

KANSAS PREHISTORY:
AN ALLUVIAL GEOMORPHOLOGICAL PERSPECTIVE

by

Richard A. Rogers

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B.A. University of Kansas, 1966

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CHAPTER ONE

INTRODUCTION

1.1 OBJECTIVES AND ORGANIZATION

The need for a geological framework to analyze local archaeological data has been recognized since the 19th Century. The use of geology provides a number of theoretical approaches for understanding the archaeological record. Hypotheses can be generated that are testable by reference to the geological data. This is particularly true for those hypotheses concerning the distribution and dating of archaeological material. A geomorphological framework for portions of the Kansas River and Arkansas River drainages was developed for this dissertation. Selected archaeological data were analyzed using this geomorphological framework. This dissertation will demonstrate the value of this framework for understanding the archaeological record of Kansas.

The geomorphological aspect of the dissertation will be presented in two parts. One chapter will describe and date the relevant terrace systems. Another chapter will discuss what caused these terrace systems to form.

Selected archaeological data will be analyzed in separate chapters for the Kansas River drainage and for the Arkansas River

drainage. Archaeological sites will be discussed in relationship to the stream terraces with which they are associated. Brief mention will be made of the artifacts from the Kansas River gravel bars. The potential of alluvial geomorphological analysis for understanding archaeological data will be examined, and the accomplishments of this analysis reviewed.

1.2 METHODOLOGY AND THEORETICAL IMPORTANCE

Theory must have a basis in data. All archaeological data have been found in a geological context. The artifacts studied by archaeologists are found either in or on geological deposits. The development of archaeological theories requires a knowledge of the geological context from which the data were derived.

Understanding the geological context of archaeological evidence can enhance archaeology in several ways. Geological units can be ordered chronologically. Subsequently, the artifacts in and on these geological deposits can be ordered chronologically. The use of geology as a dating tool has been of great significance in the history of archaeology. The effect of such research on archaeology has been as great as the effect of Darwin's theory of evolution on biology. Boucher de Perthes virtually founded the field of prehistory in 1846 by publishing his work relating discoveries of human artifacts to ancient terraces along the Somme River in France. His work clearly indicated the existence of humans contemporaneous

with extinct animals and antedating the accepted biblical interpretation of man's antiquity.

Knowledge of the location and age of geological units enables the archaeologist to predict where archaeological sites of a given antiquity might be found. For example, much of the data about australopithecines has arisen from research based on a geological framework developed in the rift area of eastern Africa (Leakey 1967). Most of this data would never have been collected if a geological framework had not been devised.

Understanding relevant geological units can provide a perspective on the nature of the archaeological sample. Archaeologists study remains of human activity which survive through time. Geological processes that erode geological units also erode the archaeological sites in, or on, these units. The material remains of human culture studied by archaeologists are altered by geological processes. Archaeologists wish to understand the significance of the sample of past culture preserved in the archaeological record. This requires knowledge of the geological processes that led to the selective preservation of the data. Binford (1964) and others have stressed the theoretical importance of archaeological sampling. Archaeological theories formed on the basis of inadequately understood samples are likely to be flawed. By enhancing the data with a geological framework, the theories derived from such data are also likely to be enhanced.

Understanding the geological framework of archaeological data enhances the ability to reconstruct ancient topography (Butzer 1971). This is very important to theories devised to explain settlement patterns (Hassan 1979). For example, site catchment studies (Roper 1979) rely on an understanding of the topography of an area during the time of a specific archaeological occupation. Such understanding is improbable without knowing what geological changes have occurred.

Alluvial terraces were the principal geological features studied in the research for this dissertation. They represent one type of geological unit that yields information useful in archaeology. Loess deposits, colluvial slopes, ancient beaches, dunes, terminal moraines etc. are examples of other archaeologically important deposits. However, alluvial terraces are probably the most archaeologically important geomorphological phenomena in Kansas. Gravel bars were also examined because of their rich yield of ancient organic material.

The State of Kansas is covered by a network of streams and rivers. All the stream systems observed by the author in Kansas have a series of alluvial terraces representing ancient floodplains. Archaeological sites are frequently found on or buried within these terraces. There are several reasons why archaeological sites would be concentrated on ancient floodplains. The primary reason is probably the proximity to water. Water is heavy and the technology for obtaining or transporting the liquid is fairly limited in technologically simple societies. It is advantageous for such societies

to camp near a natural source of water. Another factor is the presence of numerous ecological zones in stream valleys which enable societies that utilize foraging as a method of subsistence, to guarantee diverse sources of food. Societies which rely on gathering a small range of food sources would suffer greatly if one of the few sources failed. The broad range of food resources that stream valleys provide would be advantageous. Another reason ancient societies camped near rivers and streams is the possibility of water transport. Streams would also serve as natural fire breaks. Game would be concentrated along streams as a general rule, and especially during droughts. The concentration of archaeological sites in stream valleys makes the study of stream terraces of prime importance to the archaeologist.

The systematic exploration of geological units enables an archaeologist to avoid a circular trap of typology. Literature on man in the Pleistocene and early Holocene in the New World emphasizes projectile point typologies. This tendency arose historically as a result of the nature of the data recovered. The original finds of sites dating to these early chronological periods were primarily kill sites. These sites contained the bones of large extinct animals that attracted paleontologists to the sites. Projectile points used to kill the animals and a few butchering tools constituted the only cultural material recovered. The projectile points were analyzed typologically and were used as cultural "index fossils." When cul-

tural index fossils such as projectile points are used in a survey to the exclusion of a geological search to establish an archaeological chronology, the result is a chronology that is no older than the age of the oldest diagnostic artifact found. Relying on typologies to establish an archaeological sequence in an area limits the observer to what is already known. Although projectile point typologies are useful, geomorphological analysis can provide additional information. Surveying relevant geological units would enable an archaeologist to establish an archaeological sequence without a priori assumptions about the archaeological sequence.

This dissertation attempts to establish an ordering of geological units to aid archaeological analysis. The author hopes that the system of alluvial terraces described in this dissertation will aid Kansas archaeologists in several ways. It will permit the archaeologist to chronologically separate various sites. It will enable the archaeologist to predict where there is a possibility of finding an archaeological site of a given antiquity. It will also do the converse by indicating where such a site will not be found. This is very important from the perspective of an archaeological field worker who has in the past relied almost entirely on chance to find certain categories of sites. The researcher will now be able to concentrate on discrete units of the archaeological sequence to test hypotheses. A described alluvial terrace system will enable archaeologists to better understand the influence of geology on

sampling bias. For example, if a certain terrace has been largely removed by erosion it would be unreasonable to assume the sample of archaeological sites would accurately reflect the sites occupied during the time period of the badly eroded terrace. If the geology is not understood, one might conclude that the area had been extremely thinly populated during the time represented by the eroded terrace.

1.3 STUDY AREA

Alluvial terraces and archaeological sites in this study will be grouped geographically by drainage patterns. There are two principal drainage systems in Kansas, the Kansas River system which drains most of the northern half of the state, and the Arkansas River system which drains the southern half of the state. A portion of the northeast is drained directly by the Missouri River, and a small portion of central eastern Kansas is drained by the Marais des Cygnes River. This dissertation describes the alluvial terrace systems on the two principal drainages of Kansas and relates certain archaeological sites to alluvial terrace systems. The bulk of this research was focused on the Arkansas River system (particularly the Neosho River drainage). A much smaller research effort was given to studying the Kansas River drainage.

1.4 TERRACE ANALYSIS BACKGROUND

The use of terrace analysis to understand the archaeological record goes back to the 1840's with Boucher de Perthes' research on the Somme River in France. This work has continued in more recent times by such researchers as Breuil (1939) and Bordes (1956). The archaeological use of terrace analysis is world wide and has been done in such diverse areas as Russia (Klein 1969), Pakistan (Movius 1948), Burma (Movius 1948), and southern Africa (Clark 1959). The primary use of terrace analysis in the Old World has been to put lithic industries in chronological order. This has been particularly important where stratified sites representing vast spans of time were rare or lacking. The archaeological record of North America has also been analyzed by studying stream terraces. The pioneering work was concentrated in Colorado, Nebraska, and Wyoming.

Bryan and Ray (1940) demonstrated the usefulness of stream terrace analysis to date archaeological sites and provide evidence relevant to important archaeological questions. The important fluted projectile point sites of Lindenmeier and Dent in Colorado were shown to be on the "Kersey" Terrace (or Terrace Four) of the South Platte River drainage. This terrace was traced upstream into the Rocky Mountains where it was related to Wisconsin glacial phenomena. This work provided evidence for a human presence in North America during the last glaciation.

Researchers from the University of Nebraska have established a terrace system for Nebraska (Schultz and Stout 1948, Schultz and Tanner 1965, Schultz 1981) that is relevant to a number of archaeological sites. Not only was the terrace system used as a dating technique but also as a way to locate additional sites in portions of the chronological record that were not well known. The examination of these terraces has yielded numerous associations of man with extinct fauna. The success these researchers had in utilizing their knowledge of geological units to discover and evaluate archaeological sites was an important factor in encouraging the author to undertake related research in the neighboring state of Kansas. This research demonstrated that systematic exploration of terrace units could greatly extend the chronology of the local archaeological sequence.

Renaud (1940) reported on numerous surface sites from stream terraces in the Black Fork area of Wyoming. The artifacts from the high terraces were compared to artifacts from the Lower and Middle Paleolithic of the Old World. Unfortunately, only a few sites, which Renaud thought were typical, had their positions on stream terraces analyzed. Although flawed by including only the "typical" sites, this study was the first serious attempt in North America to chronologically sort lithic tool types by stream terrace analysis.

There was much early research analyzing archaeological data in North America utilizing geomorphological forms not directly related to stream terraces (and therefore not directly related to this dis-

sertation). Much of the earlier research in North America relating changes in the archaeological record to changes in a widespread geomorphological system, concerned the study of beaches formed either on sea coasts or on lakes. This has been done in the Arctic (Dumond 1977:101), in the Great Basin (Campbell 1949), in the Southwest (Antevs 1935), and in the Great Lakes region (Greenman and Stanley 1942). The overall influence on North American archaeology has probably been greater from beach analysis than from stream terrace analysis (based on the author's impression of citation frequency in the archaeological literature). This situation is surprising because stream terraces are found throughout the interior of North America where most of the archaeological work is being done and where ancient beaches are very limited. This suggests that more attention should be given to stream terrace analysis of archaeological data.

A number of recent, local efforts to study the relationships between archaeological data and stream terraces have been undertaken. The author's research represents only one in a series of such efforts.

Artz (1983) investigated the relationship of soils and landforms in the Walnut River valley, a part of the Arkansas River drainage also studied by the author. Artz independently derived the chronological relationship of the Floodplain to Terrace One. Since Artz and the author used much the same data, it is gratifying to note that our descriptions of the surface geomorphology were so similar.

Artz argued for climatically induced changes in streamflow and sediment yield as casual factors of the alluvial geomorphological landforms. The reader is referred to Chapter Three of this dissertation for reasons why the author believes that the principal factor was tectonics and not climatic change that created the stream terraces.

The relationship of archaeological sites to stream terraces has been investigated by a number of researchers in regions near (but outside) the author's study area. A terrace system was described for the Pomme de Terre River in Missouri (Haynes 1976, Brakenridge 1981, and Haynes 1981). This research represented one of the most long term and intensive terrace studies in the mid-continent area of North America. Four terraces were described, including; T-0 dating to the very late Holocene, T-1 (a very complex series of fills) dating to the Holocene and the late Wisconsin, T-2 dating to an earlier period in the Wisconsin, and a T-3 possibly having a "pre-Sangamon age." This terrace system was used to analyze the important archaeological site of Rodgers Shelter which was reported to be in "Terrace 1b" (Haynes 1976), in "T1b2" (Brakenridge 1981), and in "T-1C" (Haynes 1981). The upper deposits at Rodgers Shelter (Units G and F) are deposits derived from material that moved downslope from the hillside (Ahler 1976:137-138). The underlying deposit (Unit E) is a mixture of bands of coarse fan debris eroded from the adjacent hillside with bands of clayey silt deposited by flooding from the river (Ahler 1976:136). The upper part of the Rodgers Shelter can therefore not

be considered a floodplain. The definition of a terrace used in this dissertation is that a terrace is a floodplain, a definition that is also used by Brakenridge (1981:75). The alluvial sediments deeply buried in the site might be reasonably referred to a terrace system.

The terrace system described on the Pomme de Terre River contains numerous radiocarbon dated localities, and has numerous fills described in detail. This extensive body of data will undoubtedly be a major influence on similar work in the region.

The Marmaton River, like the Pomme de Terre River, is a tributary of the Osage River. Two terraces (T-0 and T-1) were identified on the Marmaton River in southeastern Kansas (Schmits, Donohue, and Mandel 1983). Archaeological sites on the surface of Terrace One suggested this surface was more than 1000 years old.

The work of Johnson (1977) and Kopsick (1982) resulted in a description of a terrace system in the valley of the Little Blue River (a tributary of the Missouri River) in western Missouri. Archaeological sites were known from the Floodplain (T-0) and Terrace One. Kopsick suggested that the surface of Terrace One dated to approximately 2000 B. P. because Early Ceramic (Woodland) archaeological sites were abundant on the surface of Terrace One and the majority of Archaic sites were buried under this surface. The potential of using terrace analysis to determine where certain chronological categories of sites might or might not be found was recognized.

Three terraces were described (Benn and Bettis 1981) for the Des Moines River valley in south-central Iowa. An archaeological site dating to the middle Holocene was found buried in the highest of the three terraces. The intermediate terrace dated to the late Holocene on the basis of a radiocarbon date and buried archaeological material. It was suggested that the archaeological record in this area of Iowa was affected by geomorphological change.

Terrace analyses in the region have demonstrated the usefulness of the technique as a dating method, as a predictive model to determine where certain sites will or will not be found, and as a means of understanding the nature of the archaeological sample. This previous research provides a basis for a more extended and synthetic approach for using terrace analysis to examine archaeological data from the Arkansas and Smoky Hill River drainages. It is interesting to note, that the terrace systems described for Colorado, Nebraska, Iowa, Missouri, the Arkansas River drainage in Kansas, and the Smoky Hill River drainage in Kansas are all different. This suggests the need to determine the terrace system in each drainage where archaeological work is being done. This dissertation will study two important drainages in Kansas and will provide examples of how stream terrace analysis can enhance our understanding of archaeological data from the Arkansas and Smoky Hill River drainages.

1.5 CULTURAL CHRONOLOGY

All the major divisions in the local archaeological record were encountered in the field work for this study. The archaeological sequence of Kansas put forth by most local archaeologists, includes five divisions; the paleo-Indian period, the Archaic period, the Early Ceramic period, the Middle Ceramic period and the Late Ceramic period.

The earliest inhabitants of Kansas belong to the paleo-Indian period. The artifacts of these hunter-gatherers have been found associated with the remains of extinct megafauna. Radiocarbon dates suggest this period existed in the plains before 8,000 B.C.

Chronologically, the next recognized period is the Archaic. Traditionally, this term has applied to pre-pottery, hunter-gatherers of the Holocene. Archaic sites range in time from 8,000 B.C. to approximately the time of Christ.

Early Ceramic sites follow the Archaic, and last until approximately A.D. 1000. This is a time period similar to that of the Middle and Late Woodland further eastward. Maize horticulture was present during this period.

The Middle Ceramic period in eastern Kansas shows wide spread evidence of horticulture. The sites frequently contain one or two wattle-and-daub houses. Much of Kansas lacks the pit houses of the Central Plains phase. Hunting and gathering supplemented the raising of maize and squash. These sites range in age from A.D. 1000 to A.D.

1500.

The Late Ceramic period lasted from approximately A.D. 1500 to the late 1700's. Initial contact with Euro-American civilization occurred at this time. Metal artifacts and other goods from Euro-American civilization are occasionally found at these sites.

During the 19th Century many of the local Indians were driven out by the westward expansion of Euro-American civilization. Other groups of Indians from further east were resettled in the state of Kansas.

These divisions in the archaeological sequence have proven to be useful. However, there are problems with the concept of the Archaic. The Archaic as defined here occupied the time span between 10,000 and 2000 years ago. This period includes sites containing extinct fauna in the earlier part of the time span, and some sites with pottery (e.g. the Nebo Hill site on the Kansas border with Missouri) in the latter part of the period. The Archaic thus shares key traits with the divisions that bracket it in time, and its demarcation is somewhat unclear.

CHAPTER TWO

TERRACE DESCRIPTIONS

2.1 TERRACE ANALYSIS

A minimum of two distinct terrace systems are observable in Kansas. These terraces are floodplains abandoned by downcutting streams. Terrace analysis is based on the guiding principle that older terraces are higher above the level of the stream than younger terraces. This principle has to be true because an aggrading stream would bury any older floodplain beneath it. This would change any terrace below the level of aggradation into a buried floodplain. The surfaces of the terraces, and the alluvial fills that established the surfaces provide a method of relative dating. Archaeological sites or fossils on the terrace surface could be no older than the formation of the terrace. Archaeological sites or fossils alluvially buried in the terrace fill could be no younger than the terrace surface above them.

2.2 THE KANSAS RIVER DRAINAGE

The terraces on the Kansas River drainage were examined intensively only in the area drained by the Smoky Hill River. Research concentration on the Smoky Hill River drainage was due to several

factors; a paleo-Indian archaeological site was in this drainage, numerous vertical exposures of the terrace deposits existed along the stream banks, and lack of resources limited the area that could be meaningfully studied. The vertical bank exposures of the higher terraces of the Smoky Hill River revealed a common pattern with the alluvial deposits of the terraces resting on shelves of Cretaceous bed rock. The bed rock along the streams tends to form cliffs with the capping alluvium forming vertical exposures at the edges of the rock cliffs. The exposed alluvial fills yielded index fossils that permit dating of the terraces.

The Floodplain and Terrace One were not checked for index fossils. Terrace Two was examined along Big Creek, a tributary of the Smoky Hill River near Hays, Kansas. A vertical exposure in Terrace Two on the east bank of Big Creek near Yocemento, Kansas yielded the partial skeletons of at least two individuals of Bison bison. The bison bones were eroding from a light, tan, sandy silt at a depth of approximately four feet. The exposed bone bed was approximately four feet wide. The provenience of the locality is Township 13 South, Range 19 West, in the NW quarter, of the SW quarter, of the NW quarter of section 22. The species, Bison bison, is an index fossil of the Holocene, so the presence of this taxon in the alluvial fill indicates Terrace Two is Holocene. Terrace One and the Floodplain must be Holocene because they are below Terrace Two.

The immature skull of a specimen of Bison bison was found buried in alluvium approximately two and one half feet beneath the Terrace Three surface of the Smoky Hill River near Shoenchen, Kansas. The location of the fossil was in a sand pit east of Shoenchen and south of the Smoky Hill River in Township 15 South, Range 18 West, in the NW quarter, of the NE quarter, of the NW quarter of Section 34. This index fossil indicates the Terrace Three surface is Holocene.

An exposure in Terrace Four on the east bank of the Smoky Hill River south of Bunker Hill, Kansas yielded the pelvis of a specimen of Bison bison deeply buried in the alluvial fill. The location of the find was Township 14 South, Range 13 West, in the NE quarter, of the SE quarter, of the SE quarter of Section 25. This find demonstrated a Holocene age for the surface of Terrace Four and for the alluvial fill immediately underneath the surface of the terrace.

All the bison bones examined from Terrace Four and lower terraces of the Smoky Hill River drainage were the same size or smaller than the bones of modern bison examined at the University of Kansas, Museum of Natural History. This is important because Pleistocene bison are known to be larger than Holocene bison. Bones of bison are by far the most common fossils of large animals found in Holocene deposits throughout the Central Plains, although this is not true for Pleistocene deposits (except for perhaps the last thousand years of the Pleistocene).

Terrace Five contains a remarkably different group of index fossils compared to the lower terraces. This is due to the mass extinction of much of the large fauna in North America at the end of the Pleistocene.

The north bank of the Smoky Hill River west of Pfeifer, Kansas yielded the rib fragment of an elephant, buried in a vertical exposure of Terrace Five. Because no elephant remains have been found in situ in Holocene deposits in the Central Plains, the presence of elephant strongly indicates that Terrace Five dates to the Pleistocene. The location of the elephant rib was Township 15 South, Range 17 West, in the NE quarter, of the NW quarter, of the NE quarter of Section 32.

The horse became extinct in the Central Plains approximately at the same time as the elephant taxa (the horse was reintroduced to the Western Hemisphere by European contact in very recent times). It is not surprising that horse bones appear in the same deposits along the Smoky Hill River that produce elephant remains.

A horse maxilla, an unidentified rodent bone, an unidentified bird bone and a snail fauna were recovered from a vertical exposure in Terrace Five in Township 15 South, Range 27 West, in the NE quarter, of the NE quarter, of the NW quarter of Section 12 in Gove County. The vertical exposure was in the north bank of the Smoky Hill River. The terrace surface was sixty-three feet above the Smoky Hill River. Ten feet of Cretaceous chalk was visible at the base of

the exposure, with eleven feet of sand and gravel above the chalk, and twenty-nine feet of silty sand above the sand and gravel. The upper thirteen feet of the terrace was not exposed. The bones and snail fauna were recovered from the basal portion of the silty sand. The snail fauna (J. D. Stewart, personal communication) contained: Discus cronkhitei, Discus shimeki, Vallonia gracilicosta, Succinea ovalis, Succinea avara ?, Retinella electrina ?, Pupilla muscorum ?, and Succinea grosvenori ?. Discus shimeki and Succinea ovalis are present in Kansas only in the latter part of the Wisconsin glacial advance (Leonard 1952). Therefore, Terrace Five must date to the Late Wisconsin. Discus cronkhitei, Discus shimeki, and Vallonia gracilicosta are not extant in Kansas, and these snails are presently confined to montane or boreal regions.

The 12 Mile Creek site (to be discussed in greater detail in a later chapter) near Russel Springs, Kansas has yielded the bones of Bison antiquus and a fluted projectile point. This site lies deeply buried in Terrace Five on the Smoky Hill River. The fluted point and Bison antiquus remains date to the latter part of the Wisconsin glacial advance. Two radiocarbon dates indicate the site is just over 10,000 years old.

The Duck Creek locality near Pfeifer, Kansas is also located in Terrace Five. The author discovered the fragmentary left scapula of a horse eroding from the edge of a sandpit at this locality. The locality yielded a wide variety of small vertebrates and inver-

tebrates (Kolb, Nelson and Zakrzewski 1975) to previous investigators. The location of the Duck Creek locality is Township 15 South, Range 16 West, in the NW quarter, of the NW quarter of Section 27.

The following are heights of the terraces above the Smoky Hill River at the Duck Creek locality:

TERRACE	HEIGHT ABOVE STREAM LEVEL
Floodplain	13' 9"
Terrace One	18' 4"
Terrace Two	25'
Terrace Three	40'
Terrace Four	54' 9"
Terrace Five	62' 5"

The Terrace Five alluvial fill is firmly established as Pleistocene. The fauna, cultural and radiocarbon evidence strongly indicate a Late Wisconsin date for Terrace Five.

It has been claimed in the literature that Terrace Five and the Duck Creek locality (Kolb, Nelson and Zakrzewski 1975; and McMullen 1978) date to the "Illinoian" glacial advance on the grounds that the Duck Creek locality is part of the "Pfeifer Terrace" which ranges in height between "35-65 feet" above the Smoky Hill River (McMullen 1978:374). This is a most extraordinary statement because observation of the topography of the river valley at the Duck Creek locality clearly indicates three separate terraces between 35 and 65 feet

above the Smoky Hill River, not just one terrace. Two of the terraces in this height range above the Smoky Hill River contain Holocene index fossils of Bison bison and no evidence whatsoever of "Illinoian" fossils has been revealed in these deposits. Terrace Five, the highest terrace in the supposed range of heights of the "Pfeifer Terrace," is clearly Late Wisconsin on the bases of diagnostic snails, Bison antiquus, a fluted projectile point, and two radiocarbon dates. Furthermore, it would be remarkable if the next terrace higher than a Holocene terrace was "Illinoian" and not Wisconsin. No solid evidence dating the "Pfeifer Terrace" to the "Illinoian" has been presented by those researchers claiming such a date. A Late Wisconsin radiocarbon date has recently been obtained from the Duck Creek locality (personal communication J. D. Stewart) which apparently settles the question.

There are numerous terraces above Terrace Five on the Smoky Hill River. Unfortunately, a lack of resources prevented any systematic study of the higher terraces. However, one extensive vertical exposure of a Pleistocene terrace 90 feet above the Smoky Hill River in Gove County was analyzed. The exposure is located in Township 15 South, Range 27 West, in the SE quarter, of the SE quarter, of the SE quarter of Section 12. The jaw of a horse and the canine tooth of a wolf were found in the basal gravel just above bed rock, and approximately 29 feet below the top of the terrace.

The terraces in the valley of the Kansas River have been removed by stream erosion to a much greater degree than the terraces in the Smoky Hill River valley. Several radiocarbon dates have been obtained by researchers in geology and geography from deeply buried localities in two terraces near Bonner Springs, Kansas in the Kansas River valley. Sawn lumber can be seen deeply buried in the Floodplain on the east bank of the Kansas River in Township 12 South, Range 23 East, Section 5. The sawn lumber is probably less than a hundred years old. A radiocarbon date from a pit in a terrace higher than the Floodplain in Township 11 South, Range 23 East, Section 34 yielded a date of only $2,395 \pm 65$ years B.P. even though it was from a deeply buried context. A radiocarbon date of $4,290 \pm 310$ B.P. came from a deeply buried location in an even higher terrace in a vertical bank of the Kansas River in Township 11 South, Range 23 East, Section 34 (Holein 1982). These radiocarbon dates suggest relatively rapid terrace formation (neither radiocarbon date is older than mid Holocene). This situation suggests a pattern of rapid terrace formation similar to that observed by the author on the Smoky Hill River. The evidence does indicate there were more Holocene terraces on the Kansas River than on the Arkansas River system. Hopefully, further research will expand our knowledge about older terraces on the Kansas River.

2.3 THE ARKANSAS RIVER DRAINAGE

The Arkansas River drainage in the state of Kansas has a very different terrace system from the Smoky Hill-Kansas River drainage. The rate of terrace formation in the Arkansas River drainage has been much slower than in the Smoky Hill River drainage. The terraces on the Arkansas River drainage are composed of a Floodplain and Terrace One formed during the Holocene, a Terrace Two formed during the Late Wisconsin glacial advance, a Terrace Three formed during the Early Wisconsin, a Terrace Four formed during the Middle Pleistocene and several higher terraces which have not been studied. This pattern holds true for the area studied with the exception of the Arkansas River in the vicinity of the Great Bend of the Arkansas River where an outwash of sand from dune areas has apparently caused aggradation to occur faster than uplift could form terraces.

The Floodplain in the Arkansas River drainage has yielded evidence of its Holocene affinities. The multicomponent archaeological site, 14N07, exposed in a vertical bank cut of the Floodplain of the Neosho River in Neosho County, Kansas has yielded evidence of an Early Ceramic occupation. The Early Ceramic component was identified on the basis of pottery (Schmits 1973). This cultural level was two meters below the surface. Early Ceramic archaeological sites in Kansas should date to the first millenium A.D. The bones of Bison bison (a Holocene index fossil in the Plains) were found in a vertical bank cut of the Floodplain of the Cottonwood River west of

Emporia at Township 19 South, Range 10 East, in the NE quarter, of the NW quarter, of the NW quarter of Section 20. The bison bones were between 33 and 39 inches below the surface of the Floodplain and consisted of vertebrae and fragments of a tibia. Bison bison bones were extracted from the Floodplain of the Little Arkansas River by Mr. Vernon Wedel of Halstead, Kansas. The bison skeleton was at least partially articulated and was located in Township 24 South, Range 1 West, in the NW quarter, of the NW quarter of Section 18. Mr. Bart McCollum recovered a Bison bison skull and scapula from the Floodplain at the water level of the Walnut River in Township 33 South, Range 4 East, in the SE quarter, of the SE quarter, of the SE quarter of Section 14.

Terrace One also contained evidence indicating a Holocene date for its genesis. The archaeological site 14CF12 was found in a vertical bank of Terrace One on the Neosho River in Coffey County, Kansas. The cultural layer of the archaeological site was 2.9 meters below the surface. The cultural layer was identified as belonging to the Archaic period on the basis of the style of a projectile point found in it (Schmits 1973). The Snyder archaeological site (14BU9) is a buried archaic site found in Terrace One of the Arkansas River drainage, along the Walnut River near El Dorado, Kansas in Butler County. Radiocarbon dates for the archaic material range from 20 ± 110 B.C. to $2,880 \pm 105$ B.C. (Artz 1983:34). The deepest radiocarbon date at the site (250 cm. deep) was $2,650 \pm 125$ B.C.

which does not stratigraphically agree with an older date above it (Grosser 1977). No Early Ceramic site has been found buried in Terrace One and no archaic site has been found buried in the Floodplain. Surface archaeological sites (to be discussed more thoroughly in another chapter) on Terrace One have yielded projectile points that indicate a date nine or ten thousand years old. This suggests the duration of Terrace One was from approximately 2000 B.P. to 10,000 B.P.

The faunal evidence also suggests a Holocene date for Terrace One. Near the Wallace archaeological site (to be discussed thoroughly in a later chapter), the bones of Bison bison can be seen eroding from a gully in Terrace One on the south bank of Doyle Creek, a tributary of the Cottonwood River near Peabody, Kansas. In western Kansas, the bones of Bison bison were noted in the fills of Terrace One in the Arkansas River drainage in two streams, Sand Creek and Walnut Creek. A jaw of Bison bison was found in a vertical exposure of Terrace One six feet below the surface along Sand Creek in Township 24 South, Range 36 West, in the SE quarter, of the SW quarter, of the NE quarter of Section 30. A tibia of Bison bison was found six feet below the surface in a vertical exposure in Terrace One of Sand Creek in Township 24 South, Range 36 West, in the SW quarter, of the NW quarter, of the SW quarter of Section 30. A Bison bison tibia was discovered buried eight feet below the surface in a vertical cut on the north bank of Walnut Creek in Terrace One at Township 18

South, Range 24 West, of the SW quarter, of the NW quarter, of the NW quarter of Section 22. A Bison bison jaw was found buried in a vertical exposure in the north bank of Walnut Creek in Terrace One at Township 18 South, Range 24 West, of the SW quarter, of the NW quarter, of the NW quarter of Section 26.

The fills of Terrace Two and higher terraces contain Pleistocene fauna and lack diagnostic Holocene fauna, indicating the genesis of these geomorphological units must be Pleistocene. A small tributary of the North Fork of the Cottonwood River exposed a horse jaw buried at approximately stream level in sand in Terrace Two. The location is Township 18 South, Range 1 East, in the NE quarter, of the NE quarter, of the NE quarter of Section 5. On the west side of the Little Arkansas River, two horse teeth were scraped up by earth moving equipment in an excavation in the sand of the surface of Terrace Two in Township 22 South, Range 2 West, in the NE quarter, of the SE quarter, of the SW quarter of Section 31. An elephant foot bone was plowed from a field in the surface of Terrace Two on the west side of the Little Arkansas River (north of where the two horse teeth were found) in Township 22 South, Range 2 West, in the NW quarter of Section 31. Both the horse teeth and the elephant foot bone were discovered by the landowner and are in his possession. The shallow depth at which the horse and elephant remains were found indicates the uppermost alluvial fill beneath the Terrace Two surface along the Little Arkansas River is Pleistocene. Several fragments of

elephant bone were discovered twenty feet below the surface of Terrace Two near the Arkansas River in the vicinity of Cimarron, Kansas. The elephant bone fragments were in a gravel pit at Township 20 South, Range 28 West, in the NE quarter, of the SW quarter, of the SE quarter of Section 14.

It is likely the genesis of Terrace Two occurred at least partially in the Late Wisconsin. This can be inferred from the observation that Terrace Two occurs between Terrace One which contains Holocene index fossils (including projectile point styles that indicate an early Holocene date), and Terrace Three which contains index fossils of the Early Wisconsin.

Terrace Three on the Arkansas River drainage contains numerous exposures with many vertebrate fossils. A gravel pit in Terrace Three near Plymouth, Kansas yielded mammoth molars, tusk fragments and horse teeth. The fossils were discovered in concretions by the landowner, Mr. John Bechthold. The location is on the north side of the Cottonwood River in Township 19 South, Range 10 East, in the NW quarter, of the NW quarter of section 9. Another gravel pit in Terrace Three, located on the north side of the South Fork of the Cottonwood River, has yielded fossils of mammoth, horse, large bison and coyote. The gravel pit exposes both Terrace Three and Terrace Four. The Terrace Three deposit is on the west face of the pit. A virtually complete skull of a mammoth was removed from the Terrace Three deposit at this sandpit by Professor S. L. Loewen and the specimen is

now in storage at Tabor College in Hillsboro, Kansas. A mandible belonging to the skull largely disintegrated upon removal. This fossil rich gravel pit belongs to Mr. Menno Jost and is located in Township 20 South, Range 2 East in the NE quarter, of the NE quarter, of the NW quarter of Section 17. In another gravel pit in Terrace Three along the South Fork of the Cottonwood River, Mr. William Dalke found a mammoth tooth and presented it to Tabor College. The location of the gravel pit is Township 20 South, Range 2 East, in the NW quarter of the SW quarter, of the NW quarter of Section 17. Fragments of elephant limb bones were found by the author on the surface of Terrace Three at two locations on the South Cottonwood River; at Township 20 South, Range 1 East, of the SE quarter, of the NE quarter, of the NE quarter of Section 13; and Township 20 South, Range 1 East of the SE quarter, of the NW quarter, of the NW quarter of Section 13. These fossil fragments had been plowed from the sloping edge of Terrace Three. The author discovered several fragments of mammoth tooth plowed from the edge of Terrace Three on the South Cottonwood River in Township 20 South, Range 1 East, of the NW quarter, of the SE quarter, of the NE quarter of Section 14.

A mammoth skull, lacking only the tusks, was discovered by the author at the base of Terrace Three on the North Fork of Walnut Creek. The specimen is now on display at the Museum of Natural History at the University of Kansas. Measurements of the upper third molar enamel plate thicknesses (Schultz, Tanner, and Martin 1972) in-

dicates an Early Wisconsin date for this mammoth. The mammoth skull is too fragile a fossil to have been secondarily redeposited intact more than a few years after the death of this particular animal. The absence of tusks, lower jaw, and postcranial bones does suggest the skull was moved, presumably by flowing water, after the death of the mammoth and decomposition of the tissues that held the skull to the rest of the body. The skull might have floated in water because of the buoyancy imparted by decomposition emptying the cranial cavity. Rising water would buoy the brain case upward permitting the tusks to drop out and allowing the skull to float an unknown distance from the rest of the skeleton. The metapodial of a horse was found in the same terrace exposure, in the same stratigraphic position, approximately 200 feet upstream from the mammoth skull. The location of the skull was Township 17 South, Range 25 West in the SE quarter, of the NW quarter, of the SW quarter of Section 32.

Horse teeth fragments were discovered by the author 140 cm beneath the surface of Terrace Three in a vertical cut of the east bank of Walnut Creek. The location was Township 18 South, Range 24 West, in the NW quarter, of the NE quarter, of the SE quarter of Section 18.

The author discovered an elephant rib buried 30 feet below the top of Terrace Three in a block of alluvium that may have slumped to its position of discovery from a position higher in the terrace. The locality is in the south bank of Walnut Creek in Township 17 South,

Range 26 West in the NW quarter, of the NE quarter, of the NE quarter of Section 36.

A slope of Terrace Three on the north bank of Walnut Creek yielded a femoral fragment from an elephant and a horse tooth. The specimens were lying at the base of an eroding edge of the terrace and the specimens had obviously eroded out of the terrace fill from a position higher than the point of discovery. The locality is in Township 18 South, Range 25 West, in the NW quarter, of the NW quarter, of the NE quarter of Section 4.

A sandpit in Terrace Three on the Arkansas River yielded mammoth remains. Two lower 3rd molars of a mammoth (probably from the same individual) were found in this pit in the summer of 1978 by Maxine Ralston and Edward Ply. The teeth are now in the Hamilton County Museum in Syracuse, Kansas. The average thickness of the enamel plates of the left lower molar was 2.27 mm and of the right lower molar enamel plates was 2.05 mm. According to the system developed by researchers at the University of Nebraska (Schultz, Tanner and Martin 1972), these mammoth teeth should date to the Early Wisconsin. Tusk and mandible fragments of elephant were also found at this pit. The height of the terrace where the sandpit is located is 44.5 feet above the bed of the Arkansas River. The location of the pit is Township 24 South, Range 40 West, in the SW quarter, of the NW quarter, of the SW quarter of Section 9.

Exposures of Terrace Four in the Arkansas River drainage were much less frequently encountered than exposures in Terrace Three. The bones of elephant and horse were recovered by the author from an exposure in Terrace Four at the same gravel pit that yielded Pleistocene fauna from an exposure in Terrace Three mentioned earlier in this chapter. This sand pit is on the north side of the South Cottonwood River in Township 20 South, Range 2 East in the NE quarter, of the NE quarter, of the NW quarter of Section 17. The Terrace Four exposure that yielded the Pleistocene fauna is on the east face of the gravel pit. Horse teeth were discovered eroding from a vertical exposure approximately eight feet beneath the top of the terrace, while a foot bone of an elephant was discovered at the base of the exposure.

A mammoth jaw was recovered by Mr. Vernon Wedel of Halstead, Kansas from an exposure in Terrace Four on the north bank of the Little Arkansas River. The location is Township 22 South, Range 2 West, of the N half of Section 31. A large fragment of a lower third molar from the mandible in the possession of Mr. Wedel had a mean enamel plate thickness of 2.35 mm. The enamel plates were thick enough to suggest the likelihood of a pre-Wisconsin (Middle Pleistocene) date for Terrace Four rather than an Early Wisconsin date.

Additional terraces extend up the valley walls from Terrace Four. These terraces were not studied.

The elevations above stream level of the terraces on the Arkansas River drainage are shown below. The measurements were made with a hand level. The Arkansas River near Cimarron had the following terrace measurements:

TERRACE	HEIGHT ABOVE STREAM LEVEL
Floodplain	7' 6"
Terrace One	22' 6"
Terrace Two	32'
Terrace Three	43'

The measurements were made in the vicinity of the gravel pit in Terrace Two that yielded elephant remains previously described in this chapter at Township 26 South, Range 28 West, in the NE quarter, of the SW quarter, of the SE quarter of Section 14.

Measurements on the terraces of the North Fork of Walnut Creek in the vicinity of a mammoth skull (previously mentioned) yielded the following information:

TERRACE	HEIGHT ABOVE STREAM LEVEL
Floodplain	10' 6"
Terrace One	29' 3"
Terrace Two	36' 6"
Terrace Three	48' 9"

The location of the measured terraces is Township 17 South, Range 25 West, in the SE quarter, of the NW quarter, of the SW quarter of Section 32.

The preceding two sets of terrace measurements are typical of what the author observed in western Kansas on the Arkansas River drainage. The height of one terrace surface over another terrace surface was remarkably uniform, although the height of the floodplain over the stream level was quite variable. The height of one terrace surface over another in the Arkansas River drainage differs between eastern Kansas and western Kansas primarily in the height of Terrace One over the Floodplain. In western Kansas, the height of Terrace One over the Floodplain on the Arkansas drainage is at least three times greater than it is in eastern Kansas. Otherwise, the height of one terrace over another is remarkably similar in the Arkansas River drainage in both eastern and western Kansas.

In eastern Kansas, the terrace measurements on the Little Arkansas river in the vicinity of a mammoth jaw from the fill of Terrace Four were:

TERRACE	HEIGHTS ABOVE STREAM LEVEL
Floodplain	12' 6"
Terrace One	16' 6"
Terrace Two	22'
Terrace Three	36'
Terrace Four	41'

The location of the measurements was Township 22 South, Range 2 West, in the N half of Section 31.

The terrace measurements on an eastern Kansas locality on Doyle Creek (a tributary of the Cottonwood River) at the Wallace Site, were:

TERRACE	HEIGHTS ABOVE STREAM LEVEL
Floodplain	10'
Terrace One	15'
Terrace Two	24'
Terrace Three	36'

The location is Township 21 South, Range 4 East, in the NW quarter, of the NW quarter, of the NW quarter of Section 31.

One major exception to the terraces previously described for the Arkansas River drainage can be found on the Arkansas River from the beginning of the Great Bend of the Arkansas River to a yet undetermined point downstream from Wichita, Kansas, where the floodplain shows dramatic evidence of aggrading. The aggradation is in striking contrast to the down cutting documented in this chapter for the upstream portion of the Arkansas River and for tributaries from the north (the only tributaries studied). The Little Arkansas River terraces clearly attenuate in height as the Little Arkansas River approaches its juncture with the Arkansas River. This appears to be related to sediment backing up from the Arkansas River Valley and burying the terraces of the tributaries. The author believes this local effect results from outwash of sand from large dune fields in the Great Bend area that causes the Arkansas River valley to fill

with sand at a faster rate than uplift can create terraces. Because the northern tributaries are not acquiring large amounts of sand from the dune fields, the tributaries downcut and create terraces except where the sand from the Arkansas River Valley backs over them. The Great Bend tract (the Kinsley dune tract) is the largest dune tract in Kansas and one of the larger dune tracts in the United States (Frye and Leonard 1952). The time period(s) when sand in the Great Bend area began to form the dune fields is not known. It is possible the aridity of the Holocene may have been an important factor in dune formation in this area by lessening the vegetation cover.

2.4 TERRACE SYSTEMS COMPARED

In conclusion, the Arkansas River drainage has a Floodplain and Terrace One dating to the Holocene, a Terrace Two and Terrace Three dating to the Wisconsin, and a Terrace Four probably dating to the Middle Pleistocene. The Arkansas River valley at the beginning of the Great Bend and downstream for an unknown distance is aggrading probably due to a massive outwash of sand from the dune areas of the Great Bend and thus is an exception to the terrace system. The Kansas River drainage as judged by the Smoky Hill River, presents a remarkably different terrace system from the Arkansas River drainage. The Smoky Hill River terrace system contains a Floodplain, Terrace One, Terrace Two, Terrace Three, and Terrace Four dating to the Holocene, and a Terrace Five dating to the Wisconsin.

CHAPTER THREE

TERRACE GENESIS

3.1 THE IMPORTANCE OF FLOWING WATER

Flowing water has been the primary agency shaping the topography of Kansas. Wind and glacial action are important in certain areas, but are minor factors compared to flowing water when the state is considered as a whole.

The old adage "water always flows down hill" is an observation describing the obvious fact that gravity is responsible for the flow of water in streams. Streams flow from surfaces further from the center of the earth to surfaces closer to the center of the earth. Therefore, when scientifically studying the stream pattern of an area, the most important piece of knowledge to be obtained is why the surface being studied is higher than an adjacent surface. As far as the scientific study of a stream is concerned, all other facts about the stream literally "flow" from this bit of knowledge.

All streams in the state of Kansas are part of the Mississippi drainage and eventually empty into the Gulf of Mexico, except for White Woman Creek which empties into a basin in Western Kansas (Figure 1). The most important question in studying the streams of Kansas is why the surface of Kansas is higher than the Gulf of Mex-

ico.

3.2 THE CENTRAL STABLE REGION QUESTION

The state of Kansas lies entirely within an area described by geologists as the Central Stable Region. Merriam (1963:13) in his review of Kansas geology described Kansas as "ideally situated..." to study the "stable interior of North America..." and that "Nothing in the geological makeup is dramatic or spectacular..." It is almost as if geologists were trying to make the stereotype of Kansas conservatism palpable in geological form.

It is abundantly clear from empirical evidence, that the traditional view of Kansas geology as one of great stability, is simply not so. The ultimate destination of the water that flows through Kansas, is the Gulf of Mexico approximately 500 miles south of the state. The port of Galveston, Texas is almost due south of Lawrence, Kansas. If Kansas was very stable geologically, then you would expect that over the millions of years of the Cenozoic that a well developed drainage of the state, oriented toward the south, would have formed. This drainage pattern has not occurred. Most of the drainage of the state has too definite an eastward trend to be part of a simple south or south-southeast drainage into the Gulf of Mexico. This drainage pattern cannot be explained by deflection due to bedrock formations opposing the natural direction of stream flow. The different strata of bed rock in Kansas tend to be exposed in

north-south bands. If bed rock deflection was the principal factor in determining the direction of streams in the state, then a southward orientation would be expected, which does not occur. Many of the principal streams flow across the exposed rock beds in apparent "disregard" of them (Fent 1950:81).

Uplift is a geological phenomenon that would explain the drainage of Kansas. However, uplift runs against the traditional view that Kansas is an example of a "stable" geological setting. The remains of Upper Cretaceous seabeds in western Kansas more than 3,700 feet above the present sea level, could only represent uplift on an awesome scale. Although the sea level was probably somewhat higher in the Cretaceous (seawater was not tied up in ice caps) the uplift must have been in excess of 3,700 feet. Two factors more than compensate for the higher Cretaceous sea levels, 1) the seabeds were obviously formed beneath sea level, and 2) a considerable depth of deposit has been eroded from the top of the Cretaceous deposits so we know that existing seabeds were not the uppermost that once existed in the state. Although early Tertiary deposits are not present in the state of Kansas, it is reasonably certain that the uplift that raised the Cretaceous seabeds occurred in the Cenozoic (the most recent era) because Paleocene sea deposits (the Cannonball Formation) are found north of Kansas, which indicates that at least part of the modern Plains was still inundated in the early Cenozoic. The belief held by many geologists that Kansas is a stable region is simply not

tenable when one looks at the obvious evidence of uplift exceeding 3,700 feet in the most recent geological era. Instead of being a stable geological area, Kansas is an area of impressive vertical dynamics.

3.3 UPLIFT AND STREAM TERRACES

The author's initial interest in uplift in Kansas was caused by observations on stream terraces while trying to put archaeological sites in a geological framework. Several facts about the terraces suggested they were produced by uplift.

An alluvial terrace is a surface which is a relic floodplain (an active floodplain is sometimes referred to as Terrace Zero). Alluvial terraces can be created by several agencies such as uplift, climatic change, and fluctuations in sea level. Sea level fluctuation can be ruled out as a cause of terrace formation in Kansas because of the great distance to the sea and because the terraces do not seem to decline in height over the floodplain as one goes upstream (which one would expect in a base level phenomenon such as sea level fluctuation). Climate change can cause both aggrading and degrading in a stream by causing such things as vegetational change which alters runoff and supply of sediment to a stream. The effect of climatic change as the most important factor in terrace formation in Kansas can also be eliminated. Two quite different terrace systems, one on the Arkansas River drainage, and the other on the

Smoky Hill River drainage exist in Kansas (Figure 2). Because these two terrace systems are in close proximity (they share a long common divide), and share similar vegetation, it would be incredible that such different terrace systems could be caused by climatic change. To have produced two such terrace systems by climate would have required two radically different adjacent climatic zones (having an east-west border) on the Plains which is highly improbable and for which there is not one piece of evidence. In addition, neither of these terrace systems mesh with the changes of vegetation recorded at Muscotah, the only long pollen sequence in Kansas (Gruger 1973). Since vegetational cover varies between tributaries and main streams we should expect to see idiosyncratic terrace systems in the tributaries, which are not observed.

The most reasonable explanation for the terrace sequences in Kansas is uplift. This should not be surprising considering the massive uplift known to have occurred in Kansas during the Cenozoic. Climate may have played a part in terrace formation in Kansas, but it is not the key variable. The terraces suggest that the Arkansas River drainage is uplifting at a slower rate than the Smoky Hill-Kansas River drainage. If this observation is correct, three geological situations should occur: 1) parallel drainages on a slope should become segregated on different areas of differential uplift, 2) the drainage divide between the two areas of differential uplift should show peculiarities in drainage, and 3) the area of faster

uplift and particularly the area next to the divide should be the site of a relatively high frequency of earthquakes.

A drainage on a slope should become confined to one area of uplift. It should not cross into an area with a different rate of uplift, assuming that one area of uplift is not upslope from another. Headward erosion from the area of faster uplift into the area of slower uplift, will eventually lose its headwaters to the area of slower uplift, because of vertical displacement in the stream bed. Headward erosion from the area of slower uplift into the area of faster uplift, will tend to be pirated by the faster downcutting streams centered in the faster uplift area. The end results are separate drainage patterns reflecting separate areas of differential uplift. In none of the streams investigated was there a stream in one drainage, with the terrace system of the other drainage.

Between the two areas of differential uplift there should be some topographic disturbances reflecting distortions in the earth's crust and not the regular drainage pattern. These topographic disturbances should produce drainage anomalies. The formation of large basins are examples of this phenomenon, and they occur just south of the southern divide of the Smoky Hill-Kansas River. White Woman Basin is the only large scale internally drained topographic feature in the state. White Woman Basin has an ancient abandoned valley that drained into the Arkansas River near Garden City. This indicates that White Woman Creek was once a tributary of the Arkansas

River, but was eventually "swallowed" by the formation of White Woman Basin. Since this basin would have been filled in by the Ogallala, the structural change that created the basin must have been occurring during post Ogallala times. Another example, Cheyenne Bottoms, is located a short distance south of the Smoky Hill River divide. The basin was not due to salt solution, but to structural change that can be detected below the Hutchinson salt formation (Bayne 1977). This sort of interruption of drainage patterns is just what one would expect from topographic disruption due to differentially uplifting masses of land.

Another peculiarity of the drainage of the divide is that the documented captures of streams along the divide have occurred in a way opposite to what one would expect if mature streams were in a tectonically stable region. The McPherson Valley (Fent 1950; Bayne and Fent 1963) indicates that most of the Smoky Hill River drained southeastward into the Arkansas River in the past, but was later captured by headward erosion of the Kansas River drainage. The water draining through the Arkansas River has a steeper gradient into the Gulf of Mexico than water draining through the Smoky Hill-Kansas River into the Gulf of Mexico from the point of capture. This is because the Arkansas River flows in a southeasterly direction toward the Mississippi River and the Gulf of Mexico and thus covers a much shorter distance to descend to its base level, than the water from the Smoky Hill-Kansas River drainage that flows almost due east until

St. Louis, Missouri, where the water flows south to the Gulf of Mexico. Thus, at the McPherson valley the drainage system with lesser gradient captured the drainage system with greater gradient. Water flows downhill, thus the capture at the McPherson Valley could only have been accomplished by tectonic intervention, because in a tectonically stable region the Arkansas River drainage would be expected to capture the Kansas River drainage rather than the reverse.

Earthquakes also occur as predicted. Twenty-five earthquakes have been recorded in Kansas since 1867 (DuBois and Wilson 1978). Seventy-two percent of the recorded earthquake epicenters in Kansas occurred on or north of the divide between the Smoky Hill-Kansas River drainage and the Arkansas River drainage. Furthermore, 56 percent of the state's recorded earthquakes occurred in a narrow band 25 miles wide along the edge of the southern divide of the Smoky Hill-Kansas River. The author attributes the 1927 McPherson earthquake to the southern divide of the Smoky Hill River (it was either on the divide or a few kilometers south of it). This is precisely what one would expect if the Smoky Hill-Kansas River drainage was uplifting faster than the Arkansas drainage. The number of earthquakes was greater in the area of most rapid uplift and the earthquakes are concentrated where the more rapidly uplifting drainage would create friction with the slower uplifting drainage.

Before this research, it was believed that the Nemaha anticline was a major factor in causing earthquakes in Kansas. This belief may

have to be modified.

There are five earthquakes known to have epicenters on the Nemaha ridge with an area of approximately 5,328 square miles (Figure 3). The average number of earthquakes in Kansas for an area of comparable size is 1.61918. Using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) the number of earthquakes in Kansas occurring within the Nemaha Ridge was no more than could be expected to occur by chance at the .01 level of significance. Thus, no statistical support was found for the Nemaha Ridge as a primary causal factor of earthquakes in Kansas.

However, if a 25 mile wide band along the northern edge of the southern divide of the Smoky Hill-Kansas River (Figure 4), an area of approximately 10,152 square miles, is considered, one observes that 14 earthquakes took place, when one would expect 3.0852 earthquakes in an area of comparable size in the state of Kansas. The earthquakes in the northern edge of the southern divide of the Smoky Hill-Kansas River, compared to earthquakes in Kansas outside this area are more numerous than would be expected to occur by chance at the .01 level of significance when analyzed by the Kolmogorov-Smirnov One Sample Test.

The only earthquake epicenters that occur on the Nemaha Ridge are in the area intersected by the northern edge of the southern divide of the Kansas River drainage (Figure 5). If the area of intersection is discounted, there are no earthquake epicenters

remaining on the Nemaha Ridge. However, there are still 9 earthquake epicenters on the remaining area of the northern edge of the southern divide of the Kansas River drainage (approximately 9,572 square miles).

The outcome of the statistical analysis is consistent with earthquakes being the result of differential uplift of the state's major drainages. The statistical analysis is inconsistent with earthquakes being primarily caused by movements in the Nemaha Ridge.

Statistics aside, the earthquake epicenters of Kansas plot at almost a right angle across the Nemaha Ridge (Figure 3). If the Nemaha Ridge was a principal factor in generating earthquakes in Kansas, we should expect to see earthquakes plotted on and parallel to the Nemaha Ridge and probably very near its eastern edge (where the principal area of faulting is). This is clearly not what is observed.

The hypothesis of differential uplift in Kansas should be studied further. An attempt should be made to locate an underlying geological structure that would conform to the southern divide of the Smoky Hill-Kansas River. The earthquakes plotted in Kansas must represent the shifting of underground structures, although they have never been demonstrated to conform to known underground structures. Large structures that could be responsible for earthquake patterns may prove very difficult to find. This was certainly the situation at New Madrid Missouri, epicenter of the largest earthquake in North

America in recorded history. The structure probably responsible, a graben fifty miles wide and two hundred miles long, was discovered very recently only after an intensive search of the area was made to discover the source of the earthquake. The lesson this should teach us is that we do not know all the large structures that cause earthquakes in the central United States, and that even though the structures are of large size and earthquakes indicate their approximate location, that they may still be difficult to identify.

The hypothesis that uplift has resulted in the formation of Quaternary stream terraces is the simplest available explanation of the data. It is also the only available hypothesis with significant evidence to support it, that can explain the formation of the stream terraces discussed in this dissertation.

The rate of uplift necessary to accomplish the downcutting of streams since the Ogallala (a Tertiary deposit representing a period of aggradation in the state) can be calculated. The author will demonstrate it is quite consistent with the average rate of uplift known to have occurred in the Cenozoic to lift the Cretaceous seabeds in western Kansas to their present elevation of 3,700 feet.

Precisely when Kansas rose above sea level is not known. The rocks in the state that would provide this information have eroded away. However, the presence of a Cenozoic sea in the Cannonball formation north of Kansas, suggests that an area of the present Great Plains was at least partially below sea level in the middle

Paleocene. The Puercan (early Paleocene) has a date of 64.9 million years near its base and a post-Puercan date of 58.7 million years (Savage 1975). The Kansas rise above sealevel might post date 58.7 million years ago. If 3,700 feet of elevation is divided by 58.7 million years, it would indicate a minimum of approximately 63 feet of uplift per million years.

The maximum incision of streams through the Ogallala in western Kansas, as indicated in the map of Ogallala thickness by Merriam (1963:31) is between 400 and 500 feet. For purposes of computation, I will use 450 feet as the maximum depth of stream incision through the Ogallala. I regard the Kimball cap rock as representing the termination of the Ogallala depositional regime as typified by the Ash Hollow member of the Ogallala formation. The latest date on the Ash Hollow formation is 6.8 ± 0.3 million years (Boellstorff 1978). If 450 feet of incision through the Ogallala deposit is divided by the 6.8 million years since the Ash Hollow Member, a resulting rate of down cutting of approximately 66 feet per million years is indicated. Thus it can be seen that the rate of downcutting since the Ogallala (66 feet per million years) is strikingly similar to the average rate of uplift in the Cenozoic (63 feet per million years). The amount of down cutting required to create the terrace filled valleys of Kansas would not require uplift appreciably greater than would be considered normal for the Cenozoic of Kansas.

It is not known whether Cenozoic uplift in Kansas was relatively constant (upsurges every few thousand years) or was represented by chronologically widely separated episodic events. It is also possible that periods of subsidence of the Kansas land surface occurred that were not great enough to cancel out the overall effects of uplift. A largely depositional interval such as the Ogallala might reflect subsidence in Kansas. Alternatively, the deposition of the Ogallala might have resulted from much more rapid uplift in the Rocky Mountains than uplift in the Plains.

Both the terraces of the Arkansas River drainage and the Smoky Hill River drainage suggest that the rate of incision and hence of uplift has rapidly accelerated as one approaches the present (eg. the rate of incision from the late Wisconsin to the present is disproportionately greater per unit of time than the incision from the Ogallala to the late Wisconsin).

There is the central question of what causes the uplift. William Hay has suggested that the East Pacific Rise has gone under North America, uplifting the Central Rockies and sending waves of uplift eastward into the Great Plains (anonymous 1979). Dr. Hay believes that the western part of North America is representative of a continent overriding an oceanic spreading ridge. He has observed that smoothed east-west profiles "across North America between latitudes 30 degrees and 50 degrees N closely resemble those of the the East Pacific Rise, although the elevations corresponding to the

central ridge crest are somewhat reduced. Overriding of the northern Pacific Ridge system explains progressive displacement of the continental divide to the east...(Hay 1979:441)."

Clark (1932) noted that uplift in the Great Plains was accomplished by vertically acting forces rather than by horizontal compression. This is consistent with the concept of an overriding continental plate.

If Hay's theory is correct, and western North America is overriding an oceanic spreading ridge causing uplift to spread eastward into the Great Plains then stream patterns should reflect the phenomenon. Uplift in Kansas should have initiated first in western Kansas and have initiated later in eastern Kansas. The ultimate destination of flowing water in Kansas (except for that which flows into internally draining basins) is the Gulf of Mexico to the south. Without uplift, one would expect Kansas streams to flow generally southward toward the Gulf. With uplift occurring initially in the western part of the state, one would expect headward erosion of streams into the newly higher ground. This would result in gravity orienting streams in a west to east direction. Because western Kansas would have been exposed to uplift for a greater period of time than eastern Kansas, one would expect streams to be oriented more in a west to east direction in the western part of Kansas than in the eastern part of the state, if Hay's theory is correct. The streams do orient in such a way (Figure 6). The streams in the western part

of the state are more oriented in a west to east direction, while most streams in the eastern part of the state have a much more southern component in their direction of flow.

The stream terraces suggest faster uplift (at least for the terraces analyzed) in the Smoky Hill-Kansas River drainage, than in the Arkansas River drainage. Gravity should orient the streams in a more west to east direction in the Smoky Hill-Kansas River drainage than in the Arkansas River drainage, if uplift began in the west and spread east in the state but was most rapid in the Smoky Hill-Kansas River drainage. The reason for this is the faster uplifting drainage has a relative advantage in capturing stream channels oriented in directions other than west to east. Western Kansas streams are oriented as one would expect if the above hypothesis is correct (Figure 7), with the streams being more west to east in the Smoky Hill-Kansas River drainage than in the Arkansas River drainage.

Adams (1980) has measured active tilting in the Kansas River drainage. This suggests that vertical movements in the earth's crust in Kansas are not just a phenomenon of the remote past, but are an on-going event.

In conclusion, the stream terraces of Kansas discussed in this study, appear to owe their genesis, largely or entirely to uplift. Uplift is a sufficient explanation for the stream terraces, whereas, other theoretical explanations, including climatic change, are inadequate to explain the observed data.

CHAPTER FOUR

KANSAS RIVER ARCHAEOLOGICAL DATA

4.1 INTRODUCTION

Two archaeologically relevant forms of alluvial geomorphology (stream terraces and gravel bars) in the Kansas River drainage were examined for archaeological data. Most of the archaeological data obtained during the research for this dissertation came from the Arkansas River drainage and will be discussed in the next chapter.

4.2 KANSAS RIVER GRAVEL BARS

Gravel bars are of archaeological interest primarily because of the abundance of well preserved ancient organic material sometimes found on them. This preservation may result from the material being buried beneath the water table, and being reworked into the gravel bars only recently. The principal drawback is that the data is usually not in situ. Despite this drawback, important information can be gained from gravel bars. The discoveries on the Old Crow River in the Yukon, for instance, indicating the presence of man in Beringia more than 20,000 years ago (Irving and Harington 1973).

The Kansas River gravel bars have yielded a wealth of Pleistocene remains from such species as mammoth (Mammuthus),

mastodon (Mammut), woodland peccary (Mylohyus), woodland musk ox (Symbos), stag-moose (Cervalces), ground sloth (Megalonyx) and the long horned bison (Bison antiquus). The bones are often found in abundance, and are frequently very well preserved.

Pleistocene animal bones are intermingled on the gravel bars with bones of such Holocene index fossils as Bison bison and domestic livestock. The material on the gravel bars obviously represents a mixture of objects from very different periods of time. None of the bones or cultural debris has been demonstrated to be in situ. Figure 8 shows the distribution of the fossil taxa recovered from the Kansas River in the vicinity of Bonner Springs, Kansas.

Several observations can be made on the antiquity of the material from the river. Some of the material is of very recent origin (glass bottles, pieces of machinery etc.), other material dates before Euro-American contact but is still Holocene (some of the Indian artifacts and the Bison bison remains) and still other material dates to the Pleistocene (the bones of extinct megafauna and some of the early projectile points). The presence of Bison antiquus suggests that some of the Pleistocene fauna date to the late Wisconsin. The presence of Clovis projectile points on the gravel bars suggests some of the artifacts date to the very late Wisconsin (circa 10,000 to 11,500 years B.P.). No diagnostic vertebrate fauna requiring a date prior to the Wisconsin has been found, although a fragment of a mammoth tooth found by Mr. Frank Richardson of DeSoto,

Kansas on a gravel bar near DeSoto apparently dates to the early Wisconsin (personal communication, Dr. Larry D. Martin).

There is a suggestion of temporal continuity of the material from gravel bars in the Kansas River near Bonner Springs. The bison skulls show a subtle gradation in horn core size from the short horned recent Bison bison to the long horned late Wisconsin Bison antiquus. This fits well with the concept that Bison antiquus evolved into the recent Bison bison. It also suggests the bison bones from the Kansas River represent the sampling of a relatively continuous span of time of that portion of the bison's evolutionary history. The gravel bars have also yielded Middle Ceramic pottery, Early Ceramic projectile points and pottery, Archaic projectile points and paleo-Indian projectile points. The Indian artifacts suggest the objects deposited on the gravel bars represent a relatively continuous span of time ranging from the late Holocene to the late Wisconsin, and parallel the chronology of the previously described bison skulls.

It is interesting to note the lack of evidence for any of the Pleistocene bones being in situ. No Pleistocene bones from the Kansas River have been found articulated or found in deposits that could be demonstrated to be Pleistocene.

Many of the Pleistocene bones are remarkably intact to have been reworked by the river. However, reworking can be demonstrated to have occurred in many cases. A bison with horn cores suggesting an early Holocene date was found by the author buried in the gravel with

a 19th Century ink pot firmly lodged between its zygomatic arch and its brain case. The only damaged part of the skull was a missing nasal bone. The specimen had to have been reworked in the gravel after the ink pot became wedged in the skull. Another bison skull was found by the author buried in gravel with a piece of 20th Century "house siding" under the skull. The premaxilla was broken on the bison skull, but otherwise the specimen was intact. These finds indicate bones can be reworked with very little damage in a gravel deposit, although one might intuitively think otherwise.

The geologic history of the human artifacts and the Pleistocene bones found on the Kansas River gravel bars is at present a mystery. Several theories have been suggested that may explain the presence of the fossils.

THE LAG THEORY.

The Pleistocene bones have been interpreted as a lag deposit in the Kansas River. The bones and artifacts have a greater mass than sand, silt and clay, and have a mass more comparable to the gravel. The lag deposit theory interprets the bones and artifacts as objects which have accumulated with the gravel as the finer fractions of sediment have been washed downstream.

The gravel bars at several locations can be seen to be partially buried under a floodplain, suggesting the gravel bars may be repeatedly exposed, and reburied by floodplain deposition. This may explain how the Pleistocene fossils could be reworked but frequently

preserved in very good condition. If the floodplains have eroded away and then redeposited repeatedly over the gravel bars, then the fossils may have settled on the gravel deposits in primarily vertical movements with little horizontal movement. Vertical movement (settling) of the fossils would produce relatively little damage to the bones compared to horizontal movement. This is not to say that the bones did not move horizontally, but that the horizontal movement may not have been great. The lag theory entails the extensive horizontal movement of fine grain materials, with accumulation (with minor horizontal movement) of objects with greater mass such as Indian artifacts, fossil bones and gravel.

The lag theory would explain the evidence for a fairly continuous span of time represented by the bones and artifacts (the material represents what settled since at least the late Wisconsin). The lag theory also explains why the only significant concentrations of Pleistocene bones are associated with gravel and why none of the Pleistocene bones can be demonstrated to be in situ.

The gravel bars may possibly be a lag deposit from periods in the past (Pleistocene?) when greater rainfall and greater runoff may have created a higher energy environment in the the Kansas River that led to extensive movement of the gravel. Sometime in the more recent past, a factor such as lower rainfall may have created a lower energy environment with reworking of the gravel only on a modest scale. However, the author has observed modern bricks shallowly buried in

the gravel in a bar located midstream in the Kansas River in Township 11 South, Range 23 East, Section 28. This indicates that objects with the size and specific gravity of a brick have been moved very recently by the current. It is therefore a reasonable inference that the modern Kansas River is capable of significantly moving its gravel bars.

THE GRAVEL BAR AS PLUG THEORY.

An alternative explanation for the presence of Pleistocene bones in the Kansas River gravel bars is the plug theory. The Pleistocene bones in this interpretation are exposed in gravel bars which are at least in part remnants of Pleistocene deposits ("plugs") that are being eroded by the Kansas River. This theory would explain the presence of relatively undamaged Pleistocene bones on the gravel bars. The Kansas River at various localities as it nears the Missouri River has a considerable depth of alluvium beneath its river bed. Presumably, this depth of alluvium resulted from the Missouri River downcutting beneath the present stream level sometime in the past, with resulting downcutting on the Kansas River caused by the change in base level. The deeply buried alluvium could be the hypothetical Pleistocene deposit that yielded the Pleistocene bones found on the gravel bars. A downcutting Kansas River could erode these fossiliferous Pleistocene deposits, exposing them as gravel bars.

There are several difficulties with the plug theory. The apparent chronological continuity of the bones and artifacts would require the presence of a series of plugs that spanned a relatively continuous and lengthy period of time. Such a series of plugs may exist, but they not been documented. The absence of any unequivocal evidence of in situ Pleistocene bones does not support the plug theory. A radiocarbon date (obtained by researchers in geology and geography at the University of Kansas) on a log buried in a deposit thought to be a plug in a gravel bar that has yielded numerous Pleistocene fossils, produced only a mid Holocene date. The Kansas River could be washing away Pleistocene plugs in the deepest part of the channel and then reworking the bones onto the gravel bars. This would, however, require at least as extensive horizontal movement as the lag theory. Because the rationale for the plug theory is the supposedly unrolled condition of some of the Pleistocene bones, it would be ironic if horizontal movement of the bones is to be relied on for defense of the plug theory.

In support of the plug theory, a radiocarbon date has been obtained from a plug exposed in a vertical bank near Bonner Springs, Kansas that indicates an antiquity of slightly more than 10,000 years (Holein 1982). The plug was non-fossiliferous.

THE BED LOAD SURGE THEORY.

The localities of Kansas River gravel bars that have yielded Pleistocene bones have changed over time. The data suggest a down-

stream shift in localities where Pleistocene fossils have been found (Figure 9). The earliest reference to Pleistocene fossils in the Kansas River is in the 1880's (Mason 1883:13) when elephant bones were found on bars near Manhattan, Kansas. In the first decade of the Twentieth Century, the remains of extinct bison, horse and possibly saber toothed cat (Smilodon) were found in the Kansas River at Lawrence, Kansas (Hay 1924:268). During the 1950's, Pleistocene bones were recovered from the vicinity of DeSoto, Kansas (Lillegraven 1966), and presently from the Bonner Springs vicinity. The shift downstream through time of the Pleistocene bone localities requires an explanation. The sequential occurrences could be a result of chance, and merely indicate where interested individuals happened to collect fossils from the river and make a record of their finds. A number of observations suggest that the downstream movement is not due to chance. The author has checked a number of sand bars between Lawrence and Manhattan and has not discovered any collecting localities for Pleistocene fauna. Recently, the sand bars between Lawrence and DeSoto were checked with virtually no Pleistocene fauna found, but with numerous examples of Holocene fauna recovered. Even in the DeSoto to Kansas City length of the Kansas River, the DeSoto vicinity which yielded Pleistocene fauna in the 1950's is virtually barren of it now, but downstream in the vicinity of Bonner Springs the Pleistocene fauna is abundantly present. This is the only collecting area that has anything approaching detailed documentation. A

ground sloth skull was found in 1956 on a bank of the Kansas River (Lillegraven 1966) near DeSoto, Kansas. A mastodon vertebra was also recovered from this area (Martin 1979:7). The DeSoto area of the river is now virtually barren of Pleistocene fossils. Downstream near Bonner Springs, Kansas, Pleistocene fossils are abundant on the gravel bars.

Mr. Frank Richardson, an artifact collector from DeSoto, Kansas, has independently confirmed the author's belief in a recent downstream movement of sand covering the fossil bearing gravel bars in the DeSoto area. Mr. Richardson has regularly collected the gravel bars in this area since approximately 1950. He has been forced to collect downstream near Bonner Springs because the artifact bearing gravels near DeSoto where he has done most of his collecting, have been covered over by downstream moving sand.

An explanation for the apparent downstream shift in the occurrence of Pleistocene fossils on the Kansas River may be due to an in-rush of sediments into the Kansas River in the last half of the 19th Century, possibly due to the disturbance of the vegetation by Euro-American agriculture. Local deposition in the channel of the Kansas River would logically begin in the west where the volume of water in the river to carry sediment away is the least and where the climate is drier resulting in a more fragile ground cover to hold potential sediment in place. The deposition in the channel would gradually move eastward. Because any local deposition steepens the local slope

in relation to the channel downstream (Tinkler 1973:22), a relatively high energy environment is created downstream from the local deposition. This high energy environment could expose the gravel bars with their fossils (if the lag theory is correct) by carrying away finer sized sediment, or could cause entrenchment of the channel resulting in the erosion of buried Pleistocene sediments and washing the faunal remains from the Pleistocene deposits onto the gravel bars (if the plug theory is correct). The process of channel deposition moving downstream on the Kansas River creating a high energy environment before it, could explain the apparent sequential downstream appearance of Pleistocene fossil collecting localities on the bars of the river. It could also explain why the upstream localities become unproductive in Pleistocene fossils, because they become covered with sand. It should be noted that extensive gravel bars are present only in the area of the Kansas River that is presently yielding Pleistocene fauna in the Bonner Springs vicinity, indicating a local high energy environment now confined only to the downstream part of the Kansas River. Sandpits have pumped up both gravel and Pleistocene fauna from the Kansas River at Topeka, Kansas, with no significant evidence of gravel or Pleistocene bones on the sand bars at Topeka. This data is consistent with a high energy environment moving down the channel of the Kansas River causing downstream appearances of transitory Pleistocene bone collecting localities as a result of a post Euro-American settlement bed load surge in the Kan-

sas River.

FOSSIL REMAINS.

The Pleistocene species recovered from the gravel bars are typical of the Symbos-Cervalces faunal province of Martin and Neuner (1978). Representative taxa of this faunal province found on the gravel bars of the Kansas River include Cervalces scotti (stag-moose), Symbos cavifrons (woodland musk ox), and Castoroides ohioensis (giant beaver, represented by a skull pumped out of the river by a sand company). This assemblage of fauna has been found at other localities associated with the great Pleistocene spruce forests. Other fauna recovered, included Mammut (mastodon), Mammuthus (mammoth), Mylohyus (woodland peccary), Megalonyx jeffersoni (ground sloth), Bison antiquus (long horned bison), Bison bison (modern bison), Equus (horse), Cervus elaphus (elk), Odocoileus (deer), Ursus (bear), Felis concolor (mountain lion) and Castor canadensis (beaver). The Bison bison bones are definitely Holocene, as are probably some or all of the elk, deer, bear, mountain lion and beaver remains.

The lack of Camelops (camel) and Navahoceras (an extinct deer) remains from the gravel bars of the Bonner Springs, Kansas area indicates the Camelops-Navahoceras faunal province (Martin and Neuner 1978) did not overlap from western Kansas with the fossil localities near Bonner Springs.

The distribution of the faunal discoveries from the Kansas River near Bonner Springs, Kansas, is illustrated (Figure 8). These faunal localities also reflect the present locations of gravel bars on the Kansas River. The author has not encountered any substantial gravel bars upstream from these localities (with the exception of a gravel bar immediately downstream from the Bowerstock Dam at Lawrence, Kansas which obviously results from the presence of the dam). During the last several years, the author has noted the increasing burial of upstream gravel bars by finer sediment washing downstream. As the gravel bars turn into sand bars, they become increasingly unproductive of Pleistocene bones. This observed downstream shift of sand would appear to eliminate any theory of the fossil bearing gravel bars being due to reservoirs upstream keeping sediment out, or to sand companies downstream pumping out the sand. Neither upstream reservoirs nor downstream sand companies could result in a downstream moving surge of sand in the Kansas River.

Human bones have been found on the gravel bars of the Kansas River that have yielded the bones of Pleistocene fauna. The human bones, like the Pleistocene bones, show no indication of being in situ. The presence of human bones washed into the same gravel bars with Pleistocene bones suggests the possibility that some of the human bones might date to the Pleistocene. Because of the dearth of human remains from the Pleistocene of the Western Hemisphere, any Pleistocene human remains from the Kansas River would be very impor-

tant. The human bones recovered from the gravel bars of the Kansas River exhibit a state of preservation comparable to that of many of the Pleistocene animal bones. Holocene Bison bison bones from the Kansas River sometimes exhibit similar preservation to that of the Pleistocene bones. The state of preservation of bones is an obviously untrustworthy way to date the bones, especially when the specimens are not in situ. These human bones will eventually be radiocarbon dated. The analysis of these human bones was done by Mrs. Laurine Oberdieck Rogers, a physical anthropology graduate student at the University of Kansas, and is presented here in abbreviated form.

A human frontal bone was found by Mr. Jack Neas, a graduate student in systematics and ecology at the University of Kansas. The frontal bone was found on the north bank of the Kansas River in Township 11 South, Range 23 East, Section 28. The specimen was from a small individual. The relatively sharp angularity of the upper edge of the eye orbit might suggest the individual was a female, although sexing skulls, particularly American Indian skulls is a very imperfect science. The forehead shows numerous crater-like marks. Mr. Joseph Slowinski, a student at the University of Kansas, found the proximal end of a human femur at this locality. There were obvious cut marks on the neck of the specimen, perhaps indicating the body had been disarticulated as part of a mortuary custom.

The gravel bar in Township 12 South, Range 23 East, Section 5 has yielded the greatest number of human bones (5) recovered from any single locality on the Kansas River. This gravel bar also yielded many Pleistocene fossils including a number of well preserved jaws of the woodland peccary (Mylohyus) The author discovered a fragment of a human skull cap at this locality. The fragment consists of the medial crown portion of the frontal bone with two parietal fragments attached. The skull cap was thick and robust with the sutures fused. The individual was fully adult, based on suture closure. The author found a largely intact, human, left temporal bone on this gravel bar. The specimen had a large mastoid process with an extension of the posterior end of the zygomatic process as a crest extending well past the external auditory meatus, indicating the sex of the individual to probably be male. The squamosal suture had not fused on this bone. Dr. Larry Martin discovered the left fragment of a human pelvis at this locality. A very wide sciatic notch and a large, deep preauricular sulcus indicates this specimen belonged to a female. The fragment consists of the ilium, ischium and a small fragment of the pubis. The iliac crest is mostly broken away except in the sacral region. The author discovered two left femur fragments at this locality. One specimen consisted of a femoral mid shaft and was much larger in size than the other femur found on this gravel bar. The smaller human femur found at this locality was missing its distal end and was heavily damaged (by rodent gnawing) on its proximal end. The

rodent gnawing indicates the bone had been exposed on the surface for some time after death. All the sutures on the proximal end of the femur were closed, indicating the specimen belonged to an adult. The angle of the shaft to the neck of the femur was 45 degrees suggesting a 66 % chance of the bone belonging to a male (Godycki 1957). The length of the femur was reconstructed (Steele and McKern 1969) and the stature of the individual determined to be 150.23 ± 5.87 cm (Genoves 1967) or 152.34 ± 6.14 cm (Trotter and Gleser 1958) assuming the individual to be male. This individual was very short statured, especially if male.

A gravel bar in Township 12 South, Range 23 East, Section 18 yielded a right human clavicle damaged at both ends. The specimen was found by the author on the same gravel bar with a mammoth's femur.

The author found a left human femur on the gravel bar in Township 11 South, Range 24 East, Section 29. The upper jaw of a woodland musk ox (Symbos) was found nearby. The distal end of the femur was broken away. All the observable epiphyses were fused indicating the bone belonged to an adult. The femur probably belonged to a female judging from the angle of the femoral neck to the shaft (Godycki 1957). The length of the femur was reconstructed (Steele and McKern 1969) and a stature estimate of 160.44 ± 7.12 cm was made (Genoves 1967).

A left human femur was found on a gravel bar on the south bank of the Kansas River near DeSoto, Kansas in Township 12 South, Range 22 East, Section 21 by Mr. Frank Richardson who generously donated the specimen to the Museum of Natural History at the University of Kansas. All visible epiphyses were fused indicating the bone belonged to an adult. The angle of the femoral neck to the shaft indicates the bone belonged to a female. The length of the femur was reconstructed (Steele and McKern 1969) and the height was estimated to be 158.26 ± 7.9 cm (Genoves 1967). The remains of mammoth (Mammuthus) and woodland peccary (Mylohyus) have been found on this gravel bar. Several paleo-Indian projectile points were found on this gravel bar by Mr. Richardson.

Numerous other human bones have been found on the gravel bars in the Bonner Springs vicinity. These bones are in the hands of artifact collectors.

ARTIFACTS.

The American Indian artifacts recovered from the gravel bars of the Kansas River consisted of pot sherds and projectile points. The diagnostic artifacts suggest a relatively continuous archaeological record ranging from the end of the Wisconsin glaciation to the late Holocene.

The Middle Ceramic period is represented by three shell tempered rim sherds from bowl shaped vessels. One rim sherd was found on a gravel bar at Township 11 South, Range 24 East in Section 29, and two

rim sherds were found on a gravel bar in Township 12 South, Range 23 East in Section 5.

The Early Ceramic period is represented by a Middle Woodland projectile point (Figure 11B) found on a gravel bar in Township 12 South, Range 23 East in Section 18 and the base of a "sack shaped" cord roughened pot found by Mr. Joseph Slowinski on a gravel bar in Township 11 South, Range 24 East in Section 29. The Early Ceramic period is also represented by a Late Woodland projectile point (Figure 11A) found by Mr. Frank Richardson on a gravel bar near DeSoto, Kansas.

Two Archaic period projectile points were found on a gravel bar in Township 12 South, Range 23 East in Section 5. A Nebo Hill projectile point (Figure 11D) was found at this locality by Miss Amanda Martin of Lawrence, Kansas. The Nebo Hill style of projectile point was made during the late Archaic. Another Archaic projectile point with a concave base (Figure 11C) was found a short distance from the Nebo Hill projectile point. The artifact is similar to early Archaic projectile points from the Graham Cave site (Chapman 1952).

Paleo-Indian projectile points are not commonly found in the state of Kansas. However, a surprising number have been found on the gravel bars of the Kansas River.

A Clovis projectile point (Figure 12B) was recovered by Mr. Robert Smith of the United States Army Corps of Engineers. The

Clovis projectile point was found on the north bank of the Kansas River at Township 12 South, Range 23 East, of the NE quarter, of the NW quarter, of the NW quarter of Section 5. This artifact, like the other artifacts found on the gravel bars of the Kansas River, had almost certainly been transported by the river and was not in situ. The projectile point had a maximum length of 89.9 mm, a maximum width of 26.5 mm, a width across the base of 21.8 mm and a maximum thickness of 6.4 mm. The lateral edges of the basal portion of the artifact had been dulled by grinding, presumably to keep the lashings that held the projectile point to the shaft from being cut. The tip of the projectile shows signs of impact with very fine retouching to re-establish the point, presumably indicating it had been damaged and repaired after being hurled against a resistant object. The artifact was fluted on both sides. The artifact exhibits the typical "glossy" surface of heat treated flint. Heating the flint is believed to have improved its knapping characteristics. The gray flint from which the artifact was made is probably local in origin as it contains Paleozoic fossils typical of cherts in eastern Kansas.

A narrow time range for the use of Clovis projectile points (approximately 11,000 to 11,500 B.P.) has been argued for by Haynes (1971). This is somewhat controversial because several radiocarbon dates from Clovis projectile point sites indicate a broader time range. There is little doubt, however, that Clovis projectile points are associated with the end of the Wisconsin glaciation.

A second Clovis projectile point (Figure 13A) was found by Mr. Frank Richardson of DeSoto, Kansas on a gravel bar in the Kansas River at Township 12 South, Range 22 East in Section 21. The specimen consisted of the proximal end of the projectile point. The width across the base was 28.9 mm. The projectile point has a short flute on one side, and several thinning flakes removed from the other side. The basal edges were smoothed and the specimen was made from heat treated flint. The shape and size of the specimen are quite unlike the dimensions of Meserve or Dalton projectile points found in the area.

A Hell Gap projectile point (Figure 13B) was recovered by Mr. Frank Richardson on the same gravel bar that he found the Clovis projectile point. The Hell Gap projectile point exhibits some tendency toward transverse parallel flaking, and is made from heat treated flint. The maximum length of the projectile point was 61.6 mm, the maximum width was 25.5 mm, the width at the base was 14.2 mm and the maximum thickness was 8.2 mm. The lateral edges of the basal portion of the projectile point were ground. Radiocarbon dates on the Hell Gap cultural complex in Wyoming were $9,600 \pm 230$ B.P. and $9,650 \pm 250$ B.P. at the Sister's Hill site, and $9,830 \pm 350$ B.P. and $10,060 \pm 170$ B.P. at the Casper site (Frison 1978:23).

A Milnesand projectile point (Figure 13C) was found by Mr. Frank Richardson on the same gravel bar as the Hell Gap projectile point. The artifact exhibits transverse parallel flaking and the removal of

thinning flakes has given the base a beveled appearance that is typical of Milnesand projectile points (Sellards 1955:343). The maximum length of the artifact was 58.9 mm, the maximum width was 23.8 mm, the width at the base was 17.7 mm and the maximum thickness was 7.1 mm. The lateral edges of the basal portion of the projectile point were slightly ground. The flint had been heat treated. The Milnesand "type site" is located in Texas. Wormington (1957:112) indicates that Milnesand projectile points have been found in Iowa. The Lime Creek site (Ft-41) in southwestern Nebraska (Schultz and Frankforter 1948) has yielded a projectile point type that is probably Milnesand (Wormington 1957:120) in the same stratigraphic zone as a Scottsbluff projectile point. The Milnesand projectile point type was present at the Olsen-Chubbuck site in eastern Colorado (Wheat 1967) and was also found in association with the Scottsbluff projectile point type. The Olsen-Chubbuck site has a radiocarbon date on bone collagen of $8,200 \pm 500$ years B.C. (Wheat 1972).

Seven specimens of Meserve or Dalton projectile points were found by Mr. Frank Richardson on gravel bars of the Kansas River near DeSoto, Kansas. The specimen illustrated in Figure 14A was found on the gravel bar on the south bank of the Kansas River in Township 12 South, Range 22 East in Section 13, the remainder of the Meserve or Dalton projectile points (Figures 14B,C,D and 15A,B,C) were recovered from the gravel bar on the south bank of the Kansas River at Township 12 South, Range 22 East in Section 21. Meserve or Dalton projectile

points were first found in situ at the Meserve Site (Barbour and Schultz 1932) near Grand Island, Nebraska in association with extinct bison. Very similar projectile points were later found in situ in Missouri where they were named Dalton projectile points. The lower levels of the Graham Cave site in Missouri contained Dalton projectile points and had dates of $9,700 \pm 500$ B.P. and $8,830 \pm 500$ B.P. A radiocarbon date of $7,900 \pm 500$ B.P. was obtained from an excavation level above the lower levels that contained several Dalton projectile points (Crane 1956). The specimen illustrated in Figure 14A has the lateral edges serrated except near the base where lateral edges are ground smooth. The artifact exhibits transverse parallel flaking and a flute on one side. The flint has been heat treated. The maximum length is 77.7 mm, the maximum width is 22.0 mm and the maximum thickness is 6.5 mm. The Meserve or Dalton projectile point base illustrated in Figure 14B had transverse parallel flaking with the lateral edges ground and was made from heat treated flint. The width at the base was 27.3 mm. A broken and unfinished Meserve or Dalton projectile point is illustrated in Figure 14C. This specimen was finished at the base except for edge grinding, but the anterior portion of the artifact still had a large mass of flint on one surface that had not been removed and it is possible that the artifact broke while an attempt was made to remove the lump of flint. This artifact suggests the steps in manufacturing a Meserve or Dalton projectile point was first to shape the base, second to shape the tip and third

to grind the lateral basal edges. The flint from which the artifact was made showed no evidence of heat treatment. The Meserve or Dalton projectile point illustrated in Figure 14D is made of heat treated flint and has the lateral basal edges slightly ground. The maximum length is 56.5 mm, the maximum width is 18.0 mm, the width at the base is 18.0 mm and the maximum thickness is 6.2 mm. The Meserve or Dalton projectile point illustrated in Figure 15A is made from heat treated flint. The lateral edges are unifacially beveled for more than two thirds of the forward length of the artifact. The basal lateral edges are blunted by grinding. The maximum length is 92.5 mm, the maximum width is 27.1 mm, the width at the base is 28.0 mm and the maximum thickness is 6.5 mm. The Meserve or Dalton projectile point illustrated in Figure 15B has the lateral edges unifacially beveled for more than two thirds of the forward length of the artifact. The beveled edges are serrated. The lateral basal edges are blunted by grinding. The artifact has been made of heat treated flint. The tip is broken probably because of impact during use. The maximum width is 19.1 mm, the width at the base is 18.8 mm and the maximum thickness is 5.5 mm. The Meserve or Dalton projectile point illustrated in Figure 15C is fluted on both sides. The tip was broken possibly from impact during use. The lateral edges are unifacially beveled for more than half the forward length of the artifact. The lateral basal edges are blunted by grinding. The maximum width is 26.0 mm, the width at the base is 24.9 mm and the maximum thick-

ness is 6.6 mm.

Mr. Joseph Chandler of Kansas City discovered an interesting projectile point (Figure 12A) on a gravel bar on the south bank of the Kansas River in Township 11 South, Range 24 East in Section 28. The specimen has a concave base, is fluted on one side and the basal lateral edges have been smoothed slightly by grinding. The artifact resembles a Clovis projectile point in these traits, but differs from a Clovis projectile point by being "shouldered." Projectile points with this approximate shape, have been called "Holland" projectile points. Holland projectile points have been found in a cache in Iowa with Meserve or Dalton, and Scottsbluff projectile points (Holland 1971) indicating contemporaneity of these projectile point styles. The flute is not typical of Holland projectile points.

The gravel bars which yielded the Clovis projectile points have yielded the remains of such potential prey species for Clovis hunters as mammoth, mastodon, woodland musk ox, horse, Bison antiquus, stag-moose, woodland peccary, deer and bear (Ursus) all of which are unfortunately not in situ. The Pleistocene fauna is typical of the Symbos-Cervalces faunal province (Figure 10), and is the type of fauna associated with the great Pleistocene spruce forests. Mammothus, Mammut, Bison, Equus and Ursus are all known to have been utilized by Clovis hunters but it seems likely they would also hunt other available large animals. The Kimmswick site, a Clovis projectile point site in Missouri, also falls in the Symbos-Cervalces

faunal province, but the 12 Mile Creek site, a Clovis projectile point site in western Kansas, belongs to the Camelops-Navahoceras faunal province as do most of the better known Clovis projectile point sites. It is interesting that this distinctive projectile point type occurs in two very different ecological areas and this suggests that Clovis peoples were quite adaptable in their hunting strategies.

The other early projectile point styles found on the gravel bars of the Kansas River, such as the Hell Gap, Milnesand and Meserve projectile points are famous for their association with the remains of extinct bison, which are also present on the gravel bars.

4.3 SMOKY HILL RIVER ARCHAEOLOGICAL DATA

The upstream end of the Kansas-Smoky Hill River drainage strongly contrasts with the river valley topography in the downstream end. The Smoky Hill River has produced numerous faunal localities with the faunal remains in situ in the relatively well preserved terraces, but lacks the rich gravel bar fossil collecting localities of the downstream Kansas River.

Buried prehistoric cultural material is not commonly exposed in the valley of the Smoky Hill River. The author was able to locate an Archaic site buried in Terrace Four, and determine that the 12 Mile Creek paleo-Indian site was buried in Terrace Five.

The Archaic site was found in Township 15 South, Range 17 West in the NE quarter, of the SE quarter of Section 33. The cultural affinity of the site was based on the discovery of an Archaic projectile point. The site was buried at a shallow depth of only half a foot beneath the surface of an alluvial deposit perched on an outcrop of Cretaceous chalk. The site is on the east bank of the Smoky Hill River. The site borders a plowed field, but the plowing has not approached the precipitous edge of the terrace, so the exposed site is undisturbed despite the shallowness of the site and its proximity to a plowed field. The site is buried just below the surface of Terrace Four. The terrace is rock defended by the outcrop of Cretaceous chalk. The in situ debris of the site consisted of a few flint chips and a number of clam shells. The projectile point was not in situ, but had recently eroded from the vertical exposure and had come to rest a few inches below the cultural level. The projectile point almost certainly did not come from the surface of the terrace, because sparse vegetation permitted an intensive search of the terrace surface which revealed no sign of cultural debris such as flint chips. The buried cultural level was the only plausible source for the projectile point.

THE 12 MILE CREEK SITE.

The most important archaeological discovery from a theoretical point of view in Kansas was the 12 Mile Creek site. The importance of the site to the history of science is of more than local interest.

The 12 Mile Creek site, excavated in 1895, was the first discovery of a human artifact in association with extinct animals in the Western Hemisphere by scientifically trained personnel. The discovery of this important archaeological site should have been an intellectually decisive event in the history of American anthropological thought about the early arrival of man into the New World. The discovery of this paleo-Indian site did not have such an effect on the anthropological community but did influence researchers in other fields, most notably paleontology. The history of this archaeological site sheds interesting light on how important ideas are dealt with by researchers operating in the "real world" of the scientific community.

The discovery of the 12 Mile Creek site occurred when a local resident, Mr. Charles Wood, found fossil teeth eroding from a stream-made bank cut, in Logan County, Kansas. He took the fossil teeth to a University of Kansas fossil collecting party doing field work in western Kansas. Mr. H. T. Martin and Mr. T. R. Overton, assistants in the paleontological department of the University of Kansas, were taken by Mr. Wood to the 12 Mile Creek site.

The archaeological site is on the bank of 12 Mile Creek, a small intermittent stream that generally flows from north to south, and empties into the Smoky Hill River. The fossil bones were found where 12 Mile Creek enters the north edge of the Smoky Hill River valley (Figure 16). The legal description of the site is Township 13 South,

Range 33 West, in the NE quarter, of the SW quarter, of the SE quarter of Section 32. The channel of 12 Mile Creek had eroded a vertical cut in a high bank. Bison bones were extracted from this vertical cut bank by Martin and Overton. The bone bed was ten feet square and was composed of numerous bison skeletons. The largest bison skeleton at the site was lying on its right side, and beneath the right scapula was a flint projectile point. The artifact touched the scapula and was embedded in the matrix (Williston 1902). The overlying matrix had been removed for a distance of ten feet from the bison skeleton before the right scapula was removed, exposing the projectile point so the accidental intrusion of the artifact during excavation would have been impossible. The scapula overlying the artifact is a classic example of a stratigraphically sealed provenience which would make it virtually impossible for intrusion to have produced such a situation before excavation. Short of finding the artifact actually embedded in the bone, one could not reasonably expect to find an artifact in any better association with an extinct animal.

H. T. Martin described the site as being 12 miles east of Russel Springs, Kansas and 18 miles south of the Monument Station. This location is incorrect, the actual location is approximately nine and a half miles east of Russel Springs and sixteen miles south of the train tracts. There can be no doubt the location given here is the correct one, because it is on 12 Mile Creek and H. T. Martin's loca-

tion is not, and this new location matches precisely H. T. Martin's sketch of the locality (Williston 1902). H. T. Martin's error is understandable, in 1895 the maps of this area of Kansas were inadequate to locate the site and the current grid of section roads had not been laid out, making "on the spot" distance estimations difficult. Perhaps, H. T. Martin believed the name 12 Mile Creek, meant that the creek was 12 miles east of Russel Springs. The ruts of the Butterfield Stage Line can still be seen a quarter of a mile south of the paleo-Indian site, and it is possible that 12 Mile Creek was 12 miles from Russel Springs following the curving route of the Butterfield Stage Line.

H. T. Martin's description of the deposit described Cretaceous chalk at the base of the site, covered with four inches of gravelly sand, then covered by a two feet thick layer of blue-gray silt containing the bison bones and capped by "plains-marl" at least partially of windblown origin (Williston 1902).

The present stratigraphy of the site, as measured from the bed of 12 Mile Creek is 12 feet 6 inches of Cretaceous chalk covered by 6 inches of gravel and sand, overlain by at least 17 feet of tan, sandy silt with 23 feet of unexposed slope to the surface of Terrace Five. The blue-gray silt layer that contained the bones is no longer present. The sketch of the site by H. T. Martin (Williston 1902) indicates the blue-gray silt layer was a lens surrounding the bones, and was presumably destroyed when the bones were removed. Samples of

this layer from matrix still adhereing to the bison bones in the University of Kansas Natural History Museum indicate a gray silt with little evidence of a blue color. The bones of the bison may have formed a dam hindering the flow of water and causing the distinctive gray silt to settle around the bison remains. The Cretaceous bedrock had been eroded before deposition of the bone bed. The erosion formed a depression in the chalk (Williston 1902) in what was either the bed of the late Wisconsin 12 Mile Creek or a tributary gully of 12 Mile Creek. The bison therefore rested in an ancient stream channel and had alluvial silt deposited over them.

The tan sandy silt that overlies the gray silt may have had some loess as parental material, but was almost certainly alluvially deposited, judging from the sand content. The presence of aquatic species of snails in the tan sandy silt is further confirmation of the deposit's alluvial origin.

Northward from the exposure that contained the site, and upslope, a terrace surface is encountered. The terrace surface is 53 feet above the bed of 12 Mile Creek and 65 feet 6 inches above the Smoky Hill River. It is the lowest terrace surface whose alluvial fill could be responsible for the deposit covering the site. There is a slope from the Terrace Five surface to the vertical exposure of the 12 Mile Creek site, but there is no evidence of another intervening terrace. The height of the terrace surface above the Smoky Hill River is that of Terrace Five, encountered downstream that was

the lowest terrace to contain Pleistocene fauna.

A limb bone from a bison at the 12 Mile Creek site was dated by two radiocarbon age determinations. The dating was done by the Geochron Laboratories Division of Kruger Enterprises, Incorporated. The apatite fraction yielded a radiocarbon age of $10,435 \pm 260$ years B. P. (GX-5812-A) after being C-13 corrected. The bone gelatin fraction yielded a radiocarbon age of $10,245 \pm 335$ years B. P. The dating concordance between these two bone fractions is remarkable considering the antiquity of the dates. The date obtained from either fraction is within the standard deviation of the other. The bone apatite and the bone gelatin fractions are so different it would be extraordinary to argue that each was differentially contaminated in such a way as to yield essentially the same date. The dates obtained do not appear to be due to contamination.

The bison remains from the 12 Mile Creek site were originally identified as Bison antiquus by S. W. Williston (1897) and by Alban Stewart (1897), and later assigned to Bison occidentalis by F. A. Lucas (1899). The alleged taxonomic difference between Bison antiquus and Bison occidentalis is based on a difference in shape of the horn cores with Bison antiquus having horn cores standing out at right angles to the longitudinal axis of the skull and the tips of the horn cores barely rising above the plane of the forehead, with Bison occidentalis horn cores raking backward with the tips rising noticeably above the plane of the forehead (Lucas 1899). Because the

term Bison antiquus predates the term Bison occidentalis in usage, it was Lucas's responsibility to demonstrate that Bison occidentalis is a discrete taxon. This was never done. The Casper site in Wyoming yielded both forms in the same kill site dated approximately 10,000 years ago (Frison 1978:281). Wilson (1974:141), in his analysis of the bison remains from the Casper site, reasonably concludes that Bison antiquus and Bison occidentalis are taxonomically synonymous.

The large articulated bison skeleton with which the projectile point was associated at the 12 Mile Creek site, was mounted and put on display. This was the first mounted, extinct bison to be displayed anywhere. The specimen can be viewed in the Museum of Natural History at the University of Kansas. Most published information on the bison from this archaeological site concerns the mounted skeleton, with very little published information on the other bison remains. A lack of information on the unmounted material undoubtedly led to the vague and sometimes contradictory estimates of the number of bison recovered from the 12 Mile Creek site. The number of bison recovered from the site was stated to be five or six adult animals and two or three younger ones plus a foetal skeleton within the pelvis of an adult by Williston (1902) and was stated to be seven or eight skeletons by McClung (1908) and was stated to be five skeletons by Lane (1948). The bones preserved from the site in the Museum of Natural History when analyzed during this research indicated eight adult and two subadult bison as the minimum number present based on

the count of right metacarpals and right astragali. The foetal bison skeleton mentioned by Williston (1902) is missing from the bone collection. The presence of 10 adult and subadult bison at the site, should be considered a minimal estimate because the bones were being eroded away at the time of discovery and therefore the bones represent only part of what had once been buried in the deposit, some of the bison may have been dragged away at the time of the kill by paleo-Indians or non-human predators, and some of the bison bones may have rotted away because they were not in a microenvironment that was conducive to the preservation of bone.

The heads of the bison seem to have been differentially removed relative to the post cranial material. The large mounted bison skeleton that was associated with the projectile point had the only relatively intact skull. Two horn cores, probably from the same individual, are the only other skull remains. The only mandibular remains are two mandibular condyles (representing two individual bison) and the virtually intact mandible of the large mounted bison skeleton. The underrepresentation of bison heads at the 12 Mile Creek archaeological site is probably due to removal of the heads by paleo-Indians. Direct evidence for this was found in the osteological remains in the form of an atlas (a neck vertebra) with cut marks at right angles to the vertebral column. The cuts had root marks inset over them, demonstrating that the cut marks were not made during the excavation of the bone. The large mounted bison skeleton

that was associated with the projectile point, was oriented in an easterly direction when excavated, but its skull was approximately three feet away from its anatomical position (Sellards 1952:47). A reasonable interpretation of this skeletal alignment, would be that the large bison associated with the projectile point, had been beheaded, but the paleo-Indians had not removed this skull from the vicinity of the carcasses. Interestingly, the atlas vertebra was one of the few bones of the large mounted specimen that was missing. A plaster model of an atlas was mounted in the skeleton for the exhibit.

The lack of skull remains at this site is interesting because ethnographic data suggest that the head was not ordinarily removed from the butchering site by historic Indian bison hunters (Wheat 1972:102). The 12 Mile Creek site suggests that the paleo-Indians at this site engaged in activities during butchering of the bison that were atypical of recent Indian analogues. It can be speculated that the heads may have served as trophies or functioned in some religious ceremony, but there is at present no way to test these hypotheses. The Hudson-Meng site, a paleo-Indian bison kill in northwestern Nebraska, where the 12 Mile Creek site phenomenon of missing bison skulls also occurs, demonstrated this was not an isolated event.

Other cut marks on the bison bones may also indicate butchering. Several ribs show faint cut marks on the dorsal surface at right angles to the long axis of the ribs. This may have been done during

the stripping of the outside layers of meat on the ribs.

The artifact found at the 12 Mile Creek archaeological site was a projectile point. The projectile point was first spotted by H. T. Martin as the right scapula of the large mounted bison skeleton was lifted from the matrix. T. R. Overton and an onlooker saw it an instant later (Williston 1902:313). The projectile point was firmly embedded in the matrix, with the point pressed against the shoulder blade. When the artifact was removed, it "left a perfect mold" in the matrix (Sellards 1952:47).

All that remains at the University of Kansas of the projectile point is a photograph. The dimensions of the artifact are not known. The author has traced the key features of the artifact from the photograph (Figure 17). The photograph shows a projectile point with a concave base, a flute and a somewhat asymmetrical point with an indentation on one side of the tip. The asymmetry and the indentation near the tip almost certainly indicate the projectile point had been resharpened and thereby shortened. This has been observed on many Indian projectile points. Undoubtedly, the tips of projectile points frequently broke after being hurled against a hard object. The base of the projectile point, still adhering to the shaft, could sometimes be resharpened, saving the time it would take to make a new projectile point and to fasten it to the shaft.

The projectile point recovered from the 12 Mile Creek site was almost certainly considerably longer when first made, than when it

was left at the site. A lengthened version of the projectile point would fit into the Clovis projectile point category. A similarly shortened projectile point was found at the Kimmswick Clovis site in Missouri. A resharpened Clovis projectile point was recovered in Kansas near the John Redmond Reservoir and will be discussed in the next chapter. Meserve or Dalton projectile points are sometimes fluted, but careful analysis of the photograph of the projectile point reveals no evidence of the beveled retouch that is typical of Meserve or Dalton projectile points.

The radiocarbon dates of this bison kill are somewhat surprising because it suggests that Clovis projectile points were being used at a time period when one would expect to find Folsom projectile points. The correspondence of the radiocarbon dates on two different bone fractions at the 12 Mile Creek site strongly indicates that the unexpectedly late radiocarbon dates are not the result of contamination. Haynes (1971) has argued that Clovis projectile points were used in a rather narrow time range between approximately 11,500 and 11,000 years ago. The radiocarbon dates from the 12 Mile Creek site indicate that Clovis projectile point were being used more than 500 years later than Haynes has suggested.

Most Clovis projectile point sites that contain fauna suggest that Clovis hunters preyed primarily on elephants, while most later paleo-Indian projectile point sites with fauna suggest the later hunters preyed mostly on long horned bison. The 12 Mile Creek site,

like several Folsom projectile point sites was a mass kill of long horned bison. The faunal evidence suggests the 12 Mile Creek site is later than the Clovis elephant kills that Haynes bases his dates for the use of Clovis projectile points.

Meserve or Dalton projectile points are frequently fluted (Figure 15C) and closely resemble Clovis projectile points except they are usually beveled along their forward edges. Meserve or Dalton projectile points do not closely resemble Folsom projectile points, which many archaeologists believe replaced Clovis projectile points in the tool kits of paleo-Indian hunters after 11,000 years ago. The evidence for late use of Clovis projectile points at the 12 Mile Creek site indicates the possibility the cultural traits of this projectile point type may have continued long enough to have been modified culturally by early Holocene hunter-gatherers into the Meserve or Dalton projectile point type.

Reconstructing the actions that led to an archaeologically identified event is usually a highly speculative task. Human actions may not leave an archaeologically detectable trace, evidence may decay or erode with time and still other evidence may not be recorded by the excavator. All of these problems effect the analysis of the 12 Mile Creek site.

The site was dug in 1895. The pioneering nature of the research may explain why very few notes were taken and no detailed illustrations were made of the bison bone bed. Nevertheless, certain facts

that are vital to reconstructing the events that led to the accumulation of the bison bone bed more than ten thousand years ago, can be discerned.

There were at least ten bison at the site. The remains of these bison were crowded into a space only ten feet square. The mounted bison skeleton from the 12 Mile Creek site on display at the Museum of Natural History is almost exactly ten feet long (McClung 1908). It is quite apparent that ten bison could occupy an area ten feet square only if their bodies were piled in a heap. At least some of the bones were articulated. Some of the bones are still articulated in the jackets that H. T. Martin used in removing the specimens. Articulation can be inferred from the excavator's description of the bones as "skeletons" one of which had a foetal skeleton "within the pelvis" (Williston 1902:315), and from the description of at least one of the skeletons (the mounted specimen) being oriented in a west to east direction (Sellards 1952:47). The eroded depression in the chalk bedrock on which the deposit of bison bones resided was almost certainly the ancient bottom of a stream channel that was cut when the stream flowed generally from north to south, finally emptying into the Smoky Hill River.

The presence of a foetal bison and the lack of young calves at the 12 Mile Creek site, suggest the bison kill occurred in the late winter or early spring. This assumes the breeding habits of modern bison are applicable.

A hypothetical reconstruction of the events that produced the bone bed at the 12 Mile Creek site will now be suggested. More than 10,000 years ago in the late winter or early spring, a group of paleo-Indian hunters surprised a herd of bison west of what is now 12 Mile Creek. A large bull bison was struck in the shoulder by a spear. The hunters drove the bison herd eastward toward a southward flowing stream at the present location of 12 Mile Creek. The bison plunged over a bank into the stream channel. The large wounded bull was probably the first bison over the edge and was quickly buried by the bodies of other bison that tumbled down on top of it. This would explain the eastward orientation of the large bull. The fact the large bull's skeleton was recovered almost intact and the fact the spear point was not retrieved, could be explained by the large bull being buried under the other carcasses. It may not have been worth the effort to the hunters to extensively butcher the specimen. The bison not killed by the fall were probably dispatched by the paleo-Indians. The heads of most of the bison were removed from the site. There is a paucity of butcher marks on the bones from this site so it is unlikely that any of the bison were heavily butchered. The paleo-Indians left the locality and judging from the fairly good condition of many of the bones, the kill site was rapidly silted over by the southward flowing stream. Eventually, the bone bearing deposit became part of the fill beneath a terrace surface that was sixty-five feet above the present Smoky Hill River.

The hypothetical scenario described above seems to fit the data available. This scenario is similar in some ways to a much better understood paleo-Indian bison kill, the Olsen-Chubbuck site. The Olsen-Chubbuck site in eastern Colorado is approximately eighty miles west, southwest, of the 12 Mile Creek site. A radiocarbon date from the Olsen-Chubbuck site is $10,150 \pm 150$ B. P. (Wheat 1972), which suggests the site is several hundred years later in time than the 12 Mile Creek site. The bison had been driven over the edge of a ravine. The bison at the bottom of the heaped carcasses were little disturbed during the butchering process.

There are other possible but less likely interpretations of the evidence at the 12 Mile Creek site. The bison bone bed at the 12 Mile Creek site may have represented the butchered remains of bison stacked in a pile by paleo-Indians after the bison had been killed nearby. The fact that the largest bison specimen was virtually complete and articulated, and that none of the other bison appeared to be heavily butchered suggests that the remains were not stacked by the paleo-Indians in a pile. It would be difficult to imagine the paleo-Indians bothering to stack such heavy and still largely intact carcasses, even though it is known that paleo-Indians at other sites did stack the disarticulated bones of heavily butchered prey.

It is possible that the bison had not been stampeded over the bank of the stream channel. The bison may have been driven up the stream channel until the bison met an obstacle such as a nick point

or a fallen tree trunk, or a man made barricade of logs that blocked the passage of the bison. Momentarily, the bison would have been stopped and vulnerable to being slain by the paleo-Indians. The arguments against this interpretation are that the bison would be unlikely to have piled one on top of the other in a area only ten feet square, and one would have expected there would have been more projectile points left in the lightly butchered bison remains if weapon use rather than a fall was the primary agency of destruction for the animals.

It is possible that the bison were killed in an undetermined manner by paleo-Indians some distance up the stream channel and had washed down to their present position, piling against an obstacle. A freshet would have had to occur very shortly after the kill for the bones to still be articulated after being washed downstream. It is hard to imagine, however, that a freshet washing the bison downstream would stack the carcasses one on top of the other in such a small area. The orientation of the large bull bison at a right angle to the direction of flow would be somewhat unexpected if a freshet is to be evoked for the positioning of the bison. A freshet would probably not bring the articulated remains of the large bull bison carcass downstream along with the separated skull and deposit them closely together despite their great difference in mass.

A snail fauna was recovered in the tan sandy silt three feet above the gray silt lens that contained the bison bones. Mr. J. D.

Stewart, a graduate student in the Department of Systematics and Ecology at the University of Kansas identified the following taxa of snails: Lymnaea cf. parva, Pupilla muscorum, Vallonia gracilicosta, Hellicodiscus parallelus and Succinea sp. Because the snails are slightly higher in the stratigraphic column than the bison bones, they post date the 12 Mile Creek site. The silting over of the site could have occurred quite rapidly, so there probably is not a great amount of geological time separating the snails from the bison kill site. Only Succinea and Hellicodiscus parallelus still inhabit the area of the site. Lymnaea, Pupilla muscorum and Vallonia gracilicosta are extinct in Kansas and presently inhabit a range far to the north, except at higher elevations, such as in the Rocky Mountains where they range further south. It is possible that the distribution of these locally extinct snails is limited by high summer temperatures, if this is true, then it would suggest the summers were cooler than present at a time shortly after the 12 Mile Creek bison kill occurred.

Some bison bones from the 12 Mile Creek site still had a gray silt matrix adhering to the bones, especially in the marrow cavities. Chunks of the gray silt matrix were removed and the outer surface of the chunks were abraded to reduce the chance for recent pollen to contaminate the sample. The pollen was separated from the sample using the Aaron Horowitz technique which involves the disaggregation of the pollen bearing matrix with sodium hexametaphosphate

and hydrochloric acid followed by segregation of the pollen by heavy liquid separation using zinc chloride. The pollen was stained with 5% aqueous basic fuchsin and mounted on slides with glycerin jelly.

Three slides were examined and a total of 183 pollen grains were identified. The pollen grains were reasonably well preserved except for some of the Gramineae pollen grains that were badly deteriorated. The following percentages of pollen grains per taxon were found: Pinus (pine) 37.16 %, Quercus (oak) 1.64 %, Populus (cottonwood) 1.64 %, Gramineae (grass) 32.24 %, Compositae (primarily ragweed) 23.50 % and Chenopodiaceae-Amaranthaceae 3.82 %. Not included in the count were 21 pollen grains that were unidentifiable because they were badly deteriorated or because they were obscured by debris. Unfortunately, the percentages of pollen taxa recovered from sites rarely indicate in a direct way the percentages of the taxa in the local plant community. The reasons for this are rather obvious and include such factors as different amounts of pollen are produced by different taxa of plants, pollen of different plant taxa may be differentially preserved and some pollen can be carried enormous distances by the wind (and its discovery may not be relevant to the local vegetation). Reconstructing the regional vegetation from pollen percentages is a matter of interpretation.

Analysis of the sediments of cattle-watering tanks by Kapp (1965:186-189) suggests a modern pollen rain near the Front Range of the Rocky Mountains is dominated by conifer pollen. In the central

grassland region, Compositae, Chenopodiaceae-Amaranthaceae and to a lesser degree grass pollen grains are most abundant. Near the deciduous forest margin on the eastern edge of the grasslands the pollen of Quercus increases sharply, grass pollen becomes more abundant and the Compositae remains abundant.

The pollen percentages from the 12 Mile Creek site do not fit the patterns exhibited by pollen percentages recovered by Kapp from the sediments of stock tanks. This suggests significant differences in the vegetational community in the region of the 12 Mile Creek site at the time of the bison kill, compared to the present. The Pinus (pine) pollen percentage of the 12 Mile Creek site is similar to the modern percentages of pine pollen documented by Kapp near the Front Range of the Rocky Mountains. However, the grass pollen percentage of the 12 Mile Creek site is much more similar to that found by Kapp on the modern deciduous forest margin. Kapp (1965:188) states, "Surprisingly, a high frequency of grass pollen does not typify the pollen rain of the grasslands region. Grass pollen seems to be abundant only in the moister areas of the prairie." The high percentage of grass pollen at the 12 Mile Creek site may suggest more moisture was available for plant growth at the time of the bison kill, than at the present time. The high percentage of pine pollen at the 12 Mile Creek site could have at least two reasonable interpretations; 1) the vegetation in the region of the 12 Mile Creek site was grassland with pine forests of the Rocky Mountains having significantly extended

eastward into the western edges of the prairie resulting in an increased rain of pine pollen because of closer proximity of pine forests to the west, or 2) the vegetation in the region of the 12 Mile Creek site was a pine parkland (grassland interspersed with stands of pine trees). The discovery of a pine macrofossil in a late Wisconsin deposit in western Kansas (J. D. Stewart, personal communication) demonstrates that pine was in the local area, and supports the pine parkland hypothesis. Although the percentage of pine pollen at the 12 Mile Creek site is higher than at present in the region there is no evidence of forest vegetation dominating the region at the time of the bison kill. The presence of Quercus (oak) and Populus (cottonwood) pollen at a low frequency may suggest there was some riparian forest along the Smoky Hill River.

The chitinous exoskeleton of a mite was observed on one of the slides examined for the pollen count. This suggests that an arthropod (if this particular specimen is not contamination) might be preserved in the alluvial deposits of the plains for many thousands of years. The study of arthropods extracted by heavy liquid techniques may offer great potential for future research in reconstructing past environments in the Great Plains because these creatures frequently exist within narrow environmental limits.

The discovery of a projectile point in association with an extinct animal at the 12 Mile Creek site in 1895 never had the influence on anthropological thought in America that the discovery war-

ranted. In hind sight, we know the artifact discovery was not a fraud, because in 1895 no one knew that a fluted projectile point was the appropriate style to be found associated with extinct animals. There were probably several reasons for the anthropological community's failure to grasp the significance of the find. One reason, that has never before been published, was the fact the projectile point was stolen shortly after its discovery. Only a single photograph and a rather uninformative drawing of the artifact remain at the University of Kansas. The artifact was stolen during an evening lecture delivered by S. W. Williston at the Chancellor's house at the University of Kansas. The following description of the events that surrounded the theft was principally taken from two letters written by Claude W. Hibbard to E. H. Sellards dated November 17, 1945 and March 16, 1946. Copies of these letters are on file at the Museum of Natural History at the University of Kansas. The sponsorship of the night meeting at the Chancellor's house was either Sigma XI or the forerunner of the Williston Club. S. W. Williston took several projectile points (including the projectile point from the 12 Mile Creek site) to illustrate his lecture on bison, the antiquity of man and projectile point typology. A large crowd attended the lecture including faculty and non academic people. Apparently, there were many prominent local people present (personal communication, E. Raymond Hall, who had spoken to H. T. Martin about the subject). During the lecture the projectile points were put in a box and

passed around the crowd during the lecture. An unknown member of the crowd stole the projectile point from the box. It was noted that the artifact was missing, but no one in the crowd admitted knowing anything about it. H. T. Martin urged that the sheriff be called and that all in the Chancellor's house be detained until everyone present could be searched. This proposal was rejected (presumably by S. W. Williston). The crowd dispersed, the artifact was lost and H. T. Martin was "sore" because a more vigorous attempt was not made to recover the artifact.

One can speculate that the embarrassment and possible political repercussions of detaining and searching a number of prominent, and for the most part innocent, citizens outweighed the scientific data loss in the minds of those academic officials in charge of the meeting.

One couple that attended the lecture was a dentist and his wife from a nearby town. H. T. Martin believed the dentist's wife was a kleptomaniac and was certain she had stolen the artifact. H. T. Martin kept a careful watch on the dentist's wife for decades following the theft, and he felt confident he would eventually recover the artifact. When the dentist's wife died, H. T. Martin led a group from the University of Kansas in the fall of 1928 or the spring of 1929 to interview an heir of the dentist's wife, hoping that the artifact would appear in the inheritance. Unfortunately, the artifact remained missing. H. T. Martin, still confident he would eventually

recover the artifact, died suddenly and thus did not recover his most important scientific discovery. The search for the missing artifact was to continue. In 1980, the author learned that the possessions of the dentist and his wife had been donated to a local museum. A visit to the museum and a search of the projectile points in the museum's collection failed to yield the missing artifact. Academics have thus haunted the woman and her descendants for generations.

The loss of the artifact could only have had a detrimental effect on the credibility of the 12 Mile Creek site. Another factor that resulted in the failure of the 12 Mile Creek site to sway anthropological opinion to a belief in the contemporaneity of man and extinct animals in the New World, was the failure of S. W. Williston or H. T. Martin to properly analyze the site. Had the bones been carefully analyzed at the time of the site's discovery, the rather obvious butcher marks would have strongly supported the validity of the site. Virtually no attention was given to any of the bison remains but the large mounted bull, so that not even the minimum number of individual bison at the site was known to S. W. Williston and H. T. Martin.

The discovery of projectile points in association with long horned bison at the Folsom site near Folsom, New Mexico in 1926 has traditionally been viewed (Wormington 1957:23-25) as a discovery of great importance to American archaeological theory and for the first time firmly establishing the contemporaneity of man and extinct

animals in the New World. This belief is extraordinary, because the Folsom discovery was only the fourth of a series of remarkably similar discoveries of projectile points with long horned bison. The only surprising thing about the Folsom site was that researchers were amazed rather than bored at the discovery of another site showing the association of human artifacts with extinct animals.

The 12 Mile Creek site was discovered thirty-one years prior to the discovery of the Folsom site. The site was discovered by a non-professional and excavated by museum personnel from the University of Kansas. As previously discussed, a projectile point was recovered in association with long horned bison.

The Meserve site was excavated in 1923 (three years before the Folsom site) by F. G. Meserve who was in charge of the Department of Biology in Grand Island College. F. G. Meserve had been shown the site by laymen. A projectile point was found associated with long horned bison. The site was excavated again in 1931 by the Nebraska State Museum and another projectile point was found associated with long horned bison (Barbour and Schultz 1932).

The Lone Wolf Creek site in Texas was found in 1923 by a layman, and was excavated in 1924 (two years before the Folsom site) by Mr. H. D. Boyes of the Colorado Museum of Natural History. Three projectile points were found under a long horned bison. A hammer and chisel were necessary to remove the cemented matrix surrounding at least one of the points (Figginis 1927), which would make any argument

that the artifact had been introduced accidentally during the excavation rather absurd. Interestingly, one of the projectile points "disappeared" (the artifact was presumably stolen) like the 12 Mile Creek projectile point. Fortunately, two of the three projectile points from the Lone Wolf Creek site were retained.

The Folsom site was found by laymen in 1925 and was excavated in 1926 by personnel from the Colorado State Museum (Figgins 1927). Projectile points were found in association with long horned bison.

The details of these discoveries are remarkably similar. Laymen discover bones eroding from a bank and contact officials in a museum or institution of higher learning. Researchers with biological training excavate the bones and find one or more projectile points clearly associated with the remains of long horned bison. It is an interesting question why the 12 Mile Creek site, or the Meserve site, or the Lone Wolf Creek site did not become the key site establishing man's contemporaneity with extinct animals.

The Folsom site may have become so important to American archaeological thought, not because it was a unique discovery, but because J. D. Figgins was a superb salesman of intellectual ideas. Figgins, after his first season of excavation, failed to convince archaeologists that his discovery was valid. He worked on the site for a second season and left a projectile point in place in the matrix and had several interested scientists verify the discovery. Even this failed to convince many in the archaeological community. A

third season yielded more projectile points in association with long horned bison and numerous specialists arrived to view the evidence. The intellectual tide turned, and eventually a much greater antiquity for man in the New World became widely accepted (Wormington 1957).

The presence of fossil bones drew the investigators to the sites. This is probably the reason that biological scientists were the principal founders of paleo-Indian studies.

The 12 Mile Creek site, although having little influence on American archaeological thought, strongly effected paleontological thought. Henry Fairfield Osborn in The Age of Mammals in Europe, Asia and North America (1910:464,497), a very influential text in paleontology, recognized the 12 Mile Creek site as one of great importance and presented a description of the site and a drawing of the artifact. Because of the importance of paleontologists in the early research on paleo-Indian studies, the 12 Mile Creek site provided important evidence to those researchers needing it most.

4.4 CONCLUSIONS

In conclusion, the fluvial geomorphology of the Kansas River drainage has preserved a record of the early inhabitants of Kansas. The archaeological record reviewed for the Kansas River was in a disturbed context on river gravel bars. The archaeological record examined in the Smoky Hill River valley was sparse, with an important paleo-Indian archaeological site, the 12 Mile Creek site, buried in

Terrace Five.

CHAPTER FIVE

ARKANSAS DRAINAGE ARCHAEOLOGICAL DATA

5.1 INTRODUCTION

The bulk of the research for this dissertation was undertaken in the Arkansas River drainage. Archaeological sites are extremely numerous on the stream terraces in this area. Unfortunately, vertical exposures on these terraces, except for the floodplain are not common. There were few resources available to engage in excavation, consequently, the research was heavily weighted toward surface collections.

Much less effort was spent exploring the sandpits of the Wichita, Kansas vicinity. The sandpits will be discussed first, before proceeding to the archaeologically more substantial data from the stream terraces.

5.2 WICHITA SANDPIT LOCALITIES

The artifacts and fossils from the Wichita sandpits were not in situ. The faunal remains were extremely abundant, as was the case with the material from the gravel bars of the Kansas River, already discussed. Deposition at or below the water table no doubt influences the preservation of organic material. The excellent preser-

vation of organic material is the chief reason for studying these localities.

A wide sandy floodplain with a very shallow water table exists at the junction of the Arkansas and Little Arkansas Rivers in the vicinity of Wichita, Sedgwick County, Kansas. Sand removal from sandpits in this area has resulted in the discovery of Pleistocene fossils and several early projectile points. Sand is pumped from below the water table onto a screen that separates the economically unwanted coarse fraction from the valuable finer fraction of sediment. The discarded coarse fraction of sediment contains "mud balls," water rolled cobbles, fossil bones and human artifacts. The material discussed in this section comes from the coarse fraction of five sandpits. The projectile points recovered from two of these sandpits are important because evidence for early man in Kansas is sparse. The only published, buried paleo-Indian site found in the state is the 12 Mile Creek site. Additional information on the earliest inhabitants of the State of Kansas is needed.

A sandpit, operated by the Associated Material and Supply Company Incorporated, Sec. 23, T26S, R1W, yielded two Scottsbluff projectile points. One of these Scottsbluff projectile points (Figure 18A) had the base broken off. The flint appears to be from the Flint Hills and shows evidence of heat treatment. The artifact was parallel flaked on one side, but not on the other. The side that had not been parallel flaked had a "chalky" quality, suggesting that

it was nearer the chalky cortex of the flint nodule. This suggests that parallel flaking was related to the quality of flint being knapped. The tip of the artifact showed evidence of fracturing due to impact presumably while being used on a spear. The maximum width was 35 mm and the maximum thickness was 8.7 mm.

The second Scottsbluff projectile point (Figure 18B) was found a few feet away from the first in the same heap of discarded coarse fraction sediment. This artifact was almost completely enclosed by a "mud ball" (a chunk of silt and/or clay). The men who worked the sand pumping equipment at this pit and at others in the Wichita area claim that the "mud balls" are pumped from a depth of about thirty feet below the surface where the presence of clay and silt makes deeper pumping of sand difficult. The presence of clay and silt in the lower part of the section suggests a previous cycle of alluvial deposition before the inrush of sand. According to the workmen, most of the Pleistocene fossils were pumped from the clay and silt level. The inclusion of the artifact in a "mud ball" may be a good indication that the specimen came from deep in the sandpit and has considerable antiquity. The Scottsbluff projectile point had been extensively resharpened, greatly reducing its original length. The resharpening had obliterated any evidence of parallel flaking. The cutting edges of the artifact are beveled. The flint had been heat treated and is probably from the Flint Hills. This artifact (except for the resharpened area) is of the same general proportions as the

other Scottsbluff projectile point. The artifact has been so resharpened that it resembles a Cody knife, a cutting implement frequently found associated with Scottsbluff projectile points, and it may have actually functioned as a knife. The maximum length (resharpened) is 57.2 mm, the maximum width is 32.9 mm, the width at the base is 27.5 mm, and the maximum thickness is 8.4 mm.

The presence of two Scottsbluff projectile points closely associated in the same pile of discarded coarse sediment, suggests that a kill site or camp site had been destroyed by the sand pumping activity.

Scottsbluff projectile points in the Central Plains have been radiocarbon dated at several sites. The Lime Creek site in Nebraska produced a radiocarbon date of 9524 ± 450 years B.P. (Davis and Schultz 1952) at the base of a level containing the Scottsbluff type of projectile point. The Olsen-Chubbuck site in eastern Colorado produced a radiocarbon date of $10,150 \pm 500$ years B.P. (Wheat 1972) from a bison kill that contained Scottsbluff-like projectile points. Scottsbluff projectile points have been repeatedly discovered associated with the remains of Bison antiquus.

The sandpit produced a small fragment of a human skull cap. The pit also yielded the remains of Mammuthus, Mammut americanum, Equus, Bison antiquus, Bison bison and Cervus elaphus.

The Oatville sandpit at Sec. 11, T28S, R1W yielded a Holland projectile point (Figure 19). The artifact was made from Flint Hills

flint that was heat treated. The projectile point has several parallel thinning flakes knapped from both sides of the base, presumably to enhance the hafting of the artifact. The maximum length is 86.8 mm, the maximum width is 33.4 mm, the width at the base is 25.2 mm and the maximum thickness is 7.3 mm. A cache of projectile points found in Henry County, Iowa (Holland 1971) contained numerous Holland projectile points similar to the one found at the Oatville sandpit. Also in the cache was a Meserve or Dalton projectile point and a Scottsbluff-like projectile point, demonstrating the contemporaneity of these three projectile point types.

A human ulna, mineralized comparably to the Pleistocene fauna, was recovered from this pit. A bird bone exhibiting butchering marks, but not mineralized like the Pleistocene fauna, was also found. The bones of Mammuthus, Paramylodon harlani, Equus, Camelops, Bison bison and Odocoileus were recovered from this sandpit.

The Superior Sand Company pit at Sec. 3, T27S, R1W yielded the remains of Mammuthus, Camelops, Equus, Megalonyx jeffersoni, Bison antiquus and Bison bison. The Globe Construction Company sandpit at Sec. 2, T27S, R1W yielded the remains of Mammuthus. The Miles Sand Company sandpit at Sec. 19, T26S, R1E yielded the remains of Mammuthus, Camelops and Equus.

The presence of Camelops (camel) indicates the Wichita area was in the Camelops-Navahoceros faunal province of Martin and Neuner (1978) thought to be typified by open vegetation. This faunal

province contrasts with the Symbos-Cervalces faunal province in northeastern Kansas thought to be typified by spruce forest. Not one example of Symbos or Cervalces has yet been recovered from the Wichita sandpits, although neither are uncommon in the Kansas River gravels near Kansas City. There are many more mammoth (Mammuthus) remains in the Wichita sandpits than mastodon (Mammut americanum) remains, suggesting that mammoths were much more common in the Wichita area than were mastodons. In fact, only a single mastodon fossil was recovered. Mastodon remains are common in the Kansas River gravels near Kansas City.

The most abundant Pleistocene megafauna fossils from the Wichita sandpits are mammoth (Mammuthus) and horse (Equus) and it is reasonable to suggest that these two species were the dominant large animals in the area during the time period represented by the Pleistocene deposits in the sandpits. Sloth remains occur in both the Kansas River gravels near Kansas City and in the Wichita sandpits. It appears that Paramylodon harlani and Megalonyx jeffersoni were fairly common components of the late Pleistocene fauna in Kansas, and occupied both the Symbos-Cervalces and Camelops-Navahoceros faunal provinces. Typical Symbos-Cervalces fauna have been found as far west in Kansas as Topeka. Typical Camelops-Navahoceros fauna has been found as far east in Kansas as the Wichita sandpits. The east-west distance between these faunas is less than 150 km and the ecotone between these two ice age communities must have fallen

somewhere within that area. The marked faunal differences between the Wichita sandpit localities and those of the Kansas River near Kansas City suggest that this boundary was relatively sharp.

5.3 ALLUVIAL TERRACES AND ARCHAEOLOGICAL DATA

The alluvial terraces of the Arkansas River drainage are rich in archaeological sites. Surface collections were obtained from many sites by the author. These collections will be analyzed by reference to the alluvial terrace on which they lie. Some sites extend from a lower terrace to a higher terrace. The sites in such cases have been attributed to the lower terrace, unless there is some evidence (eg. a dichotomy of artifact types or a spacial break between different parts of the site) to suggest the site was occupied at different times, in which case the parts of the site are discussed under their relevant terrace category.

FLOODPLAIN ARCHAEOLOGICAL SITES.

A total of 21 archaeological sites on the Floodplain were surface collected. The archaeological data are described below.

14CF14.

This site is located 200 feet east of the Neosho River. The site is in a plowed field that is bordered on the west by forest. 14CF14 is approximately 400 feet northwest of 14CF51. The site is small, measuring approximately 100 by 50 feet. Two cord-marked sherds were found, one of which is shell tempered, indicating a

Middle Ceramic affiliation for the site (Wilmeth 1970). The debitage included a fragment of heat treated flint and a flake with cortex.

14CF19.

This small site is 500 feet north of Eagle Creek in a plowed field on the Floodplain. To the east of the site is forest and a small intermittent stream that is a tributary of Eagle Creek. The estimated size of the site is 50 by 50 feet. One bladelet (Figure 20C) with a prepared striking platform, and a thin flake with delicate edge retouch, were found. One flake showed evidence of heat treatment. Because no diagnostic artifacts were found, the affiliation of this site is unknown.

14CF21.

The site 14CF21 is located on the Floodplain next to a meander scar left by the Neosho River (Figure 21) in a plowed field. This site is 800 feet northeast of 14CF20 and on the same side of the meander scar. The Neosho River is one quarter mile north of 14CF21. The site covers an area approximately 100 by 30 feet.

Three cord marked pot sherds identify this site as Middle Ceramic. The sherds are similar to those described by Wilmeth (1970). One sherd was tempered with shell and had reddish concretions as inclusions.

Lithic artifacts included the tip of a biface and several retouched flakes. Debitage was abundant. Heat treated flint and a flake with cortex were also found.

14CF22.

This site is on a plowed field near a meander scar on the Floodplain of the Neosho River (Figure 22). The site is approximately 400 feet east of 14CF23 on the south bank of a meander scar.

The size of the site is approximately 50 by 25 feet. The evidence of human occupation consisted of an amorphous flake core and burned rocks. The cultural affinities of the site are unknown.

14CF23.

This small archaeological site is on the Floodplain of the Neosho River near a meander scar (Figure 22). The site is in a plowed field along the west bank of a meander scar.

The site yielded one badly eroded sherd, that was not sufficiently diagnostic to determine which of the Ceramic periods this site represents. The temper of the sherd could not be determined. The only other artifact was a delicately retouched flake. The two artifacts were approximately 30 feet apart.

14CF25.

This small site, approximately 100 by 25 feet, is located on the Floodplain of Eagle Creek. Forest and an intermittent stream lie to the west of the site. Eagle Creek is approximately 700 feet to the south. The site is in a plowed field. The only cultural materials found at this location were several flint chips. The cultural affiliation of the site is unknown.

14CF26.

The site 14CF26 is located in a plowed field 150 feet north of Eagle Creek. The site is approximately 100 by 10 feet in area and is located on the Floodplain. Forest and brush border the site to the south and west. The site is approximately 700 feet southeast of 14CF25. A core and several flint chips were found. The cultural affiliation of the site is unknown.

14CF27.

This small site is located in a plowed field 200 feet north of Eagle Creek. The site is located on the Floodplain (Figure 23). A north to south line of trees borders the western edge of the site, while forest and brush border the site to the south. The size of the site is 50 by 50 feet.

A small leaf-shaped projectile point (Figure 20B) was found indicating Middle Ceramic affinities for the site, and is similar to specimens illustrated by Perino (1971:9). The only other cultural material found at the site was a large flint flake.

14CF29.

This site is located in a plowed field on the Floodplain of the Neosho River near a meander scar (Figure 21). The site lies on the southern edge of the meander scar. The Neosho River is approximately one half mile north of the site. An abandoned railroad grade is 600 feet to the south. The site covered an area approximately 70 by 30 feet.

Several pieces of burned daub were found on the surface, possibly indicating the presence of a house (Witty 1973:2). The only stone tool discovered was part of a scraper, too fragmentary to illustrate. A small, unworked piece of limonite was found. The cultural affiliation of the site is unknown.

14CF30.

The site 14CF30 is located in a plowed field on the edge of a meander scar near the Neosho River. The site is 800 feet east of the Neosho River and on the south bank of the meander scar. 14CF51 is 700 feet to the northwest and on the opposite side of the meander scar. The size of the site is approximately 100 by 50 feet.

Three sherds were found, one of which was shell tempered, which identifies the site as Middle Ceramic and is similar to those described by Wilmeth (1970). The only lithic materials from the site were flint chips.

14CF32.

This site is on the Floodplain and adjacent to the brush covered north bank of Eagle Creek. The artifacts are from a plowed field. The site is located approximately 800 feet east southeast of 14CF19.

The only artifacts found on this site were the following: a plain surface, shell tempered sherd, and a retouched flake, found approximately 50 feet apart. The sherd identifies the site as Middle Ceramic, and is similar to sherds described by Wilmeth (1970).

14CF35.

This site has been frequently visited by amateur collectors. The cultural debris is scattered over an area approximately 300 by 200 feet. West Hickory Creek has been artificially diverted, and this site is on the Floodplain, next to the remnant of the natural channel. A mass of burned rock was eroding from near the top of the old channel bank. There was a small area of forest to the west of the site on the opposite side of the natural channel remnant.

The flint tools included an end scraper (Figure 24A) and two retouched flakes. A piece of heat treated flint was also found. The cultural affinity of this site is unknown.

14CF36.

This small site is located on the Floodplain of West Hickory Creek, and is approximately 100 by 50 feet in size. The site lies on the northern edge of a remnant channel of West Hickory Creek. 14CF35 is located 500 feet south of 14CF36 on the opposite side of the remnant channel. A wooded area extends to the east, north and west of the plowed field where 14CF36 is located.

A fragment of a small triangular projectile point (Figure 24B) suggests the site was occupied after A.D. 1000 (Wedel 1961:116). The only other tools found were a graver and a fragment of a scraper. The debitage included an example of heat treated flint.

14LY9.

This site is on both Terrace One and the Floodplain of Eagle Creek. The site is in a plowed field bordered on the north by Eagle Creek and on the south by Fourmile Creek. The size of the site is approximately 400 by 150 feet.

The lithic artifacts include an end scraper (Figure 25B), a fragment of a biface and a nodule of flint with several flakes removed. The cultural affinities of this site are not known.

14CF41.

This small site is in a plowed field on the Floodplain of Eagle Creek. Adjacent to the eastern portion of the site is an oxbow lake formed by a remnant channel of Eagle Creek. The size of the site is approximately 50 by 20 feet. The site yielded two edge retouched flakes. Several limestone rocks were scattered on the surface.

14LY12.

Most of this site is located on Terrace One, although a small portion of it extends onto the Floodplain of Eagle Creek. The site is 200 feet west of Eagle Creek. A small patch of forest is located northeast of the site. The size of the site is approximately 200 by 100 feet. A combination side and end scraper (Figure 26E) and an edge retouched flake were the only lithic tools found at this site.

14CF46.

This site is approximately 400 feet south of Otter Creek, on the Floodplain next to an old meander scar. The site is approximately 40

by 20 feet in size. One large biface (Figure 27A), one flake and several burned limestone rocks were found. The cultural affinity of the site is not known.

14CF47.

This site is located in a plowed field on the Floodplain of Otter Creek. The site is approximately 100 feet east of Otter Creek and the site is bordered on the west and south by trees. An intermittent stream spills into Otter Creek 200 feet south of the site. The size of the site is approximately 40 by 20 feet.

A small triangular point (Figure 27C) indicates the site is either Middle or Late Ceramic. Similar projectile points are illustrated by Bell (1960:45). One piece of flint showed evidence of heat treatment. A piece of burned bone (too fragmentary to be identified) was also found.

14CF49.

This site is situated in a plowed field next to a vertical bank cut on Lebo Creek; a wooded area lies to the northeast of this site. The Neosho River is approximately one third mile south of the site. The site occupies an area of approximately 250 by 40 feet. The bank cut made by Lebo Creek did not expose buried levels indicating the site was confined to the surface. Only flint chips were found.

14CF51.

This site is located north of a meander scar of the Neosho River in a plowed field. The Neosho River is approximately 400 feet west

of the site. The site is approximately 100 by 100 feet in size.

A Middle Ceramic occupation is indicated by 20 sherds similar to those described by Wilmeth (1970). Most of these sherds are cord marked and shell tempered. A small, side notched triangular projectile point (Figure 28B) is also Middle Ceramic. Burned daub suggest the presence of a house. Lithic artifacts included two undiagnostic pieces of small projectile points, a biface fragment, an end scraper made from a cobble, a combination "spokeshave" and denticulate (Figure 28D), and an amorphous flake core made from a flint cobble. Unworked limonite and small unidentifiable fragments of burned bone were also found.

14N027.

This site is positioned along the edge of the Neosho River on the Floodplain. The site was 500 by 15 feet in size. The river edge of the site had been scraped away to provide fill for a dike. There was a moderate scatter of flint chips in the plowed field. The artifacts consisted of an amorphous flake core and a scraper. The affinity of the site is not known.

COMMENTS.

All the surface sites with known cultural affinities were Middle Ceramic. However, an Early Ceramic occupation, 14N07 (Schmits 1973), is known to be deeply buried in the Floodplain. This suggests the possibility that the Early Ceramic population inhabited a floodplain

surface now buried within the fill of the present Floodplain.

TERRACE ONE ARCHAEOLOGICAL SITES.

A total of 52 archaeological sites on Terrace One were surface collected. The archaeological data are described below.

14CF336.

The site lies on the top and slope of Terrace One on Eagle Creek, next to a meander scar (Figure 23). The site extends about 400 feet to the east of the road and approximately 100 feet to the west of the road. The size of the site is 520 by 100 feet. Cultural remains are abundant and the material on the slope occurs in bands approximately parallel to the terrace top, suggesting that buried levels are eroding from the edge of the terrace. This interpretation is supported by fragments of breccia composed of cemented sand and flint chips discovered on the terrace slope, that appear to have been plowed out.

An earlier survey (Witty 1961) excavated a test trench on the east side of a gravel road running north and south between Section 25 and Section 30. This trench failed to reveal cultural material beneath the plow zone. It is possible the test trench did not go deep enough. Three Early Ceramic projectile points (Figure 29A, B and D) were found. Similar projectile points are illustrated by Perino (1968:24, 1971:100). A fourth projectile point (Figure 30C) is either Archaic or a crude example of Early Ceramic manufacture. The base of an Archaic projectile point similar to those illustrated

by Bell (1958:12) was also found (Figure 29F).

One cord marked body sherd with inclusions of rust colored concretions was located on the horizontal surface of the terrace. The sherd is Middle Ceramic and is similar to those described by Wilmeth (1970).

Other lithic artifacts included several biface fragments, several flake scrapers of which an example is illustrated (Figure 31A), a bladelet with a prepared platform (Figure 29G), an edge retouched blade (Figure 31B), a combination knife-scraper on a large blade (Figure 29E), a quartzite hammerstone and several amorphous flake cores made from flint nodules with a chalky cortex and from river cobbles. The cultural affiliations of the site are Early Ceramic, Middle Ceramic and Archaic.

14LY5.

This site is located on Terrace One on the west side of Plum Creek in a plowed field. A gully filled with trees and brush is north and west of the site. The area of the site is approximately 100 by 100 feet. No tools were discovered and only a few flint chips were found at the site.

14LY6.

This site is on the edge of Terrace One east of Plum Creek in a plowed field. Forest is found to the west, east and south of the site. A thousand feet northeast of the site is the north edge of the Neosho Valley. This site is located on the opposite side of Plum

Creek from 14LY5 and about 900 feet distant. 14LY6 is a small site which yielded only a gouge (Figure 31C) and a chipped cobble, 45 feet apart.

14CF15.

This site is in a plowed field adjacent to the west bank of a meander scar. Approximately one half mile west of the site is the Neosho River. The site is narrow and oriented parallel to the meander scar (Figure 22). The estimated size is 1100 feet by 80 feet, and it is located on Terrace One. Evidence for both Early Ceramic and Middle Ceramic occupations was found at this location. A total of 23 cord marked sherds tempered with indurated clay and shell were found at the site. They have Middle Ceramic affinities (Wilmeth 1970). The notched projectile point (Figure 31D) found at this site indicates an Early Ceramic occupation (Perino 1971:21). A fragment of burned daub found on the surface of the site suggests the former existence of a prehistoric house. The lithic assemblage includes biface fragments, large flakes with prominently retouched edges, three small flakes with delicately retouched edges, a flake of heat treated flint and a flake with cortex.

14CF16.

This site is on a badly eroded remnant of Terrace One near a meander scar (Figure 22) of the Neosho River. The site is in a plowed field approximately 400 feet north of 14CF15. The size of the site is estimated at 20 feet by 10 feet.

A fragment of a Scottsbluff projectile point, similar to those illustrated by Wormington (1957:226), identifies this site as belonging to the Archaic period. The tip and part of the base (Figure 20A) are broken. There is evidence of attempted parallel flaking along the edge of the artifact, but due to the poor quality of flint the flakes ended in "hinge fractures" after a short distance. Also found at the site were two flint chips, three fragments of burned rock and one piece of unworked hematite.

A single test pit, one meter square, was dug in 20 cm levels to a depth of 60 cm to determine if there was a buried cultural deposit. This excavation was made 650 feet south of the east-west road that runs through the center of Section 14 (R13E, T20S) and 20 feet west of the edge of the meander scar. The only evidence of human occupation found in the excavation was a tiny flint chip. The flint chip was in the plow zone and therefore its provenience had been disturbed. The site appears to be thoroughly disturbed by plowing. The only evident stratigraphy in the test pit was the plow zone which consisted of recent vegetable matter mixed with tan, sandy silt. Below the plow zone was tan, sandy silt.

14CF17.

Cultural debris is scattered over an area 250 by 50 feet on a remnant of Terrace One near a meander scar of the Neosho River (Figure 22). The site is in a plowed field on the northeast bank of the bend in the meander scar. 14CF22 is south of 14CF17 on the op-

posite bank of the meander scar.

Four cord marked sherds similar to those described by Wilmeth (1970) identify this site as Middle Ceramic. Fragments of two bifaces were found, but were fragmentary and not deemed worthy of illustration. One example of heat treated flint and a flake with cortex were found.

14CF20.

This interesting Archaic site was discovered on the edge of Terrace One near a meander scar of the Neosho River (Figure 21). The site is in a plowed field bordered on the west by a line of trees. To the east is a meander scar of the Neosho River. The size of the site is approximately 400 by 150 feet.

A Nebo Hill projectile point (Figure 20D) was found, identifying the site as Archaic. The specimen is similar to several projectile points recently excavated from the Nebo Hill type site near Kansas City by researchers from the University of Kansas. The only other tool discovered was an edge retouched flake made from heat treated flint. Flakes are abundant at this site.

14CF34.

This site is on Terrace One of the Neosho River. The site is on the southeastern edge of a meander scar, and lies parallel and adjacent to the meander scar (Figure 22). There is a small area of forest to the east of the site and the Neosho River is approximately one quarter mile south of the site. The size of the site is approx-

imately 100 by 50 feet.

A cord marked, shell tempered sherd was found indicating the site was middle ceramic, and is similar to sherds described by Wilmeth (1970). Two retouched flakes were also found. The remaining lithic material consisted of flint chips.

14CF33.

This site is in a plowed field on Terrace One of the Neosho River, 400 feet from a meander scar (Figure 22). The area of the site is approximately 100 by 50 feet. The site is oriented parallel to the meander scar. The site is on the east slope of a Terrace One, while the meander scar is on the west slope. Only flakes were found and the affinities of the site are unknown.

14LY8.

This site is in a plowed field on Terrace One of Eagle Creek. A tree line borders the southern edge of the site. Fourmile Creek is 600 feet southeast of the site and Eagle Creek is 1000 feet northeast of the site. The size of the site is approximately 100 by 50 feet.

One cord marked sherd with inclusions of rust colored concretions was found indicating the site has a Middle Ceramic affinity and is similar to sherds described by Wilmeth (1970). Other artifacts consisted of two amorphous flake cores.

14LY10.

This site is in a plowed field on Terrace One of Eagle Creek near an abandoned stream channel. The size of the site is approx-

imately 250 by 100 feet.

A small triangular, side notched projectile point (Figure 26C) indicates a Middle Ceramic occupation (Wedel 1961:116). A smaller leaf shaped projectile point (Figure 26D) was also found.

An older occupation is suggested by a badly broken base of a projectile point (Figure 24C) much larger than the other two projectile points found at the site. Other lithic tools included an end scraper (Figure 26A), a graver (Figure 26B), two broken bifaces (too fragmentary to illustrate), several edge retouched flakes, and a bladelet (Figure 26F).

14LY11.

This site is in a plowed field on Terrace One of Eagle Creek. Adjacent to the southeastern edge of the site is a pond and 100 feet to the northeast of the site is Eagle Creek. The size of the site is approximately 50 by 50 feet.

Four cord marked sherds identify this site as Middle Ceramic, and are similar to sherds described by Wilmeth (1970). The only lithic tools recovered were several edge retouched flakes.

14CF48.

This site is in a plowed field on Terrace One of Eagle Creek. An intermittent stream lies 700 feet east of the site. Eagle Creek is approximately one quarter mile south of the site.

The cultural debris covers an area approximately 250 by 50 feet, and is primarily confined to the slope of the terrace, where it ap-

pears to be eroding out in parallel bands suggesting the possibility of several buried levels. The base of a projectile point (Figure 32B) was found, suggesting the site was occupied during the Early Ceramic period (Perino 1971:38). Other lithic artifacts included an end scraper (Figure 28C), a biface made from a river cobble (Figure 28A), and the tip of a well made biface. The debitage included a flake with cortex.

14NO12.

This large Archaic site is located on the slope of Terrace One of the Neosho River (Figure 33). The site occupies an area approximately 1500 by 75 feet. Mr. O. D. Sperry of Chanute, Kansas has recovered hundreds of Archaic projectile points from this site that represent the entire span of the Archaic period. Virtually all artifacts recovered from this site were projectile points. The author has visited the site, and the overwhelming preponderance of artifacts are projectile points, and this is not just a sampling bias by the collector. This suggests a very specialized occupation occurring periodically over a very long time span. This may have been a hunting camp visited regularly over many thousands of years. The virtual absence of scrapers (hide working implements) suggests a lack of female activities in the hunting camp.

The oldest artifacts from this site in Mr. Sperry's collection are a Scottsbluff projectile point (Figure 34A) and a Hi-Lo projectile point (Figure 34B). These artifacts indicate the earliest oc-

cupation of the site occurred during the very early Holocene. There appears to be a stylistic gradation between a typical Scottsbluff projectile point (Figure 34A) and later Archaic projectile points (Figure 34C and D). This suggests the possibility that the Scottsbluff projectile point style was altered gradually through time to become part of lithic tradition that resulted in the later square based Archaic projectile points. The changes required for this to occur would be a loss of parallel flaking, a thickening of the artifact and a narrowing of the base relative to the width of the shoulders.

14N013.

This site is located on the slope of Terrace One of the Neosho River (Figure 33). The cultural debris extended over an area 300 by 50 feet. The only artifacts recovered were a flake scraper and an amorphous flake core.

14N014.

This site was located on the slope of Terrace One of the Neosho River (Figure 33). The area of the site was approximately 200 by 40 feet. An amorphous flake core and a notched flake were recovered.

14N015.

This site is on the slope of Terrace One (Figure 33) of the Neosho River. It covered an area approximately 150 by 30 feet. Three projectile points were recovered. Two were broken and unidentifiable. The third specimen (Figure 35A) was similar to projectile

points dating between 5000 to 3000 B.C. in Missouri (Chapman 1975:251). Three side scrapers and four edge retouched flakes were also found.

14NO16.

This site is on the slope of Terrace One (Figure 33) of the Neosho River. It covers an area 150 by 40 feet. A fragment of a projectile point (Figure 35B) similar to projectile points dating to the late Archaic in Missouri (Chapman 1975:246) was found on the site. The base of a drill and an edge retouched flake with a graver were also found.

14NO17.

This site is on the slope of Terrace One (Figure 33) of the Neosho River. The size of the site is approximately 150 by 40 feet. Two Archaic projectile points were recovered (Figure 35C, D). They are similar in shape but differ greatly in size. These are similar to projectile points dating to the early Holocene (Perino 1971:88). The smallest projectile point, because of its size, suggests the possibility that it may have been used on an arrow. Other artifacts included; an ovate biface, a crude irregularly shaped biface, two side scrapers, one edge retouched flake and an amorphous flake core.

14NO18.

This site is on the slope of Terrace One (Figure 33) of the Neosho River. The site covers an area of approximately 200 by 150 feet. The site yielded a projectile point (Figure 35E) similar to

Archaic projectile points described by Bell (1960:74). Two side scrapers, a badly broken fragment of a blade core, a proximal end of a large blade worked into multiple gravers, six fragmentary bifaces and a small, crudely made biface were also found.

14NO19.

This site was on the top and slope of Terrace One (Figure 33) of the Neosho River. The site covered an area approximately 150 by 70 feet. There were many burned stones, flint flakes and flint nodules. The only tool recovered was an uninformative fragment of a biface.

14NO20.

This site was on the slope of Terrace One (Figure 33) of the Neosho River. The site covered an area 100 feet by 50 feet. There were a few flint chips and flint chunks, but no tools.

14NO21.

This site is located on the slope of Terrace One of the Neosho River (Figure 33). The size of the site is 100 by 50 feet. One amorphous flake core made from a flint nodule, the tip of a biface, and a large edge retouched flake from a river cobble were recovered.

14NO22.

This site is on the slope of Terrace One of the Neosho River (Figure 33). The size of the site is 100 by 50 feet. There were few flakes, but many limestone rocks, some of which had been burned. No lithic tools were recovered.

14N023.

This site is on the slope of Terrace One of the Neosho River (Figure 33). The size of the site is approximately 75 by 30 feet. The site consisted of a thin scatter of flint chips and several small burned rocks. No tools were recovered.

14N024.

This site is on the slope of Terrace One of the Neosho River (Figure 33). The size of the site was 75 by 25 feet. The only cultural material at the site consisted of flint chips and burned rocks.

14N025.

This site is on the slope of Terrace One of the Neosho River (Figure 33). The site covers an area approximately 30 by 20 feet. A small, thick, crudely made biface of heat treated flint was recovered. Three small burned cobbles also indicated human occupation.

14N026.

This site is on the top and slope of Terrace One of the Neosho River (Figure 33). The site is approximately 300 by 150 feet in area. The site yielded 7 amorphous flake cores, and one blade core (Figure 35F). All the cores were made from quarried nodules and none were made from river cobbles. Two flakes with multiple gravers and five side scrapers were recovered. Five bifaces including the base of a lanceolate projectile point similar to Archaic projectile points described by Bell (1958:78), two uninformative biface fragments, one

rectangular biface fragment and one multiple graver on a biface were also found.

14NO28.

The Barker site is located on the top and slope of Terrace One of the Neosho River in the tall grass prairie region of southeastern Kansas. The site is north of Chanute, Kansas. A meander scar of the Neosho River lies northeast of the site on a dissected floodplain. The site covers an area approximately 400 by 150 feet. The artifacts from this site were recovered from the surface by Mr. William Barker who generously donated them to the University of Kansas.

The Barker site yielded numerous projectile points that could serve as index fossils. The early Archaic period was represented by five projectile points, including a Meserve or Dalton projectile point (Figure 37A), an Alberta projectile point (Figure 37B), a Scottsbluff projectile point (Figure 37C) and two Rice Lobed projectile points (Figure 37D, E). These projectile point styles date as early as seven or eight thousand years B.C. Alberta (Frison 1978), Meserve and Scottsbluff projectile points (Wormington 1957) have been found associated with early Holocene bison kills in the Central Plains. Rice Lobed projectile points are estimated by Chapman (1975:254) to range in age from 7500-5000 B.C.

Archaeological data from the early Holocene is quite rare in Kansas. Some of the projectile points from the Barker site are similar to those found in sites in Nebraska (the Scottsbluff and Al-

berta projectile points), and some are similar to projectile points found in early Holocene sites in Missouri (the Rice Lobed projectile points). The Meserve or Dalton projectile point is a style found in both Nebraska and Missouri. The projectile point styles suggest early Holocene cultural influences from the fringe of the eastern woodlands in Missouri were overlapped in the tall grass prairie region of Kansas with the High Plains cultural influences represented by the projectile point styles of some Nebraska sites.

The middle Archaic period lasted from approximately 5000 to 3000 B.C. (Chapman 1975). Horizons III-5, III-7 and III-8 of the Coffey site in northern Kansas provide significant information about the last few centuries of the middle Archaic (Schmits 1976), but for most of the rest of the middle Archaic in Kansas, almost nothing is known. The Barker site yielded 17 middle Archaic projectile points. Nine of these projectile points (Figure 37F, G, H, I, J, K, L, M, N) are similar to those found at the Logan Creek site in northeastern Nebraska. A radiocarbon date of 6633 ± 300 years B.P. was obtained from the second highest of four occupation levels at the Logan Creek site (Kivett 1959). The Barker site also contained a Big Sandy Notched projectile point which had been reworked into a scraper (Figure 37O). Big Sandy Notched projectile points primarily date from 5000 to 3000 B.C. in central and southwestern Missouri (Chapman 1975:242). Seven other projectile points (Figure 37P, Q, R, S, T, U, V) resemble specimens dating to the last part of the middle Archaic

at the Coffey Site (Schmits 1976).

The late Archaic of Kansas is much better known than either the early or middle Archaic. Several archaeological sites dating from this period have been excavated in Kansas. The Barker site has yielded seven projectile points assignable to the late Archaic. Six of these projectile points (Figure 37W, X, Y, Z and Figure 38A, B) are similar to the late Archaic projectile points from Zone D of the Snyder site (Grosser 1971). The remaining projectile point (Figure 38C) is somewhat similar to Pontchartrain projectile points dating to the late Archaic in the lower Mississippi valley (Perino 1968:70).

Two projectile points from the Barker site could date to either the late Archaic or Early Ceramic. These projectile points are a Gary Stemmed projectile point (Figure 38D) and a Castroville projectile point (Figure 38E).

Projectile points from the Barker site likely to be restricted in Kansas to the Early Ceramic period include four contracting stem projectile points (Figure 38F, G, H, I), a type that appears in the Butler phase at the Snyder site but not in the late Archaic levels (Grosser 1971) and nine (Figure 38J, K, L, M, N, O, P, Q, R) Steuben Expanded Stem projectile points (Chapman 1980:313).

A Scallorn Corner Notched projectile point (Figure 38S) was found at the Barker site. It could date either to the Early or Middle Ceramic period (Chapman 1980:312). A Reed Side Notched projectile point (Figure 38T) from the Barker site dates to the

Middle Ceramic period (Chapman 1980:311). Two Fresno projectile points were discovered at the Barker site (one example is illustrated in Figure 38U), and they date to either the middle or late Ceramic (Bell 1960:44).

The projectile points at the Barker site indicate a long span of occupation. The diagnostic artifacts suggest the site's location was desirable as a campsite for almost all of the Holocene.

A narrow range of lithic artifact categories is represented at the Barker site. This suggests a correspondingly narrow range of economic activities, although sampling error cannot be ruled out. The artifacts consist of 49 projectile points (35%), 2 drills (1%), 48 other bifaces (34%), 30 flake cores (21%), 9 scrapers (6%), and 4 manos (3%). The projectile points are most likely a function of hunting activity, the bifaces probably relate to butchering, the drills and cores relate to tool manufacture, the scrapers were primarily used for scraping hides, and the manos were probably used for grinding seeds. The high percentages of projectile points and bifaces suggest the Barker site served primarily as a hunting camp.

The historically documented Osage Indians resided in Missouri but sent out seasonal hunting parties into eastern Kansas to obtain bison. The Barker site may indicate that a pattern of hunting parties entering from outside the region may have occurred during most of the Holocene. The low percentage of scrapers may indicate a situation analogous to the Osages that frequently did not finish

processing hides at the hunting camp, but waited until they returned to their main camp (Mathews 1961:457). The large number of flint cores may indicate that the occupants of the Barker site knapped flint tools from the abundant local flint resources when they were not preoccupied by the hunt.

Dating of the projectile point styles suggests the Barker site was a desirable location for hunters to camp during the entire Holocene. The occupation of the site took place during a period of climatic change thought to have dramatic impact on the life styles of the Great Plains inhabitants during the Holocene. The Altithermal episode (approximately 7500 to 4000 B.P.) was proposed by Ernst Antevs (1955) and was thought to be a period of high temperature and drought. Pollen from northeastern Kansas (Gruger 1973) suggests the occurrence of rather treeless grassland (Zone 4b) during part of the Altithermal episode, probably indicating drier conditions than at present in the Central Plains. Wedel (1964) has suggested the conditions of the Altithermal episode had drastic consequences for the inhabitants of the Plains, forcing the evacuation of the short grass prairie.

The middle Archaic projectile points found at the Barker site, indicate occupation during the time of the Altithermal. The recovered lithic technology suggests the site served primarily as a hunting camp throughout the Holocene, including the Altithermal episode. There is no evidence from the surface collection to in-

dicade either a hiatus of occupation or radically different subsistence adaptation during the Altithermal. The continuity of habitation at the Barker site cannot be matched by any reported site in the short grass prairie region of Kansas. This may be due to the fact that relatively few sites have been examined in the short grass prairie region of Kansas. It might also be due to a different pattern of occupation of the short grass prairie of Kansas (perhaps interrupted by drought) when compared to some tall grass prairie sites such as the Barker Site. Further research is needed.

The non projectile point bifaces from the Barker Site included; 27 undiagnostic biface fragments, 4 medium sized triangular bifaces, 2 rectangular bifaces, 15 ovate bifaces and 2 drills. One side scraper on a flake and 8 end scrapers (6 on flakes, 1 on a large tabloid and 1 on a cobble) were recovered. The 30 cores from this site included; 18 amorphous flake cores, and 12 discoidal flake cores. Three of the manos recovered, were approximately rectangular in shape, while the fourth mano was circular.

14AN12.

This site is located on the top and slope of Terrace One of the Neosho River. Meander scars adjacent to the site have dissected the floodplain. The size of the site is 600 by 200 feet, and cultural debris is abundant.

The lithic industry recovered from the site was clearly dominated by bifaces. Sixteen bifaces were recovered, including five

projectile points. One projectile point (Figure 36A) was similar to specimens dating between 1000 and 3000 B.C. in Missouri (Chapman 1975:257-258). A projectile point reworked into a scraper (Figure 36B) is similar to specimens from Missouri dating between 5000 to 500 B.C. (Chapman 1975:242). An anterior fragment of a projectile point with beveled edges (Figure 36C) is similar to specimens from Missouri dating between 7500 to 5000 B.C. (Chapman 1975:254). The badly broken base of an Osceola projectile point dating to the Archaic period (Bell 1958:68) was found. Another projectile point (Figure 36D), dating between 5000 to 3000 B.C. in Missouri (Chapman 1975:250-251), was recovered. The projectile point styles suggest the site was occupied during the earlier and middle part of the Archaic. Three thick, ovate bifaces and eight undiagnostic biface fragments were recovered. A large end scraper on a cobble, an edge retouched flake, two amorphous flake cores and two ground stone manos were also found.

14LY13.

This site lies on the slope of Terrace One of the Neosho River. The size of the site is 70 by 20 feet. The only artifact recovered was a scraper. There was very little debitage.

14LY14.

This site is located on the slope and top of Terrace One of the Cottonwood River. The site occupied an area 350 feet by 200 feet. The lithic tools from this site were dominated by bifaces. Two

projectile points were recovered including a broken notched specimen with basal grinding similar to early Archaic projectile points from Missouri (Chapman 1975:254-255) and the badly broken base of a contracting stem projectile point that could date either to the Archaic or Early Ceramic period. Other bifaces included a fragment of a large drill with a square base, a curved biface resembling what has been referred to as a "Munker's Creek knife," a fragment of a large rectangular biface, and three uninformative biface fragments. Also found were one end scraper, one side scraper, two edge retouched flakes, and seven amorphous flake cores.

14LY15.

This site was located on the slope of Terrace One of the Neosho River. The site covered an area 100 by 40 feet. The cultural occupation was indicated by a scatter of chips and several small burned cobbles. No lithic tools were recovered.

14LY16.

This site was on the slope of Terrace One of the Neosho River. It occupied an area 50 by 40 feet. The cultural material consisted of a few flint chips.

14LY17.

This site was located on the slope of Terrace One of the Neosho River. The size of the site was 200 by 75 feet. The tip of a biface and a thick, oblong biface were the only tools recovered from the site.

14LY18.

This site is on the slope of Terrace One of the Cottonwood River. The scatter of flint chips and burned rocks indicated the site covered an area 150 by 75 feet. Clam shells and unidentified fragments of bone were found scattered on the surface. Two artifacts were recovered, including the base of a lanceolate projectile point similar to projectile points recovered from Archaic contexts in Missouri (Chapman 1975:251), and an uninformative biface fragment.

14LY19.

This site lies on the slope of Terrace One of the Cottonwood River. The size of the site is 120 by 40 feet. The evidence of occupation consisted of flint chips and a few burned cobbles.

14LY20.

This site is on the slope of Terrace One of the Cottonwood River. The site occupies an area of 400 by 70 feet. Two projectile points were recovered including a shouldered specimen with beveled edges and a concave base that resembles Archaic projectile points from Missouri (Chapman 1975:250-251) and a shouldered projectile point that was too fragmentary to identify. Other bifacial tools included a rectangular biface and two uninformative biface fragments. Two end scrapers, two edge retouched flakes and three amorphous flake cores were recovered.

14CS7.

This site lies on the top of Terrace One of the Cottonwood River. The size of the site is 500 by 200 feet. A possible bone artifact made from the base of the selene of the upper molar of a bovid (cf. Bison) was recovered. A projection of dentin had been stained black by a carbonaceous substance and was highly polished. Twenty-nine lithic implements were found at the site. The cores included six amorphous flake cores, two flake cores made on elongate tabular pieces of flint, and two blade cores made on irregularly shaped pieces of flint. Seven bifaces were recovered including a plano-convex "Clear Fork gouge," a large quadrangular biface, two irregularly shaped bifaces, and three uninformative biface fragments. A laterally retouched distal fragment of a blade was found. Three notched tools, two on tabloids of flint, and one on a flake were recovered, as well as two side scrapers, and six edge retouched flakes.

14CS8.

This site lies on the top of Terrace One of the Cottonwood River. The site is approximately 150 by 100 feet in area. Four bifaces were recovered including a side notched projectile point reworked into a scraper that was similar to late Archaic projectile points recovered from the southern Plains (Bell 1958:96), a fragment of a large shouldered projectile point and two fragments of rectangular bifaces. An end and side scraper and an end scraper, both

on tabloids, an end scraper on a flake, two edge retouched flakes and an amorphous flake core were also found.

14CS9.

This site was on the top and slope of Terrace One of the Cottonwood River. Flint chips were scattered over an area 60 by 20 feet. The only tool recovered was a fragment of a narrow beveled biface.

14CS10.

This small site was on the uppermost slope of Terrace One of the Cottonwood River. A few flint chips and many clam shells and burned rocks indicated the site covered an area approximately 40 by 20 feet. No lithic tools were recovered.

14CS11.

This site is located on the slope of Terrace One on the Cottonwood River. The site covers an area approximately 150 by 40 feet. Four artifacts were recovered, including an end scraper, a notched flake, a fragment of a large biface and an amorphous flake core.

14CS12.

This site lies on Terrace One of the Cottonwood River next to an old meander scar that has filled to the level of the Floodplain. The site covered an area approximately 80 by 40 feet. A pot sherd with a smooth exterior surface and with shell temper indicates a Ceramic (probably Middle Ceramic) period occupation. The lithic tools consisted of a fragment of an ovate biface, a graver on a flake, and two amorphous flake cores.

14CS16.

This site is on Terrace One and the slope of Terrace Two. The contrast in lithic artifacts is dramatic between these two terraces. The material from the Terrace One portion of the site (covering an area approximately 30 by 10 feet) will be discussed in this section, the material from Terrace Two will be described in the section, TERRACE TWO ARCHAEOLOGICAL SITES.

The lithic tools from Terrace One of this site were dominated by bifaces which made up 26 out of 28 artifacts recovered. Seven projectile points were found, including the base of a medium sized, side notched specimen (Figure 39C) with a concave base similar to projectile points dating from 5000 to 500 B.C. in Missouri (Chapman 1975:242), the base of a square stemmed specimen (Figure 39B) similar to projectile points dating from 5000 to 1000 B.C. in Missouri (Chapman 1975:257), a Carrollton projectile point (Figure 39A) resembling material from the last part of the middle Archaic at the Coffey Site (Schmits 1976), and a Logan Creek projectile point (Figure 39D) similar to projectile points dating to the middle Archaic in Nebraska (Kivett 1959). Three undiagnostic projectile point fragments were also found. Five undiagnostic bifacial fragments, 3 rectangular biface fragments, 10 ovate bifaces and one fragmentary constricted biface (Figure 39F) which may have functioned as an axe were recovered. The only unifacial tools were a side scraper and an end scraper on a crested blade with lateral edge retouch (Figure 39E).

14CS17.

This site is on Terrace One of the Cottonwood River. The lithic debris is concentrated in an erosional channel cutting through Terrace One. The site covers an area 2200 by 200 feet. Seven bifaces were recovered from the site including a notched projectile point (Figure 36E) with beveled edges resembling late Archaic specimens from the Southern Mississippi Valley (Perino 1971:32), and an undiagnostic projectile point fragment. Four rectangular bifaces (3 of which were fragmentary) and an uninformative biface fragment were also found. Other lithic tools recovered included 6 end scrapers, 1 notched flake, 1 conical blade core, 1 discoidal flake core, 3 amorphous flake cores and 1 mano.

14CS18.

This site was on the edge of Terrace One of the Cottonwood River. The site covered an area 50 by 20 feet. The lithic artifacts consisted of six notched tools. Four of these notched tools were made on flakes and two were made on tabloids. This unusual site probably represents a very specialized activity area.

14MN24.

This site is located on the slope and top of Terrace One and extends a short distance onto the slope of Terrace Three of the North Cottonwood River. It is probable the site dates to the time of Terrace One or later, and that its extension on to Terrace Three was during the Holocene. The cultural debris consisted of flakes and

chunks of flint scattered over an area 190 by 30 feet. One edge retouched flake was recovered.

14MN25.

This site is located on top of Terrace One and extends onto the lower slope of Terrace Three on the North Cottonwood River. As in the case of 14MN24, this site probably does not predate Terrace One. The cultural material covered an area approximately 150 by 30 feet. Three bifaces were recovered, including a projectile point with a square base similar to late Archaic specimens recovered from the Lower Mississippi Valley (Perino 1968:70), an undiagnostic biface fragment, and a bifacially worked notched tool. Two tabular blade cores (Figure 49A, B), a blade with multiple notches and end retouch (Figure 49C), and an end scraper were also recovered.

14MN26.

The site 14MN26 lies on the top of Terrace One and the slope of Terrace Three of the North Cottonwood River. There are three distinct scatters of cultural debris. The lower cultural area, which will be discussed here as a Terrace One site, lies on top of Terrace One and extends on to the lower part of the Terrace Three slope. The other two cultural areas lay entirely on Terrace Three deposits and will be discussed in the section on Terrace Three sites.

The lowest cultural scatter covered an area approximately 250 by 180 feet. Three bifaces were recovered, including a fragmentary triangular projectile point probably dating to the Middle Ceramic

period (Chapman 1980:310), and two undiagnostic biface fragments. Two end scrapers were also found.

14MN34.

The Leppke Site (14MN34) is located in the Flint Hills region of central Kansas near the town of Peabody. The site is on the surface of Terrace One of Doyle Creek. Mr. Archie Leppke of Hillsboro, Kansas discovered the site and collected the artifacts described from this site.

There is little diversity in the types of tools present at this locality. Ten projectile points and one knife were found at the site. There was a lack of other stone tools such as scrapers and cores. There was also a lack of flint chips. Flint chips are usually common in sites in this area, which has abundant local flint resources. The artifacts were collected from the surface of a small area only 45 by 45 feet square, in a plowed field.

Reconstructing human behavior from archaeological data is somewhat speculative, but it is an important part of archaeology. An archaeological site with a concentration of projectile points in such a small area with no other tools except for a knife could represent a cache, or an area of game concentration where hunting took place.

Occasionally, a cache of projectile points may be found (Holland 1971) with little other evidence of occupation. Such caches of projectile points may represent artifacts being traded in bulk that were somehow misplaced. The artifacts from the Leppke Site do not

appear to be a cache because of the pattern of breakage of the artifacts. Six of the ten projectile points had broken tips and several of them were broken badly enough to make resharpening an unlikely possibility. It is improbable that anyone would have assembled a cache of badly broken projectile points.

A more reasonable explanation is that intense hunting activity took place in a confined area. Most of the projectile points had their tips broken which probably resulted from being hurled against a resistant object during hunting activity. Artifacts of the antiquity of the specimens from the Leppke Site are not found on the present floodplain. This suggests Terrace One on which the site lies was a floodplain when the site was occupied. The conduit which drains a spring into Doyle Creek is in close proximity to the archaeological site. The conduit is presently several meters deep, but when Terrace One was the active floodplain, the conduit would have been much shallower and the area of the site would have been less well drained than at present. This would likely have resulted in boggy conditions in the vicinity of the site. Boggy conditions would have created a situation where processing of killed animals would have been kept to a minimum, explaining why little more than projectile points were found at the site. The boggy ground would have been ideal for a bison wallow.

Bison herds gathered at wallows and the members of the herds would lie on their sides in the mud (Catlin 1926:281-282). While

bison used the wallow, they would be extremely vulnerable to human hunters. The artifacts found at the Leppke Site are consistent with an interpretation of hunting activity at a bison wallow.

Northeast of the site, bison bones that were not articulated were observed eroding from the Terrace One fill in the banks of the conduit that empties the local spring into Doyle Creek, demonstrating that bison frequented the immediate vicinity of the site. Several bones were removed and were found to be comparable to Bison bison bones at the University of Kansas Museum of Natural History. The bones were buried less than a meter in depth. No evidence of human activity in association with the bones was observed.

The projectile points are similar to those known from early Archaic sites dating to the early Holocene. A Meserve or Dalton projectile point with beveled anterior edges (Figure 40A) was discovered at the site. Meserve or Dalton projectile points have been found in the lower levels of Graham Cave in Missouri where radiocarbon dates of 9700 ± 500 B.P. and 8830 ± 500 B.P. (Crane 1956) were obtained. Five St. Charles Notched projectile points (Figure 40C, D, E, F, G) and three other projectile point forms (Figure 40H, I, J) from the Leppke Site are similar to early Archaic specimens from the Dalton site in Missouri (Chapman 1975:137). One projectile point (Figure 40K) has unknown affinities.

A single shouldered knife (Figure 40B) was the only non projectile point artifact recovered from the site. The outline of the

implement is similar to Cody knives found in numerous early Holocene archaeological sites in the High Plains. The artifact differs from a Cody knife (which typically has very fine flaking) by being rather crudely chipped on a flake which is largely unifacially worked. The early Holocene projectile points of the High Plains were usually much better made than the early Archaic projectile points to the east. The knife at the Leppke Site may represent a crude eastern form of the Cody knife.

The Leppke Site is important because our knowledge of the early Archaic in Kansas is based on very limited data. The artifacts from this site suggest a closer relationship with early Holocene sites in Missouri (such as the Dalton Site) than early Holocene sites in the High Plains.

TERRACE TWO ARCHAEOLOGICAL SITES.

A total of 11 archaeological sites were collected from Terrace Two. The archaeological data are described below.

14CF45.

This site is located in a plowed field on Terrace Two of Eagle Creek, approximately 500 feet north of a meander scar (Figure 23). Cultural debris is scattered over the top and slope of the terrace. The approximate size of the site is 300 by 100 feet. A pond is located approximately 500 feet west of the site.

Three square, broken bases of projectile points (Figure 24D, E and F) were found indicating an Archaic affinity for the site (Perino

1968:45). Other lithic artifacts include a gouge (Figure 27B), a notched tool (Figure 27A), several amorphous flake cores and part of a biface too fragmentary to be worth illustrating.

14CF319.

This site was first reported by Witty (1961) during a survey of the John Redmond Reservoir. The site extends for 1320 feet along the east bank of Hickory Creek. The northern portion of the site is in a plowed field. The site is just north of the Hickory Creek East Recreation Area. The site appears to be on Terrace Two but the reservoir has backed up against it, making identification of the terrace difficult, although it is definitely higher than Terrace One.

A projectile point (Figure 41A) that is possibly Early Ceramic (Chapman 1980:313) was found, but no pottery. Four other bifaces were recovered including: 2 rectangular biface fragments, 1 small asymmetrical triangular biface and 1 bifacially worked flake. Six end scrapers were recovered including: 2 spurred end scrapers (an example is illustrated in Figure 41C), 2 long end scrapers (an example is illustrated in Figure 41B), and 2 crudely made end scrapers. Other tools recovered included: 1 medial fragment of an edge retouched blade, 2 graters on flakes, 1 edge retouched flake and 2 amorphous flake cores.

The spurred end scrapers suggest a paleo-Indian occupation while the projectile point suggests an Early Ceramic occupation. The site is probably multicomponent.

Extensive erosion, largely due to the fluctuating levels of the reservoir, has damaged the site, particularly the northern end. This erosion has exposed burned rock and flint chips for approximately 150 feet along the bank in the northern portion of the site. The burned rock and flint chips appear to be coming from approximately 25 cm below the surface. This part of the site is covered with trees and shows no evidence of being disturbed by plowing.

14CF335.

This site was first reported during a John Redmond Reservoir survey (Witty 1961). Test pits were excavated during that survey and one undescribed sherd was found at a depth of .7 feet. Several other sherds and the base of a contracting stem projectile point were found on the surface of the site during that survey (Witty 1961).

The site, located on Terrace Two (Figure 42), covers an area approximately 262 by 184 feet. The site consists of two distinct areas (Figure 43): 1) a plowed area on the north and west portion of the slope of Terrace Two; and 2) an undisturbed forested area on the south and east portion of the slope of Terrace Two. Cultural material was found on the surface of the plowed area. Vegetation and organic debris prevented the sighting of artifacts on the surface of the forested area.

The author's interest in the site was stimulated by Mr. Larry Truelove, a local collector, who found three fluted projectile points (Figure 44A, B and C) on the site. These projectile points were

found in the central area of the site (the area depicted in Figure 43 in the excavation squares outside the forested area). One of the projectile points was of the Folsom type (Figure 44A) made from Alibates flint. This artifact should date between approximately 8000 and 9000 years B.C. (Wormington 1957:39). The other two fluted projectile points do not readily fit into accepted classifications. One specimen (Figure 44B) resembles a Clovis projectile point (ca. 9000 to 9500 B.C.) (Haynes 1971:5). It differs from most Clovis projectile points in being more finely chipped and wider across the midsection in proportion to its width across the base. It somewhat resembles a Browns Valley projectile point in outline, but is much narrower. The third fluted projectile point (Figure 44C) has a constricted waist like some fluted projectile points from the Eastern United States. This artifact appears to have been resharpened from a longer projectile point that was broken. Before this occurred it probably resembled a fluted projectile point (Figure 30D) found on a bluff just south of the John Redmond Reservoir area by Mr. Henry Thomsen.

During the author's survey of the site, two other projectile points were collected from the surface. One was an Archaic projectile point (Figure 30A) fashioned from heat treated flint. It was picked up near the summit of Terrace Two. The other was an Early Ceramic projectile point (Figure 30C) found on the south surface of the slope of Terrace Two near the tree line. During the initial sur-

vey the plowed area also yielded four cord marked sherds. One of the sherds had inclusions of rust colored concretions. The sherds appear to be Middle Ceramic in age (Wilmeth 1970). Other tools recovered from the surface of the plowed portion of the site include a chisel-like tool (Figure 45A), a blade core (Figure 46B), a small blade with a very small striking platform (Figure 46D), several flake cores made from river cobbles (an example is illustrated in Figure 47A), several scrapers including two side scrapers (Figure 48C and D), an end scraper (Figure 48B), a combination knife-scraper (Figure 41D) and a narrow beveled biface (Figure 48A). All of these artifacts were disturbed by plowing.

The time range of artifacts found on the surface of the site and in particular the evidence of possible paleo-Indian occupation, indicated that the site might provide valuable archaeological information if excavated. Three hypotheses, formulated to explain the distribution and variety of artifacts found on the surface of the site, influenced the excavation procedure.

Hypothesis 1

There were no buried layers of cultural debris in Terrace Two. Whatever layers might once have existed were exposed by flooding or other forms of erosion, and disturbed by plowing. A mixture of artifacts would be found within the plow zone on the slope of Terrace Two. The weathering and plowing would have disturbed the cultural proveniences and made interpretation of the distribution of ar-

chaeological data difficult or impossible.

Hypothesis 2

Early cultural layers buried within the alluvial deposits of Terrace Two might be eroding out at various points along the slope of the terrace. Later cultural material could have been deposited on the surface. This would cause the apparent mixture of early and late cultural material along the surface of the site. Deep excavation of the site might expose the buried cultural layers containing early, possibly paleo-Indian, cultural material. The surface zone would show a mixture of artifacts of different cultural periods.

Hypothesis 3

A layer of humus built up after the alluvial deposits of Terrace Two were deposited and this humus layer contained all the cultural deposits. This hypothesized layer could have been disturbed by plowing and related erosion, so that no distinct cultural layers would be found in the plowed portion of the site. Excavation in the undisturbed forested portion of the site might reveal the undisturbed cultural deposits.

The site was tested by a series of square excavation units measuring two meters on a side. Each square was excavated in 10 cm levels, and each buried artifact was plotted by three dimensional coordinates. The three dimensional coordinates are referable to a datum point located northwest of the site on a berm. Screens with a quarter inch mesh were used to sift the dirt as it was excavated.

The layout of the excavation units is illustrated in Figure 43.

The excavation of the plowed area comprising the northern and western portions of the site will be discussed first. A total of eight test pits were excavated in the plowed area, six of these in the area identified by Mr. Truelove as having yielded paleo-Indian projectile points. The other two test pits were excavated near the forest edge where disturbance due to plowing would have been minimal (farmers avoid planting close to stands of trees or hedge rows since crops suffer from the competition for light and water in those areas). The excavation revealed two stratigraphic zones in the test pits. The upper zone (plow zone) was 20 to 25 cm thick and consisted of dark organic material mixed with yellow alluvium. The second and lower stratigraphic zone consisted solely of yellow alluvium. The test pits were excavated to a depth of 80 cm. No buried tools or buried cultural levels were found. Some flint chips were found in the plow zone. No trace of human activity was found below the plow zone in the undisturbed yellow alluvial deposit. Since it was possible that a paleo-Indian cultural level might be buried at a depth greater than the 80 cm exposed by the test pits, deeper excavation was undertaken. In order to make the most efficient use of the time available and to hold down the expense involved in hand labor, it was decided to employ a backhoe to excavate deeper. The excavation crew was moved to the forested area of the site to conduct hand excavations in undisturbed deposits. The backhoe was used to dig

trenches to a depth of 7 feet in the plowed portion of the site. These trenches are depicted in Figure 43. No evidence of deeply buried occupation levels was found and Hypothesis 2 was rejected. The yellow alluvium was stratigraphically undifferentiated and because artifacts were not found buried in it, profiles of the trenches were not made.

Seven test pits were excavated in the forested portion of the site. The layout of these test pits in relation to the other excavated areas of the site can be seen in Figure 43. Excavation of the test pits in the forested portion of the site revealed a dark soil that began at the surface and extended to a depth of approximately 60 cm. The 60 cm depth of the dark soil layer was consistent as it followed the slope of Terrace Two. This dark soil appears to be due to the accumulation of humus, rather than the weathering of the underlying alluvium because it lacks the concentration of water rolled cobbles that typifies the alluvial deposit elsewhere. Unfortunately, the dark soil layer did not contain an evident natural stratigraphy. All the artifacts recovered from the test pits came from this soil layer and consequently cannot be sorted into separate stratigraphic units. Additionally, the depth measurements of artifacts from different test pits cannot be used to establish the chronological sequence of artifacts since humus may not accumulate in a regular way on the slope of a terrace, i.e., artifacts found at identical depths in different test pits may not necessarily belong to

the same occupation period since the amount of humus accumulating per unit of space may have been irregular through time.

The test pits in the forested portion of the site produced several artifacts, but no features. A small projectile point (Figure 30B), probably dating from the Late Ceramic period, was found at a depth of 27 cm below the surface. Five sherds were found. Four of the sherds were cord marked and had rust colored concretion inclusions. These sherds appear to belong to the Middle Ceramic period (Wilmeth 1970) and were found between 23 and 39.5 cm beneath the surface. A fifth sherd was thicker than the others. It also had inclusions of tiny rust colored concretions, but its cultural affinities are unknown. It was found 25 cm beneath the surface. Other artifacts found near the surface in the forested portion of the site include the following: 1 bladelet core (Figure 46A), 2 flake scrapers with beveled edges (Figure 47C is an example), and 1 small bifacially flaked end scraper (Figure 47B). A fragment of a biface (Figure 41E) was uncovered at a depth of 57 cm. It was the most deeply buried tool found at this site.

The three chisel-like tools found at the site (2 from the surface of the plowed portion of the site and 1 from the forested portion) were examined under a binocular microscope. Traces of wear were found on the chisel-like edges of the implements. One of the specimens (Figure 45C) found in the wooded area was on the end of an edge retouched blade.

The excavations in the forested portion of the site revealed no buried levels of cultural occupation in the alluvium providing further evidence for the rejection of Hypothesis 2. The third hypothesis would gain support from the nature of the soil layers found in the forested portion of the site; however, the undiagnostic nature of many of the artifacts recovered (cores, scrapers, bifaces, flint chips) and the difficulty of determining stratigraphic position in humus deposits, does not provide sufficient evidence for a stratigraphic separation of periods of cultural occupation at 14CF335. Hypothesis 3 must be accepted and the mixture of Middle Ceramic, Early Ceramic, Archaic and paleo-Indian artifacts in the plowed portion of the site must be attributed to cultivation.

A possible reconstruction of the history of the site would be an initial occupation by paleo-Indians at a time when Terrace Two was a floodplain. Archaic hunters occupied Terrace Two when Terrace One was the floodplain leaving their artifacts which were eventually buried in the accumulating humus. This process continued when the present floodplain was formed, with pottery using Indians leaving their artifacts in the upper levels of the accumulating dark, humus rich soil. When modern farmers plowed Terrace Two, much of the dark soil eroded away mixing the cultural material from different components of the site, except in a small portion of the forested area.

14AN10.

This site lies on the slope of Terrace Two of the Neosho River (Figure 50). The site covers an area approximately 150 by 75 feet. Several horse teeth were recovered from the surface of the site, but their specific gravity was the same as modern horse teeth, suggesting they are the remains of a modern not a Pleistocene horse.

Thirty-eight lithic tools were recovered. Fourteen of these were bifaces including 2 fluted bifaces. One fluted biface appears to be a fragmentary base of a Clovis projectile point (Figure 51A) of which a broken lateral edge has been reworked into a graver. The specimen exhibits some edge grinding, and is fluted only on one side. It is possible the specimen broke before the other side could be fluted. A second fragmentary base of a fluted biface (Figure 51C), fluted on both sides, may have been a blank for a fluted projectile point. The base of a Meserve or Dalton projectile point (Figure 51B) was found with evidence at the break of anterior beveled edges. Eleven other fragmentary bifaces were recovered, two examples of which are illustrated (Figure 51D and E). Flake tools included: 2 edge retouched flakes; 1 denticulate (Figure 51I), 1 notched flake (Figure 51J), 1 double graver with a notch (Figure 51G), 2 spurred end scrapers (Figure 51F and H), 1 end scraper on a cobble and 1 scraper fragment. Ten amorphous flake cores were recovered and 5 uninformative fragments of ground stone.

The fluted bifaces and the spurred end scrapers suggest a paleo-Indian occupation. The Meserve or Dalton projectile point suggests an occupation during the Wisconsin to Holocene transition time.

14AN11.

This site is on the slope of Terrace Two of the Neosho River. The site covers an area 50 by 30 feet, judging from the distribution of flint chips and burned river cobbles. No lithic tools were recovered from the site.

14CS14.

This site lies on the top of Terrace Two of the Cottonwood River on the western side of a small intermittent stream. The area of the site is 50 by 10 feet. The only lithic tool recovered was an edge retouched flake.

14CS15.

This site is on the slope of Terrace Two (Figure 52) of the Cottonwood River. It covers an area 500 by 100 feet.

The author first visited this site because the base of a Clovis projectile point (Figure 53A) found at this locality was in the collections of Emporia State University. Another Clovis projectile point (Figure 53B) was found in the general area (at some unknown spot near Clements, Kansas) but not at this site.

The author recovered 31 lithic tools from the surface of the site. Fifteen of the artifacts were bifaces, including; 1 thick triangular biface (Figure 54A), 4 rectangular bifaces (Figure 54B is

an example), 4 ovate bifaces (Figure 55A is an example), 1 massive pointed asymmetrical biface (Figure 56), 1 biface (Figure 55B) with a plano-convex edge on one side (for scraping?) and a biconvex edge on the other side (for cutting?), 1 basal fragment of a lanceolate biface (Figure 53C) showing heat damage and 3 undiagnostic biface fragments. The 7 flake tools recovered from the site included; 1 fragment of a spurred end scraper (Figure 53F), 3 side scrapers, 1 graver on a flake (Figure 53E) and 2 notched flakes (Figure 53D is an example). One blade fragment (Figure 57B) with distal and lateral retouch was found. Eight cores (all made from quarried nodules) were recovered including 6 amorphous flake cores and 2 blade cores (Figure 57A is an example).

14CS16.

This site is on the slope of Terrace Two and the top of Terrace One of the Cottonwood River (Figure 52). The portion of the site on Terrace One has already been described in the section on Terrace One archaeological sites. The Terrace Two portion of the site, which covers an area 600 by 200 feet, will be discussed here.

A total of 79 lithic tools were recovered from the surface of the site. These artifacts included: 43 bifaces (54%), 20 scrapers (25%), 2 notched flakes (3%) and 14 cores (18%).

The bifaces consisted of: 2 projectile point fragments, one specimen (Figure 58A) is similar to Midland projectile points thought to date between 11,000 and 10,000 B.P. (Perino 1971:62), and the mid

section of a parallel flaked biface (Figure 58B) that was probably a projectile point; 1 gouge-like implement (Figure 59C); 10 rectangular bifaces (Figure 60B and C are examples); 21 ovate bifaces (Figure 59A and B are examples); 3 triangular bifaces including one thick specimen (Figure 60A); 1 asymmetrical pointed biface (Figure 61) and 5 undiagnostic biface fragments. The scrapers consisted of: 18 end scrapers with two of these being spurred end scrapers (Figure 62A and B) and the specimen illustrated in Figure 58C is an example of the rest; and 2 side scrapers. The cores from the site consisted of 14 amorphous flake cores made from quarried nodules except for 2 specimens made from river cobbles.

The Midland projectile point and the spurred end scrapers suggest a paleo-Indian occupation. The lithics from Terrace Two contrast dramatically with the lithics from Terrace One of the same site.

14MN19.

This site is on the slope of Terrace Two of the South Cottonwood River. The site covers an area approximately 50 by 25 feet based on the scatter of flint chips and burned rocks. The only lithic tool recovered was a fragment of an ovate biface. Several fresh water clam shells were scattered over the surface.

14MN31.

This small site is in a vertical exposure of Terrace Two of the North Cottonwood River. Five flint chips were found lying on the

surface in a four foot wide area at the base of the vertical face of the terrace. These flint chips had obviously eroded out recently. The author, while troweling a profile in the vertical face, discovered a flint chip in place at a depth of 33.5 cm. The flint chip appeared to be in the B horizon of the soil.

14MN33.

This site is located on the slope of Terrace Two of Doyle Creek. The only material recovered from the site was a flint flake and a blade core (Figure 63) found approximately 20 feet apart.

COMMENTS.

Very few sites were located on Terrace Two. This was not due to lack of effort on the author's part, who spent a disproportionate amount of time searching the drainage for this terrace. Terrace Two is rarely preserved and is much less extensively preserved than either the terraces immediately above or below. The possible cause for the lack of this terrace could be that it was an active floodplain for a relatively short period of time, establishing a narrow surface that was easily eroded away. An alternative interpretation, could be that the streams during the time Terrace One was a floodplain engaged in disproportionately greater lateral erosion. Whatever the explanation, the relative lack of Terrace Two deposits has undoubtedly impoverished the end Wisconsin cultural record in

Kansas.

TERRACE THREE ARCHAEOLOGICAL SITES.

A total of 14 sites and one locality from Terrace Three were studied. The archaeological data are described below.

14CF24.

This site is in a plowed field on Terrace Three, 200 feet south of Lebo Creek. A forest extends along the northern edge of the site. The Neosho River is approximately a quarter mile to the south. The site rests on an eroded remnant of Terrace Three. The abundant presence of rolled river gravel indicates the deposit is fluvial. The area of the site is estimated to be 500 by 200 feet. Although thousands of tiny flint chips occurred at this site, no diagnostic artifacts were discovered despite a careful search of the site's surface. The lithic tools found at the site consisted of a blade with a small striking platform (Figure 64A), a gouge (Figure 64B), a bifacially flaked scraper (Figure 64C) and a cobble hammerstone. Artifact collectors have frequently searched this site, which may explain why no diagnostic artifacts were recovered despite the abundance of debitage.

14MN12.

This archaeological site was discovered by Mr. Archie Leppke of Hillsboro, Kansas. The author, while doing field work for this dissertation, asked Mr. Leppke if he knew of any archaeological sites buried in a high terrace. He indicated that several fire hearths had

been exposed by a diversion ditch on the slope of a high terrace, and graciously took the author to the site.

The site 14MN12 is on Terrace Three of Doyle Creek. The surface cultural debris is scattered over the slope of the terrace facing Doyle Creek. Test pits indicate that a buried component extends under the top of the terrace. The area covered by surface cultural debris is 400 by 100 feet. The buried portion of the site would greatly increase the estimate of site area.

The position of Terrace Three relative to other terraces at this site is illustrated (Figure 75). Northwest of 14MN12, is 14MN34 on Terrace One whose surface yielded a Meserve or Dalton projectile point suggesting the Terrace One surface was present during the earliest part of the Holocene. A Terrace Two surface is to the east of 14MN12. Terrace Two must be older because it is higher than the early Holocene surface of Terrace One. This is in agreement with other localities in this drainage, with Terrace Two being the lowest terrace to contain the remains of extinct Pleistocene mammals. Terrace Two must have formed during or prior to the late Wisconsin. Terrace Three at this locality must date to an earlier period than Terrace Two in the late Wisconsin or else prior to the late Wisconsin. Clovis projectile points have been found on the surface of Terrace Two at other locations on this drainage. This suggests that a site buried by alluvium in Terrace Three would be a pre-Clovis archaeological site.

The archaeological material recovered from the surface of the terrace slope indicated a multicomponent occupation. The following artifacts were recovered from the surface of the Terrace Three slope: 1 triangular projectile point dating to the Middle Ceramic (Perino 1968:52), 1 Logan Creek projectile point (Figure 76B) dating to the middle Archaic (Kivett 1959), 1 corner notched projectile point (Figure 76C) with some resemblance to late Archaic specimens (Perino 1971:10), 1 side notched projectile point with slightly serrated and alternately beveled anterior edges and a heavily ground base similar to certain early Archaic specimens (Perino 1971:14), 1 undiagnostic projectile point fragment, 2 leaf shaped bifaces, 1 "four bladed knife" fragment, 9 undiagnostic biface fragments, 6 end scrapers, 1 spurred end scraper (Figure 76A), 1 crested blade, 1 proximal fragment of a laterally retouched blade, 1 large cobble chopping tool, 2 tabular flake cores, 1 broken cobble hammerstone, and 1 undecorated shell tempered pot sherd probably with Middle Ceramic affinities. The pot sherd and one projectile point suggest a Middle Ceramic component, three projectile points suggest late to early Archaic components and the spurred endscraper suggests a paleo-Indian component.

The archaeological material buried by alluvium beneath a terrace surface cannot be any younger than the oldest artifacts on that surface. Therefore, the component buried beneath the slope of Terrace Three is likely to be (at least in part) a paleo-Indian occupation.

An 8 meter long trench, composed of Test Pits 4, 5, 6 and 7 (Figure 77) was excavated into the lower slope of Terrace Three. The profile of the trench (Figure 77) clearly shows a buried cultural level roughly following the sloping surface of the terrace edge. A small amount of cultural debris is scattered on the surface of the excavation. The surface material at this site is known to be multicomponent. It is possible that the surface material on this trench represents a separate component or components from the buried cultural level. This area has been plowed and it is possible that some material from the buried level has been plowed to the surface and mixed with later components. The cultural material is in a matrix of silty sand, the top few centimeters of which have been disturbed by plowing. A deposit of consolidated sand and gravel lies beneath the silty sand layer. The consolidated sand and gravel layer is very resistant to excavation. The upper surface of the consolidated sand and gravel (Figure 77) clearly shows small channels with their axes at right angles to the slope of the terrace edge. This demonstrates that the surface of the consolidated sand and gravel unit was not created by erosion from the sloping edge of Terrace Three. A likely source for the channels is the runoff from the spring to the west of the site (personal communication, Dr. Wakefield Dort). The spring water might also be a source for the carbonates that cemented the sand and gravel in this layer. The erosion of the surface of the sand and gravel layer means the silty sand layer containing the ar-

tifacts lies unconformably on it. We do not know how great a break in time this represents. Some of the human artifacts in Test Pit 4 (Figure 77) can be seen to follow the channel cut in the consolidated sand and gravel layer. It is interesting that a soil did not have time to form before deposition of the silty sand layer (and the artifacts enclosed in it) were deposited along the erosional surface of the consolidated sand and gravel layer. This suggests the deposition of the silty sand unit was not much later than the erosional event that created the channel in Test Pit 4. Because this portion of the site is higher than Terrace One (the highest Holocene terrace) the erosional event was probably Wisconsin. The deposition of the cultural level in the silty sand, although slightly later than the erosional event, was roughly comparable in time (because a soil did not have time to form). The formation of the silty sandy layer may have been due to colluvial or alluvial action. The slope of the buried cultural level generally follows the slope of the terrace edge. This suggests colluvium. The distribution of the artifacts is consistent with the artifacts being buried by colluvium after being deposited on a slope. A less likely possibility would be that the silty sand layer had been deposited as alluvium on a sloping stream bank, and by chance, slope erosion has created the present land surface parallel to the hypothetical ancient sloping stream bank. It is clear the present sloping surface has been rapidly eroding in recent times, indicating the cultural level was buried under more overburden

than at present. A diversion ditch had been constructed by the owner of the property to stop this erosion.

The datum for each pit was in the southwest corner. The lithic artifacts recovered from the test trench (Figure 77) on the Terrace Three slope included: 1 edge fragment of a biface (Figure 78C) found 30 cm below the datum of Test Pit 5, 1 tip of a biface (Figure 78D) found 36 cm below the datum of Test Pit 5, 1 curved edge fragment of a biface (Figure 78E) found between the surface and 20 cm beneath the datum of Test Pit 5, 1 end scraper (Figure 78A) found 30 cm beneath the datum of Test Pit 5, 1 flake blade (Figure 78F) found 30 to 40 cm beneath the datum of Test Pit 6 and 1 blade (Figure 78B) from 26 cm below the datum of Test Pit 5. The diagnostic characteristics of these artifacts are of little help in dating the site. These artifacts are without question the products of human manufacture. A toe bone of Antilocapra (pronghorn antelope) was found in the cultural level in Test Pit 4. This species has occupied North America since the Tertiary.

Test Pits 1, 2, and 3 (Figure 79) were excavated to the southeast of the test trench just described. Test Pit 1 yielded in the southwest corner the edge of a cluster of burned rocks and burned earth that indicated a fire hearth, although no charcoal was recovered. The feature was buried between 36 and 40 cm beneath the surface in the silty sand layer. Several flint chips were found at this depth in the pit. The size of the hearth was 80 by 90 cm

(Figure 80) and it was necessary to excavate outside Test Pit 1 to uncover the hearth. The consolidated sand and gravel layer began between 60 to 70 cm beneath the surface.

Test Pit 2 yielded 7 flint chips between 24 and 26 cm beneath the datum. The top of the consolidated sand and gravel layer was approximately 28 cm beneath the datum. The upper portion of the consolidated sand and gravel layer contained large clam shells (including complete bivalves) that yielded a radiocarbon date of greater than 39,000 years B.P. Two flakes of gray flint were solidly cemented into the consolidated sand and gravel unit at depths of 75 to 80 cm beneath the datum. This suggests the possibility of human activity at this site contemporaneous with the radiocarbon date in the consolidated sand and gravel layer. Two flint flakes constitute too little evidence to confirm human artifacts in the consolidated sand and gravel layer, but do indicate the need for further research. These flakes are angular and are out of place with the rounded, water rolled gravel that surrounds them.

Test Pit 3 yielded a buried cultural level in the silty sand layer. Fourteen flint flakes and one fragment of a scraper were recovered from between 27 and 31 cm beneath the datum. A single flint chip 6 cm beneath the surface was found but it may have been disturbed by plowing. The consolidated sand and gravel unit began at a depth of approximately 47 cm. Several flakes of carbonate encrusted flint were recovered from the upper portion of the con-

solidated sand and gravel layer, but it has not been possible to confirm with certainty that they were knapped by humans. A limb bone from a Pleistocene horse was found in the consolidated sand and gravel unit at a depth of 125 cm beneath the datum.

The test pits on the slope have yielded buried cultural material which is below an early Archaic projectile point and a spurred end scraper (a probable paleo-Indian artifact), suggesting the buried component in paleo-Indian. However, the evidence for a paleo-Indian component is much more persuasive from Test Pits 8 and 9 on the top of Terrace Three.

Artifacts buried by alluvium in a terrace should be as old as that terrace. Terrace Three is earlier than Terrace Two. Terrace Two has Clovis projectile points on its surface. This indicates that any artifacts buried by alluvium in Terrace Three should be pre-Clovis in age. Unfortunately, it was not possible to demonstrate that the cultural level in the silty sand unit on the slope of Terrace Three was buried in alluvium as opposed to colluvium. Test Pits 8 and 9 were excavated on the top surface of Terrace Three to determine the presence of a buried cultural level that could not have been buried by colluvium.

Artifacts recovered from Test Pit 8 included: 1 edge fragment of a biface (Figure 81H), 5 flakes knapped from the edges of bifaces, 1 graver on a flake blade (Figure 81B), 2 graters on flakes (Figure 81C and D), 1 end and side scraper (Figure 81A), 3 edge retouched flakes

(Figure 81E, F, and I), 1 fire damaged notched flake (Figure 81J) and 1 crested blade that was broken at both ends (Figure 81G). Much of the flint had been heat treated. A tiny piece of burned earth with linear impressions on it that appears to be a piece of daub was uncovered in the cultural level. This may imply the presence of a mud covered structure, or may simply be some mud trampled on grass by human feet and later burned.

Thermoluminescence dating was applied to three burned flakes from the buried cultural level of Test Pit 8 from a depth of less than 20 cm. The dates were $10,418 \pm 967$ years B.C., $40,473 \pm 3311$ years B.C. and $56,495 \pm 6838$ years B.C. These dates were obtained from the laboratory of Dr. Ralph Rowlett of the University of Missouri, Columbia, Missouri. There are a number of problems with thermoluminescence dating including the possibility that prehistoric heating may not have been sufficient "to clear" the flint (producing too old a date) or that cutting the thin section of flint may have "cleared" some of the relevant thermoluminescence (producing too young a date). The dates are all pre-Clovis and are thus in general agreement with other lines of evidence suggesting this site is paleo-Indian and possibly pre-Clovis.

Test Pit 9 was a 1 meter square pit on the southern edge of Test Pit 8. The purpose for excavating Test Pit 9 was to obtain a soil sample from the cultural level for a paleobotanical analysis. The layer between 15 and 30 cm beneath the datum was extracted. A portion

of this was analyzed for pollen using the revised Horowitz technique. One hundred pollen grains were identified with the following taxonomic affiliations: Pinus (pine) 66%, Picea (spruce) 1%, Acer (maple) 7%, Quercus (oak) 1%, Gramineae (grass) 9%, Onagraceae 11%, Malvaceae 2%, Smilicina 1%, Cyperaceae 1% and Chenopodiaceae-Amaranthaceae 1%. Seven pollen grains were not identified. This pollen spectrum is totally unlike any from the Holocene of the Central Great Plains, although it fits quite well with conifer dominated arboreal vegetation of the Pleistocene in this area. This pollen spectrum indicates a lack of disturbance of the cultural level during the Holocene, otherwise, the pollen spectrum would be quite different and would reflect Holocene pollen percentages.

14MN15.

This site lies on the slope of Terrace Three of the South Cottonwood River. The size of the site is 275 by 250 feet. Fragments of elephant bones were scattered on the surface among the cultural debris.

Sixteen lithic tools were recovered from this site including 11 bifaces. Five of the bifaces were projectile points including: 1 fragment of a shouldered projectile point (Figure 65C), 1 fragment with a concave base and long basal thinning flakes (Figure 65E), 1 fragment of a large triangular projectile point (Figure 65D) and 2 undiagnostic fragments. Other bifacial artifacts included: 2 thick triangular bifaces (Figure 66), 1 large rectangular biface fragment,

1 ovate biface and 2 undiagnostic fragments. The remaining tools consisted of: 1 end scraper, 1 side scraper, 1 transverse retouched flake struck from a biface (Figure 65A) with retouch forming a point (it may have functioned either as a projectile point or as a scraper), 1 blade retouched to a point (Figure 65B) that may have functioned as a projectile point and 1 blade core (Figure 65F).

The cultural affiliations of this site are unknown. The presence of the site on a Wisconsin terrace and the elephant bone fragments scattered about the cultural debris, suggest (but do not demonstrate) a paleo-Indian occupation. The concave base projectile point with the removal of basal thinning flakes (Figure 65E) would be consistent with a paleo-Indian occupation. The projectile points are not very diagnostic. The author was unable to find a "good fit" for the projectile points, although some Archaic projectile points show similarities to the shouldered projectile point fragment (Chapman 1975:257), and the triangular projectile point fragment (Bell 1960:42). The surface material may be multicomponent.

14MN16.

14MN16, the Duerksen Site, is on Terrace Three of the South Cottonwood River. This locality is composed of three distinct surface scatters of cultural material; 14MN16 SOUTH, 14MN16 SOUTHWEST, and 14MN16 WEST. These three distinct areas will be treated as individual sites.

14MN16 SOUTH covered an area 235 by 180 feet and was located on the south slope of Terrace Three. Fragments of elephant bone were found on the surface just northeast of the cultural area. A total of 18 artifacts were recovered from this area. The bifaces included: 1 thick sub-triangular biface (Figure 67A), 1 celt that possibly functioned as an adze (Figure 67B), 3 ovate bifaces (an example is illustrated in Figure 68A), 1 graver on a biface and 2 uninformative biface fragments. The other artifacts included: 1 end scraper, 1 spurred end scraper (Figure 68B), 1 side scraper, 1 graver on a crested blade, 3 amorphous flake cores, and 3 discoidal flake cores. The spurred end scraper suggests a paleo-Indian occupation.

14MN16 SOUTHWEST covered an area 300 by 75 feet, and was located on the top and southwestern slope of Terrace Three. A total of 21 lithic tools were recovered from this site. Blade tools dominated the cultural material from this locality and included: 9 unretouched blades, 3 blades (or blade fragments) with end retouch, 1 blade fragment with lateral retouch and 1 blade core fragment. Other tools included 4 thin undiagnostic biface fragments and 3 edge retouched flakes. The cultural affinities of 14MN16 SOUTHWEST are unknown.

14MN16 WEST covers an area 320 by 80 feet and is located on the western slope of Terrace Three. The area yielded 7 tools, including: 2 Scallorn projectile points, 1 thin leaf shaped biface, 1 uninformative biface fragment, 1 end scraper, 1 edge retouched flake and 1 small discoidal flake core. The Scallorn projectile points suggest a

Ceramic (probably Early Ceramic) occupation (Bell 1960:84).

14MN17.

This site lies on the slope of Terrace Three of the South Cottonwood River. The site is 1320 by 150 feet in size. A meander scar in Terrace One approaches the foot of Terrace Three at this site.

A total of 21 lithic tools were recovered from this site, including: 3 projectile point fragments. One fragment was from a square stemmed projectile point similar to specimens from Missouri dating between 5000 to 1000 B.C. (Chapman 1975:257), another fragment was from a lanceolate projectile point similar to Nebo Hill projectile points that date to the late Archaic, and the remaining fragment was from a corner notched projectile point similar to forms found in Early Ceramic sites (Chapman 1980:313). Other tools included: 7 undiagnostic biface fragments, 6 end scrapers, 2 edge retouched flakes, 1 notched flake and 2 amorphous flake cores.

The projectile points suggest the cultural affiliations of the site are Archaic and Early Ceramic. The site may have been occupied when the meander scar at the foot of the site was an active river channel.

14MN18.

This site lies on the slope of Terrace Three of the South Cottonwood River. The size of the site is 660 by 200 feet. Mammuthus (mammoth) tooth fragments were scattered over the surface of the site.

Thirty lithic tools were recovered including: 1 broken corner notched expanding base projectile point with alternately beveled anterior edges and a heavily ground basal edge (the author was unable to affiliate it with a known projectile point style), 1 undiagnostic fragment of an expanding stemm projectile point, 1 bifacially worked single shouldered knife, 1 pointed asymmetrical biface (Figure 73A), 5 rectangular biface fragments (Figure 74A is an example), 8 undiagnostic biface fragments, 5 end scrapers, 1 end scraper with a projection from the scraping edge (Figure 74B), 1 water rolled scraper on a quartzite cobble (Figure 73B), 1 notched flake, 1 pebble chopping tool and 4 edge retouched flakes. The cultural affinities of this site have not been determined.

14MN20.

This site is on the slope of Terrace Three of the South Cottonwood River. The size of the site is 100 by 10 feet. The only lithic tools recovered from the site were a thick triangular biface (Figure 69A) and a retouched flake.

14MN21.

This site is located on the top of Terrace Three of the South Cottonwood River. The size of the site is approximately 50 by 20 feet. Only a few flint chips were found.

14MN22.

This site is on the top and slope of Terrace Three of the North Cottonwood River. The size of the site is 600 by 300 feet. The

lithic tools included: 1 corner notched projectile point fragment with a strongly concave base with edge grinding similar to early Archaic specimens from Missouri (Chapman 1975:255), 1 corner notched projectile point fragment reworked into a scraper with some diagnostic characteristics of the previously described projectile point, 1 small thick asymmetrical biface, 2 undiagnostic biface fragments, 1 side scraper, 2 amorphous flake cores and 1 small conical blade core (Figure 69B). The projectile points suggest an Archaic occupation.

14MN23.

This site is on the slope of Terrace Three on the North Cottonwood River. The size of the site is 60 by 30 feet. The only lithic tool found at the site was an undiagnostic biface fragment.

14MN26.

This site consists of three distinct surface scatters of cultural debris. The lower scatter of cultural material lies on Terrace One and extends onto the base of Terrace Three. The lower site has been considered to belong to Terrace One and has already been discussed in the section on Terrace One archaeological data. The middle and upper cultural areas will be discussed below.

The middle cultural area is on the slope of Terrace Three of the North Cottonwood River. It covers an area 90 by 40 feet. The artifacts recovered from this area include: 1 thick triangular biface (Figure 70) made from a quartzite river cobble that broke before the implement was finished, 1 fragment of a parallel flaked biface

(possibly from an unfinished projectile point) and 1 side scraper.

The upper cultural area is on the slope of Terrace Three just below the top of the terrace. It covers an area 150 by 40 feet. There were few flint chips and the only lithic tool recovered was a large flake (Figure 71) with alternate edge retouch.

14MN27.

This site was on the top of Terrace Three of the North Cottonwood River. The size of the site was 120 by 100 feet. The artifacts recovered from the site included: 1 large undiagnostic biface fragment, 1 tanged flake end scraper, 1 end scraper, 1 fragment of grooved ground stone and 1 blade core fragment probably from a conical blade core.

14MN28.

The Oblander site is located on the top edge and slope of Terrace Three of the North Cottonwood River. The site covers an area 425 by 250 feet.

A total of 187 lithic tools were recovered from the surface of the site, of which 8% were blade cores and 37% were blades. The blade cores were predominately conical in form with the exception of a wedge shaped core. Flake cores accounted for 11% of the industry. Bifacial implements were rare. No ceramics were found at the site.

The artifacts recovered included: 1 tear drop shaped projectile point (Figure 82B), 1 bifacial gouge (Figure 82A), 6 side scrapers (Figure 83D is an example), 18 end scrapers (Figure 83A and B are ex-

amples), 29 edge retouched flakes, 12 notched flakes (Figure 82D is an example), 15 gravers on flakes (Figure 82C and Figure 83C are examples), 8 notched blades (Figure 84G is an example), 6 end retouched blades (Figure 84F is an example), 6 gravers on blades (Figure 84H is an example), 11 lateral edge retouched microblades, 20 unworked blades, 11 unworked microblades, 21 amorphous flake cores (Figure 85B is an example), 14 conical blade cores (Figure 84A is an example), 1 wedge shaped blade core (Figure 85A) and 7 blade core rejuvenation flakes (Figure 84B is one of five specimens showing removal of the striking platform and Figure 84D is one of two specimens showing the removal of the fluted face of the core). Figure 84C illustrates an unretouched crested blade.

The wedge shaped microblade core (also known as a Campus or Gobi core) is widely distributed through the north of both Asia and North America. This distinctive technological development was present during much of the time span of the Upper Paleolithic in northeastern Asia (Mochanov 1978:64). The wedge shaped microblade core technology had appeared in Alaska by the end of the Pleistocene (Powers and Hamilton 1978:74-75) and was still being used in the North American arctic during the latter part of the Holocene in Dorset sites. Wedge shaped cores are also known from archaeological sites in the Pacific Northwest, including the Intermontane Plateau located between the Pacific Coast and the Rocky Mountains (Sanger 1970:107).

The presence of a wedge shaped core in a blade tool industry at the Oblander site in the Central Plains suggests a much wider distribution of this northern lithic technology than previously known. The wedge shaped core from this site has an elongate platform, with the microblades being struck from the short axis of one end of the striking platform. The edge opposite the striking platform is wedge shaped. The wedge shaped core was made from a nodule of local, gray, Flint Hills flint. Two areas of cortex are still observable on the core. The striking platform for the detachment of microblades was created by striking a single flake from the long axis of the core using the face where the microblades were to be detached as a striking platform. A section of cortex still remains adjacent to and on the same plane as the striking platform. The flint nodule had been bifacially worked to create the wedge shape. This shape may have facilitated wedging the core into a vise to hold the core steady for the removal of the microblades (Dumond 1980:987).

The wedge shaped core is quite distinct from the other blade cores at the Oblander site. The distinctiveness of core technology and the fact that numerous other cores of a different type were available to produce microblades suggest the wedge shaped core at the Oblander site was not an independent invention, but represents (however indirectly) influence from wedge shaped core lithic traditions to the north.

A variety of exotic material was found at the Oblander site including obsidian from the Rocky Mountains, jasper from northwestern Kansas and a fragment of a glacial erratic from northeastern Kansas. The obsidian recovered from the site consisted of two flakes and a microblade. The obsidian was dated by the obsidian hydration dating technique by Dr. Irving Friedman of the United States Geological Survey. All three pieces of obsidian dated to approximately 800 to 900 years B.P. The dates were calculated on the basis of a hydration rim of 2.6 ± 0.1 micron present on each specimen of obsidian. The refractive index of the obsidian is low 1.483. Present day weather records in the area where the obsidian objects were found show a mean annual air temperature of 13.3 degrees C for a soil temperature at a depth of about 10 cm yields an estimated hydration temperature of 14.4 degrees C. The hydration rate for obsidian at this refractive index at this temperature is 8 microns squared/1000 years. The fact that one of the pieces of obsidian was a microblade presumably links the dates to the blade industry at the site. The Oblander site lies on a Pleistocene alluvial terrace. The site could not have been buried more than a few centimeters under humus before it was plowed. The obsidian hydration dates at this site should be considered maximal dates because the possibility exists that the obsidian may have been buried shallowly enough to have been exposed to a build up of solar heat which would make the dates somewhat old.

A date of 800 to 900 years B.P. would indicate the site belongs to the Middle Ceramic period of Kansas. There is no indication of more than one component at the site, although an Archaic projectile point was found a short distance away from the site on Terrace One.

The Oblander site contains a distinctive blade industry that contrasts with the Hopewell blade industries in the Lower Missouri River Valley in several ways. Cortex was present on the striking platforms of some of the conical blade cores at the Oblander site, while the platforms were made on fracture surfaces on the cores from the Lower Missouri River Valley Hopewell sites (Reid 1976:90). Blade technology dominates the lithic industry at the Oblander site, but is only a minor part of the Lower Missouri River Valley Hopewell lithic industries (Reid 1976:63). Wedge shaped blade core technology is present and the Cobden blade core technique is not present at the Oblander site, the opposite is true in the Lower Missouri River Valley Hopewell industries (Reid 1976:92-93).

14MN29.

This site is on the slope of Terrace Three on the North Cottonwood River. The site covers an area 300 by 200 feet. The artifacts recovered included: 1 broken fluted projectile point (Figure 69C), 2 projectile points with rounded shoulders and slightly expanded stems similar to specimens from Missouri dating from 3000 to 1000 B.C. (Chapman 1975:258). 1 side notched concave base projectile point similar to Missouri specimens dating from 5000 to 3000 B.C. (Chapman

1975:250), 1 fragmentary projectile point with pronounced shoulders and an expanding base similar to late Archaic specimens from Missouri (Chapman 1975:246), 2 undiagnostic projectile point fragments, 6 undiagnostic biface fragments, 1 elongate biface (resembling a "Munkers Creek knife"), 1 proximal fragment of a blade, 5 end scrapers (one has a graver on the proximal end), 1 amorphous flake core and 1 grooved ground stone artifact.

Scattered on the surface were fragments of elephant ivory. The fluted projectile point indicates a paleo-Indian occupation, while the Archaic projectile points indicate an Archaic occupation. The site appears to be a multicomponent one.

THE DALKE LOCALITY.

A gravel pit (T20S, R2E, Sec. 17, NW, SW, NW) sunk into the slope of Terrace Three of the South Cottonwood River has cut deep profiles into the Wisconsin sediments. An artifact collector (Mr. Rick Shroeder of Gossel, Kansas) recovered a human made artifact buried in the side of the gravel pit. The artifact (Figure 72) was a thick sub-triangular biface. The specimen had been knapped from a water rolled quartzite cobble. Mr. Shroeder showed the author the precise spot where he had troweled the artifact from the side of the pit. The artifact was seven feet beneath the surface of the Terrace Three slope in a deposit of cross bedded sand. The author recovered a fragment of elephant bone in close proximity at the same level in the deposit. Capping the deposit of cross bedded sand was a deposit of

indurated sand as hard as cement that would have blocked vertical intrusion of the artifact into the deposit. It could be argued that the artifact fell from the surface during work on the pit and that earth moving equipment shoved it into the wall of the excavation. This would be very unlikely because the vertical surface where the artifact was found was having the deposit removed, and there is no evidence of any earth moving activity that would have added material to the side of the pit. The cross bedded stratigraphy was intact on the vertical face arguing against disturbance.

TERRACE ANALYSIS OF ARTIFACTS.

Stream terraces vary in the length of time they have been available for human occupation. The higher terraces have the potential for being occupied at an earlier date and for a longer period of time than lower terraces on the same drainage. It would be reasonable to expect that these land surfaces would vary in the accumulation of some cultural traits. This variation would be due to factors that alter with the passage of time such as ethnic changes, cultural adaptations to a changing environment and the adoption of more effective new technologies (sometimes with the corresponding loss of less effective technologies).

Some cultural traits (fluted projectile points for example) are generally believed to have been made during a specific period of time. Sites that contain these "index fossils" should be distributed on the terraces in a distinct pattern corresponding with their ex-

pected antiquity. These will be discussed first.

Some cultural traits are distinctive and are distributed on only certain terraces although they have not yet been generally recognized as "index fossils." These probable "index fossils" will be discussed next.

Some cultural traits are common to all sites (such as site size) or are known to span a great period of time (such as blade technology). These traits will be discussed last.

The scoring of artifact types in the statistical analyses was done on the basis of presence or absence and not by the number of artifacts on a site. The percentages refer to the percentage of sites on any one terrace that have a particular artifact type present, and not to the percentage of all sites having the artifact type.

POTTERY.

Sites with pot sherds appear on all the terraces. This is what one would expect because of the late appearance of pottery. All of the terrace system was available for occupation by pottery using people. The percentages of pottery bearing sites on the terraces were: on the Floodplain 28.57% (6 out of 21 sites), on Terrace One 13.73% (7 out of 51 sites), on Terrace Two 9.09% (1 out of 11 sites) and on Terrace Three 5.56% (1 out of 18 sites). The proportions derived from dividing the number of sites with pottery on each terrace by the total number of sites with pottery did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov

One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

ARCHAIC PROJECTILE POINTS.

Archaic projectile points are not found on the Floodplain but are found on Terrace One, Terrace Two and Terrace Three. This pattern of distribution is consistent with the Floodplain not being available for human occupation by users of Archaic projectile points (because the Floodplain had not yet come into existence). The percentages of sites with Archaic projectile points on terraces were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 37.25% (19 out of 51 sites), on Terrace Two 18.18% (2 out of 11 sites) and on Terrace Three 22.22% (4 out of 18 sites). The lack of sites with Archaic projectile points on the Floodplain is statistically significant at the .05 level of confidence compared to the presence of Archaic projectile point sites on the three higher terraces using the Chi Square One Sample Test (Siegel 1956:42-47). The expected number was the average number of Archaic projectile point sites per 21 sites.

FLUTED PROJECTILE POINTS.

Fluted projectile points do not appear on Floodplain or Terrace One sites but do appear on Terrace Two and Terrace Three sites. This distribution is consistent with the belief that fluted projectile points are "index fossils" of the end Wisconsin, and should not be

expected to appear on the Floodplain and Terrace One which were not in existence during the end Wisconsin. The percentages of fluted projectile point sites were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 0% (0 out of 51 sites), on Terrace Two 27.27% (3 out of 11 sites) and on Terrace Three 5.56% (1 out of 18 sites). The proportions derived from dividing the number of sites with fluted projectile points on each terrace by the total number of sites with fluted projectile points varied from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956: 47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

SPURRED END SCRAPERS.

Spurred end scrapers have been claimed to be a possible paleo-Indian "index fossil" in the Plains (Frison 1978). The author's terrace analysis supports this idea. No sites with spurred end scrapers were found on the Floodplain or Terrace One, although sites with spurred end scrapers have been found on both Terrace Two and Terrace Three. This is consistent with the Holocene terraces not being formed when the spurred end scrapers were in use. The percentages of sites with spurred end scrapers were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 0% (0 out of 51 sites), on Terrace Two 36.36% (4 out of 11 sites) and on Terrace Three 11.11% (2 out of 18 sites). The proportions derived from dividing the number of sites with spurred end scrapers on each terrace by the total number of

sites with spurred end scrapers varied from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

COMMENTS.

Pottery, Archaic projectile points, fluted projectile points and spurred end scrapers were found only on terraces which would be available for artifacts of their time ranges to occur. This demonstrates the effectiveness of alluvial terraces in chronologically analyzing archaeological data.

Some distinctive artifacts (not yet generally recognized as "index fossils") occur only on certain terraces. These artifacts are possibly "index fossils" and will be discussed next.

THICK SUB-TRIANGULAR BIFACES.

These artifacts are found on sites on Terrace Two and Terrace Three of the Wisconsin, but not on sites on the Floodplain and Terrace One of Holocene age. A number of interpretations are possible for the distributions of these artifacts. Their presence on the Wisconsin terraces and not on the Holocene terraces suggests they may be paleo-Indian "index fossils" in this drainage. It does not rule out the possibility that similar artifacts could be much younger in other regions. One could argue that these were Holocene artifacts that were left only on Wisconsin terraces because of some unexplained geographically specialized use of the implement type. This explana-

tion is not parsimonious. Such a theory would not be very plausible considering the maximum difference in height between the Floodplain and Terrace Three is approximately 25 feet. The difference in height between Terrace One and Terrace Two is only 8 feet. It seems unlikely that such small differences in height would greatly influence the distribution of lithic artifacts. The percentages of sites with thick sub-triangular bifaces were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 0% (0 out of 51 sites), on Terrace Two 18.18% (2 out of 11 sites) and on Terrace Three 27.78% (5 out of 18 sites). The proportions derived from dividing the number of sites with thick sub-triangular bifaces on each terrace by the total number of sites with thick sub-triangular bifaces varied from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

The thick sub-triangular bifaces from the Wisconsin terraces are illustrated (Figures 54A, 60A, 66, 67, 69A and 70). These artifacts are quite different from gouges and a celt (Figure 27A) which were large bifacial tool types that occurred on Holocene terraces.

Renaud (1940) reported similar artifacts which he described as "coup de poing-like" on high terraces in Wyoming. These implements were compared to typologically similar artifacts from the Lower Paleolithic of the Old World. Wormington (1957:219) has claimed that similar implements were found in comparatively recent sites in

the area, and cites Mulloy (1954). However, Mulloy (1954) does not describe any artifacts that closely resemble Renaud's "coup de poing-like" artifacts.

Artifacts described as "handaxes" were reported by Raemsch and Vernon (1977) to have been found in situ above and below a till (claimed to be early Wisconsin in age) in New York State. Horse and bovid bones were in direct association with artifacts including a "handaxe" at one locality.

The reported discovery of a thick sub-triangular biface, deeply buried in Terrace Three at the Dalke locality suggests an antiquity well into the Wisconsin for this artifact type. The presence of thick sub-triangular bifaces on Terrace Two indicates they were still in use at least as late as the end Wisconsin in this drainage. The data recovered during this research supports Renaud's hypothesis that this tool type was used during the Pleistocene in the New World, but does not necessarily support the belief that these implements correlated with the Acheulian of the Old World. The presence of this artifact type on Terrace Two suggests that it was in use during the late Wisconsin or later, at which time it was definitely not contemporaneous with the Acheulian. Furthermore, the lithic artifacts that accompanied the thick sub-triangular bifaces are not what one would expect with an Acheulian industry (for example, the terrace sites lack cleavers).

Holmes (1897) argued that large bifaces found in North America that are morphologically similar to Old World Acheulean bifaces, were merely blanks for other tool forms that were frequently discarded at quarry localities. He also thought these were all of recent antiquity. The quarries Holmes analyzed were not dated, so his opinion as to their age was simply a guess. The ability of Holmes to guess the age of artifacts can be gauged by his belief that Clovis projectile points were recent. His belief that large bifaces resembling Lower Paleolithic tool types in the Old World were blanks for other artifacts was a plausible, but never demonstrated possibility. Alternative hypotheses are possible, such as large bifaces being specialized tools for excavating the quarries, or part of a tool kit used in subsistence activities while at the quarries.

None of the sites analyzed in this study showed evidence of being a quarry. It is therefore unlikely that the thick sub-triangular bifaces were directly related to quarrying activity. The hypothesis that these artifacts are blanks for Holocene artifacts does not explain why they are found on sites on Wisconsin terraces but not on the more abundant sites on Holocene terraces. These artifacts could be blanks for paleo-Indian artifacts, however, the nature of the hypothetical artifacts to be made from these supposed blanks are unknown.

THICK ASYMMETRICAL BIFACES.

Thick asymmetrical bifaces (Figures 56, 61, and 73A) were not found on the Floodplain and Terrace One (Holocene terraces), but were found on Terrace Two and Terrace Three (Wisconsin terraces). The percentages of sites with thick asymmetrical bifaces were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 0% (0 out of 51 sites), on Terrace Two 18.18% (2 out of 11 sites) and on Terrace Three 5.56% (1 out of 18 sites). The proportions derived from dividing the number of sites with thick asymmetrical bifaces on each terrace by the total number of sites with thick asymmetrical bifaces varied from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

There are several possible interpretations for the distribution of thick asymmetrical bifaces on the stream terraces. These interpretations are similar to those already discussed for the thick sub-triangular bifaces. Identification of thick asymmetrical bifaces as distinctive paleo-Indian artifacts in this region is probably the most parsimonious interpretation.

COMMENTS.

Terrace analysis suggests that thick sub-triangular bifaces and thick asymmetrical bifaces may have potential for being diagnostic paleo-Indian artifacts in this drainage. It is hoped that in the fu-

ture that excavations of in situ paleo-Indian components in the region will settle the question.

Some cultural traits are universal in archaeological sites or have been widespread for a very long period of time. These traits will be discussed next.

SITE LENGTH.

It is the author's observation that archaeological sites on stream terraces tend to have their longest axis parallel to the stream channel. Interpreting site size is a complex undertaking from surface data. Buried portions may greatly increase an estimate of site size based on surface data. Erosion may greatly reduce the size of a site. Stream erosion is most likely to cut away portions of the site parallel to the stream channel, thus affecting the width of the site more than the length. Buried sites exposed on the edge of a terrace tend to have their length exposed because of the tendency of sites to be oriented parallel to the channel, with the width of the site extending for an unknown distance into the terrace. This suggests that site length is probably a more reliable trait to estimate site size on stream terraces than site width (or area, which incorporates a width measurement). There are certainly exceptions to this tendency but if a number of sites on each terrace are analyzed the effect of those exceptions could be minimized.

The average lengths of sites on the terraces were: on the Floodplain 132.38 feet, on Terrace One 261.76 feet, on Terrace Two 300.55

feet and on Terrace Three 347.35 feet. The differences in average lengths of sites on the terraces were greater than chance at the .05 level of significance when analyzed by the Chi Square One Sample Test (Siegel 1956:42-47). The expected number (253.41 feet) was the average length of 100 sites (the Dalke locality was excluded because a length measurement could not be made).

The higher the terrace, the greater the average length of sites on the terrace. There are several possible interpretations for this data. Higher terraces were available for longer periods of human occupation which could explain why site length increases with higher terraces. It would be reasonable to believe that longer occupation of a site would result in cultural debris being scattered over larger areas. Another possibility is that there was a progressive trend toward shorter (smaller?) sites through time in this drainage.

THE PRESENCE OF LITHIC TOOLS.

The presence of lithic tools on archaeological sites was examined as a possible test of the intensity or duration of habitation. Terraces with greater intensity or duration of human occupation could be reasonably expected to have a greater proportion of sites with lithic artifacts than terraces that were less occupied.

The percentages of sites with lithic tools present were: on the Floodplain 80.95% (17 out of 21 sites), on Terrace One 80.39% (41 out of 51 sites), on Terrace Two 81.82% (9 out of 11 sites) and on Terrace Three 94.44% (17 out of 18 sites). The proportions derived from

dividing the number of sites with lithic tools on each terrace by the total number of sites with lithic tools did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites. This analysis of sites with lithic tools does not support an hypothesis that there were different intensities or durations of occupation on various terraces. This is puzzling considering the differences in site length on different terraces. A possible explanation may be that intensity or duration of occupation may be reflected by the number of sites on a terrace and not the quantity of artifacts on individual sites. Unfortunately, no data are available to compare equivalent areas on the terraces to see if sites vary in abundance on different terraces.

BIFACIAL ARTIFACTS.

The percentages of sites with bifacial artifacts were: on the Floodplain 33.33% (7 out of 21 sites), on Terrace One 60.78% (31 out of 51 sites), on Terrace Two 63.64% (7 out of 11 sites) and on Terrace Three 88.89% (16 out of 18 sites). The proportions derived from dividing the number of sites with bifacial artifacts on each terrace by the total number of sites with bifacial artifacts did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the

total number of sites.

PROJECTILE POINTS.

The percentages of sites with projectile points were: on the Floodplain 19.05% (4 out of 21 sites), on Terrace One 45.10% (23 out of 51 sites), on Terrace Two 54.55% (6 out of 11 sites) and on Terrace Three 44.44% (8 out of 18 sites). The proportions derived from dividing the number of sites with projectile points on each terrace by the total number of sites with projectile points did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

GOUGES.

The percentages of sites with gouges were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 3.92% (2 out of 51 sites), on Terrace Two 18.18% (2 out of 11 sites) and on Terrace Three 11.11% (2 out of 18 sites). The proportions derived from dividing the number of sites with gouges on each terrace by the total number of sites with gouges did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

SCRAPERS.

The percentages of sites with scrapers were: on the Floodplain 33.33% (7 out of 21 sites), on Terrace One 39.22% (20 out of 51 sites), on Terrace Two 45.45% (5 out of 11 sites) and on Terrace Three 66.66% (12 out of 18 sites). The proportions derived from dividing the number of sites with scrapers on each terrace by the total number of sites with scrapers did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

EDGE RETOUCHE FLAKES.

The percentages of sites with edge retouched flakes were: on the Floodplain 28.57% (6 out of 21 sites), on Terrace One 27.45% (14 out of 51 sites), on Terrace Two 27.27% (3 out of 11 sites) and on Terrace Three 50.00% (9 out of 18 sites). The proportions derived from dividing the number of sites with edge retouched flakes on each terrace by the total number of sites with edge retouched flakes did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

NOTCHED TOOLS.

The percentages of sites with notched tools were: on the Floodplain 4.76% (1 out of 21 sites), on Terrace One 11.76% (6 out of 51

sites), on Terrace Two 36.36% (4 out of 11 sites) and on Terrace Three 22.22% (4 out of 18 sites). The proportions derived from dividing the number of sites with notched tools on each terrace by the total number of sites with notched tools did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

GRAVERS.

The percentages of sites with gravers were: on the Floodplain 4.76% (1 out of 21 sites), on Terrace One 9.80% (5 out of 51 sites), on Terrace Two 36.36% (4 out of 11 sites) and on Terrace Three 22.22% (4 out of 18 sites). The proportions derived from dividing the number of sites with gravers on each terrace by the total number of sites with gravers did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

HAMMERSTONES.

The percentages of sites with hammerstones were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 1.96% (1 out of 51 sites), on Terrace Two 0% (0 out of 11 sites) and on Terrace Three 11.11% (2 out of 18 sites). The proportions derived from dividing the number of sites with hammerstones on each terrace by the total

number of sites with hammerstones did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

GROUND STONE TOOLS.

The ground stone tools consisted of manos and grooved stones ("shaft abraders"). The percentages of sites with ground stone artifacts were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 5.88% (3 out of 51 sites), on Terrace Two 9.09% (1 out of 11 sites) and on Terrace Three 11.11% (2 out of 18 sites). The proportions derived from dividing the number of sites with ground stone tools on each terrace by the total number of sites with ground stone tools did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

BLADE TECHNOLOGY.

The percentages of sites with blade technology were: on the Floodplain 4.76% (1 out of 21 sites), on Terrace One 15.69% (8 out of 51 sites), on Terrace Two 36.36% (4 out of 11 sites) and on Terrace Three 50.00% (9 out of 18 sites). The frequency of sites with blade technology clearly increases on terraces of greater height. It is possible that blade technology was a more prominent part of the tool kit in the Wisconsin than in the Holocene in this drainage. A

sophisticated blade technology was in existence in northeastern Siberia before 30,000 years ago (Mochanov 1978:64) making an early introduction of blade technology into North America plausible. Blade technology was present in Mexico more than 20,000 years ago (Mirambell 1978:228) and in northeastern Beringia in loess deposits of the Bluefish Caves with radiocarbon dates of $12,900 \pm 100$ and $15,500 \pm 130$ years B.P. (Morlan and Cinq-Mars 1982:368). Blade technology was also associated with the Clovis culture (Alexander 1978:21). It is therefore reasonable to think that the relative abundance of blade technology on the Wisconsin terraces may be due to paleo-Indian occupations.

The proportions derived from dividing the number of sites with blade technology by the total number of sites with blade technology varied from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites. This suggests that the different frequencies of sites with blade tool technology on the various terraces can not be explained by chance.

BLADE CORES.

The blade cores were primarily conical in shape. The percentages of sites with blade cores were: on the Floodplain 0% (0 out of 21 sites), on Terrace One 9.80% (5 out of 51 sites), on Terrace Two 27.27% (3 out of 11 sites) and on Terrace Three 27.78% (5 out of 18

sites). The proportions derived from dividing the number of sites with blade cores on each terrace by the total number of sites with blade cores did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

FLAKE CORES.

The flake cores were primarily amorphous flake cores. The percentages of sites with flake cores were: on the Floodplain 23.81% (5 out of 21 sites), on Terrace One 29.41% (15 out of 51 sites), on Terrace Two 54.55% (6 out of 11 sites) and on Terrace Three 38.89% (7 out of 18 sites). The proportions derived from dividing the number of sites with flake cores on each terrace by the total number of sites with flake cores did not vary from chance at the .05 level of confidence using the Kolmogorov-Smirnov One Sample Test (Siegel 1956:47-52) from the proportions derived from dividing the number of sites on each terrace by the total number of sites.

COMMENTS.

Most of the broad functional categories of lithic tools examined (scrapers, projectile points etc.) did not have distributions that differed statistically on the various terraces. This differs from most of the "index fossil" categories (Archaic projectile points, spurred end scrapers etc.). Hunting and gathering was practiced during all periods of Kansas prehistory (even when agriculture was

engaged in). It is possible the broad functional categories of lithic tools for hunting and gathering remained mostly constant for a very long period of time.

CHAPTER SIX

ARCHAEOLOGICAL IMPLICATIONS

6.1 RESEARCH ADVANTAGES

This research has been an effort to put archaeological data into a geological perspective. A number of archaeological benefits accrue from a geological approach to archaeological data. These benefits include: 1) the creation of a dating technique, 2) the creation of a predictive model, 3) the ability to reconstruct archaeologically important ancient topography, 4) an enhancement of sampling technique and 5) the provision of an organizing principle for field work. Geological processes that create extensive geomorphological features such as alluvial deposition, beach formation, loess deposition, sand dune formation etc. make possible a geological approach to understanding archaeological data. Geomorphological processes create surfaces at different periods of time. This provides some chronological information to date archaeological material deposited on those surfaces. Knowledge of the antiquity of different geological structures allows the archaeologist to predict where sites of a certain antiquity might be found. Archaeologists are interested in the topography of an area as it existed at the time of the culture they are studying. This ancient topography may be quite different from

the modern topography. Geology can aid in reconstructing the ancient topography. Archaeologists are interested in sampling the geographical distribution of cultural traits (e.g. settlement patterns) at different periods of the past. This requires geological knowledge to know what surfaces were available and what portion has been preserved. All archaeological sites are in a geological context. This context is the result of systematic geological processes. It is therefore reasonable for the archaeologist to organize survey work congruent with geological principles.

The research for this dissertation has concentrated on alluvial geomorphology. The data from this research will be used to illustrate the benefits archaeologists can derive from using this technique. An attempt will be made to show how other research might be enhanced by this approach.

POTENTIAL AS A DATING TECHNIQUE.

Stream terraces are sequentially formed. A lower terrace had to have been formed later than a higher terrace in a stream valley. Stream terrace analysis results in the identification of a series of chronologically ordered land surfaces. The chronological ordering of land surfaces creates different potentials for these surfaces to be occupied through time. Inhabitants of a given antiquity can occupy the active floodplain at that time, and any higher terraces. Obviously, they cannot occupy floodplains that had not yet formed. Dating a stream terrace system permits the archaeologist to give a

maximum date for any site on a terrace.

The research done for this dissertation illustrates how terrace analysis can give maximum dates for sites on terrace surfaces of the Arkansas River drainage. The Floodplain has yielded only sites of the Ceramic periods, which is consistent with an antiquity for that terrace of approximately 2000 years. Terrace One has Archaic and Ceramic sites on its surface, which would be expected for a terrace with a maximum age of 9000 to 10,000 years B.P. Terrace Two has paleo-Indian, Archaic, and Ceramic sites on its surface which is consistent with a maximum age extending into the late Wisconsin. It follows from this that a site found on the surface of the Floodplain would have a maximum age of 2000 years, of Terrace One would have a maximum age of 9000 to 10,000 years, and of Terrace Two would have a maximum age of late Wisconsin time.

Any archaeological site buried in a terrace fill must be no younger than the surface above it, and no older than the higher terrace surface. An example of how this technique works on the Arkansas River drainage would be 14N07 exposed in a vertical bank cut of the Neosho River. Schmits (1973) identified with diagnostic artifacts an Early Ceramic buried component. Terrace analysis would also lead to the conclusion that this site belonged to the Ceramic periods. The next higher terrace (Terrace One) contained late Archaic material in the upper portion of the terrace fill (for example the Snyder site). The Floodplain surface lacks Archaic sites, but has Ceramic sites.

An analysis of the terrace data would suggest that 14N07 was later than the late Archaic, and of the same age or older than the Ceramic age sites. An Early Ceramic date for 14N07 fits nicely with the terrace analysis.

POTENTIAL AS A PREDICTIVE MODEL.

Terrace analysis can be used to date an archaeological site. Terrace analysis can also be used to locate archaeological sites of a given antiquity. The ability to predict where sites of a specified antiquity could be found greatly enhances fieldwork by helping the researcher focus on specific chronological problems.

Stream terraces are sequentially formed. They represent a series of chronologically ordered land surfaces. Stream terraces are closely associated with water and are therefore a likely focus for human settlement. There is a high probability that sites of a given time period can be located by identifying and systematically surveying the chronologically appropriate terrace. A spectacular example of how effective this approach can be was the author's investigation of Terrace One on the Neosho River near Chanute, Kansas. Figure 33 illustrates the distribution of some of the archaeological sites in this area. Note the abundance of archaeological sites on the edge of Terrace One. Six out of the 15 sites on Terrace One illustrated in Figure 33, yielded diagnostic artifacts. These six sites were Archaic and there was no evidence of any other chronological component. The sites on Terrace One at this locality

(except for one site) were discovered in only a few hours of surveying by one person. This demonstrates the efficiency that can be achieved by using terrace analysis to locate sites of a given antiquity for problem oriented research.

POTENTIAL FOR RECONSTRUCTING TOPOGRAPHY.

Landscapes change through time, and if this were not true, terrace analysis would be impossible. The changes that produce stream terraces alter the landscape. Stream valleys are frequently foci of human habitation. Archaeologists have an interest in reconstructing the topography surrounding archaeological sites as it was at the time the sites were occupied. Such reconstructions cannot be done unless a stream terrace analysis of the relevant stream valley has been done. Some stream valleys have undoubtedly undergone very little change and consequently there may be very little need for topographic reconstruction. The archaeologist, unfortunately, will not know this to be the case unless a terrace analysis is done.

Data from the research for this dissertation illustrates the potential of stream terrace analysis for reconstructing topography. The terrace system of the Arkansas River drainage suggests that the need for an archaeologist to reconstruct topography increases with older archaeological sites. The topography of the stream valleys in the Arkansas River drainage has changed relatively little since the Ceramic periods, but has changed significantly since the Archaic. The changes have been even greater since the Wisconsin. The situa-

tion is far more dramatic in the Smoky Hill River drainage where the Holocene river valley record is divided into five terraces (including the Floodplain). Terrace Five, a late Wisconsin terrace, was approximately 65 feet above the Smoky Hill River. This is a significant portion of the total relief of the area. The topography of the region when occupied by paleo-Indians must have been quite dissimilar to the present topography. The changes in the Smoky Hill River valley have been so profound that little could be said meaningfully about the ancient settings of many archaeological sites in that region without using terrace analysis.

POTENTIAL FOR ARCHAEOLOGICAL SAMPLING.

What survives of past human behavior is only a sample of that behavior and is known as the archaeological record. Archaeologists sample this record and try to reconstruct elements of past behavior.

Archaeologists have recently placed much emphasis on how the archaeological record is to be sampled. Stream terrace formation has a significant influence on what archaeological sites are preserved or destroyed. Consequently, stream terrace systems must be understood by archaeologists before a stream valley can be intelligently sampled.

An example of how stream terrace analysis can enhance our understanding of archaeological sampling can be observed on the Arkansas River drainage. An archaeologist that surveyed an area of the river valley that was dominated by the Floodplain would discover mostly

sites from the Ceramic periods, because the principal geological deposit was of an antiquity that would yield such sites. An archaeologist that did not have available a terrace analysis of the region, might hypothesize that inhabitants of the Ceramic periods found the valley bottoms attractive places to camp, and that earlier (Archaic and paleo-Indian) inhabitants preferred other places to camp. The archaeologist might even believe that during the Archaic or paleo-Indian periods that the region was virtually uninhabited. However, a survey of the chronologically appropriate terraces would reveal all the cultural periods inhabited their contemporary floodplains.

When dealing with archaeological sites in a stream valley, it is necessary for archaeologists to control certain variables like the age of land surfaces. This is similar to what Binford (1964:429) describes as creating a stratified sample. Stream terraces provide a control over chronological variables.

The study of the area where the inhabitants of an archaeological site obtained most of their resources is known as site catchment analysis. These studies require the analytic territory to be defined by an arbitrary circle, or by the distance that could be traveled in a given length of time, or by the site's relationship to contemporaneous neighboring sites. These studies also require the resource zones to be measured within the catchment area (Roper 1979:130).

Terrace analysis could enhance site catchment studies. The catchment areas that are defined by the proximity of contemporaneous sites need to be studied to see if contemporaneous sites have possibly been removed by terrace formation processes. Archaeological sites are more likely to be destroyed by erosion nearer the stream channel than the valley wall, hence, there is likely to be a bias toward sites having large upland resource zones. When the relevant terrace survives principally in restricted areas along the valley wall, one should consider this bias to be highly probable. The reconstruction of resource zones presupposes the reconstruction of topography which can't be adequately done in a stream valley without terrace analysis.

POTENTIAL FOR ORGANIZING SURVEY WORK.

Stratigraphy offers a natural and logical way to organize the excavation of an archaeological site. Similarly, terrace analysis offers a natural and logical way to organize archaeological survey work. Stream terrace formation chronologically orders land surfaces. An archaeologist can utilize this knowledge to ensure when possible that all the chronological periods the researcher is interested in have been searched for in their appropriate geomorphological areas. Frequently, surface sites do not yield diagnostic artifacts, but if the terraces on which they reside are dated, a maximum date can be assigned. Buried sites without either absolute dates or diagnostic artifacts can be given minimal dates by terrace analysis. This may

help archaeologists in the field to assign priorities for which sites should be studied more intensively. The chronological insights provided by terrace analysis makes a framework for exploration and analysis in archaeological surveys.

6.2 RECOMMENDED RESEARCH PROCEDURES

Archaeological research frequently takes place in stream valleys. Stream terrace analysis is a logical way to organize this research. Much of American archaeological fieldwork is being financed by government contracts and some contracts specify that stream terrace analysis be done. Suggested research procedures will be discussed in this section. These procedures should be considered as possible approaches rather than inflexible rules.

PERSONNEL SELECTION.

The most desirable choice for stream terrace analysis would be a suitably trained geologist (or geographer). Finding such personnel that have a desire to work on archaeological projects is not always easy. Geology (like anthropology) is a very broad field and a researcher may be competent to do research in one aspect of the field but not in another. The most promising candidate would be a geologist interested in Quaternary problems (and alluvial geomorphology in particular). Requiring such qualifications will greatly restrict the range of possible candidates and the archaeologist will likely have to select someone less specialized.

The alternative is to have an archaeologist acquire some training working with alluvial geomorphology, and have this individual do the terrace analysis. There are advantages and disadvantages to this approach. The archaeologist may be less knowledgeable about geology, but may be more motivated to apply what is known to the relevant archaeological problem.

ARCHAEOLOGICALLY RELEVANT GEOLOGY.

Geologists and archaeologists are interested in many things. Unfortunately, they are not always interested in the same things. What may fascinate a geologist, may in some cases be of little interest to an archaeologist. Archaeological research projects may have a consultant geologist, and it is necessary for the geologist to provide the sort of data that will enhance the archaeological work. Unfortunately, not all archaeologists know what they should ask the geologist to provide in the way of data. An archaeologist working on a survey project in a stream valley should expect the geologist to provide a terrace analysis. It should be stressed that the archaeologist intends to use the terrace analysis as: 1) a dating technique, 2) a predictive model, 3) a tool for reconstructing ancient topography, 4) a sampling technique, and 5) a way of organizing survey work. Emphasis should be put on those aspects of the geological fieldwork that will enable the archaeologist to do this.

DOCUMENTATION.

When stream terraces are identified, they should be dated. Archaeologists wish to make rather precise use of these dated surfaces, so archaeologists must insist that dating of a terrace be documented. Index fossils or absolute dates must be obtained either from the surface or buried in the fill of the terrace. Only empirical documentation should be relied on. A terrace is not necessarily of great antiquity because it is high above a stream. A terrace is not necessarily of recent antiquity because it is near the level of a stream. Terraces should not be arbitrarily given dates so they will agree with some preconceived idea of climatic fluctuation. Terraces should not be assigned dates just to conform to a dated terrace system hundreds of kilometers away.

The author's research on the Smoky Hill River yielded empirical evidence dating several terraces either to the Holocene or to the late Wisconsin, which had been ascribed an antiquity of hundreds of thousands of years by researchers that had not used empirical evidence. The archaeologist that relies on dates given to terraces without empirical evidence is taking unwarranted chances.

INVESTIGATION SEQUENCE.

It is desirable, if possible, to coordinate the activities of the geologist and archaeologist when surveying a stream valley. Both fields of research can benefit. The geologist should carefully examine topographic maps and locate promising areas that will most clearly show the series of stream terraces that are present. The ar-

archaeologist should gather what archaeological data are available for the area and in cooperation with the geologist, try to find any gross correlations between the antiquity of sites and their height above the stream. Ideally, the geologist would begin fieldwork first, identifying the terraces, measuring the heights of terrace surfaces above stream level, and mapping the areas covered by different terraces. Archaeological survey work should follow with systematic exploration of the various terraces. Special emphasis should be given to examining terrace edges if the researcher desires to excavate buried components. A site that is buried in a terrace will be exposed on the terrace slope as the deposit erodes away. Although, a surface scatter of cultural debris on the slope of a terrace does not necessarily indicate there is a buried component, the odds are better than if one dug surface sites at random. Surveys for large government contracts might consider having terrace slopes plowed to expose sites that might contain buried components that would otherwise be hidden by vegetation. As sites are located, the archaeologist and geologist should formulate and refine hypotheses about the age and cultural relevance of the terraces. Archaeological data in the form of diagnostic artifacts may prove to be the most abundant datable material that the geologist can obtain in certain regions. The excavation of trenches into the terraces may be considered desirable by the geologist to determine stratigraphy within the terraces. A more efficient use of resources might be for the geologist to use ar-

chaeological site excavations to obtain stratigraphy. When fieldwork is finished, the geologist should cooperate with the archaeologist to assign maximum or minimum dates to sites lacking diagnostic artifacts or absolute dates, but having an association with stream terraces. Topographic reconstructions should be made if ecological or settlement analyses of the archaeological data are to be attempted.

Obviously, not all research could follow this idealized sequence. Large government contracts requiring several field seasons to survey such areas as reservoirs could closely approximate this idealized sequence. Smaller surveys and problem oriented research could utilize some of these proposals.

CHAPTER SEVEN

CONCLUSIONS

The proposition tested in this dissertation is that alluvial geomorphology should provide a valuable framework for understanding the archaeological record of Kansas. Research was done in the Kansas and Arkansas River drainages.

It was first necessary to describe and date the terrace systems occurring on the two drainages. The Smoky Hill River portion of the Kansas River drainage has five terraces (the Floodplain and Terraces One through Four) dating to the Holocene. A sixth terrace (Terrace Five) dates to the late Wisconsin. This contrasts with the Arkansas River drainage that has two terraces (the Floodplain and Terrace One) dating to the Holocene, two terraces dating to the Wisconsin (Terrace Two and Terrace Three) and at least one terrace (Terrace Four) dating to the Middle Pleistocene.

It is important to note that at least two very distinct terrace systems exist in adjacent drainages in Kansas. An archaeologist should not assume that a distant terrace system will necessarily be applicable to the region being studied.

Terrace systems are thought to be created by such factors as uplift and climatic change. Climate does not appear to be the most important factor involved in creating the terrace systems that were

studied in Kansas. The terraces of neither system can be shown to correlate with the major climatic changes that have occurred in the region. The existence of two extremely different but adjacent stream terrace systems in Kansas could only be explained climatically by making the assumption that there were two radically different but adjacent climatic regimes in Kansas conforming to drainage boundaries. There is no evidence for this. The uplift theory has much to recommend it. Asymmetrical stream valleys in the region indicate crustal movement is influencing modern drainages. Earthquakes concentrate along the divide separating the Arkansas and Kansas River drainages which is consistent with friction that would be generated from two adjacent pieces of the earth's crust uplifting at different rates. The heights of consecutive terrace surfaces relative to each other are remarkably consistent in different parts of the same drainage. This could be explained by episodes of relatively uniform uplift causing widespread downcutting of streams. It is not consistent with changes induced by climatically controlled variables such as vegetation and runoff that would vary at different points in the drainage. Uplift is the most probable major factor in terrace formation in Kansas, although climate may have been a minor factor.

A total of 101 archaeological sites were located on stream terraces of the Arkansas River drainage. Such diagnostic artifacts as ceramics, Archaic projectile points, fluted projectile points, and spurred end scrapers were found only on terraces that were in ex-

istence when these artifacts were believed to have been used. This is interpreted as a successful demonstration that terrace analysis can be used to examine chronologically the archaeological record of Kansas.

Broad categories of artifacts, not thought to be "index fossils," such as bifaces, scrapers, edge retouched flakes, notched tools, etc. did not show statistically significant differences in terrace distribution. Blade technology was a lone exception, with it being more abundantly represented on the higher terraces. The general uniformity of the various broad lithic categories on the different terraces requires an explanation. A probable explanation is that hunting-gathering activity occurred during the entire human prehistoric record in this area. It is conceivable that a broadly similar lithic tool kit was used in this region for hunting-gathering activities which did not change greatly from the Wisconsin to Euro-American contact.

The terrace system discovered on the Arkansas River drainage was used to search for sites of specific antiquity. The author, using stream terrace analysis, was able to discover paleo-Indian sites, Archaic sites, and sites from the Ceramic periods. Each of these categories of sites were located by searching chronologically appropriate terraces, and not by randomly searching the landscape.

Although most of the archaeological research for this dissertation was done in the Arkansas River drainage, the Kansas River

drainage was briefly examined. The 12 Mile Creek site, the first paleo-Indian site to be excavated by scientifically trained personnel, was found to be buried in Terrace Five. The site was radiocarbon dated to be somewhat more than 10,000 years old. Important ecological information (from analyses of pollen and snails) was recovered. The pollen analysis suggested the presence of a pine parkland. The snail data suggested cooler summers than now occurring in the area.

Gravel bars on the Kansas River were examined. These geomorphological forms were important primarily because of the abundance of ancient organic material preserved on them. These gravel bars are the principal source of knowledge about the Wisconsin mammalian fauna of northeastern Kansas. Potentially important human bones are found scattered on the gravel bars. Many of the human bones are found near bones of Pleistocene animals. Some of the human remains exhibit preservation similar to that of nearby extinct animal remains. The gravel bars have also yielded paleo-Indian projectile points. Radiocarbon dates will be obtained in the future on the human bones. The probable reason for the abundance of ancient organic material on the gravel bars, is that they were washed from deposits beneath the water table where they had been preserved by anaerobic conditions. The location of gravel bars yielding Pleistocene fauna appear to have shifted downstream in historic time. This may be due to a post Euro-American settlement bed load surge.

The Wichita sandpits on the Arkansas River drainage yielded a similar abundance of organic material. The preservation was also probably due to anaerobic conditions beneath the water table. The sandpits have yielded many Pleistocene fossils and botanical remains. Several projectile points dating to the Wisconsin-Holocene boundary time, and a few human bones have also been discovered at the sandpits. The fauna from the Wichita sandpits is typical of the Camelops faunal province, while the fauna from the Kansas River gravel bars is typical of the Symbos-Cervalces faunal province. This indicates that during the Wisconsin there were two quite different and well demarcated biogeographic provinces in Kansas.

The material strewn on the gravel bars of the Kansas River and pumped up from the Wichita sandpits lacks adequate provenience. Although these data can be archaeologically useful, the material from stream terraces is in most cases much more important because it has much better provenience.

This study has demonstrated that knowledge of alluvial geomorphology can greatly enhance Kansas archaeological research by 1) creating a dating system, 2) creating a predictive model for locating sites of a specific antiquity, 3) providing a way to reconstruct archaeologically important ancient topography, 4) improving sampling technique, 5) providing a way to organize field work, and 6) locating areas likely to yield abundant organic material. These benefits support the idea that alluvial geomorphological analysis should be

widely used in local archaeological projects undertaken in stream valleys. Suggestions on how to do terrace analysis for an archaeological project have been discussed.

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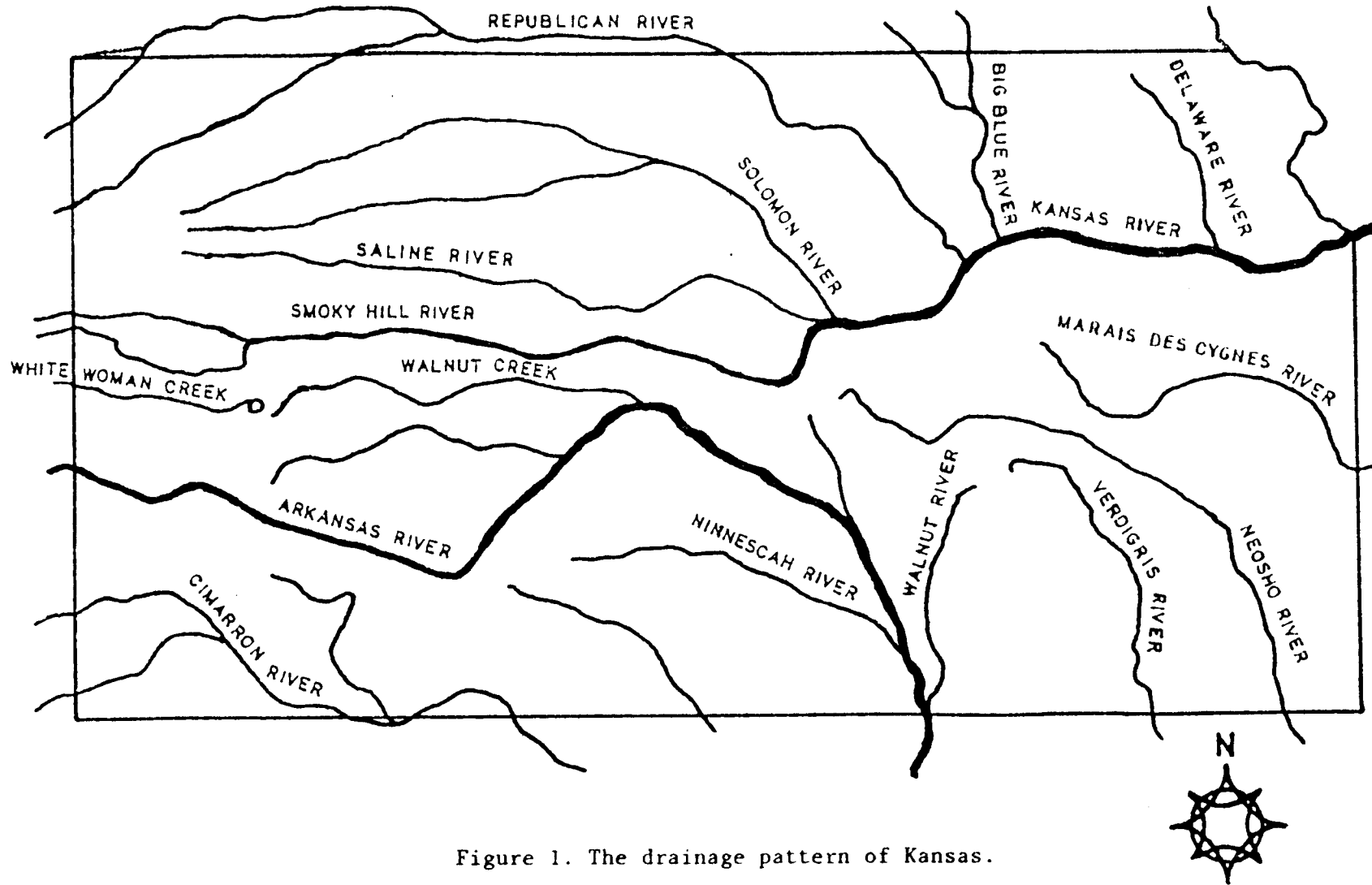


Figure 1. The drainage pattern of Kansas.

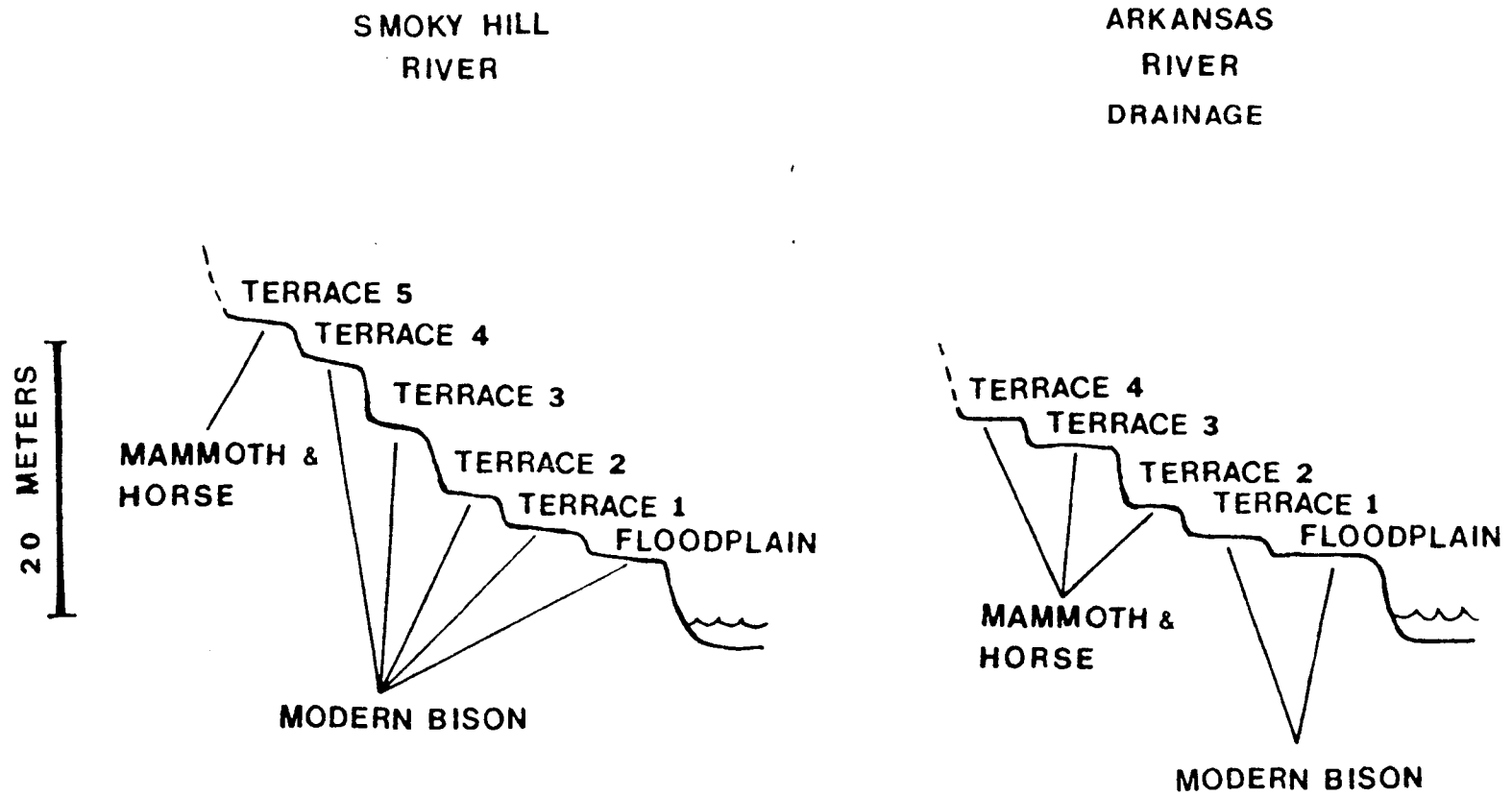


Figure 2. The contrast is illustrated between terrace systems of the Arkansas and Smoky Hill drainages.

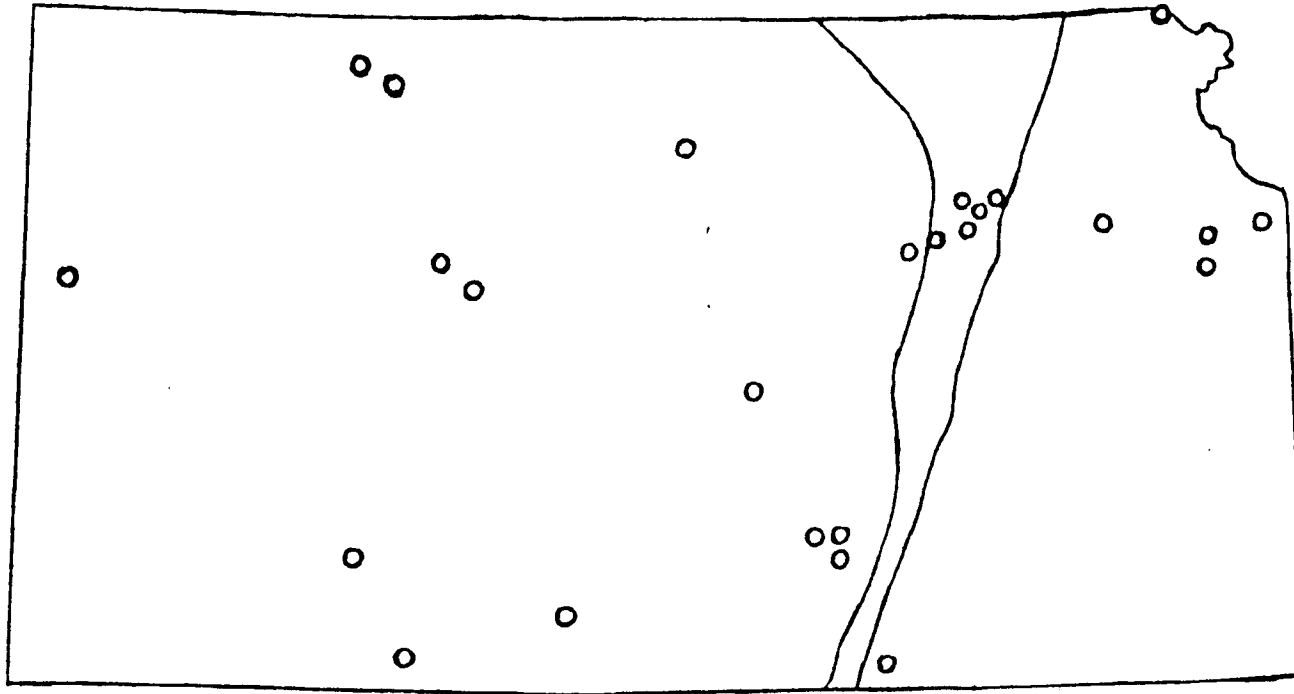


Figure 3. Distribution of earthquake epicenters (circles) in Kansas and the location of the Nemaha anticline in the eastern part of the state.

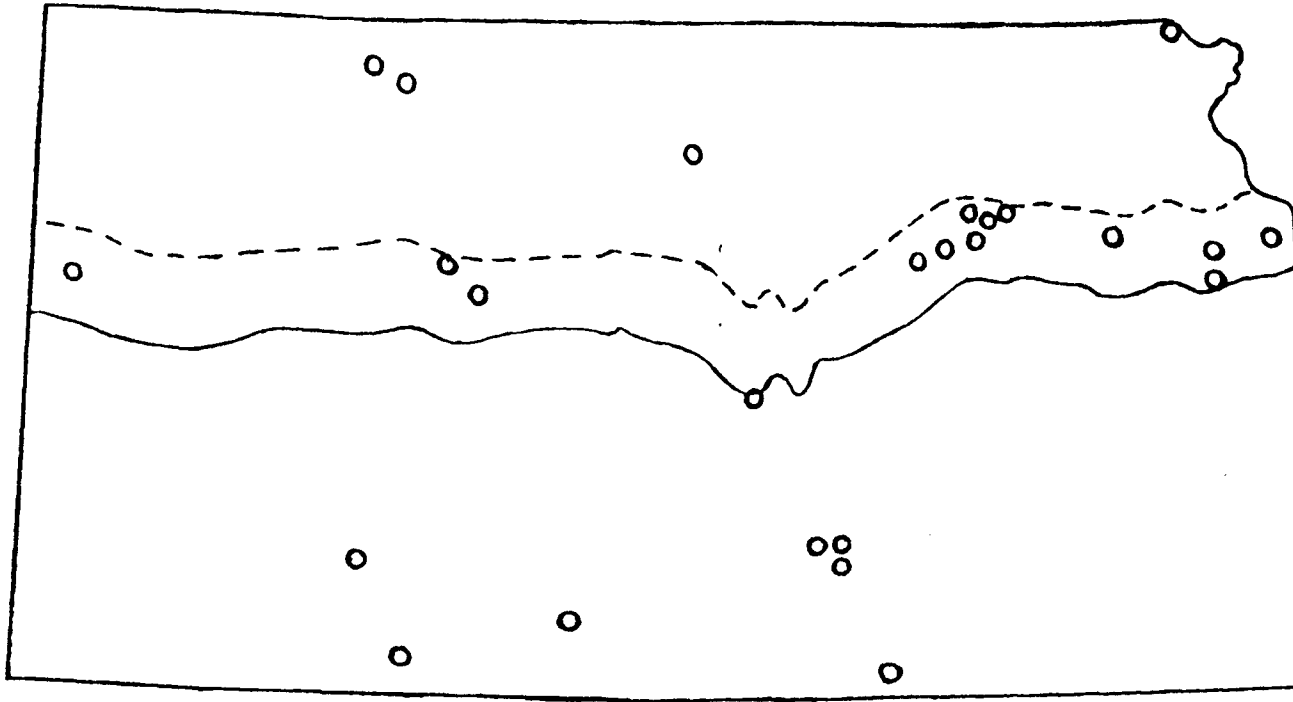


Figure 4. Distribution of earthquake epicenters (circles) in Kansas and the location of a 25 mile wide band along the northern edge of the southern divide of the Smoky Hill-Kansas River drainage.

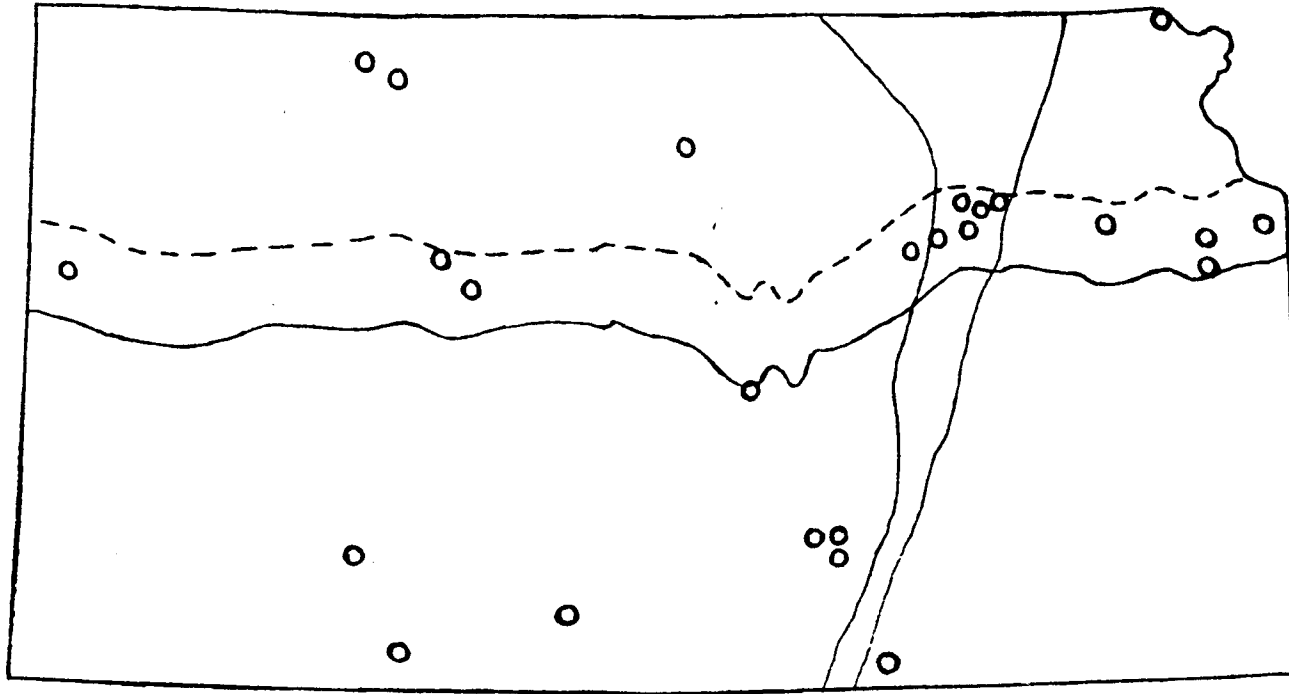


Figure 5. Distribution of earthquake epicenters (circles) in Kansas showing that the only earthquake epicenters on the Nemaha anticline are in the area intersected by the northern edge of the southern divide of the Smoky Hill-Kansas River drainage.

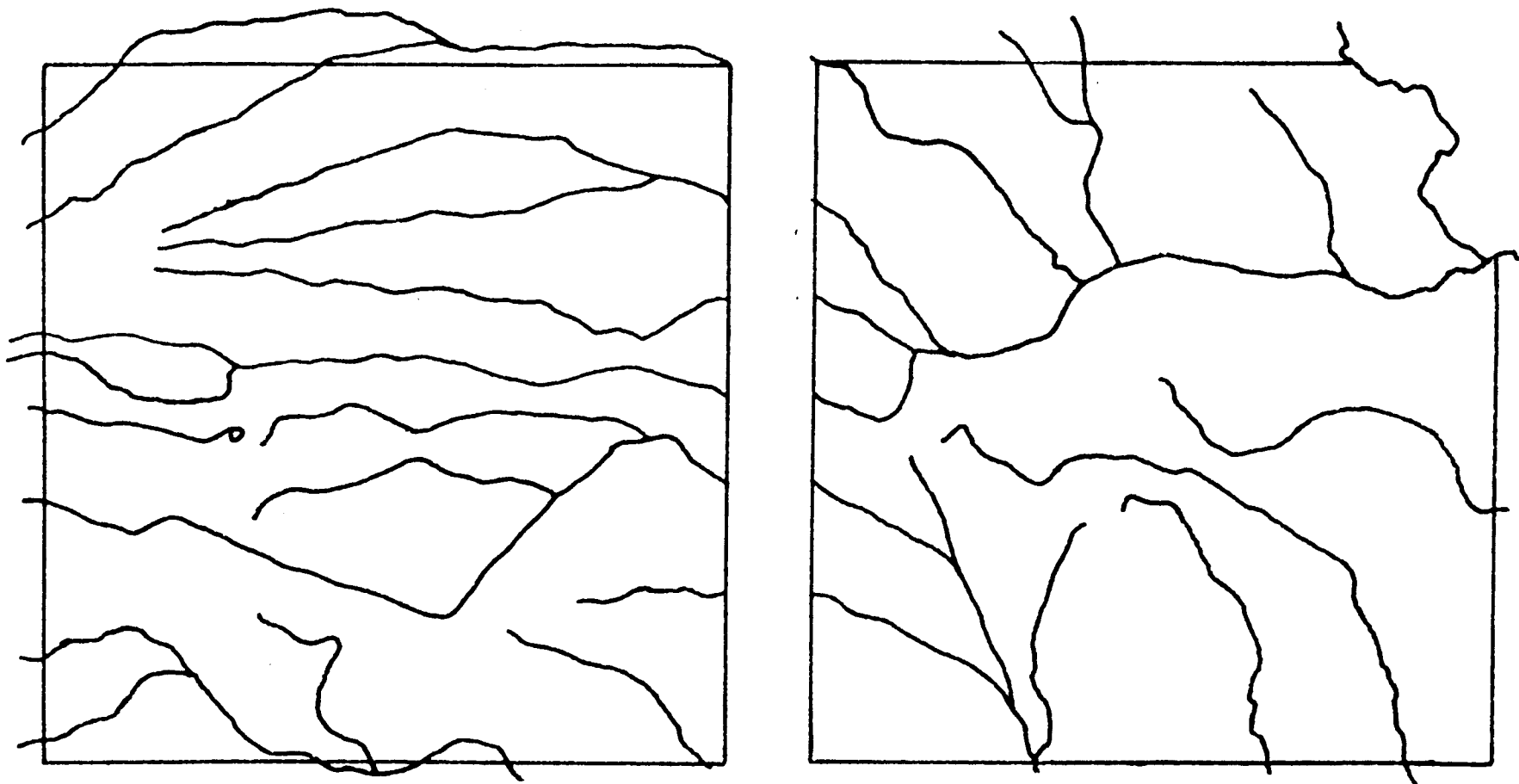


Figure 6. An illustration of how the streams in the western part of Kansas are oriented more in a west to east direction, than streams in the eastern part of Kansas.

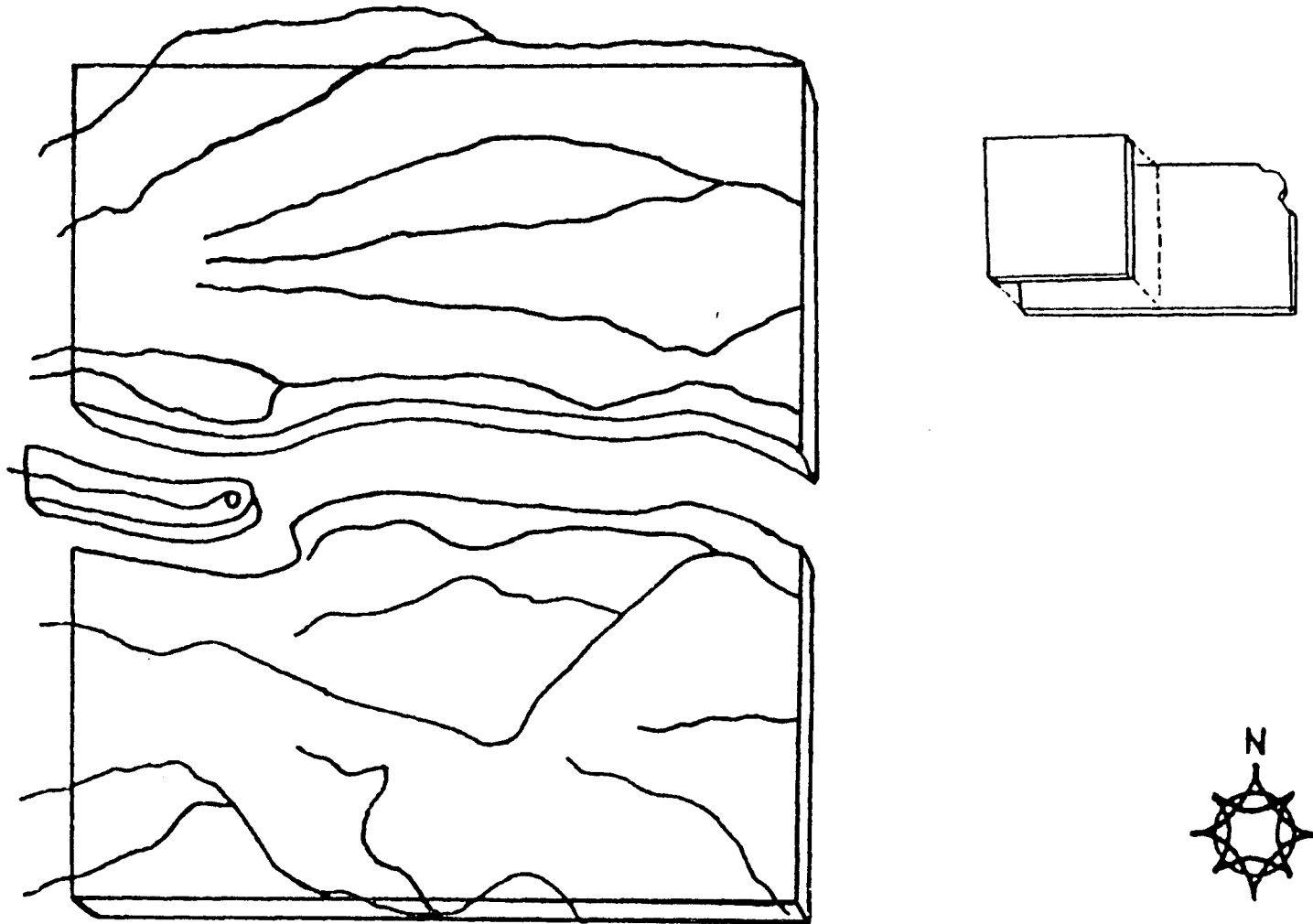


Figure 7. An illustration of how the streams in western Kansas are oriented more west to east in the Smoky Hill-Kansas River drainage than in the Arkansas River drainage.

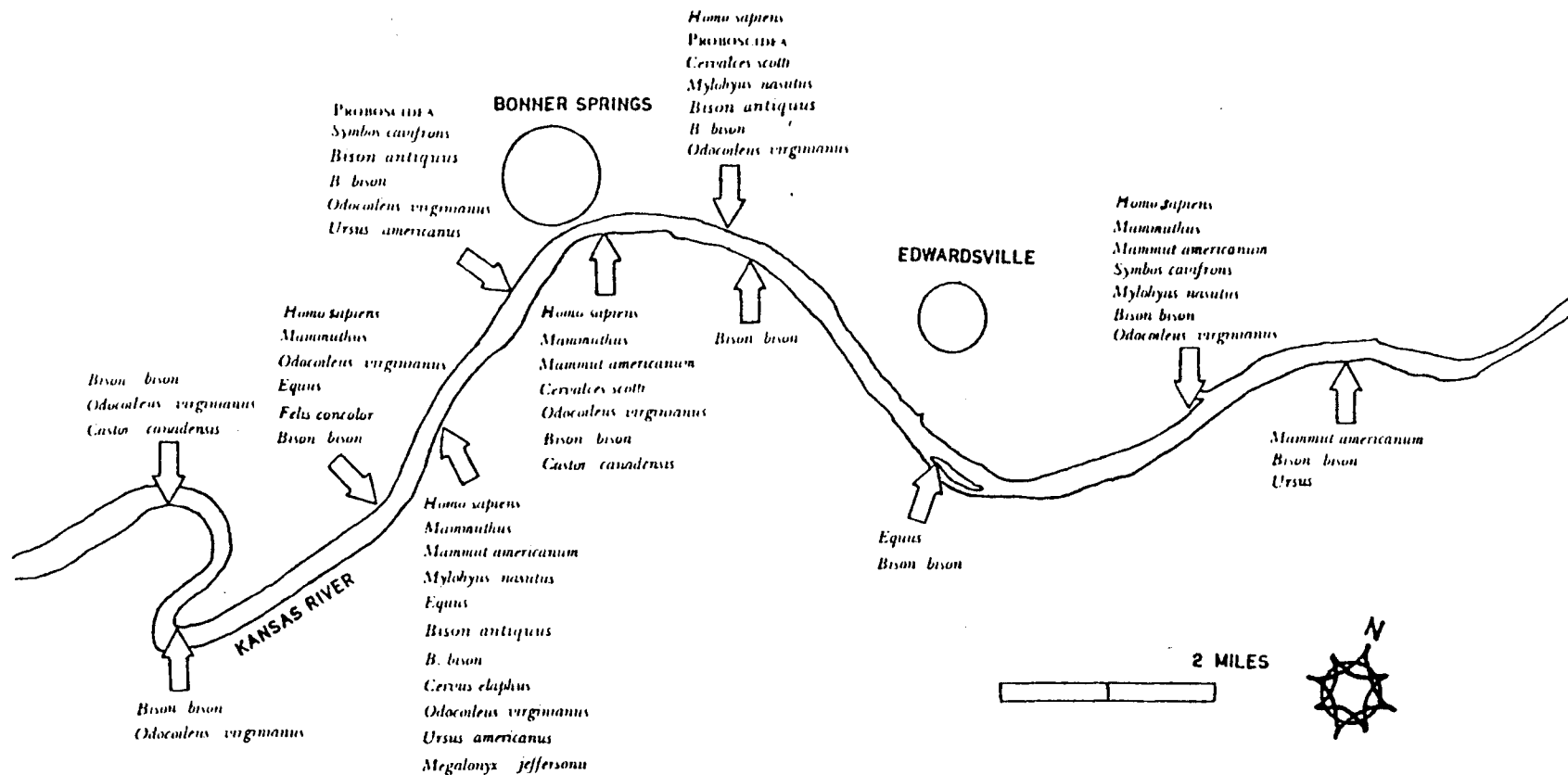


Figure 8. The distribution of mammalian taxa recovered from the Kansas River in the vicinity of Bonner Springs, Kansas.

KANSAS RIVER

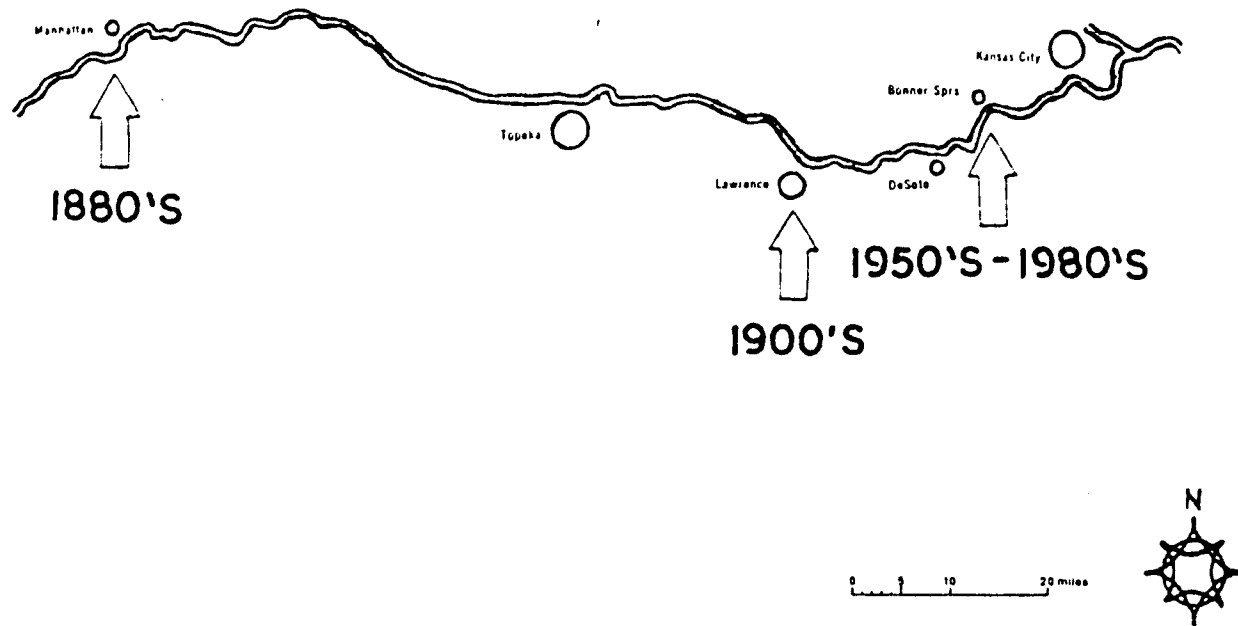


Figure 9. Approximate dates when Kansas River localities have yielded Pleistocene fossils, suggesting a downstream shift of collecting localities through time.

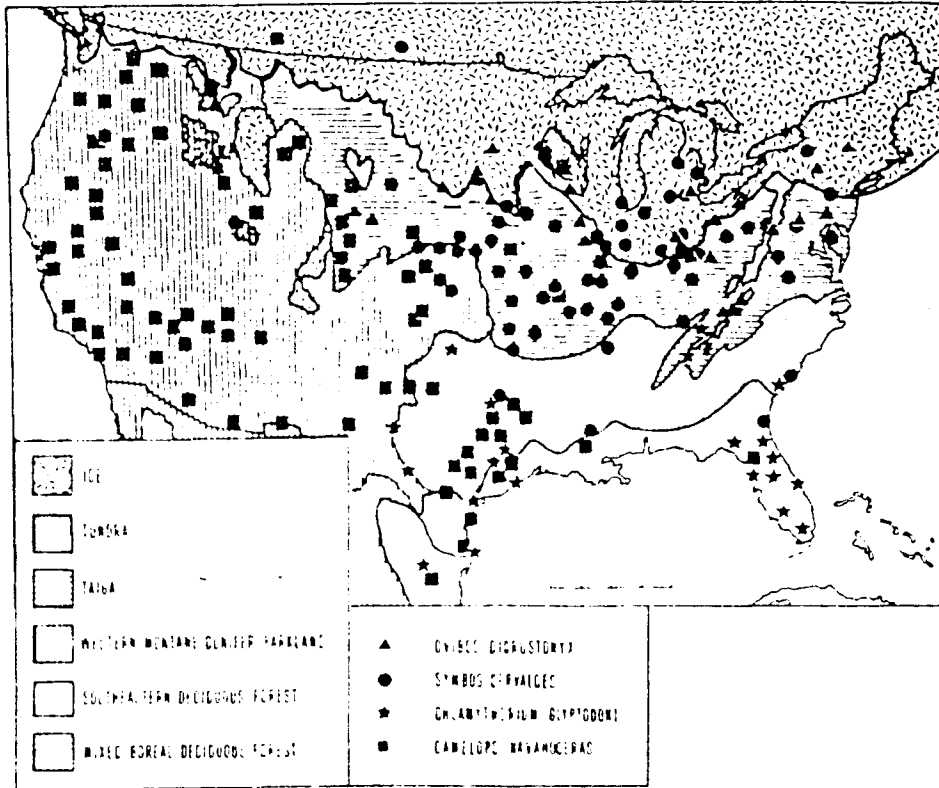


Figure 10. The North American Wisconsin Faunal Provinces of Martin and Neuner (1978).

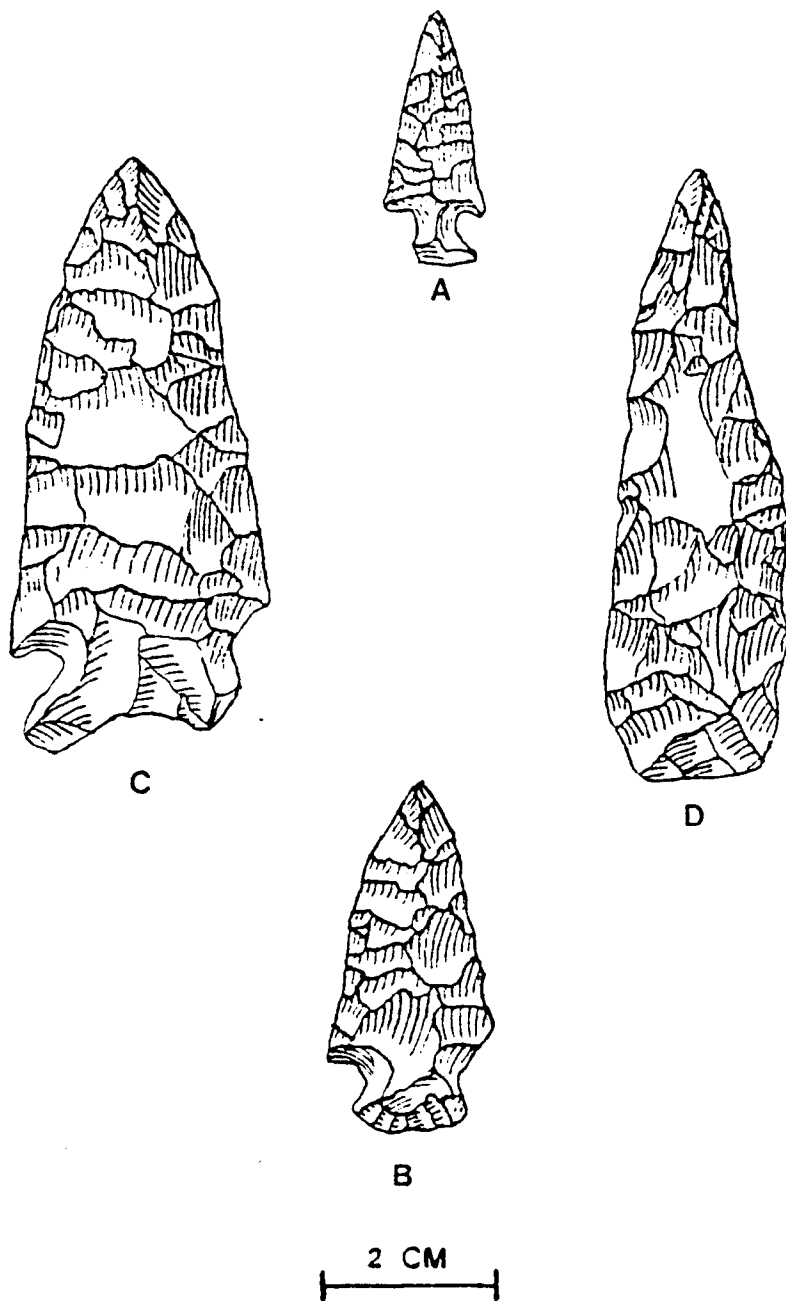


Figure 11. Ceramic period (A, B) and Archaic (C, D) projectile points from the Kansas River.

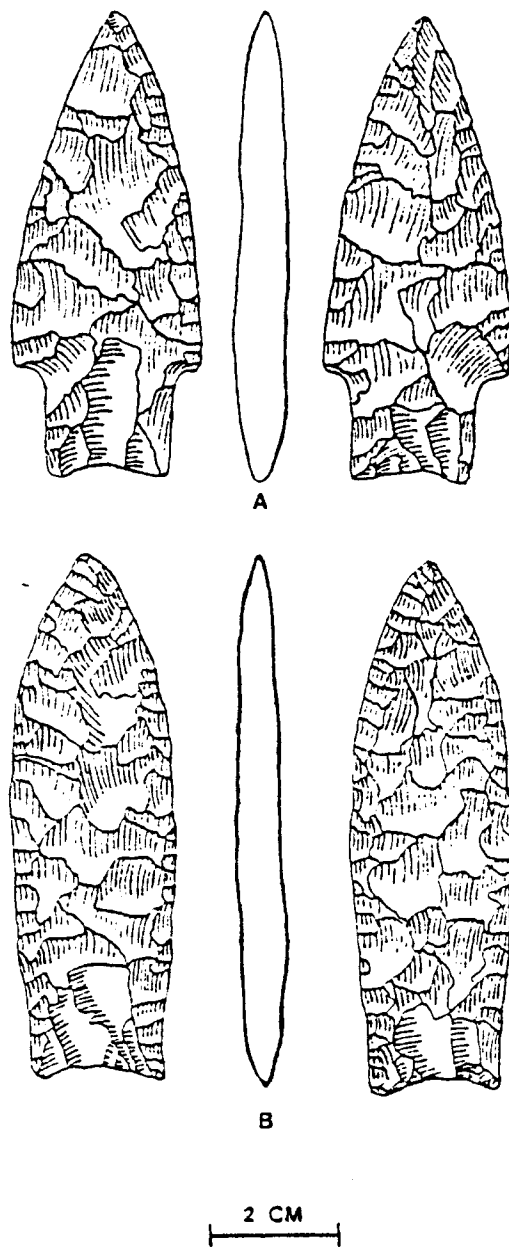


Figure 12. Holland (A) and Clovis (B) projectile points from the Kansas River.

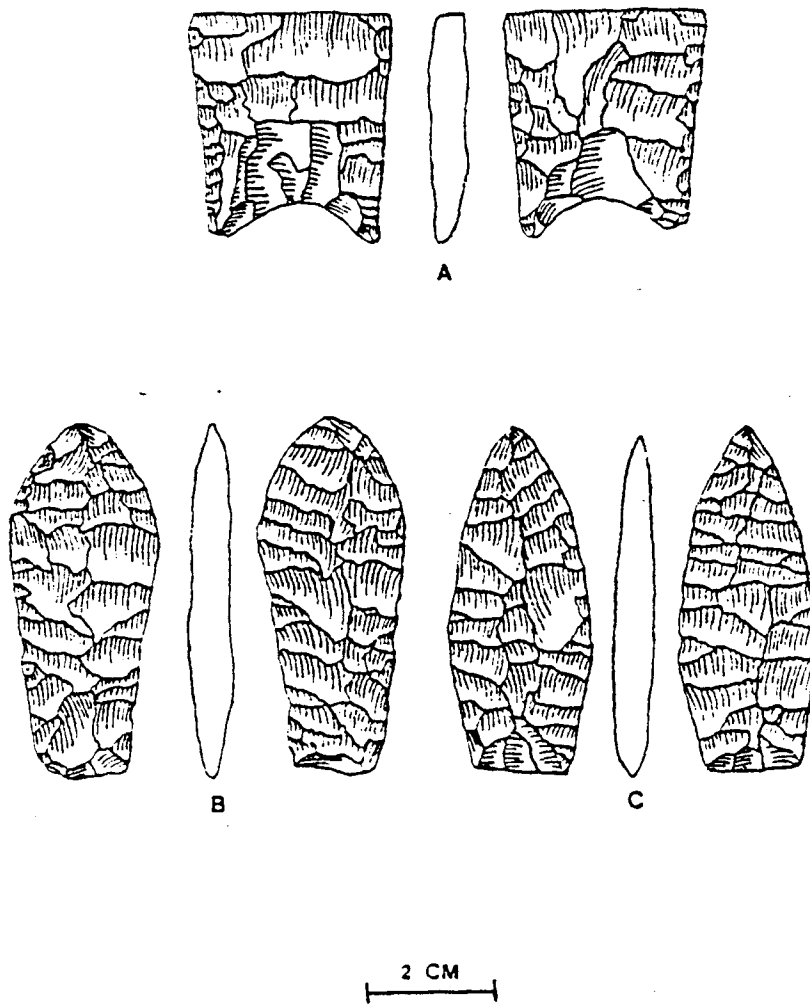


Figure 13. Clovis ? (A), Hell Gap (B), and Milnesand (C) projectile points from the Kansas River.

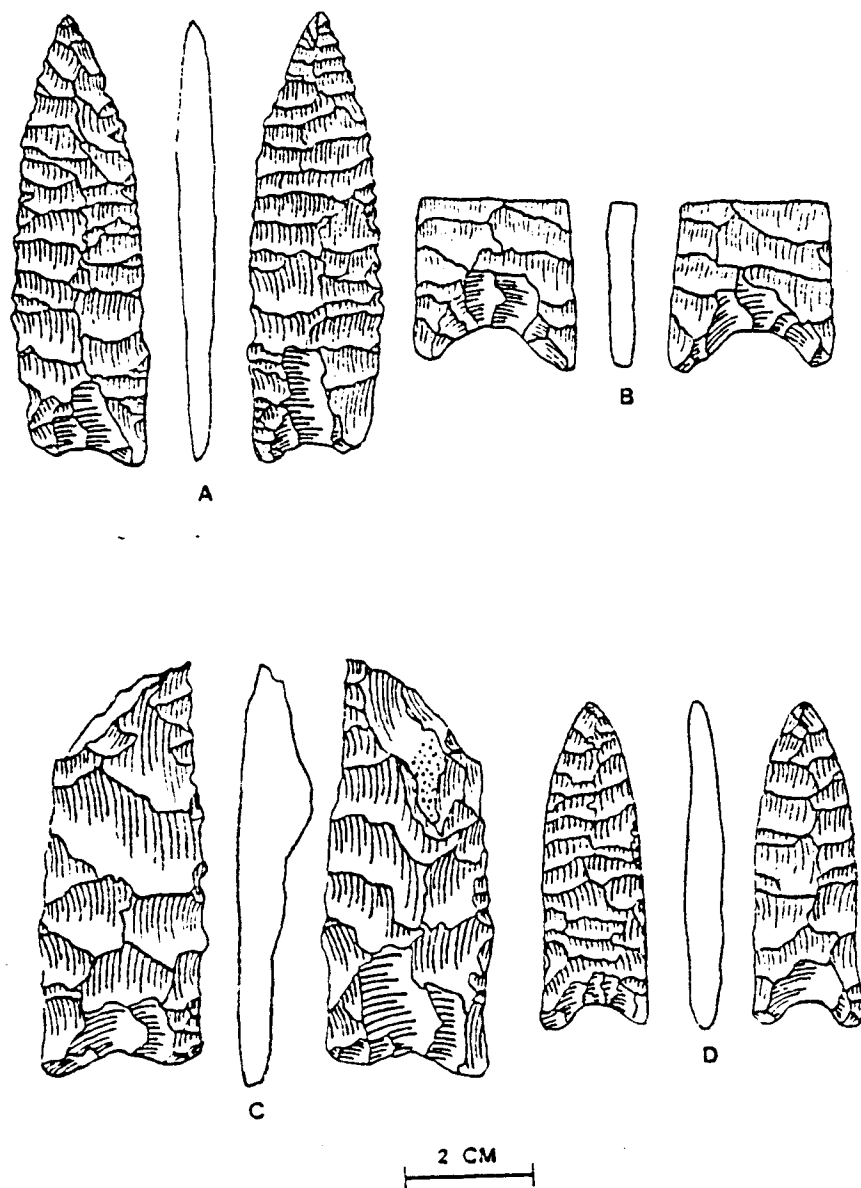


Figure 14. Four Meserve or Dalton projectile points from the Kansas River.

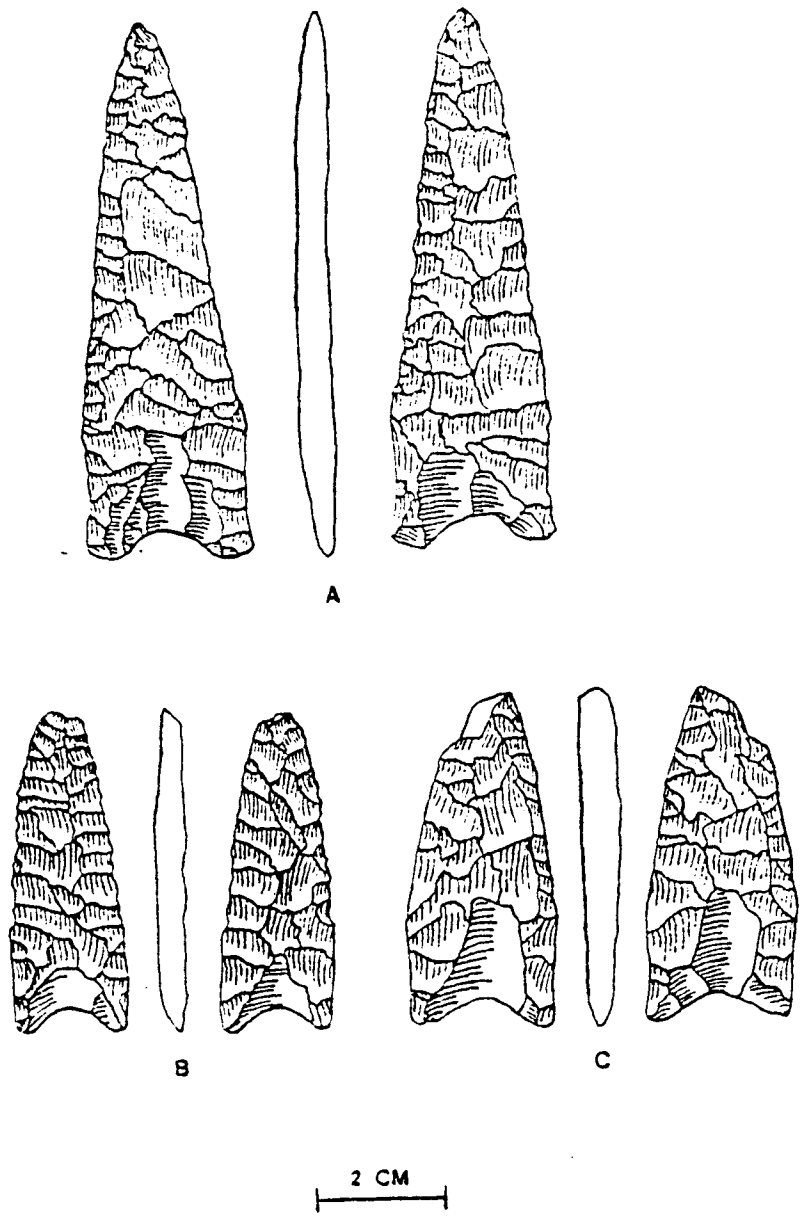


Figure 15. Three Meserve or Dalton projectile points from the Kansas River.

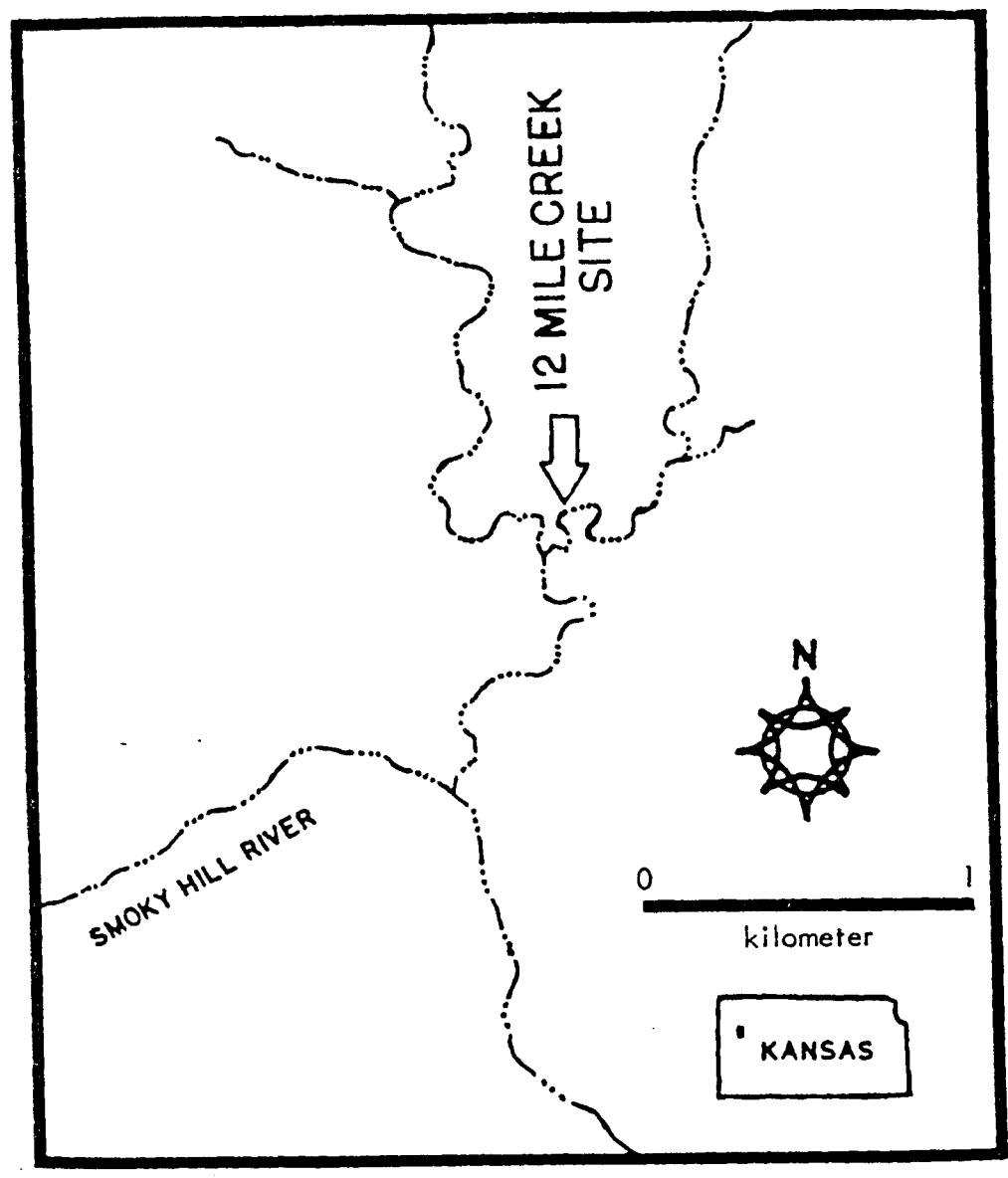


Figure 16. Location of the 12 Mile Creek site.

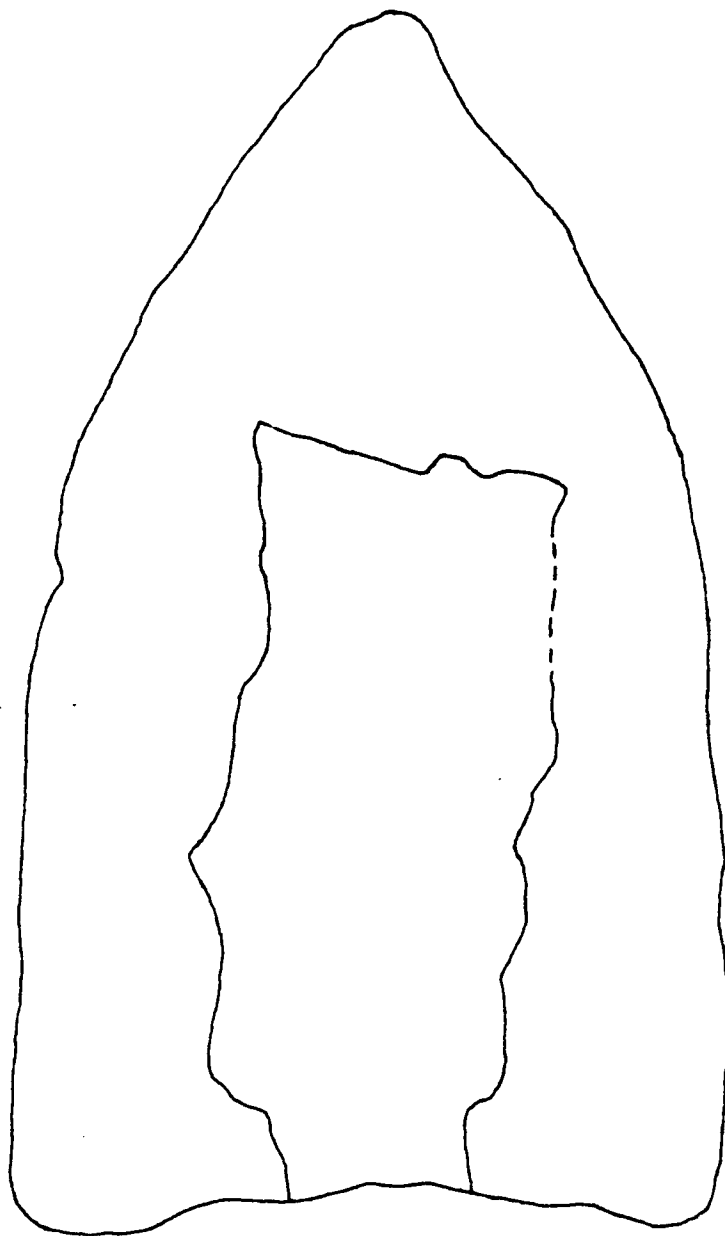


Figure 17. Outline of the projectile point (not to scale) from the 12 Mile Creek site, the area of the flute is outlined, and the asymmetrical tip (probably indicating resharpening) is shown.

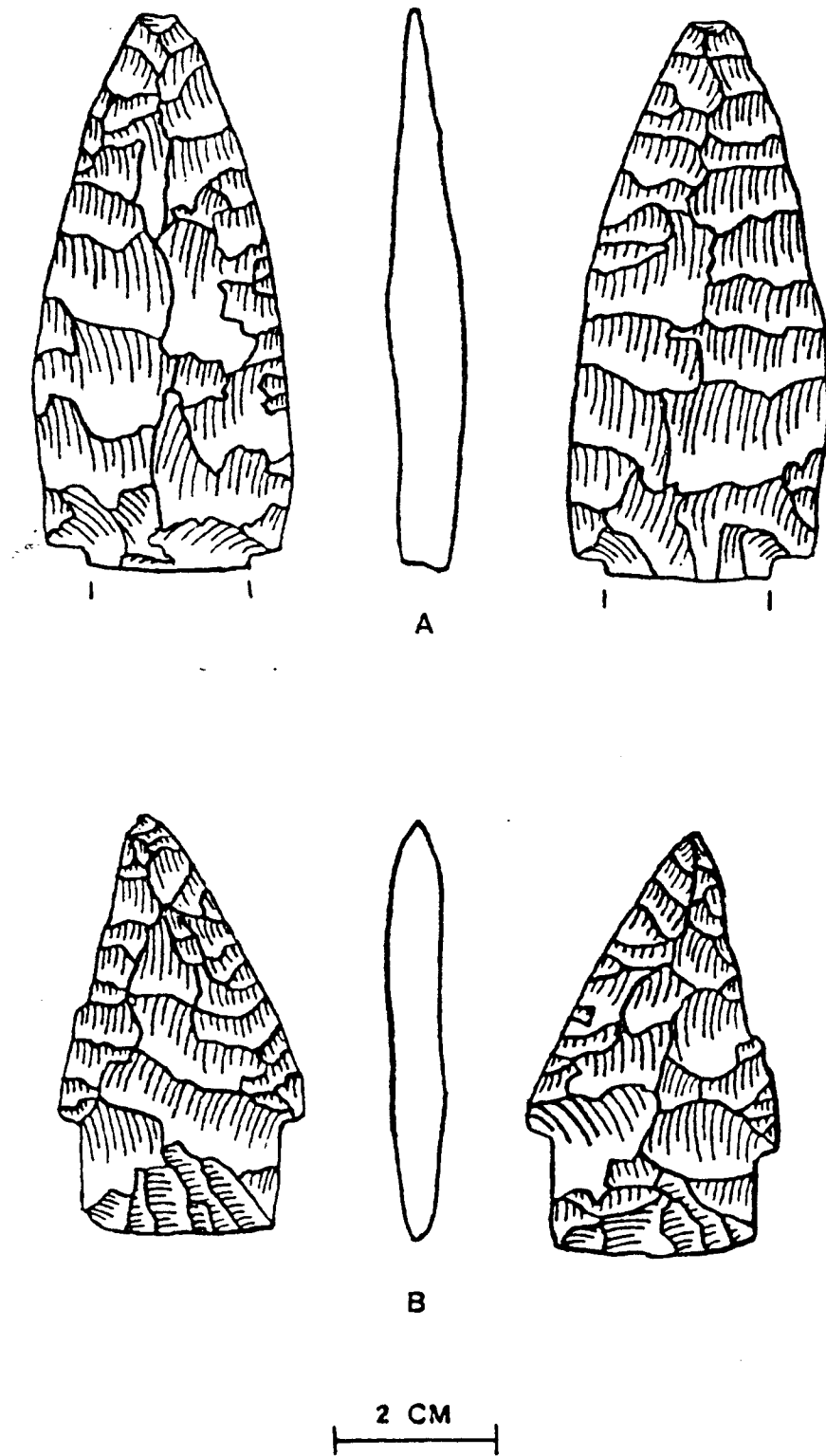
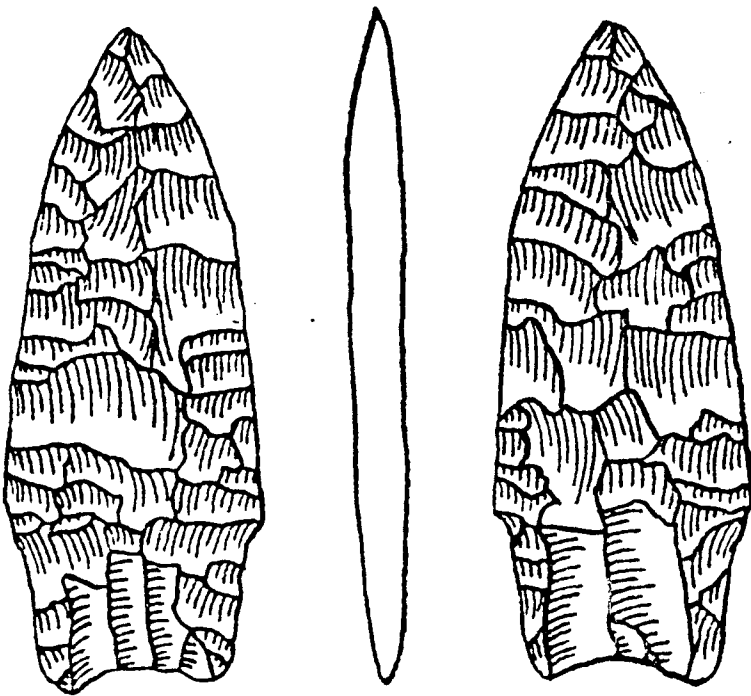


Figure 18. Early Holocene projectile points from a Wichita sandpit.



2 CM

Figure 19. A Holland projectile point from a Wichita sandpit.

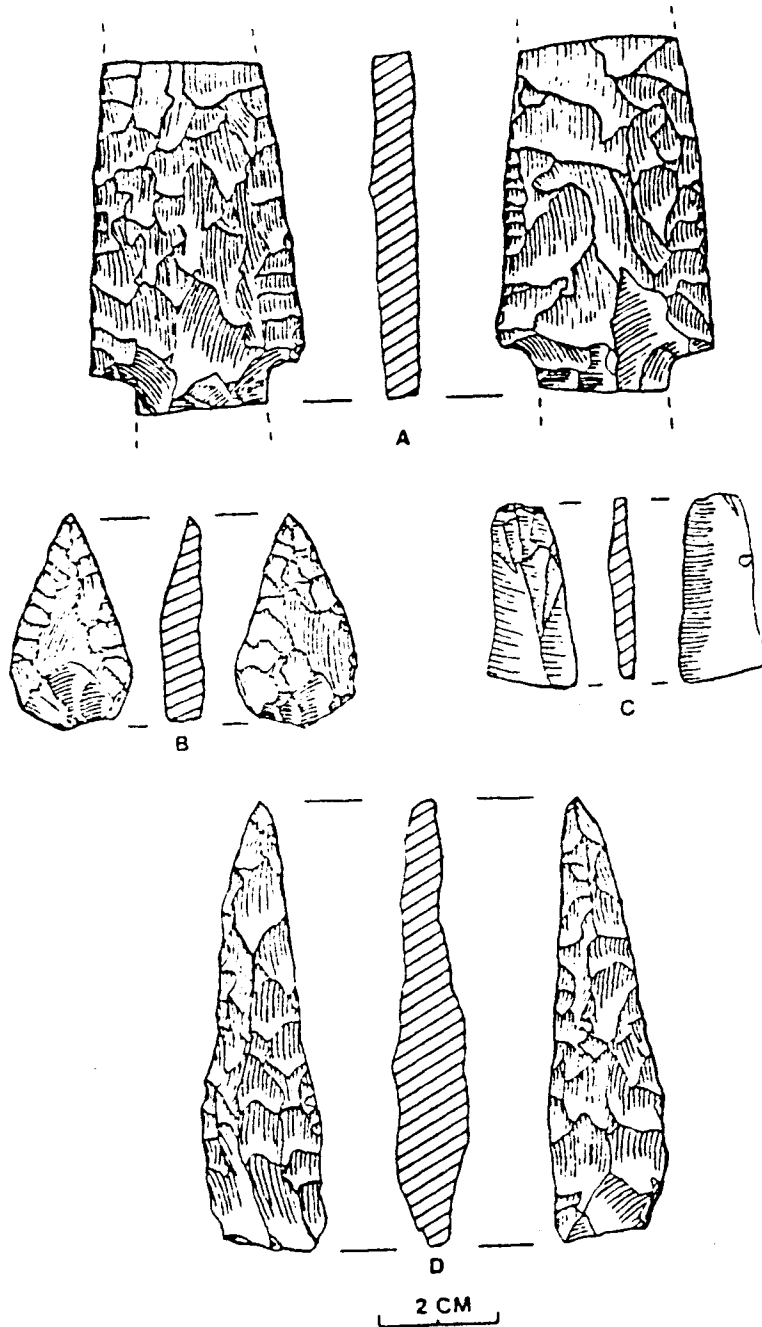


Figure 20. Artifacts from 14CF16 (A), 14CF20 (B), 14CF19 (C), and 14CF20 (D).

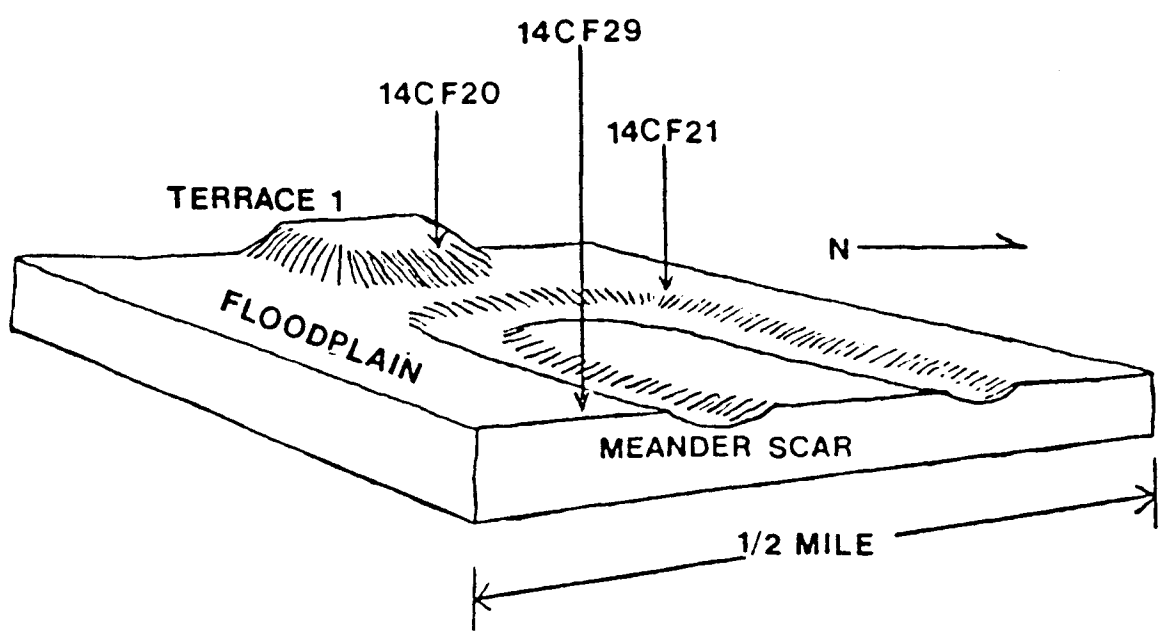


Figure 21. Sites 14CF20, 14CF21, and 14CF29 are shown in relationship to stream terraces (vertical dimensions are not to scale).

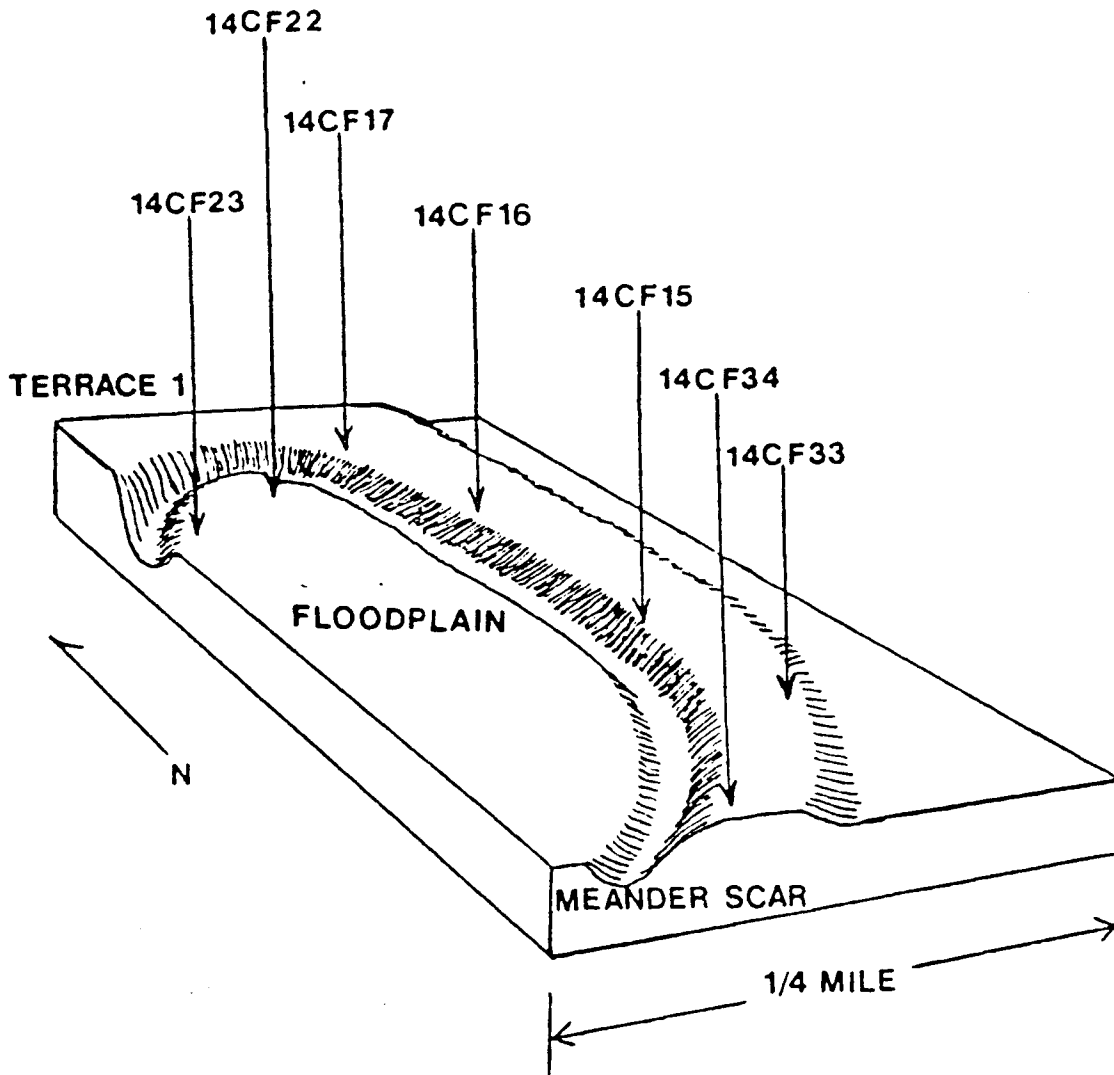


Figure 22. Sites 14CF23, 14CF22, 14CF17, 14CF16, 14CF15, 14CF33, and 14CF34 are shown in relationship to stream terraces (vertical dimensions are not to scale).

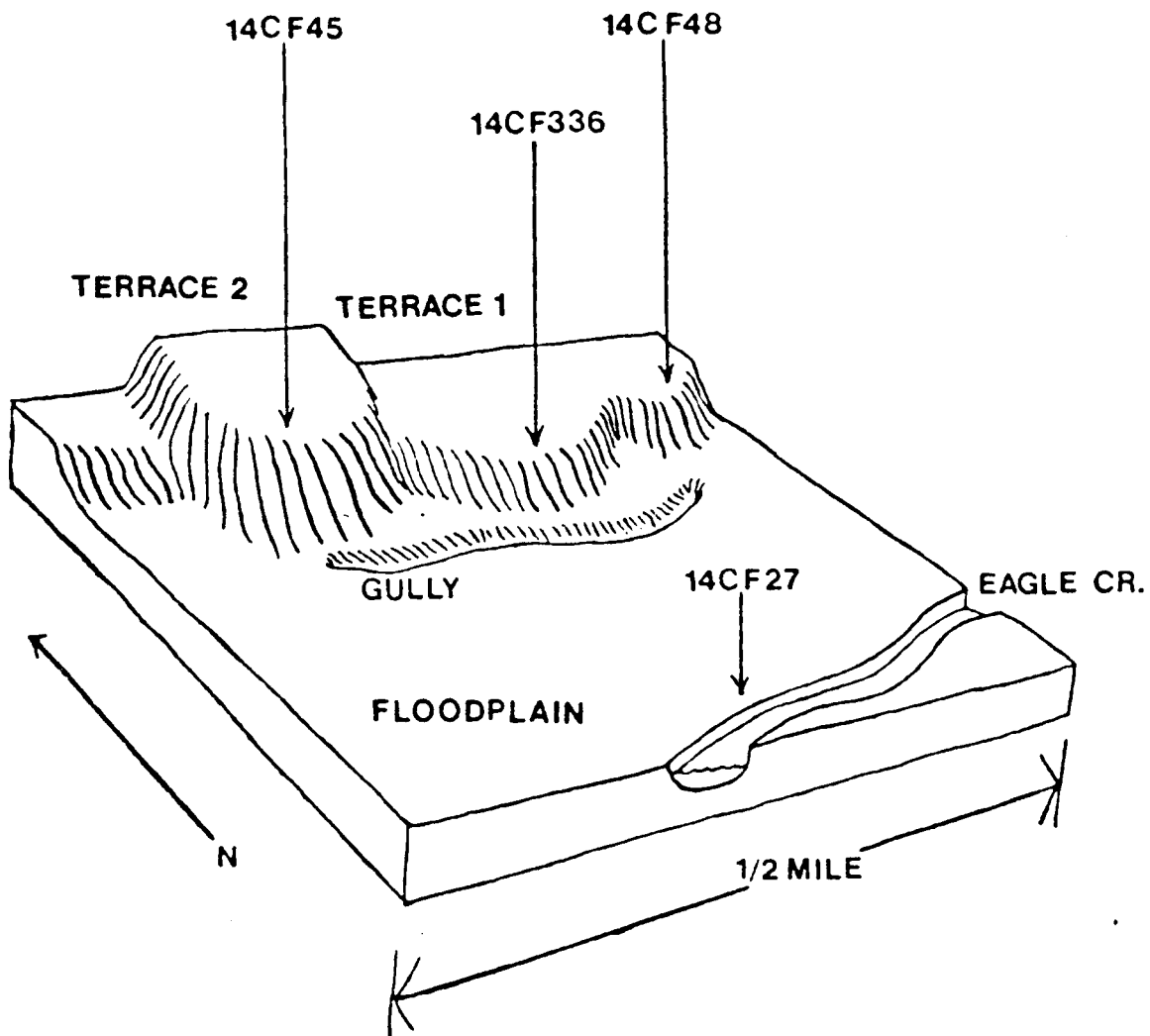


Figure 23. Sites 14CF45, 14CF336, 14CF48, and 14CF27 are shown in relationship to surface geological features (vertical dimensions are not to scale).

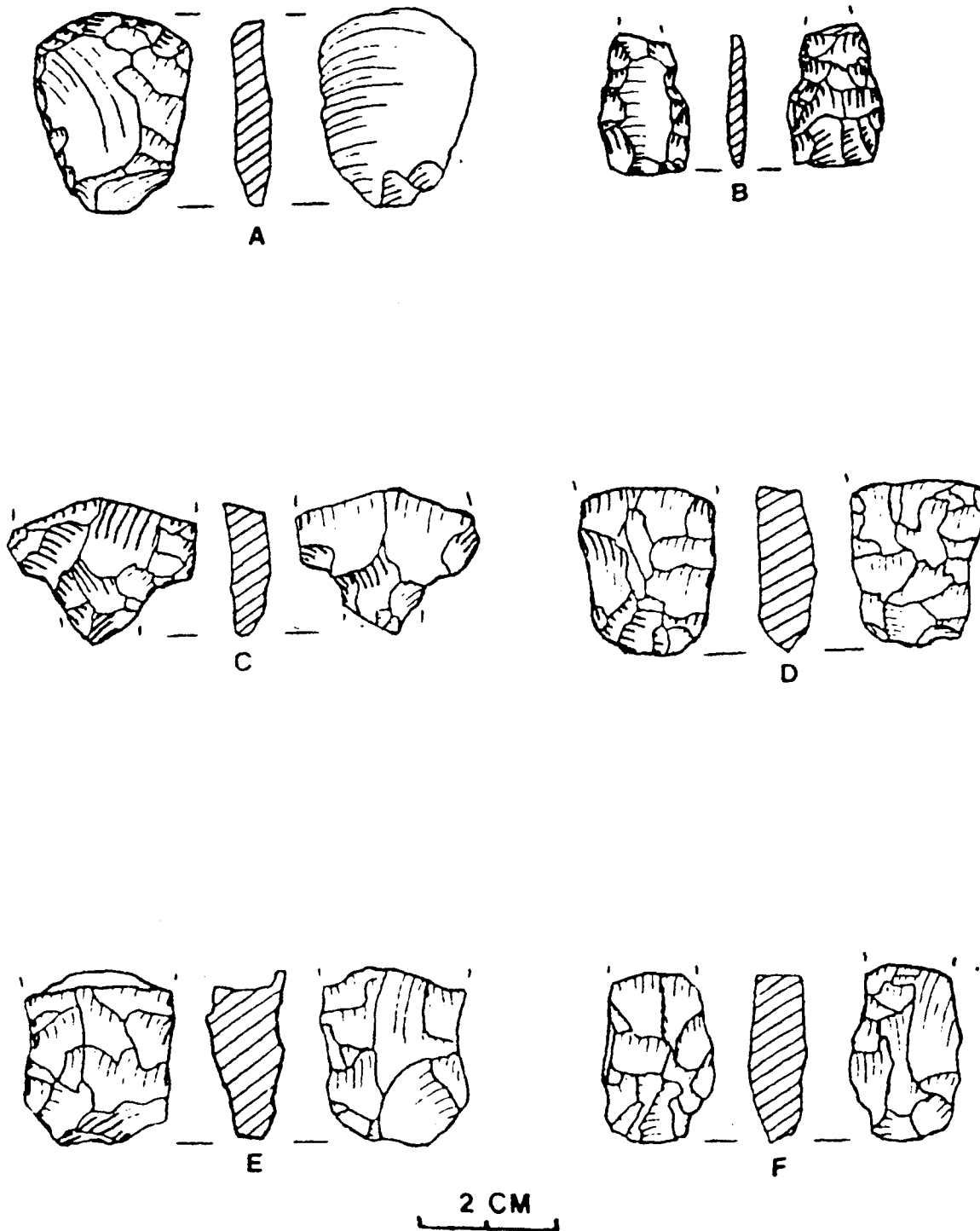


Figure 24. Artifacts from 14CF35 (A), 14CF36 (B), 14LY10 (C), and 14CF45 (D, E, F).

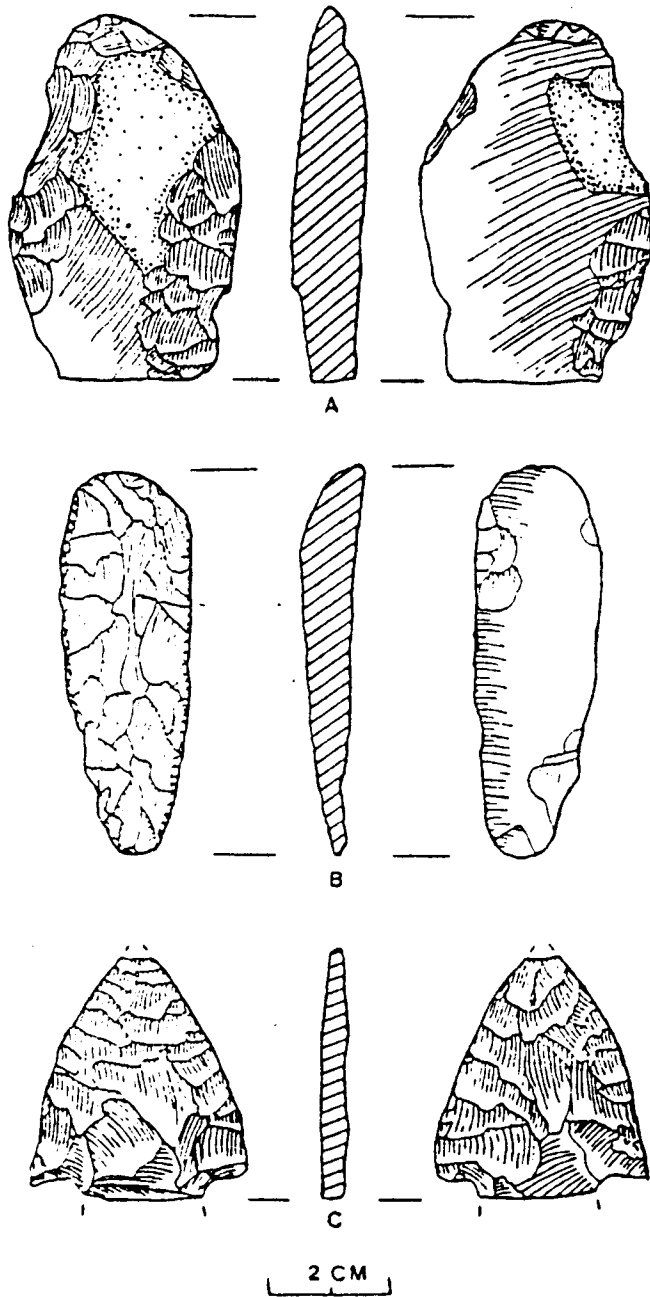


Figure 25. Artifacts from 14CF37 (A, C) and 14CF40 (B).

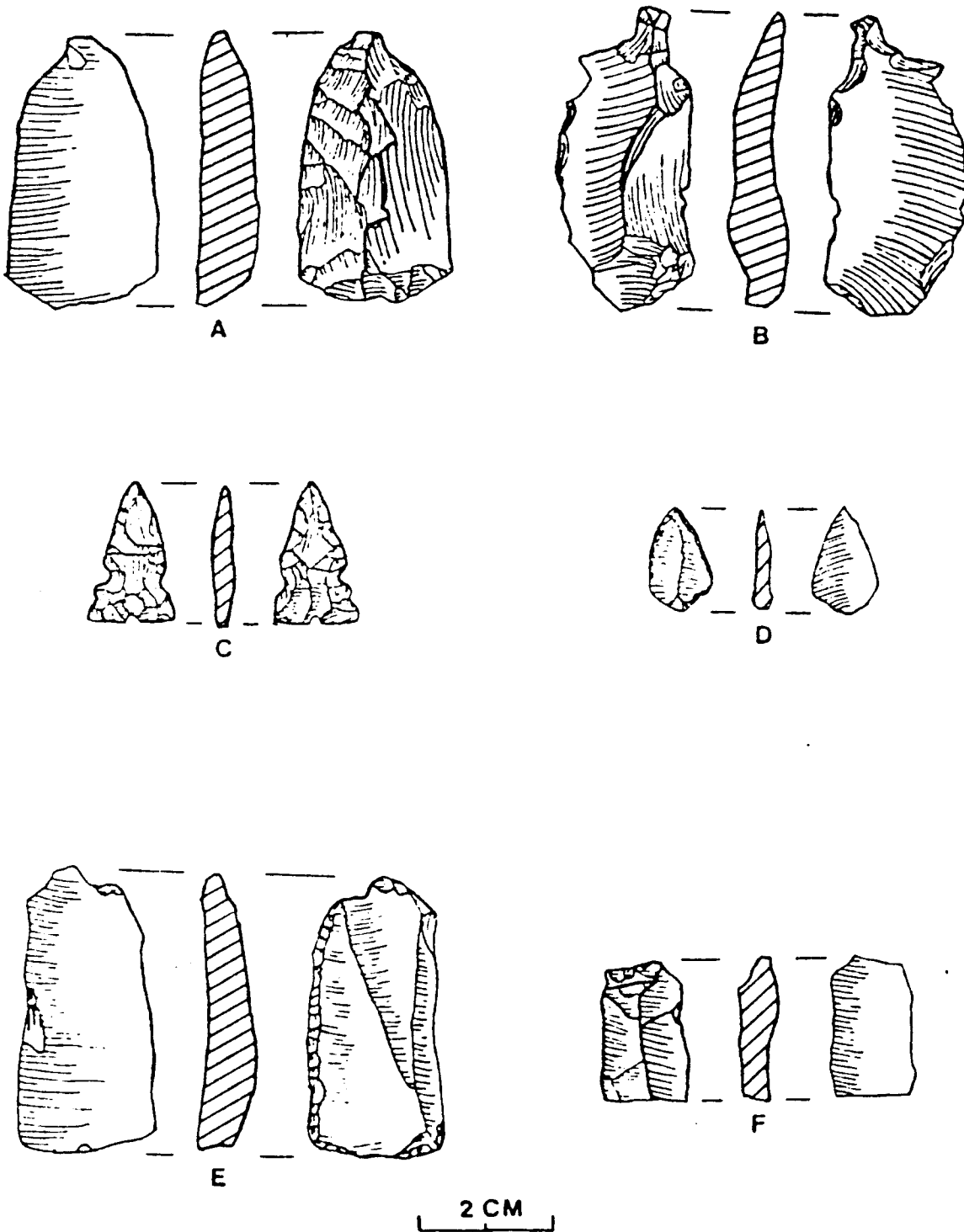


Figure 26. Artifacts from 14LY10 (A, B, C, D, F) and 14LY12 (E).

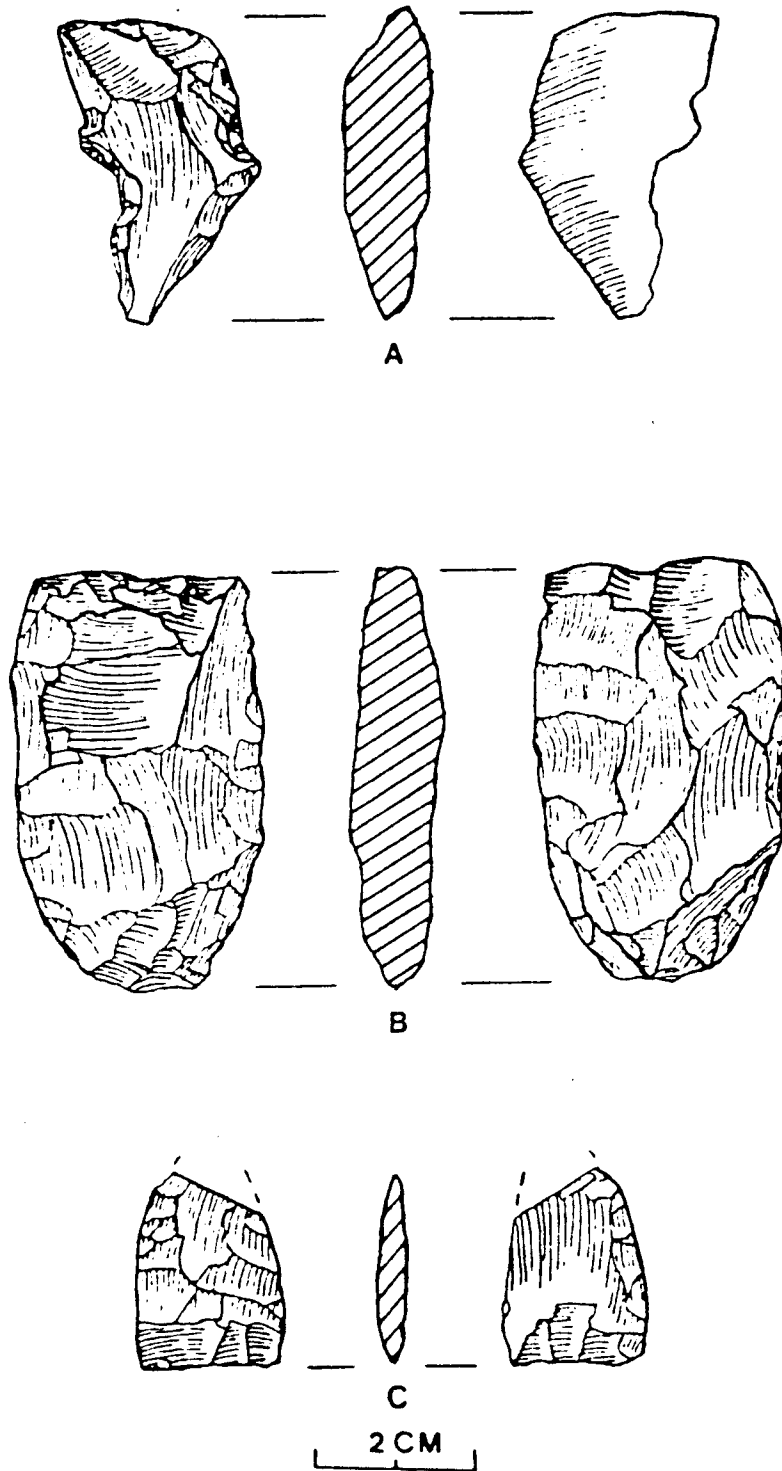


Figure 27. Artifacts from 14CF45 (A, B) and 14CF47 (C).

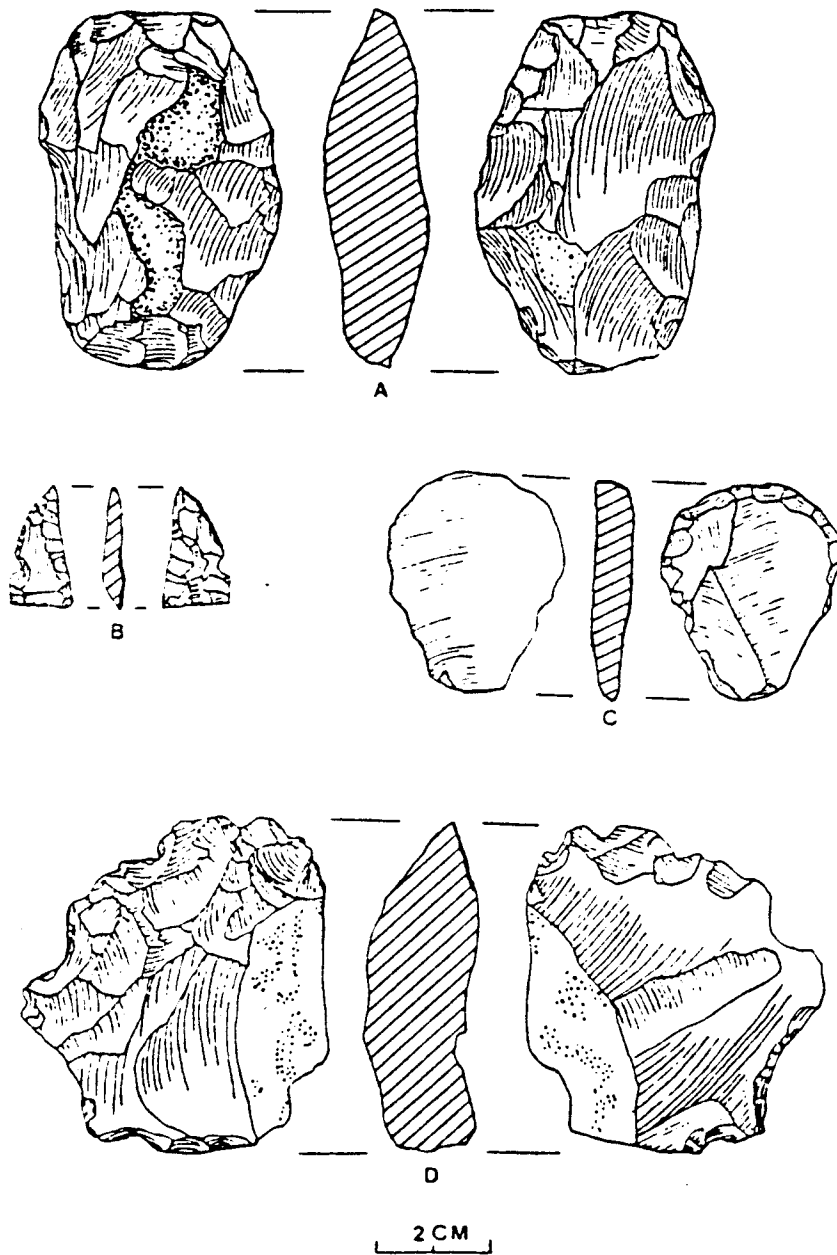


Figure 28. Artifacts from 14CF48 (A, C) and 14CF51 (B, D).

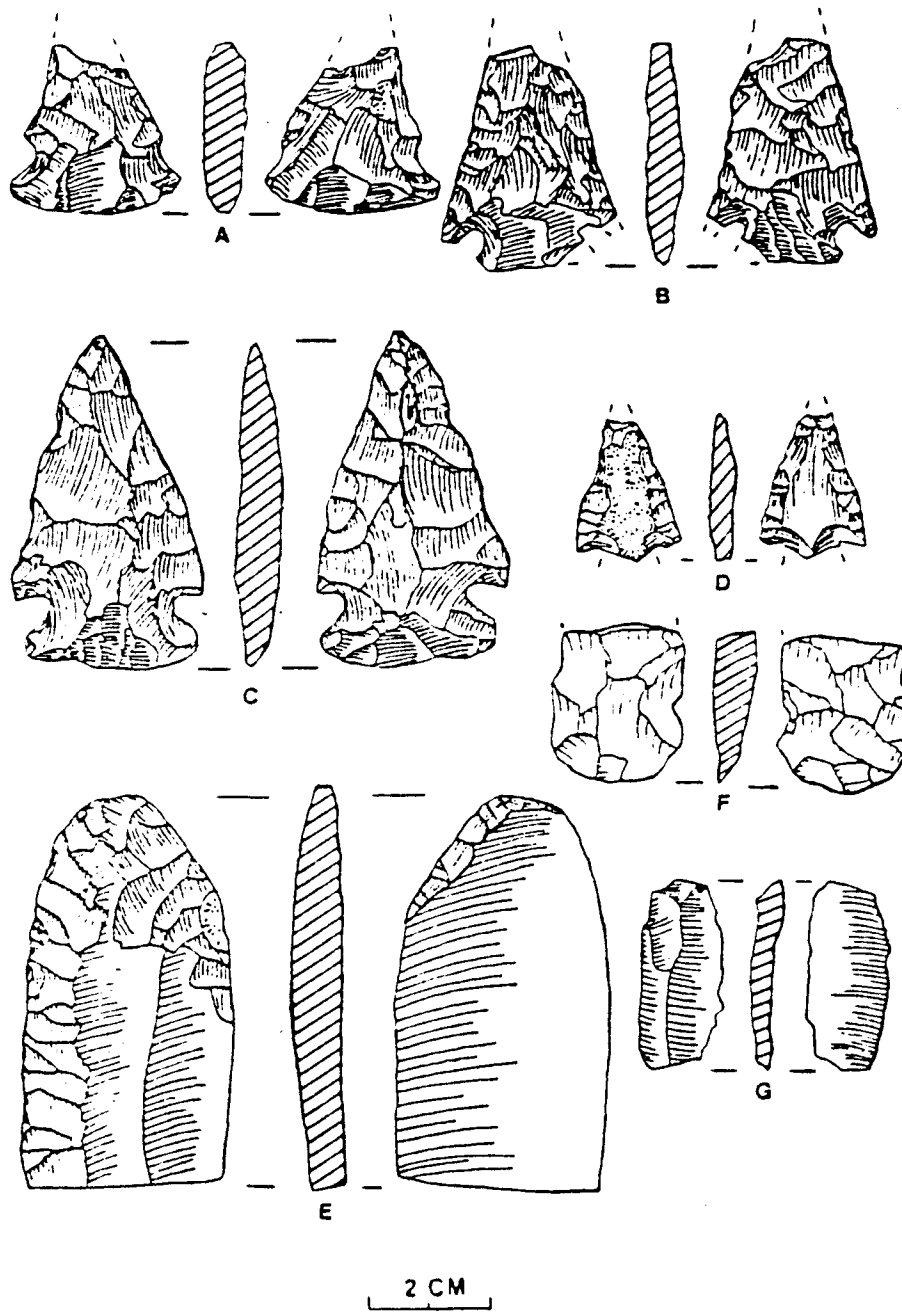


Figure 29. Seven artifacts from 14CF336.

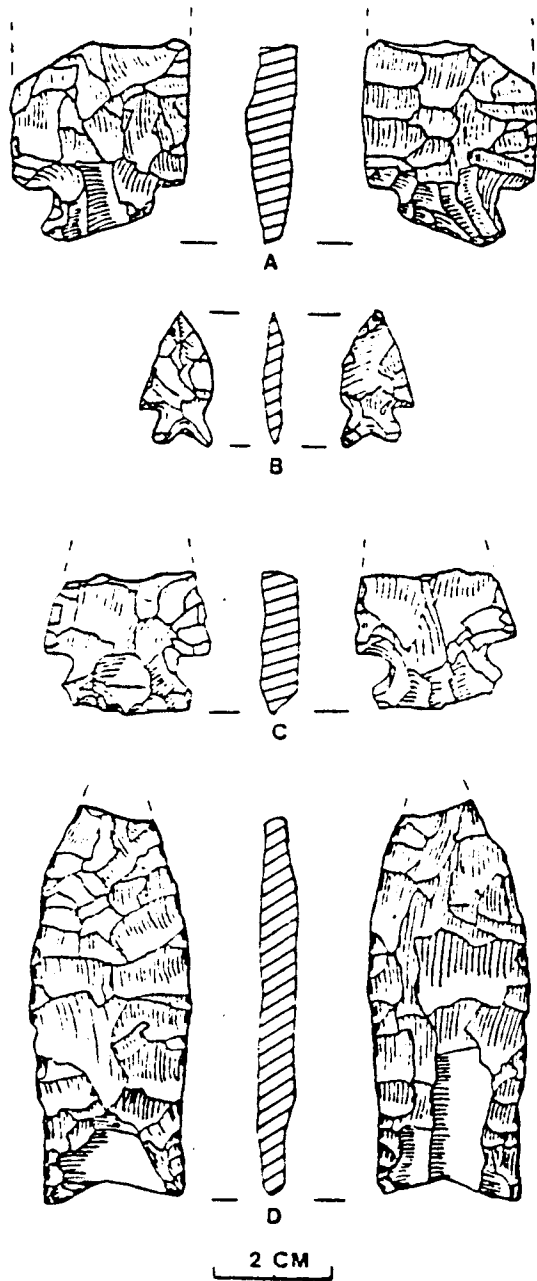


Figure 30. Artifacts from 14CF335 (A, B, C) and an isolated discovery from south of the John Redmond Reservoir (D).

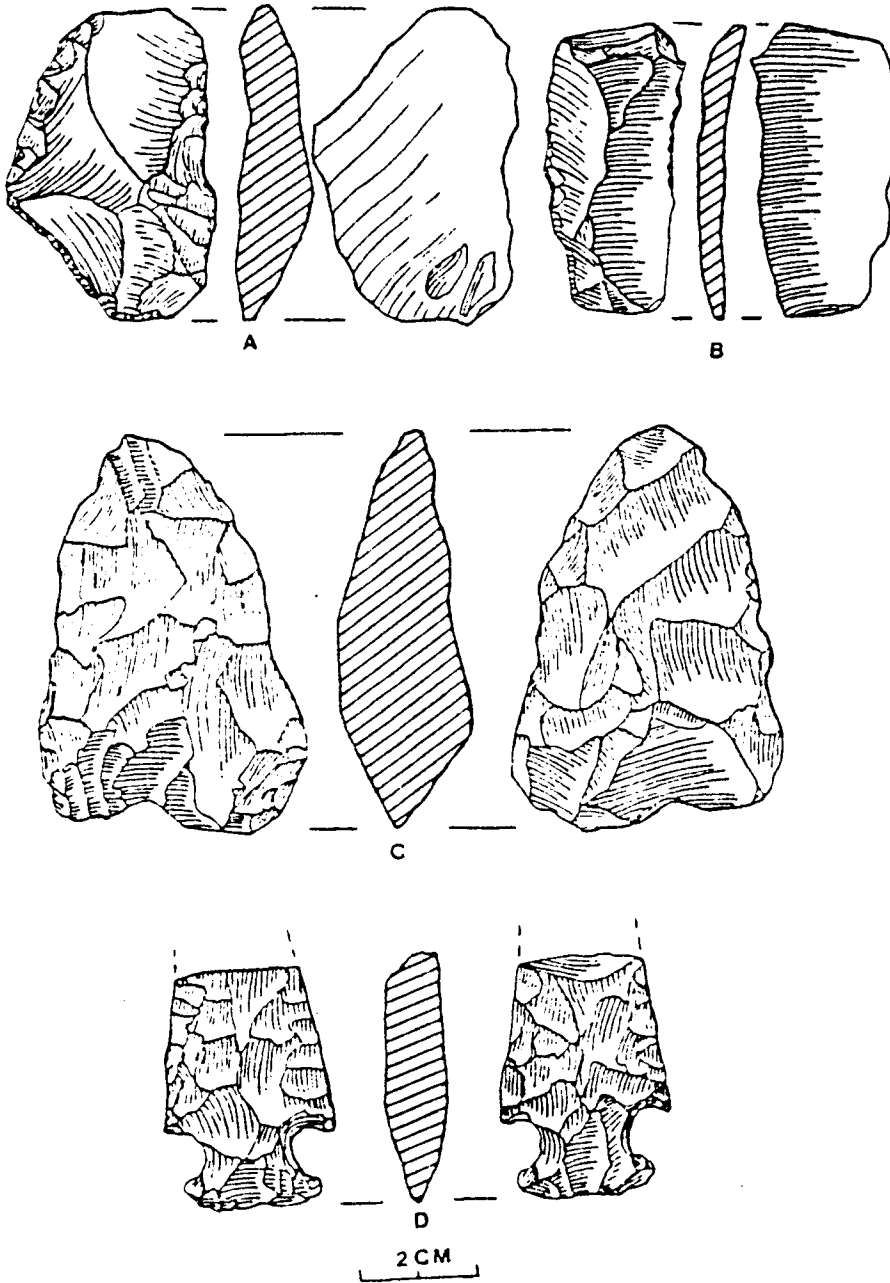


Figure 31. Artifacts from 14CF336 (A, B), 14LY6 (C), and 14CF15 (D).

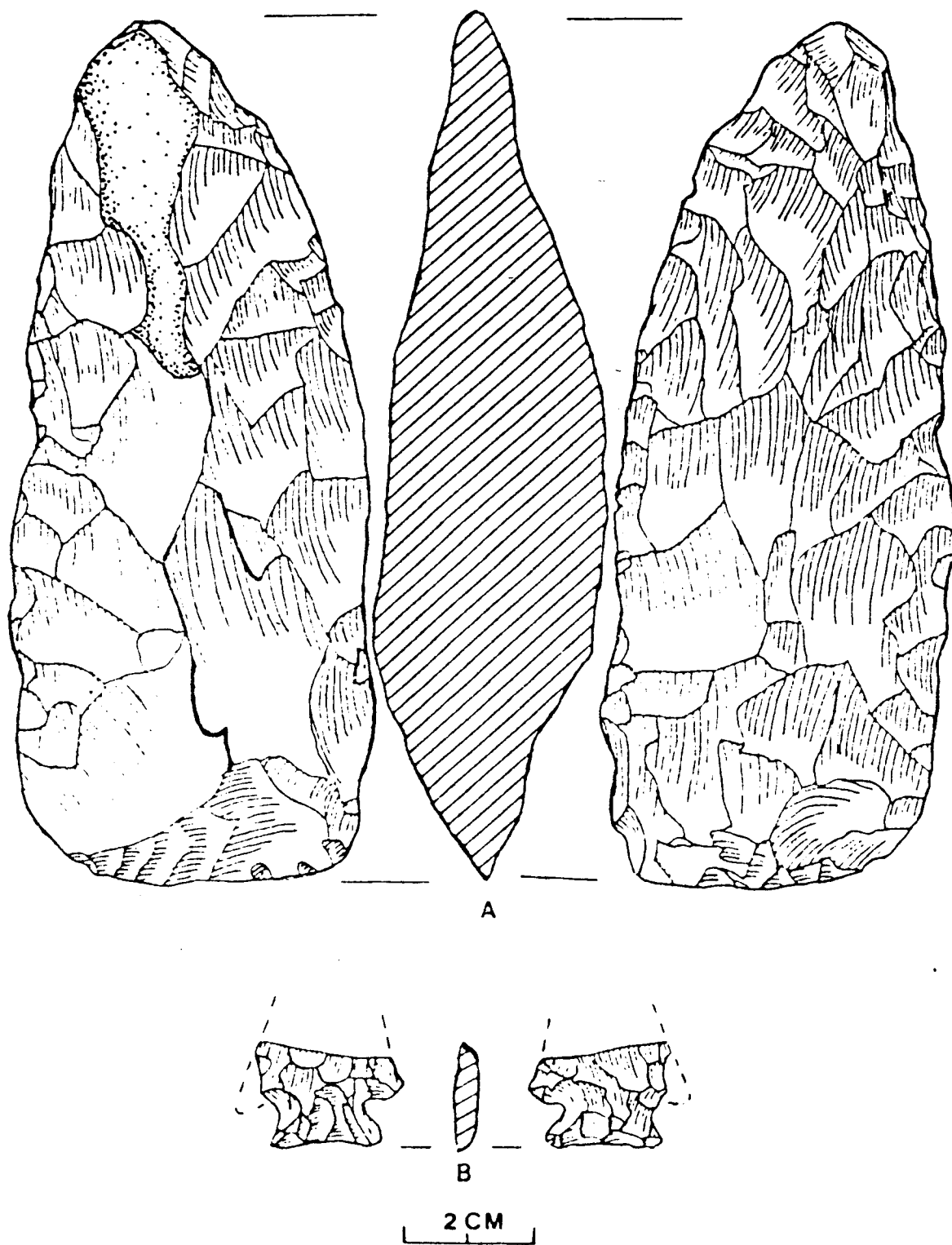


Figure 32. Artifacts from 14CF46 (A) and 14CF48 (B).

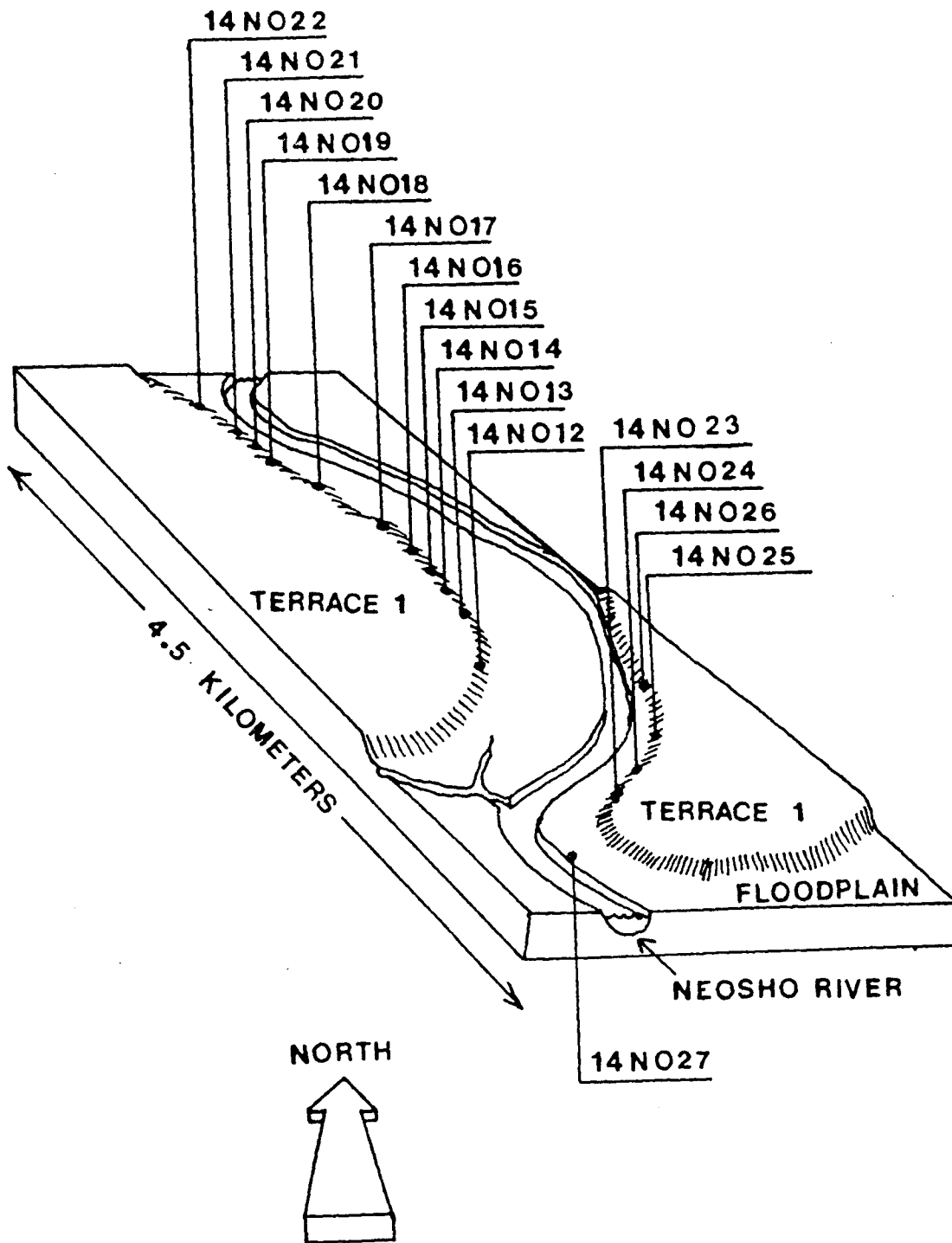


Figure 33. Archaeological sites and stream terraces near Chanute, Kansas (vertical dimensions are not to scale).

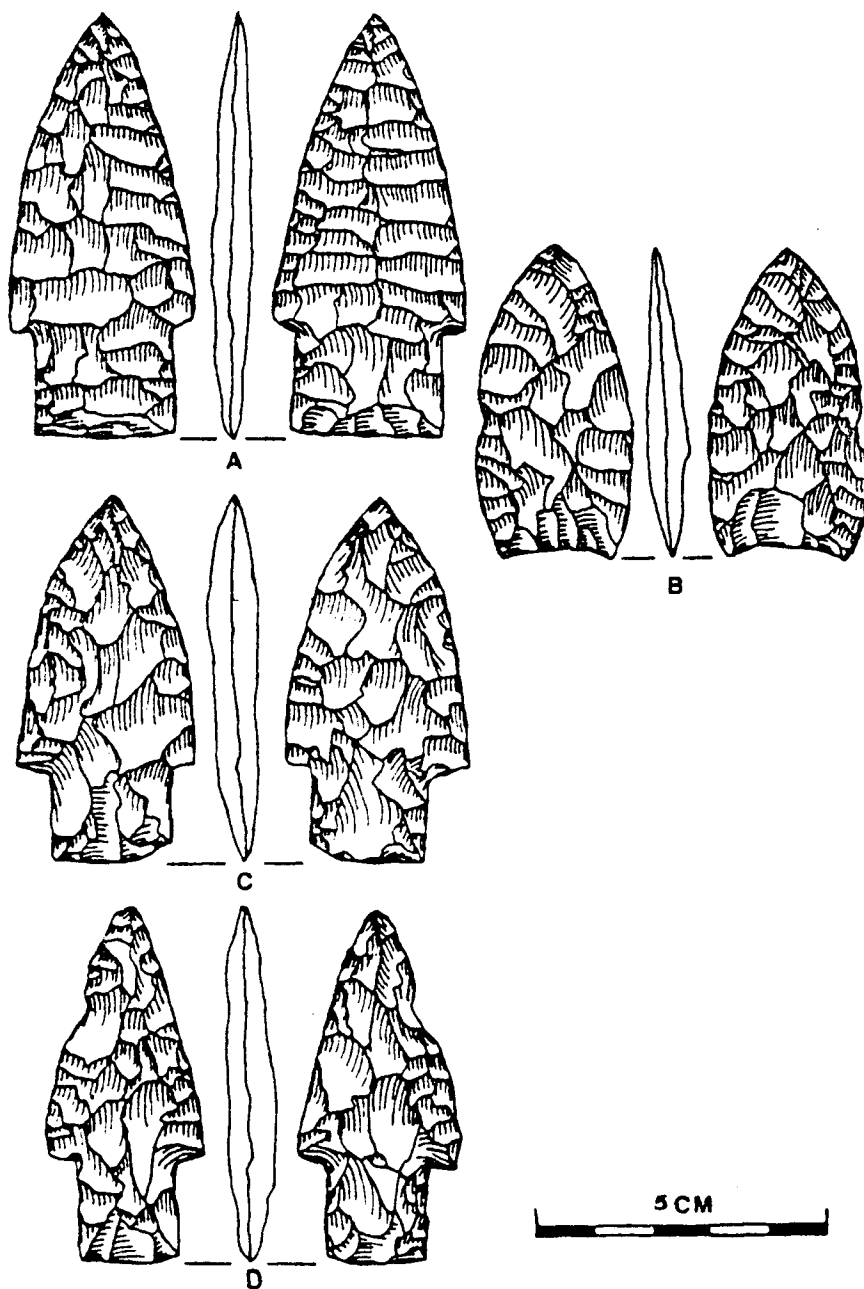


Figure 34. Artifacts from 14N012.

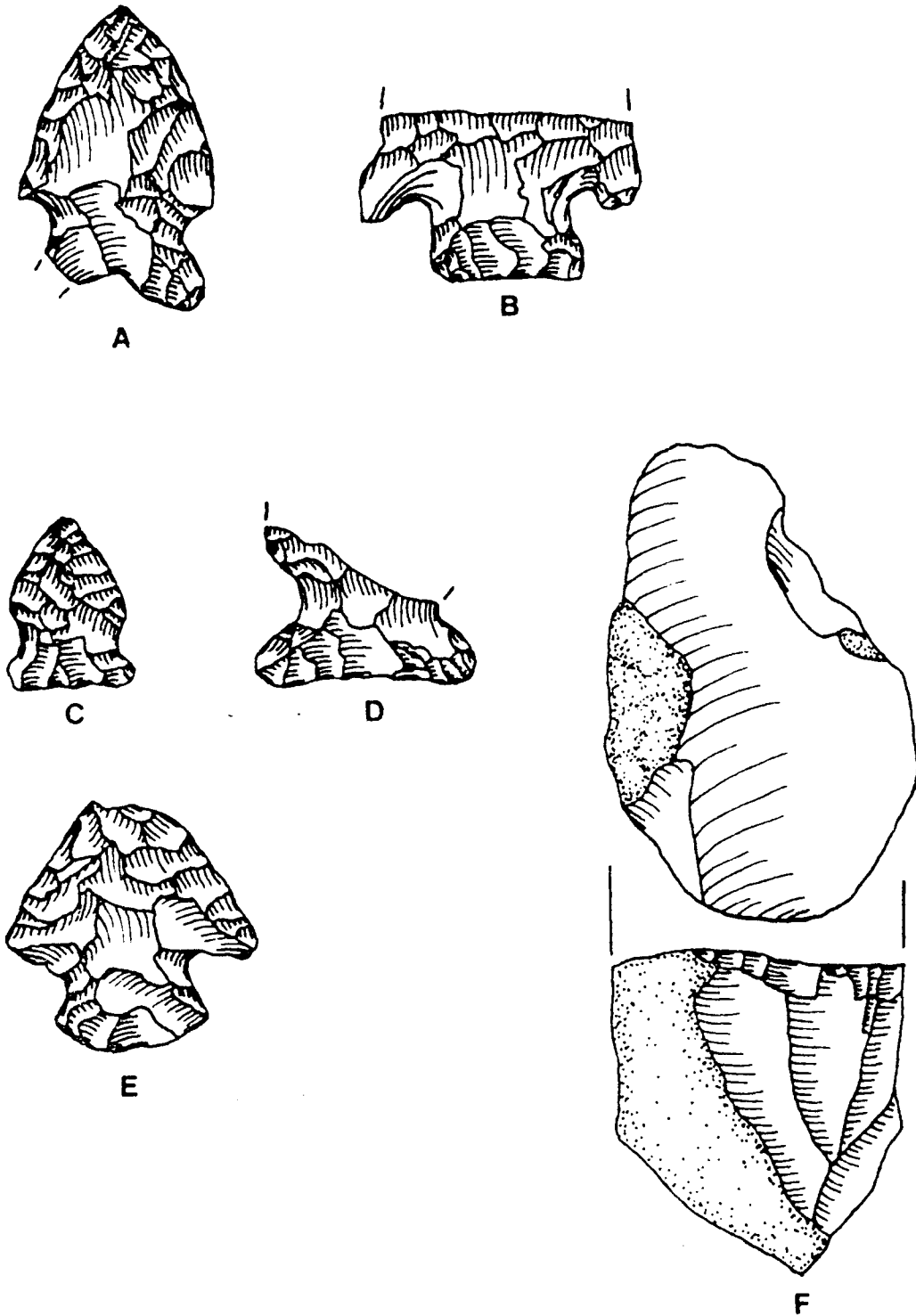


Figure 35. Artifacts from 14N015 (A), 14N016 (B), 14N017 (C, D), 14N018 (E), and 14N026 (F).

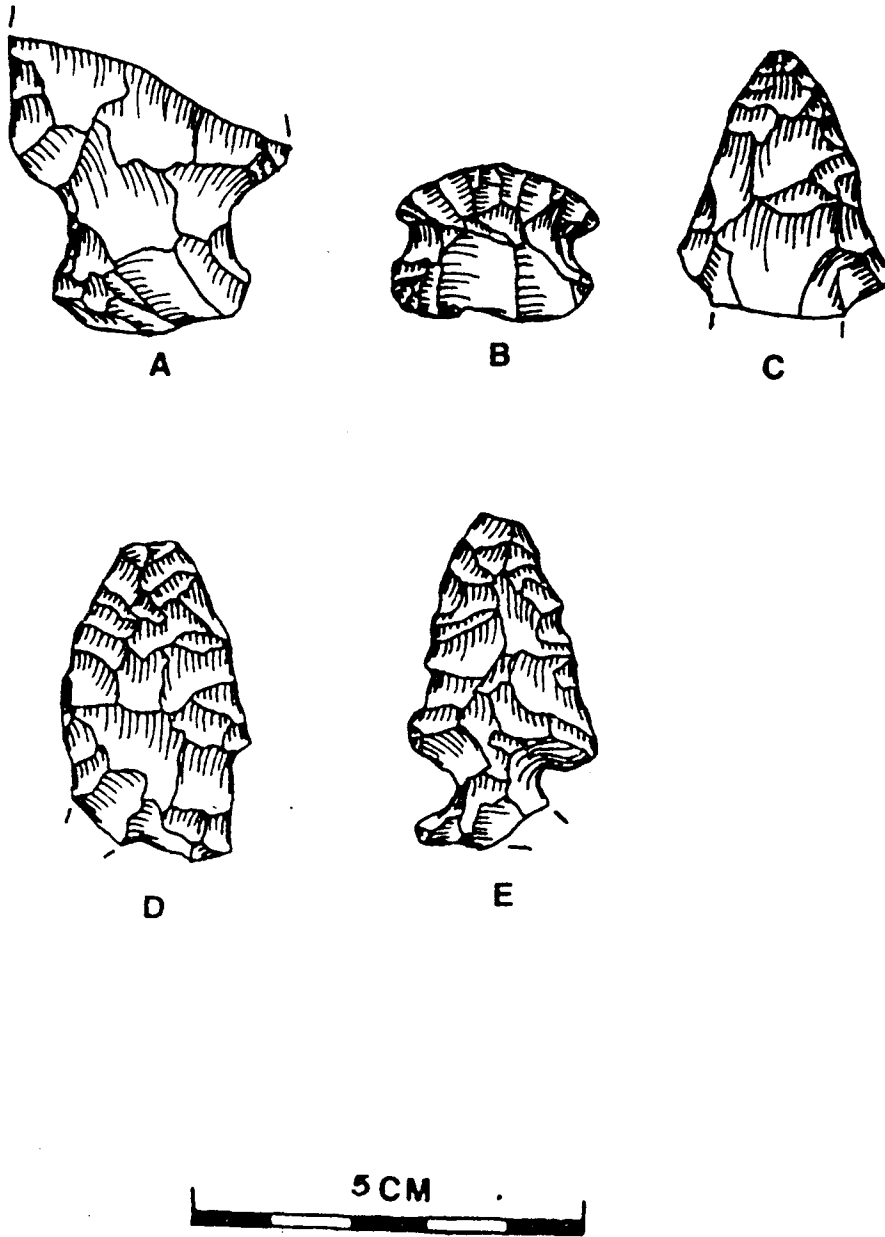


Figure 36. Artifacts from 14AN12 (A, B, C, D) and 14CS17 (E).

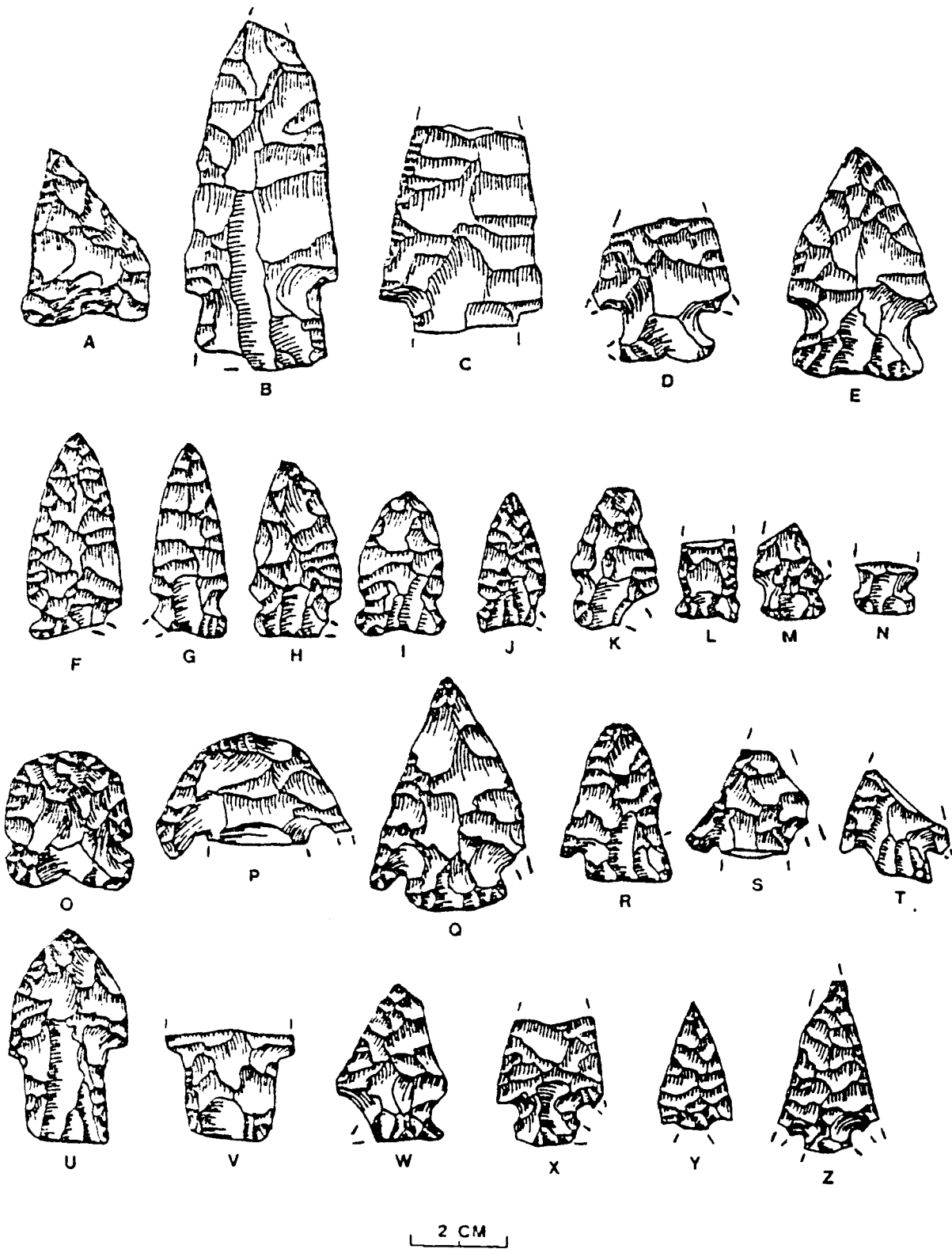


Figure 37. Twenty-six artifacts from 14N028.

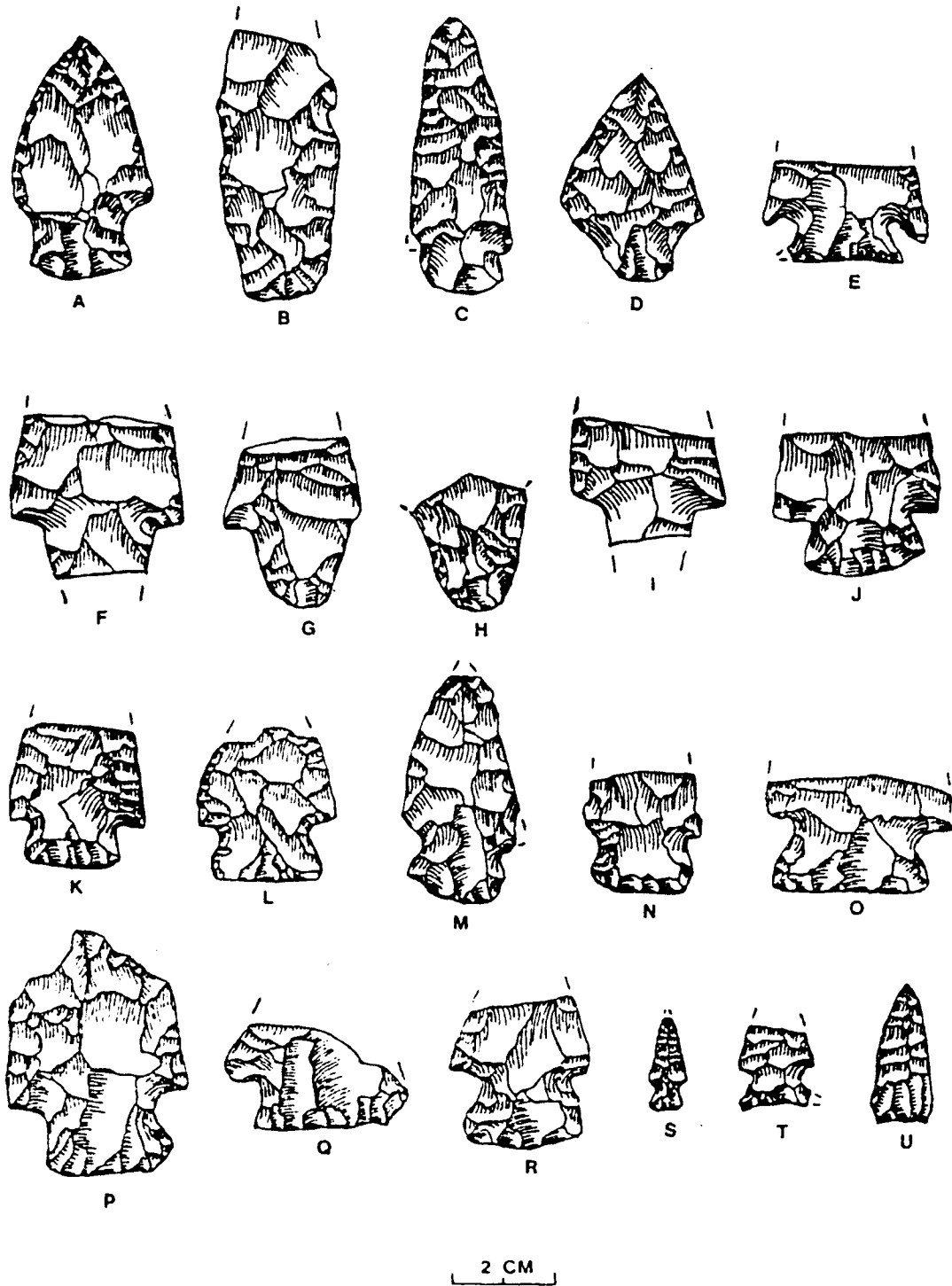


Figure 38. Twenty-one artifacts from 14N028.

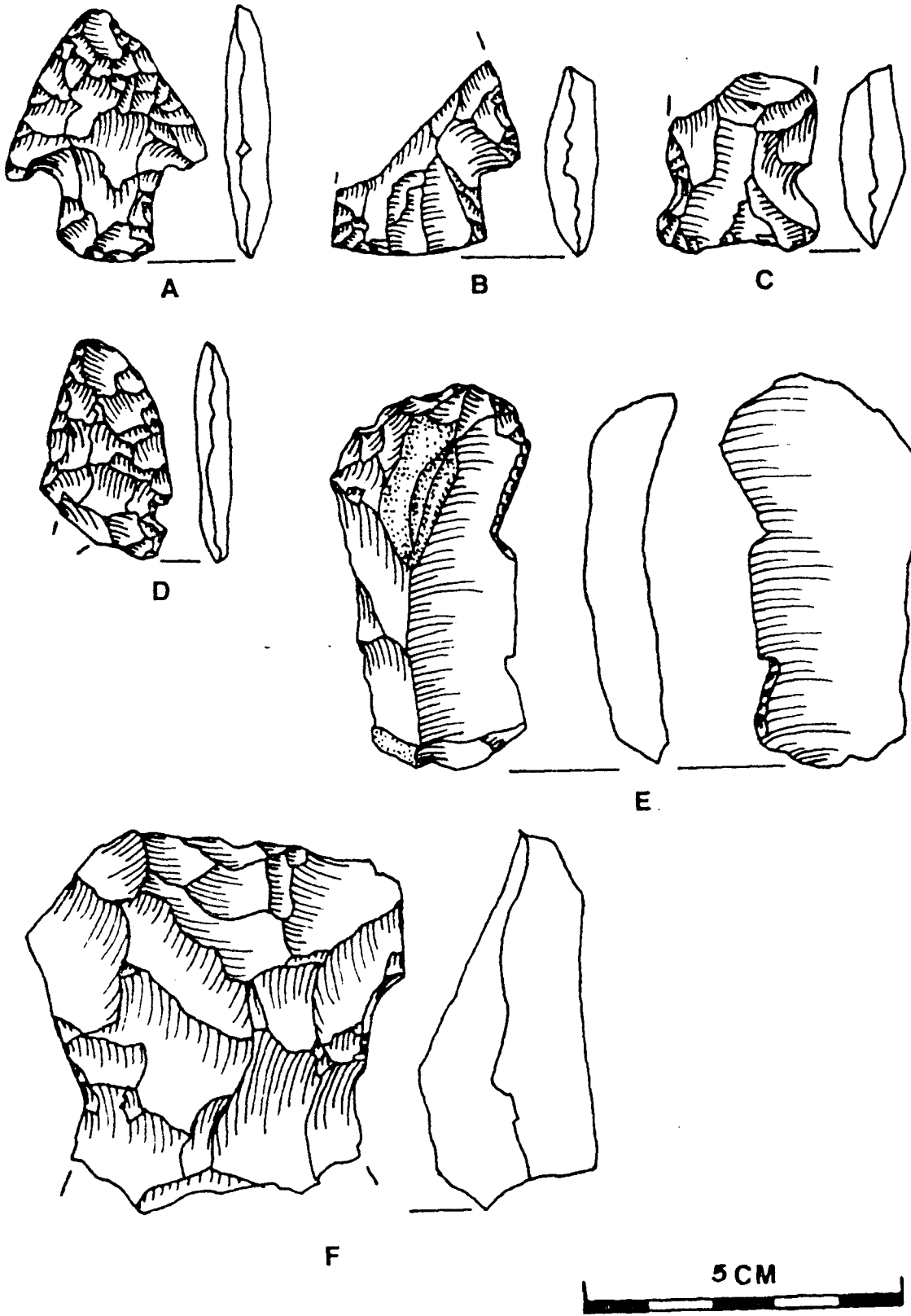


Figure 39. Artifacts from 14CS16.

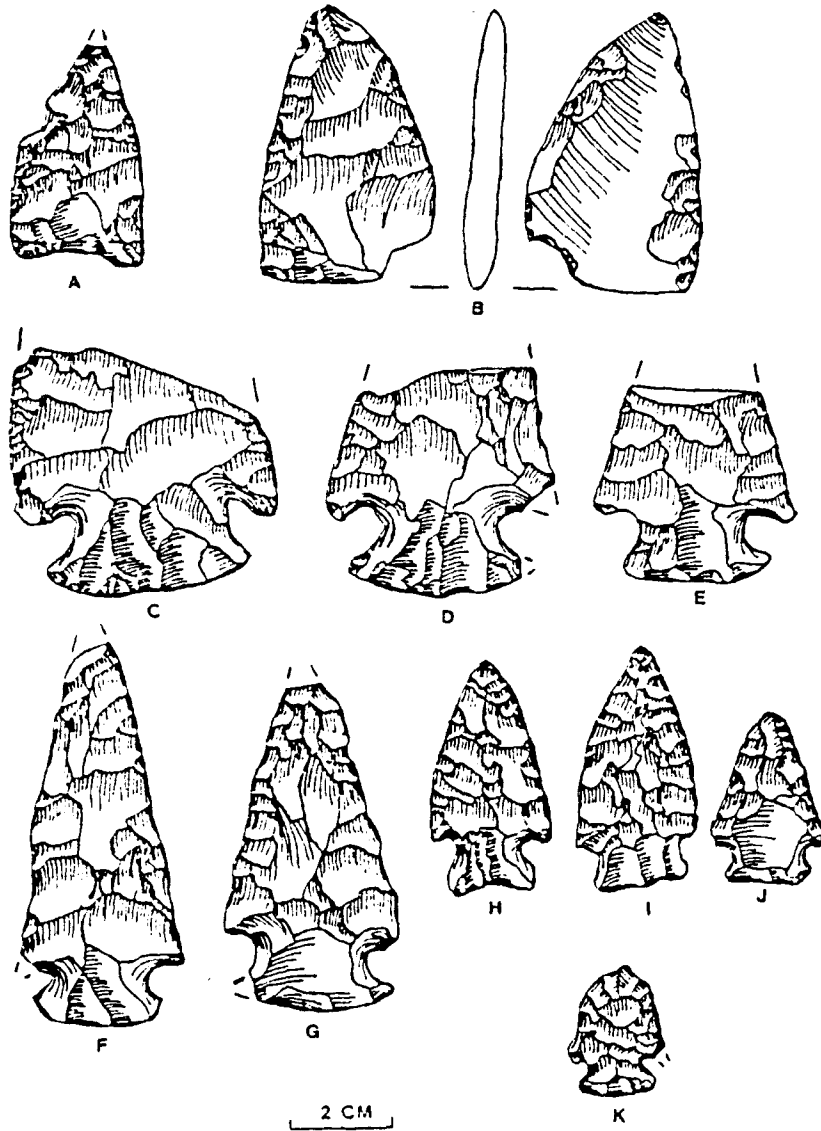


Figure 40. Artifacts from 14MN34.

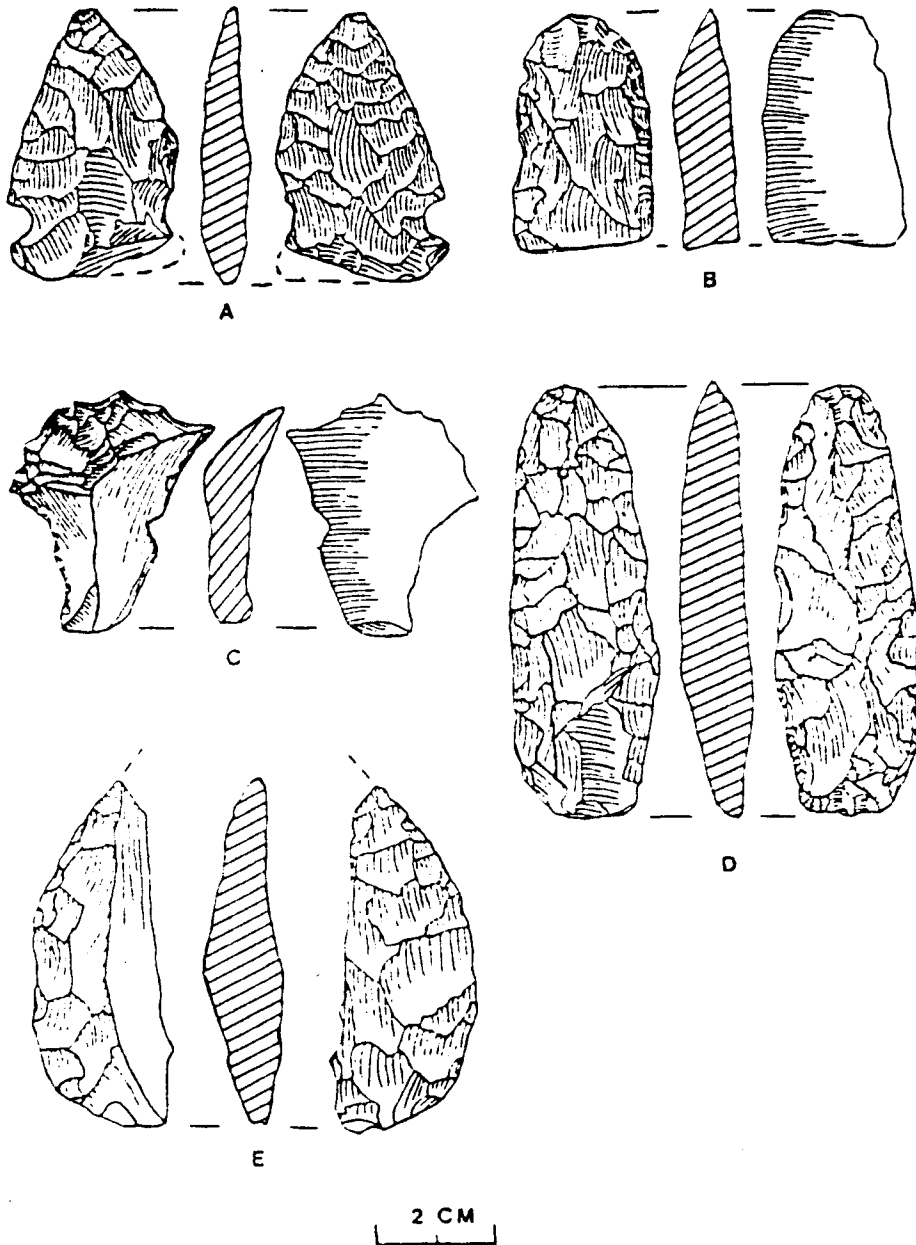


Figure 41. Artifacts from 14CF319 (A, B, C) and 14CF335 (D, E).

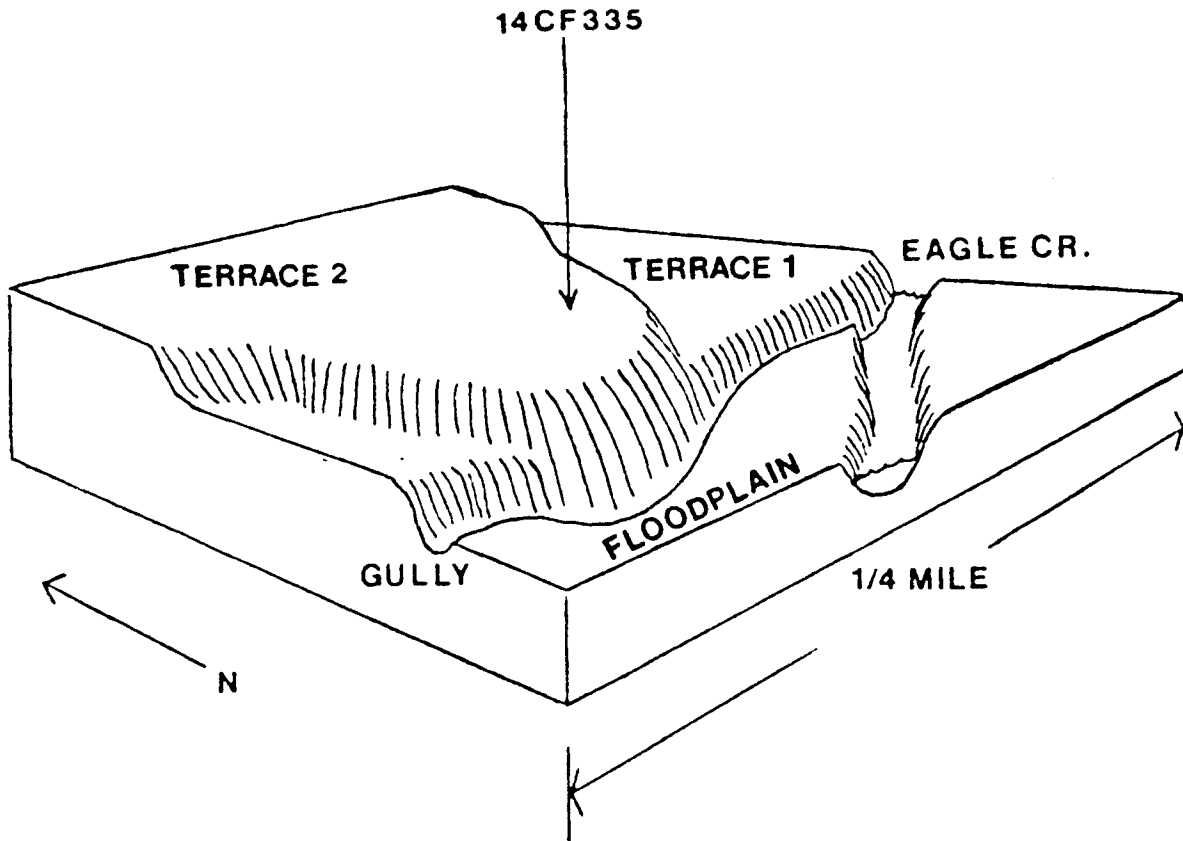


Figure 42. The site, 14CF335, in relationship to stream terraces (vertical dimensions not to scale).

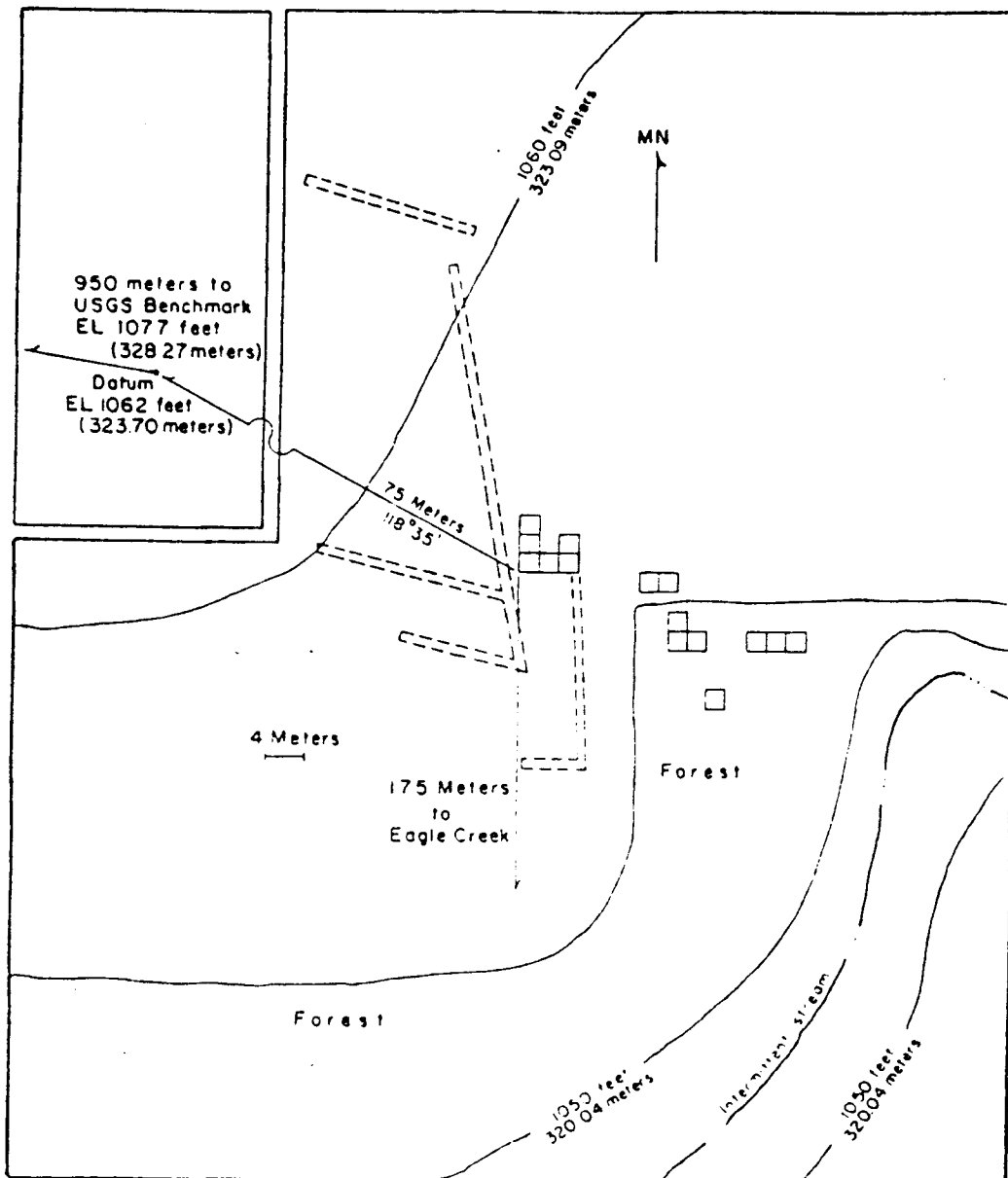


Figure 43. A map of 14CF335, the squares represent 2 meter excavation squares and the dashed lines delineate trenches dug by a backhoe.

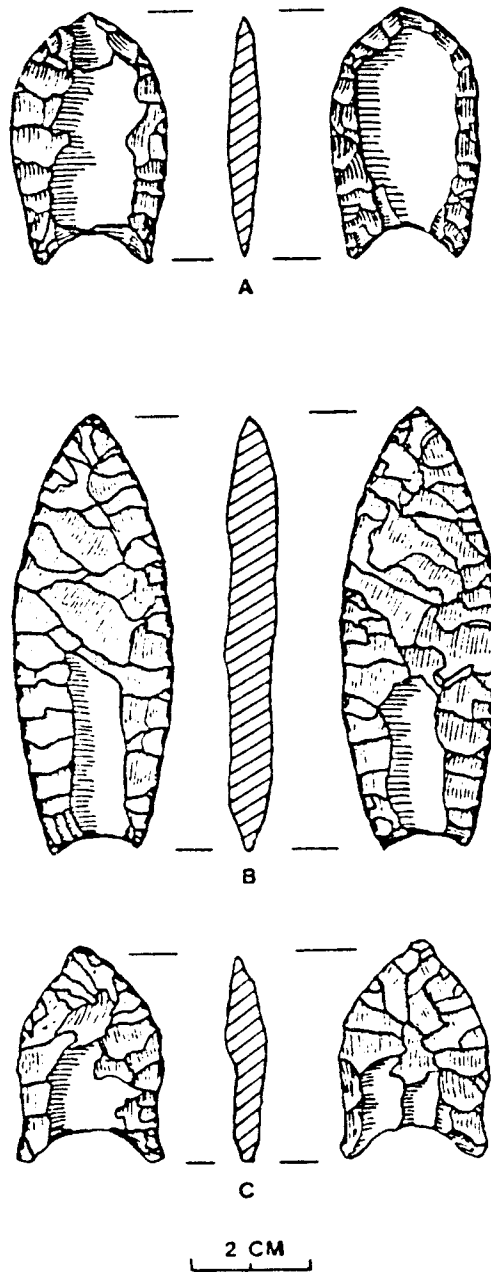


Figure 44. Paleo-Indian artifacts from 14CF335.

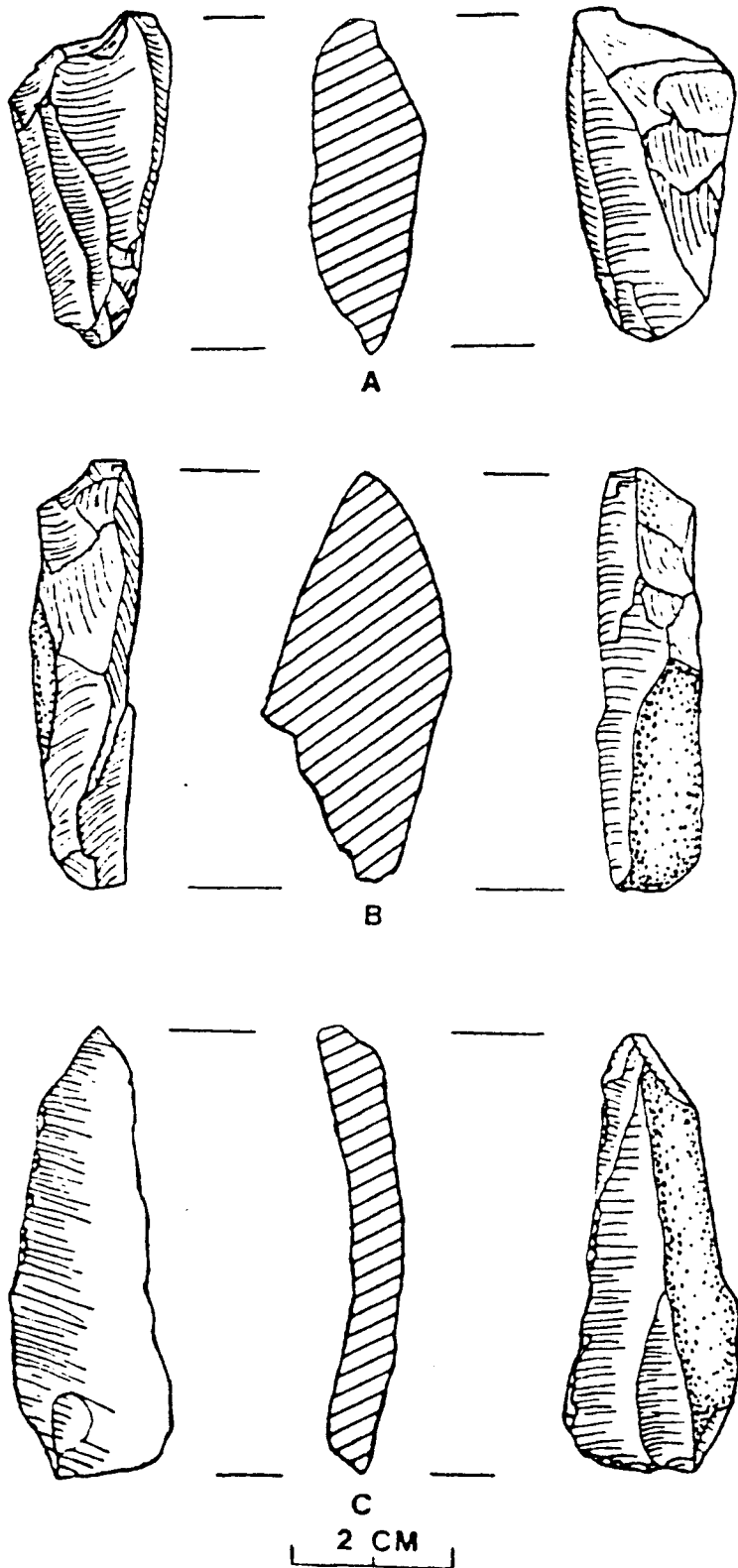


Figure 45. "Chisel-like" tools from 14CF335.

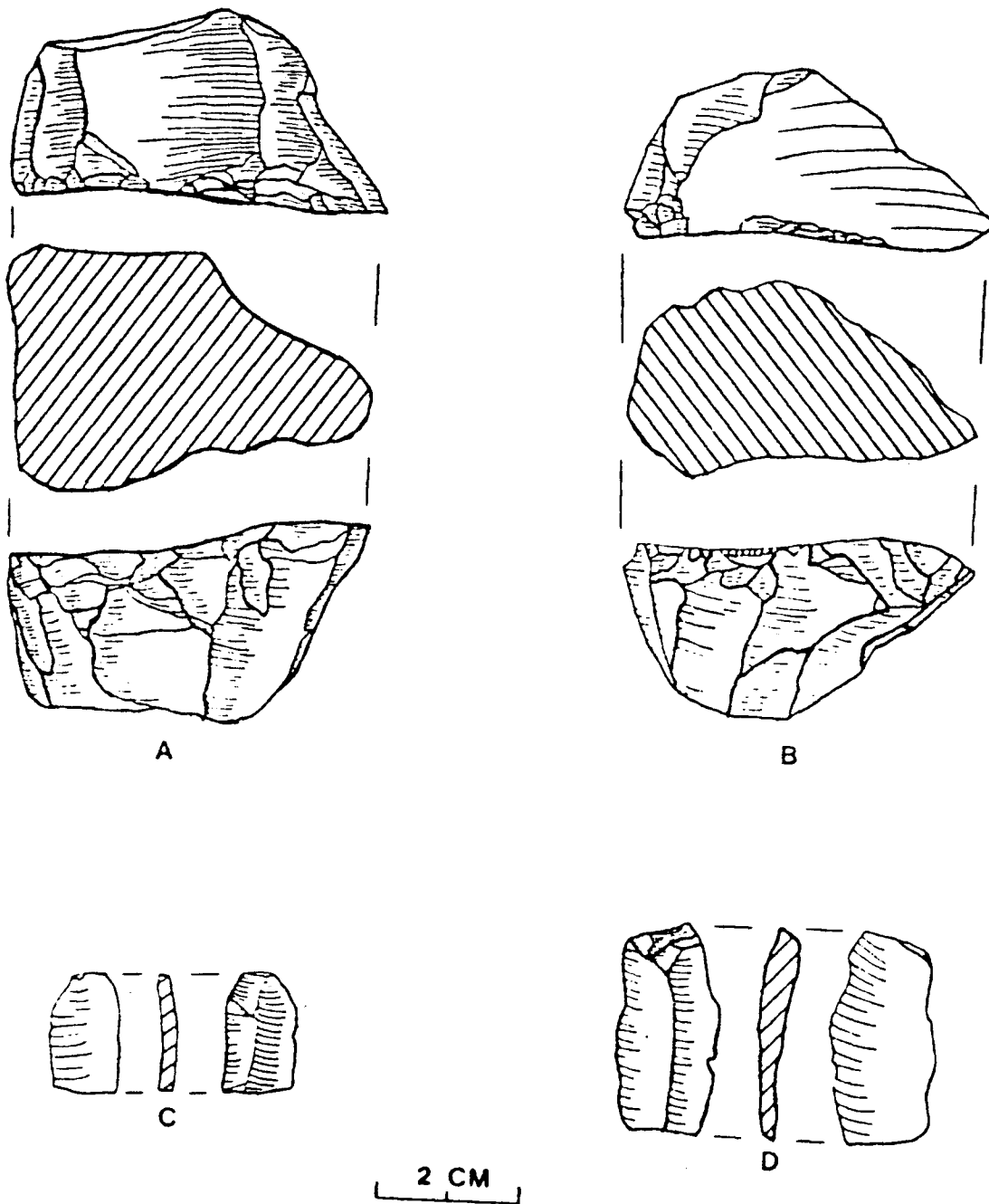


Figure 46. Blade technology from 14CF335.

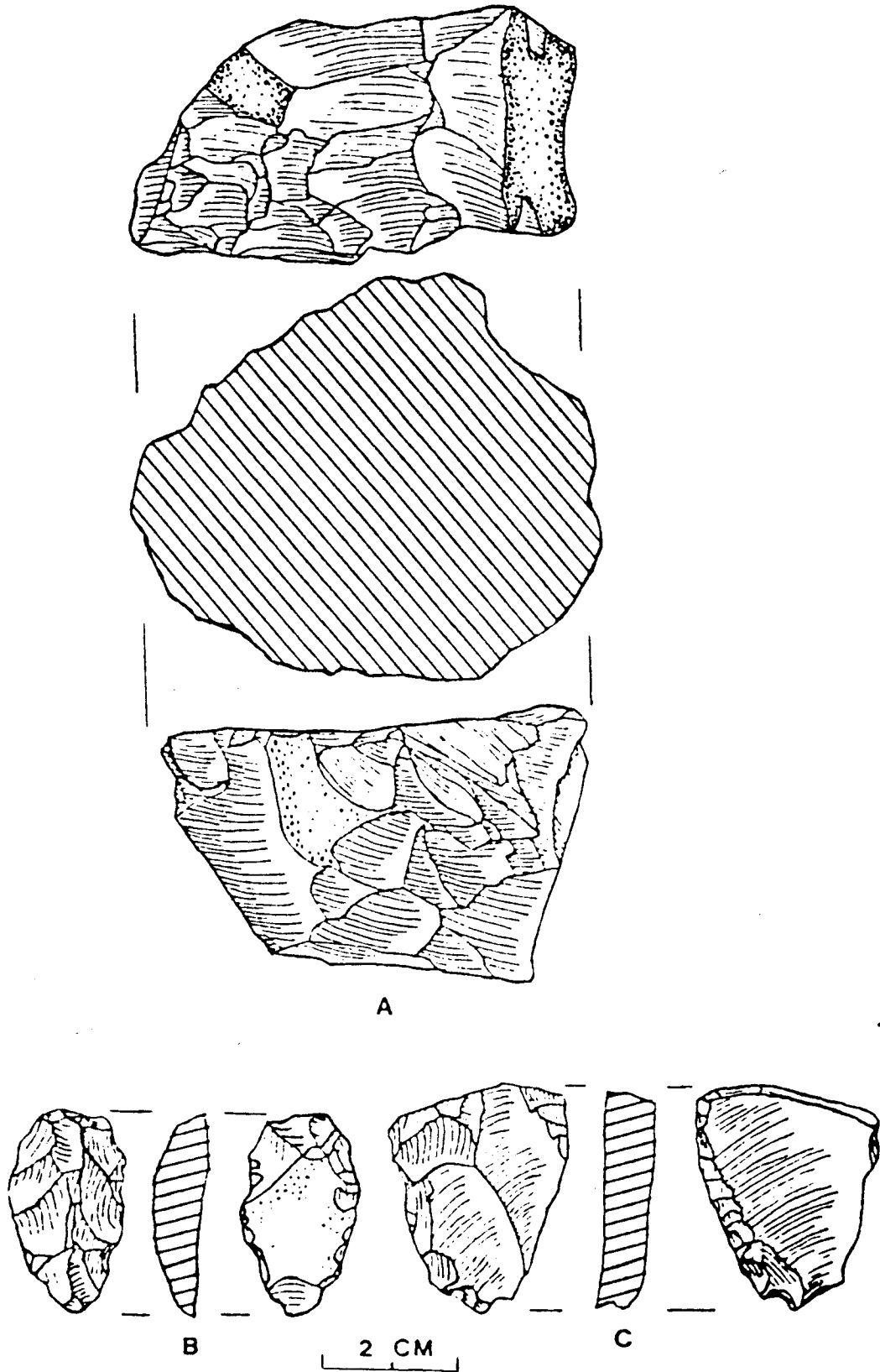


Figure 47. Artifacts from 14CF335.

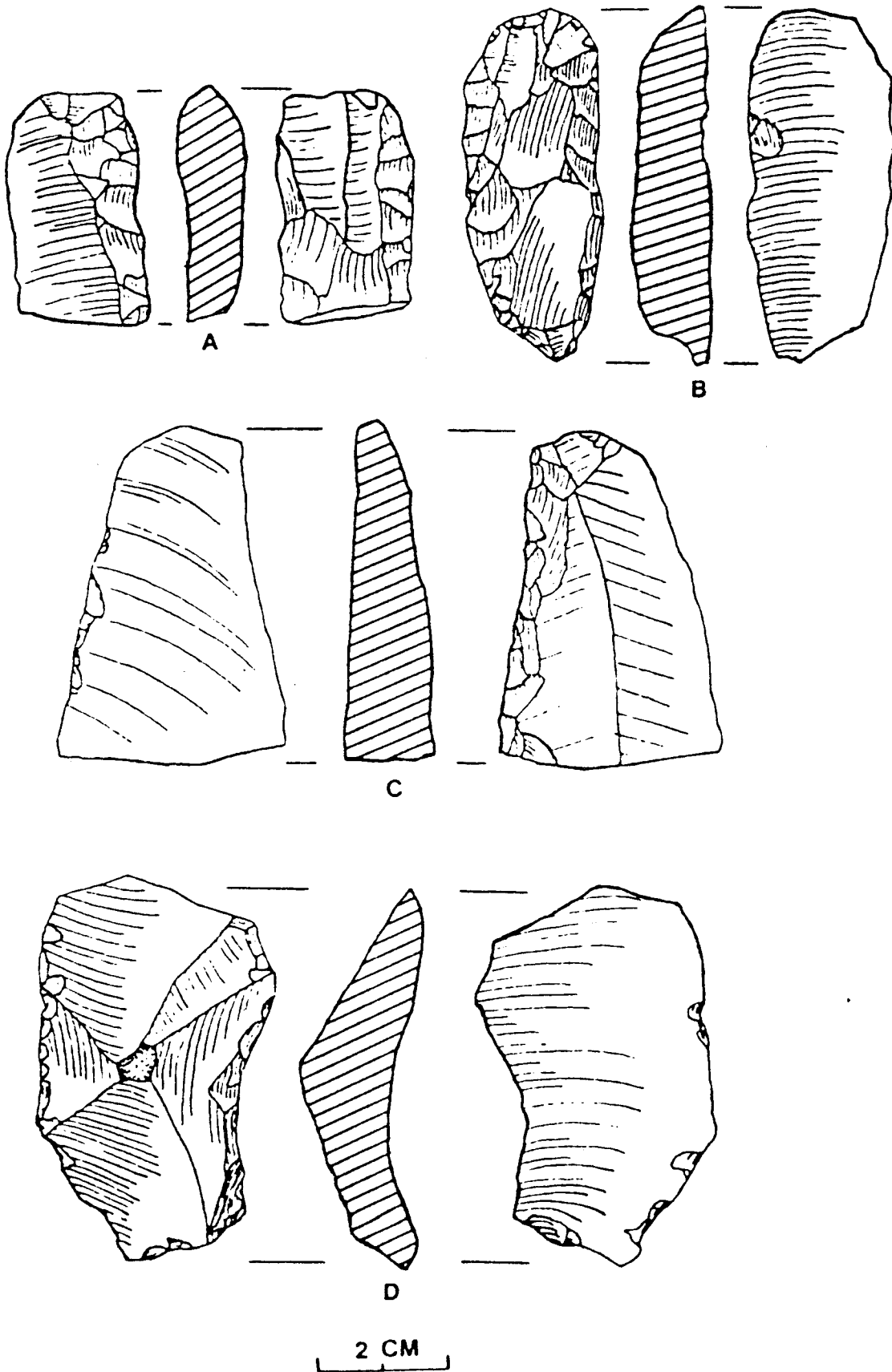


Figure 48. Four artifacts from 14CF335.

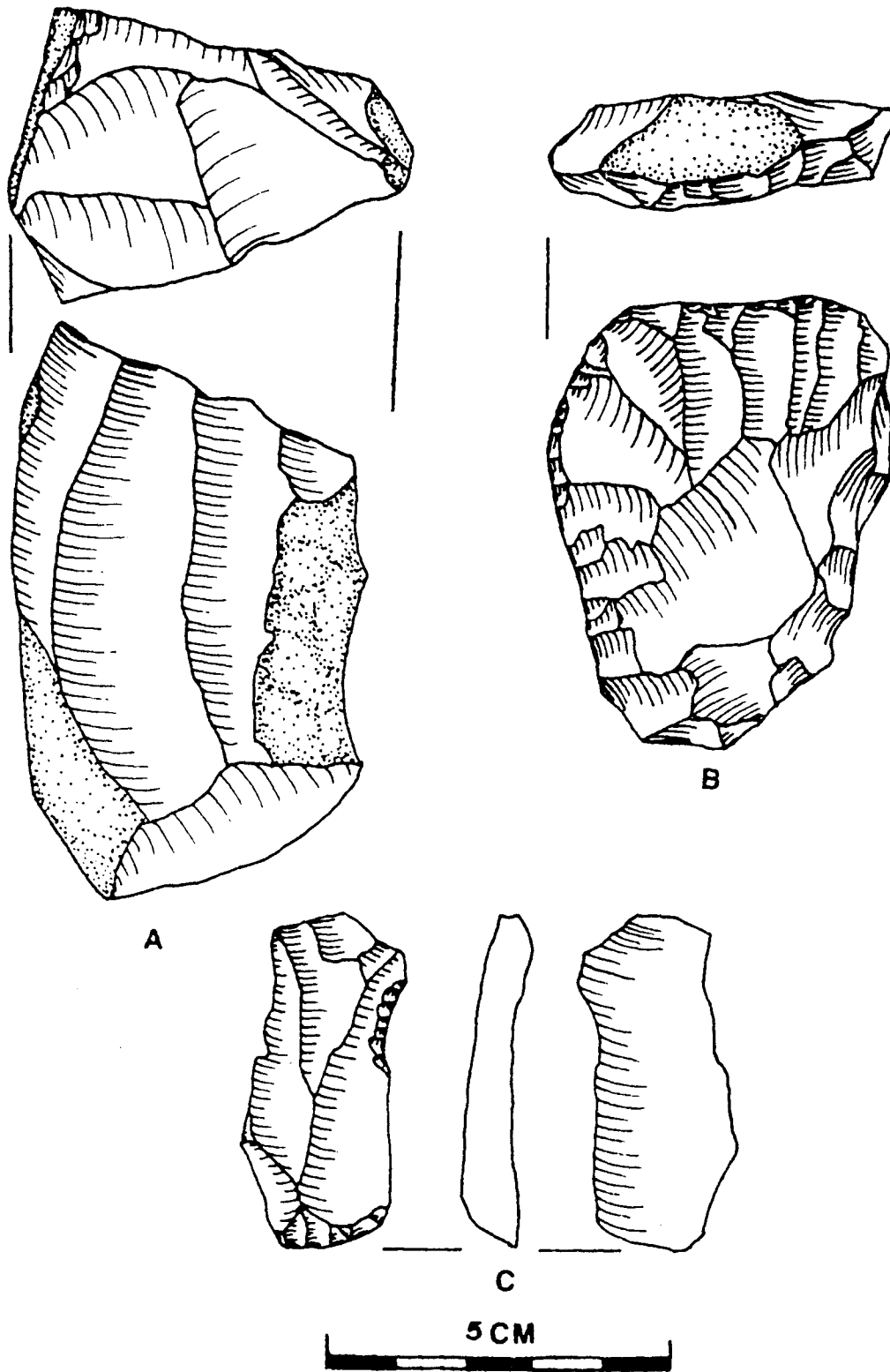


Figure 49. Artifacts from 14MN25.

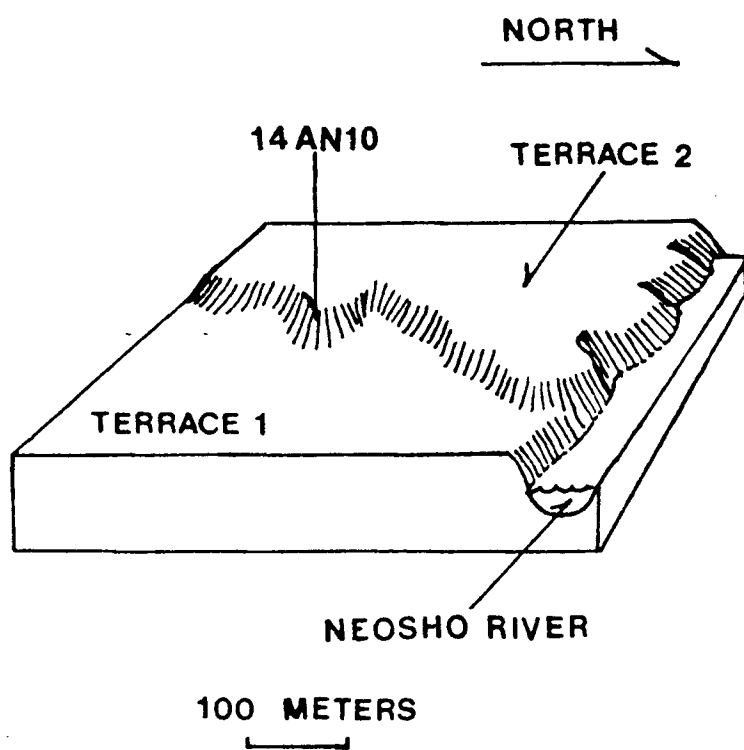


Figure 50. Stream terraces in relationship to 14AN10 (vertical dimensions not to scale).

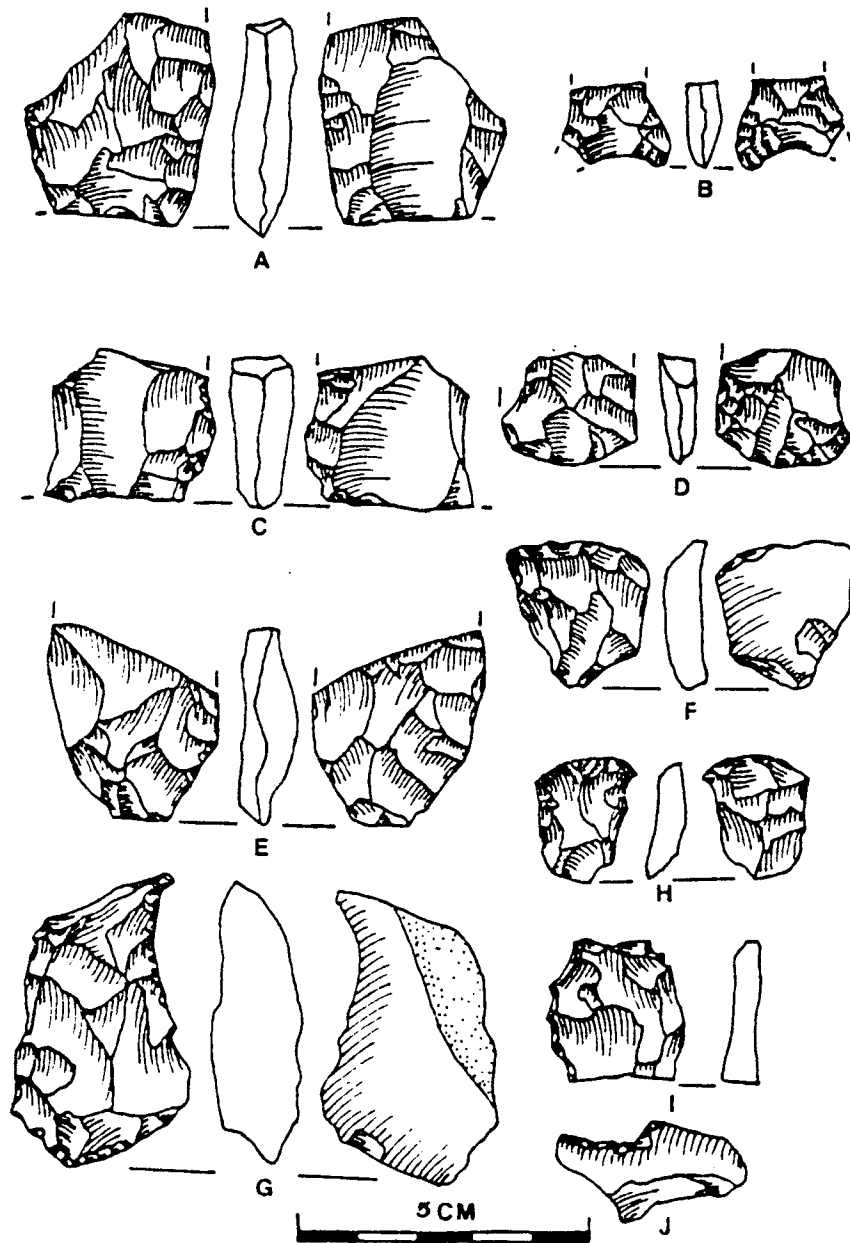


Figure 51. Artifacts from 14AN10.

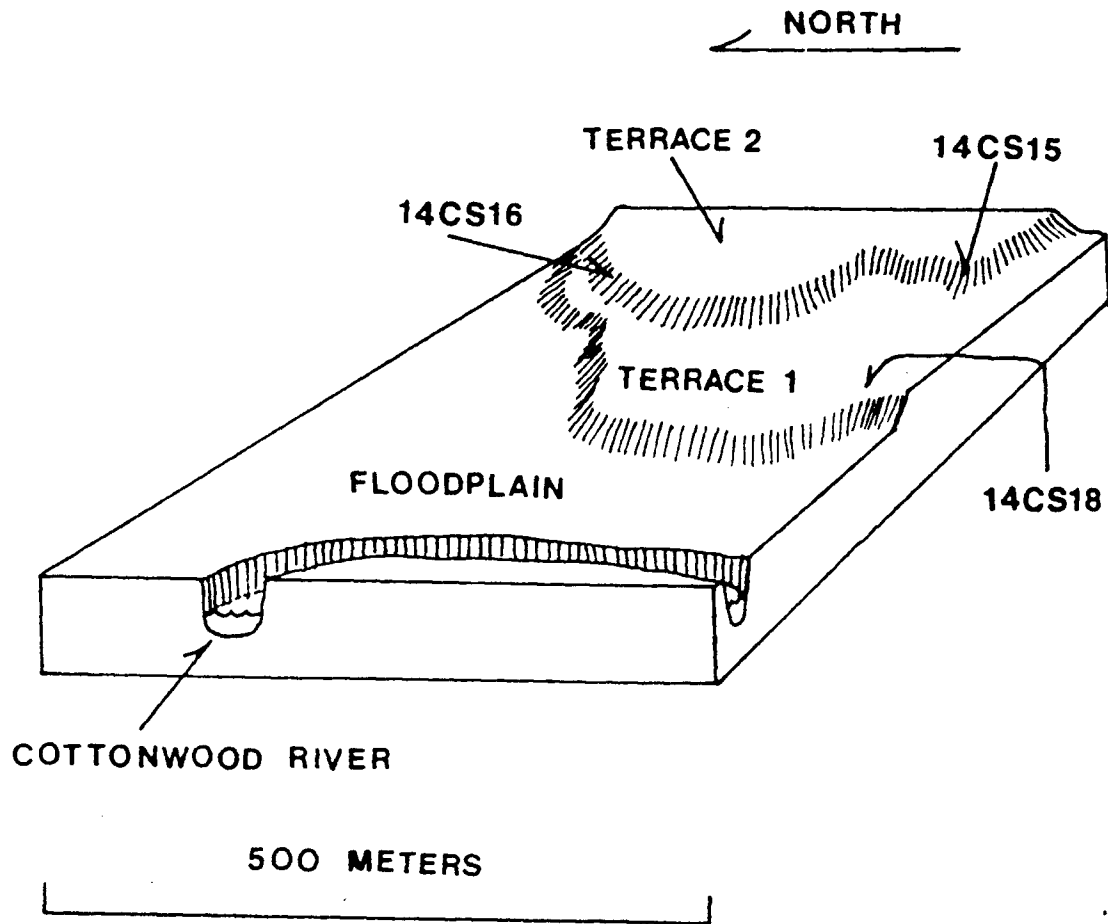


Figure 52. Stream terraces in relationship to 14CS16, 14CS15 and 14CS18 (vertical dimensions not to scale).

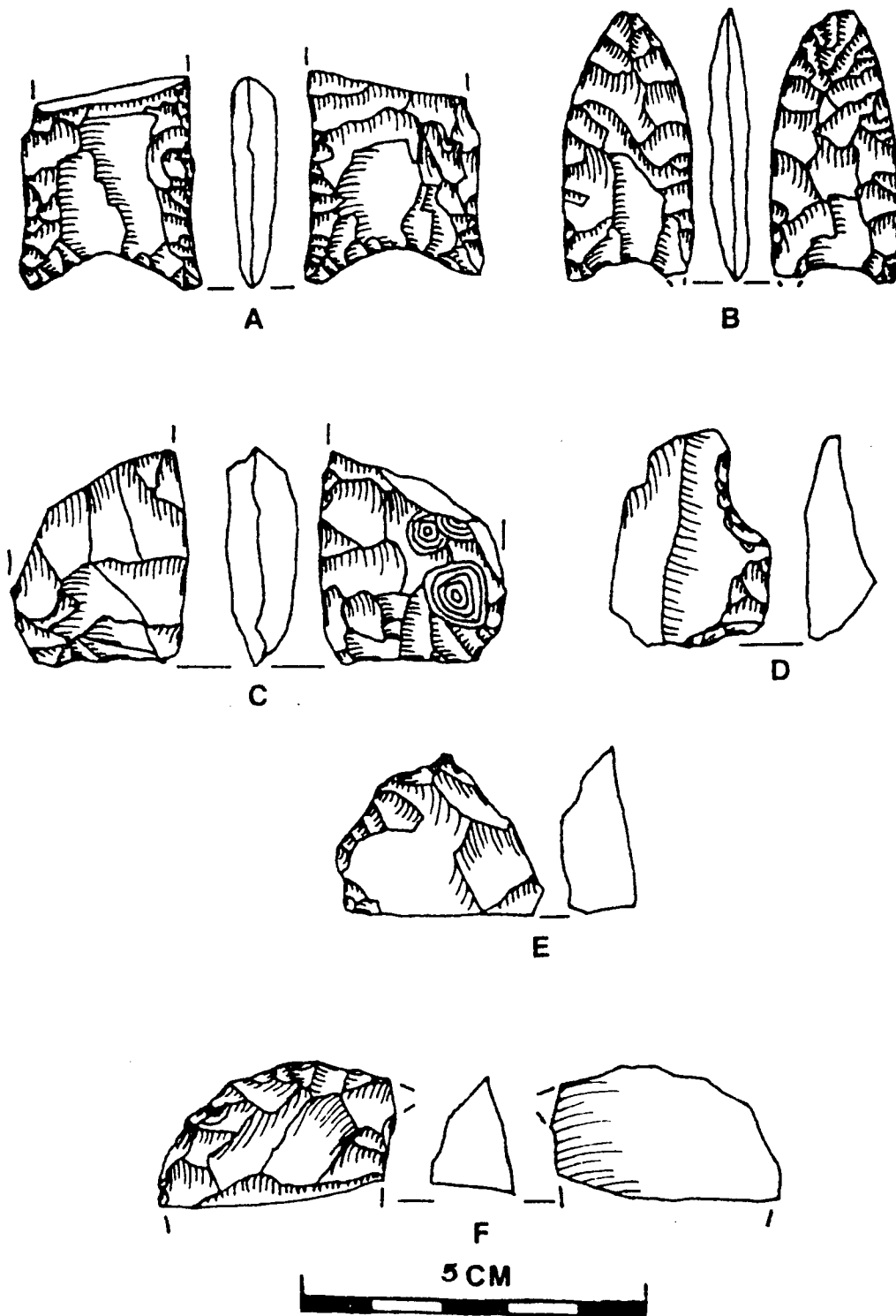


Figure 53. Artifacts from 14CS15, except for B which was found in the vicinity of Clements, Kansas.

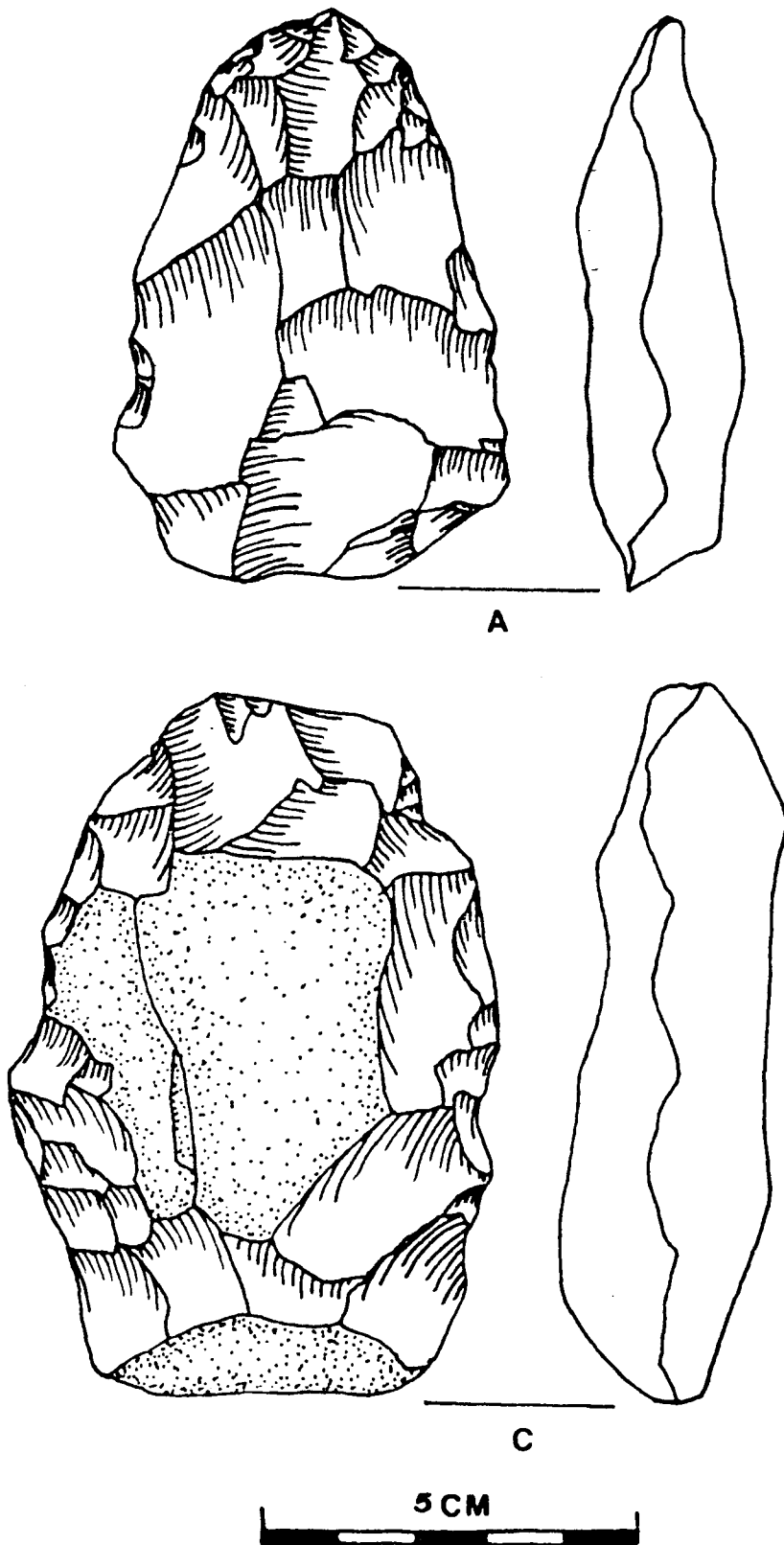
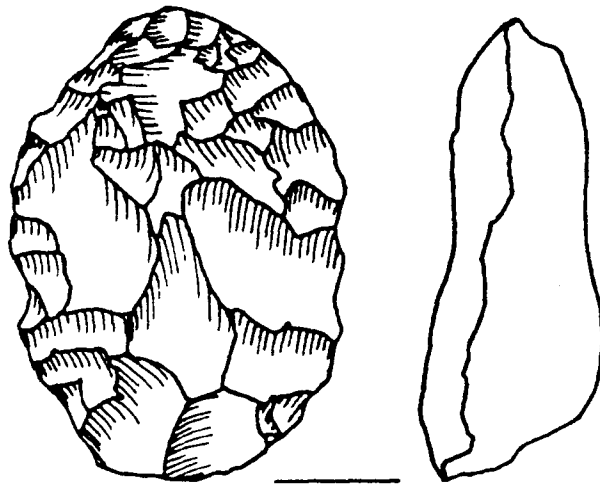
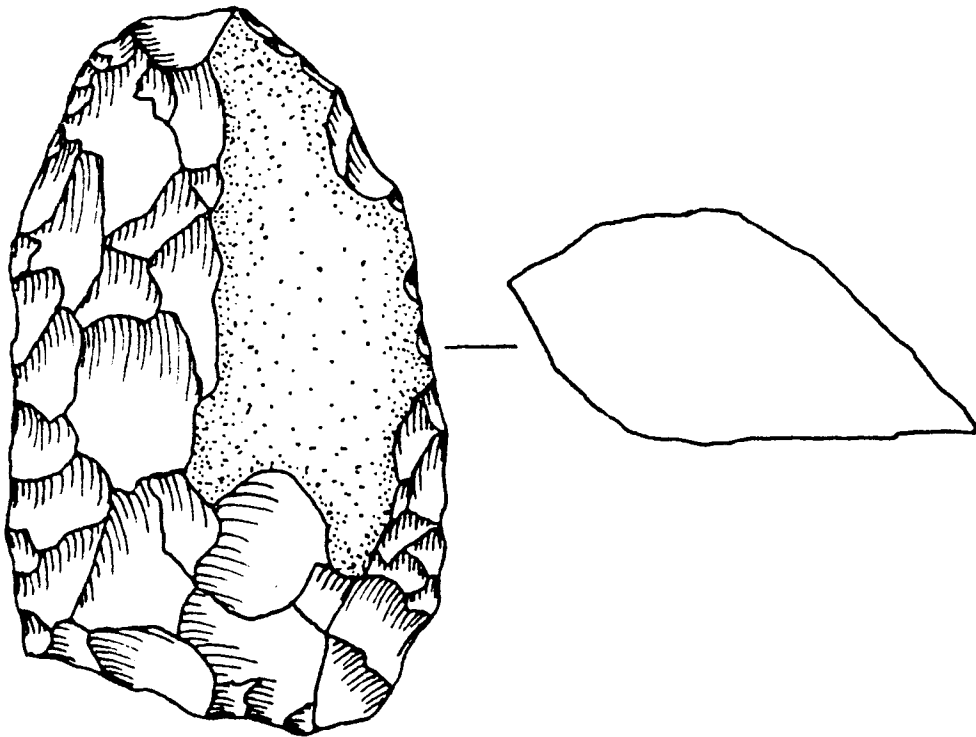


Figure 54. Large bifaces from 14CS15.



A



B



Figure 55. Two bifaces from 14CS15.

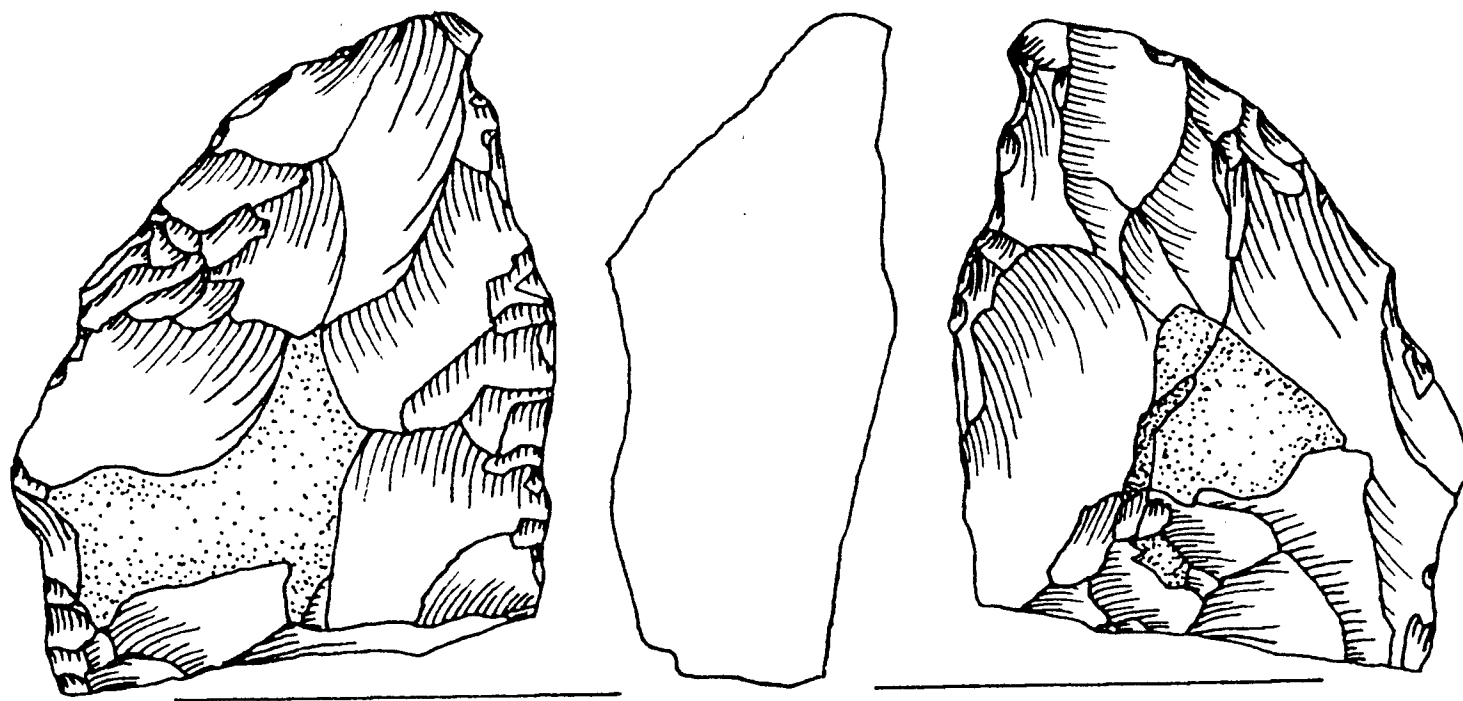


Figure 56. A large biface from 14CS15.

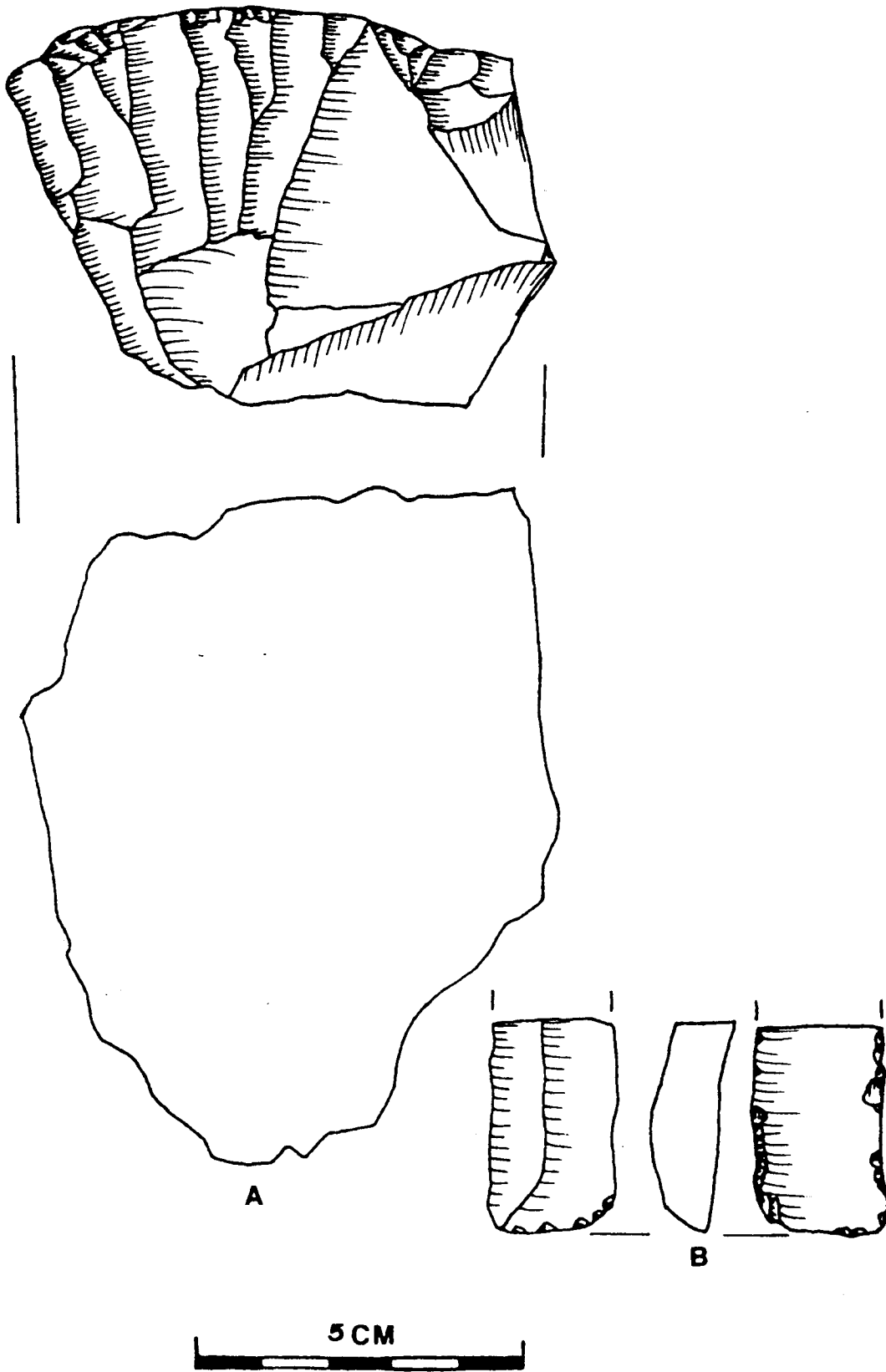
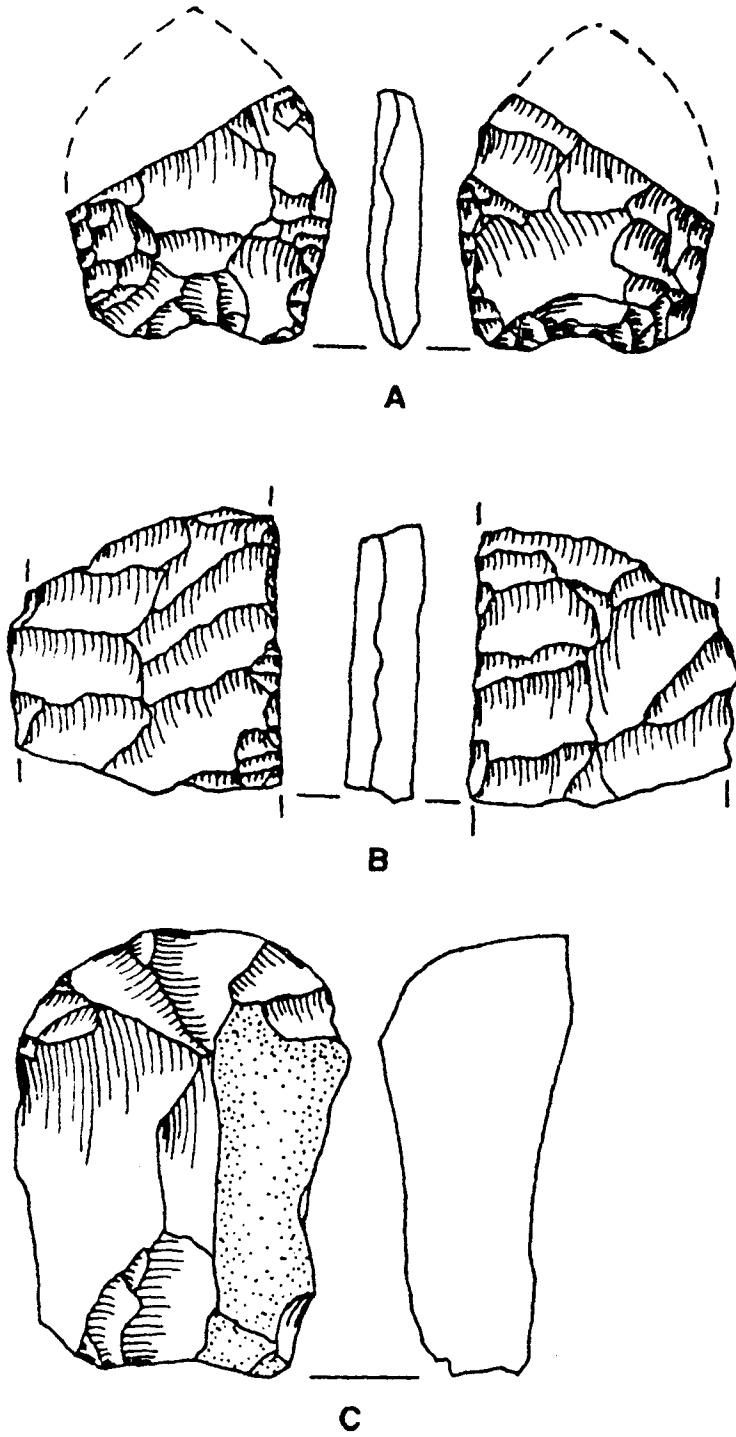


Figure 57. A blade core (A) and blade (B) from 14CS15.



5 CM

Figure 58. Three artifacts from 14CS16.

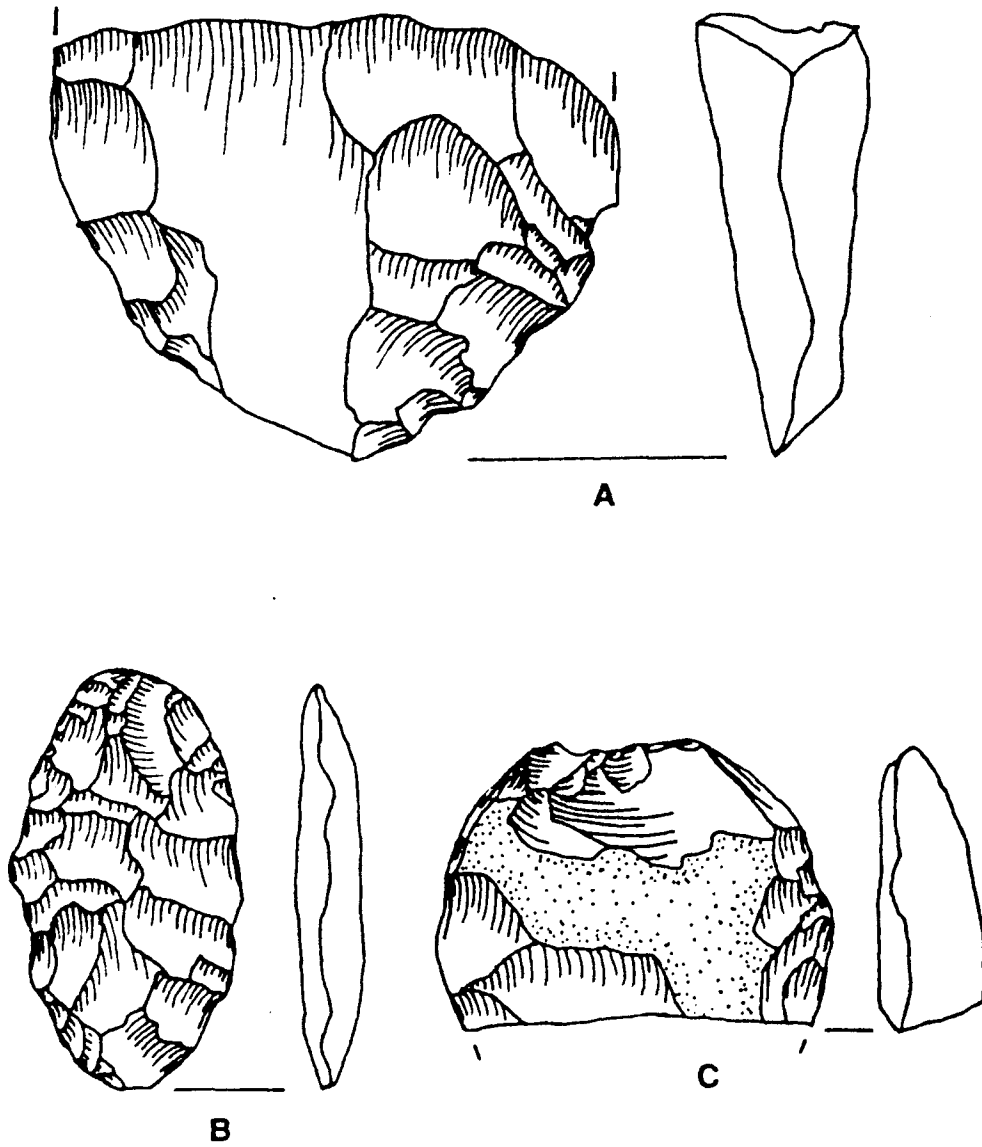


Figure 59. Bifaces from 14CS16.

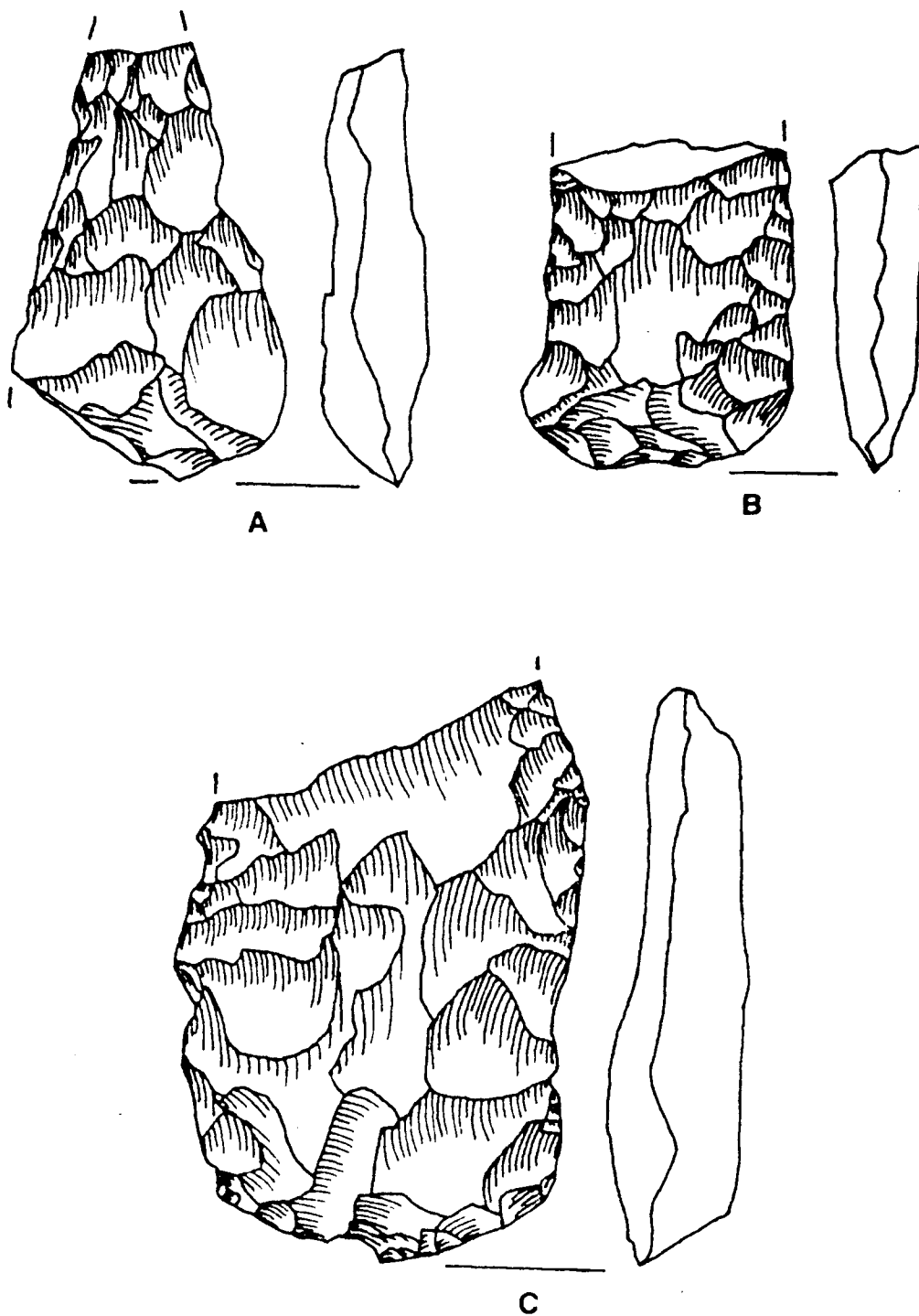
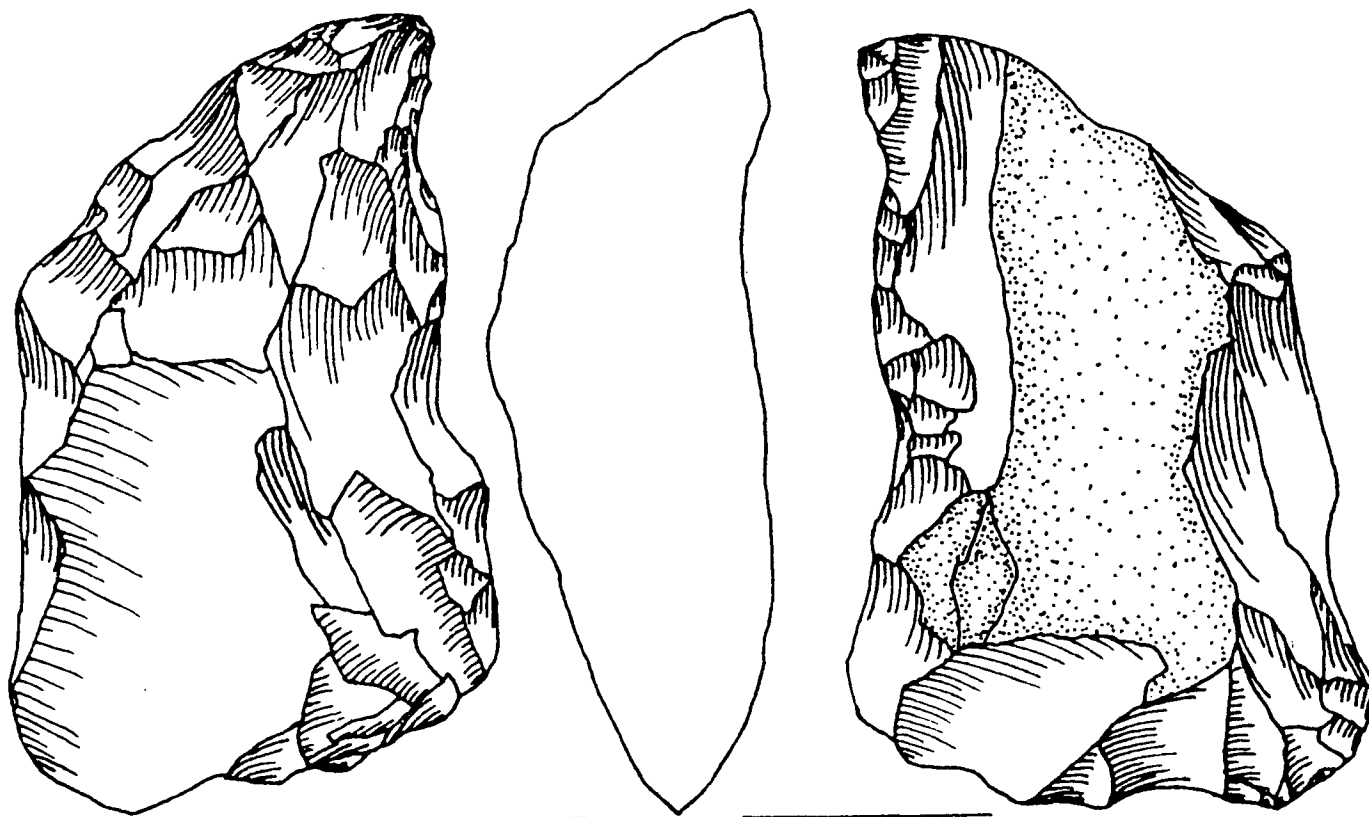
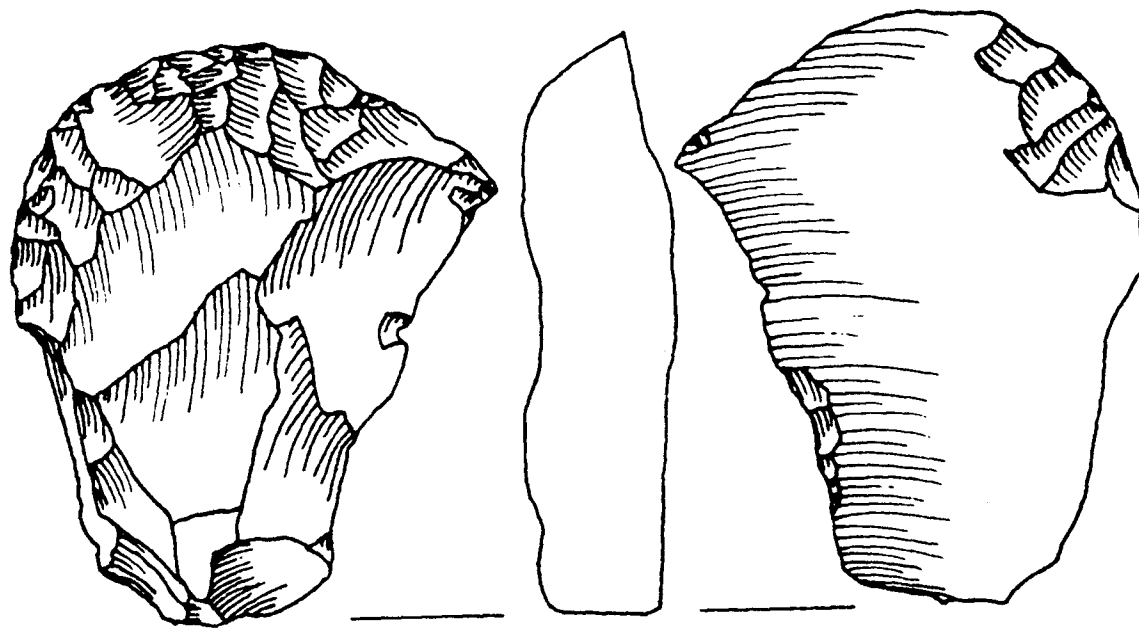


Figure 60. Three bifaces from 14CS16.

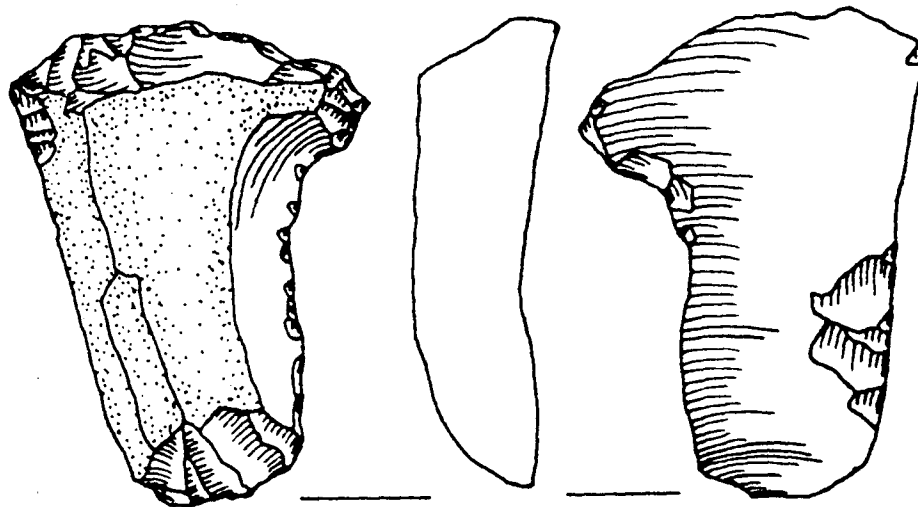


5 CM

Figure 61. A biface from 14CS16.



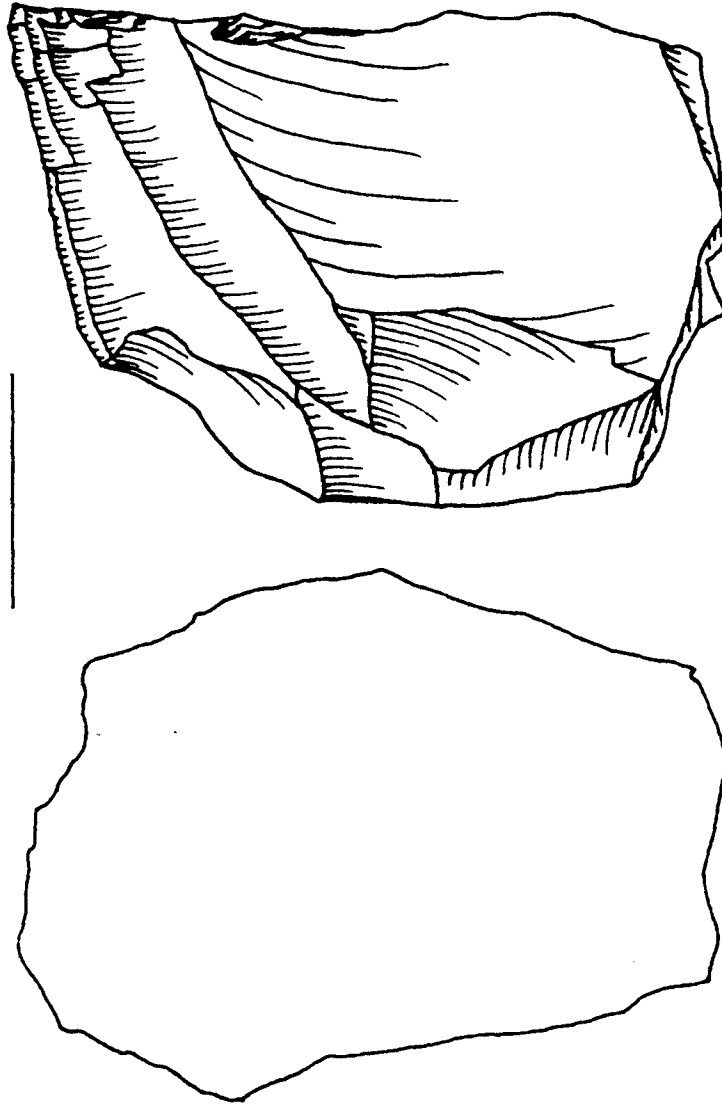
A



B



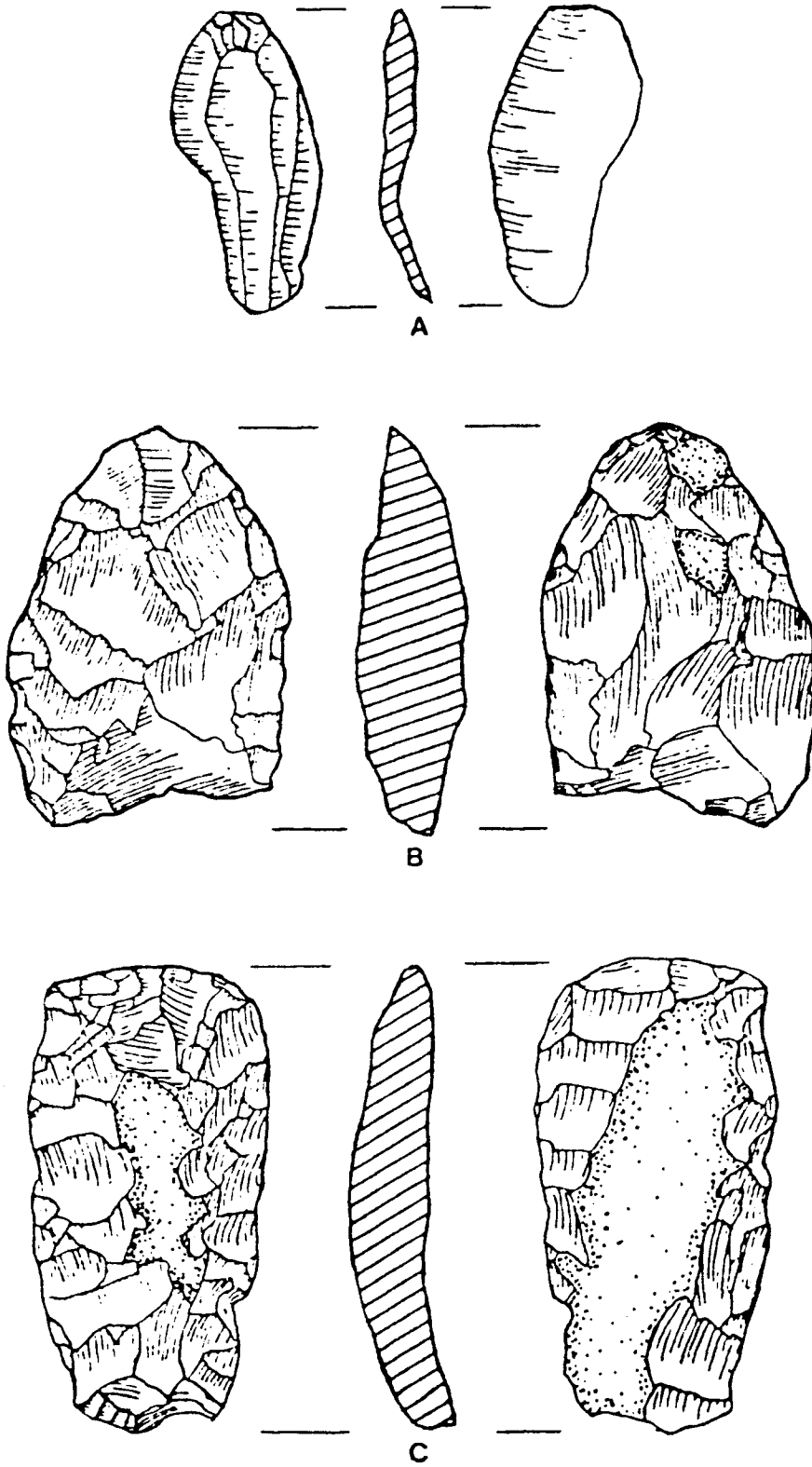
Figure 62. Spurred end scrapers from 14CS16.



5 CM



Figure 63. A blade core from 14MN33.



2 CM

Figure 64. Artifacts from 14CF24.

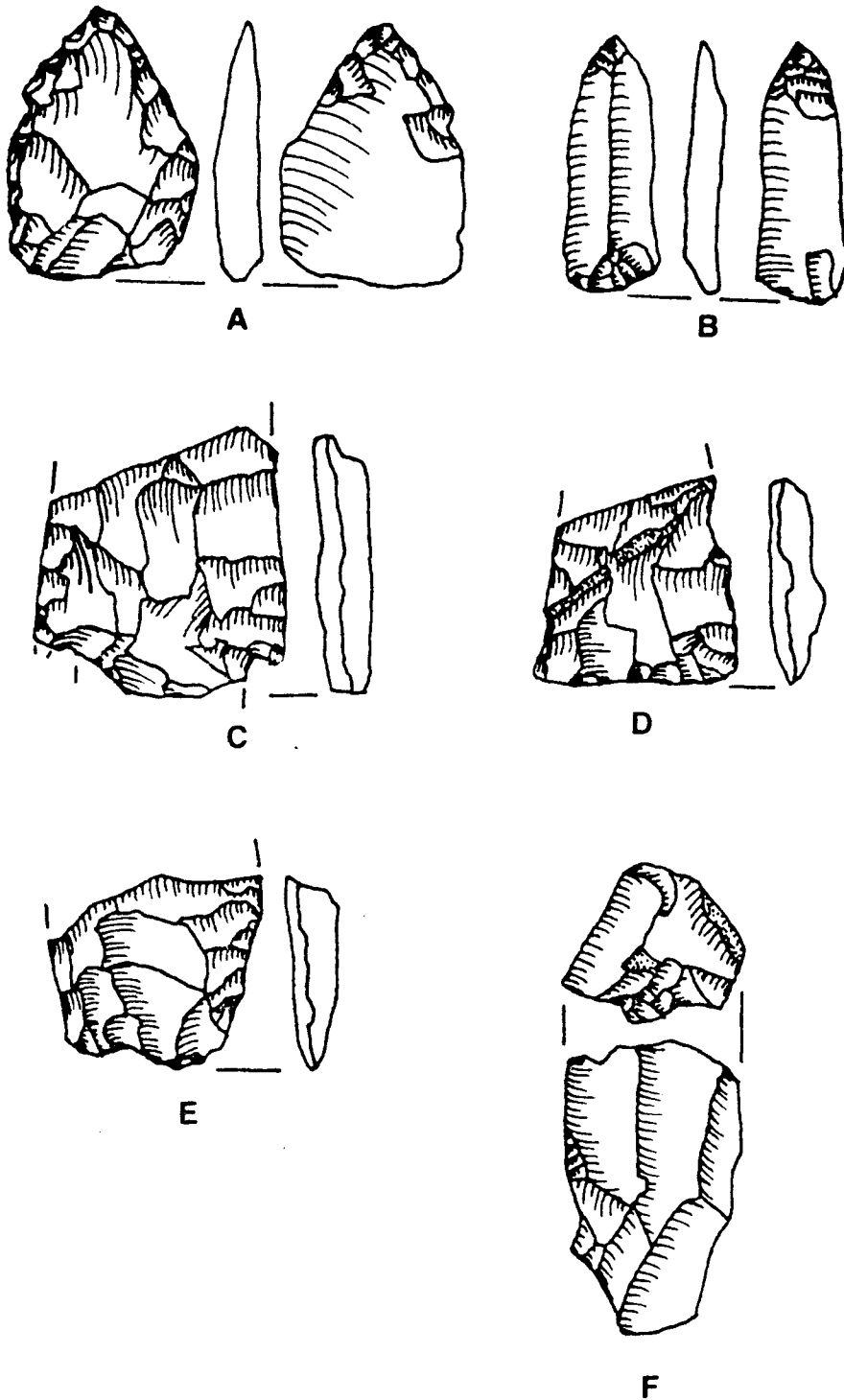
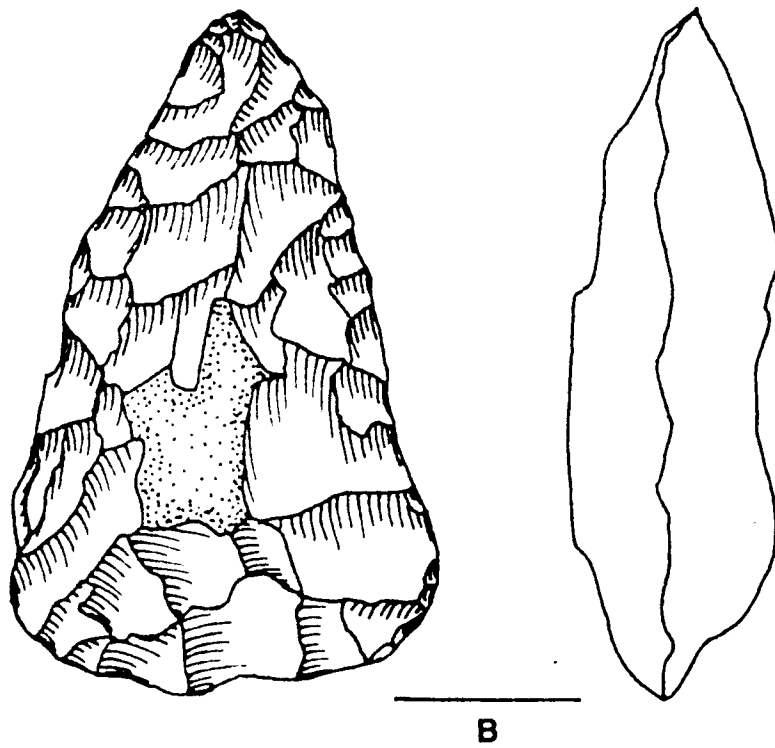
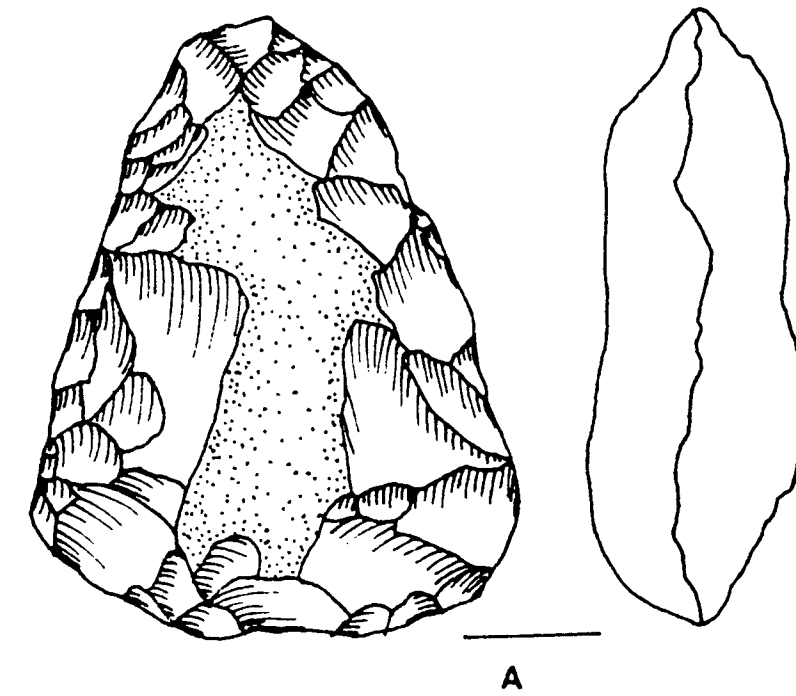


Figure 65. Artifacts from 14MN15.



5 CM

Figure 66. Thick sub-triangular bifaces from 14MN15.

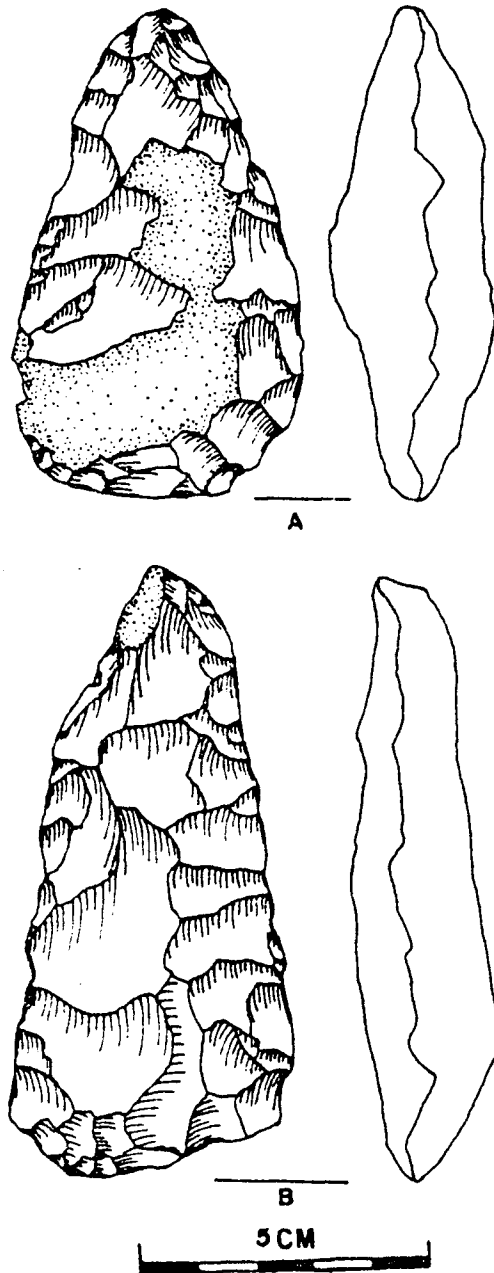
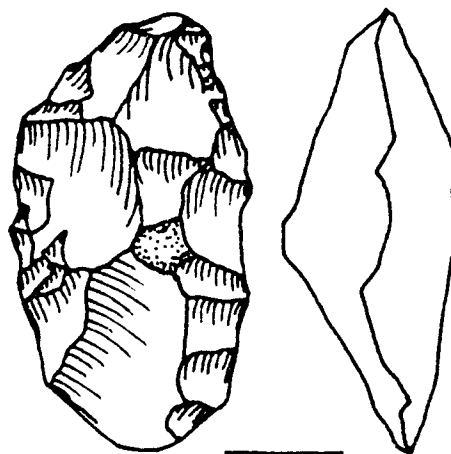
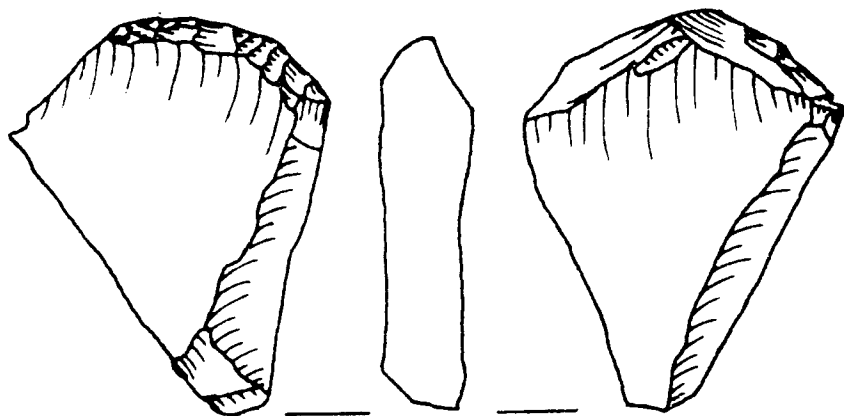


Figure 67. A thick sub-triangular biface (A) and a celt (B) from 14MN16.



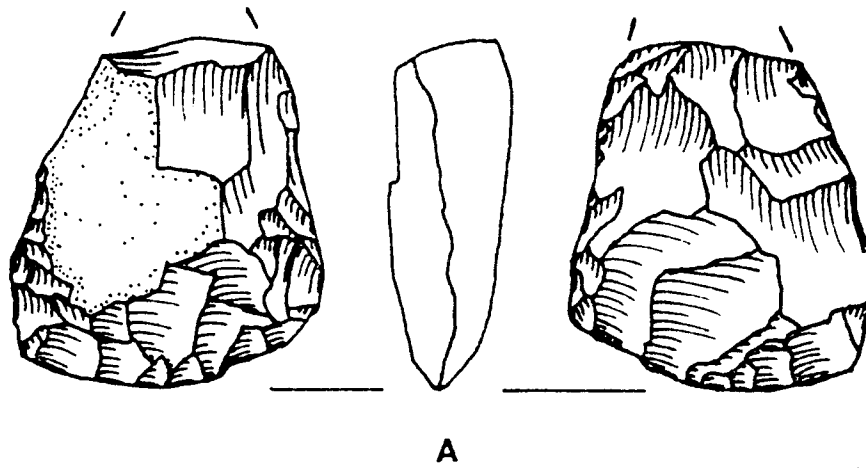
A



B



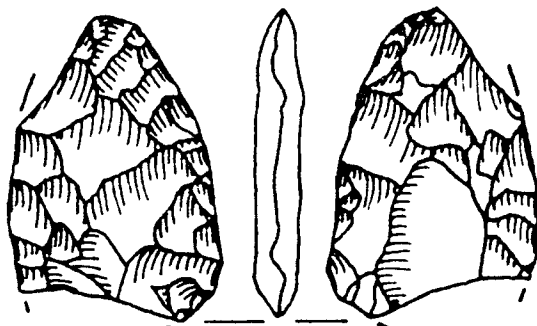
Figure 68. Two artifacts from 14MN16.



A



B



C

5 CM

Figure 69. Artifacts from 14MN20 (A), 14MN22 (B) and 14MN29 (C).

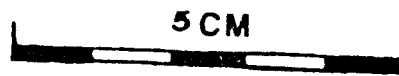
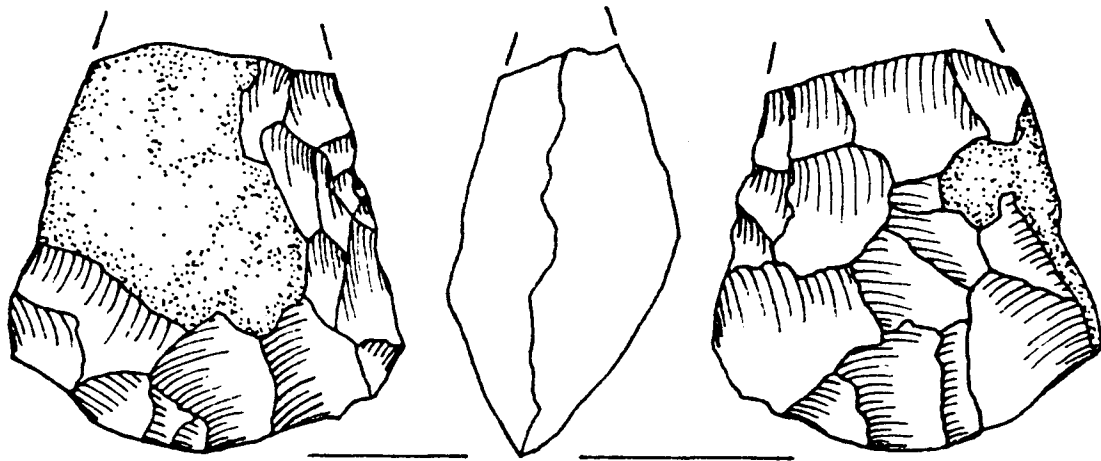


Figure 70. A thick sub-triangular biface fragment from 14MN26.

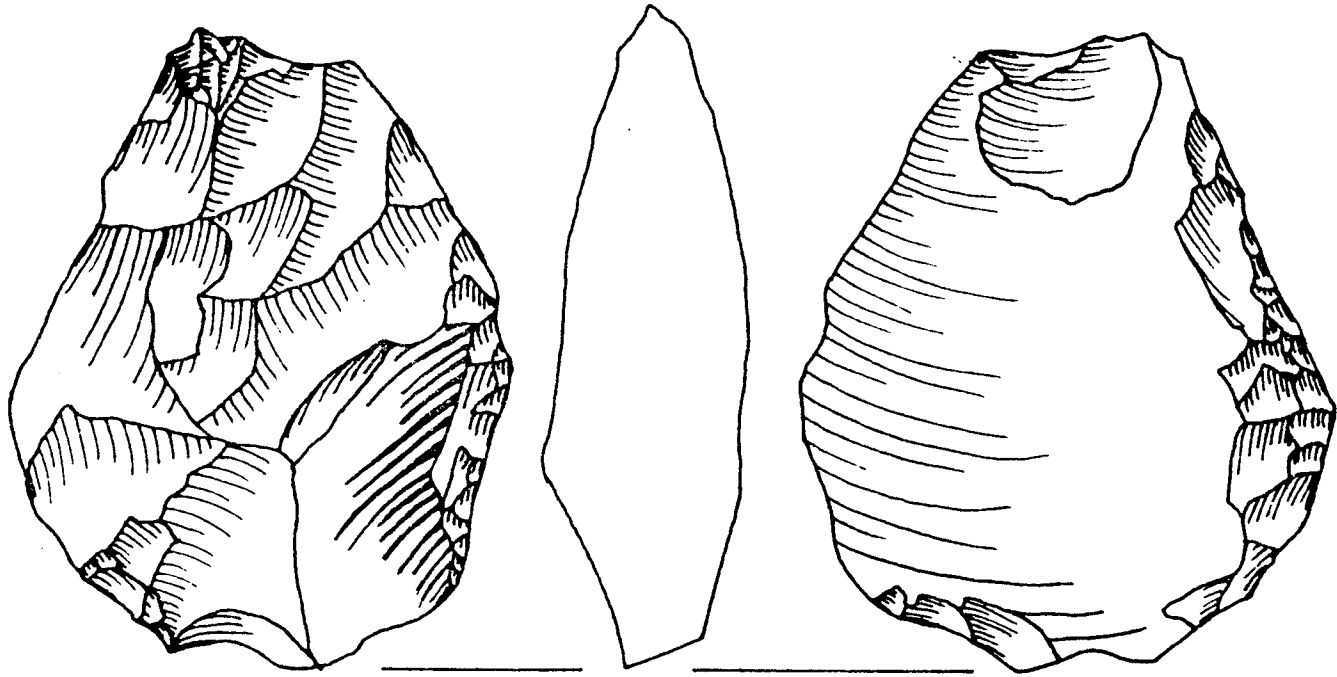


Figure 71. An artifact from 14MN26.

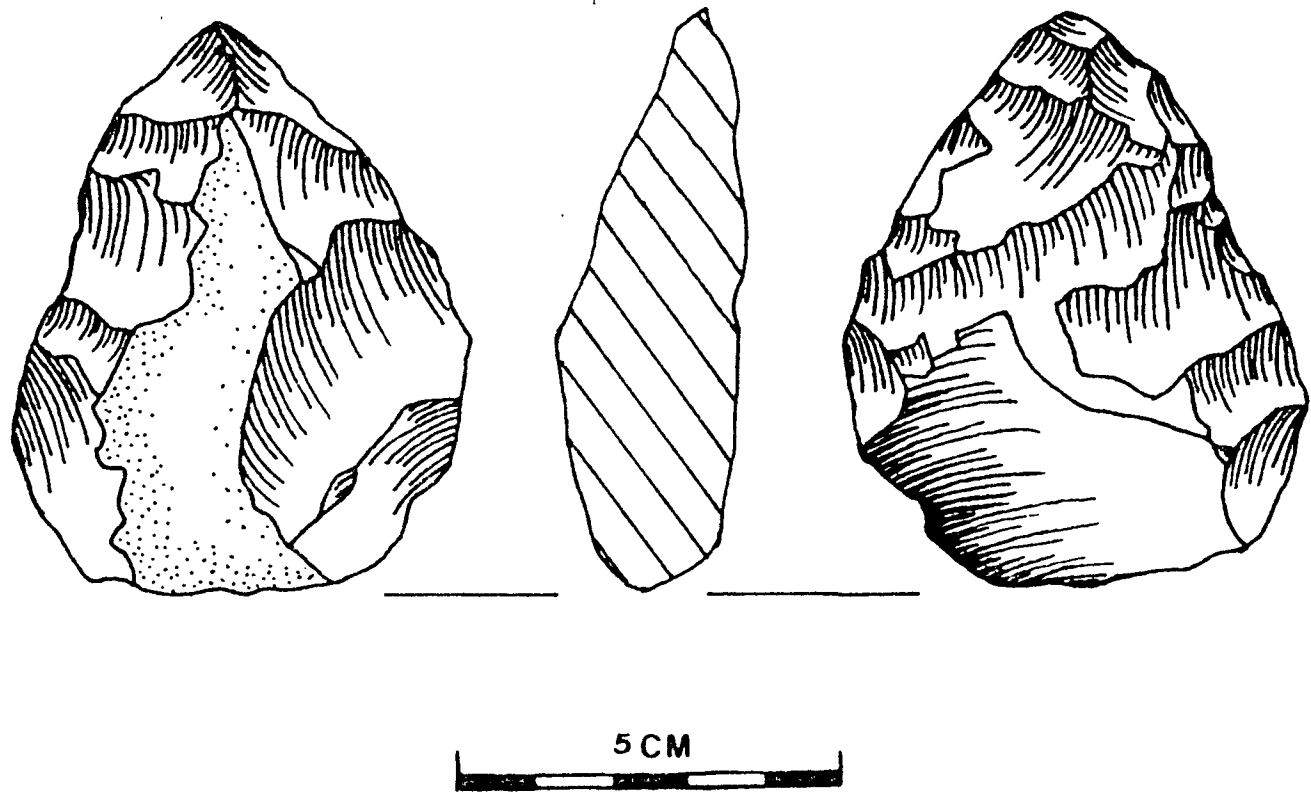
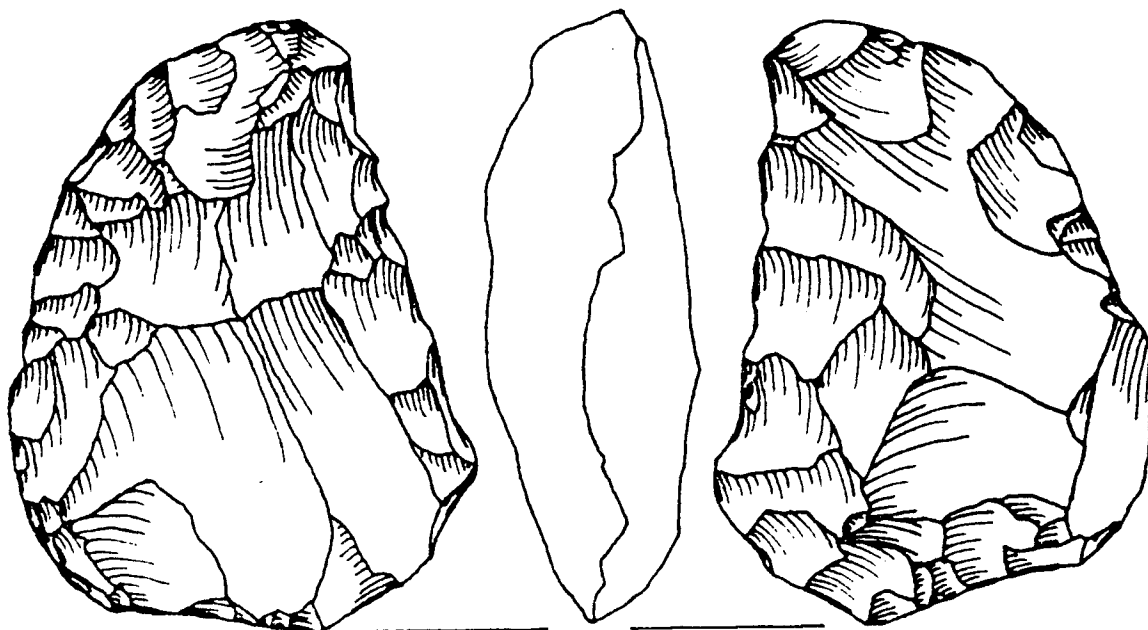
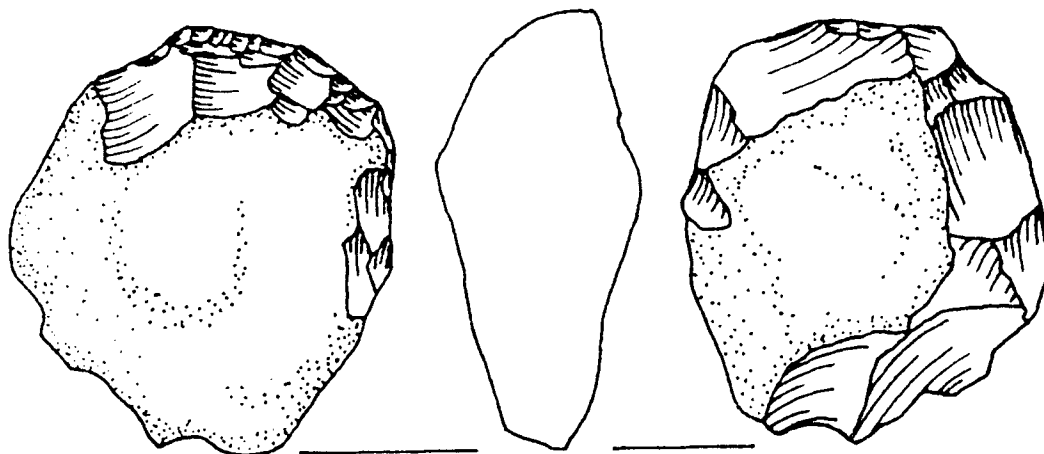


Figure 72. A thick sub-triangular biface from the Dalke locality.



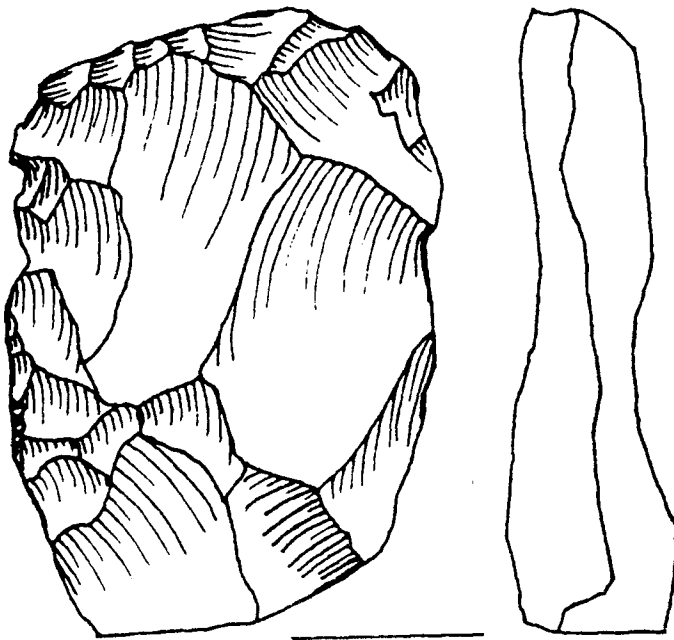
A



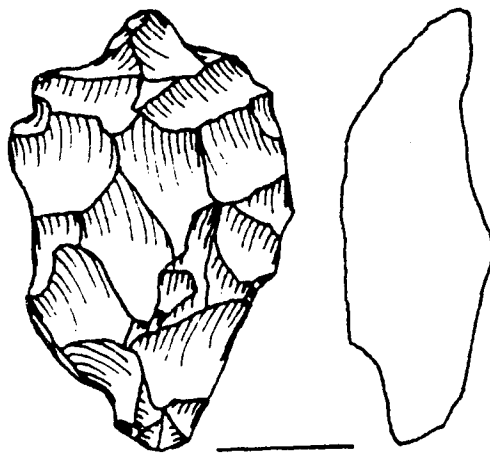
B

5 CM

Figure 73. Two artifacts from 14MN18.



A



B



Figure 74. Artifacts from 14MN18.

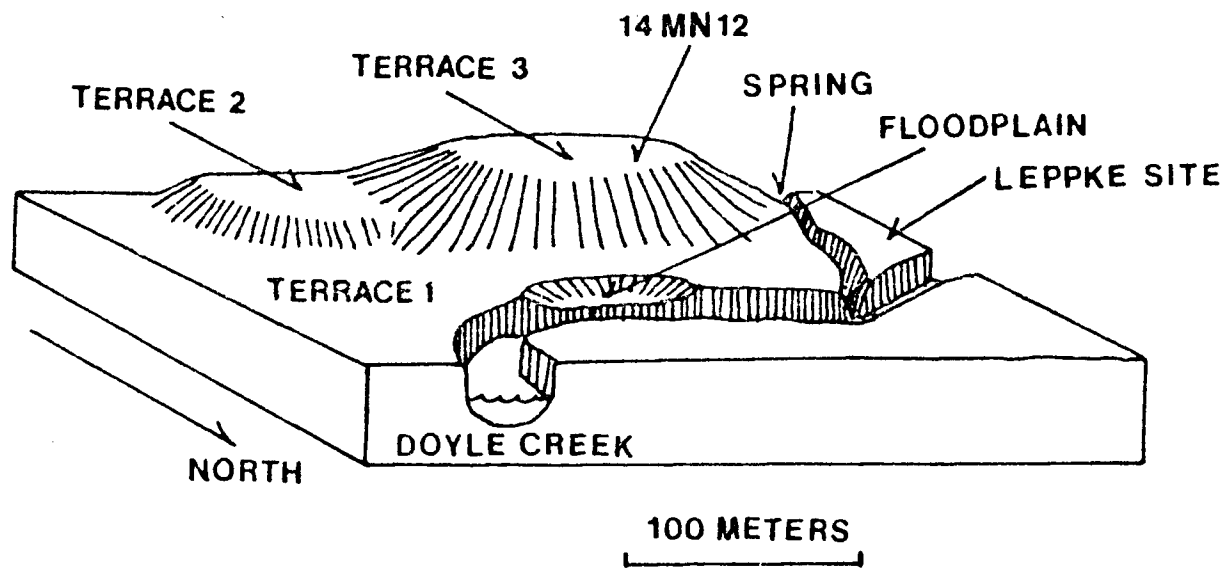


Figure 75. Stream terraces in relationship to 14MN12 (vertical dimensions not to scale).

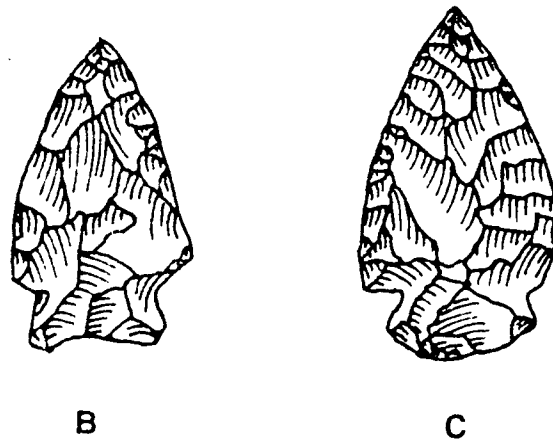
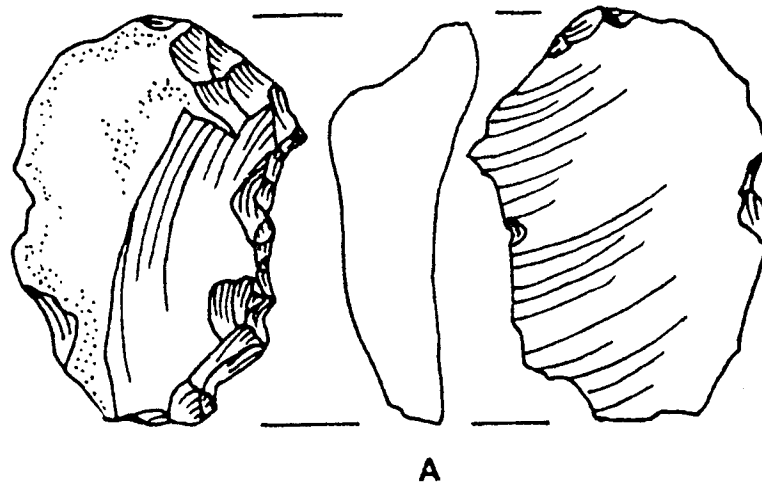


Figure 76. Three artifacts from 14MN12.

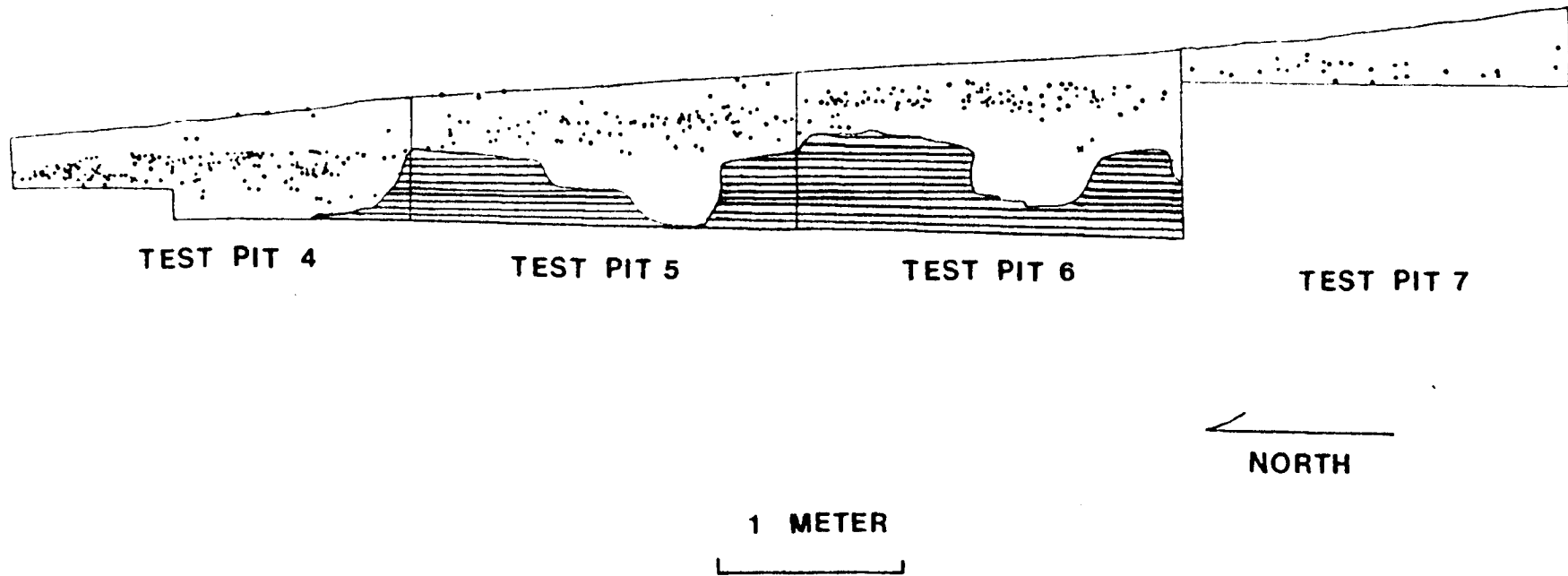


Figure 77. Test trench on the slope of 14MN12.

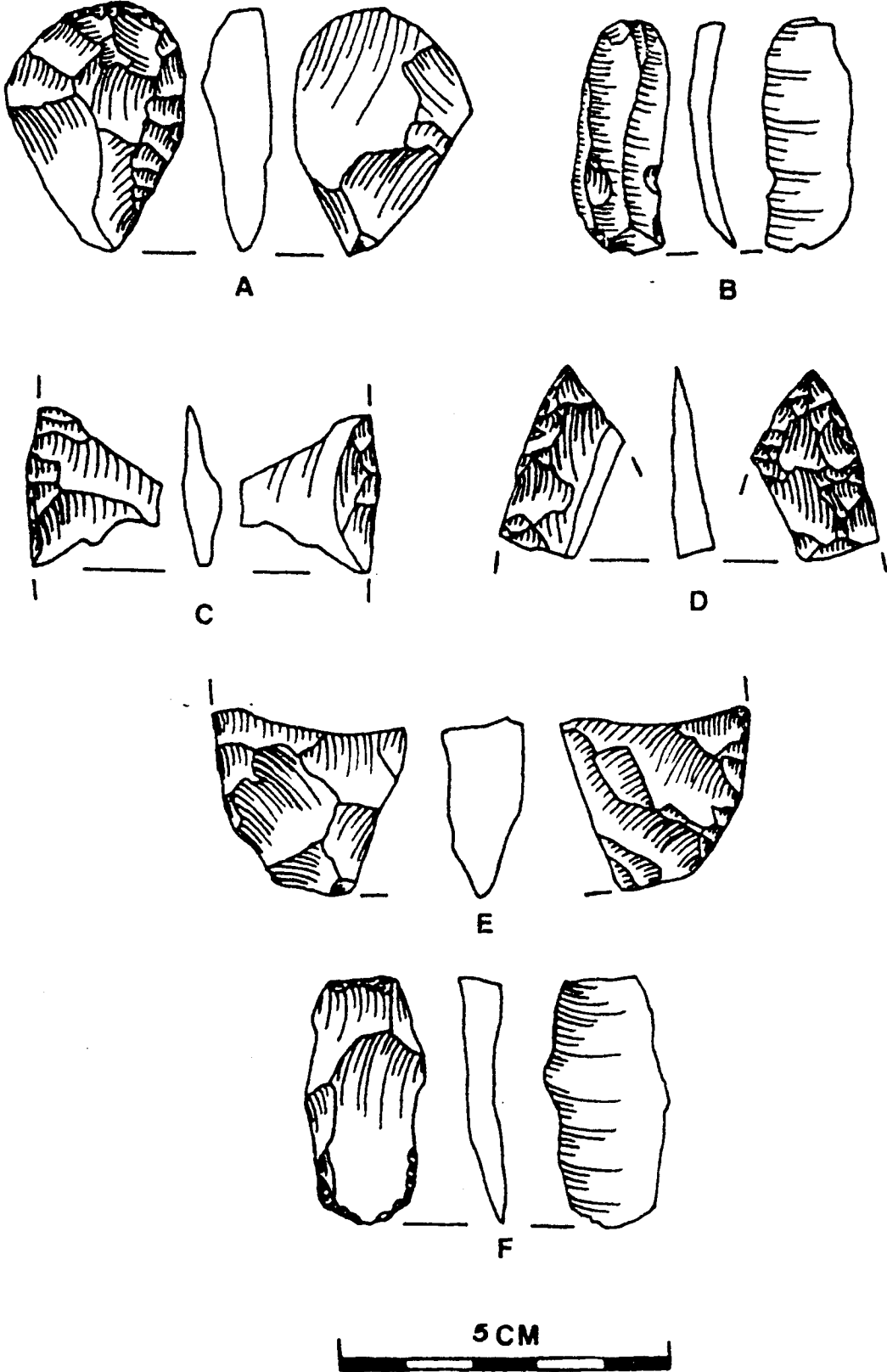


Figure 78. Artifacts excavated from 14MN12.

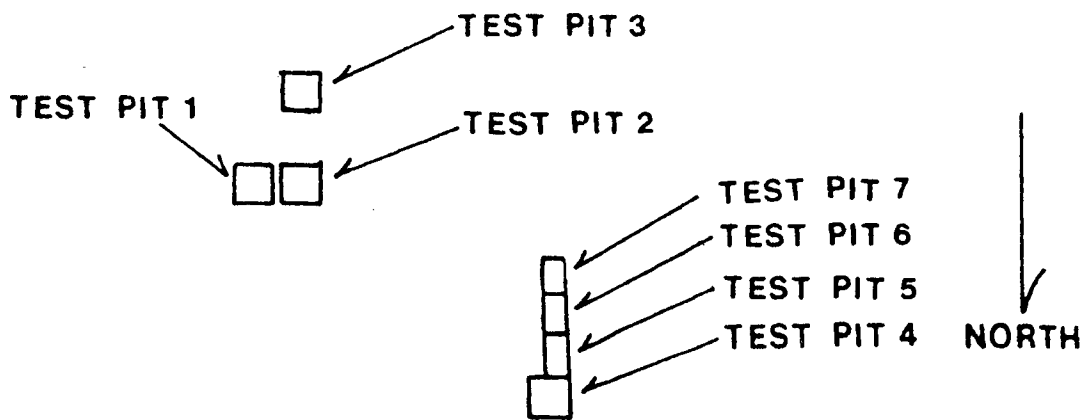
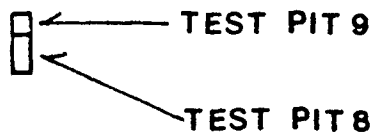


Figure 79. Positions of test pits of 14MN12.

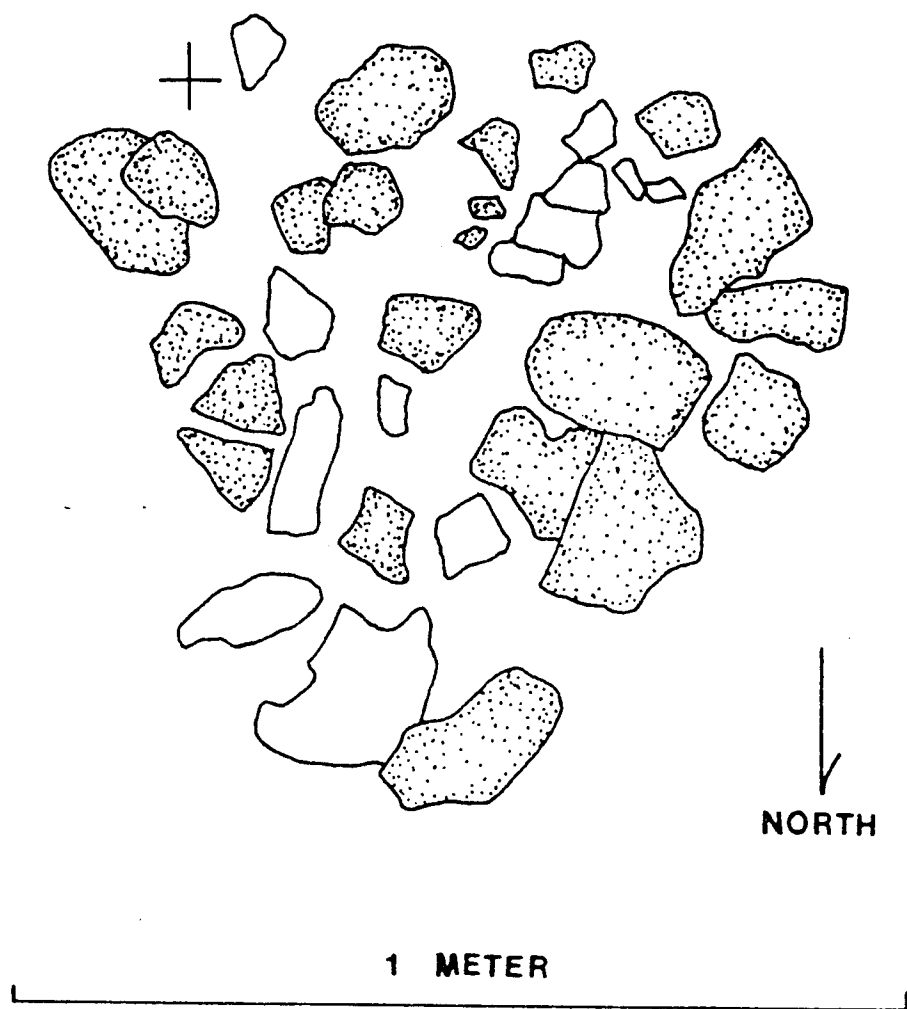


Figure 80. Fire hearth excavated at 14MN12 (stippling indicates fire reddened rocks).

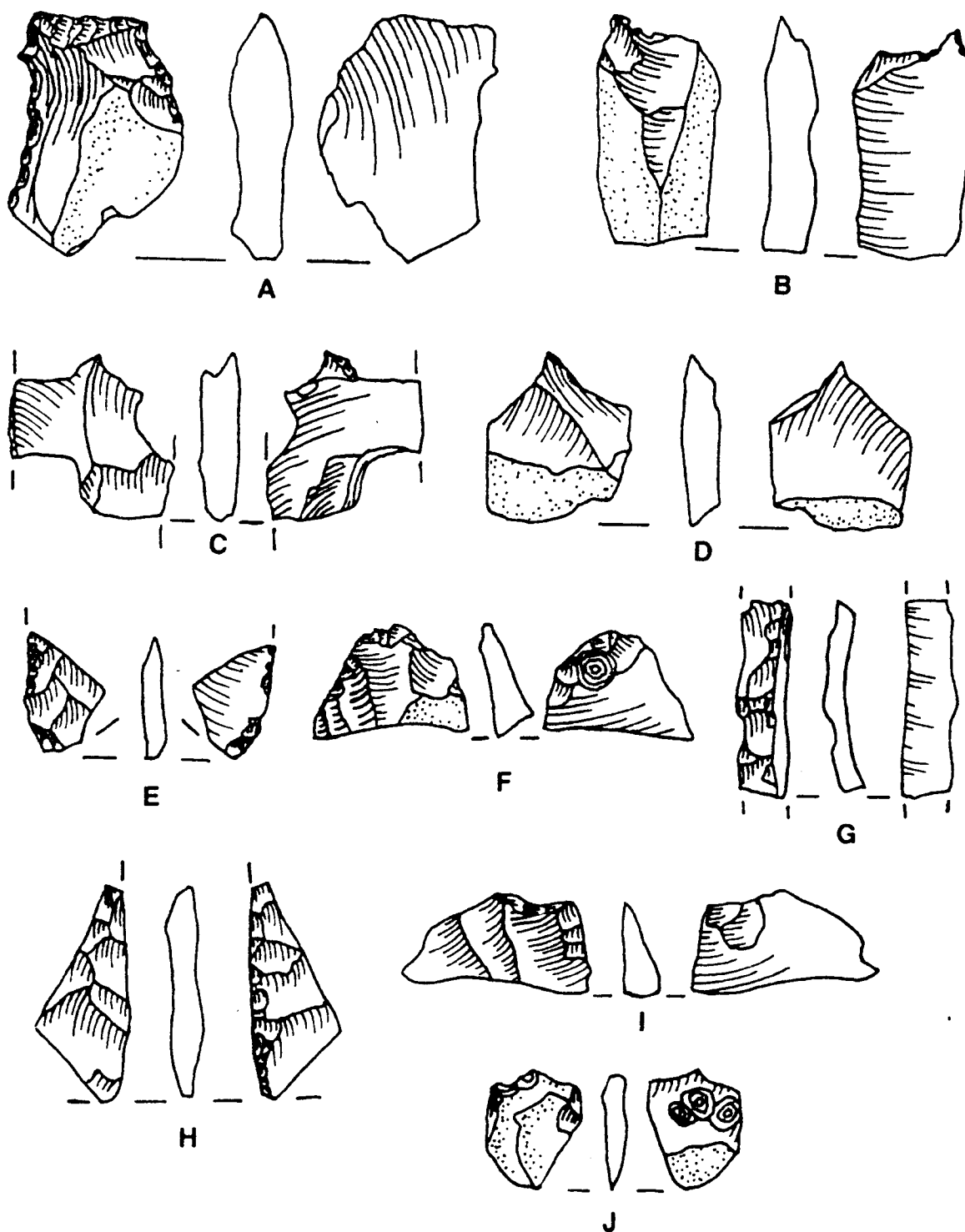


Figure 81. Artifacts excavated from Test Pit 8 at 14MN12.

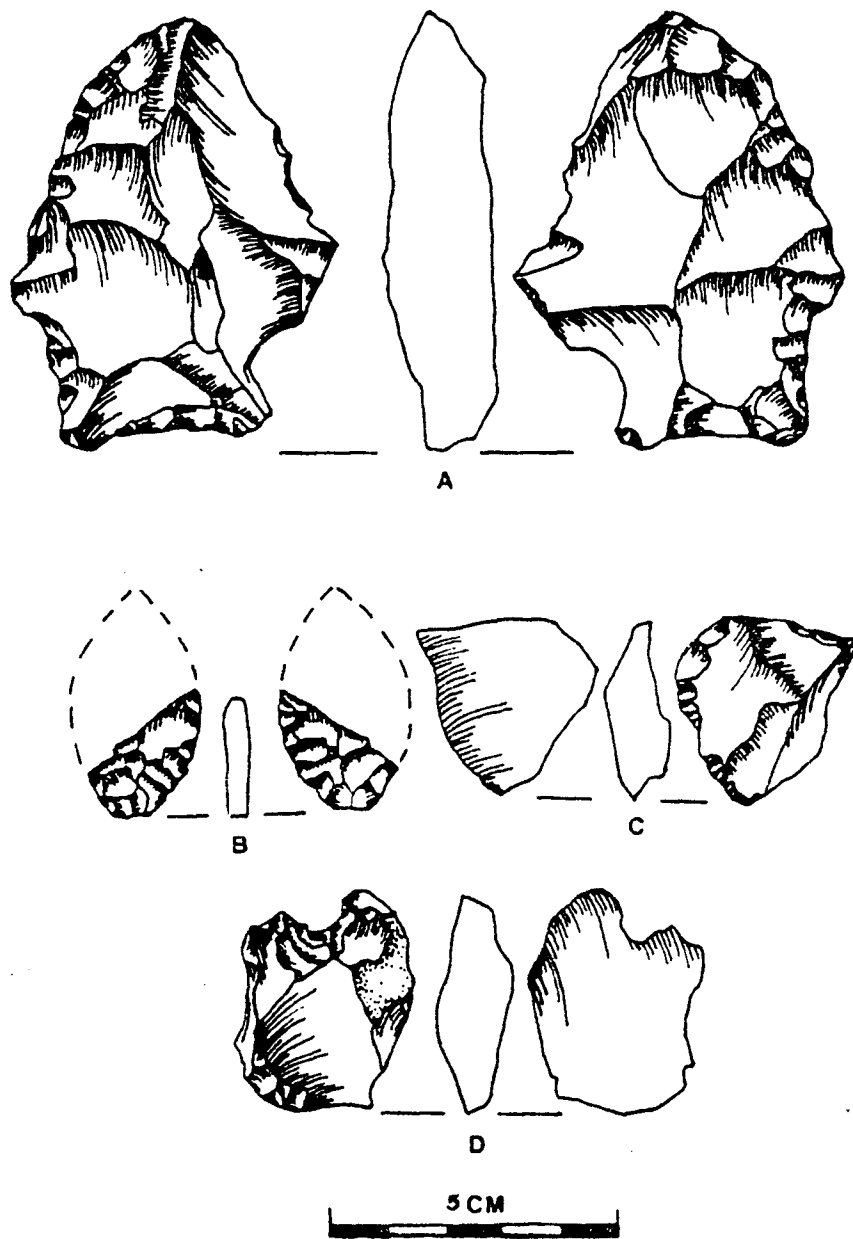


Figure 82. Artifacts from 14MN28.

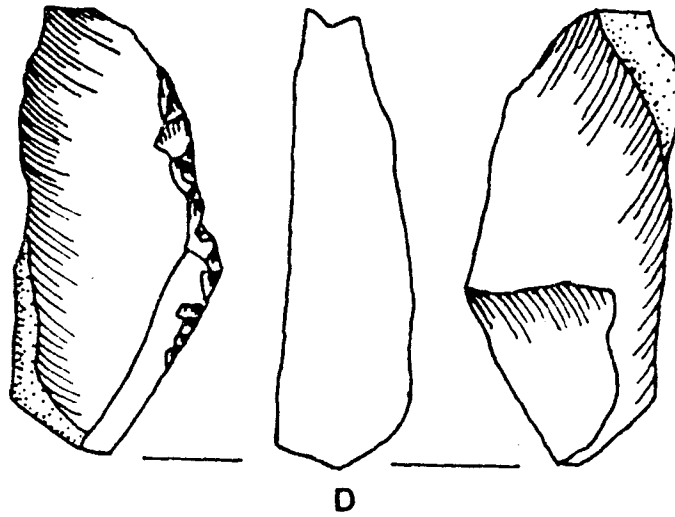
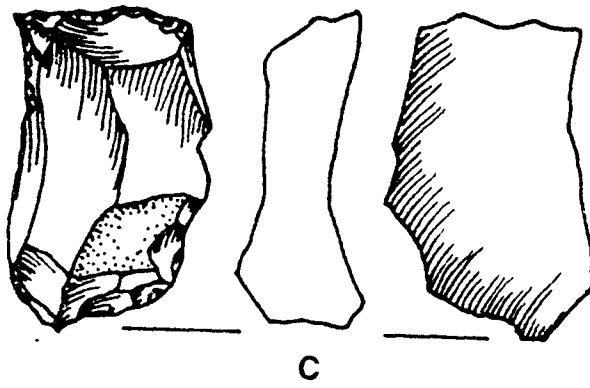
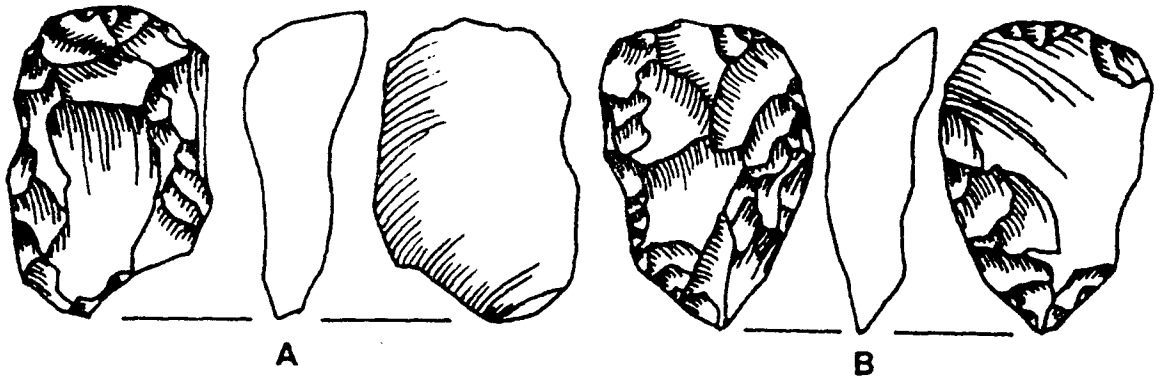


Figure 83. Four artifacts from 14MN28.

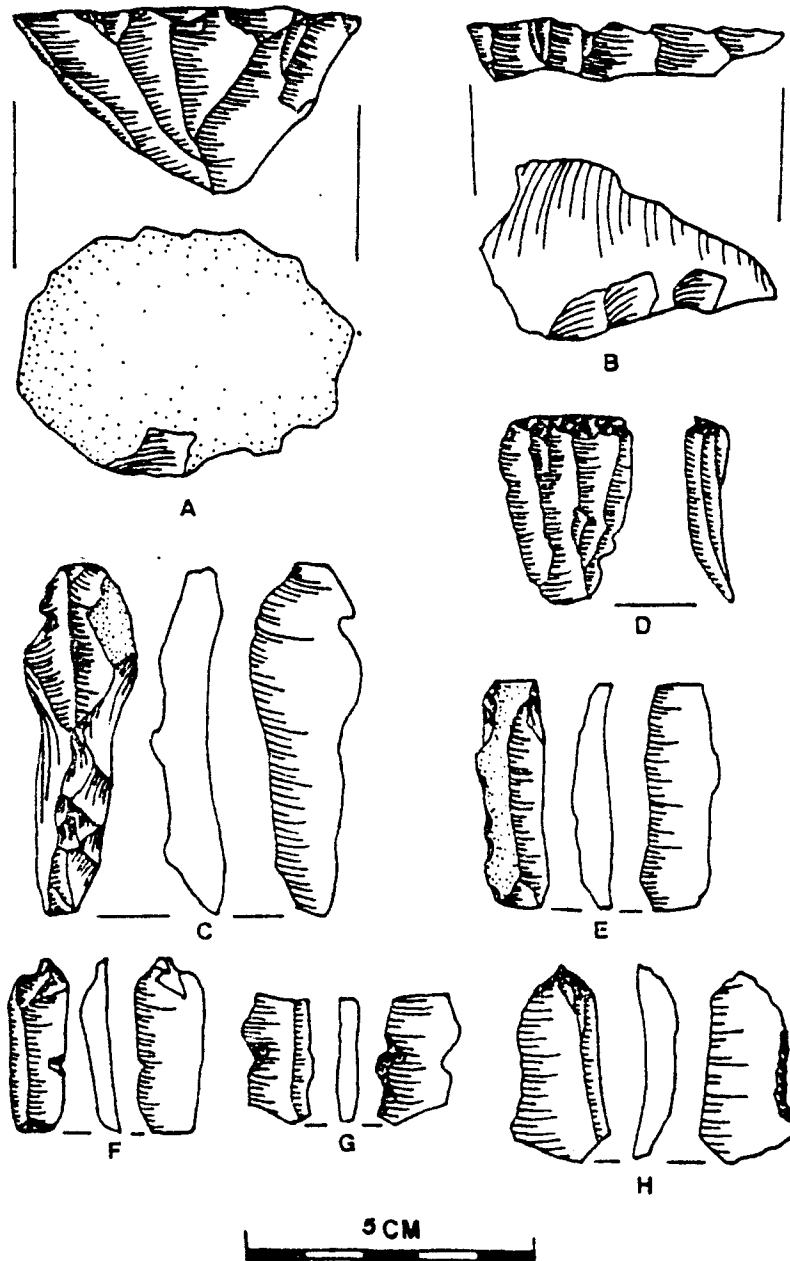


Figure 84. Eight artifacts from 14MN28.

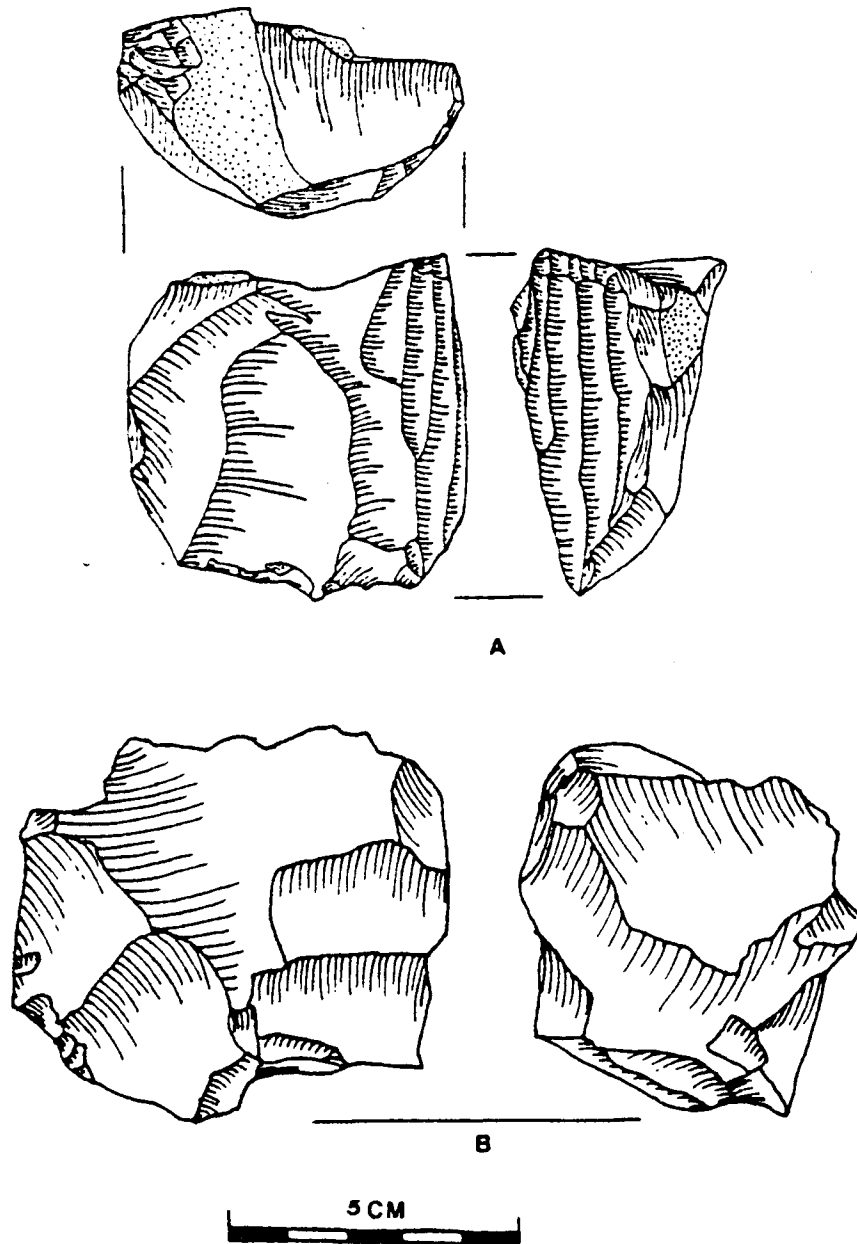


Figure 85. Wedge shaped microblade core (A) and amorphous flake core (B) from 14MN28.