocene and Holocene vertebrae fauna from central Texas, Lundelius (1967) disclosed the complexity of the faunal record, noting that the faunal assemblages are disjunct; yet, they contain sympatric associations of taxa that today occupy diverse ecological settings. Generally, this sympatric concentration of fauna is interpreted to represent considerably reduced extremes of seasonality, wetter full glacial climates, and a more patchy vegetational environment (Lundelius, 1992). Willimon (1972) examined late Pleistocene vertebrae and invertebrate faunas near Dallas concluding that conditions were cooler than today with a significant increase in stream discharge.

Lundelius (1967, 1992) interpreted the loss of cold adapted animals in regions of north and west Texas as a result of loss of niches during climate change to a drier and warmer Holocene. Yet, Lundelius (1967) concluded that the post-glacial faunal assemblages record no indication that conditions were drier during the Altithermal. Similarly, Graham (1987) contends that middle Holocene faunas from the Southern Plains suggest conditions moister than today. In a like manner, Winkler (1990) interpreted the fauna from the Wilson-Leonard site in Central Texas to indicate that the middle Holocene was moister than today.

Climatic interpretations of moist conditions during the middle Holocene contrasts sharply with other lines of faunal evidence. Johnson (1974) found invertebrate faunal remains at the Lubbock Lake site, which suggest a change in vegetation and climate towards drier and warmer conditions throughout the Holocene. Similarly, Dillehay (1974) examined the response of bison populations to environmental change on the Southern Plains. He determined that bison were rare during the middle Holocene from ca. 8/7 to 4.5 ka. He attributes the causative factor to climatic change, which reduced population density and range shifts during periods of drought. Moreover, at Mustang Springs on the Southern High Plains of Texas, Meltzer (1991,1999) notes the replacement of microfaunas with more drought tolerant species and a drop in bison numbers as a function of diminished surface water and loss of forage. In his review of middle Holocene paleoenviromental data from the Southern Plains, Ferring (1995) concludes that the middle Holocene was a period of reduced biomass and surface water.

In contrast, the late Holocene climate reflects a return to conditions moister than the middle Holocene. On the Southern Plains, Dillehay (1974) noted the presence of bison from ca. 4.5 to 1.5 ka and ca. 0.8 to 0.45 ka. He attributes their presence to improved range conditions resulting from increased precipitation. Alternately, Lynott's (1979) review found similar results with presence of bison ca. 0.8 to 0.4 ka. Yet, he interprets the data to indicate climatic drying resulting in a local increase in short grass prairies, the favored bison habitat. Similarly, Hall (1988) and Creel (1990) attribute bison presence to drier conditions in the Southern Plains. Clearly, the presence of bison cannot be the result of both climatic interpretations. Indeed, the problem of equifinality of proxy evidence has resulted in little agreement regarding the identification of major climatic events (Ellis, 1995, Caran, 1998). However, Dillehey's (1974) argument that bison populations increase as grazing conditions improves during periods when climates are wetter makes ecological sense. Additionally, oxygen and carbon isotopic evidence correlated with rates of alluviation evidence from the Aubrey Clovis site (see below) supports Dillehey's climatic interpretation (Humphrey and Ferring, 1994).

Stable Isotopes

Archaeologists seeking to reconstruct past environments have recently turned to stable isotopes to examine a variety of concerns: paleodiets, paleoecology, paleoclimate, and paleovegetation. As a result, oxygen isotope studies have examined a variety of materials to include: bone, mussel and snail shells, and soil organic matter and carbonates. Simplistically, the ratio of $^{16}O/^{18}O$ varies in meteoric water with latitude, altitude, annual rainfall, seasonality, and temperature, but is roughly predictable. An increase in ^{18}O relative to ^{16}O can be used to infer warmer temperature, while an increase in ^{16}O relative to ^{18}O reflects cooler temperatures.

The case of carbon isotopes is more complex, but plants that use the more common C_3 photosynthetic pathway yield isotopically lighter organic carbon. Dissimilarity, plants utilizing the C_4 pathway yield isotopically heavier organic carbon. Accordingly, isotopically lighter carbon should signal cooler and/or wetter climates, and isotopically heavier carbon should signal warmer and/or drier climates (Dansgaard, 1964).

At the Lubbock Lake site, carbon isotopes were utilized to reconstruct paleoclimates and vegetation (Haas, et al., 1986). The carbon was derived from organic rich marsh sediments and buried A horizons. In their analysis, the early Holocene ca. 10.5 and 6.7 ka is documented by depleted $\delta^{13}C$ values indicating the growth of C_3 grasses and reeds during a period of increased moisture. A shift towards drier climates and C_4 grasses is documented by a decrease in $\delta^{13}C$ values ca. 5.7 ka chronicling the onset of the middle Holocene. Using bison bone from Lubbock

Lake, Meltzer and Collins (1987) found a drop in $\delta^{13}C$ suggesting that the bison had increased their reliance on C_3 grasses as a result of the loss of C_4 grasses during the middle Holocene. Additionally, at Mustang Springs on the southern margin of the Llano Estacado, Meltzer (1991) included carbon isotope studies of sediments associated Altithermal wells. The results are similar to the Lubbock Lake locality; early Holocene samples are depleted in ^{13}C indicating a wetter climate, and there is a striking shift ca 7.0 ka to compositions enriched in ^{13}C, marking a change to drier climates and C_4 grasses.

In central Texas, stable carbon isotope analysis was performed on organic carbon in alluvial deposits and soils of three streams on the Fort Hood Military Reservation. Like the Lubbock Lake and Mustang Springs studies, this research documents a relatively cooler and wetter early Holocene. During the middle Holocene an almost completely C_4 dominated plant community emerges indicating a shift to a warmer and drier climate between ca. 8.0 and 4.0 ka. The late Holocene ca. 4.0 ka to present is marked by a return to more mesic conditions with a drier period ca. 2.0 ka (Nordt, *et al*., 1994).

Closer to the study area, Humphrey and Ferring (1994) studied a series of lacustrine, spring, and soil carbonates from the Aubrey Clovis site located in north-central Texas. In their examination of soil carbonates, they concluded that the alteration of soil carbonates was insufficient to alter the original δ^{18}O of the original meteoric waters. In fact, they were able to demonstrate that oxygen isotope values reflect changes in the source reservoir of the Gulf of Mexico, which varies due to changes in the Laurentide ice sheet volume and melt water influx. Additionally, problems associated with lacustrine carbonates and input from ground water, precluded strict temperature estimates based on oxygen isotope data. However, the stable carbon isotopic record, coupled with interpretations based on sedimentlogy and rates of alluviation, clarifies the paleoclimatic record for the Upper Trinity Basin (Fig. 1.10).

The isotopic evidence, combined with pond desiccation and deflation at the Aubrey Clovis site, suggests that prior to the early Holocene the climate was cool and dry. This interpretation equates with Haynes (1991) identification of a Clovis drought that was concurrent with mega fauna extinctions, ca. 11.3 to 10.9 ka. Following this short but significant dry interval, the early Holocene ca. 11.0 to 7.5 ka is a period of more depleted isotopic composition linked with rapid valley alluviation indicating a return to higher precipitation. This trend of increased precipitation occurs again from ca. 3.5 to 2.0 ka. In contrast, the middle Holocene isotopic record is enriched from ca. 7.0 to 4.0 ka, and is marked by slow alluviation and pedogenesis indicating drought conditions. A similar dry spell occurs from ca. 2.0 to 1.0 ka. Thus, the isotopic data from the Aubrey Clovis site is correlated with aggradation during periods of increased moisture and drier periods are marked by slow alluviation with pedogenesis. In sum, the evidence from the Aubrey Clovis site records a dry interval prior to the Holocene, a wet early Holocene followed by a dry middle Holocene, and a generally moist late Holocene with a dry interval from 2.0 to 1.0 ka. (Ferring, 1993).

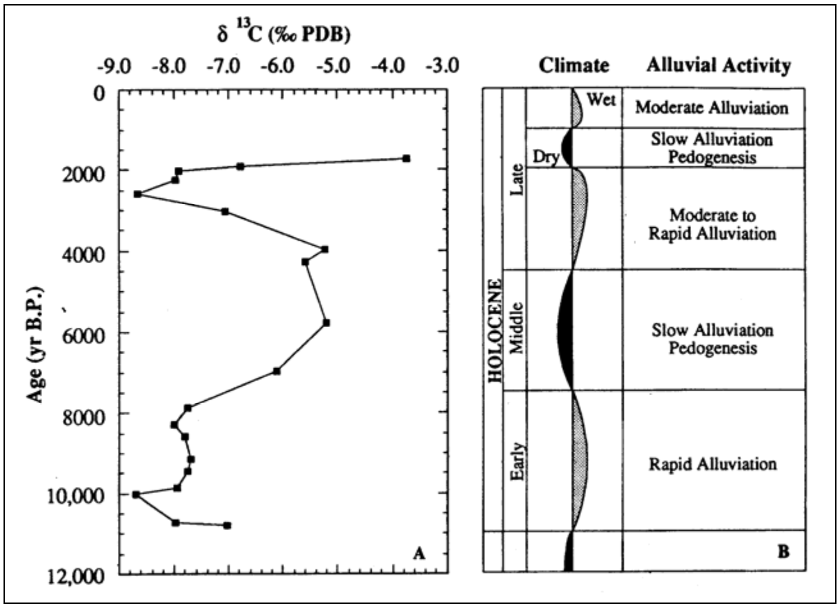


Figure 1.10 Comparison of isotopic data and alluvial history from the Aubrey Clovis Site (from Ferring, 1993). Note that periods of depletion of δ^{13}C correlate with rapid alluviation during the early and late Holocene indicating periods of increased moisture. The middle Holocene and briefly during the late Holocene reflect periods of δ^{13}C enrichment accompanied by slow alluviation and pedogenesis indicating drier climates.

Archaeology

The study area occupies an ecotonal position between the Great Plains and the Gulf Coastal Lowlands; it straddles a cultural boundary as well. To the east, in late prehistoric times, Caddoan peoples lived in sedentary villages with maize agriculture, ranked societies, and trade networks (Story, 1981). To the west the Wichita, like other Southern Plains cultures, relied on a broad-spectrum subsistence economy without sedentary villages (Newcomb, 1961, Ferring and Yates, 1998). Previous archaeological investigations have centered on the Elm Fork and East Fork of the Trinity River, paralleling the construction of federally funded reservoirs. Story (1990) and Prikryl (1990) provide detailed reviews of these investigations. In comparison, the West Fork of the Trinity River has not been as thoroughly investigated as demonstrated in the following summary of previous archaeological investigations of the Upper Trinity River.

Initial investigation of the Upper Trinity River began with Shuler's (1923) report on the Lagow Sand Pit. Human remains were found in the same cross-bedded sands that contained Late Pleistocene faunas. No artifacts were associated with the remains, and later chemical analysis proved the remains to be much younger than the Pleistocene faunas. Inspired by the large number of mammoths and mastodons in the sandy terraces, Shuler (1932) encouraged archaeologists to look more closely at the Trinity River terraces. Albritton and Patillo (1940) examined a human burial in terrace deposits of Denton Creek, a tributary of the Elm Fork, noting that measurements of the skull were consistent with Wichita and Caddoan groups.

The most prolific early investigator was the advocationalist R. K. Harris. In 1936 he noted that sites along the East Fork appeared to be closely related to the Caddos while the sites along the Elm Fork seemed to resemble cultures located farther west along the Brazos River. Harris worked closely with the Dallas Archaeological Society (DAS) and W. W. Crook Jr. to record and publish numerous sites along the channels of the Elm, East, and main Trinity, while the West Fork and Clear Fork of the Trinity remained largely unexplored (Prikyl, 1990). Crook and Harris (1952, 1955) defined their Trinity aspect of the Archaic and reported on the Obshner paleoindian site. However, their most controversial publication was the Lewisville site, 41DN72, in which a Clovis point and 21 burned features were associated with late Pleistocene fauna. Radiocarbon dates derived from the features dated to greater than 37,000 BP (Crook and Harris, 1957, 1958). This extreme age created a controversy that could not be resolved before the site was inundated by Lake Lewisville. During a severe drought in 1979-80, lake levels fell and the Smithsonian Institution reinvestigated the site. Stanford (1983) was able to demonstrate that a mixture of lignite and charcoal from the features led to erroneous dates.

The earliest professional archaeological investigations were conducted by Stephenson (1948, 1949a, 1949b), working for the Smithsonian Institution River Basin Surveys. He surveyed four federally financed reservoirs from west to east: Benbrook, Grapevine, Lewisville, and Lavon. At Benbrook, on the West Fork of the Trinity, he found no evidence of prehistoric occupations, and at Grapevine, on Denton Creek, only five sites were recorded. However, with the help of DAS members, he was more successful with the eastern most reservoirs. He recorded 27 prehistoric sites at the Lewisville Reservoir on the Elm Fork of the Trinity, and 25 sites at Lavon Reservoir on the East Fork of the Trinity (Prikryl, 1990). At two sites along the East Fork, 41COL1 and 41COL10, Stephenson (1952) reported large circular pit features associated with corn, pottery, and single, multiple, and flexed burials. The artifact assemblages included dart and arrow points, and the pottery seemed to show both plains and Caddoan traits; he called these features Wylie focus pits. However, recent investigations at Richland Creek Reservoir by Bruseth and Martin (1987) concluded that the Late Prehistoric Wylie focus is an insupportable concept.

Following the early work of Stephenson, avocationalists and professional archaeologists continued their investigations of the Elm and East Fork of the Trinity. The Texas Archaeological Salvage Project (TASP) investigated numerous Late Archaic and Late Prehistoric sites before reservoir construction (Harris and Suhm, 1963, Shafer, 1964, Ross, 1966). With the passage of the National Environmental Policy Act of 1969 archaeological investigations increased dramatically. During this period, area universities competed for archaeology contracts associated with environmental impact studies for new reservoir construction. Southern Methodist University (SMU) partially surveyed the Elm Fork for the proposed Ray Roberts Reservoir recording 26 sites (Bousman and Verrett, 1973). Additionally, SMU investigated the

East Fork with the expansion of Lake Lavon (Dawson and Sullivan, 1973, Lynott, 1975). Nunley (1973) recorded 50 sites, in conjunction with the Richland Archaeological Society, along the shoreline of Lewisville Lake. Ferring (1975) surveyed along Denton Creek near Grapevine Dam recording two additional sites.

In the 1980s, Environmental Consultants Inc. (ECI) surveyed and tested prehistoric sites along the Elm Fork for the proposed Ray Roberts Lake (Skinner et al. 1982). The most recent and comprehensive work at Ray Roberts was conducted by the University of North Texas (Brown et al., 1990, Prikryl and Yates, 1987, Ferring and Yates, 1998, 1997). Unique to this effort was the utilization of a geoarchaeological approach to site discovery, site densities, and site formation processes. This approach informs the evidence for diachronic change in past settlement intensities and patterns, in technology, and in mobility (Ferring and Yates, 1997). Almost all the prehistoric sites are Late Holocene with one exception, the Aubrey Clovis site. The Aubrey site is a rare *in situ* Clovis site that has yielded a wealth of evidence from faunal procurement to intersite patterns of tool manufacture and repair (Ferring, 1989b, 1990b, 1995).

East of Ray Roberts on Mountain Creek, Peter and McGregor (1988) undertook archaeological investigations before the construction of Joe Pool Lake. Using an ecological approach, they sought to demonstrate response within settlement-subsistence systems to environmental change. Their research determined that a hunting-gathering way of life was maintained despite the introduction of maize during the Late Prehistoric. Bruseth and Martin (1987) and McGregor and Bruseth (1987) reached similar conclusions farther south at Richland-Chambers Reservoir. Their initial focus was paleoenvironmental and its impact on prehistoric economy, settlement patterns, and material culture. As data became available the scope of inquiry narrowed, and the investigators were able to demonstrate a Late Archaic origin for Wylie pit features and house patterns more similar in construction to the Great Plains than the Caddoan area to the east.

West Fork of the Trinity

Limited archaeological investigations have been conducted on the West Fork of the Trinity. Peter (1987) working with the University of Texas at Arlington excavated the River Bend site (41TR68) an ephemeral site located in the buried West Fork soil (Ferring, 1986b) on the north side of the West Fork. Peter perceived the site to be a specialized foraging camp dated to between AD 850 and 1350. In 1990, Tarrant County Archaeological Society conducted excavations at the Chambers site (41TR114) located on an eroded terrace above the West Fork of the Trinity. This is a Late Prehistoric site with abundant arrow points (130), ceramics, and burned rock features. A significant Late Archaic floodplain site (41TR142) was tested in 1996 by Geoarch Consultants (Ferring and Byers, 1996). The site is located in the West Fork floodplain adjacent to an abandoned meander belt. Covering an area of 20,500 square meters, it is considered to be the largest such site on the West Fork below Lake Bridgeport.

At the Rough Green site (41TR162), Alan Skinner (1999) documented seasonal floodplain occupations on the south side of the West Fork. Diagnostic projectile points and radiocarbon dates bracket the site to the end of the Late Archaic and Late Prehistoric periods. The most intensive occupations appear to be during the Late Archaic; Skinner proposes that the site served as a seasonal camp for bur oak (*Quercus macrocarpa*) acorn collection. Similarly, the Fountain site (41TR136) located on the east side of Village Creek, a tributary of the West Fork, is considered to be an acorn-processing site (Hanson and Kvernes, 1977). The University of Texas at Arlington conducted extensive excavations at the Fountain site documenting mixed terrace deposits with hearths, postholes, extensive lithic scatters, and faunal remains of deer and bison. Lithics and radiocarbon date the site from the Late Archaic to the Late Prehistoric periods. The authors suggest that the most intensive occupation occurred between AD 1000 and 1400. Chronologically, the excavated sites are restricted to the Late Archaic and Late Prehistoric periods. A similar chronological distribution of sites is noted for Parker County.

Archaeological Site Atlas

A review of the Texas Historical Commission's Archaeological Sites Atlas yielded 88 recorded sites for Parker County. Usable data could be obtained from 77 of these recorded sites. Notably, the vast majority of sites (71%) reflect cultural resource management efforts at Fort Wolters and Lake Mineral Wells State Park along tributaries of the Brazos River. In contrast, only 7 sites (4%) have been recorded along the West Fork of the Trinity and its tributaries. Overall, there are more prehistoric sites (70%) than historic sites (30%). The sites are classified chronologically primarily by recovery of diagnostic artifacts (Table 1.1).

Table 1.1 Chronological distribution of Parker County sites. The only recorded Paleoindian site in Parker County is the Carr site. Note the lack of Early Archaic sites and the abundance of Late Archaic and Late Prehistoric Sites. However, 29 sites (52%) are lithic scatters without diagnostic artifacts (THC-Site Atlas).

Paleo-indian	Early Archaic	Middle Archaic	Late Archaic	Late Pre-historic	Neo American	Unknown
1	0	3	10	9	3	29

Cultural Chronology of Upper Trinity River

Paleoindian: 11,500-8,500 BP

Evidence of Paleoindian occupation in the study area is limited mainly to surface finds of Clovis, Dalton, Plainview, Midland, San Patrice, and Scottsbluff projectile point types (Prikryl., 1990). The most common types found are Plainview and Dalton suggesting that this region was a cultural hinterland utilized by both the western Plainview culture and eastern Dalton culture. Meltzer (1987) observes that despite the large number of Paleoindian projectile points from private collections, *in situ* unmixed Paleoindian assemblages are extremely rare. Only two sites lay claim to an *in situ* Clovis occupation: Lewisville and Aubrey.

The Lewisville site (Crook and Harris, 1957, 1958) contained a series of hearth features, an apparently mixed faunal assemblage (Ferring, 1997), and a Clovis point. A controversial age of greater than 37 ka was obtained from carbonized matter found in the hearths. Subsequent investigation by Stanford (1983) demonstrated that a mixture of lignite with charcoal from the hearths led to erroneous radiocarbon ages. Additionally, the claimed stratigraphic position of the site is much too old to contain Clovis materials buried by alluvium (Ferring, 1997). Similarly, Stanford (1983) indicates the presence of an unconformity, resulting from erosion of the original occupation surface. Stanford interprets this to mean that Clovis people dug hearths into existing sediments containing earlier faunas and then left the bones of later faunas within the features, resulting in a mixed faunal assemblage. Thus, lacking a reliable date and good stratigraphic control on overlying sediments, the Lewisville site has limited potential for regional Clovis studies (Ferring, 1997).

In contrast, the Aubrey Clovis site (Ferring, 1989b, 1990c, 1995, 2000) is *in situ*, deeply buried in floodplain alluvium of the Elm Fork of the Trinity River, and well dated to 11,550 BP.

The stratigraphic record at Aubrey is exceptional containing spring and lacustrine sediments providing evidence of paleoenvironments to include pollen, snail, insect, and vertebrate data. These data indicate a cool prairie environment at the close of the Pleistocene. In addition, the discovery of a well feature may indicate drought conditions during Clovis times (Ferring, 2000; Haynes, 1991)

Diverse high quality lithic raw materials are all non-local, but no single raw material dominates the assemblage. High frequencies of Tecovas quartzite may be the result of a few large pieces being reduced at the site. Tecovas quartzite probably came from outcrops along the Llano Estacado (Ferring, 2000, Banks, 1990). However, similar quartzites are found in the Catahoula Fm. in outcrops along the Gulf Coastal Plain of Texas and Louisiana (Thomas, 1960, Heinrich, 1984). Other materials include chalcedony, white Edwards chert, and rare Alibates suggesting that the materials were brought to Aubrey from long distances. Lithic use activities include intensive raw material curation, final bifacial tool manufacture, as well as tool use and resharpening (Ferring, 2000).

Spatial patterns suggest a brief encampment that may have been associated with a kill site. Large animal procurement is suggested by the presence of bison and mammoth/mastodon. However, a diverse fauna from the camp area is suggestive of broad based subsistence practices. There is clear evidence for procurement and processing of small animals to include rabbits, squirrel, lemmings, and turtle (Ferring, 2000).

Other Paleoindian sites are known from surface collections, with Dalton and Plainview points (Fig. 1.11) being the most common in this region (Prikryl, 1990). Chronologies from other regions suggest that these assemblages date to 10,700 to 10,200 BP (Morse, 1997). The Dalton-Plainview association suggests that this region was a borderland connecting the

Plainview culture of the High and Rolling Plains with the Dalton culture that is concentrated to the east (Johnson, 1987; Johnson and Holliday, 1980). Other Paleoindian points from surface collections include Golondrina, Midland, and Scottsbluff projectile points (Fig. 1.11). This mixture of point types, most of which are made of non-local chert, suggests highly mobile groups with low population densities moving through the area. The majority of these sites (ca. 68%) are located on tributary terraces to major rivers (Prikryl, 1990). Ferring (1986b) advises that those along major channels may be invisible due to deep burial by alluvium as evidenced by the Aubrey site.

Although early reports from kill sites on the western part of the Great Plains suggest a heavy reliance on large game animals such as mammoth and bison, little evidence supports this claim (Bryant and Shafer, 1977). In contrast, a more generalized hunting and gathering economy is evidenced by such sites as the Lewisville and Aubrey sites (Crook and Harris, 1957, 1958; Ferring, 1989b). At the Lewisville site, terrapins are the most common faunal remains, but other associated animals include mammoth, bison, camel, horse, skunk, raccoon, rabbit, prairie dog,

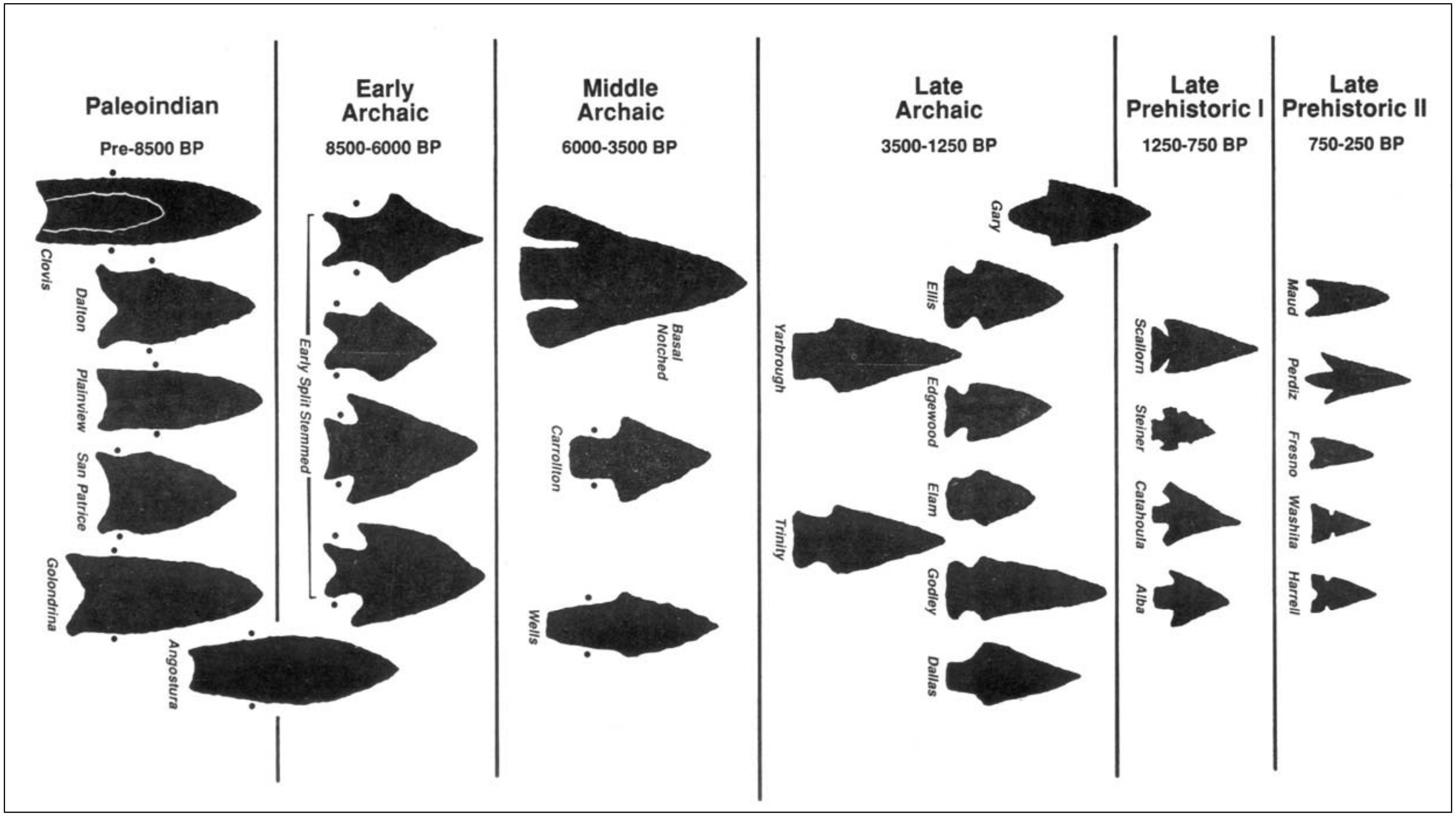


Figure 1.11 Proposed projectile point sequence for North Central Texas. Note Dalton and Plainview are the most common paleopoints for this region (Prikryl, 1990).

and aquatic turtles (Prikryl, 1990). At the Aubrey site, turtle is also common, but deer, rabbit, pocket gopher, vole, squirrel, birds, and bison are present as well (Ferring, 1989). Thus, a more generalized hunting-gathering economy is suggested that shared many similarities with later Archaic groups (Ferring, 2000).

Early Archaic: 8,500-6,000 BP

The Early Archaic cultures share many characteristics with the Paleoindian cultures that preceded them. They are recognized primarily from surface collections, but one *in situ* site, 41DN20, at Lake Lewisville contained an Early-Middle Archaic component (Ferring and Yates, 1997). The site formed in sandy colluvial sediments at the base of a terrace scarp of Little Elm Creek. Due to slope position and sandy sediments, bone and charcoal preservation was poor precluding radiocarbon dating, and paleoenvironmental and subsistence studies. However, projectile points in the lower levels such as Kirk and Early Split-stemmed, and Clear Fork gouges are associated with Early Archaic assemblages from areas adjacent to the study area (Story,1990). Additionally, two Early Archaic points have been recovered from the Aubrey Clovis site 1.5 meters above the Clovis paleo surface but not *in situ* (Ferring, 1989a). Documented sites from Central and Southwest Texas such as Youngsport (Shafer, 1963), Loeve, and Tombstone Bluff (Prewitt, 1982) have helped establish a chronological framework for the Early Archaic. The most numerous diagnostic projectile points are the Angostura and Early Split-Stemmed groups (Fig. 1.11).

A continuation of generalized hunting and gathering economy similar to Paleoindian strategies is assumed for the Early Archaic. Grasslands and wetter climates appear to characterize this period (Ferring, 1993b; Humphrey and Ferring; 1994, Prikryl, 1987). Like the

Paleoindians, it is probable that they were highly mobile, ranging over large areas without defined territories. Similar to Paleoindian sites, Early Archaic sites are located on terraces along tributaries of major rivers, but sites adjacent to larger river channels may be deeply buried.

Middle Archaic: 6,000-3,500 BP

Middle Archaic artifacts are rare in this region, and only one site of this age is known in the Trinity River drainage basin. The Calvert Site (41DN102) is on a low Pleistocene terrace at Lake Ray Roberts on the south bank of Isle du Bois Creek (Skinner et al. 1982). Initial investigations centered on Late Prehistoric and Late Archaic materials on the upper part of the terrace. Later excavations by the University of North Texas revealed Middle Archaic materials in lower deposits off the terrace edge. A rock-filled hearth, a tightly flexed burial of an adult male, and an unmixed assemblage of artifacts and fauna were found in these deposits. Projectile points included Frio, Trinity, Carrollton, and Wells with 50% of the points made of regional chert and the rest of Ogallala quartzite (Ferring and Yates, 1997). The faunal record reflects a higher percentage of small game, perhaps reflecting a paucity of large game as a result of drier Middle Holocene climates.

In his study of surface collections from the Elm Fork of the Trinity, Prikryl (1990) notes that projectile points from this period are found at fewer localities than any other point. This scarcity of diagnostic points may be the result of reduced populations in response to harsh climatic conditions of the Altithermal as proposed by Antev (1955). In the Upper Trinity River Basin, extensive geoarchaeological investigations demonstrate that the middle Holocene was a period of floodplain stability and pedogenesis as a result of reduced precipitation (Ferring, 2000). Renewed floodplain alluviation during the late Holocene resulted in deep burial and preservation of middle Holocene deposits. Despite good preservation, Middle Archaic materials are scarce in middle Holocene soils (Ferring, 1995). Localized dune construction near Decatur, Texas at the Dodd Pit and George King (Ferring, 1995) sites is similar to eolian activity on the High Plains (Holliday, 1989) and provides further evidence of middle Holocene aridity. The Dodd Pit site is located on the Denton Creek floodplain and contains Late Archaic and Late Prehistoric materials. The George King site occupies an interfluve of Catlett Creek, and contains Paleoindian and Late Prehistoric materials. Noticeably, Middle Archaic materials are absent from both sites supporting other regional studies that propose low population densities for the Middle Archaic.

Adjacent regions record the same decrease in site densities during the Middle Holocene. On the High Plains, Holliday (1989) found geologic evidence for middle Holocene aridity in the form of dune migration and eolian sedimentation in draws. Well digging at Clovis (Blackwater Draw Locality No. 1) and Mustang Springs bear witness to falling water tables and Middle Archaic peoples response to arid conditions (Haynes and Agogino, 1966; Meltzer and Collins, 1987; Meltzer, 1991). Spring-fed localities were utilized as well; at the Lubbock Lake locality sparse lithic scatters and bison remains bear witness to at least episodic occupations during the Middle Holocene (Johnson and Holliday, 1986). Thus, the evidence suggests that on the High Plains episodes of marked aridity limited Middle Holocene populations.

The Rolling Plains have a similar archaeological record of lower site densities for the Middle Archaic. At the Lake Theo site Folsom materials are overlain by middle Holocene sediments apparently devoid of artifacts (Harrison and Killen, 1978). At McKenzie Reservoir Paleoindian, Late Archaic, and Late Prehistoric occupations are present, but Middle Archaic materials are absent (Hughes and Willey, 1978). In his review of middle Holocene environments, Ferring (1995) notes the complex fluvial response to drier middle Holocene climate for this region resulting in poor site preservation and visibility. Despite these problems, archaeological evidence suggests lower site densities; surface collections from terraces and upland setting registers the same decrease in Middle Archaic projectile points (Ferring, 1995).

Late Archaic: 3,500-1,250 BP

A dramatic increase in Late Archaic site densities suggests that populations expanded during this period. Sites of this age are very common along the Trinity as a result of shallow burial below floodplains (Ferring and Yates, 1997). Surface collections of terrace localities contain 2-3 times more Late Archaic projectile points than any other archaeological period (Prikryl, 1990). In addition, adjacent regions reflect the same increase in Late Archaic site density (Ferring, 1988, Prewitt, 1983. Skinner, 1981).

Multiple causative factors have been suggested for the increase in population density. Story (1981) suggests the increase is due to new subsistence strategies that allowed the environment to be more effectively exploited, decreased mobility, and an environmental change to a wetter climate. Development of the West Fork Paleosol during the latter part of the Late Archaic period lends support for climatic change to a wetter environment (Ferring, 1986b). A wetter environment would have encouraged expansion of the Eastern Cross Timbers, providing a larger mast crop for both humans and game animals (Prikryl, 1990). Additionally, Lynott (1981) proposes intensive exploitation of bottomland resources during the Late Archaic.

The use of bottomland resources is well represented at the Gemma site, 41CO150. This site offers an exceptionally well-stratified sequence of Late Archaic occupations on the eastern floodplain of the Elm Fork of the Trinity (Ferring and Yates, 1997). The site is located in an abandoned chute cut-off channel; periodic flooding resulted in occupation surfaces separated by near-sterile alluvium. The channel offered sheltered habitation during dry periods and was abandoned during seasonal flooding (See Fig. 1.12). The majority of features were unlined or clay-lined hearths and one (in stratum B5) was associated with discrete clusters of burned rock that may represent dumpings from boiling in food baskets.

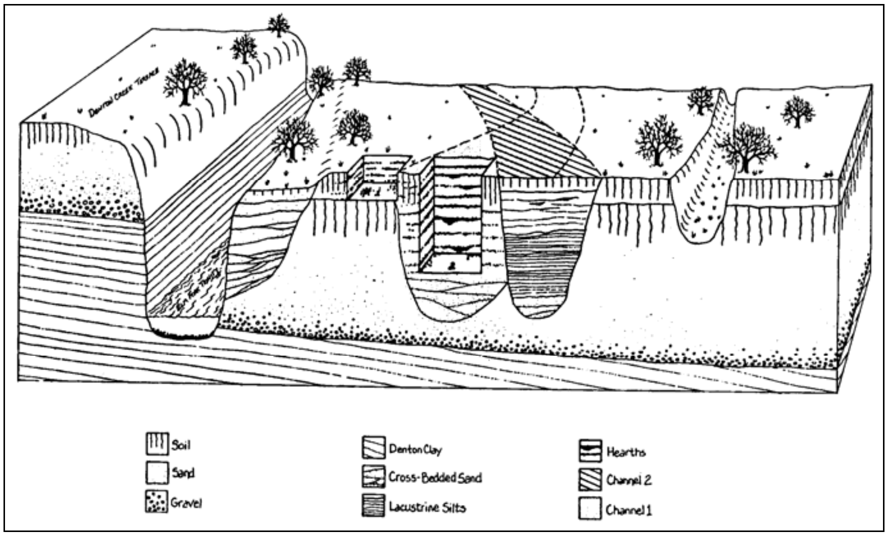


Figure 1.12, Block diagram of stratigraphy at the Gemma Site (from Ferring and Yates, 1997).

Abundant faunal remains of deer, rabbit, and turtles suggest prolonged occupation episodes and exploitation of multiple habitats typical of bottomland environments. Low artifact densities indicate that little tool manufacture took place. However, local quartzite was used in all on-site tool manufacture, and chert debitage appears to be associated with tool maintenance and repair (Ferring and Yates, 1997).

The Jayrn site, 41CO144, has similar geologic context as the Gemma site (Ferring and Yates, 1997). Jayrn is located in a chute cut-off channel and reveals repeated occupations, limited tool manufacture, and a reliance on deer as the primary source of protein. Together these sites illustrated the importance of local resource exploitation of bottomland habitats by an apparently mobile population.

The reliance on local resources is best illustrated in projectile point raw material types. Prikryl (1990) analyzed the use of raw materials from surface collections focusing on the relative percentages of quartzite and chert used in the manufacture of projectile points. His results indicate a heavy reliance on local quartzites for the Late Archaic period. A comparison of his data with data from excavated, *in situ* sites from lake Ray Roberts and Lewisville is shown in Table 1.2.

Table 1.2 Raw material frequency for Late Archaic projectile points. Note the high nonlocal raw material frequency for Late Archaic projectile points. Data from Ray Roberts and Lewisville is from excavated sites; Prikryl's data is from surface collections (modified from Ferring and Yates, 1998).

	Prikryl (1990)		Ray Roberts (1998)		Lewisville (1998)	
Period	local	non-local	local	non-local	local	nonlocal
Paleoindian	6	94	-	-	-	-
Early Archaic	20	80	-	-	-	-
Middle Archaic	30	70	50	50	68	32
Late Archaic	62	38	64	35	63	37
Late Prehistoric I	52	48	58	42	62	38
Late Prehistoric II	31	69	53	47	54	46

The data from excavated sites support Prikryl's analysis of surface collections. Taken as a whole, the data suggest that raw material acquisition by Late Archaic groups was conditioned by location rather than preference (Ferring, 1998). The Gary point is the most diagnostic dart point for this period but a greater diversity of dart points are present to include Dallas, Trinity, Godley, Ellis, Elam, Edgewood, and Yarbrough. Generally, these dart points suggest cultural ties with areas to the north in Oklahoma and to east Texas. The majority of these points are made from local Ogallala quartzite found in the Uvalde Gravels suggesting decreased mobility and or increased territoriality (Skinner, 1981; Prewitt, 1983).

Late Prehistoric: 1,250-350 BP

The Late Prehistoric period was a period of technological innovation that includes ceramics, bow and arrow, houses, and storage features. In conjunction with these innovations, maize made its first appearance in the region as evidenced at 41DL148, the Cobb Pool site (Peter and McGregor, 1987). While the importance of maize in the prehistoric diet has not been established, deer, rabbit, and turtle appear to have been important meat sources (Prikryl, 1990). In the later part of the Late Prehistoric, bison is more common in faunal assemblages dating to ca. 650-300 BP (Lynott, 1981). Lynott (1981) and Hall (1982, 1990) attribute this increase to drier climates that would favor short grass prairies, the favored habitat of bison. Their interpretation, that a decrease in moisture would result in an increase in biomass, is counter intuitive and makes poor ecological sense. Evidence from adjacent areas demonstrates that bison populations are stimulated by an increase in precipitation (Dillehay, 1974; McDonald, 1981; Ferring and Yates, 1998).)

Using comparative data from adjacent areas, Lynott (1977) divided the Late Prehistoric into two phases, early and late. His early phase is characterized by sand-grog tempered ceramics, similar to the Early Caddoan period, and Scallorn, Alba, and Rockwall (Steiner) points. Lynott associates the late phase with Krieger's (1946) Henretta Focus. Similarly, Prikryl (1990) divides the Late Prehistoric into two phases (at ca. 750 BP) based on projectile point types and changes in raw material frequencies (Figure 1.11; Table 1.2). However, the number of sites with discrete assemblages is very small and the majority of Prikryl's sites are surfical with mixed assemblages. In contrast, excavations at Lake Ray Roberts (Ferring and Yates, 1997) and Lake Lewisville (Ferring and Yates, 1998), provide *in situ* examples of Late Prehistoric sites. Further east, work at additional local reservoirs (Peter and McGregor, 1988; Lynott, 1975) provide examples of *in situ* Late Prehistoric archaeological sites.

At Lake Lewisville, the majority of the sites are located along the eastern edge of the Eastern Cross-Timbers near the border with the Blackland Prairie. In contrast, the Ray Roberts occupations are all within the middle portion of the Eastern Cross-Timbers (Ferring and Yates, 1998). At Lewisville, four sites were excavated that contained occupations dating to the "Late Prehistoric II" based on radiocarbon ages alone. All four sites contained ceramics dominated by Nacona Plain and a mixture of projectile point types with Washita and Fresno points occurring with "earlier" Bonham-Alba and Catahoula points. The same mixture of arrow points is seen at Ray Roberts at sites such as 41DN103 and 41CO141 (Ferring and Yates, 1997). Altogether, the data suggests that Prikryl's division of the Late Prehistoric is not supported by *in situ* excavations (Ferring and Yates, 1998).

While Plains Village traits are more common in assemblages from the Elm Fork of the Trinity (Wendel, 1961; Ferring, 1986c), Caddoan traits are more common from sites along the East Fork of the Trinity (Lynott, 1975, 1981). At Ray Roberts, no ceramics were found with Late Prehistoric I assemblages that contained Scallorn, Alba, and small Gary points. Additionally, Late Prehistoric II occupations lack architecture, or evidence of horticulture. Thus, the Ray Roberts prehistoric data suggest regional traditions emerging largely independent of the Plains or East Texas Woodlands (Ferring and Yates, 1997; Story, 1990).

Research Strategy

In the broadest sense the focus of this thesis is the application of geoarchaeological methods and concepts to reconstruct the late Quaternary geologic history of the site locality. Establishing the geologic history allows the mammoth remains and the archaeological components to be placed in temporal, spatial, and environmental context, and provides the framework to address regional and site specific research objectives.

Secondary to establishing the geologic history, geoarchaeological methods are utilized to determine if the mammoth remains are the result of natural or cultural processes (Butzer, 1982; Schiffer, 1976, 1983) based on the presence or absence of associated artifacts and taphonomic considerations. Additionally, the geologic history of the Mill Creek drainage records the same landscape evolution as that found in the Upper Trinity River Basin during the Pleistocene Holocene transition.

In terms of the archaeological components, site formation processes are the primary focus to determine if the residues are *in situ* or disturbed. For example, both floodplain and terrace deposits are examined to determine if the materials are buried or surfical in nature. Buried components preserve spatial relationships and offer the best research potential for inferring human behaviors. The archaeological remains are also examined in terms of cultural chronology and history, both within the study are and regionally.

Methods

Archaeology

Fieldwork began with topographic mapping of the site and reestablishing the original metric grid system instituted during initial testing by Tarrant County Archaeological Society

(TCAS) in 1990. A primary datum set arbitrarily at 100 meters was established at the eastern most point of the grid system (Fig. 2.7). Vertical measurements were stated as distances above or below the primary datum. Elevation reference stakes were set for each test unit, and string and line levels were used to measure vertical levels and provenience of artifacts and features. Horizontal control was maintained by designating test units as measured from the central 0/0 grid point located in the approximate center of the site. Test unit designation represents the northeast corner of each unit, a convention established during the TCAS testing in 1990. Test units were 1x1 meter squares and were dug by 50 cm by 50 cm quads specified by cardinal directions (e.g., NE quad, SW quad, etc). All quads were dug in arbitrary 10 cm levels unless features or special circumstances were encountered. All test unit information was recorded on standardized level forms to ensure consistency of information and format. All matrix was water screened through 1/16th inch window screen. Recovered artifacts (lithics, bone, shell, etc.) were bagged with provenience information. Fire cracked rocks were drawn on level forms noting type and number then discarded. The method of excavation varied according to circumstance; generally, careful shovel skimming or trowelling was employed until significant artifacts or features were encountered, then more meticulous excavation techniques were employed. Test units were chosen based on proximity to the mammoth, surface collections, and previous TCAS testing.

Geology

A geologic reconnaissance was conducted to choose suitable profiles for description and sampling. Gully number three (Fig. 2.7) provided a good cross-section of the site and a series of profiles were described along its north side. The field profiles were described, recording standard soil properties including texture, color, structure, boundaries, and other relevant data

(Soil Survey Staff, 1974; Buol, Hole, and McCracken, 1989). After soil horizons were established , they were marked with surveyor’s tape and color slides were taken of each profile. Samples of approximately 1,000g were taken from each horizon; two samples were taken of horizons greater than 50 cm in thickness. These samples were then physically and chemically analyzed. After drying to ambient moisture and 2 mm screening to remove gravel-sized particles, the samples were riffle split into suitable sub samples. Particle size was determined on oven-dried, organic free samples. The pipette method was used to measure clay content; sand content was determined by wet sieving; silt was determined by subtraction (Gee and Bauder, 1986). The Walkey-Black method was used to measure organic carbon (Walkey, 1947). A Chittick device was used to measure carbonates less than 2 mm. A pH meter submerged in a 1:1 slurry of sediment and deionized water determined pH. The results of these analyses are reported in Appendix A.

CHAPTER 2

GEOLOGIC SETTING OF THE CARR SITE

Bedrock Geology

Cretaceous and Pennsylvanian sedimentary rocks underlie the entire Upper Trinity River drainage basin (Hill, 1901; Shuler, 1918; Barnes, 1988; Hendricks, 1957). Pennsylvanian rocks underlie a small portion of the upper part of the West Fork of the Trinity drainage, while the remainder of the Upper Trinity drainage basin developed over Cretaceous carbonate and siliciclastic rocks (Fig. 2.1,Table 2.1). The Cretaceous beds dip gently to the southeast and strike north south resulting in broad bands of sedimentary rock at the surface. Since climate is essentially uniform throughout the region, lithologic differences among these exposed rocks is the primary control on landform genesis, development of drainage networks, and sediment supply (Ferring, 2000). Subsequently, four major physiographic subdivisions are recognized from west to east: Western Cross Timbers, Fort Worth Prairie, Eastern Cross Timbers, and the Black Prairie (Hill, 1901; Fenneman, 1938; Fig. 2.2).

Hill (1887) first noted the relationship of the Cross Timbers to geologic formations that produced sandy soils that favored trees. The Antlers Fm underlies the main belt of the Western Cross Timbers. However, the Paluxy Fm underlies the eastern boundary south of the West Fork. First classified by Hill in 1891, the Paluxy consists of sand, sandstone, and sandy shales deposited in a regressing sea. Readvancement of the sea over the land deposited the Walnut Fm., a neritic facies consisting of clays, limestone seams, and shell aggregates. The sands underlying the Walnut Fm. are generally assigned to the Paluxy formation (Hill, 1901; Hendricks, 1957; Fisher and Rodda, 1967). However, Sellards (1932) states that the first 100 feet of sand immediately under the Walnut should be included with the Walnut formation based on lithological differences between the coarse red sandstone of the Paluxy formation and the finer-grained and lighter colored Walnut sands. Nevertheless, these sandstones have been deeply dissected and form broad gently sloping valleys in the study area. Within the Western Cross Timbers the most common soil is Paleustalfs (Greenwade, Kelley, and Hyde, 1977). These soils support climax vegetation of oak savanna dominated by Post Oak (*Quercus stellata)* and Blackjack Oak (*Quercus marilandica*). Grasses dominated by little bluestem (*Andropogon scoparius*) and various forbs constitute the understory vegetation (Dysterhuis, 1948).

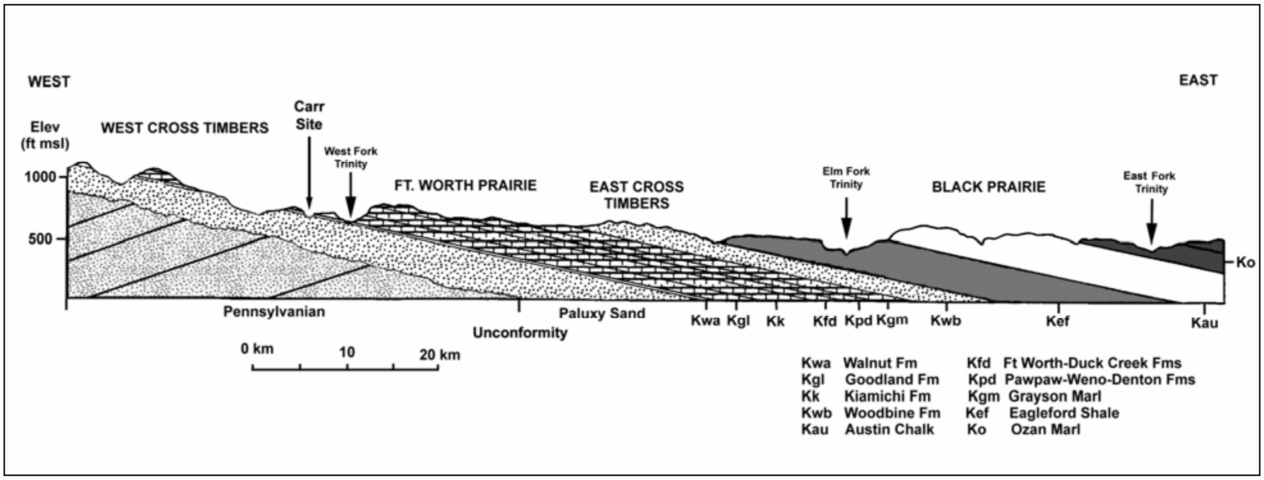


Figure 2.1 Geologic cross-section of North Central Texas. Note relationship of underlying bedrock to physiographic regions. See Table 2.1 for bedrock descriptions (modified from Ferring, 2000).

Hill (1901) defined the Fort Worth Prairie as the central portion of the Grand Prairie north of the Brazos River. This physiographic subdivision is underlain by a series of Lower Cretaceous limestones and marls beginning with the Walnut Fm. on the west and ending with Grayson Marl to the east (Fig. 2.1). Variation in the bedrock lithology creates local differences in landforms throughout the Fort Worth Prairie. Generally, the relief is gently sloping to level dip plains broken only by stream drainages (Hill, 1901). Soils show the same variation based on differences in parent material, but most of the soils are Chromusterts, Calciustolls, or Haplustolls (Ford and Pauls, 1980). Relict climax vegetation indicates coverage by mid-grasses dominated by little bluestem, *Andropogon scoparius* (77%), some tall and short grasses, and a variety of forbs (Dysterhuis, 1948).

Table 2.1 Cretaceous stratigraphy of north central Texas.

STRATIGRAPHIC UNITS	THICKNESS	LITHOLOGY
Upper Cretaceous		
Ozan Marl	500’	calcareous clay, silt and sand, montmorillonitic, blocky; weathers light brownish grey
Austin Chalk	400-600’	massive chalk with thin marl interbeds; weathers white.
Eagle Ford Group	250-300’	sandstone beds and calcareous concretions; weathers gray.
Woodbine Formation	200-350’	predominantly fine grained sandstones with thinner shale beds and members; weathers red with numerous ferruginous concretions.
Lower Cretaceous		
Grayson Marl	30-60’	marl and calcareous clay with few thin limestone beds; weathers yellowish brown.
Main Street Limestone	10-25’	fossiliferous limestone and calcareous shale; weathers light gray to white.
Pawpaw Formation	15-50’	sandstones with shale inter-beds, many ferruginous concretions; weathers brown.
Weno Limestone	60-130’	marl and limestone, many concretions, fossiliferous; weathers gray.
Denton Clay	20-45’	calcareous shaley clay and thin limestones; weathers brownish gray.
Fort Worth Limestone	25-35’	massive and burrowed limestone with thin marl interbeds, fossiliferous; weathers yellowish brown.
Duck Creek Formation	50-100’	fossiliferous limestone with thin marl interbeds; weathers yellowish brown.
Kiamichi Formation	20-50’	marl and thin limestone with a few thin calcareous sandstones; weathers dark gray to brown.
Goodland Limestone-Walnut Clay	30-90’	massive and nodular limestone with beds of marl and clay; weathers dark gray to brown.
Antlers Sand	500-650’	sand, clay and conglomerate, increasing carbonates to the south; weathers yellowish brown.
Paluxy Sand	40-50’	sandstone, mudstone, and limestone, friable to calcite cemented; weathers yellowish brown, red brown.

The Eastern Cross Timbers is a belt of moderately dissected low hills that corresponds to the narrow exposure of the Woodbine sandstone. As a result, the Eastern Cross Timbers is narrower than the Western Cross Timbers. The Woodbine consists of sandstones, shales, and sandy shales that provide the parent materials for Paleustalfs, the most common soil type in this subdivision (Ford and Pauls, 1980). These soils support climax vegetation similar to the Western Cross Timbers of oak savanna dominated by Post Oak (*Quercus stellata)* and Blackjack Oak (*Quercus marilandica*). Grasses dominated by little bluestem (*Andropogon scoparius*) and various forbs constitute the understory vegetation (Dysterhuis, 1948).

The eastern most Black Prairie subdivision is underlain by the Upper Cretaceous rocks of the Eagle Ford Fm., the Austin Chalk, and the Ozan Marl. The Eagle Ford is an easily eroded calcareous shale yielding low relief valleys. The Austin Chalk is a white limestone that is more resistant to erosion and forms a westward facing cuesta called the White Rock Escarpment. The Ozan Marl underlies the main belt of the Black Prairie and is sculpted into gently rolling uplands and small depressions known as “hog wallows” (Hill, 1901). The Black Prairie is named for its thick black calcareous and clayey soils (Hill, 1901; Coffee, Hill, and Ressel, 1980). These soils support a mixed grass prairie system with some oak and cedar along drainages. Generally, the relief is gently rolling with few streams, except for those through flowing streams with headwaters to the west (Hill, 1901).

Drainage Patterns

Hill (1901) was the first to note the “adolescent” nature of the Trinity River having formed in the upland plains intervening between the older drainages of the Red and Brazos Rivers (Fig. 2.2). The Clear Fork, West Fork, Elm Fork, and East Fork merge to form the Trinity

River in North Central Texas. The West Fork of the Trinity is a consequent stream of the Upper Trinity River Drainage Basin that is superposed over the resistant Woodbine and Austin Chalk (Ferring, 2000). Further east, the Elm Fork and East Fork of the Trinity are subsequent drainages that follow regional bedrock dip with elongated dendritic patterns.

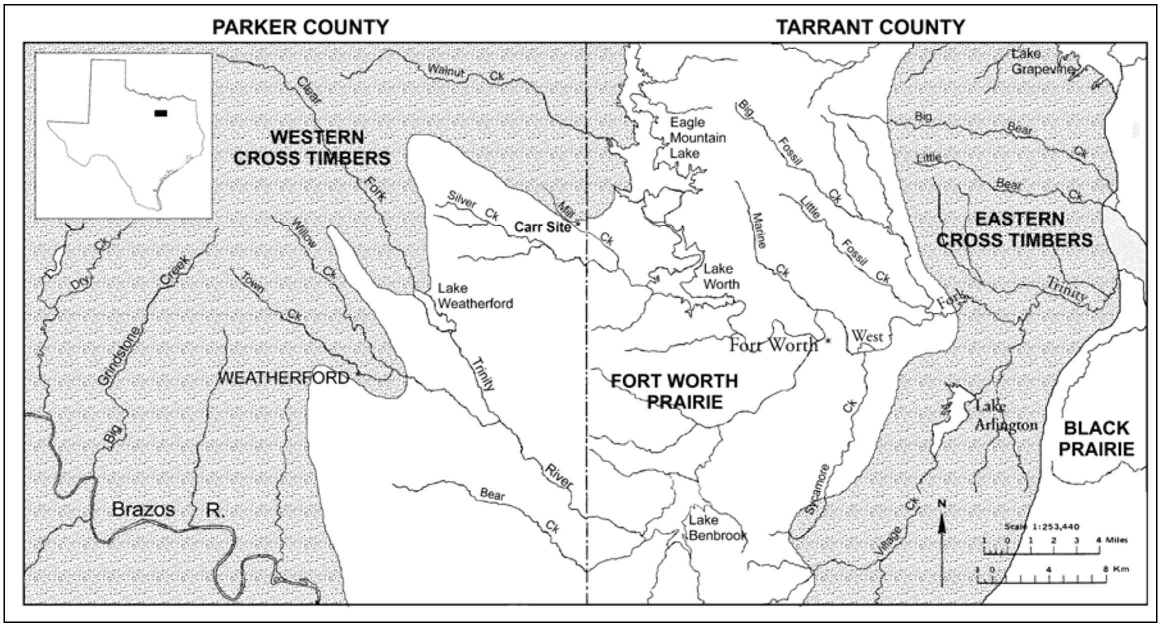


Figure 2.2 Physiographic regions and drainages of North Central Texas. Note physiographic changes from west to east and north to south trends resulting from underlying bedrock controls. See Figure 2.1, Table 2.1 for bedrock descriptions.

In Parker County, all the tributary streams drain southeast into the West Fork of the Trinity in Tarrant County. The dominant stream is the Clear Fork of the Trinity, a subsequent stream following bedrock dip southeast through Parker County. However, stream flow changes to the northeast at the contact between the Walnut and Weno Limestone Formations in Tarrant County. (Fig. 2.2). This change may represent the effect of differential resistance to erosion since the Weno Fm. is mostly clay and soft limestone. Alternatively, the change may represent a more complex regime of stream capture.

The Carr site is located on Mill Creek a perennial effluent stream that is a tributary of Silver Creek. Both streams are resequent streams of the West Fork of the Trinity River (Bloom, 1991). The Mill Creek basin drains an area of approximately 4,388 acres (1773 hectares). Stream down-cutting into softer Paluxy sandstone creates a dendritic drainage pattern with a main channel that runs approximately 6.5 miles (10.46 kilometers) with a local relief of 625 feet (190.5 meters)yielding a fairly steep channel gradient of 49 feet per mile (1.43 meters per kilometer). It is a third order stream using Strahler's 1964 system of classification. The Mill Creek channel is essentially straight with a bedrock channel in the upper reaches where channel gradients are steeper, and in the lower reaches the channel is alluvial (Figs. 2.2, 2.3).

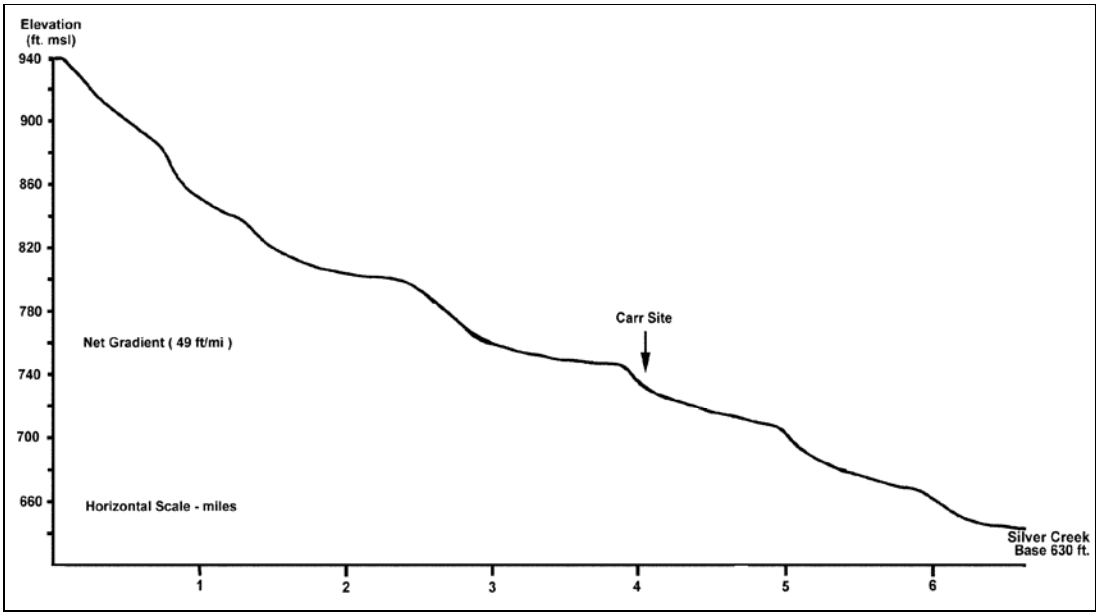


Figure 2.3. Mill Creek channel profile. Note steeper gradient in upper reaches of channel indicating headward erosion. Upper reaches dominated by bedrock channel, with change to alluvial channel at the 3.5 mile interval.

Structure and Tectonics

Just east of the study area, there is an angular unconformity between the Pennsylvanian and Cretaceous strata, and the beds of the two systems dip in almost opposite directions (Fig.

2.1; Hendricks, 1957). Cretaceous beds dip gently (30-40 feet per mile) to the east-southeast, while Pennsylvanian strata dip more steeply (70-120 feet per mile) to the northwest (Scott and Armstrong, 1932). The pre-Cretaceous surface suggests a plain that Hill (1901) referred to as the Wichita Paleoplain. Mesozoic uplift and erosion created the truncated edges of Pennsylvanian beds on which the Cretaceous beds are deposited (Hendricks, 1957). There is some evidence of several small anticlinal structures in the Pennsylvanian system northeast of Lake Mineral Wells and south of the Brazos River in Parker County (Russell, 1953). The structure of the Cretaceous beds within the study area consists of gentle dip to the southeast. However, to the northeast Cretaceous rocks are deformed into the Sherman syncline and the Preston anticline (Ewing, 1991).

Regarding tectonics, this region is understood to have been inactive since the late Paleozoic Ouachita orogeny (Davis, Pennington, and Carlson, 1989). Generally, faults in Cretaceous rocks are not common, and no mapped faults are noted within the study area (Barnes, 1988). South of the study area, mapped faults are found south of Dallas associated with the Balcones Escarpment (Barnes, 1988). To the east, Ferring (1993b) reported a north-south trending fault in a Woodbine rock escarpment overlooking the Elm Fork of the Trinity; as well as, numerous unmapped faults within the Austin Chalk near Dallas. Further northeast, Cretaceous faults are associated with the Sherman syncline and Preston anticline (Ewing, 1991). Similar to Cretaceous rocks, no mappable faults are noted in Pennsylvanian rocks within the study area. However, small-scale faults do occur in the Pennsylvanian beds south of the Brazos River associated with anticlinal structures (Hendricks, 1957).

Sedimentary Environment

The importance of the sedimentary environment in archaeological investigation is addressed by a number of researchers (Butzer, 1982; Ferring, 1992, 1986a; Rapp and Hill, 1998; Schiffer, 1996; Waters, 1992). For Butzer (1982), "the first objective in site analysis is to examine the sedimentary matrix of the site and so to identify the related predepositional environment." Sedimentary or depositional environments are the locations where sediments accumulate, and provide the matrix that surrounds all artifacts, features, and ecofacts. Additionally, these environments provide soil parent material, evidence of past environments, and site formation histories. Butzer (1982) and Waters (1992) identify a spectrum of depositional environments; five environments are found at the Carr site: alluvial, colluvial, eolian, slope, and spring sedimentary environments.

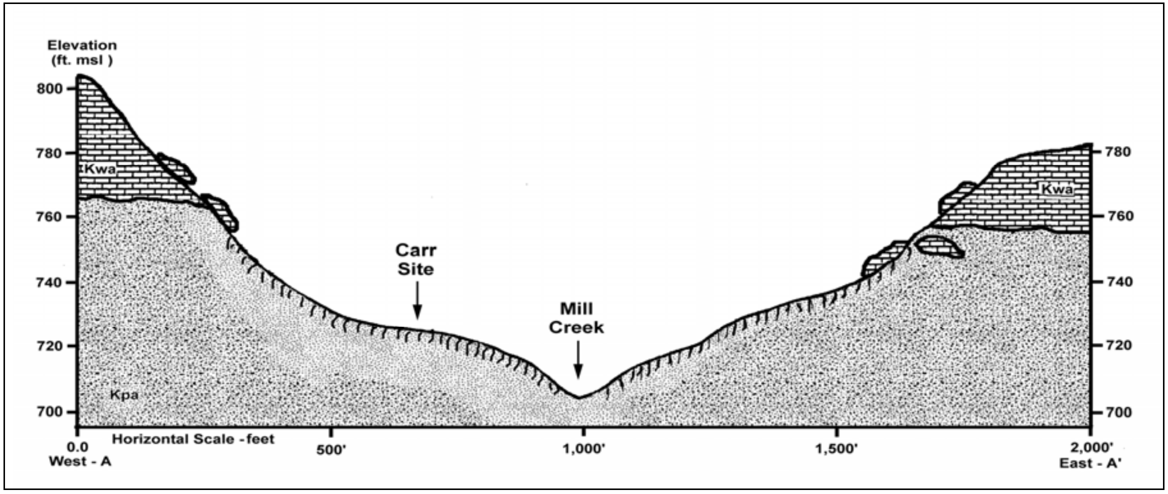


Figure 2.4. Topographic and bedrock stratigraphic cross-section of Mill Creek Valley showing bedrock control of valley formation. Note that the Walnut Formation (Kwa) forms the ridge system and the softer Paluxy Formation (Kpa) is the valley forming bedrock.

Butzer's slope or topographic matrix determines patterns of soil and biotic distributions that have important implications for prehistoric activities for acquiring food, fuel, and other materials. Figure 2.4 shows a topographic cross section of Mill Creek at the site locality. The valley form is concavo-convex with erosional topography found in humid mid-latitudes (Butzer, 1982). The Carr site is located on the west side of the valley. The upper segments of the slope profile are convex with a slope angle of 50^0 from the crest of the slope to the 760’ contour interval. On the topographic map (Fig. 2.5), note the spur shaped hill on the west with contour lines bulging convexly outward. Together, the slope profile and contour map can be combined to describe the three-dimensional surface of the landscape (Fig. 2.6). The resulting morphology is important because contour curvature controls routes taken by water, sediments, and solutes downslope (Summerfield, 1991).

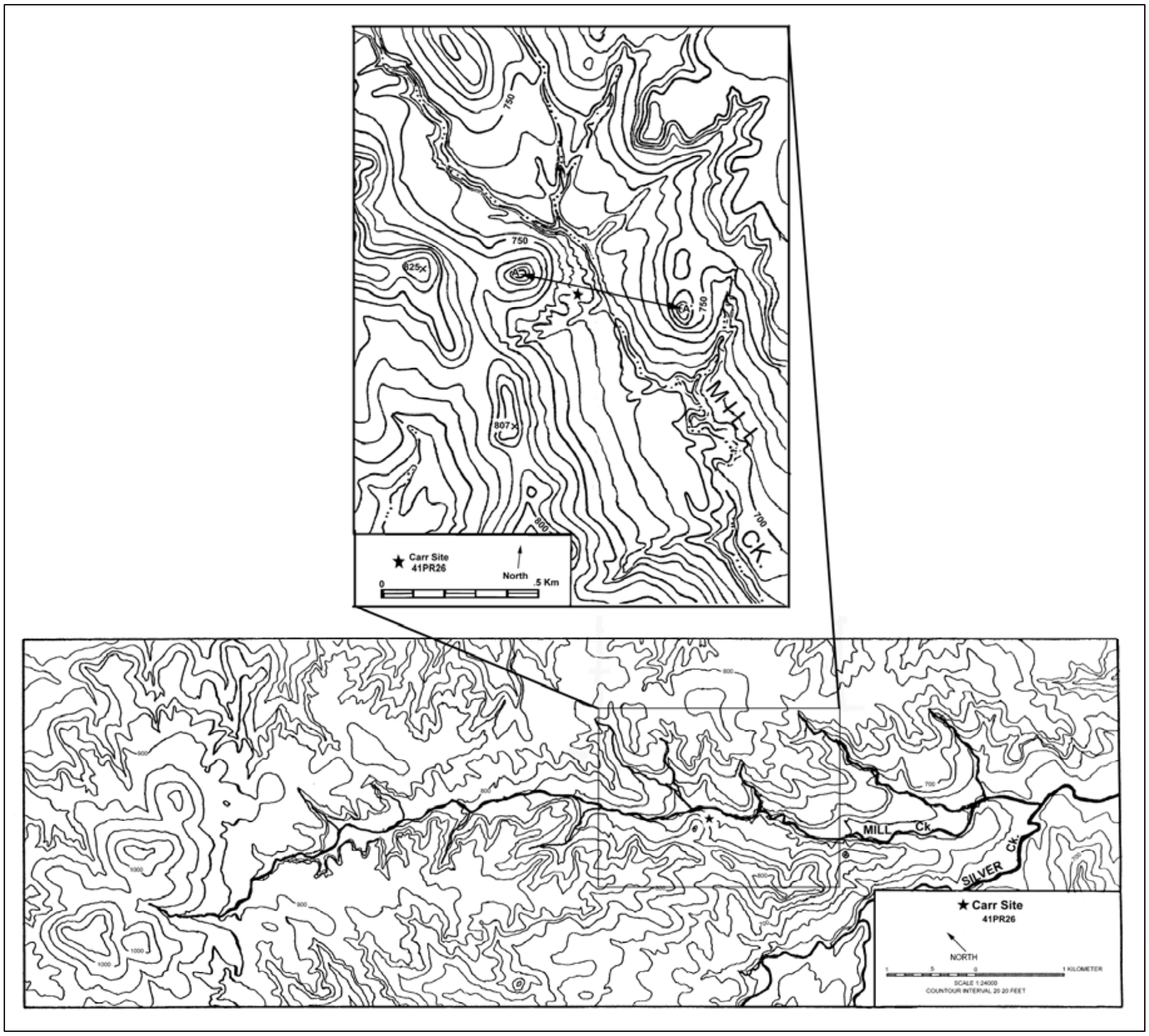


Figure 2.5 Topographic map of Mill Creek drainage. Note the essentially straight channel morphology and site location. On inset map note the site location at the foot of spur shaped hill, narrow stream channel at constriction point between two ridge features. Line indicates transect for Figure 2.4, see Figure 4.7 for detail of inset.

The Walnut Fm., an important source of clays, calcium carbonate, and shell aggregates, underlies the upper segment of the slope. Soil creep and mass wasting largely control slope morphology, as evidenced by large blocks of Walnut bedrock and colluvium. Increasingly finer materials are moved down slope as water is spread laterally as it flows downhill (Fig. 2.4).

Along the 740-foot contour interval intermittent contact seep springs occur on the east and south side of the hill. Here the contour lines bulge convexly outward creating a “nose” that spreads water laterally downhill (Bloom, 1978). At this point the slope angle diminishes to 40^0 and becomes more concave and is largely controlled by sheet wash and erosion. Along the seep spring line the soil A horizon has been removed exposing either underlying Bt horizons or bedrock. Heads of deeply dissected gullies begin approximately ten feet below the line of seep springs exposing the underlying bedrock to further erosion (Fig. 2.7). Underlying bedrock for this section is the Paluxy Fm., poorly cemented and friable sandstone. The formation provides sand, silt, and clay-sized particles, but yield of sand particles is about 75% of most samples. The sands are well sorted to very well sorted and composed chiefly of quartz. Iron is present as both hematite and limonite, as well as oxides of calcium and magnesium (Fisher and Rodda, 1967).

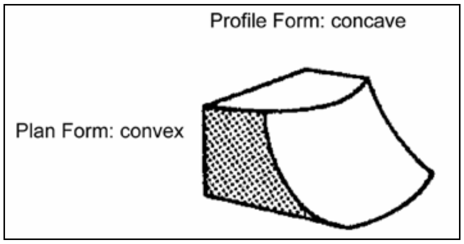


Figure 2.6 Three-dimensional surface of landscape at the Carr Site the resulting morphology is a combination of slope profile and contour map (Birkland, 1999).

The lower section of the slope profile is a fairly level to gently sloping surface becoming convex near the active channel. This segment is dominated by alluvial processes, and is underlain by vertical and lateral accretion deposits of fine-grained alluvial sediments. These sediments carry the signature of both Walnut and Paluxy Fm. materials from upstream and upslope weathering processes. Clay, abundant calcium carbonate, and gravels consisting mostly of shell aggregates dominate sediments adjacent to the channel. Under the level portion of the lower slope profile sediments are sandier with iron oxides and lack calcium carbonate.

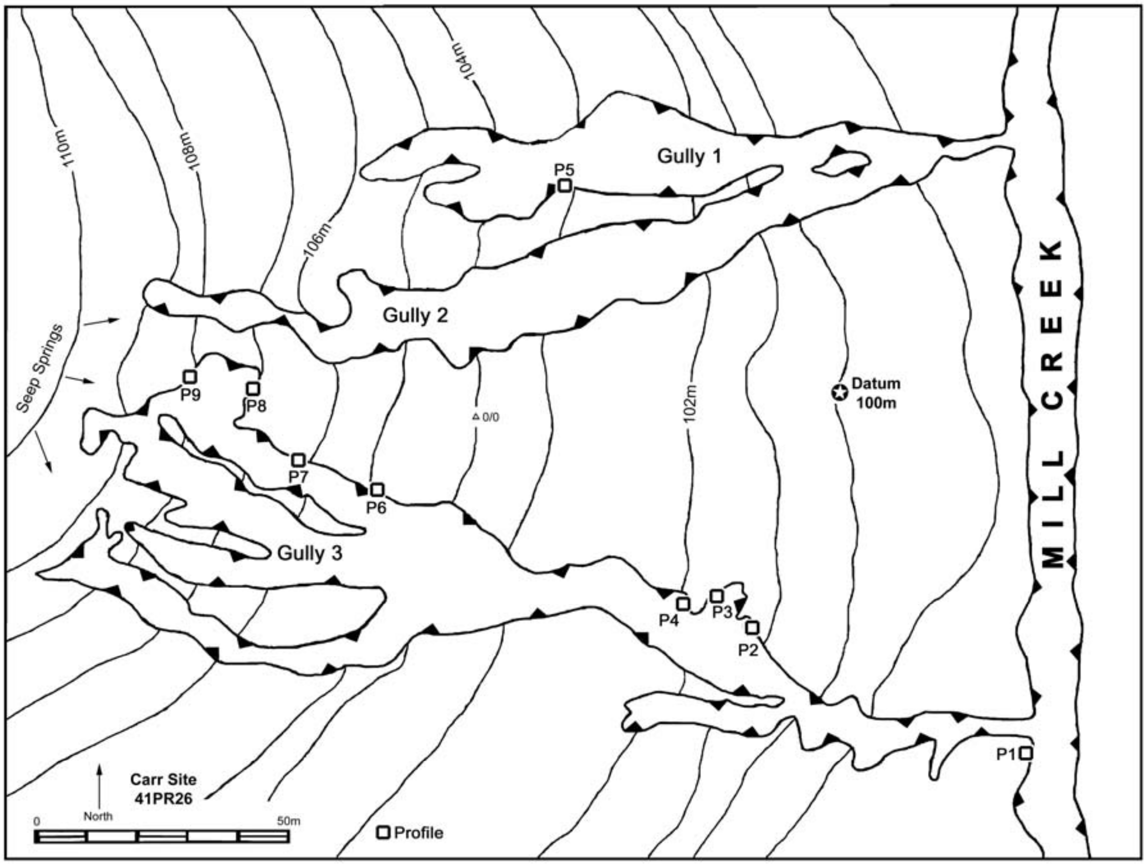


Figure 2.7 Site topographic map showing location of soil profiles. Note seep springs at the head of gully system and changes in elevation across site.

Eolian processes within the region consist of irregularly shaped mounds along streams or upland divides as evidenced by the Dodd Pit and George King sites (Ferring, 2000). Generally, these features are found on the north side of drainages that are the source of fine-grained sands.

At the Carr site, no mound features were noted, but over-thickened sandy A horizons were noted in the northern portion of the site. This may be the result of Altithermal climatic changes or more recent land clearing activities.

In sum, the sedimentary environment at the Carr Site is constrained by bedrock lithology and alluvial and colluvial processes. Differences in the bedrock lithologies of the Walnut Clay and Paluxy Formations have controlled landform development in terms of slope morphology and soils. Alluvial processes have shaped the landscape through erosion and deposition. Extensive erosion is evidenced by a large gully system across the site (Fig. 2.7). Seep springs near the head of this gully system contribute to the erosion as well. In terms of deposition, colluvial sediments dominate the sides of the valley and vertical accretion alluvial deposits along channel margins. Eolian processes are not well documented and contribute only to a minor extent to sediment deposition.

Soils

Regional Soils

Since climate in this region is essentially uniform, the fundamental geomorphic and edaphic control is differences in bedrock lithology (Ferring, 2000). As previously discussed, four major upland physiographic regions are attributed to these differences: Western Cross Timbers, Fort Worth Prairie, Eastern Cross Timbers, and Black Prairie (Hill, 1901, Fenneman, 1938). The Carr Site occupies a position that is ecotonal between the Western Cross Timbers and the Fort Worth Prairie (Fig. 2.2). Soils of the Western Cross Timbers correlate with the Windthorst-Duffau-Weatherford soil association. This association is gently sloping to sloping with deep loamy to sandy soils that have formed over the weakly cemented sandstone Paluxy Fm. Of minor extent is the Yahola soil series on nearly level to gently sloping bottom lands where deep loamy or clayey soils have formed in calcareous, loamy alluvial sediments (Greenwade, Kelley, and Hyde, 1977).

In contrast, the Fort Worth Prairie is identified with the Aledo-Venus-Bolar soil association (Ressel, 1981). These soils are gently sloping to sloping and undulating with very shallow to deep loamy soils over limestone or clay loam. A subordinate member of this association is the Maloterre series, which consists of very shallow calcareous gravelly loamy soils on uplands. Slopes are gently sloping to steep and the underlying parent material is the Walnut Clay Fm.

Locality Soils

Figure 2.8 illustrates the soil series present at the site locality. These series demonstrate the importance of slope and parent material on soil formation. The Maloterre series occupies the highest slope position on ridgetops surrounding Mill Creek. These soils are very shallow (17cm A horizon) and formed in indurated limestone of the Walnut Fm. Runoff is rapid, and in places the underlying bedrock is exposed. The Duffau-Orthents and Windthorst series occupy mid-slope positions and formed in the soft sandstones of the Paluxy Fm. These soils are characterized by thin A horizons and thick well developed Bt horizons. In contrast, the Yahola series formed in alluvial sediments and occupies the lowest slope position along the Mill Creek drainage. Rapid rates of sedimentation result in weakly developed A horizons and thick Ck horizons not found in the upland soils. Bedding planes and other sedimentary structures are often preserved (Greenwade, Kelley, and Hyde, 1977).

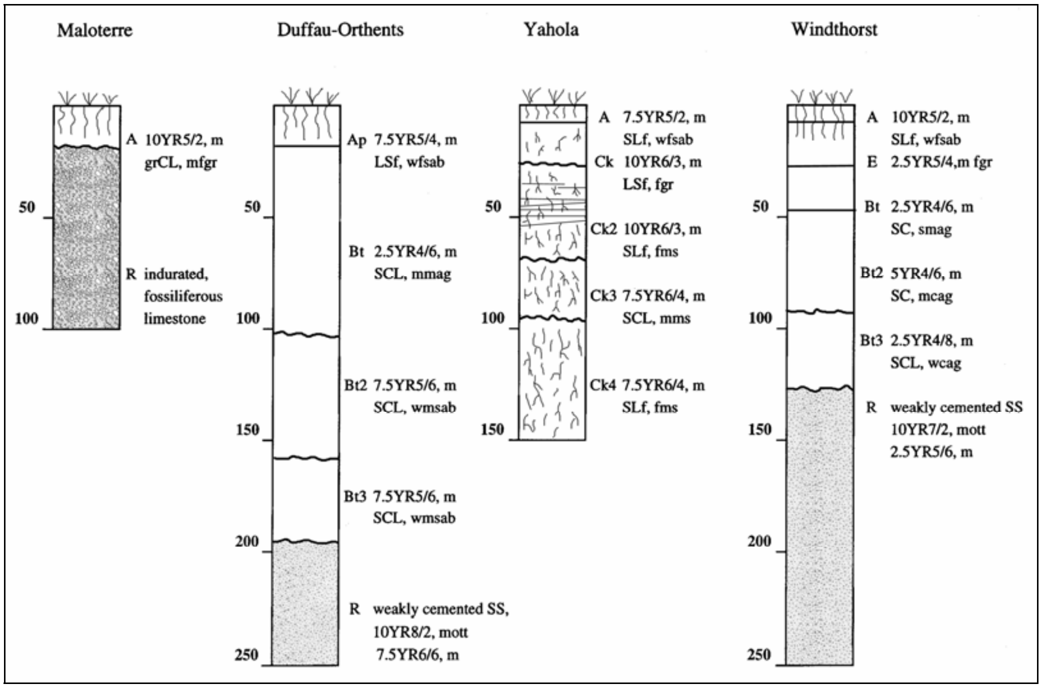


Figure 2.8 Soil series sequence present at the site locality showing parent material and slope position relationships. Maloterre is topographically the highest and underlain by the Walnut Fm. Duffau and Windthorst are mid-slope and underlain by the Paluxy Fm. Yahola is along floodplains formed in sediments derived from both formations.

Table 2.2 Bedrock-soils relationships, Parker County, Texas. Soil orders are listed in relationship to underlying bedrock and slope position. The Maloterre series is the highest and is found along hills and ridges. (* includes both Duffau and Weatherford soils)

Soil Series	Bedrock Unit Formation (s)	Lithology	Soil Taxon	Areal %
Maloterre	Walnut Clay	LS, shell masses, clay	Lithic Ustorthents	.5
Duffau	Paluxy	SS, clay	Udic Paleustalfs, Orthents (eroded)	13.5*
Weatherford	Paluxy	SS, clay	Ultic Haplustalfs	*
Windthorst	Paluxy	SS, clay	Udic Paleustalfs	14.5
Yahola	alluvium	calcareous, loamy	Typic Ustifluvents	1.5
			Total %	60

Stratigraphy of Carr Site

The Walnut and Paluxy Fms. are the underlying bedrock units at the Carr Site and provide the primary source of sediments released by erosion and redeposited at the Carr site. Since Mill Creek is constrained by these formations, and since bedrock lithology is the primary factor influencing regional morphogenesis, the result is a fairly uniform parent material for landform construction. The bedrock and sediments are divided into three stratigraphic units based on two criteria. First, morphostratigraphic units (terrace and floodplain) are defined; secondly, nine geologic profiles allow further assessment based on parent material, textural differences, presence of carbonate or ferromanganese concretions, and buried soils. (Fig. 2.4, 2.9, Profiles 1-9, Appendix A). Stratigraphic Unit I is a buried Pleistocene landform; Unit II is the current Holocene surface, and Unit III represents the upland ridge system that surrounds the Mill Creek drainage.

Stratigraphic Unit I

Stratigraphic Unit I is topographically the lowest stratum and is sub-divided into two morphostratigraphic units, Ia (terrace) and Ib (flood plain). Unit Ib is 1.9 meters below the current floodplain of Mill Creek and reflects a fining upward sequence of sediment from gravelly sandy loam to clay loam with a buried soil (Fig.2.9, Ap. A Profiles 2,3). In Profile 3, the upper boundary is an erosional unconformity with the overlying IIb unit, and is the top of a truncated Btckb horizon. There is a marked textural change from clay loam to loam in the overlying unit. In Profile 2, the upper boundary is the top of the Btkb horizon. This buried horizon has a distinct line of carbonate concretions at the top of the profile, is topographically higher (60 cm), and represents a portion of the original horizons overlying the Btckb horizon in Profile 3. Profiles 3 and 2 reflect lateral changes in the expression of soil characteristics and varying degrees of erosion. The lower boundary of both units is the deepest bedrock surface or gravel beds below the floodplain. Unit I terminates abruptly down slope where the lateral boundary is recent inset floodplain sediments (Profile 1, Unit IIc). Upslope the lateral boundary could not be clearly defined due to poor exposures, but inspection of adjacent gullies suggest deeper burial or truncation approximately 15 meters up slope from Profile 3. Distinguishing characteristics of this unit include a buried soil, common large carbonate concretions, abundant vertical crayfish burrows, and faunal remains of a mammoth.

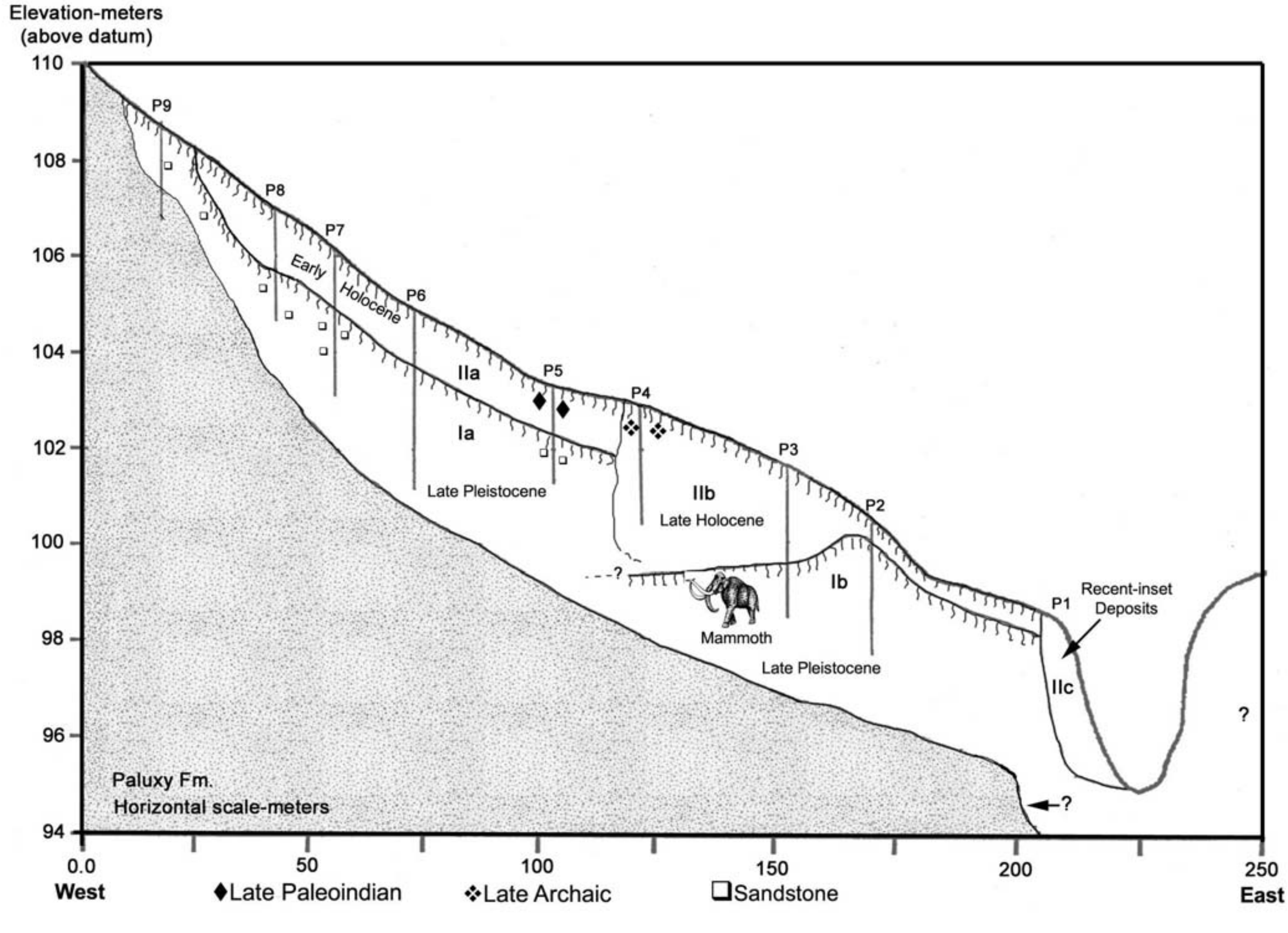


Figure 2.9 Topographic and stratigraphic profile of site locality showing profile locations and depth. Chronological and stratigraphic relationship of Ia and Ib remain problematic.

A prominent feature of Unit Ib is a buried soil horizon (Btckb, Profile3) the upper boundary is clear and wavy indicating an eroded surface. A well-expressed soil profile, as evidenced by increased clay content, a thick clay film on ped faces, and concretions of $CaCO_3$ and FeMn, represent a mature soil prior to subsequent erosion and burial. When compared to the overlying Btck horizon, the buried Btkcb horizon shows a significant increase in clay (8%), a coarser distribution of sand, and an increase in silt (Table A 2.3, 5.3). Additionally, in the overlying Btck horizon few rounded carbonate concretions are present ranging from 2-8 mm; while the buried soil contains carbonate concretions ranging in size from 30-60 mm, with larger concretions lower in the profile associated with a change in texture from clay loam to sandy loam. Using the classification system for carbonate stages developed by Gile (and others, 1981), the carbonate development is stage 2. Ped faces are slightly reactive to HCl, but some ped interiors are non-reactive suggesting that carbonates continue to be leached and may be the result of recent exposure from erosion (Table 2.3, 2.4).

Slope position and proximity to the drainage channel control accumulation of carbonates at the site. Sources of the carbonate are atmospheric and limestone parent material, especially the Walnut Fm., and possibly the Goodland Fm. which has been completely removed by weathering (Table 2.1). Rabenhorst (and others 1991) note that if the parent material is limestone, the source is obvious. However, Reeves (1970) in his study of the Southern High Plains sees accumulation of carbonates as a function of the extent of infiltration of water following the accumulation of calcareous loess, regardless of parent material. Similarly, Birkland (1999) stresses the importance of atmospheric carbonate over parent material based on dust trap data from Las Cruces New Mexico (Ruhe, 1967; Gile and others, 1981). Nevertheless, the abundance of carbonates at the site is best understood in terms of slope position and proximity to the paleo-channel as indicated by gravel deposits in Profile 2.

As discussed in the sedimentary environment section, contour curvature controls routes taken by water, sediments, and solutes down slope (Summerfield, 1991). The soils underlying terrace surfaces (Profiles 4-9) are devoid of carbonates indicating leaching and lateral movement of solutes downslope to the flood plain. Moreover, soil profiles underlying the present flood plain demonstrate a striking increase in carbonates (Profiles 2-3, Table 2.3, 2.4) as compared to the terrace soils. Additionally, flood plain position affects rates of accretion and carbonate accumulation; high rates of accretion tend to decrease carbonates and low rates increase carbonate accumulation (Leeder, 1975). Evidence of channel gravels in Profile 2 suggests that the paleo-channel was migrating down slope (east); as the channel migrated, the accretion rate would diminish allowing an increase in carbonate accumulation.

In addition to the well-developed buried soil, Unit Ib contains the faunal remains of *Mammuthus columbi*. Excavation of the mammoth revealed that it was deposited on a gravelly loam surface. Sieve size analysis of the gravels (Fig. 2.10) revealed a distribution identical to the 2Bkcb horizon in Profile 2 as well as the same elevation (98.98m). *Mammuthus columbi* is Late Pleistocene in age, ranging from 130-10 ka (Agenbroad, 1984). Identification as to species was based on a comparison of the maxillary teeth with specimen data from the Colby Mammoth Site (Winkler, 1998, personal communication; Frison and Todd, 1986). It is considered to be an adult using Laws Age Class XVII or XIX, which would make it 30-32 African elephant years old (Winkler, 1998, personal communication; Laws, 1966). Without radiometric dating of the faunal remains, isotopic analysis of carbonates, or associated artifacts, assigning an age to Unit Ib remains problematic. Yet, since the mammoth was recovered within a well developed buried soil a minimum age of 12-10,000 years is indicated, but could be as great as 130 ka.

Table 2.3 Floodplain units > 2mm fraction. Floodplain Unit Ib > 2mm fraction consists of carbonates and angular shell fragments from soil samples. However, large carbonate concretions ranging from 3-6 cm are present lower in the profile.

Profile	Unit	Elevation	Depth (cm)	Horizon	Description	Size Range
3	Ib	100.49	210	Btkcb	pedogenic carbonate, angular	1-2 cm
	Ib		250	Btkcb	pedogenic carbonate, angular-rounded	2-7 mm
	Ib		270	Btkcb	pedogenic carbonate, angular-rounded	2-6 mm
	Ib		295	Btkcb2	ss, sub-angular	2-5 mm
	Ib		310	Btkcb2	ss, sub-angular-rounded	2mm- 1cm
	Ib					
2	Ib	100.49	55	Btkb	pedogenic carbonate, rounded	2-3 mm
	Ib		75	Btk2b	pedogenic carbonate, rounded	2-5 mm
	Ib		95	Btk3b	pedogenic carbonate, rounded	2-5 mm
	Ib		115	Btk3b	pedogenic carbonate, rounded	2-5 mm
	Ib		130	Btk3b	pedogenic carbonate, rounded, 20%, shell frags. 80%	2-5 mm, carbonates, 2-7 mm, shell frags.
	Ib		144	Bkb	pedogenic carbonates, rounded-flat, 40%, flat-angular shell frags. 60%	2-8 mm, carbonates, 2-5 mm, shell frags.
	Ib		170	2Bckb	pedogenic carbonates, rounded-flat, 5-8%, angular shell frags., few complete	2-8 mm, carbonates, 2 mm- 1.5 cm, shell frags.
	Ib		228	3Bck2b	pedogenic carbonates, rounded-flat, 5-8%, angular shell frags., few complete	2-8 mm, carbonates, 2 mm-2.5 cm, shell frags.
	Ib		250	4Bck3b	pedogenic carbonates, rounded	2-3 mm

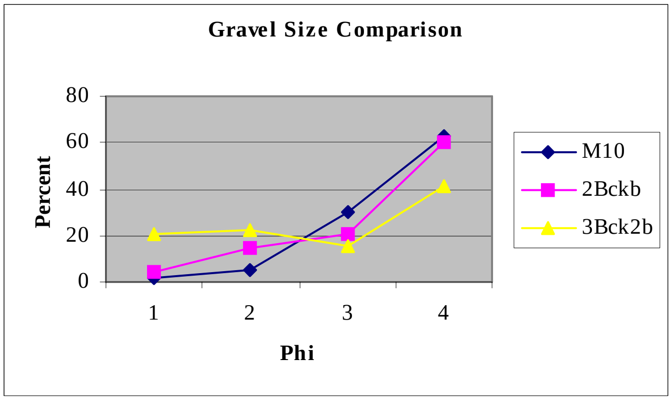


Figure 2.10, Gravel sieve analysis of Unit Ib gravels with M10 gravels underlying mammoth ribs. Note similarity of distribution of M10 and 2Bckb horizon.

Unit Ia

Unit Ia underlies the current terrace surface at the site location; although it is not as complex as Unit Ib, the mature nature of the buried soil suggests a Late Pleistocene age as well. Similar to Unit Ib, the upper boundary of this unit is the truncated surface of a buried soil (Btb, Profiles 5-9). The lower boundary is the deepest bedrock surface or possibly gravels in the lower section of the terrace. The upslope lateral boundary is the exposed Btb horizon on the surface at the head of the gully system. The upper and lower boundaries are clearly expressed in Profile 9 where top of the Btb horizon is transitional to an A horizon, and the underlying Paluxy Fm.is exposed by heavy erosion in gully 3 (Fig.2.7). Downslope the lateral boundary can be clearly traced to within two meters of Soil Profile 4, where both Unit Ia and IIa terminate abruptly. See discussion of Unit IIb for explanation.

In the field, the distinguishing characteristics of the buried soil are a marked increase in rubification, structure, and horizon thickness when compared to the overlying Bt horizon in Unit IIa. Using the Buntley Westin (1965) color index, the buried Btb has a value of 64 as compared to 24 for the overlying Bt indicating a soil significantly older than 10 ka (Birkland, 1999). Also, differences in horizon thickness illustrate the great age of the buried soil; the Btb is in excess of 2 meters as compared to .84 meters of the overlying Bt in Unit IIa. Both indices denote a very mature soil.

Unlike the buried soil in Unit Ib, the boundary between the two units is clear and smooth without clear evidence of severe erosion. However, no evidence of an A horizon could be detected suggesting that erosion stripped the terrace of A horizon materials or the materials were significantly reworked with subsequent deposition of Unit IIa sediments. Truncation by erosion of the uppermost part of paleosols characterizes most paleosols (Retallack, 1988). Evidence of erosion is suggested by variation in slope gradient of the buried unit; the buried unit has a fairly steep slope gradient of 10 cm/meter as compared to 7cm/meter for the existing slope surface. The slope gradient of the upper section of the buried surface has a slope gradient of 17 cm/meter. The steeper upper part of the slope would lead to instability and erode fairly rapidly from increased sheet flow and rain splash (Summerfield, 1991).

Colluvial Processes

The presence of angular sandstone fragments in Profiles 5-9 indicate a sedimentary environment dominated by colluvial processes associated with a higher slope gradient. Tables 2.3, 2.4 compare the distribution of the greater than 2 mm fraction for soil profiles 5-9 of Units Ia and IIa. Unit Ia has an average clast size of 3.82 by 3.14 centimeters as compare to 0.98 by 0.54 centimeters for Unit IIa. The largest angular clasts are in the upper segment of the slope as seen in profiles 9-7, while clast size decreases and morphology changes to sub-angular and rounded in profile 5.

Concretions

Unlike Unit Ib, the high slope gradient and sandy loam parent material allows ground water to move laterally downslope resulting in carbonates being completely leached from the soil horizons (Tables 2.3, 2.4). FeMn stains and concretions are present in some profiles (8,5) but are not evenly distributed along the slope. Fluctuating soil moisture content produces alternating oxidizing and reducing conditions that produce redoximorphic features, such as mottles and nodules of Fe and Mn. Mottles are present with ped interiors indicating high oxidizing conditions (2.5YR4/8) and ped faces, cracks, and root casts appear more reduced (7.5YR6/8 to

Table 2.4 Terrace units > 2 mm fraction. Compares the >2mm fraction for profiles 5-9 for Units Ia and IIa based on slope position. Note changes in clast size and morphology downslope.

Profile	Unit	Elevation	Depth cm	Horizon	Description	Size Range
9	Ia	108.72	110	Bt3	ss, angular frags.	2-5 mm
	Ia		120	Bt3	ss, two angular, tabular	10x9 cm, 9x7.5 cm
8	Ia	106.9	130	Btcb	ss, two angular, tabular	1.5x1 cm, 3x2.5 cm
7	II a	106.27	45	Bt2	ss, one angular, tabular	1.5x1 cm
	Ia		135	Btb	ss, one angular, tabular	4x3 cm
	Ia		165	Bt2b	ss, one sub-angular	2.5x2 cm
	Ia		210	Bt3b	ss, one angular domed shaped top, one angular, tabular	6.5x5.5 cm, 4.5x3.3 cm
	Ia		260	Bt4b	ss, sub-angular	5.5x4.0 cm
	Ia		285	Bt5b	ss, sub-angular	4.5x3.3 cm
5	II a	103.32	5	A	ss, sub-angular-rounded	2-3 mm
	II a		15	A	ss, sub-angular to rounded	2mm-1 cm
	II a		25	A2	ss, sub-angular to rounded	3mm-6 mm
	II a		35	A2	ss, sub-angular	2-5 mm
	Ia		105	Btb	ss, sub-angular to angular	2-5 mm
	Ia		120	Btb	ss, sub-angular to angular	2-6 mm

10YR6/2). When present FeMn stains and concretions are found only in ped interiors indicating that when formed the soils were seasonally drained and oxidizing conditions were obtained (Birkland, 1999). Absence of FeMn stains and concretions in Profiles 7 and 6 suggest soil moisture content was high enough at these locations for the Mn to remain in solution and subsequently removed as ground water moved laterally downslope. Removal of carbonates and Mn downslope can be seen in the increase of concretions in Profiles 4 and 3.

Sand Sieve Analysis

As the slope gradient decreases downslope colluvial processes could not be easily detected in the field and suggest a more alluvial sedimentary environment downslope of Profile 5. In order to define differences in sedimentary environments, sand sieve analysis was used to compare Units Ia and IIa. Sand-size distribution of the Bt and Btb horizons were compared with the current A horizon materials (Tables A 3.2-3.9). The analysis revealed a remarkable similarity of parent materials for Unit Ia and the overlying Unit IIa (Figure 2.11, Table A 4.1). Very fine-grained sand dominated the samples with 96% of the distribution falling in the Phi sizes of 3-4. As a result, no real difference in sedimentary environments could be established using sand-sieve analysis. Sand size distribution for the underlying Paluxy Fm. was slightly coarser with 96% of the distribution falling in the Phi size of 2-3 for the lighter colored sandstones that are the dominant bedrock at the site locality (Table A 3.10).

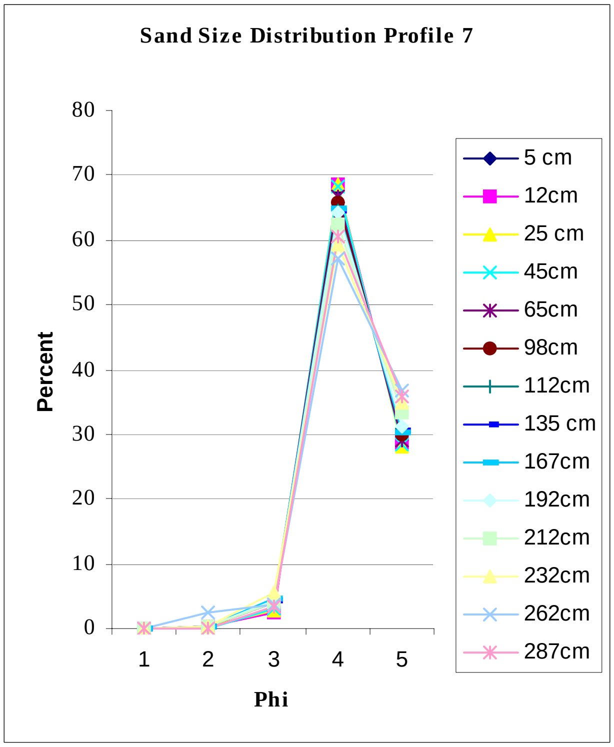


Figure 2.11 Sand size distribution for all samples in Profile 7 demonstrates the remarkable homogeneity of parent materials of terrace soils. The boundary between Unit Ia and IIa is between 98 and 112 cm. Note the homogeneity of sand size distribution down profile.

Clay-Free Sand and Silt

Since sand sieve analysis did not reveal a parent material difference, the soil texture was recalculated for clay-free silt and sand, which did reveal a disconformity between Unit Ia and IIa (Table A 5, Fig. 2.12). The Btb horizon in Profile 6 showed an increase of 7.6% in clay-free silt when compared to the overlying Bt horizon. Differences decreased upslope with Profile 7 at 5.3%, and Profile 8 with 3.6%. The increase in silt size particles downslope may reflect parent material layering from a depositional environment closer to the paleo-channel described in Unit Ib, or translocation of silt downslope by colluvial processes. Regardless of the causative factor, the only physical property, other than color, that could be used to document the disconformity between Unit Ia and IIa was clay-free texture.

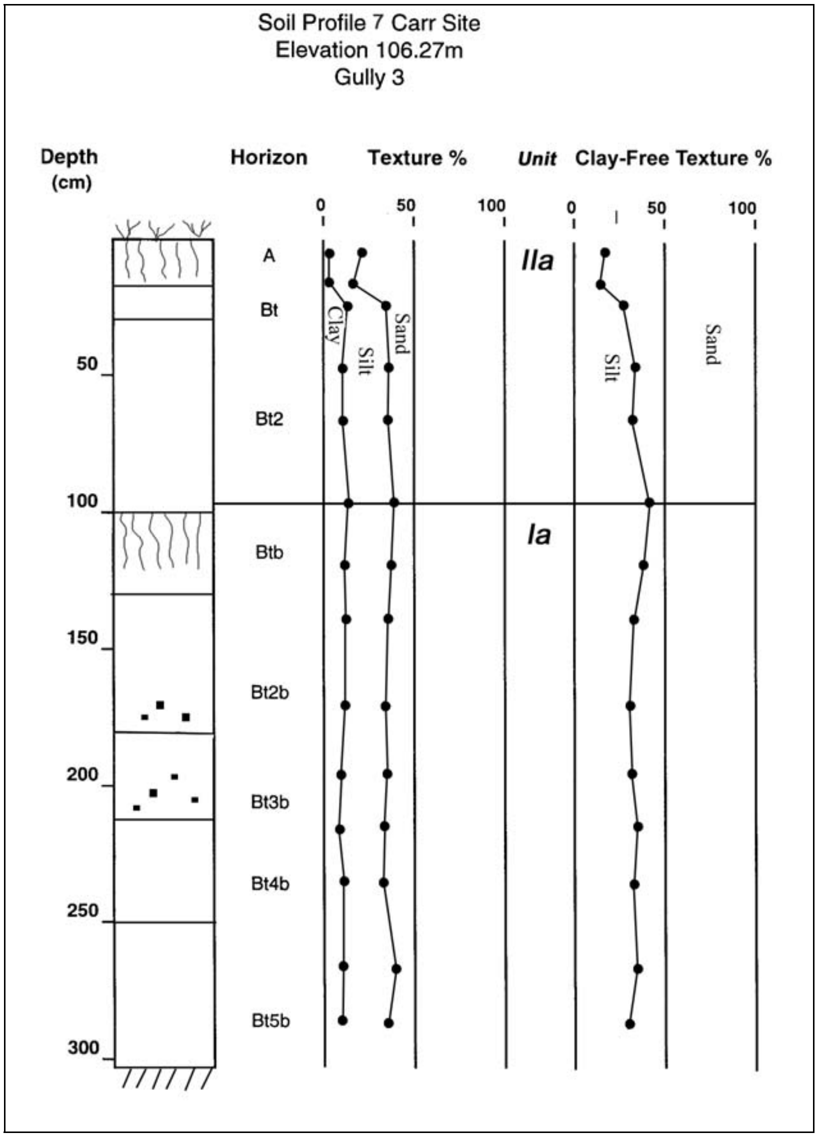


Figure 2.12 Profile 7 is located mid-slope and is representative of the terrace soils. Note that the buried soil texture is similar to the overlying unit and the disconformity between the two units can only be detected with corrected silt and sand values.

Stratigraphic Unit II

Stratigraphic Unit II represents the current surface with associated terrace and floodplain soils of Mill Creek at the site locality. Similar to Stratigraphic Unit I, this unit is sub-divided into two morphostratigraphic units, IIa (terrace) and IIb (floodplain). Unit IIb is documented in

Profiles 2-4 by variations in depth, presence or absence of concretions, texture, and cross-cutting relationships (Fig. 2.9). In Unit IIb the upper boundary is the current floodplain surface, and the lower boundary is the erosional unconformity with underlying Btckb horizons in Profiles 2-3. This unit terminates abruptly downslope 15 meters from the modern Mill Creek channel where the lateral boundary is the recent inset floodplain sediments described in Profile 1. Similarly, the upslope lateral boundary is fairly abrupt 2 meters upslope from Profile 4 suggestive of an erosional unconformity indicating a north-south trending gully cut and fill sequence. For example, in Profile 2 Unit IIb is the thinnest at 55cm and devoid of concretions; Profile 3 is 190cm with carbonate and FeMn concretions; Profile 4 is in excess of 250cm with FeMn concretions, but devoid of carbonates. In terms of texture, Profiles 2 and 3 have higher amounts of clay-free silt when compared to Profile 4, reflecting proximity to the existing Mill Creek channel (Tables 2.3, A 5, Fig. 2.13). The increase in clay-free sand in Profile 4 suggests deposition of sandier terrace sediments from erosion and subsequent spalling of sediments from the gully wall. The absence of carbonates in Profile 4 and presence of carbonates in Profile 3 reflect parent material differences within the fill sequence. Additionally, the morphology of this unit is similar to the existing gully systems at the site location; the lower boundary is relatively flat with fairly vertical lateral boundaries.

In terms of chronology, Unit IIb is the youngest based on the crosscutting relationship found in Profile 4. The upslope lateral boundary of Unit IIb is an erosional unconformity that cross cuts both Units Ia and IIa. Additionally, presence of Late Archaic artifacts in the Btc horizon as compared to Late Paleoindian artifacts found in the Bt horizon of Unit IIa further documents the chronological relationship of these two units . While assigning a maximum age to this unit is problematic, a minimum age can be established for the upper third of the unit since

Late Archaic (3,500 BP) artifacts have been recovered from the A and Bt horizons in Profile 4 (see Ch. 3 for discussion of materials).

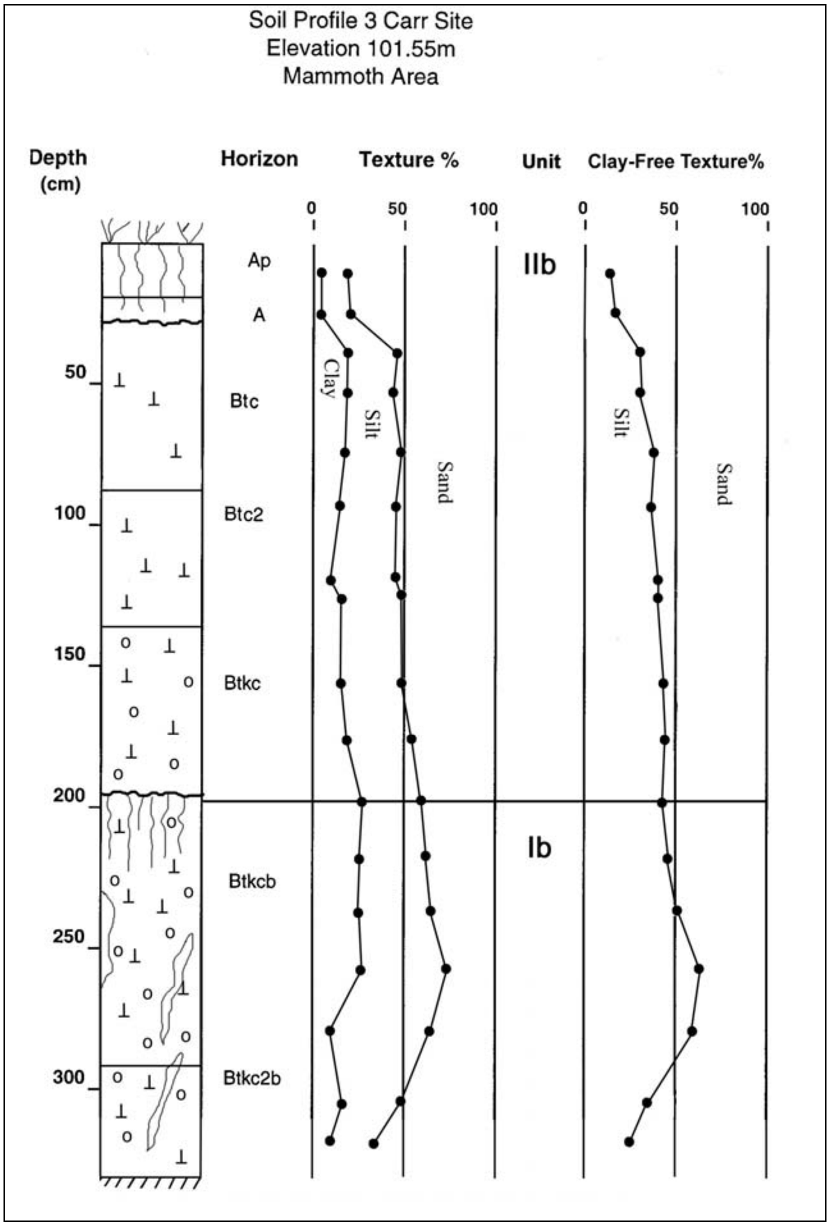


Figure 2.13 Profile 3 represents floodplain deposits with a buried soil. Textural changes indicate presence of erosional disconformity and depositional differences between the two stratigraphic units.

Unit IIa

Stratigraphic Unit IIa represents the current terrace surface above the Mill Creek drainage; Profiles 5-9 illustrates this unit. The lower boundary is the top of the truncated Btb horizon of Unit Ia. The lateral boundary downslope is the abrupt truncation of Units Ia and IIa two meters upslope from soil Profile 4 as described above. Upslope the unit pinches out at the erosional surface of Unit Ia or seep spring surface. Designation of this unit as a terrace surface is based on slope morphology and absence of calcium carbonates. Figure 2.9 demonstrates that beginning at the 103m topographic interval slope morphology changes to a relatively flat surface where slope gradient decreases by half (8cm/m to 4cm/m). However, carbonate concretions are not present until the 102m topographic interval; consequently, this interval is used to define the boundary between floodplain and terrace soils. All soil profiles above this interval are completely leached of carbonates by movement of ground water downslope (Tables 2.3, 2.4).

Unlike Unit Ia the presence of colluvial processes in Unit IIa could not be as easily detected in the field by angular sandstone fragments like those found in Unit Ia. Only one angular sandstone fragment was noted in the Bt2 horizon of Profile 7, and sub-angular to rounded sandstone fragments in the 3-6mm range were recovered in the A horizon of Profile 9 (Table 2.4). However, clay-free texture analysis of this unit reveals an increase in sand with no appreciable difference in silt content regardless of slope position (Table A 5). Consequently, the abundance of sand sized particles suggest that colluvial processes may have dominated the initial sedimentary environment of this unit. Without radiometric dating, the true rate of sedimentation cannot be determined, but the rate was rapid enough to preserve the pedogenic properties of the underlying buried soil and to lower the slope gradient. The unit is remarkably uniform in terms of depth averaging 1.04 meters, but soil horizon thickness changes downslope. A horizons thicken downslope (18 cm-50cm) with underlying E horizons in some locations. In contrast, Bt horizons thin downslope (84 cm-40cm) despite an increase in clay (11.4-16.9 %). These differences are counter to normal expectations for a soil catena or toposequence. Since clay particles move laterally by through-flow subsurface waters, B horizons should thin upslope and thicken downslope (Birkland, 1999). The difference in Bt horizon thickness may be a function of the underlying slope gradient of Unit Ia and resulting parent material differences during deposition of Unit IIa sediments. As noted the upper slope gradient of Unit Ia is fairly steep (17 cm/meter) creating a depressed surface that diminishes downslope as the gradient changes to 10 cm/meter. This change in slope morphology would trap sediments in the topographic low leading to initial parent material difference in Unit IIa. In addition, erosion of the Btb horizon of Unit Ia may have contributed to increased clay content initially in the upper segment of Unit IIa.

Chronologically, the well-developed soil of Unit IIa is older than the associated floodplain soil of Unit IIb. Unit IIb forms a cross cutting relationship with units Ia and IIa and contains artifacts dated to the Late Archaic period. In contrast, Unit IIb contains Late Paleoindian artifacts in the Bt horizon to a depth of at least 70 cm (see Ch. 3). Dalton (10,500-9,900 BP, Goodyear, 1982) and Plainview (10,000 BP, Johnson, 1987) projectiles are associated with this soil unit indicating a minimum age of at least 10,000 years for this soil. Accordingly, deposition of the sediments for this unit occurred some time prior to this age.

Examination of stratigraphic and paleoenvironmental evidence from other localities demonstrates rapid valley incision during the Late Pleistocene followed by rapid early Holocene aggradation and increased colluvial processes. These changes have been documented for the Southern Plains, High Plains, and Gulf Coastal Plains west of the Mississippi for localities ranging from Aubrey, Texas, to Lehner, and Murry Springs, Arizona (Ferring 1990, 1993;

Haynes, 1967, 1981, 1982, 1984). The closest locality is Aubrey where rapid alluviation began ca. 10.9 to10.5 ka. (Ferring, 2000). This represents a major environmental change to a moister environment resulting in large magnitude floods with an associated increase in spring activity. The same environmental change may be present at the Carr Site with rapid colluvial deposition of Unit IIa sediments ca. 11 ka. The apparent rapid deposition would have been aided by increased spring activity from the present seep springs found at the head of gullies at the Carr Site (Fig. 2.7).

Unit IIc

Stratigraphic Unit IIc is topographically the lowest and chronologically the youngest (Fig. 2.9). The upslope lateral boundary for this unit is an abrupt erosional contact with Units Ib and IIb 4-6 meters upslope from the current cut-bank exposure of Unit IIc; the downslope boundary is the current cut-bank exposure along Mill Creek. This unit consists of recent inset floodplain deposits with limited soil development. The top of the unit is a dark organic rich A horizon and the bottom of the unit consists of well rounded shell fragments and gravels of Mill Creek. Since visual inspection revealed the recent nature of the deposits and in the absence of artifacts, no physical analysis of the sediments are included in this report. This unit is defined on the basis of Profile 1 and demonstrates an immature soil consisting of an A horizon underlain by a series of Ckc horizons representing fairly rapid and changing depositional events.

Stratigraphic Unit III

Stratigraphic Unit III is topographically the highest, and is composed of the current Maloterre soil unit and the underling Walnut Fm. Limestone (Table 2.1, Fig. 2.9). The upper boundary is the present soil surface or exposed bedrock surface and the lower boundary is the contact between the Walnut and Paluxy formations. This unit is more resistant to erosion and forms the ridge system and interfluves that surround the Mill Creek drainage basin. Its importance to the stratigraphy and sedimentary contributions has been discussed previously in the bedrock geology section of this paper.

CHAPTER 3

ARCHAEOLOGY OF THE CARR SITE

Introduction

Local collectors have known the Carr Site since the mid-1960s; it came to the attention of Tarrant County Archaeology Society (TCAS) in 1990. A local doctor introduced society member Mike Shannon, of Azle Texas, to the site as a teenager. As an adult, Mike relocated the site and obtained permission from landowner Dickie Carr to record and test the site. Since the owner ran a sand and gravel operation, surface collection and testing were conducted by TCAS in 1990-91 to document the site in the event of loss to quarry operations. Preliminary testing revealed a site with research potential since it contained both Late Paleoindian artifacts and a mammoth in an upland setting. The results of this first investigation are briefly summarized in this report with results documented in Appendix B, Tables B4-5.

In 1996, this author revisited the site with Dr. Reid Ferring to establish its potential as a thesis project. Under his direction a joint project was organized in cooperation with TCAS, the Fort Worth Museum of Science and History, and the University of North Texas. The goals of the archaeological investigation were to test the mammoth for possible archaeological associations, to test the several archaeological components, and to assess site formation processes. The results are organized by a discussion of the surface materials, excavation results, and site formation processes related to geologic contexts.

Site location and geologic context are discussed in Chapters 1 and 2. Figure 3.1 shows location of areas of archaeological interest that were tested in 1990 and 1996. Table 3.1 summarizes all surface materials collected and areas of excavation.

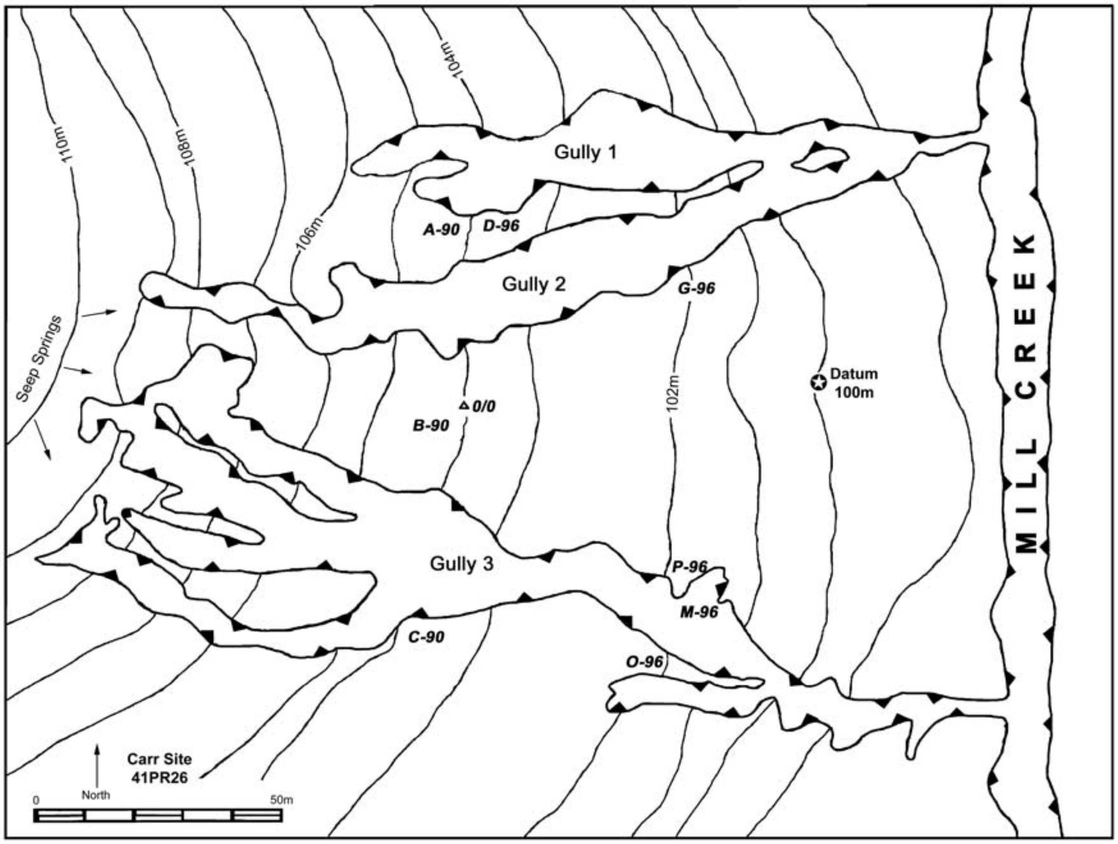


Figure 3.1 Topographic map of Carr site showing areas of archaeological investigation. Excavation areas are designated with capital letters followed by year of excavation. Results of these investigations are reported by area in Appendix B and summarized in Table 3.1

Table 3.1 Summary of Carr site archaeological materials. Surface materials are totals from 1990 and 96. Archaeological areas A, B, and C represent scattered test units excavated by TCAS in 1990; areas D, G, O, and P were named after the person opening the first unit during the 1996 excavation season.

Area	Surface	A-90	B-90	C-90	D-96	G-96	O-96	P-96
Units	90, 96	5	5	5	6	3	2	7
Bifacial Tools								
Projectile Points								
Dalton	8							
Plainview	1				1			
Carrollton	1							
Castroville	1							
Elam	1							
Ellis	2							

(continued)

Table 3.1 (continued).

Area	Surface	A-90	B-90	C-90	D-96	G-96	O-96	P-96
Units	90, 96	5	5	5	6	3	2	7
Bifacial Tools								
Projectile Points (continued)								
Godley	1							
San Patrice var. St John’s					1			
Kent	1							
Morrill	1							
Trinity					1			
Williams	1							
Yarborough	3							
Indeterminate dart	12				1	1		3
Preform	11	1				1		2
Drill	4				1			1
Unifacial Tools								
Scraper	18				3			2
Burin	2							
Graver - perforator	4				1			
Gouge	4							2
Retouched flake	12				2	2		3
Hammer-Ground Stone								
Hammer-stone	5				1			
Ground-stone	5				3			1
Other Materials								
Cores	9				2			
Debitage	0	185	39	45	1281	235	32	781

Surface Materials

Investigation of the three main gullies at the Carr Site revealed the heaviest concentration of surface materials along two north-south trending bands. Paleoindian materials were found approximately 10 meters east and west of the 104m contour, while Archaic materials were exposed in a narrower band along the 102m contour (Fig. 3.1). Surface materials reflect all artifacts collected in 1990 and 1996, with a few materials provided by local collectors. Only retouched flakes and materials that were considered tools were surface collected (Table 3.2). Few artifacts were found in the upper reaches of the gullies near the seep springs due to erosion of overlying A horizons. In 1990, TCAS opened fifteen widely scattered test units along the north-south axis of the 104m contour. Since no diagnostic artifacts were recovered in 1990, the results are summarized in Appendix B, Tables 4-5, and will not be discussed in detail in this report. In 1996, both the 104m and 102m contours were tested in order to determine the extent of the site and to compare terrace and floodplain deposits.

Table 3.2 Summaries of Surface Collections, 1990, 1996. Summary of all surface materials collected, see Appendix B for detailed descriptions and collection period. Note wide range of projectile types represented and large number of Late Paleoindian projectiles (43% of identifiable).

Bifacial Tools		Unifacial Tools	
Dalton	8	Scraper	18
Plainview	1	Burin	2
Carrollton	1	Graver – perforator	4
Castroville	1	Gouge	4
Elam	1	Retouched flake	12
Ellis	2	Total	40
Godley	1		
Kent	1	Hammer-Ground Stone	
Morrill	1	Hammer-stone	5
Williams	1	Ground-stone	5
Yarborough	3	Total	10
Indeterminate dart	12		
Preform	11		
Drill	4	Cores	9
Total	48	Surface total	107

Projectiles

As with most surface collections the results are biased toward formal tools since only artifacts considered "diagnostic" were collected. Formal tools represent 82% of the surface materials; of these tools 45% are bifacial as compared to 37% unifacial. A total of 33 bifacially reduced projectiles were recovered; twelve of which were unidentifiable due to fragmentary nature or crude workmanship. Identifiable projectile points (21) represent at least three archaeological periods: nine Late Paleoindian, two Middle Archaic, and ten Late Archaic. Of the twenty-one identifiable points, 23% are considered complete and the remainders are either broken or late stage discards.

Late Paleoindian: ca. 10,500-9,000 BP

As discussed in Chapter 1, the most common types of Paleoindian artifacts found in this region are Dalton and Plainview (Prikryl, 1990). In his analysis of surface collections from the Elm Fork drainage, six paleoindian sites had a combined total of nine Dalton and six Plainview points. Of these six sites, only two terrace localities contained both Dalton and Plainview. The Wheeler site (41DL30) and 41DN6 contained three Dalton and two Plainview each. Similarly,

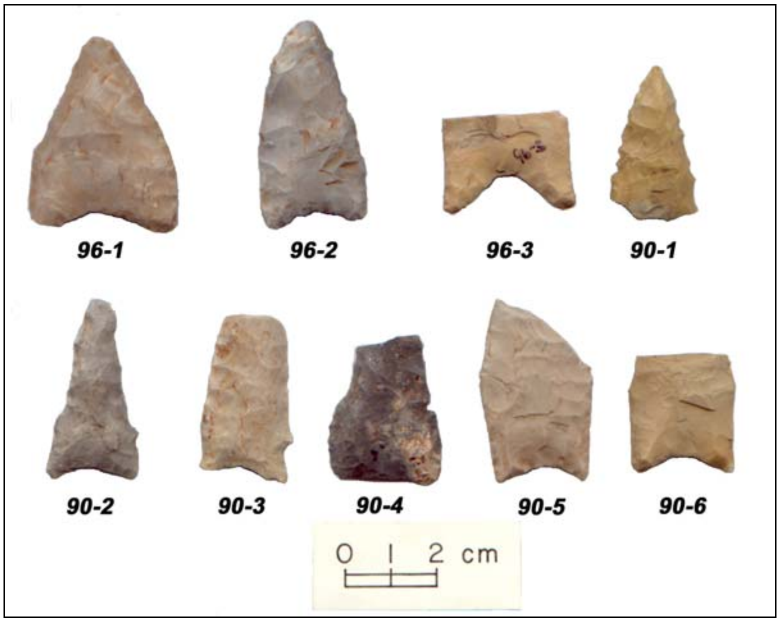


Figure 3.2 Late Paleoindian projectiles from surface collections. Dalton points dominate the assemblage: 96-1-3, 90-1-4, 6; only one Plainview point 90-5 was recovered (see Table B1, B2 for descriptions).

the Carr location is a terrace site with both Dalton and Plainview. However, the Carr site differs in that the ratio of Dalton to Plainview is eight to one (Figure 3.2). No other sites in the study area exhibit such a large number of Dalton materials; consequently, the site must be viewed primarily as a record of the Dalton complex.

Dalton

Chronologically, Goodyear's (1982) analysis indicates that the interval from 10,500 to 9,900 BP best represents the Dalton complex, placing it at the boundary between Late Pleistocene and very Early Holocene. Geographically, the Dalton homeland is considered southeastern Missouri and northern Arkansas. Classic Dalton sites include: Rodgers' Shelter and the Judge S.P. Dalton Site in west central Missouri; the Sloan, Lace, and Brand sites in northeastern Arkansas (Johnson, 1989, Morse, 1997). In Texas, sites with good stratigraphic context are the more western sites. Horn Shelter No. 2 on the middle reaches of the Brazos River contained both Dalton and Plainview artifacts in a sealed stratigraphic context (Redder, 1985), as well as the Wilson-Leonard site on the Edwards Plateau (Johnson, 1989). East of the study area, Story (1990) notes distribution of Dalton materials along the Red River and upper reaches of the Sabine and Sulphur Rivers. Despite the large distribution of Dalton materials, significant well-stratified sites are lacking. One exception is the Quince site (Perttula, 1985) in southeastern Oklahoma. Like Horn Shelter No. 2, Dalton and Plainview co-occur in the uppermost early horizons.

Within the Dalton homelands, settlement sites tend to cluster near watershed centers occupying ecotonal positions at the upland-lowland border. Sites are predominately temporary extraction camps with less than 5% of recorded sites being base camps and cemeteries (Morse, 1990). Similarly, the Carr site is located approximately at the center of Mill Creek and is midpoint between a ridge and flood plain (Figs. 2.3,2.5).

Dalton groups employed a complex foraging strategy with frequent movement of residential camps. The diet of Dalton bands was directed toward forest and forest edge resources with a focus on whitetail deer, but numerous species have been documented including bison, elk, rabbit, squirrel, raccoon, and aquatic species. There is no evidence of exploitation of extinct species although they may have been present at the time.

Dalton tool kits are described as highly mobile containing points, end and side scrapers, gravers on flakes and end scrapers, blades, bipolar cores, wedges, and bifacially chipped stone adzes for wood working (Story, 1990). Additionally, Dalton tools are highly curated and often reworked in other tools. At the Carr site, all the points are either broken or considered late-stage discards. The Dalton artifacts display presence of extensive reworking/resharpening, representative of Goodyear's (1982) final stage resharpening in the Dalton sequence (Fig. 3.2). Two of the points were reworked into drills (90-2, 90-3), one has basal burins with a gouge at the distal end (90-3), two are considered complete but exhausted discards (96-1, 96-2), two basal fragments, (96-3, 90-6), and one distal end (90-1). Additionally, there is considerable variation in base morphology with artifact 96-3 representing the classic Dalton morphology associated with the Dalton homelands of Missouri and Arkansas, whereas artifacts 96-1, 2, and 90-6 are representative of Johnson's (1989) western expression of the lanceolate Dalton base morphology. In terms of raw materials all of the points are made from non-local cherts; half are Edwards chert and half are unidentified cherts.

Plainview

A detailed examination of all reported Plainview sites in Texas is beyond the scope of this report but significant sites are addressed. The Plainview point type was established from a band-level communal mass kill of over one hundred *Bison antiquus* associated with 18 Plainview projectile points located on the outskirts of the town of Plainview, Texas (Sellards, Evans, and Mead, 1947). In contrast, the Plainview period at the Lubbock Lake site on the outskirts of the city of Lubbock, Texas is a small kill of six *Bison antiquus* by a residential unit of a small group of people associated with two Plainview projectile point (Johnson, 1987). Both sites are located in draws on the Llano Estacado and are well dated to about 10,000 BP. Using comparative data from additional Texas sites to include Bonfire Shelter, Horn Shelter 2, and the Wilson-Leonard site, Leroy Johnson (1989) suggests Plainview assemblages date from 10,100 to 9,200 BP; however the upper limits are not firmly established. Thus, Dalton and Plainview are roughly contemporaneous, and date to the boundary between Late Pleistocene and very Early Holocene. All well-defined Plainview sites are generally west of the study area and are at least partly the result of typological dilemmas in that the Plainview label has been assigned to a broad range of specimens with lanceolate blades and concave bases (Wheat, 1972). As a result, few sites with unmistakable Plainview assemblages have been reported.

At Bonfire Shelter (Dibble and Lorrain, 1968) on the Rio Grande River the use of bison jumps is well documented by bone bed two representing three separate kills of over 120 *Bison antiquus* associated with four complete and two possible broken Plainview points. Horn Shelter 2 and the Wilson-Leonard site both contain a Plainview component but are mixed with other late-paleo artifacts (Johnson 1989). The majority of reported sites come from surface collections. Thurmond (1990) plots the distribution of Plainview finds on the Southern High

Plains of Texas, Oklahoma, and New Mexico. The largest concentrations occur along major ecotones. Major north-south distributions are at the boundary between the Llano Estacado and Rolling Plains and along the western border of the Cross Timbers with major east-west distributions along the southern edge of the Balcones Escarpment.

In terms of subsistence Plainview groups practiced intensive bison hunting; bison bone beds dominate indeed all well documented sites. However, broad spectrum opportunistic foraging is also indicated. At Lubbock Lake evidence of butchering of puddle ducks, muskrats, and antelope are present (Johnson, 1987).

Plainview tool kits are highly mobile containing points, end and side scrapers, gravers on flakes and end scrapers, blades, and bone expediency tools (Johnson, 1987). The Plainview component at the Carr site is limited to a single projectile point (90-5, Fig. 3.2) and illustrates the typological problems associated with Plainview. Although fragmentary, 90-5 is made from Edwards chert, and conforms to Wheat’s (1972) mode I classification in that it expands slightly from the base to the midpoint. It matches as well Johnson’s (1989) Plainview II technological mode a bifacial preform industry associated with more eastern sites.

Dalton-Plainview Summary

Chronologically Dalton and Plainview are contemporaneous ca. 10,000 years ago placing them at the boundary between Late Pleistocene and very Early Holocene, and represent the earliest occupation of the Carr site. They represent two different geographic areas; the Dalton complex is indicative of Eastern Woodland deer hunters; while the Plainview complex is considered to be characteristic of Great Plains bison hunters (Prikryl, 1990; Story, 1990; Johnson, 1987, and others). The study area is thought to be a marginal area for both groups;

however, Dalton materials have a slightly higher frequency of occurrence in surface collections within the region (3/2 ratio) and at the Carr locality (8/1 ratio). This difference suggests that this region may have been more suitable to deer populations than bison during the Pleistocene-Holocene transition. Interestingly, no whitetail deer were present in the faunal record until the time of Clovis occupations at the Aubrey Clovis site (Ferring, 2001).

Both groups represent the human response to environmental change following the close of the Pleistocene discussed in Chapter 1. Generally, the terminal Pleistocene in this region was cool and dry with open grasslands followed by a cool and moist early Holocene with grasses peaking at 10 Ka and increases in oak and composites along riparian zones. Low population densities, high mobility, and a generalized hunting and gathering economy characterize both groups. However, Plainview groups appear to be more specialized participating in communal-level hunts of the extinct *Bison antiquus* where as there is no evidence that Dalton groups hunted extinct faunas although they may have been present at the time.

Both Plainview and Dalton tool kits were highly mobile containing points, end and side scrapers, gravers on flakes and end scrapers, blades, with only minor variations and additions. In the case of Plainview, bone expediency tools are present (Johnson, 1987), and with Dalton bipolar cores, wedges, and bifacially chipped stone adzes for woodworking are present (Story, 1990). Both groups reworked/rejuvenated projectile points but Dalton projectiles were more highly curated with extensive reworking into drills, gouges, burins, etc. At the Carr site all of the points were reworked or considered late stage discards and may represent a more residential occupation by Dalton groups than Plainview.

Middle Archaic: 6,000-3,500 BP

Two projectile points represent the Middle Archaic period: one Carrollton (96-4) and one Morrill (90-7, Fig. 3.3, Table 3.2). Warm and arid conditions prevailed during the Middle Archaic favoring prairie grasslands. Population densities are considered low due to the small number of diagnostics artifacts of this period in regional surface collections. Sites are usually on the first terrace above major drainages and not tributaries (Prikryl, 1990). In order of prevalence Wells, Carrollton, Morrill, and Calf Creek points are diagnostic of the Middle Archaic period in the study area. In terms of distribution Carrollton is found around the Dallas area along the Trinity River, while Morrill is usually found in East and East-Central Texas. There are no associated dates for Morrill, but Carrollton has been dated to around 3,800 BP (Prikryl, 1990).

Late Archaic: 3,500-1,250 BP

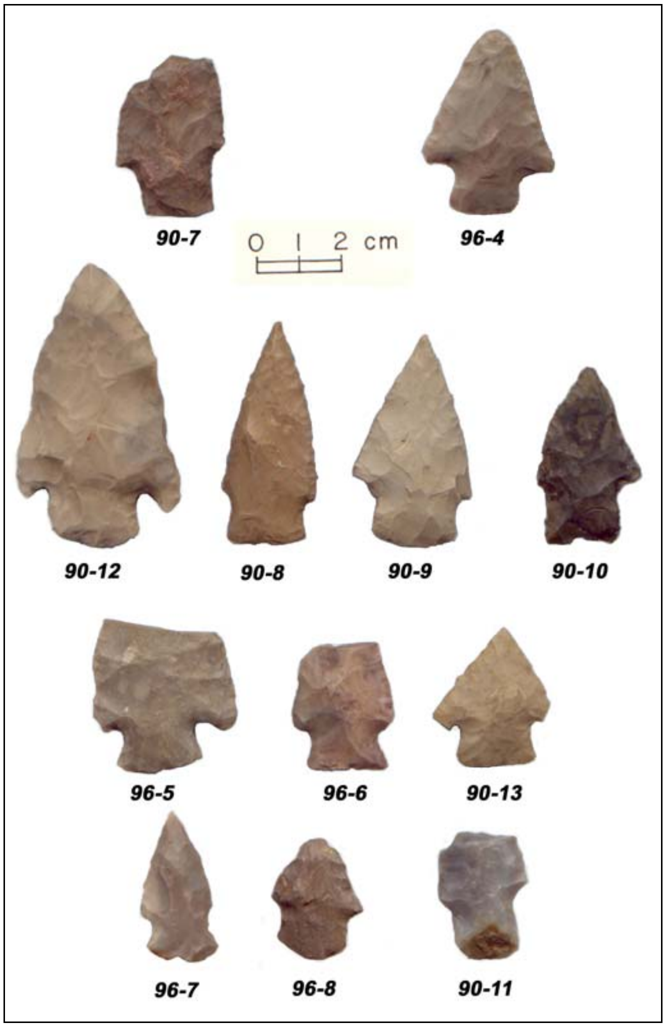
Ten of the projectiles from the surface collection are classified as Late Archaic (Fig. 3.3, Table 3.2). During the Late Archaic period climate began to ameliorate to current conditions with an oak-savanna regime that developed at the expense of grasslands. A dramatic increase in population is indicated by the large number of Late Archaic points and sites along major drainages, their tributaries, and floodplains (Story, 1990). Surface collections of terrace localities reveals two to three times more Late Archaic projectile points than any other archaeological period (Prikryl, 1990). However this is not the case at the Carr site where Paleoindian and Late Archaic point are approximately equal (9/10, respectively). The most common diagnostic for the Late Archaic period regionally is the Gary projectile point/knife (Prikryl, 1990). Nevertheless, no Gary points were recovered at the Carr site.

In terms of raw materials, 90% were made from chert, and like the paleo-projectiles, Edwards chert is dominant. Only one point, an Elam (96-8), was made from petrified wood (Tables B1, B4). This raw material difference contrasts sharply with research conducted on sites east of the Carr site where local materials are dominant (see Table 1.2). All of the projectiles, with the exception of Williams (96-5) and Castroville (90-12), are normally found within the study area, while Williams and Castroville are generally considered Central Texas points.

Archaic Summary

The Middle Archaic component is consistent with regional data from surface collections and excavated sites. Middle Archaic projectile points are rare as a result of low populations during the stressful Altithermal period. Prikryl (1990) reported the lowest number of recorded sites with a Middle Archaic component. Similarly, test excavations at Ray Roberts and Lewisville lakes produced a small number of sites with either Carrollton or Merrill diagnostics (Ferring and Yates, 1998, 1997). Only two Middle Archaic points were recovered from surface collection.

In contrast, the Late Archaic period at this locality is dissimilar to regional records in that Ogallala quartzite was not used extensively for tool manufacture. The number of projectile points was not as numerous as would be expected for this period, and the ubiquitous Gary point was absent. Apparently, this locality was under utilized during the Late Archaic period.



Key	Type	Davis (1991)	Hester (1985)	Prikryl (1990)
90-7	Morrill	early-late	early-middle	middle
96-4	Carrollton	middle	middle	middle
90-12	Castroville	early-late	late	late
90-8-10	Yarbrough	early-middle	early-late	late
96-5	Williams	middle-late	middle-late	late
96-6, 90-13	Edgewood-Ellis	late-transitional	middle-transitional	late
96-7	Godley	late-transitional	late-late prehistoric	late
96-8	Elam,	late-transitional	late	late
90-11	Kent	late-transitional	middle-transitional	-

Figure 3.3 Surface projectile Figure 3.3 Surface projectile points classified as Archaic. Artifacts 90-7 and 96-4 are Middle Archaic while the remainder is grouped into the Late Archaic due to ambiguous dates assigned by various authors.

Other Surface Materials

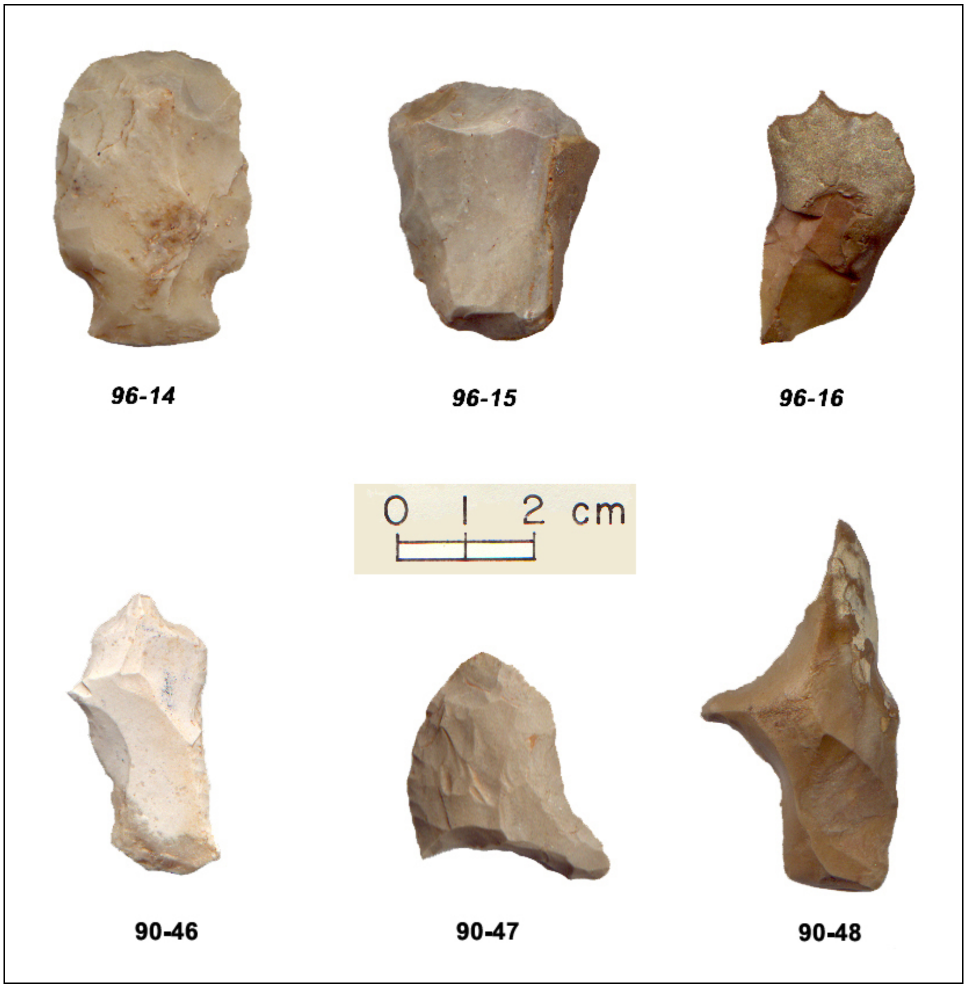


Figure 3.4 Selected surface artifacts. Note variety of tool forms: Quince scraper (96-14), end scraper (96-15), gravers (96-16, 90-46), atypical tools (90-47, 90-48). All tools are made from chert, three with cortical surfaces. (Appendix B).

Of special note are small biface scrapers dubbed “Quince scrapers” by Leroy Johnson (Story ,1990). Johnson notes that most Quince scrapers are bifacial, some retain original ventral surfaces with minimum or no retouch on the underside surface. This latter description compares favorably with artifact 96-14 (Figure 3.4, Table B1). This scraper while included within the surface materials is the only surface artifact found *in situ* eroding out of the south wall of Gully 1. The scraper was 48 cm below surface in the Bt horizon described for Profile 9. The artifact was tilted to a 25^{o} angle suggesting that it had been moved into this horizon via bioturbation. Unifacial gravers 96-16 and 90-46 are indicative of Dalton materials (Goodyear, 1982). While artifacts 90-47 and 90-48 are considered atypical and defy straightforward classification, a smaller version of 90-48 made with the same raw material was recovered during excavation in Area D (see Fig. 3.9 96-38, Table B2, B4).

The remaining surface materials consist of relatively small numbers of cores, hammerstones, and groundstone. Unlike the projectiles, the core raw material shows an increase in quartzite to 36% from the 6% noted in the projectiles. The cores are best described as exhausted or represent end-stage discards. Hammerstones are local Ogallala quartzites and Paluxy gastroliths. All groundstone collected was in the form of manos with only one complete. The complete mano was highly polished and may have been a discard. The remaining manos were fragmentary and appear to have been broken in usage (Table B4).

In sum, the surface artifacts indicate that the site was utilized during at least three archaeological periods: Late Paleoindian, Middle Archaic, and Late Archaic. A high proportion of broken or end-stage projectile points, few cores, and limited groundstone artifacts recovered imply that the site may have been used as a hunting or seasonal camp where tool curation activities occurred (Binford, 1979).

Excavations

As previously mentioned, the focus of this thesis is the excavations conducted in the 1996 field season; the 1990 site testing is not considered due to differences in excavation techniques. In 1990, all excavated sediments were dry-screened with ¼ inch mesh in 10 cm levels across the entire $1m^2$ test unit. However, in order to recover more data in terms of spatial patterning of artifacts, the 1996 materials were wet-screened using 1/16-inch mesh. Test units were divided into quadrants; each quadrant was individually excavated in 10cm levels.

In 1990, test units were distributed mid-slope along the north-south 0/0 grid line, and no testing was performed in floodplain deposits adjacent to Mill Creek (Fig. 3.5). To test the maximum extent of archaeological deposits in 1996, both mid-slope ant floodplain deposits were tested. No units were opened below the E53 gridline due to previous quarrying of topsoil by the property owner (Fig. 3.1). Areas O and G are summarized in Table 3.3. Materials recovered from these units were limited but did demonstrate the presence of archaeological resources. Area P proved to contain the highest concentration of artifacts and was in close proximity to the mammoth remains. As a result, 7 units were excavated in Area P for comparison of excavation results in terrace deposits in Area D (Fig. 3.1).

Table 3.3 Summary of Area O and G excavations. Comparison of excavation results from test units located downslope from the previous 1990 investigations to test for maximum extent of archaeological deposits. Area O is the southernmost and Area G is the northernmost unit within the floodplain.

Area O	No.	Comments	Area G	No.	Comments
Units	2	depth range: 10-30 cm		3	depth range: 20-60cm
Indeterminate dart	0			1	96-24, distal fragment level 2
Preform	0			1	96-27, dart level 2
FCR	39	hearth feature, level 2 of both units		6	scattered, level 1
Debitage	32	chert small interior, 75%		235	chert small interior 90%

Area P Excavation Results

Two primary classes of alluvial soils are floodplain soils and terrace soils; floodplain soils are subject to intermittent additions of parent material during flooding, while terrace soils are generally not subject to flooding (Baker *et al.*, 1983; Gerrard, 1987). Rate of sedimentation (Rs = cm/yr) is a function of geomorphic setting based on distance from stream channels. In general, floodplains have higher rates of sedimentation; terraces lower rates. Differences in rates of sedimentation influence the degree of pedogenesis and archaeological site formation processes (Butzer, 1982; Ferring, 1992; Schiffer, 1987). A high Rs promotes superpositioning of artifacts and features; low Rs result in accumulation of artifacts as mixed assemblages. Thus, Rs effects changes in vertical distributions of artifacts and provides evidence of syndepositional or post-depositional occupations (Ferring, 1986). The excavation results from Area P represent archaeological materials recovered from floodplain deposits, while Area D represents materials from terrace deposits (Ch. 2). Both areas are described in terms of the vertical distribution of debitage, the diagnostic artifacts, and site formation processes.

Debitage Vertical Distribution: Area P

The location of Area P test units is shown in Figure 3.5; a total of seven units were excavated. However, unit P-1 is excluded from the analysis of Area P due to distance from other units and ground water seepage that prevented complete excavation. In order to compare individual verses contiguous units all debitage counts by level were converted to volume metric densities (n/m^3). In terms of raw material, chert was dominant with only small amounts of quartzite present usually in the form of hammer-spalls or chips from Paluxy gastroliths. Due to the quite limited amounts of quartzite present in Area P, only chert volumetric densities are considered. Figure 3.6 shows the vertical distribution of chert debitage converted to volumetric densities per level.

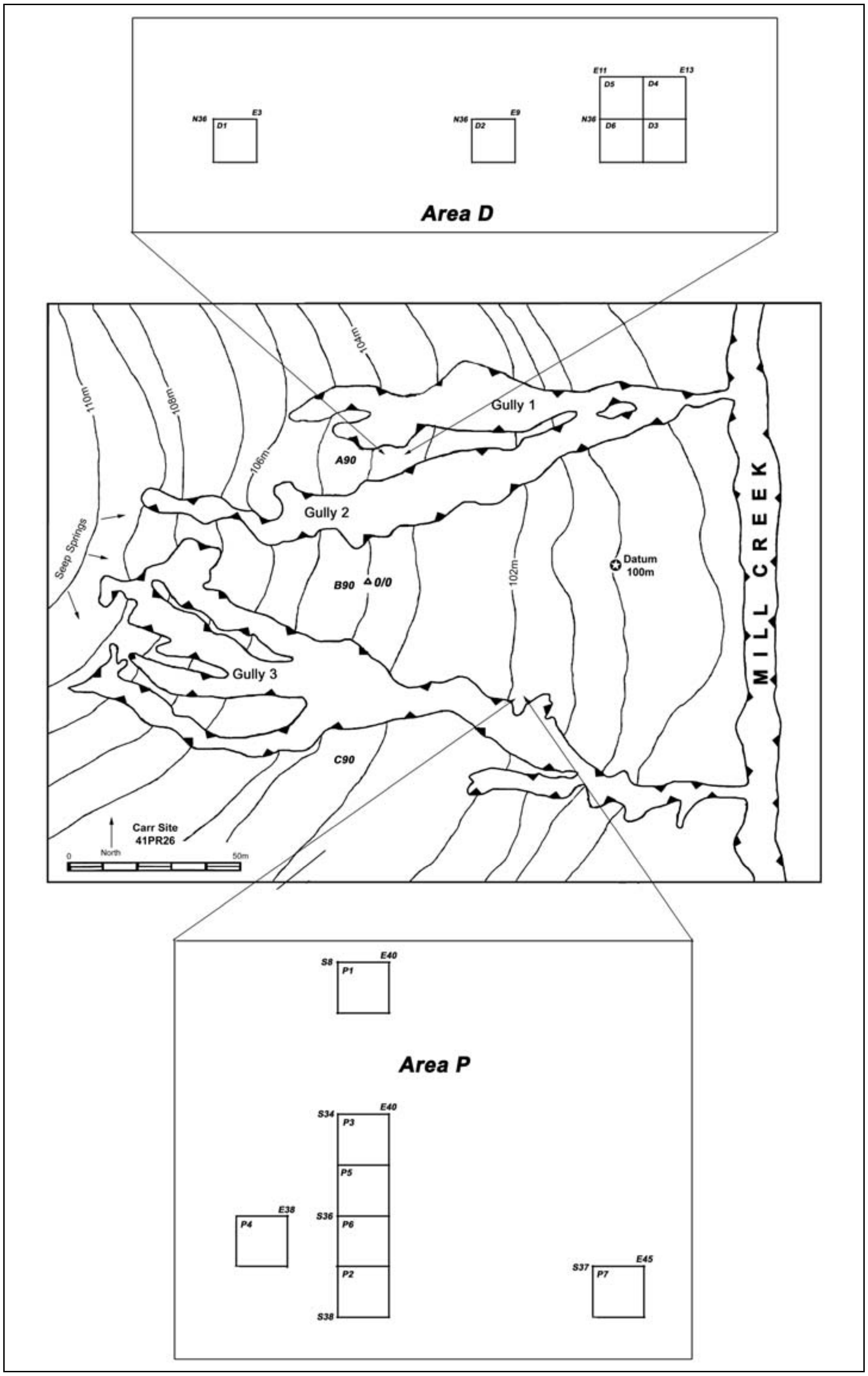


Figure 3.5 shows number and location of major test units for Area P (floodplain) and D (terrace). Area D afforded block excavations; in Area P a more linear approach was taken as a result of spatial constraints.

The use of micro-artifacts to identify potential surfaces of human occupation is increasing but not routinely used. A consensus of the size definition of micro-artifacts is, at this time, rather arbitrary (Dunnell and Stein, 1989). Therefore, the term minute-debitage is used to define small flakes and chips that range in size from 2-9mm (Figure3.6, CSI). Post-depositional disturbance of artifacts is a function of artifact size, sediment texture, soil-mixing agents, and time (Mitchie, 1990; Schiffer, 1987; Waters, 1992; Wood and Johnson, 1978). In general, smaller objects are easier to displace and consequently can be used as indicators of post-depositional disturbance or potential surfaces of human occupations.

In Area P, the vertical distribution of minute-debitage (CSI, Fig. 3.7) indicates a buried occupation surface (level 3) within four contiguous units. The western most unit, P-4, shows a buried component with a peak in volumetric density at level 3 as well.

Table 3.4 Chert volumemetric densities by level. Note high densities in level 3 for contiguous units and P-4; unit P-7 has highest density in level 2. Key: CSI-chert small interior, CSC-chert small cortex, CLI-chert large interior, CLC-chert large cortex.

Unit P4				
Level	CSI	CSC	CLI	CLC
L1	80		30	
L2	370		70	10
L3	380		90	10
L4	120		20	10
L5	70	10	30	
L6	30		20	
Total	1050	10	260	30
Contiguous				
Level	CSI	CSC	CLI	CLC
L1	110		20	5
L2	255	5	38	8
L3	410	3	47	8
L4	335		38	5
L5	120	3	33	5
L6	33		8	5
Total	1263	11	184	36

(table continues)

Table 3.4 (continued).

Unit P7				
Level	CSI	CSC	CLI	CLC
L1	100		20	
L2	360		30	
L3	250	10	20	10
L4	60		30	10
L5	10		10	
Total	780	10	110	20

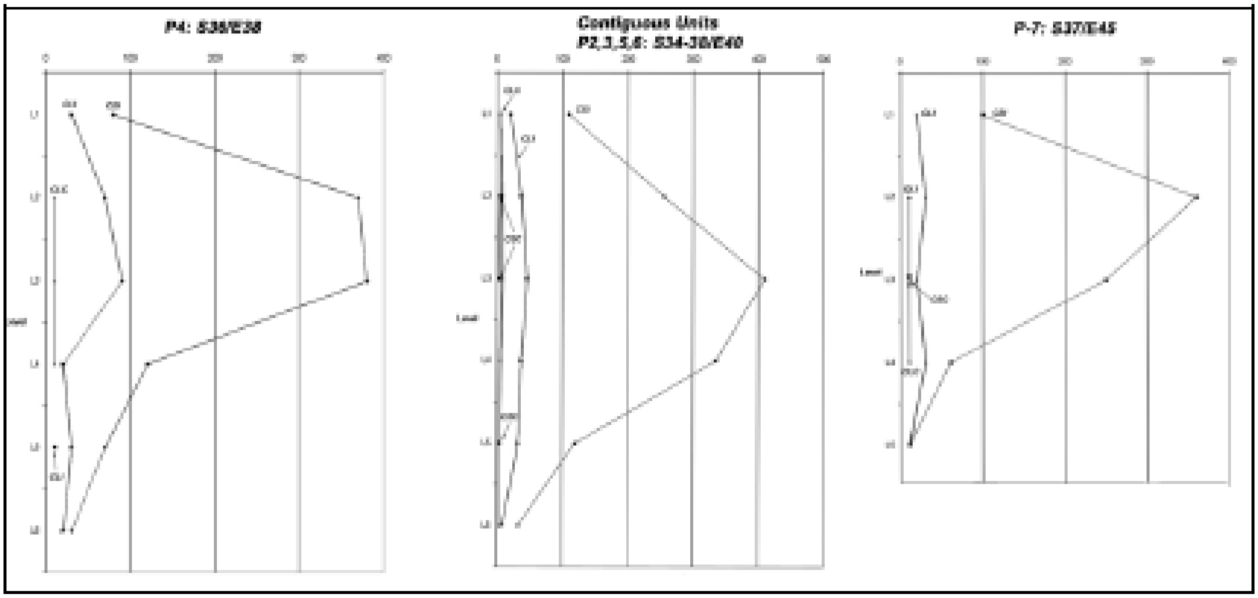


Figure 3.6 Area P Volumemetric density (n/m3) distribution of chert debitage by level. Note peak in CSI (410/m^3) in level 3 in contiguous units indicating a buried component. Figure 3.5 shows location of units; units are distributed across 7 meters with a slope of 6cm/m between P4 and P7. Key: C-chert, L-large (>1cm^2), S-small (<1cm^2), C-cortex, I-interior, respectively.

However, level 2 of P-4 has a volumetric density just slightly less than level 3, and indicates that these two levels split the occupational surface. In contrast, the eastern most unit, P-7, records a density peak in level 2. This difference is the result of removal of some A horizon materials from quarrying activities at P-7. In all units, the peak volumetric density of minute-debitage occurs in the E soil horizon identified in Profile 4. Regardless of slight level differences across the site, this distribution of minute-debitage indicates a syndepositional occupation (see Figure 3.7)

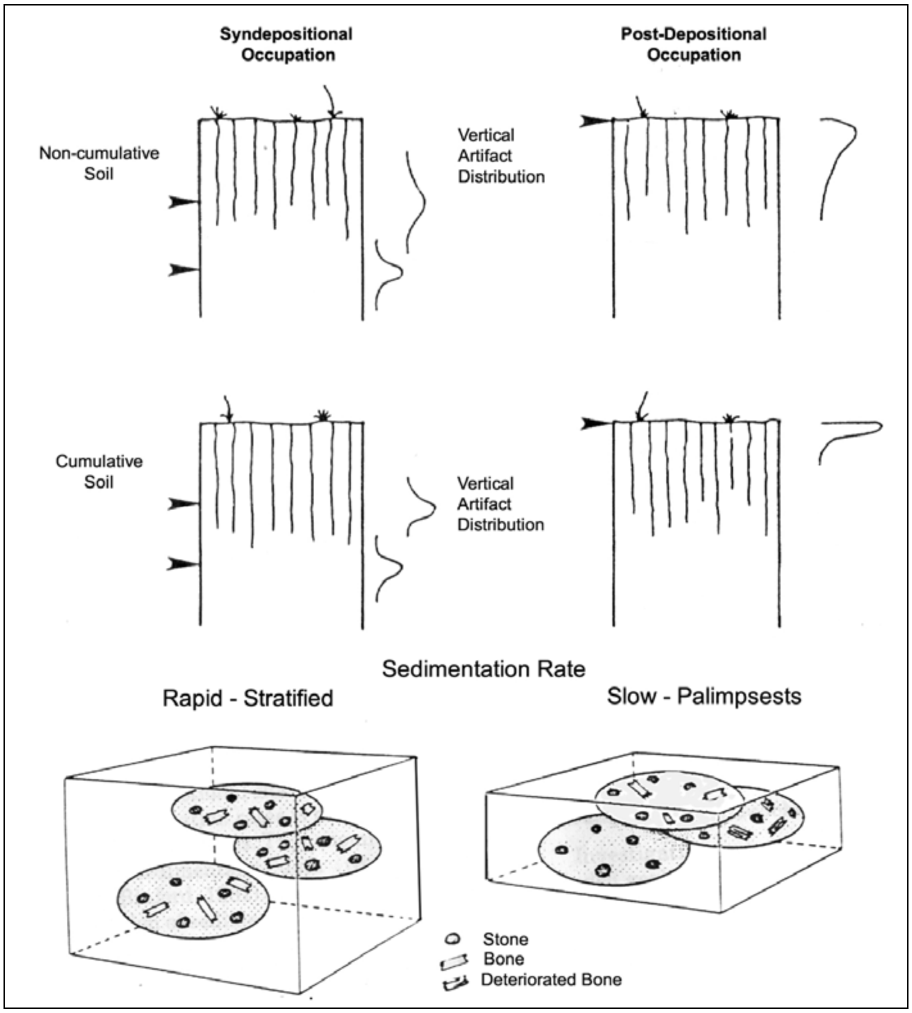


Figure 3.7 Illustration showing the interrelationship between site modification, sedimentation, and pedogenesis. Syndepositional occupations occur during periods of accumulation of soil parent materials. Post-depositional occupations occur after parent materials have been deposited. In both examples, continued pedogenesis will affect spatial relationships of the archaeological record. Nevertheless, high rates of sedimentation favor stratification and preservation of organic materials; low rates result in mixing of artifacts and reduced preservation of organics (compiled and modified from Ferring, 1992, 1986).

Spatial Relationship of Artifacts Area P

Since the minute-debitage in level 3 indicated a buried occupation surface, this level was examined in terms of the distribution of debitage totals across the site by quadrant for intrasite variation (Figure 3.8). The results revealed four distinct clusters of debitage indicating tool maintenance or manufacture. P-4 contained the highest volumetric density for chert small and large interior flakes with the highest concentration in the northwest quadrant (Table 3.4). Examination of large biface thinning flakes indicates three raw material types present, suggesting production or finishing of at least three large bifacial tools. In contrast, the remaining units show only evidence of tool maintenance in the form of resharpening chips and pressure flakes on a variety of raw materials.

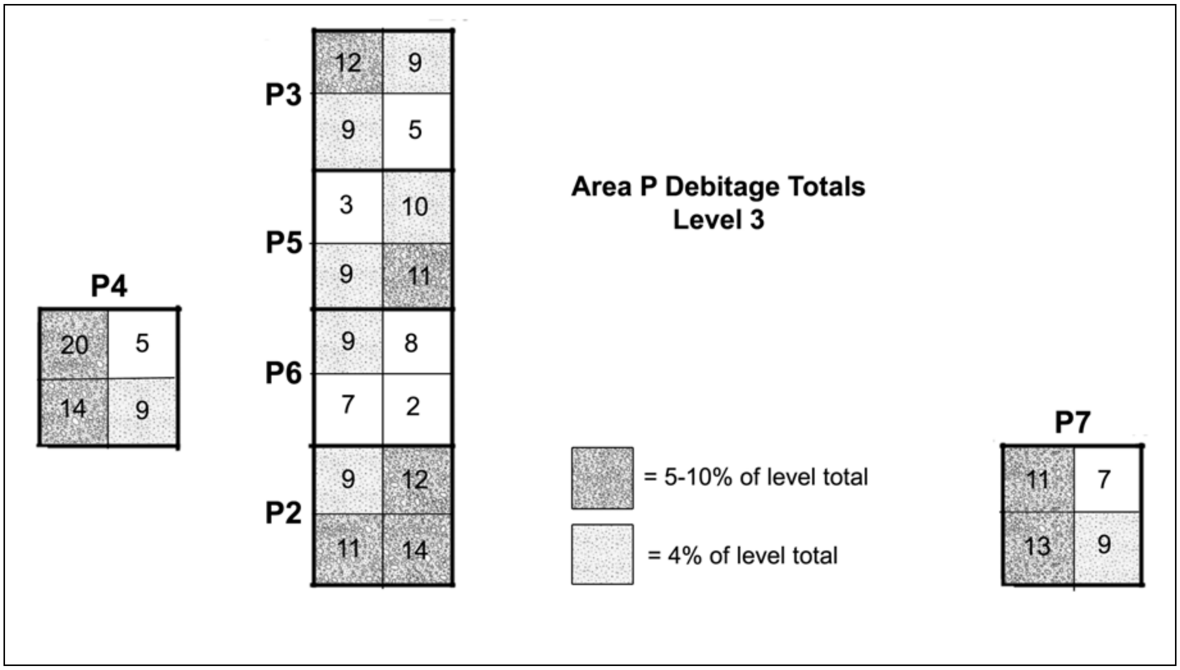
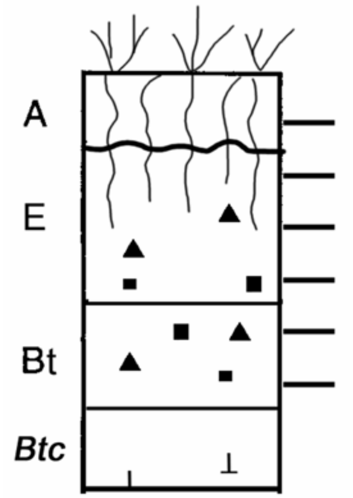


Figure 3.8 Debitage totals for level 3 by quadrant for contiguous units and P4; P7 counts reflect level 2 totals.

Vertical Distribution of Artifacts: Area P

The larger artifacts such as fire cracked rocks, projectiles, scrapers, and gouges in Area P are found at greater depths in levels four and five (see Figure 3.9). This greater depth of burial is the result of bioturbation, which includes faunalturbation and floralturbation (Wood and Johnson, 1978). However, due to the sandy nature of the soils at the site, faunal turbation by burrowing animals such as badgers, gophers, earthworms, ants, and gopher tortoise is the more probable (Mitchie, 1990). In addition, Gunn and Foss (1997) note that the greatest rates of downward movement of artifacts occur in fine-textured sands. During excavation, krotovina of pocket gophers, *Geomys bursarius majori*, were common and encountered intermittently throughout the A and E horizons. Thus, burrowing activity by *Geomys bursarius majori* resulted in burial of the larger artifacts as burrow roof materials collapsed. Moreover, half of the bifaces and FCR recovered were at an angle of 25 to 60 degrees indicating post-depositional disturbance by burrowing animals.



Level	Flk	Pt	Dr	Sc	G	Rf	Gs	FCR
1	84							
2	175	1						
3	237							9
4	170	1				2	1	14
5	93	3	1	1	2	1		18
6	22							6
Total	781	5	1	1	2	3	1	41

Figure 3.9 Summary of excavation results for Area P by level. Note that level 5 has the highest tool and FCR count and is at the boundary between the Bt horizon and the overlying E horizon. Key: Flk-flakes, Pt-projectiles, Dr-drills, Sc-scraper, G-gouge, Rf-retouched flake, Gs-groundstone, FCR-fire cracked rock black squares-fire-cracked rocks, black triangles-chert flakes.

No time-specific diagnostic artifacts were recovered from Area P. However, fragmentary projectiles indicate a Late Archaic occupation based on lack of basal grinding, small size, and presence of stemmed points (Figure 3.10). Differences in point morphology may suggest at least two occupational sequences. Artifact 96-23 is indicative of the broad bladed Castroville, Marshall, or Williams points all of which occur early in the Late Archaic sequence (3,500 to 1250 BP). Artifact 96-22 while untyped and fragmentary does have basal and barb characteristics suggestive of the Marshall point type. Artifact 96-20 is untyped, but its small size relative to 96-23 suggests occurrence later in the sequence.

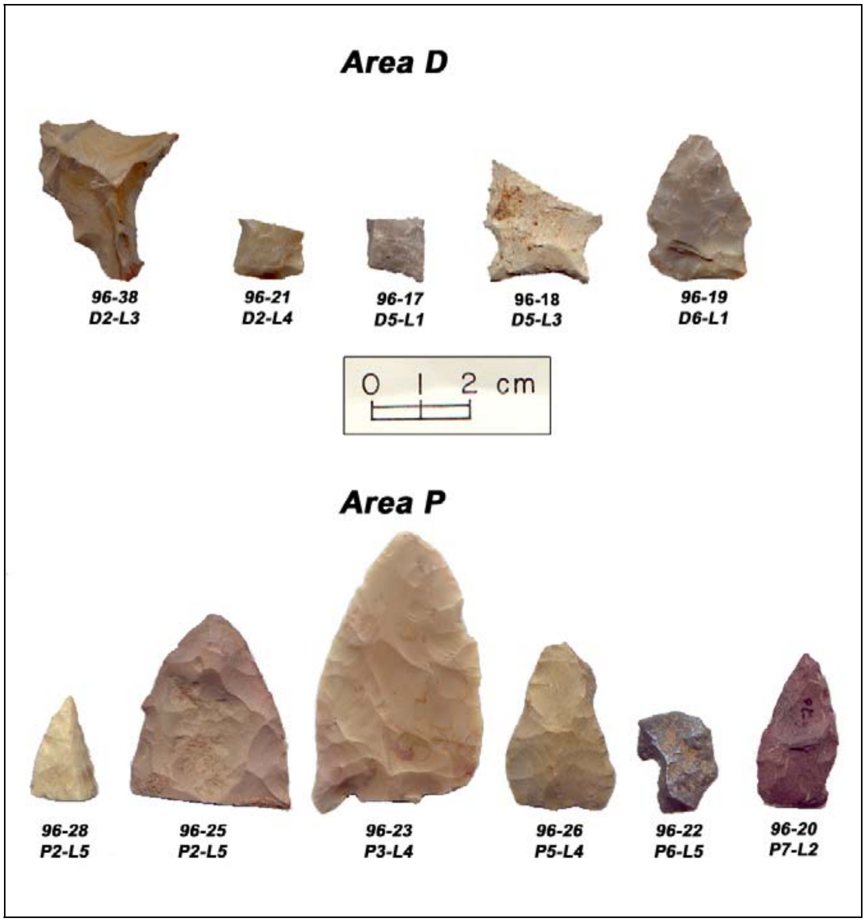


Figure 3.10 Comparison of selected bifacial tools from excavations of Area D and P. Note presence of San Patrice var. St. Johns (96-18) and Trinity (96-19), Early and Late Archaic respectively, in Area D. In contrast, Area P contains a fragmentary assemblage that indicates a Late Archaic occupation based on lack of basal grinding, small size, local raw materials, and stemmed points (96-23, 26, 20).

Figure 3.11 shows the spatial distribution for levels four and five in contiguous units. Data from levels four and five were collapsed since the top of the Bt horizon occurs at the bottom of level four and the underlying Bt horizon is well developed which would restrict further bioturbation of artifacts to deeper levels. No intact features were found during excavations, but presence of FCR scatter, some small charcoal fragments, and pot-lidded bifaces (96-22, 25, 30) indicate that this area of the site was used for cooking fires (Fig. 3.11, P-5-6). The southern edge of the FCR scatter (P-2, 6) shows evidence of limited activity in the form of two pot-lidded biface fragments (96-22, 25), a distal drill fragment (96-28), and a small groundstone fragment (96-50). In contrast, artifact density and tool type increased in units P-3 and P-5 one meter north of the FCR scatter. This segment of the site contained two gouges (96-36, 37), an end-side scrapper (96-31), one pot-lidded biface fragment (96-30), a large broken biface (96-23), and a stacked preform (96-26) with basal edge wear suggestive of use as scraper. This intrasite difference in tool type and density suggests this area of the site was used for specialized activities that may have included woodworking, hide processing, and/or tool maintenance.

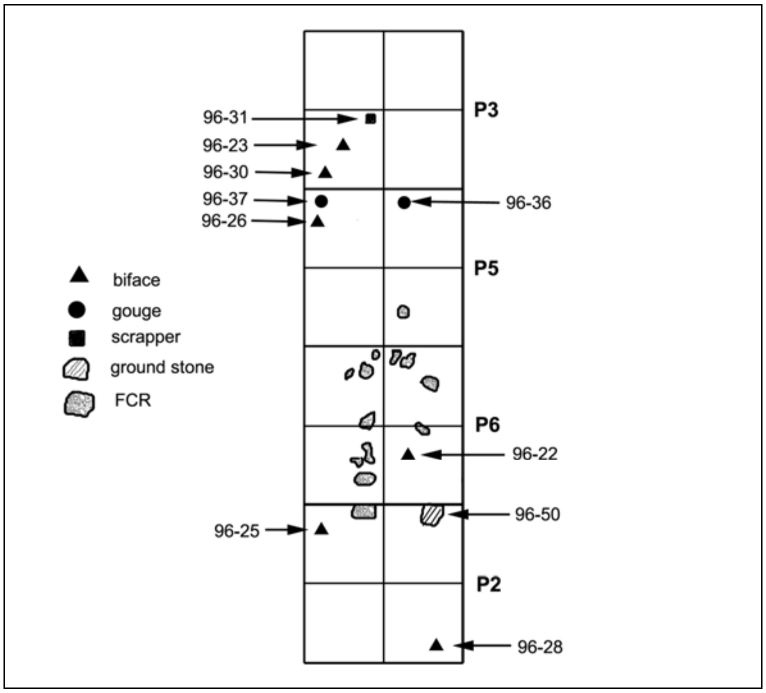


Figure 3.11 Spatial relationship of tools and FCR in levels 3-4of Area P. Note concentration of FCR in P-5 and P-6 and differences in artifact densities and tool types on either side of FCR scatter. See Table 3.5 for description of artifacts.

Table 3.5 Description of artifacts for Figure 3.11.

Specimen #	Type	Description
96-22	Indeterminate dart	chert, 2.5Y4/1, dark gray, proximal fragment with one barb, pot-lidded
96-23	Indeterminate dart	chert, 2.5Y7/3, pale yellow, red oxide veins, extremely well made, thin, base and one barb missing
96-25	Preform dart	chert, 10YR6/4, light yellowish brown, distal fragment, cortex on tip, pot-lidded
96-26	Preform dart	chert, 2.5Y7/4, pale yellow, small preform with large distal stack
96-28	Drill	chert, 2.5Y8/3, pale yellow, distal fragment, bilaterally beveled
96-30	Biface fragment	chert, 2.5Y6/3, light yellowish brown, biface fragment, pot-lidded
96-31	End+side scraper	chert, 2.5Y6/4, light yellowish brown, split pebble, steep retouch, unilateral cortex
96-36	Gouge	chert, 10YR7/3, very pale brown, fine grained dark inclusions, well knapped, steeply beveled, biface
96-37	Gouge	quartzite, 2.5Y6/3, light yellowish brown, broken, unilateral cortex, pebble
96-50	Ground- stone	fine-grained sandstone, 10YR6/3, pale brown, thin tabular fragment, unifacially lightly ground

Area D Excavation Results

Since Late Paleoindian artifacts were recovered in gully one (90-5, 6) and gully two (96-1, 2) at the 104m interval, six units were excavated in Area D (Figs. 3.3, 3.7). Unlike Area P floodplain deposits, Area D excavation units are mid-slope in terrace deposits. As a result, intrasite differences between terrace and floodplain soils are analyzed in terms of site formation processes, chronology, and assemblages. Chronologically, Area P was limited to the Late Archaic period; in contrast Area D contained Late Paleoindian, Early and Late Archaic bifaces (Fig. 3.10). Additionally, Area D contained more unifacial tools, ground-stone, evidence of lithic reduction, a fire cracked rock feature, and an absence of gouges (See Table 3.6).

Table 3.6 Artifact comparison Area D and P. Note increase in debitage, cores, groundstone, and identified bifaces in Area D. Six units were analyzed for each area.

Excavation Area	D-96	P-96
# Units	6	6
Bifacial Tools		
Plainview	1	
San Patrice var. St John's	1	
Trinity	1	
Indeterminate dart	1	3
Preform		2
Drill	1	1
Unifacial Tools		
Scraper	3	2
Graver-perforator	1	
Gouge		2
Retouched flake	2	3
Hammer-Ground Stone		
Hammerstone	1	
Groundstone	3	1
Other Materials		
Cores	2	
Debitage	1281	781

Debitage Vertical Distribution: Area D

Since Area D is located in terrace deposits, there is a marked difference in the vertical distribution of debitage when compared to Area P, which is located in floodplain deposits. Figure 3.12 illustrates that the vertical distribution of chert debitage is indicative of post-depositional occupation (Fig. 3.7). In units D-1 and the contiguous units D-3-6, the minute-debitage portion (chert small interior) is highest in level one and decreases down profile. This distribution indicates that Area D is a surfical terrace site occurring on or near the terrace surface and was occupied after terrace genesis (Ferring, 1992). Since occupation occurred on a stable terrace surface, the archaeological record is subject to greater post-depositional processes: Schiffer's (1996) cultural and non-cultural or natural site formation processes, and Butzer's (1982) physical, biogenic, and anthropogenic components.

The sandy nature of terrace deposits at this locality, the presence of abundant krotovina of pocket gophers, and the dip of artifacts indicate that bioturbation is the principal agent responsible for translocation of debitage down profile. However, variations or a discontinuity in vertical distribution of debitage indicates periodicity of occupation. Mitchie (1990) makes the case that older artifacts have more time to descend down profile and that vertical separation of cultural stratigraphy will remain comparatively intact. For example, in unit D1 (Fig. 3.12, Table 3.7) CSI flakes decrease linearly to level four then increase in level five. Similarly, CLI and CLC flakes abruptly end in level three, are absent in level four, and reappear in levels five and six. In unit D2, CSI indicate a buried surface in level two and CLI abruptly increase in level four. As a result, several occupational episodes are indicated in units D-1 and D-2.

In the contiguous units D-3-6 cultural stratigraphy is not as apparent in the chert debitage; however, differences in the quartzite fraction of the debitage does indicate vertical separation (Fig. 3.13). QSI noticeably decreases from level one to level two, remains stable in levels two and three, then abruptly increases in level four. QLI also decreases from level one to level two, is absent in level three, and returns in level four, indicating occupational surfaces at levels one and four.

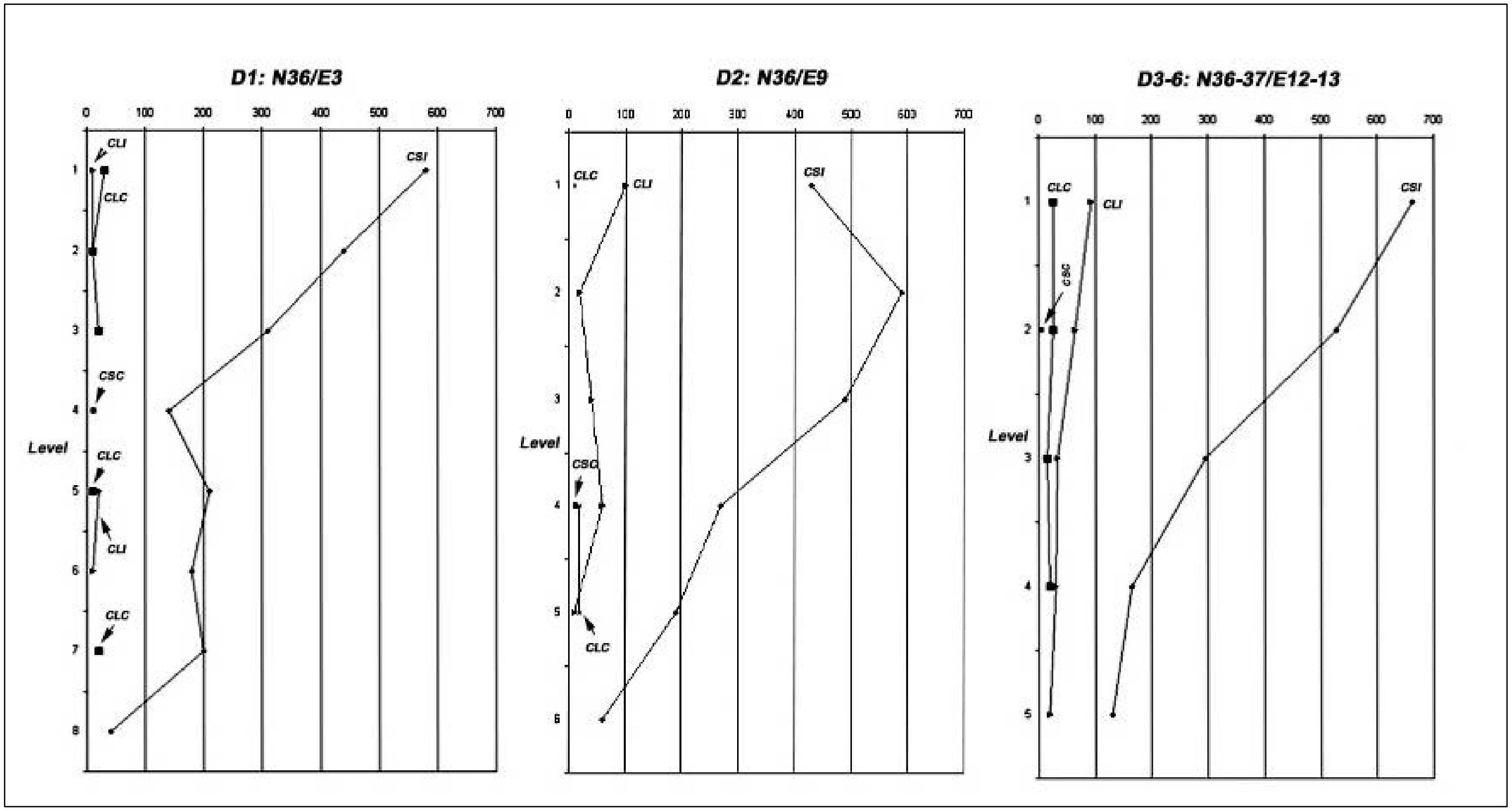


Figure 3.12 Volumemetric density (n/m^3) distribution of chert debitage by level. Note peak in CSI (663/m^3) in contiguous units D3-6 in level one indicating a post depositional occupation. Figure 3.7 shows location of units; units are distributed across 10 meters with a slope of 7cm/m between D1 and D3. Key: C-chert, L-large (>1cm^2), S-small (<1cm^2), C-cortex, I-interior, respectively.

Table 3.7 Chert and quartzite volumetric density by level. Only 2% of debitage is quartzite. Note increase in QLI and CSI in level five unit D-1 and in level two unit D2. These depositional breaks indicate periodicity of occupation and possible occupational surface. See Figs. 3.12-13 for key.

D1 N36/E3

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	Total
L1	10		20		580		10	30	650
L2	10		20	10	440		10	10	500
L3					310		20	20	350
L4					140	10			150
L5			10		210		20	10	250
L6					180		10		190
L7					200			20	220
L8					40				40
							Unit	Total	2350

D2 N36/E9

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	Total
L1			10		430		100	10	550
L2			20		590		20		630
L3			10		490		40		540
L4					270	10	60	20	360
L5					190		10	20	220
L6					60				60
							Unit	Total	2360

D3-6 N36-37/E12-13

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	Total
L1	10	5	8	3	663		93	25	807
L2	3		5		528	3	65	25	629
L3	3	3			295		33	15	349
L4	8		3		165		30	20	226
L5				10	130		20		160
							Unit	Total	2171

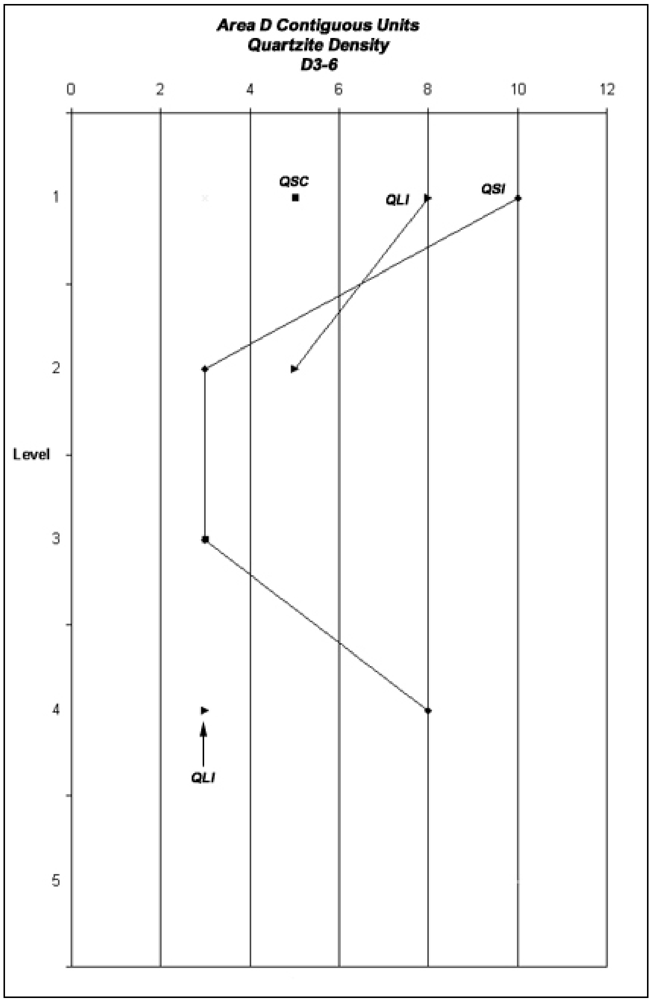


Figure 3.13 Vertical distribution of volumetric density of quartzite debitage. Note breaks in deposition for QSI and QLI. Key: Q-quartzite, L-large (>1cm^2), S-small (<1cm^2), C-cortex, I-interior.

Spatial Relationship of Artifacts: Area D

In view of the fact that area D is a surfical site subject to post-depositional disturbances, cluster analysis is limited and problematic. However, the volumetric density of CSI in unit D-2, level 2, and a fire cracked rock feature in levels two/three of the contiguous units indicates a possible buried component (Fig. 3.12). Based on this evidence, the spatial relationship of artifacts in the contiguous units was plotted for levels 2-3 (Fig. 3.14). Presence of *in situ* hammerstone, a core, large flakes, and a broken/discarded St. John’s projectile suggest that lithic

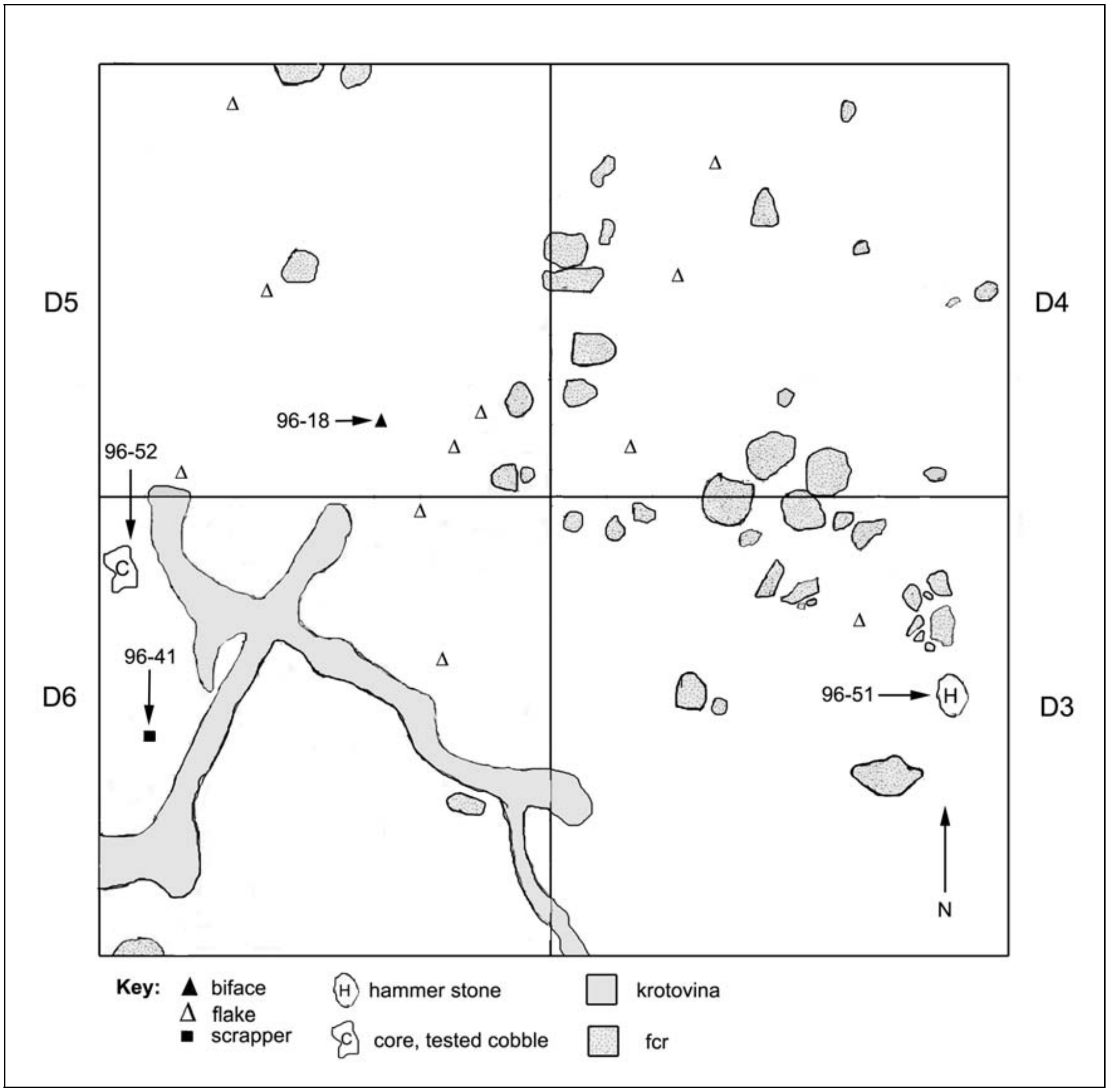


Figure 3.14 Spatial relationship of artifacts and FCR feature in levels 2-3 of contiguous units D 3-6. FCR feature was exposed in level 2 with base of feature in level 3.

Table 3.8 Description of artifacts for Figure 3.14.

Specimen #	Type	Raw Material	Description
96-18	San Patrice var. St. Johns	fossiliferous chert, 2.5Y7/3, light yellowish brown	asymmetrical base, proximal fragment
96-41	scraper, retouched flake	chert, 2.5Y6/1, gray	cortical flake, unilateral retouch
96-51	Hammerstone/core	quartzite, 10YR6/4, light yellowish brown	cobble, unifacial platform
96-52	core	chert, 10YR7/4, very pale brown	cobble, bifacial platforms

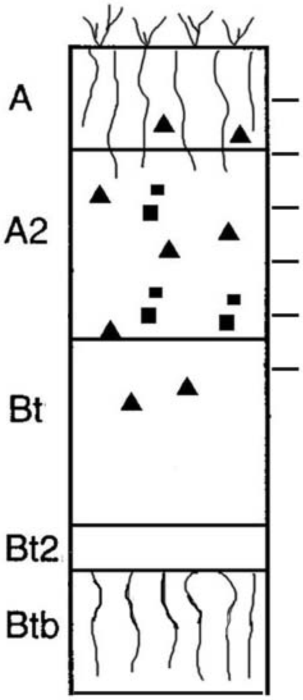
reduction/maintenance activities took place adjacent to FCR feature in units D-5 and D-3. Additional support for this interpretation is evidenced by the fact that units D-5 and D-3 have the highest volumetric densities for area D. Unit D-5 has 680/m^3 and D-3 has 820/ m^3 representing 60% of the excavation block's total volumetric density. Unit D-6 volumetric density was not considered due to presence of krotovina in levels three and four (Fig. 3.14).

Since 98% of the debitage consists of small interior pieces, attempts to refit biface-thinning flakes were unsuccessful. However, raw material analysis of the large flakes reveals some discrete clustering of debitage. For example, the southwest quadrant of D-3 had the highest volumetric density for the unit with a few large interior flakes matched for raw material. Similarly, the northwest quadrant of D-5 had the highest volumetric density for the unit with large interior flakes matched for raw material. Two expediency tools, a scraper on a retouched flake (96-41) and a tested cobble or core possibly used as a chopper (96-52), recovered from D6 could be matched with raw materials from the southwest quadrant of D-5 (Fig. 3.14). Both artifacts appear to be manufactured on site from local stream-worn cobbles. While D-5 contained more cortical pieces than D-3, cortex was generally limited to platform surfaces and only a few primary flakes, thereby indicating that extensive initial reduction was not taking place. Instead, the presence of limited large interior biface thinning flakes, numerous small pressure flakes, and resharpening chips in both units signify tool maintenance and limited biface manufacture from tool blanks of non-local cherts.

Vertical Distribution of Artifacts: Area D

The vertical distribution of all artifacts indicates a post-depositional occupation consistent with the distribution of debitage noted in Figures 3.12, 3.13. Cultural materials are present throughout the A and A_2 horizons and diminish dramatically in the underlying Bt horizon (Fig. 3.15). Since artifact densities decrease significantly in the underlying Bt horizon, the soil was well developed prior to occupation with the Bt horizon restricting the bioturbation of artifacts to greater depths. No archaeological materials were recovered from the buried Btb horizon.

As with Area P, due to the sandy nature of the soil in Area D faunalturbation by pocket gophers, *Geomys bursarius majori,* is the most probable agent of artifact burial. During excavation, krotovina of pocket gophers were common and encountered intermittently thorough out the A and A_2 horizons (Figs. 3.14, 3.15). Approximately half of the flakes and lithic artifacts mapped *in situ* had dip angles of 20 to 90 degrees indicative of bioturbation. Mitchie (1990), argues that despite bioturbation processes, in fine-grained sandy soils, cultural stratigraphy will remain relatively intact since older artifacts will have more time to descend in the profile. This appears to be the case for Area D since a Late Archaic Trinity point (96-19) was recovered in unit D-6, level one, and an Early Archaic St. John’s (96-15) was recovered at greater depth in unit D5, level three. Since smaller objects are more easily moved than larger objects, some degree of mixing is to be expected. For example, a basal fragment of a Plainview (96-17) was recovered from unit D-5, level one, but its small size ($1cm^2$) may explain its presence in this level. Still, the vertical separation of artifacts, breaks in the volumetric density of quartzite debitage, and indications of a buried component in unit D-2 indicate that limited cultural stratigraphy is present.



Level	Flk	Pt	Dr	Sc	Rf	Gs	FCR
1	442	2		1		1	11
2	364				1	1	16
3	228	1	1				36
4	141	1		1	1	1	21
5	79						2
6	15						3
7	12						
Total	1281	4	1	2	2	3	89

Figure 3.15 Shows the vertical distribution of all artifacts for Area D. Note distribution of flakes decrease down profile indicating post-depositional occupations of terrace deposits. Level 3 contains the highest FCR counts. Key: Flk-flakes, Pt-projectiles, Dr-drills, Sc-scraper, G-gouge, Rf-retouched flake, Gs-groundstone, FCR-fire cracked rock, black squares-fire-cracked rocks, black triangles-chert flakes.

Cultural Stratigraphy: Area D

In terms of cultural stratigraphy, level one appears to be a lithic scatter with one isolated Trinity point (96-19), a scraper (96-32), and a mano fragment (96-48). The presence of a basal fragment of a Plainview (96-17) may have been the result of bioturbation. No features were exposed in level one, but FCR was widely scattered throughout all units. The chert debitage varied greatly in raw material but tan to yellow brown (10YR6/4) colored cherts dominate the assemblage. These cherts are commonly found in Brazos River gravels (48 km west) and the Edwards Plateau (142 km south west). Ultraviolet fluorescence does not reveal a difference between the two, both raw materials fluoresce bright yellow-to-yellow brown characteristic of Edwards. Raw material from as far west as Big Springs, Texas has the same fluorence; thus, fluorescence more accurately identifies Cretaceous cherts and cannot be used to delineate exact geographic source. Yet, examination of cortical pieces shows thin rind-like cortex ranging in color from yellowish brown (10YR5/4) to dark yellowish brown (10YR3/8) making Brazos River gravels more probable.

Within level one of the contiguous units, 40% of the volumetric density of debitage was distributed in just three quadrants of two test units; the northwest and southwest quadrants of D-5 and the northwest quadrant of unit D-6. Quartzite debitage consists mainly of hammer spalls from Paluxy gastroliths and small amounts of Ogallala quartzite.

Level two contained just two artifacts, a retouched flake made from a local stream-worn cobble (96-41) and a metate fragment (96-47). There was less variation in raw materials of the chert debitage with a color change to dark grays (10YR5/1), dark browns (10YR4/3), and white (2.5Y8/1) colors more indicative of Edwards chert than Brazos River cobble. Quartzite was similar to level one, and mixing between levels one and two was noted by matching Ogallala quartzite flakes and presence of groundstone in both levels.

Level three appears to be the boundary between the Early and Late Archaic occupations. The fire-cracked rock feature present in levels two-three of the contiguous units was associated with evidence of lithic reduction or maintenance activities and an Early Archaic St John’s biface fragment (96-15, Fig. 3.10). This is a basal fragment; the blade is broken transversely, probably while still hafted, and was discarded on site. The raw material is Chico Ridge chert, a distance of 75 kilometers to the northwest. No debitage of similar raw materials could be matched with this specimen. However, ultraviolet fluorescence of a scraper (96-33) from level four of the same unit and quadrant indicates Chico Ridge as the source area of the raw materials. Both the scraper and the St John's biface are mottled light purple using ultraviolet light. Also, associated with the fire cracked rock feature was a scraper (96-41), a hammerstone (96-51) with unifacial platform flake removal, and a tested cobble or core with bifacial platform flake removals (96-52). All three artifacts were made from local materials and may have functioned as expediency tools manufactured on site; both the hammerstone and core may have functioned as chopping tools. From unit D-2, a drill fragment (96-29) and an atypical scraper/perforator (96-38) were recovered (Fig. 3.10, Appendix B).

Level four was the last unit that contained identifiable tools. In unit D-2, a second basal fragment (96-21) was recovered; it could not be identified to type but heavy basal grinding is indicative of early cultures. Two scrapers (96-33, 43) and a ground stone fragment (96-49) were recovered. The groundstone was small, >3cm^2, and may have been bioturbated to this depth.

In levels five to seven, flake counts dropped precipitously and no diagnostic artifacts were recovered during excavation. Visual inspection and shovel scraping of gully walls adjacent to Area D did reveal the presence of flakes scattered throughout the Bt horizon down to the buried Btb horizon. Additionally, four meters downslope of Area D in gully one, a Late Paleoindian "Quince scraper" (96-14) was found *in situ* with a dip angle of 25^o in the Bt horizon.

In terms of the limited cultural stratigraphy represented in Area D, levels one and two are the most mixed and limited to the Late Archaic period. Beginning with level three, Late Paleoindian and Early Archaic materials are encountered, since older artifacts have more time for bioturbation to depth.

Area M Excavation Results

During preliminary testing in 1990, members of Tarrant County Archaeological Society (TCAS) noted deeply buried bone in gully three (Fig. 3.1, Area M). Size and deep burial suggested great antiquity of the bones, and members of the Dallas Paleontological Society were asked to participate in the excavation. During initial excavation, the bones proved to be ribs of a large animal; further excavation revealed a mammoth mandible and portions of tusk. Once identified and photographed, the mammoth remains were covered with plastic and the area back-filled. Minimal excavation was performed and no material was screened at the time. In 1996, TCAS and members of the Fort Worth Museum of Science and History returned to recover as much of the mammoth as possible and to test for possible archaeological associations. This cooperative effort produced colorful and exhilarating dialogue among the participants.

A total of ten 1x1 meter units were excavated; six by archaeologists; four by paleontologists (Fig. 3.16). A mandible, scapula, portions of the tusks, and maxillary teeth of a mammoth were plaster cast and removed. Unfortunately, no archaeological materials were recovered during the excavation. The faunal remains were identified as those of *Mammuthus columbi*. *M. columbi* is Late Pleistocene in age, ranging from 130-10 Ka (Agenbroad, 1984). Identification as to species was based on a comparison of the maxillary teeth with specimen data from the Colby Mammoth Site (Winkler, 1998, personal communication, Frison and Todd, 1986). It is considered to be an adult using Laws Age Class XVII or XIX, which would make it 30-32 African elephant years old (Winkler, 1998, personal communication, Laws, 1966). Without radiometric dating of the faunal remains, isotopic analysis of carbonates, or associated artifacts, assigning an age to the remains is problematic. However, a minimal age of between

10,000 to 12,000 years ago can be established, since there is general agreement that mammoths disappeared from North America during this period (Agenbroad, 1984).

Mammoths *(M. columbi)* appear to be widespread with the heaviest concentrations within the Mississippi valley from the Great Lakes through Texas and Arizona. The west coast and Florida also have relatively high concentrations. Figure 3.17 shows the distribution of mammoth sites in Texas. Based on coprolite analysis, mammoths are considered open country grazers with a diet of 95% grasses and sedges with the remainder a mixture of riparian shrubs (Mead *et al*, 1986). Mammoths occupied regions that can be characterized as a mosaic of grassland-savanna-woodland environments.

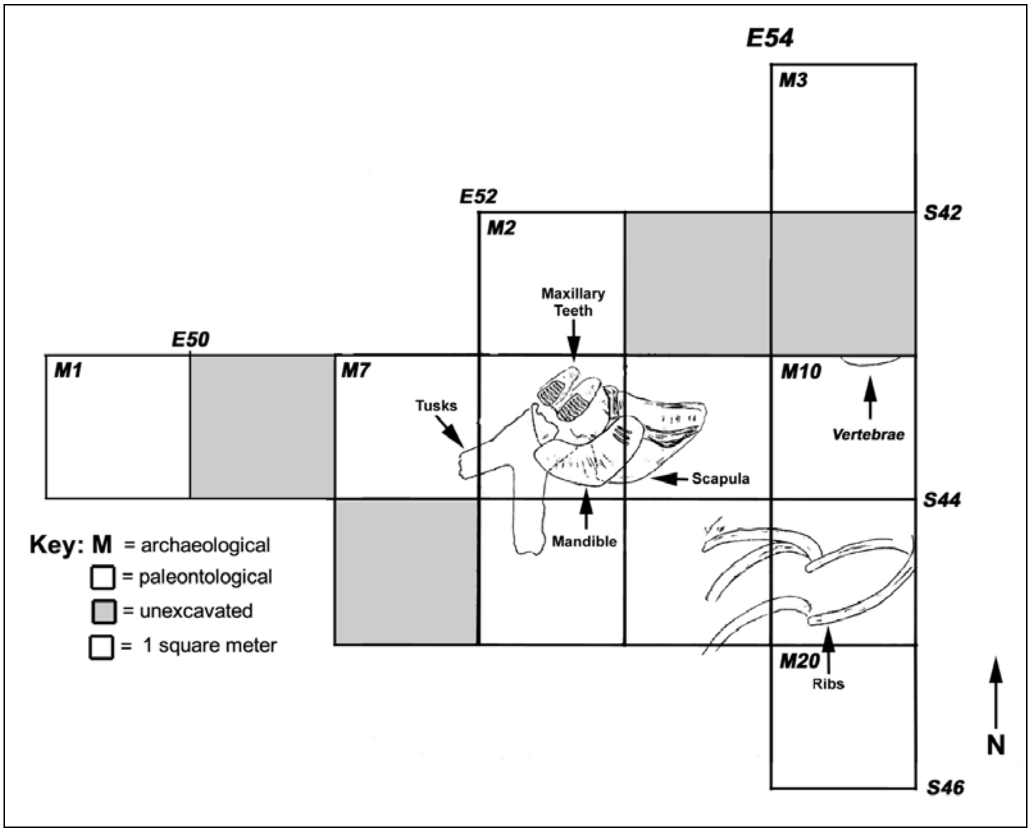


Figure 3.16 Area M excavation grid. Six units designated M# were excavated by archaeologists in quadrants with level control. Paleontologists, using their own idiosyncratic methodology, excavated the other units. However, matrix from all units was water-screened through 1/16th inch mesh. See Figure 3.1 for grid location.

Mammoths and Archaeology

Late Pleistocene humans encountered multiple proboscidean taxa in the Americas. The three most common species in North American were the Columbian mammoth (*Mammuthus columbi),* the woolly mammoth (*Mammuthus primigenius),* and the American mastodon (*Mammut americanum*). Since the 1930s discovery of the Dent site in Colorado and the Clovis type-site in New Mexico, North American archaeologists have focused on the interaction of humans and mammoths (Wormington, 1957).

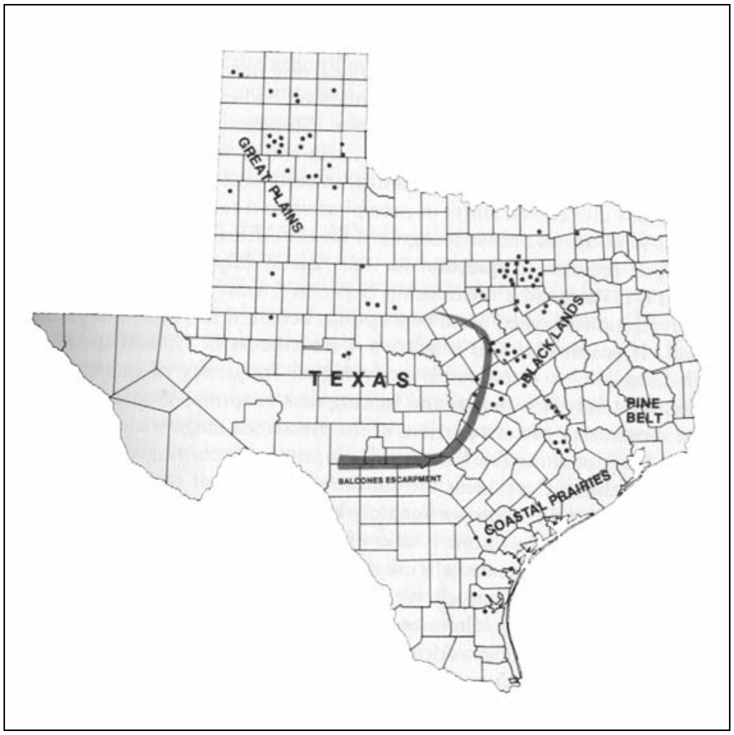


Figure 3.17 Shows the distribution of mammoth sites in Texas. Note high concentrations in Dallas and Tarrant Counties, along the eastern edge of the Balcones Escarpment, and the High Plains regions. (modified from Fox, *et al*,1992).

The cause of the extinction of mammoths and numerous other Pleistocene animals from North America is still being debated. Martin (1984) has argued for human overkill as the causative factor; others dispute overkill and argue for an environmental cause. Grayson and Meltzer (2002) contend that since only 12 Clovis sites contain remains of mammoths there is no evidence to support the argument that people played a significant role in causing Pleistocene extinctions. Ten sites from Texas are mentioned in their research: Aubrey, Bonfire Shelter, Duewell-Newbury, Gault, Kincaid Rockshelter, Lewisville, Lubbock Lake, McLean, Midland, and Miami. Since Grayson and Meltzer's primary focus of analysis was Clovis-aged archaeological associations that demonstrated hunting of extinct mammals, only the Miami site was included in their analysis. The Miami site, excavated in 1937, is buried in the basin fill of a small playa located on the open surface of the Llano Estacado. The site contained the partial remains of five mammoths associated with three Clovis points and a scraper found among the remains. The bone bed probably dates to ca. 11,400-10,500 BP (Holliday, *et al*, 1994).

Other Mammoth Sites

While mammoth sites with clear archaeological associations are quite limited in Texas, mammoth finds are fairly common, especially of isolated teeth. Data from teeth suggest a 20:1 ratio of mammoth to mastodon in 40-25 ka contexts (Fox and Redder, 1992). As early as 1921, Lull reported 13 mammoths in terrace deposits of the Trinity River in Dallas. Slaughter, *et al* (1962) reported an additional 15 semi-articulated skeletons near the same location. Both sites represent herd sites from riparian settings, which is not surprising since mammoth localities correlate highly with water resources. Adult elephants require at least 35 gallons of water daily (Fox, *et al*,1992). An additional example of herd bunching is the Waco Mammoth site on an oxbow lake between the Bosque and Brazos rivers in McLennan County, Texas. The bone assemblage represents a young matriachal herd of 15 individuals led by one or two females. These mammoths died in a single event radiocarbon dated to 28,000 ka. The cause of their demise is problematic and numerous hypotheses have been suggested (Fox, *et al*, 1992).

Carr Mammoth

Isolated finds are more commonly reported; the Carr mammoth represents a single individual, but like the herd sites, it is associated with a riparian setting. The mammoth was deposited on a gravelly loam point bar of the paleo-channel described in Chapter Two, page 64. The mammoth is located in Gully 3 between Profiles 2 and 3 in Stratigraphic Unit Ib that represents a fining upward sequence of channel deposits (Figs. 2.7, 2.9, 3.1). The top of the mandible had an elevation of 99.30 m and elevation at the top of the ribs was 98.92 m. Figure 3.18 illustrates that the mammoth ribs, scapula and cranium were on top of the gravel deposits of horizon 2Bckb shown in profile two. However, all the bones were covered by the over lying Btckb clay-loam horizon materials represented in profile three. The bones were in variable states of preservation the tusks and ribs in the poorest condition and the denser bones of the mandible, cranium and scapula in fair condition. As a result, detailed taphonomic studies could not be accomplished but the distribution of the bones offers taphonomic evidence of their final deposition. The cranium was upside down and extended into the 2Bckb; it was not completely excavated but appeared to be intact. The mandible was close to correct anatomical position but, like the cranium, was upside down. One scapula was close to the correct anatomical position with the glenoid process up. The ribs were between one and two meters from the cranium with the rib heads all oriented to the northeast. Notably absent are the larger elements such as the femurs, humeri, and pelvis. Their absence may be the result of limited excavation (only eleven units) or erosion and subsequent exposure to weathering since gully two bisected the depositional unit.

In wet environments, decomposition and disarticulation are accelerated with disarticulation proceeding from the extremities inward (Fox, *et al*,1992, Toots, 1965).

Experimental studies of fluvial transport of elephant bones by Todd and Frison (1986)

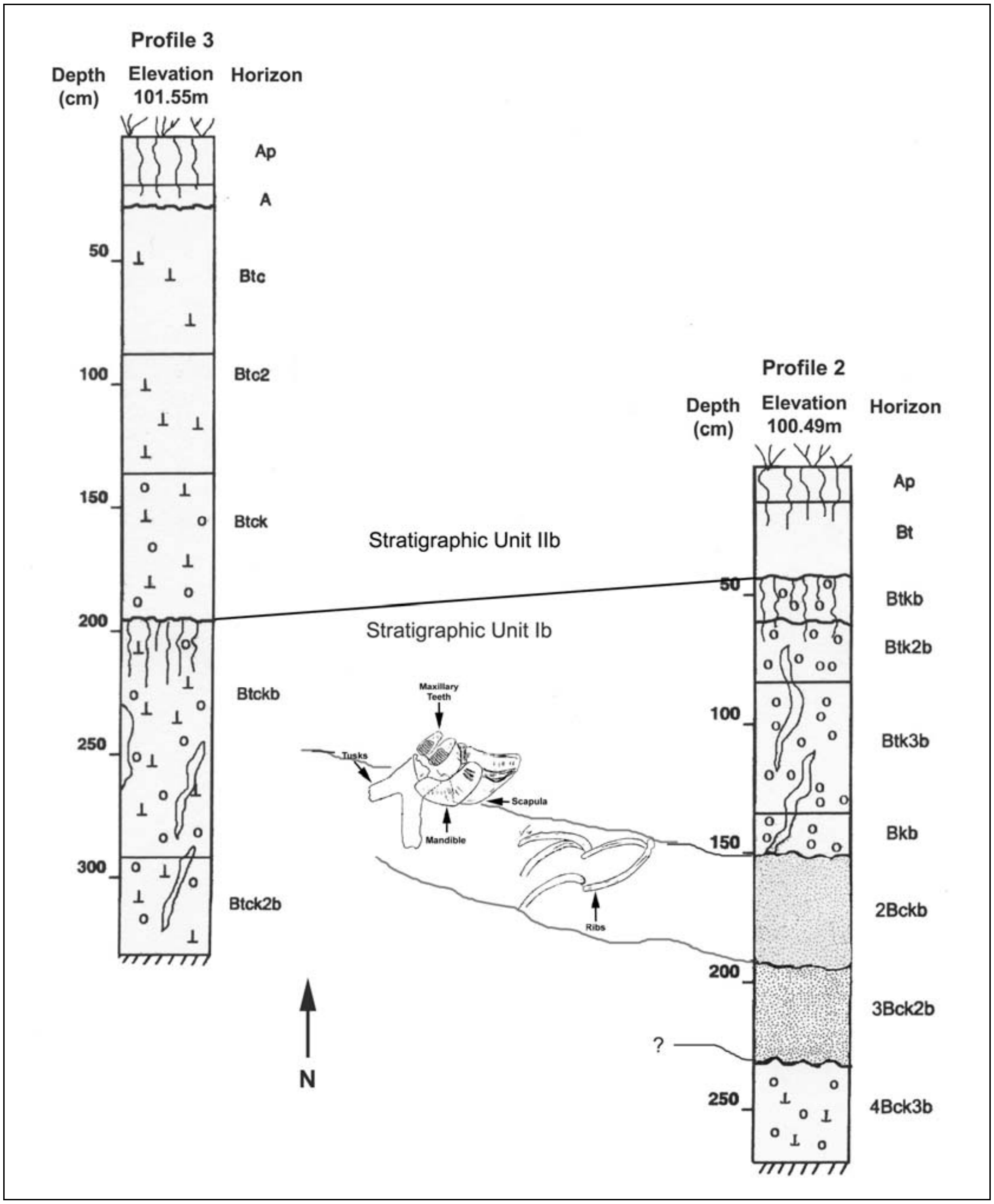


Figure 3.18 Distribution of mammoth bones contained in stratigraphic Unit Ib. The bones were distributed across three meters of point bar deposits represented by the 2Bckb horizon and covered by the overlying Bkb abd Btk3b horizons shown in Profile 2.

(cont.) provide evidence that fluvial transport distributes bone at differential rates and distances.

Their study of fluvial transport of elephant bones compare favorably with the general pattern of transport found by Voorhies (1969) for smaller animals. Skulls and mandibles are the least transportable group; intermediate transportable elements are the femora, tibiae, humeri, metapodials, pelvises, and radii; highly transportable elements are the ribs, vertebrae, sacrum, patella, astragalus, and vertebrae (Frison and Todd 1986).

Since skulls and mandibles are the least transportable elements due to size and density, their location should be upstream relative to the highly transportable ribs and vertebrae. As noted earlier, ribs were one to two meters to the southeast of the skulls. The scapula with the glenoid oriented upstream is a relatively stable element (Frison and Todd, 1986) and it was oriented to the northwest. Thus the paleo-channel was flowing from northwest to southeast (Fig. 3.18). Geologic evidence supports this interpretation since the channel gravel deposits pinch out of the to the west (unit 2Bckb, profile two). The ribs and one vertebra (Fig. 3.17) were located a short distance from the skull indicating that water velocities were too low to carry them a great distance. At higher velocities, ribs tend to orient parallel the channel flow, since the heads and tubercles of ribs are the heaviest and tend to catch on the channel surface causing the lighter rib blade to move downstream. Additionally, the heads of all the ribs were oriented to the northeast and perpendicular to channel flow indicating that they may have been deposited as a unit with some skin still intact (Fox, *et al*,1992). The distribution and orientation of the elements of the Carr mammoth indicate that it was not subject to extensive post-deposition depositional disturbance. All bones were covered by overlying Btckb clay-loam (Profiles 2-3, Fig. 3.18) indicating a high rate of sedimentation associated with channel migration to the east.

CHAPTER 4

SYNTHESIS

Introduction

The purpose of this chapter is to summarize the result of geoarchaeological investigations at the Carr site, 41PR26, and to examine the site within the regional context of the Upper Trinity River basin. Comparisons will be drawn with respect to previous investigations of the East and Elm Forks of the Trinity River in terms of archaeology, geology, and late Quaternary paleoenvironments. Beginning with the 1970s, extensive archaeological and geological investigations were conducted by area universities associated with new reservoir construction along the Elm and East Forks of the Trinity contributing significant insight to the regional prehistoric record. Along the West and Clear Fork of the Trinity, reservoir construction preceded regulatory requirements for cultural and environmental impact studies. As a result, the West Fork of the Trinity, its tributaries, and the Rolling Plains are often considered the “black-hole” of Texas archaeology. Investigations at the Carr site shed some light on the region.

Archaeological Discussion

The site is an archaeological-paleontological locality that was first investigated in 1990 by Tarrant County Archaeology Society (TCAS). This organization opened fifteen scattered units, surface collected artifacts, found a deeply buried mammoth, and recovered a total of 469 artifacts including debitage (389). A joint project was organized in 1996 with TCAS, UNT, and the Fort Worth Museum of Science and History to investigate the archaeology and to test the mammoth for possible archaeological associations. A total of eighteen units were opened and surface collections conducted with a total of 6,405 artifacts recovered, including debitage

(6,355). Disparities in artifact totals were the result of methodological differences. In 1990, quarter-inch screens were utilized; in 1996 all matrixes were fine-screened. No diagnostic artifacts were recovered during excavation in 1990; excavation results are summarized in Appendix B and are not addressed in this analysis. Since numerous diagnostic artifacts were surface collected in 1990, they are included with the results of 1996 investigations to illustrate the overall chronological and stylistic variation of the diagnostic artifacts from the site (Figure 4.1, Table 3.1). The Carr site is unique in that it is the only recorded and tested Paleoindian site in Parker County, and it contains a mammoth in an upland setting (see Table 1.1).

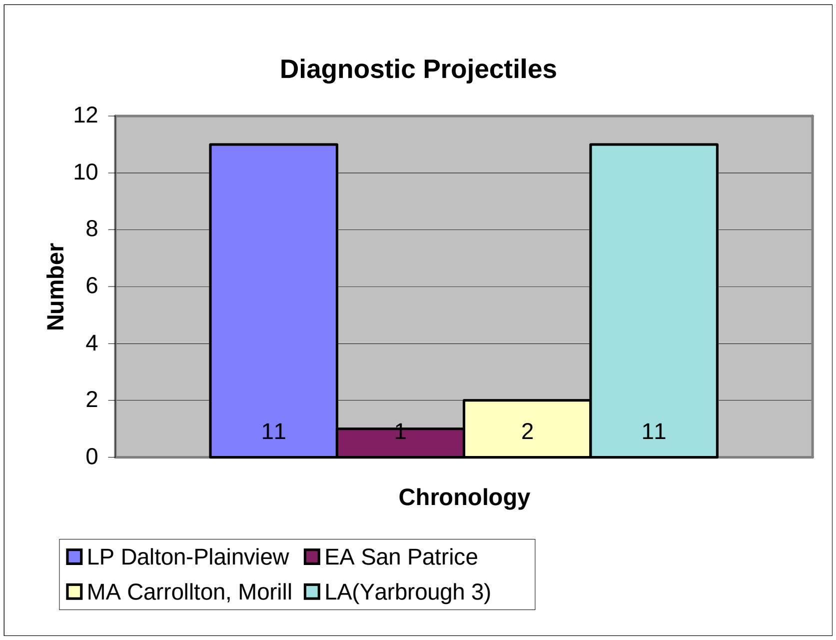


Figure 4.1 Summary of projectile points. Note the equal number of Late-Paleoindian (L.P.) and Late Archaic (L.A.) projectiles. One Early Archaic (E.A.) and two Middle Archaic (M.A.) projectiles were recovered. Late Archaic projectiles are represented by single specimens with the exception of Yarbrough (3) and Ellis/Edgewood (2). No Late Prehistoric projectiles were present.

Late Paleoindian: 10,000-9,000 BP

Regionally, with the exception of the Aubrey and Lewisville sites, Paleoindian sites are known mainly from surface collections, with Dalton and Plainview points (Fig. 1.11) being the most common in this region (Prikryl, 1990). Within their homelands, Dalton dates from 10,700 to 10,200 BP; in Texas, Plainview dates to 10,000 BP (Morse, 1997; Johnson, 1987). The Dalton-Plainview association suggests that this region was a borderland connecting the western Plainview culture of the High and Rolling Plains with the Dalton culture to the east (Johnson, 1987; Johnson and Holliday, 1980). At this locality, Dalton materials outnumber Plainview nine to two, respectively. Thus, Dalton groups utilized this locality more intensely than Plainview groups. Of the eleven Dalton bifaces, only one was complete, the Quince scraper; three were extensively reworked and may have been discards; the remainder were fragmentary. Two Plainview artifacts were basal fragments and probably represent discards associated with curation activities. The fragmentary nature of the Dalton and Plainview assemblages suggests that both groups may have used the locality as a hunting camp. However, the site may have been more residential in the case of Dalton based on the large number of artifacts recovered.

The distribution of Late Paleoindian surface artifacts is quite limited when compared to Late Archaic artifacts (Fig. 4.2). The paleo-artifacts were distributed along a north-south axis at the 104m topographic interval with the heaviest concentrations found on the south side of gully one and the north side of gully two. The location is mid-slope and would have been intermediate between the seep springs and the drainage channel.

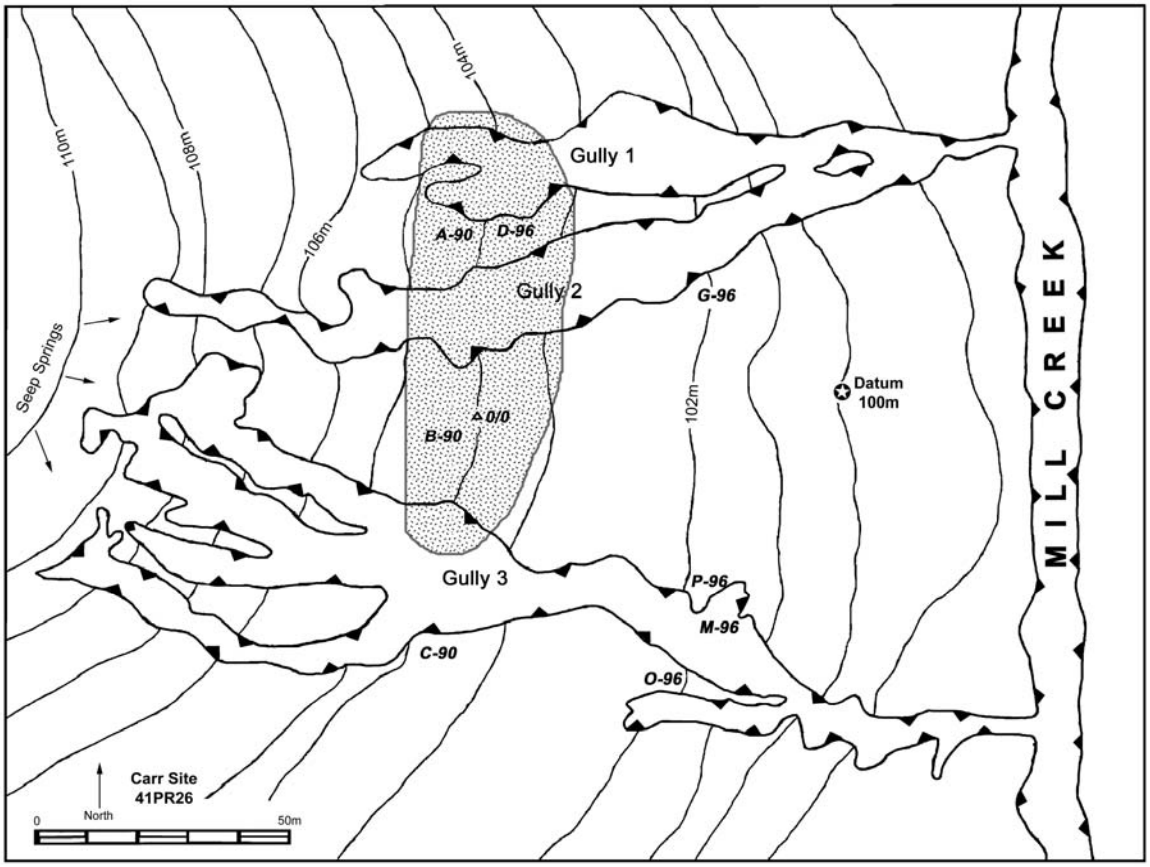


Figure 4.2 Site map showing the distribution of paleo-artifacts found during surface collection (stippled area). Archaic artifacts were widely distributed across the site but generally found below the 104m topographic interval.

Early and Middle Archaic: 6,000-3,500 BP

In addition to being the only recorded Late Paleoindian site in Parker County, the Carr site is now the only recorded site with an Early Archaic component. A Saint Johns variant of a San Patrice projectile point was recovered during excavation of area D (level three, D-5). In Louisiana and southeast Texas, the Dalton equivalent is San Patrice. St. Johns is thought to occur later in the San Patrice tradition and may be the precursor to the Early Archaic Keithville and Kirk side-notched (Morse, 1997, Johnson, 1989). The point is similar to those found at Horn Shelter No. 2 on the Brazos River. The St. Johns variety is not well dated, but Morse (1997) places San Patrice in Louisiana an East Texas between 9,800-9,700 BP.

Prior to this investigation, three Middle Archaic sites were recorded in Parker County. Surface collection at the Carr site yielded two Middle Archaic projectiles, a Carrollton and a Morrill increasing the number of Parker County sites to four. Carrollton is commonly found in the Upper Trinity River region, but Morrill is less common and geographically constrained to East and East Central Texas (Prikryl, 1990).

Late Archaic: 3,500-1,250 BP

Notably, the Carr site contains an equal number of Late Paleoindian and Late Archaic projectile points. This ratio contrasts sharply with surface collections of terrace localities in the eastern Upper Trinity River basin. Along the Elm and East Forks of the Trinity, Late Archaic projectile points are two to three times more numerous than any other archaeological period (Prikryl, 1990). Adjacent regions reflect the similar increases in Late Archaic site density (Ferring, 1988; Prewitt, 1983; Skinner, 1981). The dramatic increase in Late Archaic site densities suggests that populations expanded during this period. Sites of this age are very common along the Trinity as a result of shallow burial below floodplains (Ferring and Yates, 1997). Eleven Late Archaic projectile points were identified; Yarbrough (3) and Ellis/Edgewood (2) was the most common. Single specimens represent the remainders: Elam, Godley, Kent, and Trinity, commonly found in the region; Williams and Castroville, customarily found in Central Texas. Notably absent is the Gary point, the most common Late Archaic projectile, found in the Upper Trinity River region (Prikryl, 1990). The relatively small number and diversity of Late Archaic projectile points indicate that this locality was not extensively utilized for residential camps and may have been occupied on a seasonal or logistical basis.

Other Materials

The most numerous tools were scrapers; both side and end scrapers are present and often occur in combination (Fig. 4.3). The second most abundant tool was retouched flakes, a rather nefarious category, so only those with distinctive retouch are included. Scrapers and retouched flakes are associated with cutting-butchering activities. The remaining categories: burins, drills, gravers, gouges, and perforator/spoke-shaves are best considered multi-purpose tools with a range of functional uses. Generally, these tools are thought to be utilized with materials such as bone, wood, and hide. The burins, gravers, and perforator/spoke-shaves were all found adjacent to Area D and are consistent with tools associated with other paleoindian sites (Fig. 4.2). Of special interest are the two perforator/spoke-shaves (90-96, 96-38); these are unique items made on identical raw materials. Artifact 90-96 was recovered in Gully 2 and artifact 96-36 was recovered in unit D-2 level three, the same level in which other late Paleoindian artifacts were recovered. It would appear that both artifacts were made by the same knapper and could represent a new Paleoindian tool type (Figs. 3.4, 3.10).

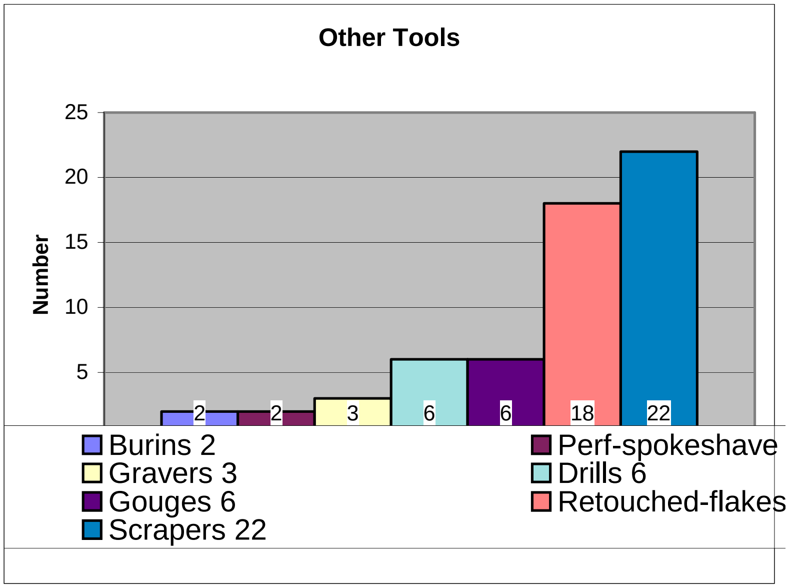


Figure 4.3 Variation in tools from the site. Note the large number of scrapers and retouched flakes.

Few groundstone artifacts were recovered; only four fragments of groundstone and five manos were present (Fig. 4.4). Manos were fragmentary or well worn and may represent discards. Groundstone technologies were not present until the Late Archaic period, and their limited numbers suggest that the site was not used extensively during this period for processing plant foods. Cores, hammerstones, and dart preforms indicate that tool manufacture was taking place, but was apparently quite limited during all cultural periods. Small numbers of cortical debitage (1%) indicates that initial reductions had taken place elsewhere. Eleven cores were present but this is a relatively small number considering that occupations began ca. 10,000 BP. Two of the eleven cores were local Paluxy quartzite gastroliths, one was a small Ogallala pebble, and the remainder was chert.

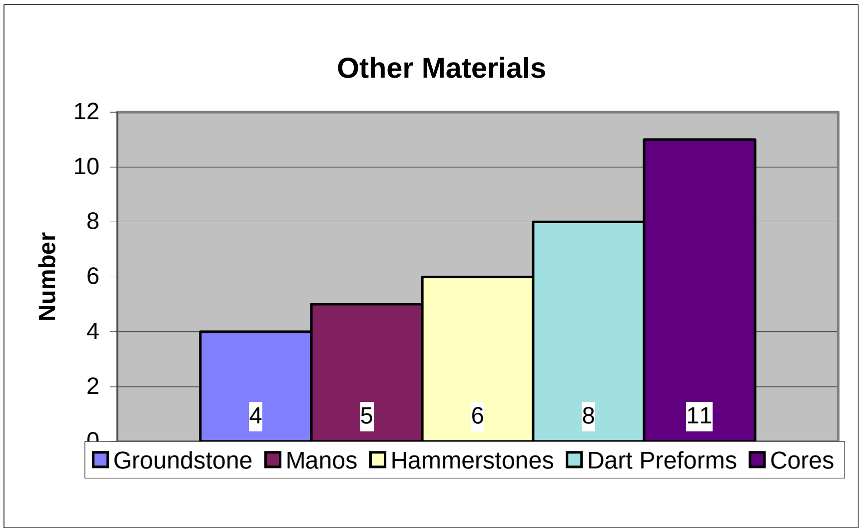


Figure 4.4 Graph of other materials recovered during surface collection and excavation. Note the relatively few number of groundstone/manos. Hammerstones were local Paluxy gastroliths. The small number of dart preforms and cores indicate limited manufacture of lithic tools.

Raw Materials

In terms of both tools and debitage, the dominant raw material is chert. Of the twenty-four identified projectile points one, the Morrill, is Ogallala quartzite, one an Elam is petrified wood, and one indeterminate dart point is jasper. Thus, only 12% of the identified points are made from non-chert materials. Analysis of debitage showed an even more dramatic raw material difference; less than 1% (0.8%) of the debitage was quartzite. Additionally, the quartzites were mainly from local Paluxy gastroliths and appear to be hammer stone spalls. Only a few flakes were identified as Ogallala quartzite, indicating its limited use at this locality. Prikryl (1990) analyzed the use of raw materials from surface collections focusing on the relative percentages of quartzite and chert used in the manufacture of projectile points. His results indicate a heavy reliance on local quartzites for the Late Archaic period. Prykryl's data is consistent with data from excavated, *in situ,* sites from lake Ray Roberts and Lewisville (Ferring and Yates, 1998, see Table 1.2). In contrast, chert is the dominant raw material at the Carr site.

Three sources of flint were identified: the Edwards Plateau, the Brazos River, and Chico Ridge (Banks, 1990). The chert debitage varied greatly in raw material, but tan to yellow brown cherts is the most common. These cherts are commonly found in Brazos River gravels (48 km west), and the Edwards Plateau (142 km southwest). Both Brazos River and Edward Plateau cherts are Cretaceous in age. Chico Ridge (75 km northwest) is Pennsylvanian in age and is fossiliferous ranging in color from gray to brown. A small number of unidentified raw materials, considered exotic to the region, included chalcedony, silicified shale, and chert breccia, representing source areas from greater distances.

Site Formation and Geologic Context

Detailed analysis of excavation results for Area D and P have been discussed previously in Chapter 3, and will not be extensively reviewed. The focus, instead, is to illuminate the interplay between the geologic context and the archaeological record. Two areas were tested at the Carr site. Area D is located in terrace deposits; Area P is in floodplain deposits; this difference in geomorphic settings resulted in distinctive vertical distributions of debitage (Fig. 4.5).

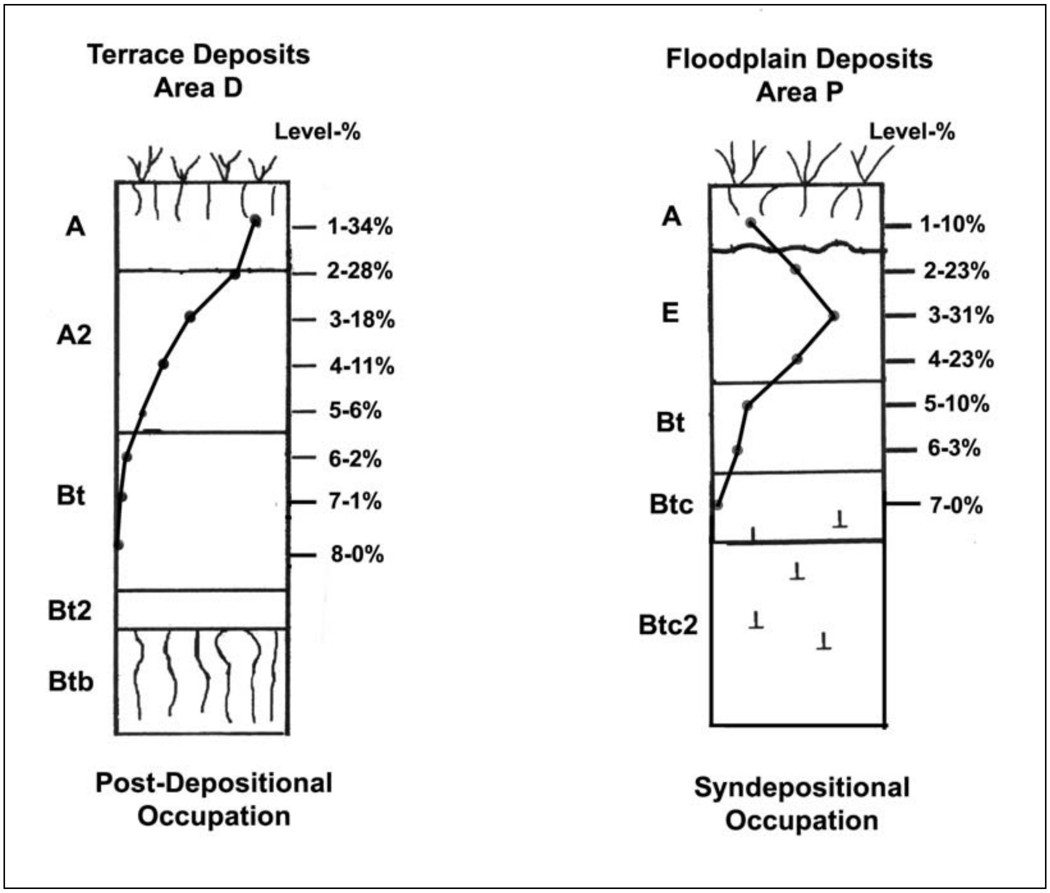


Figure 4.5 Illustration showing vertical distribution of debitage totals for Areas D and P. Note that the highest frequency of debitage occurs in level one Area D indicating a post-depositional occupation. In contrast, Area P has the highest frequency in level three indicating a syndepositional occupation.

Area D is a surfical terrace site occupied after terrace genesis and soil formation. Occupation occurred after the sediments were in place and the underlying Bt horizon was at least weakly developed as evidenced by the dramatic decrease in artifacts (3%) within the Bt horizon. Once a well-developed Bt horizon is in place it retards further Translocation of artifacts down profile. Terrace occupations are subject to greater post-depositional site formation processes, especially in the upper levels where materials are subject to mixing, particularly by faunal bioturbation (Fig. 3.14). Despite the sandy texture of sediments, cultural stratigraphy may be intact since older materials will have more time to be translocated down profile. This is the case in Area D, where levels one and two are highly mixed and limited to the Late Archaic period. Then, beginning with level three, Late Paleoindian and Early Archaic materials were encountered.

Area P is a buried site with the highest concentration of artifacts occurring in level three, thereby representing a syndepositional occupation. That is, occupation occurred while soil genesis was taking place in conjunction with a high rate of sedimentation. As a result, the occupational level was buried, thereby preserving the primary spatial relationship of artifacts as measured by small interior flakes (Fig. 3.8). Consequently, there was less vertical displacement of cultural materials as compared to Area D since the majority of archaeological materials were confined to levels 3 and 4 (Fig. 3.11). Unlike area D, soil genesis may not have been as advanced at the time of occupation since a greater frequency of artifacts were recovered in the Bt horizon (13%). The high rate of sedimentation in Area P increased its research potential since primary spatial relationships of artifacts were preserved. Additionally, it reinforces the need for excavation awareness in the field whereby buried occupational surface are discovered early on and not later back in the lab.

Proposed Geologic History

The intention of this discussion is to briefly characterize the Mill Creek drainage basin and to interpret the Late Quaternary geology of the site locality by finding the best-fit explanation of its development within the regional framework of the upper Trinity River basin

(Ferring, 1994). Direct comparisons are inhibited by the lack of comprehensive investigation of small tributaries like Mill Creek, absence of bore hole data, suitable dating of sediments, and differences in channel morphology.

Hill (1901) was the first to note the “adolescent” nature of the Trinity River having formed in the upland plains intervening between the older drainages of the Red and Brazos Rivers. Similarly, Mill Creek is an adolescent tributary of Silver Creek. Both are resequent streams of the West Fork of the Trinity River (Bloom, 1991). Stream down-cutting into soft Paluxy sandstone created a dendritic drainage pattern with a main channel that runs approximately 6.5 miles with a local relief of 625 feet yielding a fairly steep channel gradient of 49 feet per mile. The Mill Creek channel is essentially straight. In the upper reaches bedrock channel gradients are steep, in the lower reaches the channel is alluvial and gradients diminish (Figs. 4.6). The valley form is concavo-convex with erosional topography found in humid mid-latitudes (Butzer, 1982).

In straightforward terms, genesis of the Mill Creek basin is a function of bedrock controls and fluvial response to climatic change. The entire drainage is underlain by Cretaceous calcareous and siliciclastic bedrock. The Walnut Fm. is an indurated limestone consisting of clays and shell aggregates; the Paluxy Fm. is weakly cemented, fine-grained sandstone and sandy shales. Differential resistance to erosion controls valley morphology. The Walnut bedrock, an important source of clays, calcium carbonate, and shell aggregates, is highly resistant to erosion and forms the irregular ridge system above the drainage. The poorly cemented Paluxy bedrock provides sand, silt, and clay sized particles, is less resistant to erosion, and forms gently sloping valleys. Thus, the rate of erosion is an obvious factor in geomorphic evolution at this locality and is primarily a function of climate. With increased effective

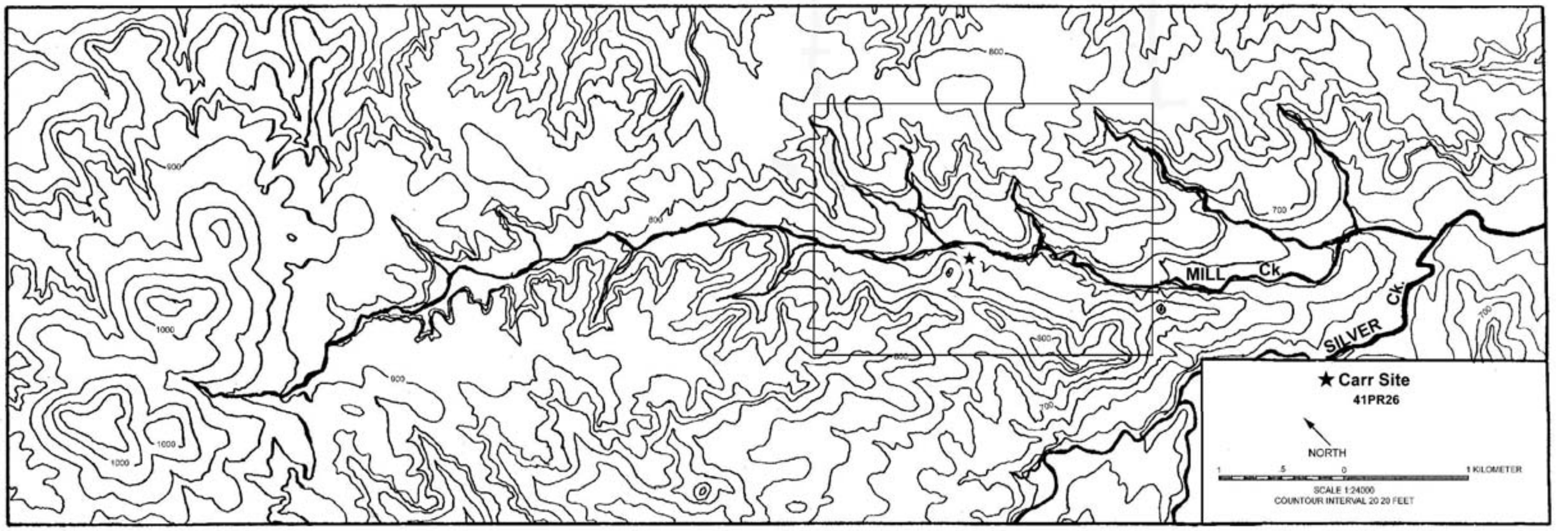
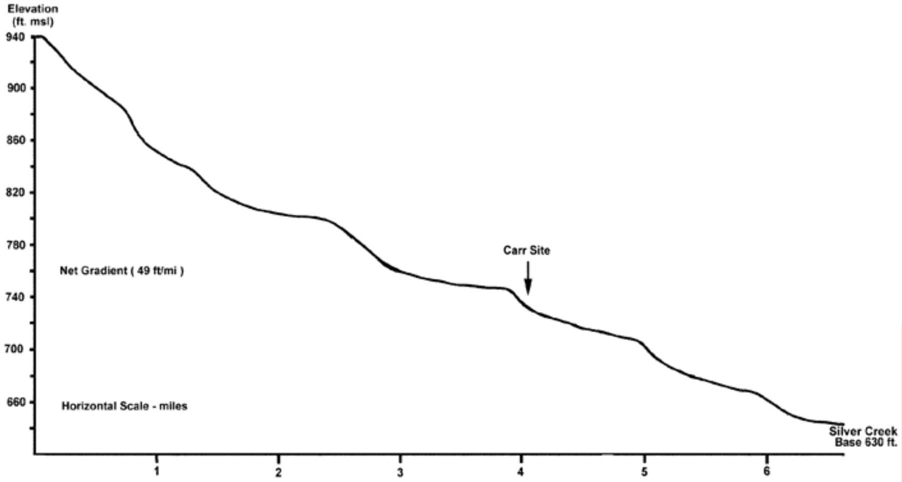


Figure 4.6 Topographic map of Mill Creek drainage and channel slope. Note the essentially straight channel morphology and steep gradient of the drainage. See Fig. 4.7 for detail of topographic inset.



precipitation limestones weather at higher rates, a necessary prerequisite for removal of the Walnut bedrock prior to valley formation.

Initial Channel Development

Incipient formation of Mill Creek began with initial removal of overlying Walnut limestones exposing the Paluxy sandstone to weathering. First noted by Hill (1901), area streams with similar bedrock controls have crescent shaped erosional areas at the boundary between the Walnut and Paluxy formations. Once exposed, the soft sandstone quickly erodes facilitating dramatic headward erosion of the Walnut limestone by mass wasting with lateral erosion occurring at a much slower rate. This process creates deep, narrow channels with little initial lateral migration of streams. This process can be seen at the 750 contour intervals up stream from the site. Figure 4.7 shows the site location in detail with fairly steep slopes to the west and gentler slopes to the east. This evidence suggests lateral channel migration to the east leaving sandstone and sediments in place for subsequent pedogenesis.

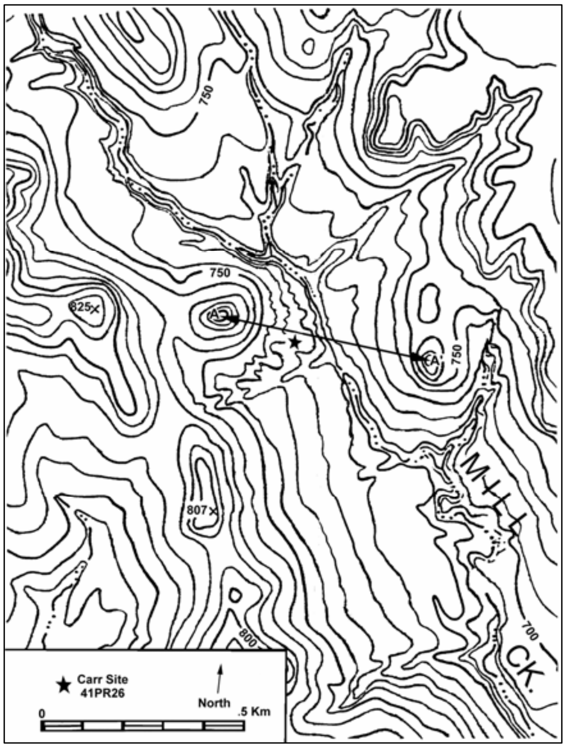


Figure 4.7 Topographic map showing narrow channel morphology of Mill Creek and site location. The 750' contour interval approximates the Walnut-Paluxy contact. Note steep slope to west and gradual slopes to east. Dark line indicates transect for Fig. 2.4.

Late Pleistocene Buried Surfaces: Stratigraphic Units Ia and IIb

Figure 4.8 shows the topographic and stratigraphic sequence of the Carr site. Two buried stratigraphic units are present; Unit Ia is a buried terrace, while Unit IIb is a buried floodplain. While the exact temporal relationship between the two units cannot be firmly established, the units represent the earliest geomorphic features at the site.

Stratigraphic Unit Ib

Unit Ib is indicative of the earliest incision of Mill Creek into bedrock (Profiles 2-4). Time of incision is uncertain, but Unit Ib is early in the sequence based on its stratigraphic position, degree of pedogenesis, and faunal remains of *Mammuthus columbi*, which are Late Pleistocene in age ranging from 130-10 ka (Agenbroad, 1984). Thus, initial down-cutting and channel formation were well developed prior to deposition of the mammoth, and the alluvium is at least Late Pleistocene in age.

The great age of Unit Ib is further supported by the extensive pedogenesis expressed in Profile 2 (Fig. 3.18). The unit represents a fining upward sequence of alluvial deposits with basal gravels unconformably overlain by loam. This depositional sequence indicates channel abandonment followed by a high rate of deposition. Following deposition of sediments, an extended period of surface stability is indicated by extensive pedogenesis. Massive, coarse, angular and subangular blocky structure, abundant calcium carbonate and ferro-manganese concretions characterize Unit Ib.

The upper boundary of this unit is a erosional surface caused by later channel migration or gully formation. Timing of this erosional event is problematic, but a Late Holocene age is proposed based on crosscutting relationship of Unit Ib to terrace Units Ia and IIa, presence of Late Archaic artifacts, and regional climatic reconstructions (Fig. 4.8).

Stratigraphic Unit Ia

Unit Ia is a buried Paleustalf; it is Late Pleistocene in age based on its spatial and stratigraphic relationship to Unit Ib and extent of pedogenesis (Profiles 5-9). The geologic history of this unit is not as straightforward as Unit Ib, since there is no associated fauna and basal parent materials were not found in the middle reaches of gully system. Figure 4.8 shows some evidence of colluvial deposition in the form of sandstone fragments in Profiles 7-9; the remainder of the unit appears to be alluvial in nature. A few fragments were found in Profile 5, but this profile is from a separate gully on the northern edge of the site (Fig. 2.7). The great age of this unit is evidenced by rubification (10R4/8), massive coarse angular blocky structure, and thickness of Bt horizon. Regional soils with basal sandstones are less than two meters in thickness (Duffau and Windthorst series, Fig. 2.8), while the argillic horizons at this locality are greater than two meters and maybe as much as three meters based on auger holes placed at the base of Profiles 6 and 7. A comparison is drawn from Paleustafs on the Hickory Creek terrace adjacent to Isle du Bois Creek, which have thick red argillic horizons in excess of two meters (profile 455-A, Ferring, 1998). At this locality soils formed in alluvial parent materials derived from Woodbine sandstone and to that extent are similar to Unit Ia sediments derived from Paluxy sandstones. The gravel, sand, and loamy alluvial fill of Hickory Creek terraces reveal a prolonged period of alluvial deposition and are estimated to be Middle Wisconsin in age, ca. 70-28 ka. While a direct correlation cannot be made, similarities in parent materials and degree of pedogenesis are striking. Both profiles have thick red argillic horizons in excess of two meters, massive angular and sub-angular blocky structure, and FeMn stains and concretions. The comparison at least confirms the great age of Unit Ia and advances the hypothesis that the Mill Creek drainage may have its origins in the Middle Wisconsin glacial period.

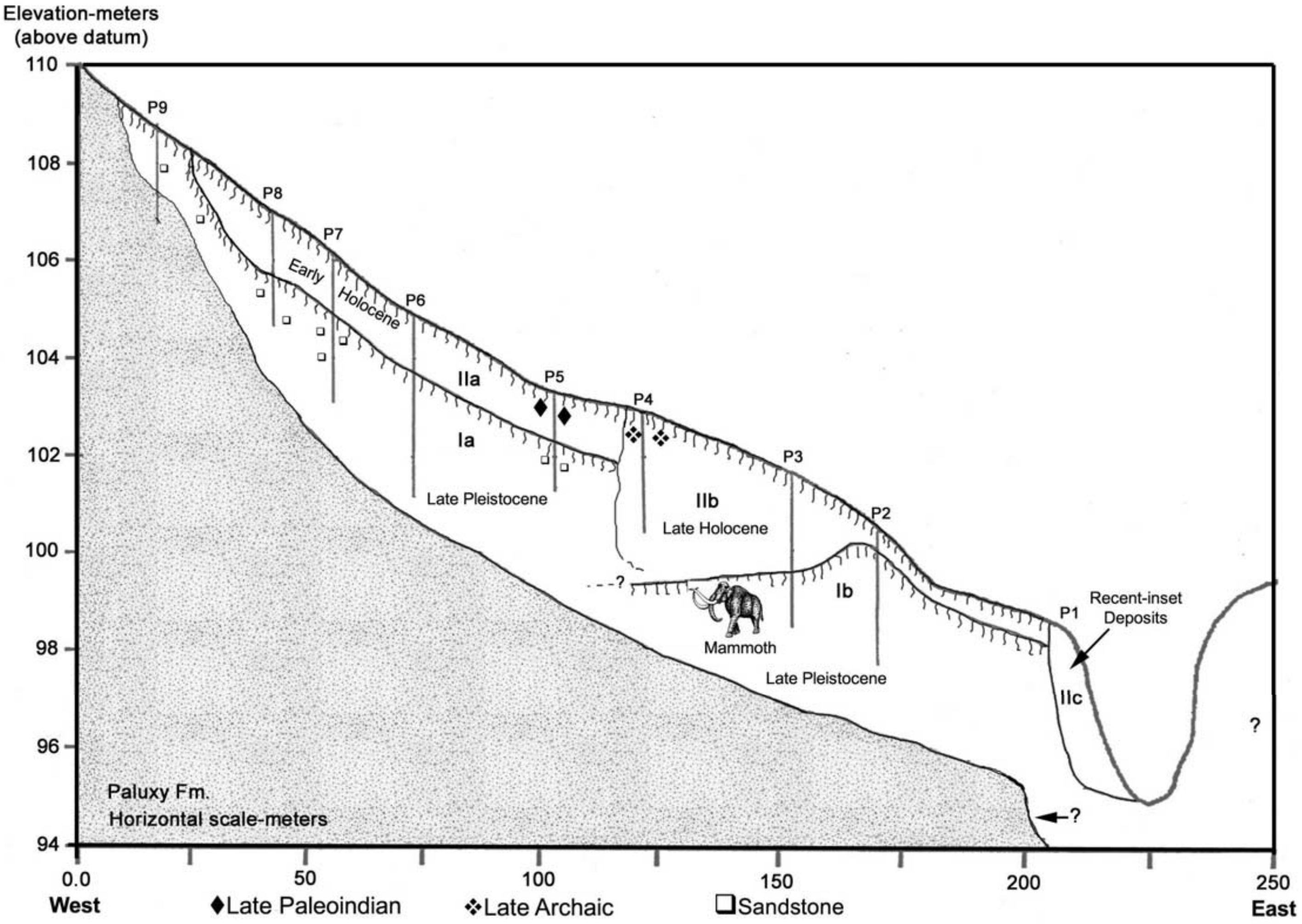


Figure 4.8 Topographic and stratigraphic representation of site locality with profile locations, artifacts, and assigned geologic periods. Note the presence of artifacts, mammoth and crosscutting relationship of Unit IIB to Units Ia and IIa.

The upper boundary of Unit Ia is a clear, smooth conformable contact with the overlying Unit IIa. There is no evidence of major erosion prior to deposition of Unit IIa sediments; yet, the absence of a buried A horizon is suspicious. The A horizon may have been extensively reworked during deposition of Unit IIa or was obliterated by subsequent pedogenesis.

In sum, Units Ib and Ia are the oldest buried surfaces at the locality providing a record of the nascent geomorphic and environmental history of the Mill Creek drainage. Unit Ib is associated with primary valley formation, channel development, and floodplain construction. Unit Ib represents a fining upward sequence of floodplain deposits with basal channel gravels changing to loam and sandy loam. This sequence is the result of lateral channel migration to the east followed by an extended period of pedogenesis. Unit Ia documents initial terrace construction through a cut and fill sequence of colluvial and alluvial deposition. Following construction, an extended period of pedogenesis indicates a remarkably extensive period of surface stability following major entrenchment of Mill Creek that may have occurred during the Late Wisconsin ca. 30-14ka.

Present Surface: Stratigraphic Units IIa, IIb, and IIc

Stratigraphic Unit IIa

Unit IIa represents the present terrace surface at the Carr site (Profiles 5-9). Parent materials appear to be more alluvial in nature based on the lack of angular sandstone fragments (Fig. 4.8). The lower boundary of Unit IIa is a clear, smooth conformable contact with the underlying Unit Ia; the upper boundary is the present surface. A Paleustalf developed in the sediments consistent with the regional Duffau-Windthorst soil series. The soil is characterized by arenic A horizons (20cm), leached E horizons (23 cm), and well-developed argillic horizons

65-160 cm thick (Profile 6). Like the underlying buried surface, the present day terrace surface indicates an extended period of surface stability.

Regionally, major entrenchment of the Trinity River valley into bedrock began ca. 28-30 ka. (Ferring, 1994). Examination of stratigraphic and paleoenvironmental evidence from other localities demonstrates rapid valley incision during the Late Pleistocene followed by rapid early Holocene aggradation and increased colluvial processes. These changes have been documented for the Southern Plains, High Plains, and Gulf Coastal Plains west of the Mississippi for localities ranging from Aubrey, Texas to Lehner and Murry Springs, Arizona (Ferring 1990, 1993; Haynes, 1967, 1981, 1982, 1984). The closest vicinity is the Aubrey Clovis site where rapid alluviation began ca. 10.9 to10.5 ka. (Ferring, 2000). This represents a major environmental change to a moister environment resulting in large magnitude floods with an associated increase in spring activity. The same environmental change may be present at the Carr Site with rapid colluvial/alluvial deposition of Unit IIa sediments ca. 11 ka. The apparent rapid deposition would have been aided by increased spring activity from seep springs found at the head of gullies at the Carr Site (Figs. 2.7, 4.8).

Further support for and Early Holocene date for the deposition of Unit IIa sediments comes from associated Late Paleoindian artifacts discussed previously. The Dalton/Plainview (ca. 10-9,000 BP.) occupation occurred after deposition and pedogenesis of Unit IIa sediments.

Stratigraphic Unit IIb

Unit IIb represents floodplain deposits along Mill Creek (Profiles 2-4). A Late Holocene (ca. 4.5 ka – present) date is given to Unit IIb based on the crosscutting relationship of the unit with terrace Units Ia and IIa and the presence of a syndepositional Late Archaic occupation

(Figs. 4. 8, 4.5). Up-slope, the lateral boundary of this unit is gradational; the lower boundary is abrupt wavy indicating extensive erosion prior to deposition of sediments. Timing of this erosional event cannot be determined, but it occurred after the soil of Unit Ia was fully developed. Similarly, it cannot be firmly established if the erosion was the result of a meander scar or gully construction. However, the unit is fairly thin (2-2.5m), a depth that is consistent with gullies in the immediate area. The deposition of sediments within this erosional feature most likely occurred as the result of increased precipitation following the drier middle Holocene. Moderate to rapid alluviation occurred ca. 4.5- 2 ka regionally as a result of over-bank flooding during this period (Ferring, 1990, Hall, 1988).

The unit is within the floodplain, but soil characteristics are not consistent with the regional Yahola soil series (Fig. 2.8), in that it has a well-developed argillic horizon. Lateral differences in profile expression are notable; an E horizon is present in Profile 4 but absent in Profile 3. Soil development in this unit is unique with characteristics of both terrace (E and Bt horizons) and floodplain soils (5-7% increase in clay).

Stratigraphic Unit IIc

Stratigraphic Unit IIc is topographically the lowest and chronologically the youngest (Fig. 4.8). The upslope lateral boundary for this unit is an abrupt erosional contact with Units Ib and IIb, 4-6 meters upslope from the current cut-bank exposure of Unit IIc; the downslope boundary is the current cut-bank exposure along Mill Creek. This unit consists of recent inset floodplain deposits with limited soil development. The top of the unit is a dark organic rich A horizon and the bottom of the unit consists of well rounded shell fragments and gravels of Mill Creek. Since visual inspection revealed the recent nature of the deposits, no physical analysis of the sediments is included in this report. This unit is defined on the basis of Profile 1 and consists of an A horizon underlain by a series of Ckc horizons consistent with the Yahola soil series.

CHAPTER 5

CONCLUSIONS

The following are the main results of this study:

1. Mill Creek is a small influent resequent stream of the West Fork of the Trinity River. It drains heterogeneous Cretaceous sedimentary rocks creating a dendritic pattern with an essentially straight main channel. Bedrock lithology is the main control on landscape evolution at this locality. The indurated fossiliferous limestone of the Walnut Formation forms the ridge system surrounding the Mill Creek Valley, and the softer weakly cemented sandstone of the Paluxy Formation forms the valley floor.

2. The geologic history of the site is one of remarkable landscape stability through out the Pleistocene and Holocene geologic periods. Two stratigraphic units are present and illustrate the sedimentary depositional changes that occurred at the Pleistocene Holocene boundary. The lowest stratigraphic unit is Pleistocene in age and composed of terrace, floodplain and channel deposits. Colluvial processes dominated sedimentary deposition at the valley margins indicating initial valley formation. The floodplain and channel deposits are rather narrow and at higher elevations than the present floodplain and channel. The highest stratigraphic unit is Holocene in age and composed of terrace and floodplain deposits. Alluvial deposition is the dominant sedimentary process of both terrace and floodplain genesis. Together these stratigraphic units record the late Pleistocene-Holocene transition as evidenced by channel migration to the east of the incipient Mill Creek channel followed by deep down cutting of the channel then increased alluvial deposition during the earliest Holocene.

3. Testing of the mammoth remains, *Mammuthus columbi*, for possible cultural associations was significant because Late Paleoindian artifacts were present at the site and relatively few

mammoths remains are tested by archaeological methods. Despite the fact that no cultural remains were recovered, careful excavation demonstrated that its final deposition was the result of natural deposition on a point bar followed by a fairly high rate of deposition. Since the remains were late Pleistocene in age they were used as an index fossil to demonstrate that eastward channel migration and entrenchment occurred at this locality during the terminal Pleistocene.

4. Geoarchaeological methods and concepts were used to examine the depositional environment of the archaeological residues. The vertical distribution of debitage was used to determine if the deposits were surfical in nature or if there was a buried component. The late Paleoindian terrace occupation proved to be post-depositional indicating that occupations occurred after sediments and soils were in place. The Late Archaic floodplain occupation proved to be syndepositional as evidenced by a buried component meaning that the occupation occurred concurrently with sedimentary deposition and soil development.

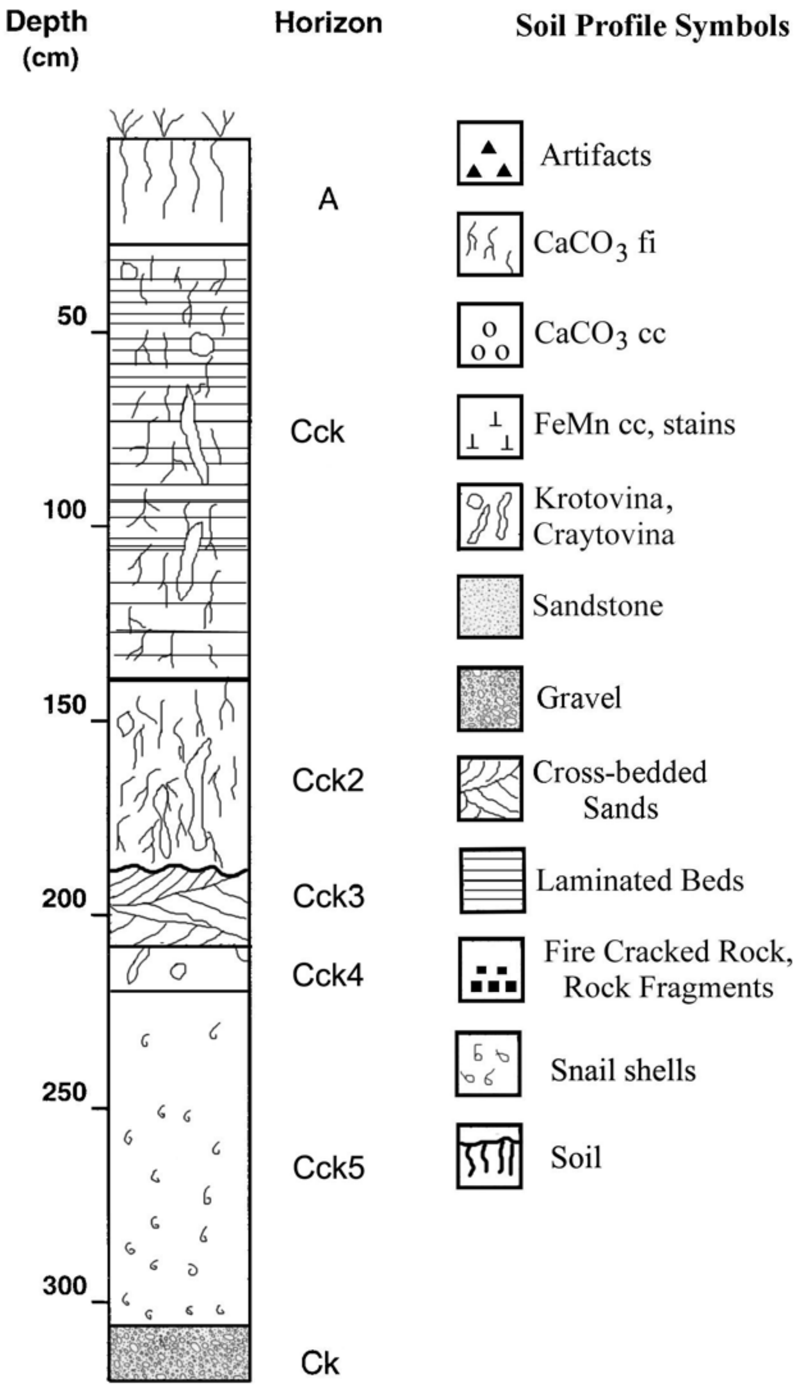
5. The cultural history of the Carr site is significant in that it is primarily a Dalton culture site. Late Paleoindian sites throughout the state of Texas are composed primarily of isolated projectile points found on terraces. This is the first well-documented excavation of Dalton materials within the region. In addition to the Late Paleoindian component, rare Early Archaic and Middle Archaic components were also discovered making this the only site in Parker County, Texas to have all three-culture periods represented. The Late Archaic period is poorly represented and is in direct contrast with site to the east along the Elm and East Forks of the Trinity. At these localities Late Archaic materials outnumber all other culture periods by a factor of 2 to 3 times. At the Carr site Late Paleoindian artifacts and Late Archaic artifacts are fairly equally divided.

6. Finally, the geoarchaeological approach taken in this study illustrates the importance of determining the geologic history of a site location so that the cultural remains can be placed in context. Without a through appreciation of the final depositional environment of the archaeological residues any interpretations of past human behaviors is merely speculative. A geoarchaeological approach can also help focus research strategies by identifying buried intact surfaces quickly so that excavation efforts can focus on the most productive areas of the site. Additionally, this approach aids in site prediction, discovery, dating, and interpreting past environments and human behaviors.

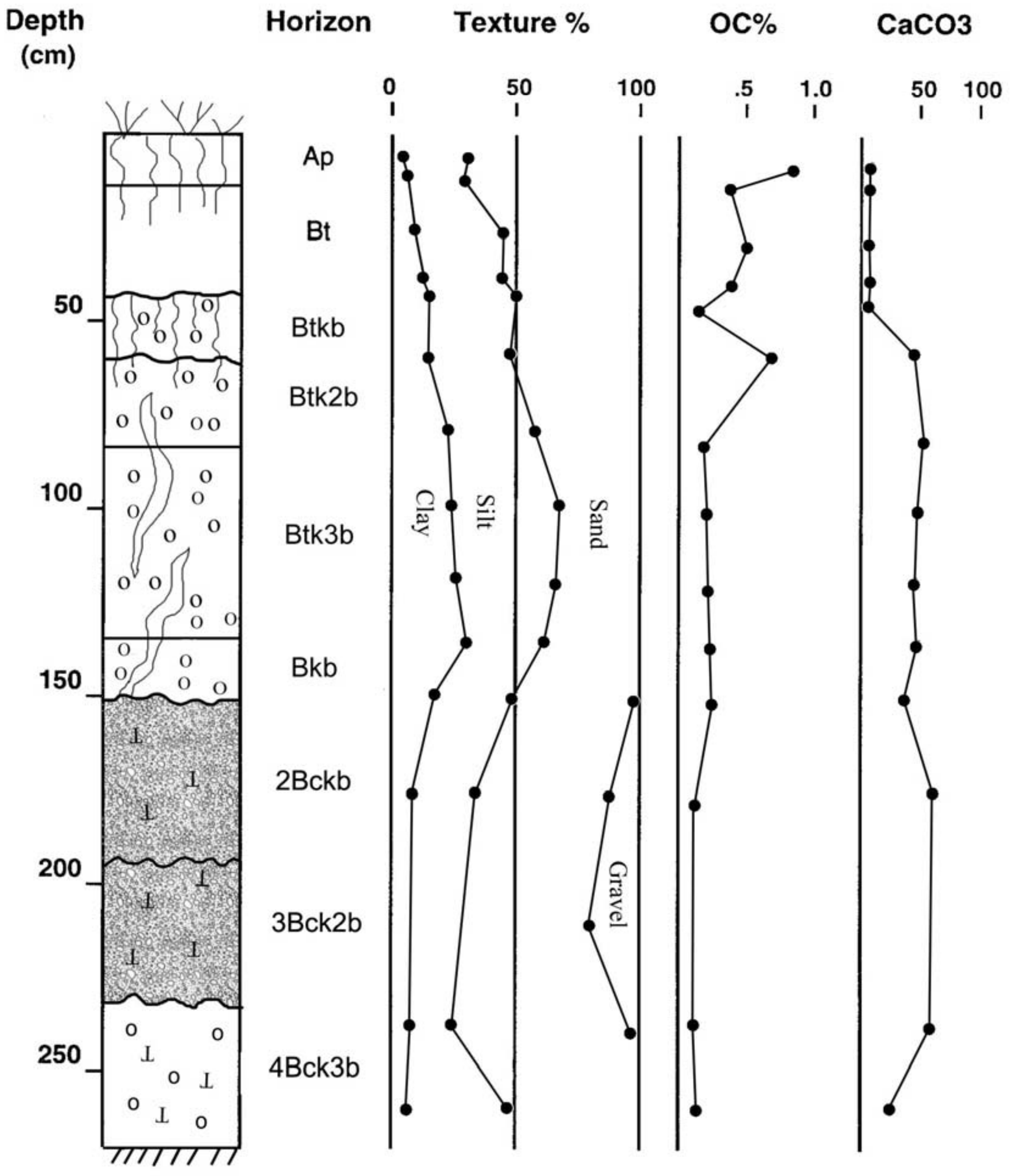
APPENDIX A

SOIL-STRATIGRAPHIC PROFILE DESCRIPTIONS AND LAB DATA

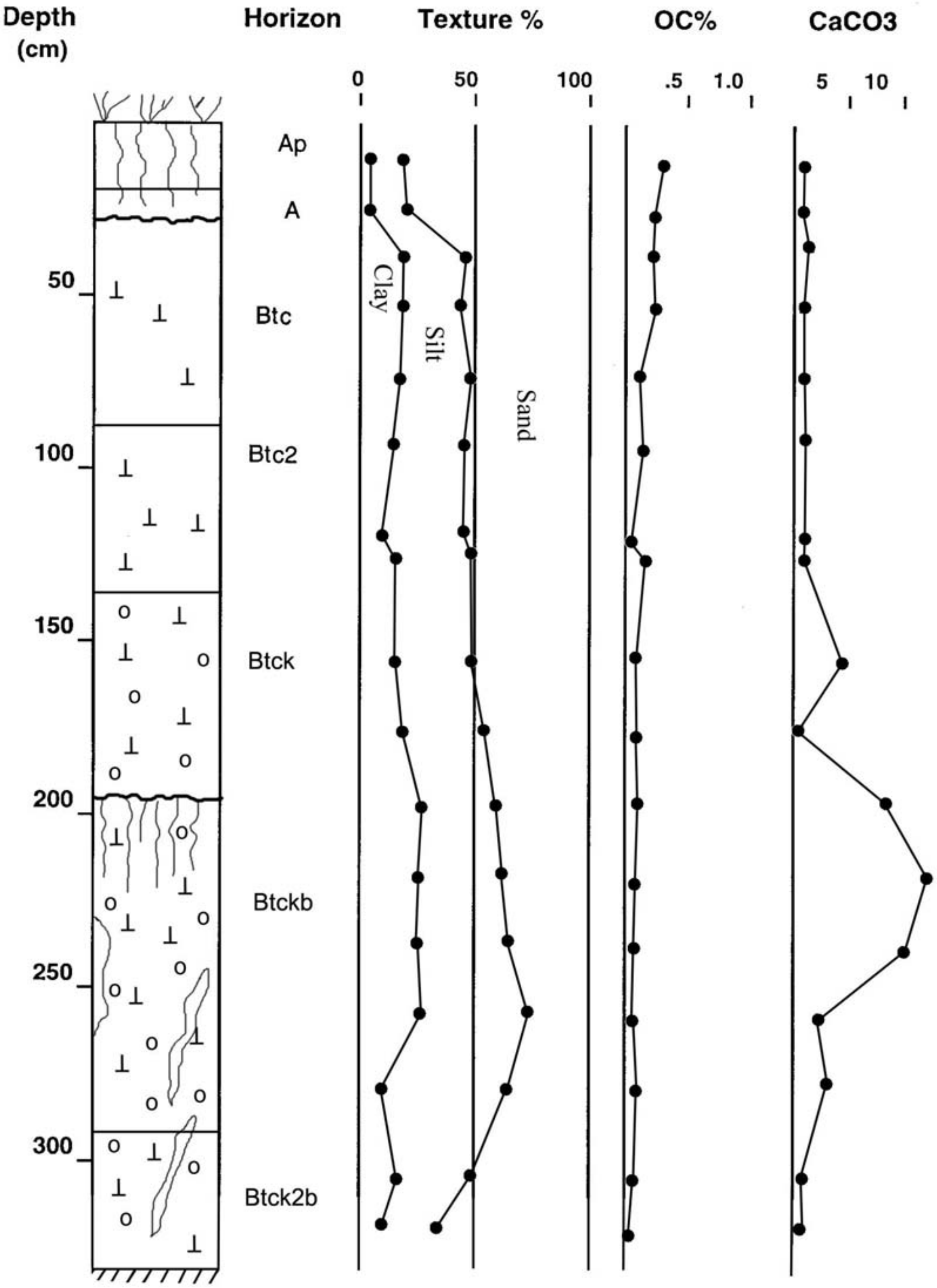
Soil Profile 1 Carr Site
Elevation 97.89
Mill Creek Cutbank



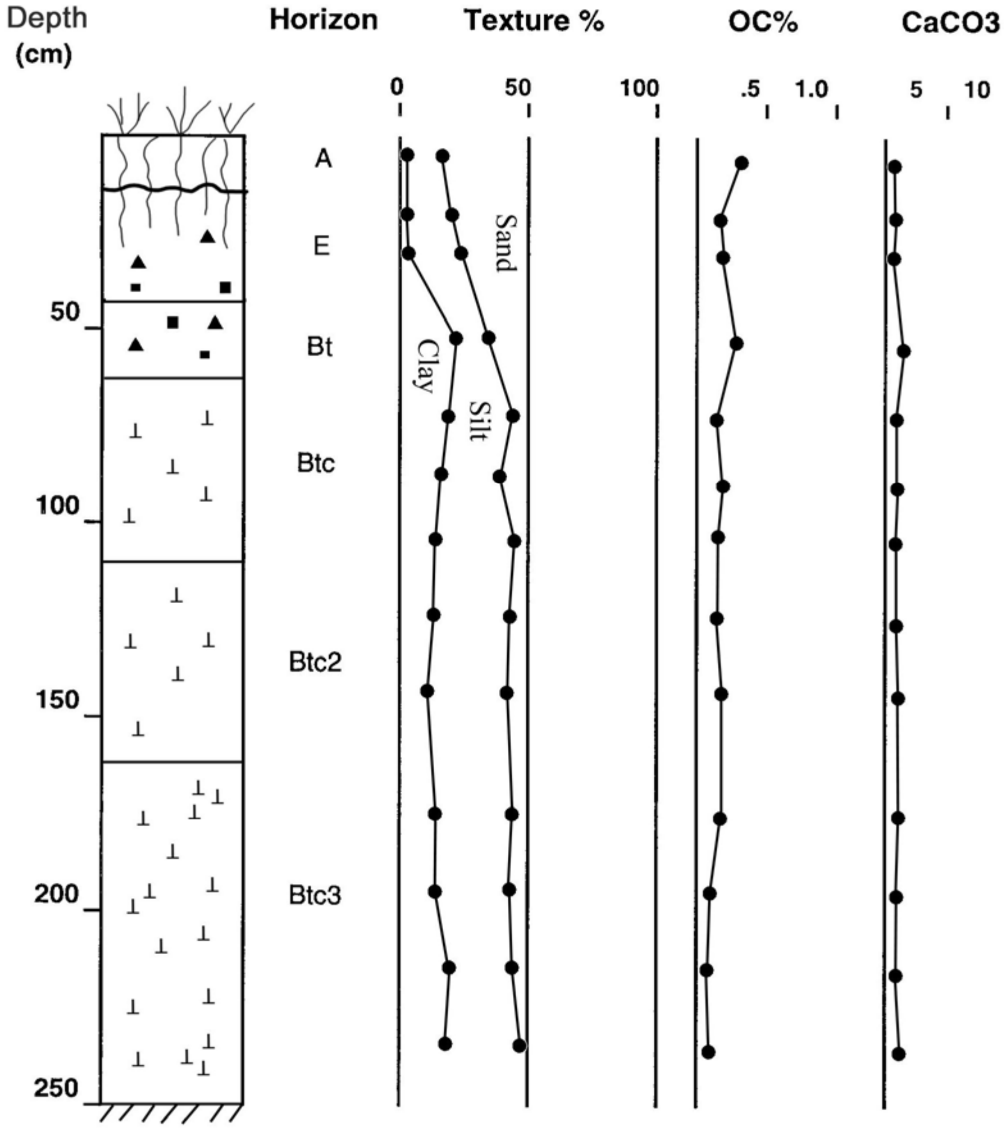
Soil Profile 2 Carr Site
Elevation 100.49m
Mammoth Area



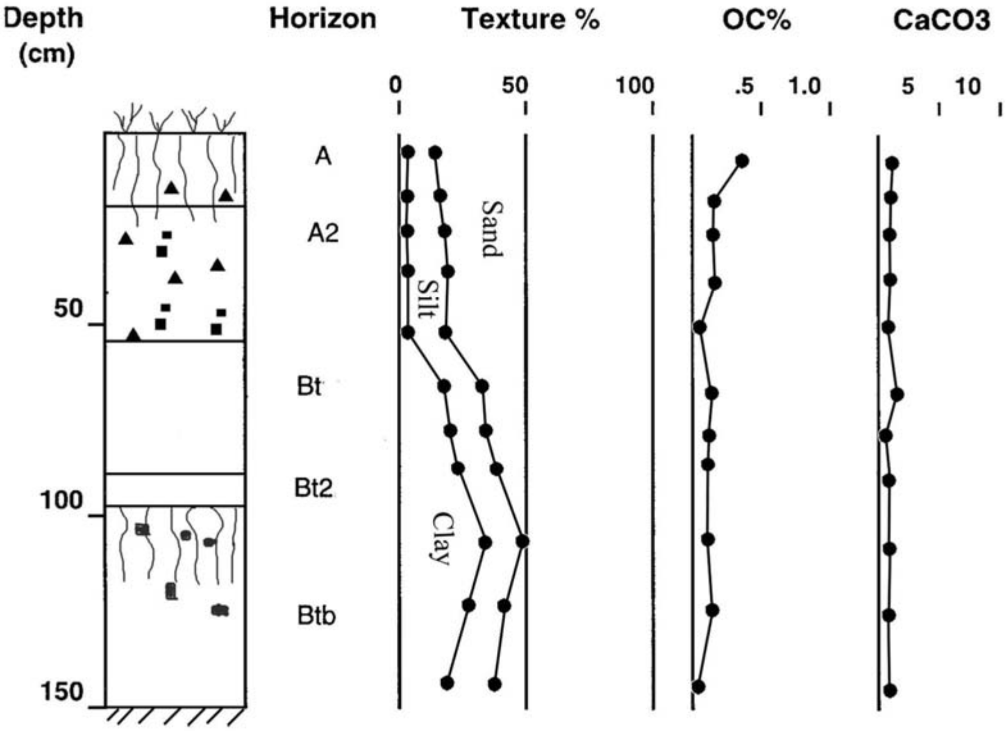
Soil Profile 3 Carr Site
Elevation 101.55m
Mammoth Area



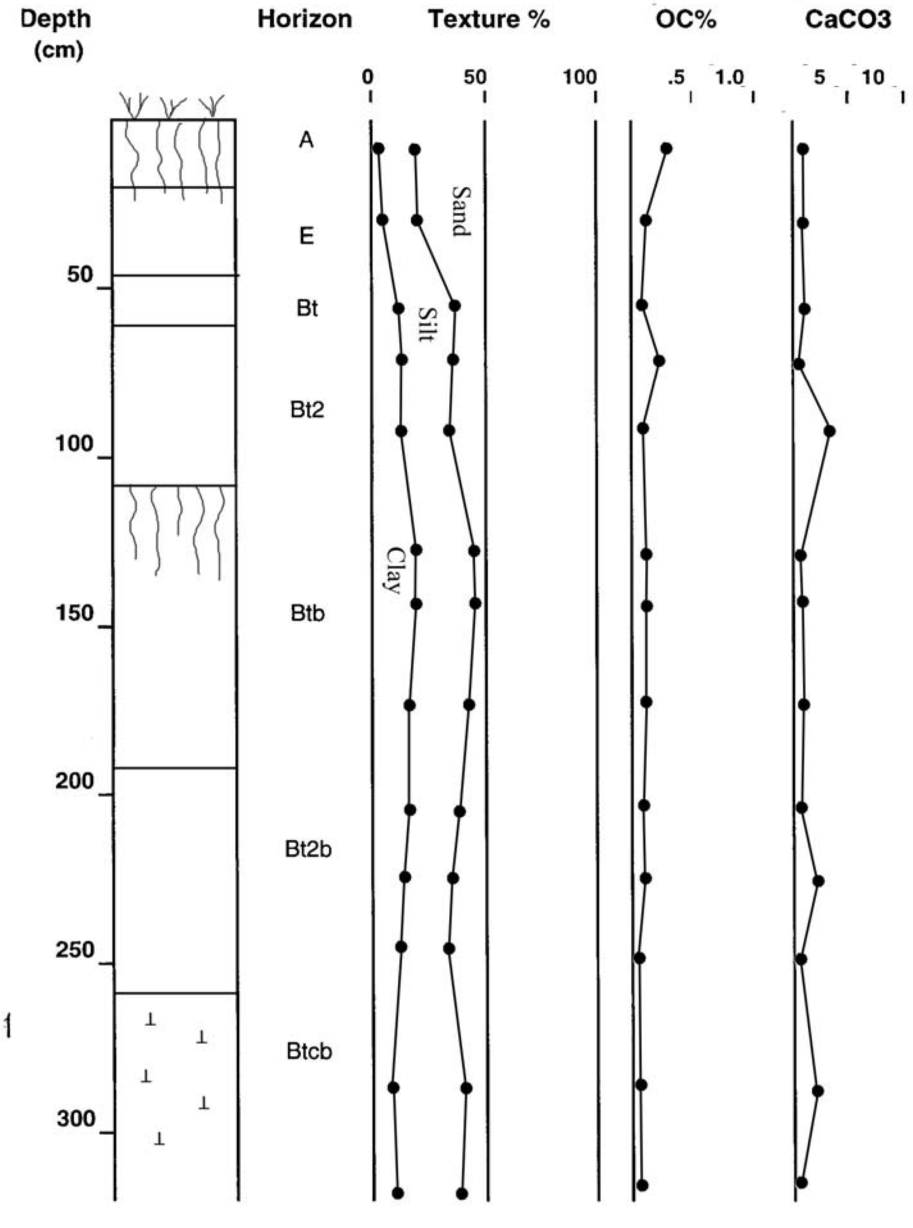
Soil Profile 4 Carr Site
Elevation 102.19m
Area P



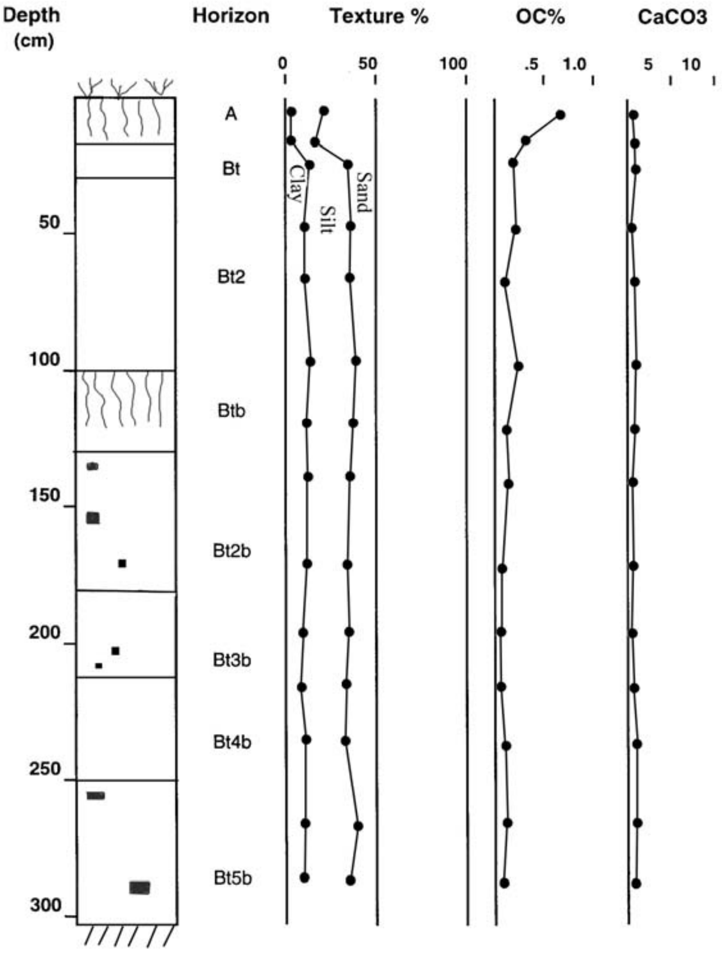
Soil Profile 5 Carr Site
Elevation 103.32m
Area D



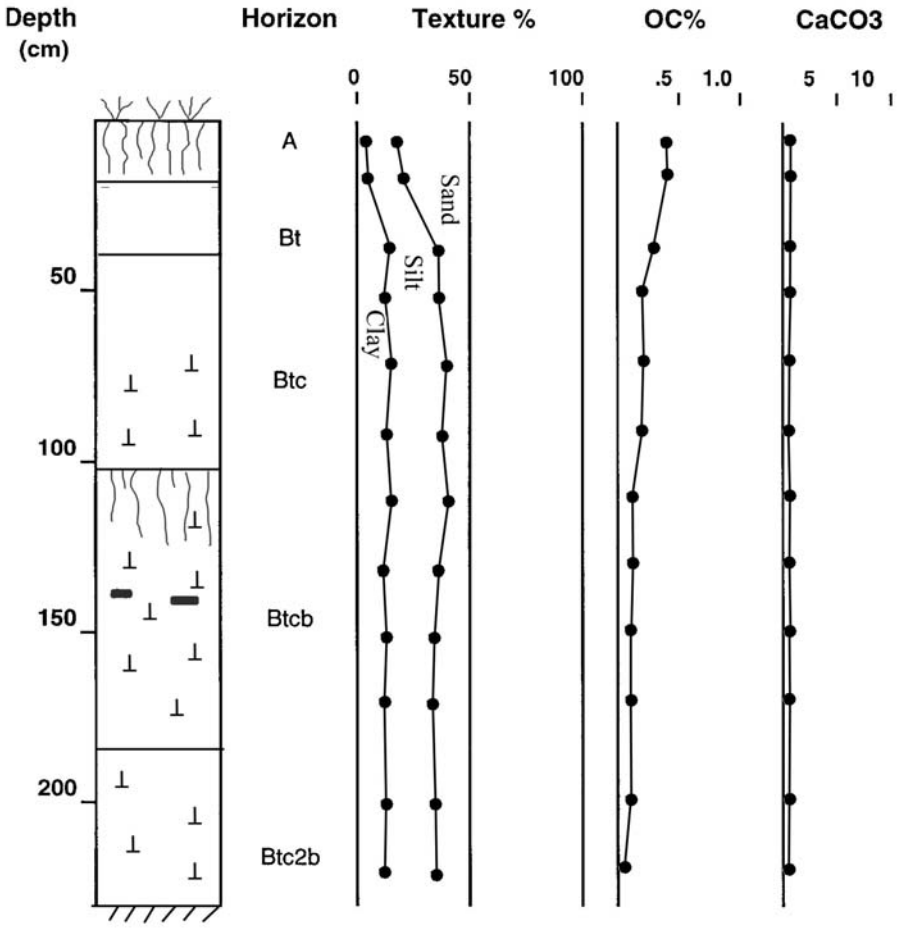
Soil Profile 6 Carr Site
Elevation 104.85m
Gully 3



Soil Profile 7 Carr Site
Elevation 106.27m
Gully 3



Soil Profile 8 Carr Site
Elevation 106.90m
Gully 3



Soil Profile 9 Carr Site
Elevation 108.72m
Gully 3

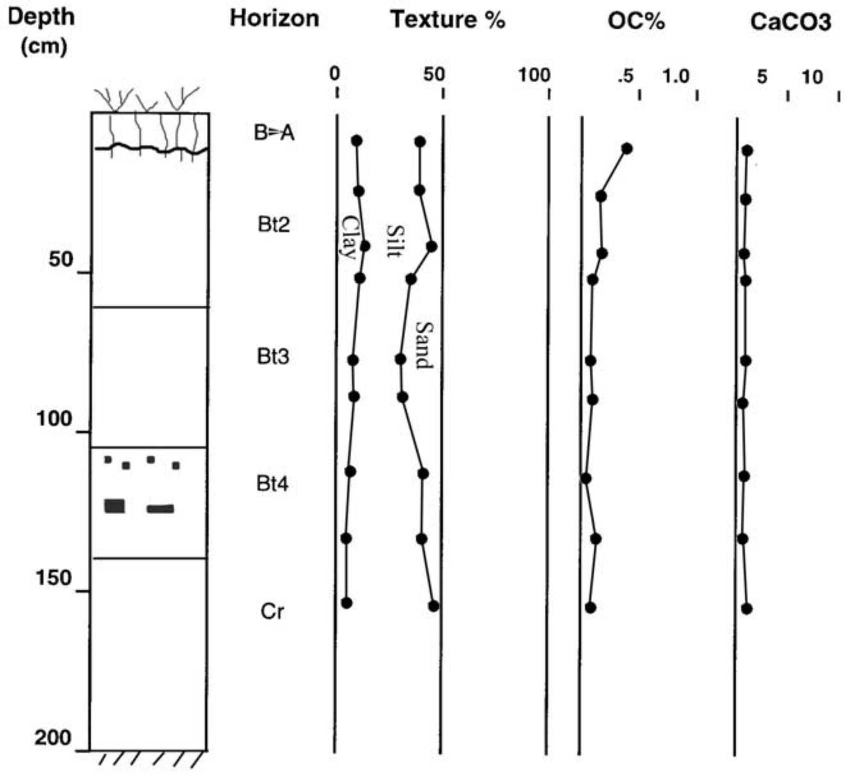


Table A1. Soil Profile Description Key

COLOR	all colors are Munsell moist, unless otherwise noted

TEXTURE

S	sand	SC	sandy clay	SCL	sandy clay loam
Sand Size		f- fine	m- medium	c- coarse	
s	silt	sC	silty clay	sCL	Silty clay loam
		sL	silt loam		
C	clay	CL	clay loam		
L	loam	LS	loamy sand		
gr	gravelly				

STRUCTURE

Grade:	w- weak	m- moderate	s- strong	
Class:	f- fine	m- medium	c- coarse	
Type:	ms	massive	gr	granular
	sab	subangular blocky	ag	angular blocky
	pr	prismatic	>	breaking to
	slik	slickensides		

CLAY FILMS

Amount

v1	very few	< 5%
1	few	5-25%
2	common	25-50%
3	many	> 50%

Distinctness

f	faint
d	distinct
p	prominent

Location

pf	films on ped faces
po	clay films interstitial pores, tubular
br	as bridges
co	colloid coats mineral grains
cobr	coats and bridges

CARBONATES

Abundance

f- few	<2%	c- common	5-10%
m- many	2-5%	a- abundant	>10%

Fabrics

fi	filaments	ct	coatings
cc	concretions	rz	rhizomorphs
po	pore linings		

CONCRETIONS

Abundance (per carbonates)

Size	f	fine	<1 mm
	m	medium	1-5 mm
	lg	large	5-10 mm
	vlg	very large	>10 mm
Type	FeMn	ferromanganese	

MOTTLES

Abundance

f	few	<2%
c	common	2-20%
m	many	>20%

Size

f	fine	<5 mm
m	medium	5-15 mm
c	coarse	>15 mm

Grade

f	faint
m	moderate
s	strong

BOUNDARIES

Distinctness

d	diffuse	> 10 cm
g	gradual	5-10 cm
c	clear	2-5 cm
a	abrupt	< 2 cm

Topography

s	smooth
w	wavy
i	irregular

PORES

Abundance

f	few
c	common
abnt	abundant

Size

s	small	< 1 mm
m	medium	1 mm
lg	large	> 1 mm

GRAVEL

Size

granule	2-4 mm
pebble	4-16 mm
cobble	16-64 mm

ROOTS

Abundance

c	commom
abnt	abundant

Type

f	fine fibrous
w	woody

Size

f	fine	≤ 1 mm
m	medium	1-4 mm
c	course	≥ 4 mm

BIOTURBATION

Burrows	≤ 2 cm, insects
Krotovina	> 2 cm, mammals
Craytovina	> 2 cm, crayfish

SOIL PROFILE SYMBOLS: See soil profile 1
(modified from Birkeland, 1999)

Table A 1.1 Profile 1
Elevation 97.89 m
Mill Creek Cutbank

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
A	0-35	2.5YR3/2	LS	sc >m gr	strong	as	abnt f roots, c burrows, cm and lg pores
Cck	35-140	2.5YR7/4 and 2.5YR4/2	SL	sm > f ag	strong	cs	c sand filled burrows, krotovina, clg pores, lenticular beds 1-4 mm of S and SL, few char frags, c $CaCO_3$ fi, FeMn stains, cc
Cck2	140-190	2.5Y5.5/2	L	mm ag	strong	cw	c burrows and krotovina, cs and lg pores, c $CaCO_3$ fi, FeMn stains along root canals
Cck3	190-210	2.5Y7/3	S	w gr	strong	cs	cross bedded sands w/ *Gryphea* shell fragments, FeMn stains, cc
Cck4	210-220	2.5Y5/2	SL	mc ag	strong	cs	c burrows, cm and lg pores, FeMn stains
Cck5	220-320	2.5Y4/1	SCL	mc ag	violent	cs	fs pores, abnt fossil shell frags including *Gryphea*, c snails, FeMn stains, cc
Ck	320+	2.5Y5/1	gr clay marl	n/a	violent	bop	gravels of Mill Creek, well rounded shell frags including *Gryphea*, ss frags, calcareous clay

Table A 1.2 Profile 2
Elevation 100.49 m
Mammoth Area

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
Ap	0-14	10YR4/3	LS	wf gr	nr	as	abnt ff roots, c burrows, cs pores
Bt	14-44	7.5YR5/4	SL	sc ag	nr	aw	mf and w roots, c pellet filled burrows, 2f pf
Btkb	44-57	2.5YR6/6	SL	mm sab	strong	cw	mf and w roots, c pellet filled burrows, 2d pf, alg soft $CaCO_3$ cc
Btk2b	57-82	2.5YR6/5	L	mm sab	strong	gs	abnt s pores, 2d pf, cm soft CaCO3 cc
Btk3b	82-136	2.5YR7/2 cms mottles 10YR5/6	L	sm ag	strong	cs	cw roots, c craytovina filled w/ 10YR6/1 LS, 2d pf, alg CaCO3 cc
Bkb	136-151	2.5YR7/2 cms mottles 10YR5/6	gr L	mc sab	strong	cw	cw roots, c craytovina with 10YR6/1 LS, 2p pf and po, rounded granules (1%), sand cts
2Bckb	151-190	7.5YR5/8 matrix	gr SL	lenticular beds of sand and gravel	violent	cw	matrix supported granule to pebble gravel (8%), well rounded fossil clasts, including *Gryphaea*, c FeMn cc, stains
3Bck2b	190-234	7.5YR5/8 matrix	gr LS	lenticular sand and gravel in beds	violent	cw	matrix supported granule to cobble gravel (15%), rounded fossil clasts including *Grygpaea*, c FeMn cc, stains
4Bck3b	234-270 +	10YR6/6	LS	massive >wf sab	strong	bop	ff roots, cs pores, 1f po, clg hard CaCO cc, FeMn cc

Table A.1.3 Profile 3
Elevation 101.55
Mammoth Area

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
Ap	0-20	10YR4/6	LS	wf gr and wf sab	nr	cw	cf roots, c burrows, krotovina, cs pores
A	20-26	10YR6/4	LS	mm gr	nr	as	cf roots, c burrows, cf pores, bioturbated
Btc	26-80	10YR5/4 cms mottles 2.5YR4/8	SL	wm pr> mc ag	nr	gs	fs pores, 2d pf and po, comm vert cracks w/ sand ct, flg soft and hard FeMn cc
Btc2	80-135	10YR6/2 ped surface 5YR4/6 ped interior	SL	sc ag	slight	gs >d	3d pf, comm vert cracks w/ sand ct, fm soft-hard FeMn cc
Btck	135-190	10YR7/1 cms mottles 10YR6/7	L	sm ag	slight	cw	f vert clay filled craytovina, 3d pf, clg $CaCO_3$ cc , fm soft-hard FeMn cc in clusters
Btckb	190-290	10YR5/6 cms mottles 10YR6/1	CL	sc ag	slight	gs	f vert clay filled craytovina, 3d pf, cvlg C_aCO_3 cc, fm soft-hard FeMn cc
Btck2b	290-310+	2.5YR3/2 cms mottles 7.5YR5/8	SL	mc ag	nr	bop	f vert clay filled craytovina, 2d pf, cvlg $CaCO_3$ cc, fm soft hard FeMn cc

Table A.1.4 Profile 4
Elevation 102.19
Area P

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
A	0-15	10YR5/3	LS	wm sab	nr	gw	cfw roots, c burrows, fs pores, few sm flint flakes
E	15-43	10YR5/5	LS	wm sab gr	nr	cs	cfw roots,c burrows, fs to m pores, few ss frags, few sm flint flakes,.
Bt	43-60	10YR5/4 ccs mottles 5YR5/8	SCL	mm pr> mm ag	nr	cs	cw roots, c burrows, 3d pf and po, vert cracks w/ thin sand ct, mm FeMN stains cc, few ss frags, flint flakes, bioturbated
Btc	60-110	7.5YR5/3 ccs mottles 2.5YR5/8	SL	mm pr> mc ag	nr	cs	3d pf and po, vert cracks, sand cts, cm soft FeMn cc
Btc2	110-160	2.5YR6/3 ccs mottles 2.5YR4/8	SL	wm pr > sc ag	nr	gs	cw roots, clg pores, 2p pt and po, increase in vert cracks w/ sand ct, cm soft FeMn cc
Btc3	160-250+	2.5YR6/3 ccs mottles 10YR6/8	SL	sc ag	nr	bop	cw roots, comm sand ct, 2d pf, clg FeMn cc in clusters

Table A.1.5 Profile 5
Elevation 103.32
Area D

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
A	0-20	10YR5/3	S	wf gr	nr	gs	cf roots, c burrows, krotovina, comm flint flakes
A2	20-55	10YR6/2 and 10YR7/4	S	m> wm gr	nr	cs	cfw roots, cs pores, comm fine char, c burrows, krotovina, ss frags 7.5YR5/8, comm flint flakes
Bt	55-90	10YR6/2 cms mott 5YR5/8	SCL	sc>m ag	nr	gs	cw roots, cm pores, 1f pf and po, vert cracks w/ sand ct
Bt2	90-95	10YR6/2 cms mott 7.5YR5/8	SCL	sc ag	nr	cs	cw roots, c lg pores, 2d pf, cracks w/ sand ct
Btb	95-150+	10YR6/1 cms mott 2.5YR4/6	SCL	sc ag	nr	bop	cw roots, 3d pf and po, m lg FeMn stains cc

Table A.1.6 Profile 6
Elevation 104.85
Gully 3

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
A	0-22	10YR4/4	LS	wm gr	nr	gs	cff roots, c burrows, fm pores
E	22-45	10YR5/4	LS	wm gr	nr	cs	cmw roots, c burrows, fs pores
Bt	45-60	7.5YR5/6 cmm mottles 5YR5/8 10YR5/6	SL	sc ag	nr	gs	cmw roots, m burrows, 1f pf
Bt2	60-110	5YR4/6 cms mottles 10YR6/6	SL	sc ag	nr	cs	cw roots, abnt s pores, 1f pf
Btb	110-182	10R4/8 mms reticulated mottles 10YR7/1	SL	mc ag	nr	gs	cw roots, ff pores, 2d fp
Bt2b	182-260	10YR4/8 mcs mottles 7.5YR5/8	SL	sc ag	nr	gs	ff roots, fs pores, 3p pf
Btcb	260-325+	2.5YR5/8 mcs mottles 7.5YR5/8 10YR6/2	SL	sc ag	nr	bop	ms pores, 3p pf, vert cracks and root casts w/ grey halos, fm soft FeMn cc and stains

Table A.1.7 Profile 7
Elevation 106.27
Gully 3

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
A	0-18	7.5YR4/3	LS	wm gr	nr	cs	cff roots, c burrows, fm pores
Bt	18-31	7.5YR6/8 cms mottles 5YR5/8	LS	wm ag >f ag	nr	gs	cff and w roots, c burrows, 1f po
Bt2	31-100	5YR4/6	SL	sm ag	nr	cs	cw roots, fs pores, 1f po
Btb	100-128	2.5YR4/8	SL	sm ag	nr	gs	cw roots, 2d pf po, fs pores
Bt2b	128-180	2.5YR4/8 mms mottles 5YR6/8	SL	sc ag	nr	gs	cw roots, fs pores, 2dpo, few angular ss frags
Bt3b	180-220	2.5YR4/8 mms mottles 7.5YR6/6	SL	sc ag	nr	gs	comm mottles along roots, rare m pores, 3d pf, few angular ss frags
Bt4b	220-250	2.5YR4/8 mcs mottles 7.5YR6/8	SL	sc ag	nr	gs	flg pores, 3d pf
Bt5b	250-310+	5yr5/8 mcs mottles 7.5YR6/6	SL	sm ag	nr	bop	flg pores, 3d pf

TableA.1.8 Profile 8
Elevation 106.90
Gully 3

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
A	0-18	5YR4/6	LS	wm gr	nr	cs	cf roots, many burrows, bioturbated
Bt	18-40	5YR5/8 and 2.5YR4/8	SL	sm ag	nr	gs	cw roots, c burrows, cm to lg pores, 3d po, heavily bioturbated
Btc	40-102	5YR4/6	SL	sc ag	nr	cs	abnt f roots, cm to lg pores, 2f po, lg cracks w/ sand ct, ff soft FeMn cc and stains
Btcb	102-187	2.5YR4/8	SL	sc ag	nr	ds	abnt ff roots, c sand filled burrows, cm to lg pores, 3d po and po, vert cracks, few sm angular ss frags, ff FeMn cc and stains
Btc2b	187-230	2.5YR5/8	SL	sc ag	nr	bop	cm to lg pores, 3d pf, ff FeMn stains

Table A.1.9 Profile 9
Elevation 108.72
Gully 3

HORIZON	DEPTH (cm)	COLOR	TEXT	STRUCT	RCTN HCL	BNDY	COMMENTS
Bt⇒A	0-10	5YR5/6	SL	wf gr	nr	aw	cf roots, c burrows, 3d pf
Bt2	10-60	2.5YR4/8	SL	sc ag	nr	gs	c sand filled burrows, cm to lg pores, 3d pf
Bt3	60-105	5YR5/8	SL	sc ag	nr	gs	c sand filled burrows, 3d po, few angular limonite ss frags
Bt4	105-140	5YR/5/8 and 10YR5/8	L	mm ag	nr	gs	3d po
Cr	140-200	10YR7/1 and 5YR5/8	L	wm ag	nr	bop	fs pores, 2f po, vert cracks in ss/clay

Table A 2 Profile Analysis Data

Table A 2.2 Profile 2 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
Ap	5	2.9	22.7	74.4	0	0.8	7.5
	10	3.4	23.0	73.7	0	0.4	7.1
Bt	24	8.5	29.2	62.3	0	0.5	7.0
	34	10.3	30.9	58.8	0	0.4	7.3
	40	10.5	36.6	52.9	0	0.2	7.5
Btkb	55	13.5	32.1	54.4	36.8	0.7	7.7
Btk2b	75	17.9	36.9	45.2	43.7	0.2	7.9
Btk3b	95	24.8	39.7	35.5	43.3	0.2	7.8
	115	25.4	38.6	36.0	41.2	0.2	7.7
	130	25.7	34.3	40.0	39.7	0.2	7.8
Bkb	144	17.3	30.5	52.2	33.9	0.2	7.7
2Bckb	170	6.5	23.6	69.9	51.5	0.1	7.9
3Bck2b	228	5.5	15.6	78.9	51	0.1	7.9
4Bck3b	250	4.9	37.0	58.1	21.7	0.1	7.8

Table A 2.3 Profile 3 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
Ap	10	2.1	13.1	84.8	0	0.3	6.3
A	23	2.7	15.0	82.3	0	0.2	6.4
Btc	35	16.1	26.3	57.6	0.3	0.2	6.2
	50	18.5	25.4	56.1	0	0.2	6.4
	70	16.5	29.4	54.1	0	0.1	6.9
Btc2	90	14.5	29.3	56.2	0	0.1	7.4
	115	12.3	31.5	56.2	0	0	7.7
	120	14.8	30.5	54.7	0	0.1	8.0
Btck	150	15.1	36.0	48.9	3.6	0	8.4
	170	17.3	37.0	45.7	0	0	8.4
Btckb	190	26.0	31.8	42.2	7.5	0	8.3
	210	26.8	33.3	39.9	10.3	0	8.2
	230	25.7	37.7	36.6	8.8	0	8.1
	250	26.2	46.9	26.9	2.2	0	8.1
	270	12.4	51.9	35.7	2.1	0	7.8
Btck2b	295	17.9	28.3	53.8	0	0	7.7
	310	12.9	20.5	66.6	0	0	7.7

Table A 2.4 Profile 4 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
A	5	1.7	12.9	85.4	0	0.3	6.1
	20	1.9	16.0	82.1	0	0.1	6.4
E	30	0.5	19.4	80.1	0	0.1	6.5
Bt	50	19.6	18.3	62.1	0.5	0.2	6.1
Btc	70	17.4	22.2	60.4	0	0.1	6.1
	85	14.7	21.9	63.4	0	0.1	6.2
	100	14.0	26.5	59.5	0	0.1	6.2
Btc2	120	11.6	27.5	60.9	0	0.1	6.2
	140	10.9	27.9	61.2	0	0.1	6.2
Btc3	170	13.4	27.8	58.8	0	0.1	6.4
	190	11.0	29.0	60.0	0	0	6.5
	210	16.6	25.6	57.8	0	0	6.5
	230	17.8	27.8	54.4	0.5	0	6.5

Table A 2.5 Profile 5 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
A	5	0.5	9.7	89.8	0	0.3	5.8
	15	0.5	8.8	90.7	0	0.1	5.4
A2	25	0.5	10.9	88.6	0	0.1	5.3
	35	0.6	11.7	87.7	0	0.1	5.6
	50	1.0	12.0	87.0	0.5	0	5.2
Bt	65	15.3	14.5	70.2	1.3	0.1	5.3
	75	15.6	13.3	71.1	0	0.1	5.4
Bt2	85	19.8	13.0	67.2	0	0.1	6.0
Btb	105	30.2	11.5	58.3	0	0.1	6.8
	120	26.3	12.1	61.6	0	0.1	7.2
	140	20.5	14.3	65.2	0	0	7.4

Table A 2.6 Profile 6 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
A	10	0.5	12.0	87.5	0	0.3	5.9
E	30	1.3	12.5	86.2	0	0.1	6.3
Bt	55	12.0	21.6	66.4	0	0.2	5.9
Bt2	70	12.5	21.3	66.2	0	0.1	6.1
	90	12.2	18.4	69.4	3.8	0.1	5.9
Btb	125	16.8	23.8	59.4	0	0.2	5.6
	140	17.2	23.6	59.2	0	0.1	5.5
	170	15.7	21.3	63.0	0	0.1	5.6
Bt2b	200	13.9	20.4	65.7	0	0.1	5.6
	220	12.3	19.4	68.3	1.4	0.1	5.6
	240	11.8	19.0	69.2	0	0.1	5.6
Btcb	280	9.8	24.9	65.3	1.4	0.1	5.8
	310	10.5	24.9	64.6	0	0	5.8

Table A 2.7 Profile 7 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
A	5	0.9	14.6	84.5	0	0.7	5.6
	15	1.1	11.8	87.1	0	0.3	5.6
Bt	25	10.6	18.6	70.8	0	0.2	5.9
Bt2	45	13.0	22.0	65.0	0	0.2	6.1
	65	12.9	22.31	64.8	0	0.1	6.2
Btb	95	14.2	26.5	59.3	0	0.2	6.0
	115	11.0	27.3	61.7	0	0.1	5.9
Bt2b	135	12.2	23.2	64.6	0	0.1	5.8
	165	12.4	22.4	65.2	0	0.1	5.8
Bt3b	190	10.3	22.9	66.8	0	0	5.7
	210	6.9	25.5	67.3	0	0	5.8
Bt4b	230	10.0	23.7	66.3	0	0.1	5.8
	260	11.4	23.7	64.9	0	0.1	6.0
Bt5b	285	10.7	21.5	67.8	0	0	5.9

Table A 2.8 Profile 8 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
A	5	1.8	14.2	84.0	0	0.4	5.5
	15	3.3	13.4	83.3	0	0.4	5.2
Bt	35	11.4	21.0	67.6	0	0.3	5.7
Btc	50	10.0	23.5	66.5	0	0.2	5.6
	70	11.0	25.0	64.0	0	0.2	5.3
	90	13.2	20.3	66.5	0	0.2	5.3
Btcb	110	13.7	23.3	63.0	0	0.1	5.3
	130	12.9	22.0	65.1	0	0.1	5.3
	150	12.4	20.0	67.6	0	0.1	5.4
	170	11.4	20.2	68.4	0	0.1	5.3
Btc2b	200	11.4	20.6	69.0	0	0.1	5.4
	220	10.6	22.3	67.1	0	0	5.7

Table A 2.9 Profile 9 Data

Horizon	Depth	%Clay	%Silt	%Sand	Carb<2	%OC	pH
Bt⇒A	8	11.7	27.5	60.8	0	0.4	7.1
Bt	25	10.6	27.3	62.1	0	0.2	6.8
	40	10.5	25.3	64.2	0	0.2	5.9
	50	11.5	22.1	66.4	0	0.1	5.9
Bt2	75	10.1	22.0	67.9	0	0.1	5.8
	85	9.2	24.0	66.8	0	0.1	6.1
Bt3	110	8.9	32.7	58.4	0	0	6.3
	130	7.6	39.8	52.6	0	0.1	6.3
Cr	150	6.0	41.5	52.5	1.3	0.1	6.3

Table A 3 Sand Sieve Analyses
A to Bt Horizon Comparison

Table A 3.2 Profile 2 Data

Horizon	Ap	Bt	Btkb	Btk3b	2Bkcb
Depth	10 cm	24 cm	55 cm	95 cm	170 cm
Phi	%	%	%	%	%
0.0	0.000	0.079	1.767	2.390	33.163
1.0	0.323	0.288	2.867	5.031	32.912
2.0	4.292	4.548	7.500	11.768	17.863
3.0	64.823	63.095	47.250	42.013	11.468
4.0	30.563	31.989	40.617	38.798	4.593

Table A 3.3 Profile 3 Data

Horizon	Ap	Btc	Btkcb
Depth	10 cm	50 cm	210 cm
Phi	%	%	%
0.0	0.000	0.199	0.263
1.0	0.000	0.337	0.351
2.0	3.854	4.247	3.627
3.0	69.422	62.897	63.198
4.0	26.725	32.320	32.560

Table A 3.4 Profile 4 Data

Horizon	A	Bt	Btc3
Depth	20 cm	50 cm	210 cm
Phi	%	%	%
0.0	0.000	0.000	0.086
1.0	0.227	0.181	0.222
2.0	5.109	4.426	3.982
3.0	67.664	67.814	61.608
4.0	27.000	27.580	34.102

Table A 3.5 Profile 5 Data

Horizon	A	A2	Bt	Bt2	Btb
Depth	15 cm	50 cm	55 cm	75 cm	105 cm
Phi	%	%	%	%	%
0.0	0.350	0.000	0.000	0.070	0.000
1.0	0.611	0.263	0.404	0.368	0.184
2.0	4.031	4.336	5.007	4.926	4.230
3.0	72.598	71.598	69.873	69.660	65.957
4.0	22.411	23.803	24.716	24.975	29.629

Table A 3.6 Profile 6 Data

Horizon	A	Bt	Btb
Depth	10 cm	55 cm	140 cm
Phi	%	%	%
0.0	0.000	0.053	0.043
1.0	0.156	0.233	0.268
2.0	3.325	4.274	4.591
3.0	70.898	70.390	65.422
4.0	25.621	25.050	29.676

Table A 3.7 Profile 7 Data

Horizon	A	Bt	Bt2b
Depth	5 cm	25 cm	135 cm
Phi	%	%	%
0.0	0.145	0.027	0.000
1.0	0.326	0.170	0.244
2.0	2.690	2.835	4.368
3.0	67.799	68.725	64.705
4.0	29.040	28.244	30.682

Table A 3.8 Profile 8 Data

Horizon	A	Bt	Btcb
Depth	5 cm	35 cm	130 cm
Phi	%	%	%
0.0	0.048	0.077	0.016
1.0	0.153	0.176	0.180
2.0	2.384	2.684	3.858
3.0	68.146	68.588	66.633
4.0	29.268	28.475	29.313

Table A 3.9 Profile 9 Data

Horizon	Bt-A	Bt2	Cr
Depth	8 cm	40	150
Phi	%	%	%
0.0	0.000	0.128	0.061
1.0	0.251	0.158	0.267
2.0	3.804	2.855	2.165
3.0	62.910	64.059	13.909
4.0	33.034	32.801	67.321

Table A 3.10 Parent Material Data

Sample	R SS	Silty SS	Y SS	W SS
Phi	%	%	%	%
0.0	0.000	0.000	0.000	0.000
1.0	0.544	0.158	0.077	0.171
2.0	42.810	6.230	30.124	49.948
3.0	48.786	14.252	66.650	48.828
4.0	7.861	79.360	3.149	1.053

Table A4 Sand Sieve Analysis
Comparison of Terrace and Floodplain
Profiles 3 and 7

Table A 4.1 Profile 3 Data

Horizon	Ap	A	Btc	Btc	Btc	Btc2	Btc2	Btc2
Depth	10 cm	23 cm	35 cm	50cm	70cm	90cm	115cm	120 cm
Phi	%	%	%	%	%	%	%	%
0.00	0.000	0.000	0.199	0.000	0.000	0.000	0.000	0.000
1.00	0.000	0.147	0.363	0.337	0.075	0.096	0.073	0.075
2.00	3.840	3.652	5.066	4.247	3.701	3.618	3.639	3.751
3.00	69.422	68.126	64.716	62.897	61.033	60.674	60.484	60.039
4.00	26.725	28.065	29.853	32.320	35.189	35.611	35.805	36.134

Horizon	Btkc	Btkc	Btkcb	Btkcb	Btkcb	Btkcb	Btkcb	Btkc2b	Btkc2b
Depth	150 cm	170 cm	190 cm	210cm	230cm	250 cm	270 cm	295 cm	310 cm
Phi	%	%	%	%	%	%	%		
0.00	0.000	0.000	0.000	0.263	0.000	0.425	0.133	0.135	0.000
1.00	0.133	0.110	0.100	0.351	0.300	0.763	2.105	0.632	0.543
2.00	3.714	3.484	3.202	3.627	4.747	7.120	12.996	23.748	16.810
3.00	56.866	54.587	50.585	63.198	50.467	48.141	46.522	59.296	64.431
4.00	39.287	41.819	46.113	32.560	44.485	43.550	38.244	16.188	15.217

Table A 4.2 Profile 7 Data

Horizon	A	A	Bt	Bt2	Bt2	Bt2	Btb
Depth	5 cm	12cm	25 cm	45cm	65cm	98cm	112cm
Phi	%	%	%	%	%	%	%
0.00	0.14	0.05	0.03	0.09	0.02	0.06	0.01
1.00	0.33	0.22	0.17	0.12	0.19	0.20	0.23
2.00	2.69	2.32	2.83	3.09	3.98	3.96	4.33
3.00	67.80	68.60	68.72	68.30	66.63	65.73	64.67
4.00	29.04	28.82	28.24	28.40	29.18	30.05	30.76

Horizon	Bt2b	Bt2b	Bt3b	Bt3b	Bt4b	Bt5b	Bt5b
Depth	135 cm	167cm	192cm	212cm	232cm	262cm	287cm
Phi	%	%	%	%	%	%	%
0.00	0.00	0.03	0.010	0.05	0.09	0.03	0.09
1.00	0.24	0.22	0.240	0.28	0.24	2.55	0.14
2.00	4.37	4.48	4.390	3.87	5.57	3.6	3.55
3.00	64.71	64.89	64.130	62.34	59.26	57.08	60.46
4.00	30.68	30.38	31.24	33.45	34.84	36.74	35.76

Table 5 Clay Free Textures

Table A 5.2, Profile 2 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
Ap	5	2.9	22.7	74.4	23.4	76.6
	10	3.4	23	73.7	23.8	76.2
Bt	24	8.5	29.2	62.3	31.9	68.1
	34	10.3	30.9	58.8	34.4	65.6
	40	10.5	36.6	52.9	40.9	59.1
Btkb	55	13.5	32.1	54.4	37.1	62.9
Btk2b	75	17.9	36.9	45.2	44.9	55.1
Btk3b	95	24.8	39.7	35.5	52.8	47.2
	115	25.4	38.6	36	51.7	48.3
	130	25.7	34.3	40	46.2	53.8
Bkb	144	17.3	30.5	52.2	36.9	63.1
2Bkcb	170	6.5	23.6	69.9	25.2	74.8
3Bkc2b	228	5.5	15.6	78.9	16.5	83.5
4Bkc3	250	4.9	37	58.1	38.9	61.1

Table A 5.3 Profile 3 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
Ap	10	2.1	13.1	84.8	13.4	86.6
A	23	2.7	15	82.3	15.4	84.6
Btc	35	16.1	26.3	57.6	31.3	68.7
	50	18.5	25.4	56.1	31.2	68.8
	70	16.5	29.4	54.1	35.2	64.8
Btc2	90	14.5	29.3	56.2	34.3	65.7
	115	12.3	31.5	56.2	35.9	64.1
	120	14.8	30.5	54.7	35.8	64.2
Btkc	150	15.1	36	48.9	42.4	57.6
	170	17.3	37	45.7	44.7	55.3
Btkcb	190	26	31.8	42.2	43.0	57.0
	210	26.8	33.3	39.9	45.5	54.5
	230	25.7	37.7	36.6	50.7	49.3
	250	26.2	46.9	26.9	63.6	36.4
	270	12.4	51.9	35.7	59.2	40.8
Btkc2b	295	17.9	28.3	53.8	34.5	65.5
	310	12.9	20.5	66.6	23.5	76.5

Table A 5.4 Profile 4 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
A	5	1.7	12.9	85.4	13.1	86.9
	20	1.9	16	82.1	16.3	83.7
E	30	0.5	19.4	80.1	19.5	80.5
Bt	50	19.6	18.3	62.1	22.8	77.2
Btc	70	17.4	22.2	60.4	26.9	73.1
	85	14.7	21.9	63.4	25.7	74.3
	100	14	26.5	59.5	30.8	69.2
Btc2	120	11.6	27.5	60.9	31.1	68.9
	140	10.9	27.9	61.2	31.3	68.7
Btc3	170	13.4	27.8	58.8	32.1	67.9
	190	11	29	60	32.6	67.4
	210	16.6	25.6	57.8	30.7	69.3
	230	17.8	27.8	54.4	33.8	66.2

Table A 5.5 Profile 5 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
A	5	0.5	9.7	89.8	9.7	90.3
	15	0.5	8.8	90.7	8.8	91.2
A2	25	0.5	10.9	88.6	11.0	89.0
	35	0.6	11.7	87.7	11.8	88.2
	50	1	12	87	12.1	87.9
Bt	65	15.3	14.5	70.2	17.1	82.9
	75	15.6	13.3	71.1	15.8	84.2
Bt2	85	19.8	13	67.2	16.2	83.8
Btb	105	30.2	11.5	58.3	16.5	83.5
	120	26.3	12.1	61.6	16.4	83.6
	140	20.5	14.3	65.2	18.0	82.0

Table A 5.6 Profile 6 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay Free %Silt	Clay Free %Sand
A	10	0.5	12	87.5	12.1	87.9
E	30	1.3	12.5	86.2	12.7	87.3
Bt	55	12	21.6	66.4	24.5	75.5
Bt2	70	12.5	21.3	66.2	24.3	75.7
	90	12.2	18.4	69.4	21.0	79.0
Btb	125	16.8	23.8	59.4	28.6	71.4
	140	17.2	23.6	59.2	28.5	71.5
	170	15.7	21.3	63	25.3	74.7
Bt2b	200	13.9	20.4	65.7	23.7	76.3
	220	12.3	19.4	68.3	22.1	77.9
	240	11.8	19	69.2	21.5	78.5
Btcb	280	9.8	24.9	65.3	27.6	72.4
	310	10.5	24.9	64.6	27.8	72.2

Table A 5.7 Profile 7 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
A	5	0.9	14.6	84.5	14.7	85.3
	15	1.1	11.8	87.1	11.9	88.1
Bt	25	10.6	18.6	70.8	20.8	79.2
Bt2	45	13	22	65	25.3	74.7
	65	12.9	22.31	64.8	25.6	74.4
Btb	95	14.2	26.5	59.3	30.9	69.1
	115	11	27.3	61.7	30.7	69.3
Bt2b	135	12.2	23.2	64.6	26.4	73.6
	165	12.4	22.4	65.2	25.6	74.4
Bt3b	190	10.3	22.9	66.8	25.5	74.5
	210	6.9	25.5	67.3	27.5	72.5
Bt4b	230	10	23.7	66.3	26.3	73.7
	260	11.4	23.7	64.9	26.7	73.3
Bt5b	285	10.7	21.5	67.8	24.1	75.9

Table A 5.8 Profile 8 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
A	5	1.8	14.2	84	14.5	85.5
	15	3.3	13.4	83.3	13.9	86.1
Bt	35	11.4	21	67.6	23.7	76.3
Btc	50	10	23.5	66.5	26.1	73.9
	70	11	25	64	28.1	71.9
	90	13.2	20.3	66.5	23.4	76.6
Btcb	110	13.7	23.3	63	27.0	73.0
	130	12.9	22	65.1	25.3	74.7
	150	12.4	20	67.6	22.8	77.2
	170	11.4	20.2	68.4	22.8	77.2
Btc2b	200	11.4	20.6	69	23.0	77.0
	220	10.6	22.3	67.1	24.9	75.1

Table A 5.9 Profile 9 Data

Horizon	Depth	%Clay	%Silt	%Sand	Clay-Free %Silt	Clay-Free %Sand
BtÞA	8	11.7	27.5	60.8	31.1	68.9
Bt	25	10.6	27.3	62.1	30.5	69.5
	40	10.5	25.3	64.2	28.3	71.7
	50	11.5	22.1	66.4	25.0	75.0
Bt2	75	10.1	22	67.9	24.5	75.5
	85	9.2	24	66.8	26.4	73.6
Bt3	110	8.9	32.7	58.4	35.9	64.1
	130	7.6	39.8	52.6	43.1	56.9
Cr	150	6	41.5	52.5	44.1	55.9

APPENDIX B

EXCAVATION RESULTS AND ARTIFACT ANALYSIS

Table B.1
Specimen Catalogue, Surface Materials, 1996

Bifacial Tools

Projectiles

Spec. #	Type	Raw Material	Blank	Grinding	Serration	Comments
96-1	Dalton	Edwards chert, 2.5Y7/2, light grey, few floating quartz grains	I	L,B	A	Complete, base bifacially thinned, extensively resharpened, discard?
96-2	Dalton	Edwards chert, 2.5Y7/1, light grey	F	L,B	A	base, unifacially thinned, reworked, discard?
96-3	Dalton	chert, 2.5Y7/5, pale yellow	I	L,B	A	proximal fragment, base bifacially thinned, fractured in haft?
96-4	Carrollton?	Edwards chert 2.5Y6/2, light brownish gray, band 10YR5/3, brown	I	A	A	complete, short base for Carrollton, base unifacially thinned
96-5	Williams	Edwards chert, 2.5Y6/3, light yellowish brown, many white inclusions	I	A	A	distal snap fracture, one barb broken, base bifacially thinned
96-6	Edgewood-Ellis-	chert breccia, 10YR6/4, light yellowish brown, 2.5Y6/1, grey inclusion	F	A	A	distal snap fracture, base bifacially thinned
96-7	Godley	Edwards chert, 10YR5/2, greyish brown	I	A	A	complete, crudely knapped, steep unilateral retouch, cortex on base
96-8	Elam	petrified wood, 2.5Y5/3, light olive brown	I	A	A	complete, crudely knapped

Table B.1 (cont.)

Projectiles

Spec. #	Type	Raw Material	Blank	Grinding	Serration	Comments
96-9	Indeterminate dart	Edwards chert, 2.5Y5/4, light olive grey	I	L	?	proximal fragment, shoulders broken, straight stem base, unifacially thinned
96-10	Indeterminate dart	coarse chert, 5Y5/1, grey	F	A	?	crudely knapped, base snapped, broken barbs
96-11	Preform dart	chert, 2.5Y7/3, pale yellow	I	A	A	proximal fragment, cortex on base
96-12	Preform dart	Edwards chert, 5Y6/1, grey, vuggy, red oxide inclusions	F	?	A	distal fragment with small stack
96-13	Indeterminate Preform	Edwards chert, 2.5Y6/1, grey	I	A	A	distal fragment, dart point?
Key:	A absent	B basal	F flake	I Indet.	L lateral	

Unifacial Tools

Spec. #	Type	Raw Material	Blank	Comments
96-14	Quince hafted end-scraper	coarse grained chert, 2.5Y7/3, pale yellow	side notched biface	distal end steeply retouched, base and lateral notches ground
96-15	Side-end scrapper	Edwards chert, 2.5Y7/1, light grey	cortical flake	thick end scraper, steeply retouched
96-16	Graver	chert, 10YR6/4, light yellowish brown	cortical flake	well made, single distal graver

Table B.2 (cont.)
Excavation Specimen Catalogue, 1996

Bifacial Tools

Projectiles

Spec. #	Type	Raw Material	Blank	Grinding	Serration	Comments
96-17	Plainview?	Edwards chert, 10YR7/2, light grey	I	L,B	?	small basal frag., distal snap fracture
96-18	San Patrice var. St. Johns	fossiliferous chert, 2.5Y7/3, light yellowish brown	I	L,B	P	asymmetrical base, proximal fragment
96-19	Trinity	Edwards chert, 2.5Y5/1, grey, white inclusions	F	L	A	crudely knapped, reworked, base bifacially thinned
96-20	Indeterminate dart	jasper, 2.5YR3/3, dusky red	F	A	A	complete, crudely flaked, unilateral cortex
96-21	Indeterminate dart	chert, 2.5Y6/2, light brownish grey	I	L,B	?	proximal fragment, straight stem
96-22	Indeterminate dart	chert, 2.5Y4/1, dark grey	I	L,B	A	proximal fragment with one barb, pot-lidded
96-23	Indeterminate dart	chert, 2.5Y7/3, pale yellow, red oxide veins	F	?	A	extremely well made, thin, base and one barb missing
96-24	Indeterminate dart	grainy chert, 2.5Y7/3, pale yellow, fine grained dark inclusions	I	?	A	distal fragment
96-25	Preform dart	chert, 10YR6/4, light yellowish brown	I	?	A	distal fragment, cortex on tip, pot-lidded
96-26	Preform dart	chert, 2.5Y7/4, pale yellow	I	A	A	small preform with large stack distally

Table B.2 (cont.)

Projectiles

Spec. #	Type	Raw Material	Blank	Grinding	Serration	Comments
96-27	Preform dart	chert, 10YR7/4, very pale brown	I	A	A	thick crudely knapped, unilateral cortex

Drills

96-28	Drill	chert, 2.5Y8/3, pale yellow	I	?	A	distal fragment, bilaterally beveled
96-29	Drill	chert, 2.5Y4/1, dark grey	I	?	A	distal fragment
96-30	Biface fragment	chert, 2.5Y6/3, light yellowish brown	I	?	?	biface fragment, pot-lidded

Unifacial Tools

Spec. #	Type	Raw Material	Blank	Comments
96-31	End+side scraper	chert, 2.5Y6/4, light yellowish brown	pebble	split pebble, steep retouch, unilateral cortex
96-32	End+side scraper	Edwards chert, 2.5Y6/1, grey	cortical flake	fine steep retouch, unilateral cortex
93-33	End scraper	chert, 2.5Y7/4, pale yellow	cortical flake	fine steep retouch, bilateral cortex
96-34	End scraper	Edwards chert, 10YR5/2, greyish brown, white inclusions	biface	crudely knapped biface, distal moderate retouch
96-35	Side scraper	fine grained quartzite, 7.5YR7/1, light grey	cortical flake	moderate retouch
96-36	Gouge	chert, 10YR7/3, very pale brown, fine grained dark inclusions	biface	crudely knapped, steeply beveled
96-37	Gouge	quartzite, 2.5Y6/3, light yellowish brown	pebble	broken, unilateral cortex
96-38	Perforator + spokeshave	chert, 10YR7/4, very pale brown	cortical flake	single perforator adjacent to spokeshave, unilateral cortex

Table B 2 (cont.)

Unifacial Tools

Spec. #	Type	Raw Material	Blank	Comments
96-39	Retouched flake	Edwards chert, 10YR5/2, greyish brown	cortical flake	bilateral retouch
96-40	Retouched flake	chert, 2.5Y6/2, light brownish grey	cortical flake	unilateral retouch
96-41	Retouched flake	chert, 2.5Y6/1, grey	cortical flake	unilateral retouch
96-42	Retouched flake	chert, 2.5Y7/2, light grey	interior flake	unilateral bifacial retouch
96-43	Retouched flake	chert, 2.5Y7/2, light grey	cortical flake	bilateral retouch
96-44	Retouched flake	chert, 2.5Y7/1, light grey	interior flake	unilateral retouch
96-45	Retouched flake	chert, 10YR7/4, very pale brown	interior flake	bilateral retouch, patina on dorsal surface

Hammer-Ground Stone, Cores

Spec. #	Type	Raw material	Blank	Comments
96-46	Hammer- stone	well cemented fine grained sandstone, 10YR6/4, light yellowish brown	cobble	triangular in shape, impact scars at each corner
96-47	Ground- stone	fine grained sandstone, 2.5Y6/3, light yellowish brown	I	thin tabular fragment, unifacially ground, metate fragment?
96-48	Ground- stone	fine grained sandstone, 5YR5/4, reddish brown	I	angular fragment, unifacially ground, mano fragment?
96-49	Ground- stone	fine grained sandstone, 5YR5/4, reddish brown	I	thin tabular fragment, bifacially ground, metate
96-50	Ground- stone	fine grained sandstone, 10YR6/3, pale brown	I	thin tabular fragment, unifacially lightly
96-51	Core, hammer-stone	quartzite, 10YR6/4, light yellowish brown	cobble	unifacial platform
96-52	Core	chert, 10YR7/4, very pale brown	cobble	bifacial platforms

Table B 3 Excavation Debitage Data by Area, 1996

Debitage Data D1 N36/E3

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1NW					9				9	
NE	1				11				12	
SW			1		22			2	25	
SE			1		16		1	1	19	65
2 NW					6				6	
NE	1			1	21				23	
SW			2		6				8	
SE					11		1	1	13	50
3 NW					7			1	8	
NE					5				5	
SW					7			1	8	
SE					12		2		14	35
4 NW					1				1	
NE					3				3	
SW					5	1			6	
SE					5				5	15
5 NW					7				7	
NE					3				3	
SW					2		2	1	5	
SE			1		9				10	25
6 NW					6				6	
NE					10		1		11	
SW					2				2	
SE									0	19
7 NW					7			1	8	
NE					3			1	4	
SE	*	*	*	*	*	*	*	*	0	
SW	*	*	*	*	*	*	*	*	0	12
8 NW									0	
NE					1				1	
SE	*	*	*	*	*	*	*	*	0	
SW	*	*	*	*	*	*	*	*	0	1
TOTAL	2	0	5	1	197	1	7	9		222
%										

* Quad not excavated

Table B 3 (cont.)

Debitage Data D2 N36/E9

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW			1		26		3		30	
NE					1		2		3	
SW					7		4		11	
SE					9		1	1	11	55
2 NW					24		2		26	
NE					11				11	
SW			1		11				12	
SE			1		13				14	63
3 NW			1		8				9	
NE					14		3		17	
SW					13		1		14	
SE					14				14	54
4 NW					4		3	1	8	
NE					7		2	1	10	
SW					11				11	
SE					5	1	1		7	36
5 NW					4			1	5	
NE					6				6	
SW					3		1		4	
SE					6			1	7	22
6 NW	*	*	*	*	*	*	*	*	0	
NE					1				1	
SW	*	*	*	*	*	*	*	*	0	
SE					2				2	3
TOTAL	0	0	4	0	200	1	23	5		233

* Quad not excavated

Table B 3 (cont.)

Debitage Data D3 N36/E13

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					18		4		22	
NE					11		1	1	13	
SW					6		2		8	
SE				1	6		2		9	52
2 NW					15		3		18	
NE			1		24		2		27	
SW					30		1		31	
SE					4		2		6	82
3 NW					9		1	1	11	
NE					4		3		7	
SW					5		1		6	
SE					6		2		8	32
4 NW	1				4			2	7	
NE					1			1	2	
SW					6			1	7	
SE					6		1		7	23
5 NW				1	5		2		8	
NE					1				1	
SW					2		1		3	
SE				1	5				6	18
TOTAL	1	0	1	3	168	0	28	6		205

* Quad not excavated

Table B 3 (cont.)

Debitage Data D4 N37/E13

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					13				13	
NE	1		1		16				18	
SW					8			2	10	
SE					2		1		3	44
2 NW					8		1	1	10	
NE					5		1	2	8	
SW					5		2		7	
SE					15		1		16	41
3 NW					17				17	
NE		1			9		1		11	
SW					9				9	
SE					5				5	42
4 NW			1		2		1		4	
NE					5		2	2	9	
SW					3		2		5	
SE					6		3		9	27
5 NW					6				6	
NE					7		1		8	
SW										
SE										14
TOTAL	1	1	2	0	141	0	16	7		168

* Quad not excavated

Table B 3 (cont.)

Debitage Data D5 N37/E12

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW	1				29		2	3	35	
NE			1		15		3		19	
SW					30		3		33	
SE					19		3	1	23	110
2 NW					18		2		20	
NE					15				15	
SW					13		2	2	17	
SE	1				13		1	1	16	68
3 NW	1				9		2	1	13	
NE					11				11	
SW					13		1	2	16	
SE					7		1	1	9	49
4 NW					5				5	
NE					3			1	4	
SW					6				6	
SE	2				2				4	19
TOTAL	5	0	1	0	208	0	20	12		246

* Quad not excavated

Debitage Data D6 N36/E12

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW		1			32		5	2	40	
NE	2		1		20		3	1	27	
SW					19		4		23	
SE		1			21		4		26	116
2 NW			1		17		4		22	
NE					13	1	2	2	18	
SW					7				7	
SE					9		2	2	13	60
3 NW					7		1		8	
NE					1				1	
SW					1			1	2	
SE					5				5	16
4 NW					2		1		3	
NE					8				8	
SW					1		2	1	4	
SE					6				6	21
TOTAL	2	2	2	0	169	1	28	9		213

* Quad not excavated

Table B 3 (cont.)

Debitage Data P1 S8/E40

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW							2		2	
NE	1						2		3	
SW					4	1	2		7	
SE					4	1			5	17
2 NW					2		1		3	
NE					7		1		8	
SW									0	
SE					2				2	13
3 NW					6	1			7	
NE					4	2			6	
SW					1				1	
SE					3			2	5	19
4 NW									0	
NE					2				2	
SW					1			1	2	
SE					3				3	7
5 NW					4				4	
NE	1				4		1		6	
SW				1	4				5	
SE					7	1	1		9	24
6 NW									0	
NE							1	1	2	
SW									0	
SE								1	1	3
TOTAL	2	0	0	1	58	6	11	5		83

* Quad not excavated

Table B 3 (cont.)

Debitage Data P2 S37/E40

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					1				1	
NE									0	
SW					2				2	
SE					3				3	6
2 NW					8		1		9	
NE					1				1	
SW					3				3	
SE					9				9	22
3 NW					8			1	9	
NE	1				9		2		12	
SW					10	1			11	
SE					12		1	1	14	46
4 NW	1				5				6	
NE					9				9	
SW					14		2		16	
SE					10		1		11	42
5 NW					4				4	
NE					2		1		3	
SW					3		1		4	
SE					5				5	16
6 NW									0	
NE					1				1	
SW					1				1	
SE					2				2	4
TOTAL	2	0	0	0	122	1	9	2		136

* Quad not excavated

Table B 3 (cont.)

Debitage Data P3 S34/E40

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					1			1	2	
NE									0	
SW					4			1	5	
SE									0	7
2 NW					2	1			3	
NE					6	1	1		8	
SW					4		2		6	
SE					4		2		6	23
3 NW					12				12	
NE					9				9	
SW					8		1		9	
SE					4		1		5	35
4 NW					2		2		4	
NE					11		1	1	13	
SW				1	11		2		14	
SE					20		1		21	52
5 NW				1	3		1		5	
NE					3				3	
SW				1	2		2	1	6	
SE					3				3	17
6 NW									0	
NE									0	
SW									0	
SE								1	1	1
TOTAL	0	0	0	3	109	2	16	5		135

* Quad not excavated

Table B 3 (cont.)

Debitage Data P4 S36/E38

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					1				1	
NE					3		1		4	
SW					2		1		3	
SE					2		1		3	11
2 NW					15		2		17	
NE					8		2		10	
SW					5		2	1	8	
SE					9		1		10	45
3 NW					18		1	1	20	
NE					1		4		5	
SW					11		3		14	
SE					8		1		9	48
4 NW					2				2	
NE					4		1		5	
SW					2		1	1	4	
SE					4				4	15
5 NW					2	1	1		4	
NE					1		2		3	
SW					2				2	
SE					2				2	11
6 NW					1		1		2	
NE					1		1		2	
SW					1				1	
SE									0	5
TOTAL	0	0	0	0	105	1	26	3		135

* Quad not excavated

Table B 3 (cont.)

Debitage Data P5 S35/E40

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					6				6	
NE					7				7	
SW					2		1		3	
SE					3		1		4	20
2 NW					3		1	1	5	
NE					8				8	
SW					2				2	
SE					9		1		10	25
3 NW					3				3	
NE					9		1		10	
SW					9				9	
SE					10		1		11	33
4 NW					7				7	
NE					10		1		11	
SW									0	
SE					1				1	19
5 NW					2		2		4	
NE		1			5				6	
SW					2		1		3	
SE					1				1	14
6 NW					1			1	2	
NE		1							1	
SW					1		1		2	
SE									0	5
TOTAL	0	2	0	0	101	0	11	2		116

* Quad not excavated

Table B 3 (cont.)

Debitage Data P6 S36/E40

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					2		1		3	
NE	1								1	
SW					1		1		2	
SE					4		1		5	11
2 NW					1			1	2	
NE					2				2	
SW					1				1	
SE					2				2	7
3 NW					9				9	
NE					6		2		8	
SW					6		1		7	
SE					2				2	26
4 NW					6		1		7	
NE					10		1		11	
SW					2				2	
SE					4		1		5	25
5 NW					1				1	
NE					1			1	2	
SW					1		1		2	
SE					3		1		4	9
6 NW					1				1	
NE					3				3	
SW									0	
SE									0	4
TOTAL	1	0	0	0	68	0	11	2		82

* Quad not excavated

Table B 3 (cont.)

Debitage Data P7 S37/E45

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					3				3	
NE					5				5	
SW					2		1		3	
SE							1		1	12
2 NW			1		10				11	
NE					5		2		7	
SW					12		1		13	
SE					9				9	40
3 NW					8		1		9	
NE			1		6		1		8	
SW					7	1		1	9	
SE					4				4	30
4 NW					2		2		4	
NE					1				1	
SW					2			1	3	
SE					1		1		2	10
5 NW									0	
NE					1		1		2	
SW									0	
SE									0	2
TOTAL	0	0	2	0	78	1	11	2		94

* Quad not excavated

Table B 3 (cont.)

Debitage Data G1 N27/E53

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					12				12	
NE					5				5	
SW	1				6				7	
SE	1				6				7	31
2 NW					20		2		22	
NE			1		26				27	
SW					24		3		27	
SE					15	1	1		17	93
3 NW					4				4	
NE					16		3		19	
SW					4				4	
SE					6		1		7	34
4 NW					1				1	
NE								2	2	
SW					3				3	
SE					1				1	7
5 NW									0	
NE	*	*	*	*	*	*	*	*	0	
SW	*	*	*	*	*	*	*	*	0	
SE	*	*	*	*	*	*	*	*	0	0
TOTAL	2	0	1	0	149	1	10	2		165

* Quad not excavated

Debitage Data G2 N22/E44

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					6				6	
NE					2				2	
SW					4		2		6	
SE					2				2	16
2 NW					9				9	
NE					1	1			2	
SW									0	
SE					4		1		5	16
TOTAL	0	0	0	0	28	1	3	0		32

* Quad not excavated

Table B 3 (cont.)

Debitage Data G3 N18/E53

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW	1				9				10	
NE					2		1		3	
SW					14				14	
SE									0	27
2 NW									0	
NE	1				10				11	
SW									0	
SE									0	11
TOTAL	2	0	0	0	35	0	1	0		38

* Quad not excavated

Debitage Data O1 S73/E50

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					1		3		4	
NE					1		1		2	
SW									0	
SE					6				6	12
2 NW					1				1	
NE									0	
SW									0	
SE									0	1
3 NW							1		1	
NE									0	
SW									0	
SE						1	1	1	3	4
TOTAL	0	0	0	0	9	1	6	1		17

* Quad not excavated

Debitage Data O2 S72/E50

LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	QUAD TOTAL	LEVEL SUM
1 NW					4				4	
NE					5				5	
SW									0	
SE					6				6	15
TOTAL	0	0	0	0	15	0	0	0		

* Quad not excavated

Table B 4
Specimen Catalogue Surface Materials, 1990

Bifacial Tools

Projectile Points

Spec. #	Type	Raw Material	Blank	Grinding	Serration	Comments
90-1	Dalton	chert, 2.5YR6/6, olive yellow, few quartz filled vugs	I	L,B	P	basal ears broken
90-2	Dalton	Edwards chert, 5Y7/1, light grey	I	L,B	A	drill, bifacially resharpened
90-3	Dalton	chalcedony with floating quartz grains, 2.5Y7/3, pale yellow	I	L	P	bilateral burin blows to base, distal end steeply beveled
90-4	Dalton	chert, 5Y5/1, grey, vuggy with red oxide linings, few white sponge spicules	I	A	A	pressure retouch along one edge of base, cortex on base
90-5	Plainview	Edwards chert, 2.5Y7/2, light grey	I	L,B	A	distal snap fracture, base bifacially thinned
90-6	Dalton	Edwards chert, 2.5Y7/4	I	L,B	A	distal snap fracture, base bifacially thinned, resharpened above haft
90-7	Morrill	Ogallala quartzite, 2.5Y5/3, light olive brown	I	A	P	distal end impact fractured, base snap fractured
90-8	Yarbrough	chert, 2.5Y6/4, light yellowish brown, angular quartz inclusions	I	L,B	A	steep bilateral retouch along entire blade

Table B 4 (cont.)

Projectiles

90-9	Yarbrough	Edwards chert, 2.5Y7/3, pale yellow	I	A	A	asymmetrical retouch along one edge, broken shoulder, basal thinning
90-10	Yarbrough atypical	silicified shale, 2.5Y4/3, 3/1, olive and dark olive brown	I	L	A	slightly bevelled resharpening, one shoulder missing, distal impact scar
90-11	Kent	Edwards chert, 2.5Y4/1, dark grey	I	L	A	distal end snapped, cortex on base
90-12	Castroville	Edwards chert, 2.5R7/4, pale yellow with 2.5Y6/3 yellowish brown band	I	A	A	crudely knapped
90-13	Ellis	chert, 2.5Y7/4, pale yellow, fine brown inclusions	I	A	L,B	broken barbs
90-14	Indeterminate dart	chert, 2.5Y6/4, yellowish brown with 2.5Y6/3 yellowish brown band	I	N/A	P	distal dart point fragment
90-15	Indeterminate dart	Edwards chert, 5Y7/3, pale yellow	I	N/A	A	distal dart point fragment
90-16	Indeterminate dart	chert, 2.5Y7/3, pale yellow	I	N/A	A	distal dart point fragment
90-17	Indeterminate dart	chert, 2.5Y6/3, light yellowish brown	I	N/A	A	distal dart point fragment
90-18	Indeterminate dart	chert, 2.5Y5/2, grayish brown, 2.5Y4/1, dark grey band, few red oxide inclusions	I	N/A	A	medial dart point fragment

Table B 4 (cont.)

90-19	Indeterminate dart	Edwards chert, 2.5Y5/2, greyish brown, 2.5Y8/3, pale yellow inclusion	I	N/A	A	medial dart point fragment
90-20	Indeterminate dart	Ogallala quartzite, 2.5Y6/2, light greysih brown	I	A	N/A	straight stem dart point fragment
90-21	Indeterminate dart	chalcedony, 10YR5/2, greyish brown, floating quartz grains, red oxide inclusions	I	L,B	N/A	straight stem dart point fragment
90-22	Indeterminate dart	chert, 2.5Y7/4, pale yellos	I	L	N/A	straight stem dart point fragment
90-23	Indeterminate dart	Edwards chert, 2.5Y6/3, light yellowish brown	I	A	N/A	expanding stem dart point fragment

Drills

90-24	Drill, distal fragment	chert, 2.5Y6/4, pale olive, band, 2.5Y6/3, pale olive	I	N/A	P	alternating retouch along entire blade
90-25	Drill, distal fragment	fine grained quartzite, 2.5YR3/4, dusky red	I	N/A	P	bilateral retouch
90-26	Drill, distal fragment	Edwards chert, 2.5Y7/3, pale yellow	I	N/A	P	bilateral retouch
90-27	Drill, proximal fragment	chert, 2.5Y7/5, pale yellow, red oxide and black inclusions	I	A	N/A	alternating retouch

Table B 4 (cont.)

Unifacial Tools

Spec. #	Type	Raw Material	Blank	Comments
90-28	End scraper	silicified shale, 2.5Y4/3, olive brown, 2.5Y3/1, dark olive brown	biface	broken biface, unilaterally retouched
90-29	End scraper	chert breccia, 10YR8/3, very pale brown, 2.5Y5/2, greyish brown inclusion	biface	bilateral retouched, proximal end snapped
90-30	End scraper	Edwards chert, 2.5Y5/2, greyish brown, many white sponge spicules	cortical flake	thick end scraper steeply retouched
90-31	End scraper	Edwards banded chert, 2.5Y7/4, pale yellow, 2.5Y5/2, greyish brown	biface	small amount of brown cortex, moderate retouch
90-32	End scraper	chert, 2.5Y6/3, light yellowish brown	biface	small amount of white cortex, steep retouch
90-33	End scraper	Edwards chert breccia, 2.5Y7/6, yellow, 2.5Y6/2 light yellowish grey inclusion	biface	small amount of yellow cortex, light retouch
90-34	End scraper	Edwards chert, 2.5Y7/2, light grey	biface	moderate retouch
90-35	End scraper	chert, 2.5YR4/4, dusky red, few white sponge spicules	primary flake	distal fragment, moderate retouch
90-36	End scraper	Edwards chert, 5Y7/2, light grey	cobble	atypical end scraper, flat retouch along two sides of angular cobble
90-37	End-side scraper	Edwards banded chert, 5.Y7/3, pale yellow, 5Y6/2, light olive grey	cortex flake	unilateral cortex, steep retouch on two edges
90-38	Side scraper	Edwards chert, 5Y6/3, pale olive	cobble	thick coarse retouched along one edge
90-39	Side scraper	chert, 2.5Y5/4, light olive brown, many 2.5Y7/3, pale yellow inclusions	pebble	steep working face with moderate retouch

Table B 4 (cont.)

Unifacial Tools

90-40	Side scraper	Edwards chert, 2.5Y6/2, light brownish grey	interior flake	moderate retouch
90-41	Side scraper	fine grained quartzite, 10YR6/4, light yellowish brown	cortical flake	atypical five sided scraper with moderate retouch along four edges
90-42	Side scraper + spokeshave	Edwards chert, 2.5Y6/2, light brownish grey, small amt. white patina on one face	biface	steep retouch on spokeshave, bifacial retouch on scraper
90-43	Side scraper + spokeshave	chert, 2.5Y7/3, pale yellow	cortical flake	unilateral cortex, steep retouch on spokeshave, moderate retouch on scraper
90-44	Burin	chert, 2.5Y8/3, pale yellow	biface	burin blows to lateral edges
90-45	Burin	Edwards chert, 2.5YR7/3, pale yellow	expanding stem dart point base	impact fractured base with burin blow to lateral edge
90-46	Graver- multiple	Edwards chert, 2.5Y8/1, white	cortical flake	patinated, small amt. unilateral cortex, two graver points, retouch along one edge
90-47	Graver-perforator-spokeshave	Edwards chert, 2.5Y7/2, light grey	biface	atypical piece, spokeshave steeply retouched bounded by graver and perforator
90-48	Perforator-spokeshave	chert, 10YR6/4, light yellowish brown	thick interior flake	atypical piece, steeply retouched spokeshave bounded by two perforators
90-49	Gouge	fine grained quartzite, 2.5Y6/3, light yellowish brown	Paluxy cobble	crude gouge on broken cobble, steep retouch
90-50	Gouge	chert, 2.5Y6/2, light brownisn grey	angular pebble	steep retouch, CaCo3 on one side
90-51	Gouge	chert, 2.5Y8/2, pale yellow	angular pebble	steep retouch, CaCo3 on one side

Table B 4 (cont.)

Unifacial Tools

90-52	Gouge	jasper, 2.5YR4/4, dusky red	cobble	proximal end snapped, use wear on proximal and distal ends
90-53	Notched piece	Edwards chert, 10YR7/2, light grey	tabular cortical flake	bilateral cortex, heat treated, single notch on one edge
90-54	Retouched flake	Edwards chert, 2.5Y7/2, light grey, many white inclusions	cortical flake	cortex on platform, moderate unilateral retouch
90-55	Retouched flake	chert, 2.5Y7/1, light grey,	interior flake	light unilateral retouch
90-56	Retouched flake	Edwards chert, 2.5Y7/3,pale yellow, many dark inclusions	interior flake	light quadrilateral retouch
90-57	Retouched flake	chert, 2.5Y7/3,pale yellow	flake	light unilateral retouch
90-58	Retouched flake	fine grained Ogallala quartzite, 5YR3/2, dark reddish brown	interior flake	moderate unilateral retouch
90-59	Retouched flake	chalcedony, 2.5Y8/1-2.5Y8/4, white to pale yellow	thick angular cortical flake	bilateral cortex, light unilateral retouch
90-60	Retouched flake	chert, 2.5Y7/4, pale yellow	interior flake	moderate unilateral retouch
90-61	Retouched flake	Edwards chert, 2.5Y7/2, light grey	biface fragment	light retouch on bifacial edge
90-62	Retouched flake	Edwards chert, 2.5Y6/2, light brownish grey	cortical flake	bilateral cortex, unilateral light retouch
90-63	Retouched flake	chert, 2.5Y3/1, very dark grey	cortical flake	thick unilateral cortex, small amount of chert lightly retouched
90-64	Retouched flake	Edwards chert, 2.5Y5/1, grey	cortical flake	bilateral light retouch

Table B4 (cont.)

Cores, Preforms

Spec. #	Type	Raw Material	Blank	Comments
90-65	Core	fine grained quartzite, 10YR6/3, pale brown	angular cortical cobble	multi-directional platforms
90-66	Core	fine grained Ogallala pebble, 2.5Y5/2, greyish brown	tabular cortical pebble	bifacial platforms
90-67	Core	fine grained quartzite, 10YR7/3, very pale brown	cortical pebble	multi-directional flake removal, aborted scraper?
90-68	Core	Edwards chert, 10YR6/1, grey	angular cortical cobble	bifacial, multi-directional flake removal, blank?
90-69	Core	chert, 2.5Y7/2, light grey	cortical pebble	multi-directional platforms
90-70	Core	Edwards chert, coarse, 2.5Y6/1, grey	?	exhausted core, multiple platforms
90-71	Core	coarse chert, 2.5Y7/2, light grey, pink inclusions	cortical angular pebble	exhausted core, moderate bilateral retouch on notch
90-72	Core	chert, 2.5Y7/2, light grey	thick cortical flake	exhausted core, multiple platforms
90-73	Core	Edwards chert, 2.5Y7/2, light grey	angular cortical pebble?	multiple platform radial core
90-74	Preform, dart	chert, 2.5Y7/2, light grey	cortical flake	abandoned post distal step fracture?
90-75	Preform, dart	petrified wood, 7.5YR3/2, dark brown	interior flake	thick, crudely flaked
90-76	Preform, dart	chert, 10YR7/3, very pale brown	cortical flake	heat treated, fine pressure flaking

Table B4 (cont.)

90-77	Preform, gouge?	coarse grained quartzite, 10YR6/3, pale brown	cobble	crude, broken gouge preform, bilateral use wear
90-78	Preform side scraper	Edwards chert, 2.5Y7/2, light grey, red oxide inclusions	cortical flake	side scraper preform, bilateral retouch
90-79	Preform indeterminate	Edwards chert, 2.5Y7/3, pale yellow	I	medial fragment
90-80	Preform indeterminate	Edwards chert, 2.5Y7/4, pale yellow	I	proximal fragment
90-81	Preform indeterminate	chert, 2.5Y5/1, grey	I	proximal fragment

Hammer-Ground Stone

Spec. #	Type	Raw material	Blank	Comments
90-82	Hammer-stone	Ogallala quartzite, 2.5Y5/3, light olive brown	cobble	heavy use of one protuberance, several ground areas
90-83	Hammer-stone	Ogallala quartzite, 2.5Y5/3, light olive brown	angular cobble	impact scars, 5-6 flake removals, several ground areas
90-84	Hammer-stone	Ogallala quartzite, 2.5Y5/2,greyish brown	angular pebble	heavy use wear on all edges, several impact scars, 3 flake removals
90-85	Hammer-stone	coarse grained quartzite, 10R3/3, dusky red	rounded cobble	broken hammerstone, impact scars in three areas
90-86	Hammer-stone	fine grained Paluxy quartzite	rounded cobble	bilateral impact scars
90-87	Mano	very fine grained limonite cemented sandstone, 10YR5/4, yellowish brown	cobble	unilaterally polished, the opposing face moderately ground
90-88	Mano	very fine grained silica cemented sandstone, 2.5YR3/1, very dark grey	cobble	broken, bilaterally polished

Table B 4 (cont.)

Hammer-Ground Stone

90-89	Mano	fine grained silica cemented sandstone, 10YR6/4, light yellowish brown	cobble	broken, moderately polished unilaterally, opposing face removed
90-90	Mano	coarse grained silica cemented sandstone, 2.5YR6/4, light yellowish brown	cobble	broken, bilateral impact scars, moderate bilateral polish
90-91	Mano?	quartzite, 2.5YR7/4, pale yellow	cobble	fragmentary, bilaterally polished

Table B 5
Excavation Debitage Data by Area, 1990

Area A-90

TEST PIT	LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	LEVEL TOTAL	UNIT SUM
N30-E0	1									0	
	2			1		7		2	2	12	
	3					2		1	1	4	
	4			1						1	17
N36-E7	1						1	1		2	
	2					14	8	1	4	27	
	3			1		1	4		2	8	
	4					1	1		1	3	
	5		1			3		2	1	7	
	6					3	2	1		6	53
N37-E6	1					6	3	1		10	
	2				1	8	2	3	2	16	
	3				1	4		1	3	9	
	4			3		4	1	3	2	13	
	5				1				2	3	51
N37-E7	1								1	1	
	2	1			1	9	4	5	4	24	
	3				1	4	3	2	3	13	
	4					1	1	2		4	
	5					3	2	1	3	9	
	6					1				1	52
N38-E7	1									0	
	2					4	4	2	2	12	
	3									0	12
TOTAL		1		6	5	75	36	28	33	185	185

Table B 5 (cont.)

Area B-90

TEST PIT	LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	LEVEL TOTAL	UNIT SUM
N0-W6	1					1		1		2	
	2					2		1		3	
	3					5			1	6	
	4									0	11
N0-E9	1					1				1	
	2					4		1		5	
	3							3		3	
	4									0	9
N3-E0	1					3				3	
	2							1		1	
	3					1				1	5
N6-E0	1					6		3		9	
	2									0	9
S6-E0	1									0	
	2							1	1	2	
	3					1				1	
	4									0	
	5		1							1	
	6					1				1	5
TOTAL			1			25		11	2	39	39

Table B 5 (cont.)

Area C-90

TEST PIT	LEVEL	QSI	QSC	QLI	QLC	CSI	CSC	CLI	CLC	LEVEL TOTAL	UNIT SUM
S48-W12	1						1			1	
	2									0	
	3								1	1	
	4	1				2	1			4	
	5					2	1		2	5	11
S48-W13	1									0	
	2					1				1	
	3					5	1	1		7	
	4									0	8
S49-W13	1						1			1	
	2	1								1	
	3					1				1	
	4					1		1	1	3	
	5							1		1	7
S51-E6	1									0	
	2									0	
	3					1		2		3	
	4									0	
	5	1						1	1	3	
	6							1	1	2	8
S51-E9	1									0	
	2					1				1	
	3									0	
	4					4	1			5	
	5	1				2		2		5	11
TOTAL		4	0	0	0	20	6	9	6	45	45

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