LATE WISCONSINAN AND HOLOCENE ALLUVIAL STRATIGRAPHY, PALEOECOLOGY, AND ARCHAEOLOGICAL GEOLOGY OF EAST-CENTRAL IOWA

GUIDEBOOK SERIES NO. 12

Iowa Department of Natural Resources
Larry J. Wilson, Director
April 1992

LATE WISCONSINAN AND HOLOCENE ALLUVIAL STRATIGRAPHY, PALEOECOLOGY, AND ARCHAEOLOGICAL GEOLOGY OF EAST-CENTRAL IOWA

GUIDEBOOK SERIES NO. 12

prepared by

E. Arthur Bettis III [1], Richard G. Baker [2],
William R. Green [3], Mary K. Whelan [4], and David W. Benn [5]

[1] Research Geologist, Geological Survey Bureau - Iowa Department of Natural Resources
[2] Professor, Departments of Geology and Botany - The University of Iowa
[3] State Archaeologist and Adjunct Assistant Professor, Department of Anthropology - The University of Iowa
[4] Assistant Professor, Department of Anthropology - The University of Iowa
[5] Archaeologist - Lansing, Michigan

Iowa Quaternary Studies Group
Contribution Number 51

April 1992

Prepared for North-Central Section, Geological Society of America
26th Annual Meeting, April 30-May 1, 1992, Iowa City, Iowa
Field Trip No. 2, April 29, 1992

Iowa Department of Natural Resources
Larry J. Wilson, Director

TABLE OF CONTENTS

STOP DESCRIPTIONS AND DISCUSSIONS

INTRODUCTION

The behavior of the fluvial system has been of interest to people since they first settled along the banks of streams and gathered food from river valleys. Even today, an understanding of the fluvial system is paramount in planning our use of the landscape. Most of the modern research on fluvial systems has focused on hydrologic and sedimentologic issues, since these reflect the behavior of the system, and therefore record some of the system's history.

Studies of Iowa's fluvial system during the last decade have centered on defining the lithologic (and sedimentologic) characteristics, chronology, and fossil associations of alluvium in modern valleys. The goal of these investigations was to develop a stratigraphic framework for alluvium that could be used for a wide range of purposes including environmental studies, soil mapping, geotechnical investigations, cultural resource management, and geohistorical research.

The majority of the alluvial fill in Iowa's valleys is late Wisconsinan and Holocene in age. Our investigations have focused on alluvium of this age. Except for that in streams draining the Des Moines Lobe, late Wisconsinan alluvium has yet to be formally named in the state. Holocene valley fill sediments are called the DeForest Formation, originally defined in small western Iowa valleys by Daniels and others (1963). The stratigraphic framework of the DeForest Formation below the formation level has been extensively modified from the original scheme, and now includes four members, Camp Creek, Roberts Creek, Gunder, and Corrington (Bettis, 1990). The members have been identified in tributaries to the master streams across Iowa, and in adjacent states, and are mappable lithostratigraphic units.

Table 1 provides a summary of lithologic properties of DeForest Formation members in eastern Iowa. The texture (grain-size) of the members varies regionally across Iowa as the nature of the source materials changes. Alluvium in the thick loess area of western Iowa is silty, whereas alluvium in southcentral Iowa, where loess is thinner and loamy Pre-Illinoian deposits crop out on most slopes, is loamy and clayey. Three easily observed properties of the deposits, matrix color, nature of stratification, and secondary alterations (pedogenic and diagenic), serve as criteria for identification of the members.

A large number of radiocarbon ages and archaeological associations has given us a detailed picture of chronologic relationships within the formation. Alluvium of a given member is roughly the same age in similar-size (order) valleys across the region (Fig. 1). The basal age of a member increases moving to larger elements of the drainage network (the Corrington Member is an exception). The Gunder Member is early to middle Holocene in age, Roberts Creek Member is late Holocene in age, and Camp Creek Member is very late prehistoric to Historic in age. These relationships are significant for understanding long-term movement of sediment through the fluvial system, and for evaluating cultural resources associated with the valley fill.

The DeForest Formation is the context in which well-preserved archaeological and paleoecological records are preserved (Bettis and Thompson, 1981; Van Nest and Bettis, 1990; Bettis, 1990; Chumbley et al., 1990). An understanding of the completeness of the alluvial stratigraphic record, and of the depositional environments represented in the record, allows us to estimate the effects of fluvial and weathering processes on the archaeological and paleoecological records. This broad-scale taphonomic information is essential for accurate interpretations of the known archaeological and paleoecological records. The stratigraphic framework of the DeForest Formation makes mapping broad age groups of alluvium relatively easy. The ability to recognize and map these fills lets us evaluate the effects of burial and erosion on our perceptions of the archaeological record (see overview of Mississippi valley prehistory in the Appendix), and makes the search for paleobiotic records dating to specific time intervals somewhat easier.

For many years the only chronology for the expansion of the Prairie Peninsula came from Minnesota, the Dakotas, and western and central Iowa (Webb et al., 1983). In these areas the prairie began to expand eastward from the Dakotas before 10,000 B.P., replacing deciduous and conifer-hardwood forest. It reached its maximum extent between about 8000 and 5000 B.P., when climate was warmest and driest, and then retreated southwestward as oak forest or savanna replaced it. The prairie-forest boarder reached its present position about 3000 years ago and has been relatively stable since then.

The accuracy of reconstructions of the Holocene movement of the prairie-forest border in eastern Iowa and adjacent southwestern Wisconsin has recently been challenged by Baker and others (1990; in press), Chumbley and others (1990), and Winkler and others (1986). These studies have shown that mesic deciduous forest remained in eastern Iowa and Wisconsin until about 5500 B.P. The warmest, driest phase of the Holocene in this region, when prairie expanded into eastern Iowa, was from about 5500 to 3000 B.P.

Two of these studies (Baker et al., 1990 and

Chumbley et al., 1990) used pollen records preserved in DeForest Formation alluvium. These demonstrated that very detailed pollen, plant macrofossil, and fossil bryophyte records are preserved in valleys of landscapes where upland depressions, the traditional type of site containing these records, are not preserved. In addition to vegetation records some DeForest Formation localities also contain associated vertebrate, mollusc, and insect fossils, providing a multifaceted picture of past environments.

On this field trip we will examine the lithologic and stratigraphic relationships of DeForest Formation members in interior tributary valleys of eastern Iowa, and along the western margin of the Mississippi Valley. Paleoecological and archaeological associations will also be examined and discussed. The localities we will visit are still under investigation and the overall picture of eastern Iowa's Holocene past is still emerging. We hope that the discussions fostered by this trip and the various perspectives of the participants will provide us with new insights into an evolving picture of past environments and people's lifeways.

Table 1. Generalized characteristics of DeForest Formation members in eastern Iowa.

Camp Creek Member

Very dark grayish brown to yellowish brown (10YR3/2-5/4) silt loam to loam (sandy loam if sandy source materials are common) grading to sand and gravel in the channel belt; usually noneffervescent; horizontally stratified where greater than 0.25 meters in thickness; surface soils are Entisols (A-C profiles); unit often buries pre-settlement surface soil; thickest in and adjacent to modern channel belt, and at the base of steep slopes; ranges in age from 400 B.P. to modern.

Roberts Creek Member

Very dark gray to dark grayish brown (2.5Y3/0 to 10YR3/1-3/2) silt loam, silty clay loam and loam grading downward to sand and gravel; usually noneffervescent; thick sections are stratified at depth; detrital organic matter in lower part; relatively thick Mollisol (A-C or A-Bw-C profile) developed in upper part; strong brown and yellowish red (7.5YR5/8 and 5YR5/8) mottles may occur throughout unit; found within the present floodplain, usually parallels the modern channel, also found in fan trenches; ranges in age from about 4000 to 500 B.P.

Gunder Member

Brown to yellowish brown to grayish brown (10YR4/3-5/4 to 2.5Y5/2) silt loam, silty clay loam, or loam grading to sand and gravel at depth; usually noneffervescent; lower part may be stratified; detrital organic matter often present in lower, stratified, coarse part of unit; moderately well to somewhat poorly drained Mollisols and Alfisols (A-Bw-C, A-Bt-C, or A-E-Bt-C profile) developed in upper part; C horizons usually contain strong brown, yellowish red, or dark brown (7.5YR5/8, 5YR5/8, or 10YR3/3) mottles; usually comprises low terrace that merges with sideslope in a smooth concave upward profile; ranges in age from 10,500 to about 3000 B.P.

Corrington Member

Dark grayish brown to yellowish brown to olive brown (10YR4/2-5/4 to 2.5Y4/2-4/4) loam and silty clay loam with sandy loam, pebbly sandy loam, and gravelly interbeds; noneffervescent grading to effervescent at depth; upper part of unit has thick Mollisol or Alfisol (A-Bw-C, A-Bt-C, or A-E-Bt-C profile) developed in it; at least one and often several buried paleosols within unit; unit consists of several upward-fining sequences, most having paleosols developed in their upper part; brown mottles common; found in alluvial fans and colluvial slopes along the margins of large to moderate-size valleys; unit ranges in age from about 9000 to 2500 B.P.

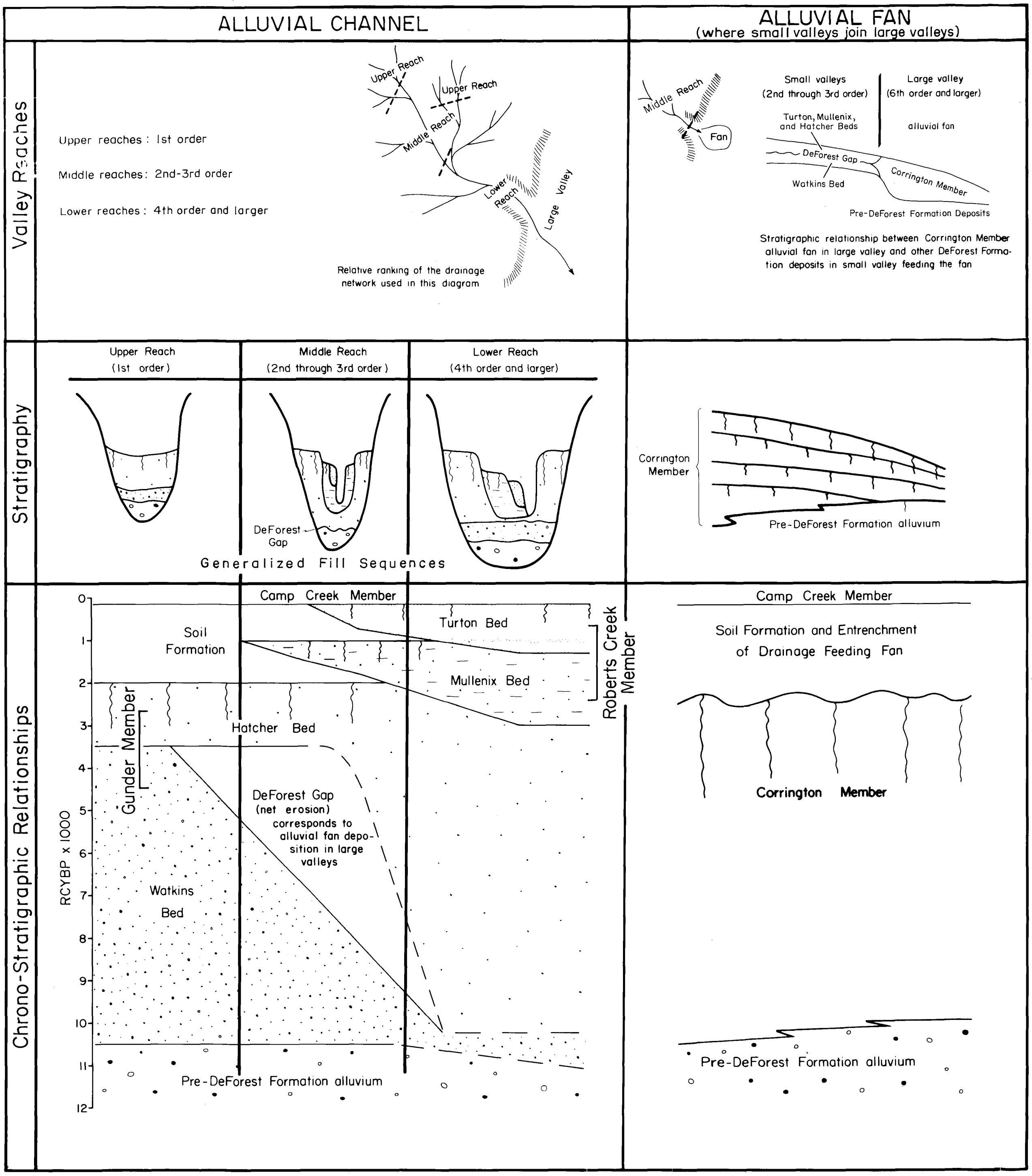


Figure 1. Chronogram of the DeForest Formation in Iowa. The chronogram shows stratigraphic and chronologic relationships among DeForest Formation members proceeding from upper reaches of the drainage network (left side of diagram) to lower reaches (right side of diagram). Beds within members are only distinguished in the thick loess regions of western Iowa.

STOP 1. MUD CREEK, TWO BRIDGE AREA AND LILIENTHAL SITE

At this stop we will examine exposures along a third-order reach of Mud Creek Valley that exhibit typical stratigraphic relationships and lithologies of the DeForest Formation in eastern Iowa. These exposures also contain well-preserved paleontological and paleobotanical deposits that provide detailed information on environmental conditions during the middle Holocene. The stop consists of two substops, the first to examine a paleontological site in the Gunder Member of the DeForest Formation, and a second farther upstream where we will examine the Gunder and informal pre-Gunder members of the formation.

Mud Creek is a tributary of the Wapsipinicon River and is one of the few studied areas in the Upper Midwest where Holocene plant macrofossil, pollen, and paleontologic records are preserved in the alluvial fill of a single drainage basin. Paleontological sites along Mud Creek were discovered in 1970 by R.S. Nelson and L.D. Drake. Kramer (1972) first analyzed floral and faunal remains from several exposures along the creek, and a single date of 6220±110 B.P. (I-6228) was obtained from one of the sites. More recent work on pollen and plant macrofossils from several sites has expanded the data base to cover the early to middle Holocene (Baker et al., 1990; Baker, unpublished data), and Thorson (unpublished data) in particular has done a very detailed study at the Lilienthal site (stop 1a). The records from eastern Iowa sites show discrepancies in the timing and direction of vegetational change compared to records from farther west in central and east-central Iowa, and contrast sharply with the record predicted by pollen-based climate models (Chumbley et al., 1990; Baker et al., 1990).

Investigations along Mud Creek have identified numerous localities that contain well-preserved biotic records. Analysis of these sites is beginning to provide us with a detailed picture of the timing and direction of Holocene environmental change in Mud Creek basin. A key element in these on-going studies is the documentation of the age and depositional environment of the alluvium that contains the biotic remains. The stratigraphic framework of the DeForest Formation permits a quick and easy distinction between alluvium greater than about 10,000, 9,500 to about 4,000, and less than 3,500 years old. This helps us distinguish sites that contain late Wisconsinan/Holocene, early and middle Holocene, and late Holocene paleoecological records. Detailed sedimentologic studies allow us to address hydrodynamic aspects of the alluvium that in large part control the distribution, appearance, and state of preservation of the fossil deposits.

The content of both pollen and plant macrofossils in each member of the DeForest Formation from sites in eastern Iowa is also diagnostic. The informal pre-Gunder member is dominated by spruce, larch, and sedges in both the pollen and macrofossil record. Apparently floodplains were the last refuge of the conifers in the early Holocene. The Gunder Member is characterized by a diverse assemblage of deciduous-tree taxa. The macrofossil assemblage also contains remains of a number of forest-floor herbs that require deep shade. The Roberts Creek Member has almost no forest taxa in either the pollen or plant macrofossil records. Instead pollen of "prairie forbs" (Webb et al., 1983) is dominant. Although these pollen types are not diagnostic of prairie, that interpretation is supported by a rich array of prairie macrofossils. The Camp Creek Member is characterized by high ragweed pollen content and abundant seeds and fruits of disturbed-ground plants, including many non-native weeds.

Mud Creek basin is situated along the boundary between the Iowan Surface and Southern Iowa Drift Plain landform regions in eastern Iowa (Prior, 1991). Uplands in the basin range from strongly sloping in the northern part to moderately sloping in the southern and central part. Peoria Loess is the surficial deposit across most of the basin's upland and slopes, and ranges from about four to seven meters in thickness on the upland. A complex array of late Wisconsinan and older erosion surfaces developed on glacial deposits is buried by the loess on the upland and slopes (Autin and Bettis, 1991). West and north of Mud Creek Pre-Illinoian glacial deposits are beneath the loess, while east of the creek remnants of Illinoian glacial deposits (Kellerville Till Member of the Glasford Formation) are present. Silurian carbonate bedrock (Gower Formation) crops out in a few locations in the northern part of the basin. The basin is bisected by the Cleona Bedrock Channel, the presumed location of the diverted Mississippi River during the early (Kellerville) phase of the Illinoian glaciation (Fig. 2; Anderson, 1968). The sag that marks the Cleona Channel contains a sequence of loess-mantled terraces ranging from pre-Wisconsinan to late Wisconsinan in age (Autin and Bettis, 1991; 1992). Since at least the late Wisconsinan Mud Creek has flowed northeastward to the Wapsipinicon River through the Cleona Channel.

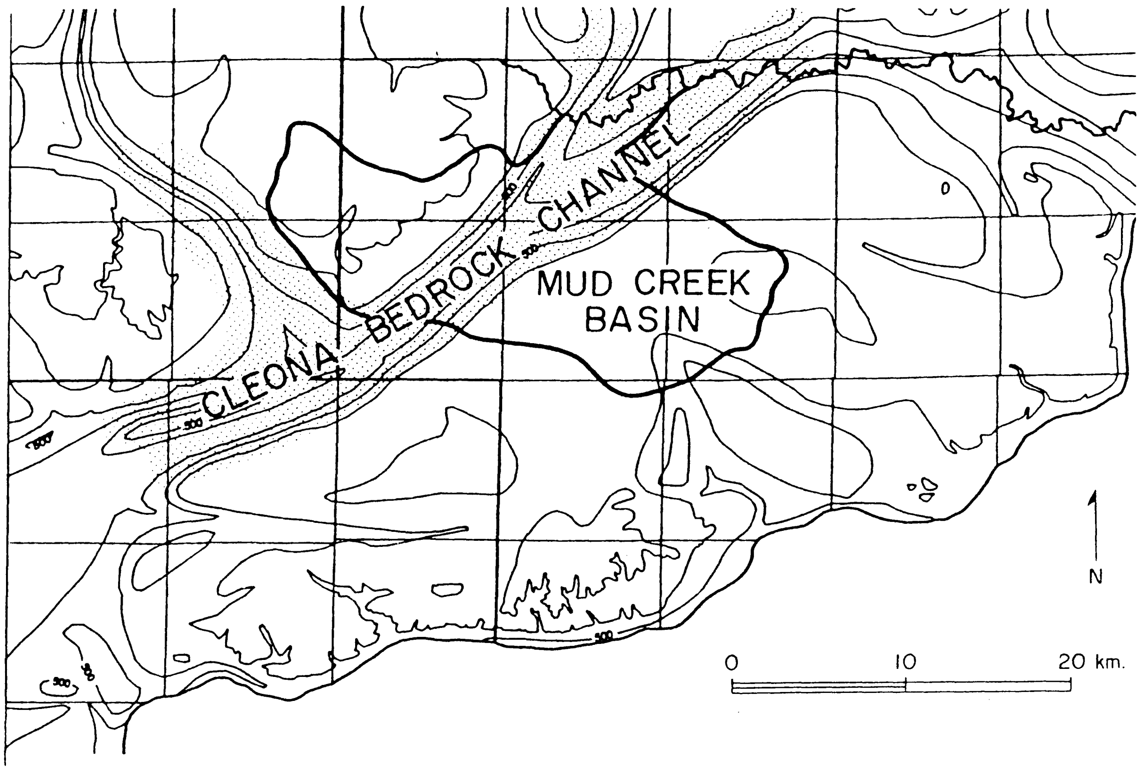


Figure 2. Elevation of the bedrock surface in Scott and portions of Cedar counties showing the location of the Cleona Bedrock Channel relative to Mud Creek basin (adapted from Autin and Bettis, 1991). Contour interval is 33 meters (100 ft.).

The upper reaches of Mud Creek are cut into Pre-Illinoian glacial deposits, and in some cases into the upper part of the bedrock surface. This part of the creek flows southeasterly and is bordered by moderately sloping valley walls that descend to a relatively narrow valley. The creek turns and flows northeasterly when it enters the Cleona Channel. From this point almost to it's junction with the Wapsipinicon Valley Mud Creek's valley is broad and bordered by longer and gentler valley wall slopes. DeForest Formation lithologies and stratigraphic relationships are similar throughout the basin (Autin and Bettis, 1991).

Stop 1a.
Stratigraphy of the Two Bridges area

Figure 3 shows the location of stop 1 along the upper reaches of Mud Creek (NE 1/4 NE 1/4 Sec. 12 T79N R1W). The distribution of DeForest Formation units in this area is typical for upper reaches of Mud Creek and tributaries flowing to the Cleona Channel in the basin. Figure 4 is a cross-section passing from the western valley wall, turning at the creek, then running to the southern valley wall. Approximately one meter of Camp Creek Member buries early Historic soils developed in upper parts of the Roberts Creek and Gunder members. The Roberts Creek Member is inset into the Gunder Member, and a very subtle scarp (subtle because it has been masked by the Camp Creek Member) marks the margin of the Roberts Creek floodplain. Within the Roberts Creek floodplain older alluvium has been eroded. The Gunder Member is set against the valley wall and extends toward the creek until it is cut out by the Roberts Creek Member. Outside the Cleona Channel the Gunder Member is cut into the informal pre-Gunder member which in turn, is cut into Pre-Illinoian glacial deposits or carbonate rock.

Lithofacies

Each DeForest Formation member can be subdi-

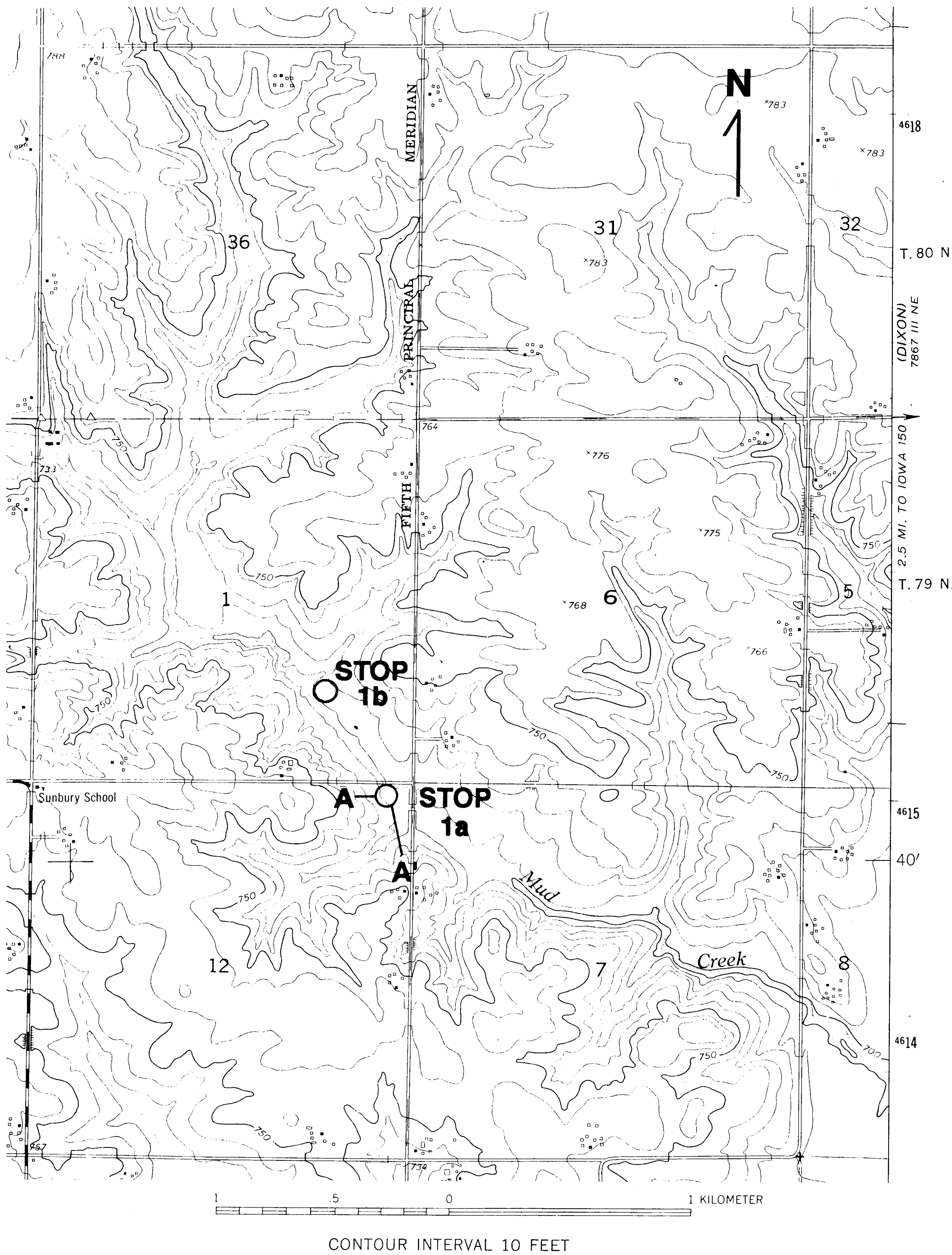


Figure 3. Topographic map showing the location of stops 1a and 1b in the Two Bridges area of Mud Creek, Cedar County, Iowa. Taken from USGS 7.5 minute Bennett, Iowa quadrangle.

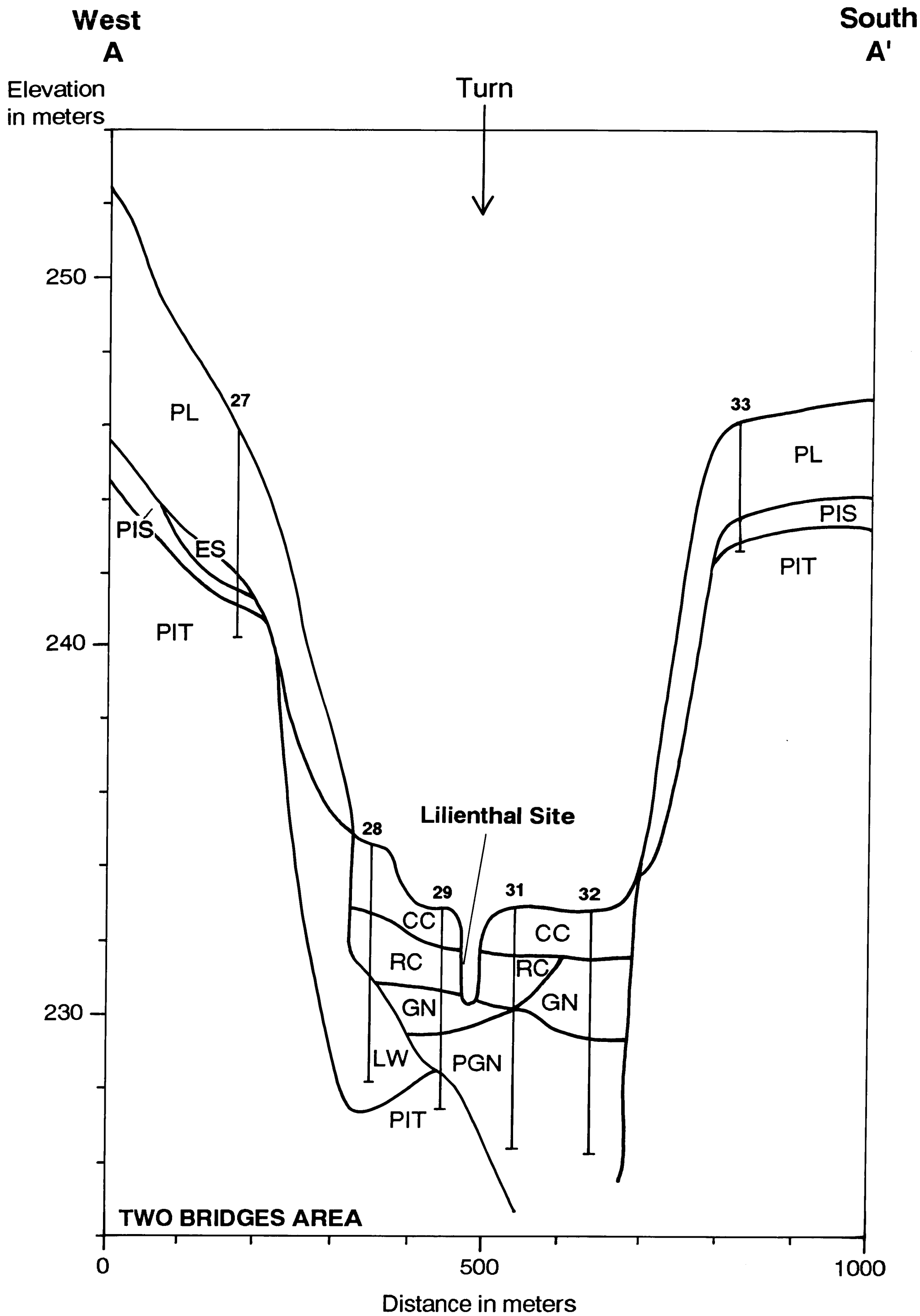


Figure 4. Cross-section of the valley fill of Mud Creek in the Two Bridges area of Mud Creek valley. Note turn in middle of cross-section. Location of cross-section is shown on figure 3. Numbers with vertical lines beneath are core locations. Unit abbreviations: PIT - Pre-Illinoinan diamicton; PIS - Pisgah Formation; PL - Peoria Loess; LW - late Wisconsinan alluvium/colluvium; PGN - pre-Gunder mbr.; GN - Gunder Mbr.; RC - Roberts Creek Mbr.; CC - Camp Creek Mbr.

Table 2. Lithofacies associations found in DeForest Formation alluvium of small eastern Iowa valleys, interpreted depositional environments, and estimates of the potential for preservation of biotic records.

Lithofacies	Properties	Depositional Environments	Biotic Record Potential*
channel belt (CB)	Cross-bedded medium to coarse sand, pebbly sand, or gravel with thin loamy and silty zones rich in detrital organic matter. Detrital organics may also be present in the sands and pebbly sands. Upper part may be loamy with sand interbeds. Contact unconformable with underlying unit.	channel, bar, overflow (abandoned) channel	PP (in fine-grained) ; MM; VV
eroded bank (EB)	Fine-grained throughout; mixed (commonly burrowed) inter-member contact present, often with clasts of older unit engulfed in younger unit. Contact inclined unless exposure is parallel to former stream bank.	channel margin/ cut bank	P- (lower part); M- (lower part); V
levee (L)	Laminated and/or planar bedded loam or silt loam with minor amounts of sand in valleys draining to the Cleona Channel. Sand more abundant in the Cleona Channel area. Occasionally horizontal ly diffuse pebble zones , one clast thick, are present.	natural levee, splay	--; --; V
overbank (O)	Fine-grained, bedding not evident, burrowed.	floodplain distal to channel	--; --; V-
soil (S)	Pedogenic structure, soil horizons, gradual lower boundary, burrowed and rooted.	slowly aggrading to nearly stable surfaces	--; --; --
authigenic organics (AO)	Peat, muck. Root traces extending into underlying deposits.	wet floodplain with little or no input of mineral sediment	PP; MM; ?

*Biotic Record Potential: two symbols-good potential; single symbol and dash- moderate potential; two dashes-poor potential. P-pollen; M-plant macrofossils and insect fossils; V-vertebrate fossils.

vided into lithofacies that display a limited range of primary sedimentary structures and/or secondary pedogenic features that reflect specific depositional settings. In these Holocene alluvial deposits the depositional setting controls the sedimentologic conditions and subsequent taphonomic agents that determine the potential for the preservation of biotic records.

For the purposes of evaluating this potential, six lithofacies have been recognized in DeForest Formation deposits in Mud Creek basin (Table 2). The authigenic organic facies has only been recognized in the Roberts Creek and informal pre-Gunder members, but the remaining facies have been documented in all DeForest Formation members. Rarely are all lithofacies present in a single member at the same location, and in some cases a single lithofacies may be repeated in a vertical section. Descriptions of cores 29, 31, and 32 illustrate the sequence of lithofacies in the stop 1a vicinity (Fig. 5).

Chronology

Regional chronologic relationships of DeForest Formation members were outlined in the introduction. The chronology of the Gunder Member in Mud Creek basin conforms to the regional pattern with radiocarbon ages ranging between 9310 and 5350 B.P. (Table 3). The informal pre-Gunder member ranges from 9860 to 10,370 B.P. in its upper part, but its base has not been dated. Radiocarbon ages from the Roberts Creek Member in Mud Creek basin range from 7110 to 240 B.P., with most clustering between 5000 and 6000 B.P. This discrepancy between the almost exclusively post-4000 B.P. ages obtained from the Roberts Creek Member elsewhere in Iowa and the older ages in Mud Creek Basin is perplexing. We believe that most of the dated wood from the Roberts Creek Member in Mud Creek basin has been reworked from nearby Gunder Member exposures.

Figure 5. Description of cores 29, 31, and 32 from the Two Bridges area. See figure 4 for locations.

16MC 29 -- Mud Creek, Iowa; NW 1/4, NW 1/4, Sec. 12, T.79N., R.1W.; core from Mud Creek floodplain; elevation 710 ft (232.9 m); 0-1 percent slope; drilled in pasture on 7-31-90 by E. A. Bettis; described by W. J. Autin and E. A. Bettis.

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CAMP CREEK MEMBER
S	0-30	A	Dark grayish brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable consistence; common roots and pores; clear boundary.
L	30-110	C	Dark grayish brown (10YR 4/2) silt loam; friable consistence; common roots and pores; distinct laminations; clear boundary.
			ROBERTS CREEK MEMBER
S	110-150	2A	Very dark gray (10YR 3/1) silt loam; moderate, medium, granular structure; friable consistence; common roots and filled worm burrows; gradual boundary.
S	150-180	2Bw	Very dark gray (10YR 3/1) silty clay loam, moderate, fine, subangular blocky structure; friable consistence; common roots; strong brown (7.5YR 5/6) stains on root traces; gradual boundary.
O	180-220	2C	Very dark gray (10YR 3/1) silty clay loam; slightly plastic consistence; few roots and root traces; abrupt boundary.
			GUNDER MEMBER
CB	220-290	3C1	Brown (10YR 5/3) loam; very friable consistence; few roots; scattered shell hash; medium sand interbeds; effervesces; gradual boundary.
CB	290-340	3C2	Pale brown (10YR 6/3) coarse sand; loose consistence; scattered shell hash; yellowish red (5YR 5/8) stains at base; effervesces; abrupt boundary.
			PRE-GUNDER MEMBER
CB	340-380	4C1	Greenish gray (5GY 5/1) loam; slightly sticky consistence; sand filled burrows; scattered gravel; effervesces; abrupt boundary.
CB	380-450	4C2	Olive (5Y 5/4) coarse sand; loose consistence; coarse gravel lag at base; effervesces; abrupt boundary.
			PRE-ILLINOIAN TILL
	450-550	5C(UU)	Very dark (5Y 3/1) pebbly loam; slightly plastic consistence; olive (5Y 4/4) streaks; effervesces.

16MC 31 --Mud Creek, Iowa; NE 1/4, NE 1/4, Sec. 12, T.79N., R.1W.; core from Mud Creek floodplain; elevation 710 ft (232.9 m); 0-1 percent slope; drilled in pasture on 7-31-90 by E. A. Bettis; described by W. J. Autin and E. A. Bettis. Radiocarbon dates on wood collected from Roberts Creek Member 228 to 248 cm below land surface 5370 ± 90 B.P. (Beta - 41171), and 248 to 267 cm below land surface 5820 ± 110B.P. (Beta - 41173), and from pre-Gunder member 270 to 297 cm below land surface 9860 ± 110 B.P. (Beta - 41173).

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CAMP CREEK MEMBER
S	0-50	A	Dark grayish brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable consistence; common roots and pores; gradual boundary.
L	50-90	C	Dark grayish brown (10YR 4/2) silt loam; friable consistence; common roots and pores; distinct laminations; gradual boundary.
			ROBERTS CREEK MEMBER
S	90-130	2A	Very dark gray (10YR 3/1) silt loam; friable consistence; few roots; common filled worm burrows; gradual boundary.
S	130-190	2Bw	Very dark gray (10YR 3/1) silty clay loam with common, fine, distinct strong brown (7.5YR 5/6) mottles; moderate, medium, angular blocky structure; slightly plastic consistence; common worm fills; heavy yellowish red (5YR 5/8) stains at base; abrupt boundary.
O ↑ CB	190-250	2C1	Very dark grayish brown (10YR 3/2) silt loam; slightly plastic consistence; scattered clasts of Gunder Member; light brownish gray (10YR 6/2) color bands; strong brown (7.5YR 5/8) stains on root traces; scattered organic material; radiocarbon age of 5370 ± 90 B.P. (Beta - 41171) on wood at 228 to 248 cm; abrupt boundary.
CB	250-270	2C2	Grayish brown (10YR 5/2) coarse to medium sand; loose consistence; scattered shell hash and organic material; radiocarbon age of 5820 ±110 B.P. (Beta - 41172) on wood at 248 to 267 cm; scattered clasts of Gunder Member; abrupt boundary.
			PRE-GUNDER MEMBER
O ↑ CB	270-350	3C1	Dark gray (5Y 4/1) silt loam; plastic consistence; common roots at top of unit; interbeds of sand, loam, and sandy clay loam; scattered shell hash; scattered organic materials; radiocarbon age of 9860 ±110 B.P. (Beta - 41173) on wood at 270 to 297 cm; gradual boundary.
CB	350-650	3C2	Dark gray (5Y 4/1) coarse to medium sand; loose consistence; interbeds of sand and sandy clay loam; augered from 440 to 650 cm.

16MC 32 --Mud Creek, Iowa; NE 1/4, NE 1/4, Sec. 12, T.79N., R.1W.; core from Mud Creek floodplain; elevation 710 ft (232.9 m); 0-1 percent slope; drilled in pasture on 7-31-90 by E. A. Bettis; described by W. J. Autin and E. A. Bettis.

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CAMP CREEK MEMBER
S	0-30	A	Dark brown (10YR 4/3) silt loam; weak, very fine, granular structure; friable consistence; common roots and pores; clear boundary.
L	30-140	C	Dark grayish brown (10YR 4/2) silt loam; friable consistence; common roots and pores; distinct stratification; clear boundary.
			GUNDER MEMBER
S	140-175	2A	Very dark grayish brown (10YR 3/2) silt loam; moderate, fine, granular structure; friable consistence; common roots and filled worm burrows; gradual boundary.
S	175-210	2ABw	Dark grayish brown (10YR 4/2) silt loam; moderate, fine, subangular blocky structure; friable consistence; clear boundary.
S	210-280	2Btg	Light brownish gray (2.5YR 6/2) silt loam with common medium, distinct strong brown (7.5YR 5/8) mottles; moderate, coarse, angular blocky structure; friable consistence; common roots; common very dark grayish brown (10YR 3/2) krotovina, thin discontinuous coats on peds, and root fills; very dark brown (10YR 2/2) concretions; gradual boundary.
S	280-350	2BCg	Light brownish gray (10YR 6/2) silt loam with few, fine, distinct strong brown (7.5YR 5/8) mottles; slightly plastic consistence; common very dark grayish brown (10YR 3/2) krotovina; heavy yellowish red (5YR 5/8) stains at base; abrupt boundary.
			PRE-GUNDER MEMBER
O	350-670	3Cg	Greenish gray (5BG 5/1) silt loam; plastic and sticky consistence; sand, silty clay loam, and clay loam interbeds; scattered organic material.

Table 3. Radiocarbon ages from DeForest Formation alluvium in Mud Creek basin, eastern Iowa. All ages are uncorrected.

LOCATION	ELEVATION, M	LAB #	AGE
ROBERTS CREEK MEMBER			
18MC17[3]	229.7	B - 41176	240 ± 80
82MS18b	210.1	B-51469	690 ± 60
16MC31[3]	232.9	B - 41171	5370 ± 90*
82MC46[4]	232.9	B - 7341	5480 ± 80*
82MS18A[3]	210.3	B - 41177	5580 ± 70*
16MC31[3]	232.9	B - 41172	5820 ± 110*
16MC35[3]	241.1	B - 41174	7110 ± 90*
GUNDER MEMBER			
82MS18[3]	210.3	B - 39434	5350 ± 60
Lilienthal	233.6	B - 46212	5920 ± 60
82MS13[3]	229.7	B - 39430	6130 ± 80
82MS7[3]	232.9	B - 41175	6140 ± 80
NC7NWF[5]	232.9	I - 6228	6220 ± 110
Lilienthal	233.4	B - 46211	6240 ± 50
Lilienthal	232.9	B - 41170	6300 ± 80
82MS3[3]	229.7	B - 39433	6540 ± 80
______[4]	232.9	B - 25837	6820 ± 90
82MC88[4]	232.9	B - 7342	9310 ± 90
PRE-GUNDER MEMBER			
16MC31[3]	232.9	B - 41173	9860 ± 110
82MS13[2]	229.7	B - 39431	10,370 ± 80

[1] All radiocarbon ages from wood samples, laboratory determinations by Beta Analytical, Inc., unless otherwise noted.

[2] All samples from C horizons except 82MS13 pre-Gunder sample from an O Horizon.

[3] From Autin and Bettis, 1991

[4] From Baker et al., 1990

[5] From Kramer, 1972, laboratory determination by Isotopes, Inc.

* probably wood reworked from Gunder Member

Lilienthal Site

The Lilienthal site is located along the right bank (facing downstream) of Mud Creek in an actively eroding bank. During the last year Paula Thorson, a graduate student in the University of Iowa Geology Department, has been studying paleobotanical and paleontological remains contained in the Gunder Member from this exposure. Three members of the DeForest Formation, Gunder, Roberts Creek, and Camp Creek, are present. Approximately 90 cm of Camp Creek Member (levee facies) bury older Holocene alluvium in the exposure (Fig. 6). The dark-colored presettlement surface soil beneath the Camp Creek Member is developed in the Roberts Creek Member. This soil was somewhat poorly drained and exhibits prominent secondary iron accumulation in the Bt horizon, approximately 53 to 60 cm below the original soil surface. The transition to the underlying soil horizon is quite abrupt both texturally and in color, and krotovina (animal burrows) are common. This horizon boundary is interpreted to coincide with the Roberts Creek/Gunder Member contact. The characteristics of this contact suggest an eroded bank facies, with the present stream bank more or less paralleling the old bank at the time of Roberts Creek Member accumulation. The Gunder Member here consists of oxidized and reduced channel belt facies. The sequence represents a point bar influenced by the presence of an overturned tree stump. The channel was located just west of the present exposure.

Although work at this site is still in progress preliminary results provide us with a detailed picture of this part of Mud Creek valley ca. 6100 B.P. The pollen spectrum is dominated by oak (47%) with significant amounts of other trees including hickory (6%), basswood (2%), black walnut (4%), butternut (1%), elm (3%), and ironwood/blue beech (3.4%). Nonarboreal pollen comprises 32% of the total pollen and is predominantly composed of ragweed (13%), goosefoot (7%), grass (4%), and sedge (3%). Plant macrofossils are extremely well preserved, and basswood, sugar maple, and hazel are most abundant, along with lesser amounts of butternut, walnut, white oak, bitternut hickory, bladdernut, and green ash. Giant ragweed and goosefoot are also present as macrofossils.

The vegetation of the Two Bridges area of Mud Creek, and probably of a much larger area in eastern Iowa, was mesic deciduous forest about 6000 B.P. In fact, mesic elements are more abundant at about this time than at any other time in the Holocene. The most common herbaceous plants present locally (in both pollen and macrofossil analyses) are weedy disturbed ground plants--giant ragweed and goosefoot--that are common on floodplains. No pollen or macrofossils of any indicator species of prairie were found. At Cedar Rapids, a pollen sequence from a river-bluff site now under dense forest cover indicates that few trees were present there 6000 yr. B.P. (Baker et al., 1990). Apparently the prairie-forest border at this time was between Cedar Rapids and Mud Creek.

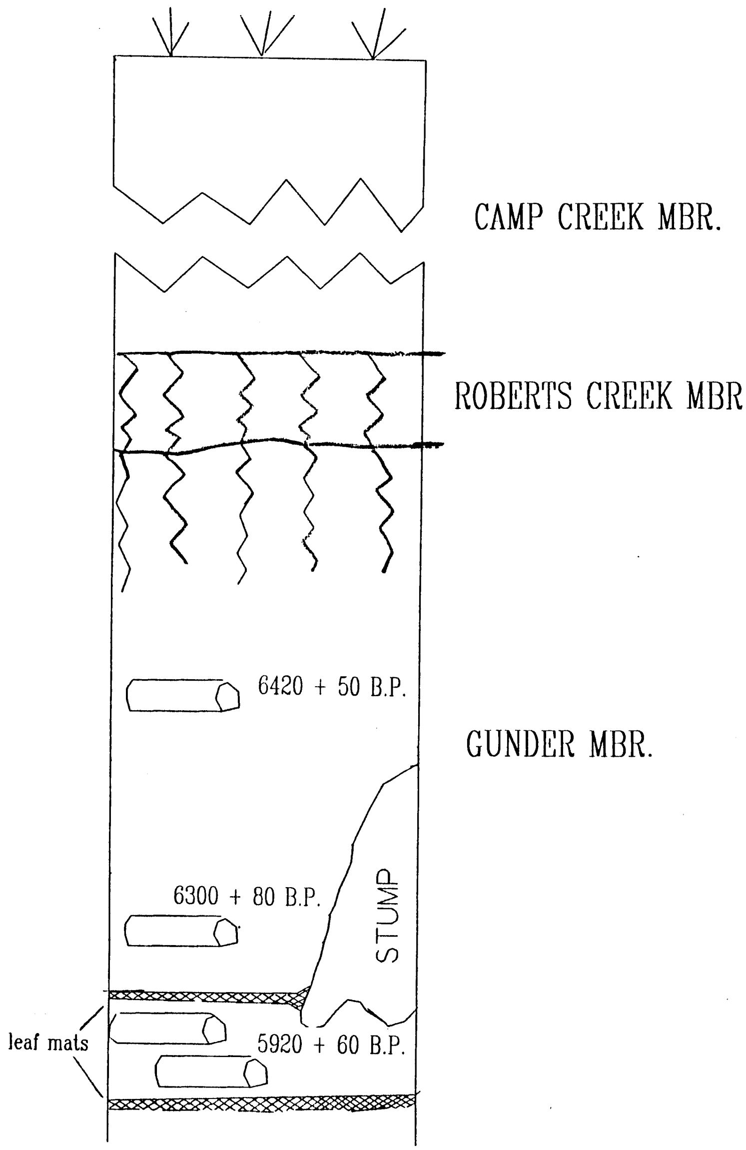


Figure 6. Schematic profile of stratigraphy at the Lilienthal Site along Mud Creek.

Archaeology

There are no recorded archaeological sites in the Two Bridges area. In fact, there are no sites recorded on either the Bennett or Dixon quads, which encompass most of Mud Creek basin. The absence of recorded sites in this area probably reflects a paucity of recent contract-related investigations rather than a lack of use by prehistoric groups.

Stop 1b.
Gunder and pre-Gunder members

At this substop we will examine the lithologic properties of the informal pre-Gunder member, and stratigraphic relationships among the Camp Creek, Gunder and pre-Gunder members. This exposure is located where a second-order tributary joins Mud Creek, and exhibits soil, levee, overbank, and channel bank facies in DeForest Formation deposits (Fig. 3). The Gunder Member is separated from the underlying pre-Gunder member by an erosion surface overlain by Gunder Member channel belt facies (Fig. 7). The pre-Gunder exhibits it's typical silt loam texture, quite distinct from the dominantly loam and silty clay loam textures of younger DeForest Formation alluvium in eastern Iowa. We attribute the silty texture of this unit to having been derived from very locally eroded, pedogenically unaltered Peoria Loess. Early Holocene radiocarbon ages of *9860±110 (Beta-41173) and* 10,370±80 B.P. (Beta-39431) have been obtained from the upper part of the pre-Gunder member, but its lower part is undated (Autin and Bettis, 1991). Pollen spectra from the reduced (deoxidized) silty matrix of the unit are dominated by coniferous taxa, supporting a late Wisconsinan to Wisconsinan/Holocene age. The pre-Gunder is the oldest alluvial fill in the part of the valley that has no loess mantle. It probably began to accumulate during the latter part of Peoria Loess deposition and continued to until the early Holocene.

Figure 7. Description of exposure at stop 1b in the Two Bridges area of Mud Creek.

16MC 7 -- Mud Creek, Iowa; NW 1/4, SE 1/4, Sec. 1, T.79N., R.1W.; measured section from cut bank in Holocene alluvium, left bank of Mud Creek, junction of second-order tributary with Mud Creek; elevation 710 ft (232.9 m); 0-1 percent slope; site in pasture; described on 7-20-90 by W. J. Autin. Radiocarbon date on wood in Gunder Member collected 322 cm below land surface 6140 ± 80 B.P. (Beta - 41175).

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CAMP CREEK MEMBER
S ↑ L	0-45	A1	Dark brown (10YR 3/3) silt loam; moderate, granular structure; friable consistence; abundant roots; common pores and worm burrows; faint silt loam stratifications at base; abrupt, smooth boundary.
S	45-75	A2	Very dark grayish brown (10YR 2/2) silt loam; moderate, medium, granular structure; friable consistence; common roots and pores; abundant worm burrows, some filled with A1 material; mixed horizon with underlying Gunder Member; gradual, smooth boundary.
			GUNDER MEMBER
S	75-105	2A	Very dark brown (10YR 2/2) silty clay loam, moderate, fine, granular structure; friable consistence; some roots; abundant pores and worm burrows; gradual, smooth boundary.
S	105-125	2Bw	Very dark brown (10YR 2/2) silty clay loam with few, fine distinct strong brown (7.5YR 5/6) mottles; moderate, fine, granular structure; friable consistence; few roots; common pores and worm burrows; gradual, irregular boundary.
S	125-145	2Bt	Dark grayish brown (10YR 4/2) loam with common, medium, distinct strong brown (7.5YR 5/6) mottles; moderate, fine, granular structure; friable consistence; few very dark grayish brown (10YR 3/2) krotovina, root fills, and ped coats; gradual, wavy boundary.
S	145-175	2BC	Light brownish gray (2.5Y 6/2) sandy loam with common coarse, distinct yellowish red (5YR 5/8) mottles; friable consistence; common very dark grayish brown (10YR 3/2) krotovina and root fills; yellowish red (5YR 5/8) iron stain layer at base; gradual, wavy boundary.
O	175-230	2C1	Light gray (2.5Y 7/2) loam, friable consistence; few very dark grayish brown (10YR 3/2) krotovina; faint bedding and pockets of sandy loam; abundant brownish yellow (10YR 6/8) iron stained roots; gradual, smooth boundary.
CB	230-320	2C2	Light brownish gray (10YR 6/2) sandy loam; friable consistence; rare very dark grayish brown (10YR 3/2) krotovina; faint loam beds; abundant brownish yellow (10YR 6/8) iron stained roots; large wood fragments in lower 20 cm; abrupt, irregular boundary.

CB	320-325	2C3	Brownish yellow (10YR 6/6) coarse sand and gravel; single grain structure; loose consistence; shell, and shell fragments; large wood fragments; radiocarbon age of 6140 ± 80 B.P. (Beta - 41175) on wood at 322 cm; brownish yellow (10YR 6/8) stains; abrupt, irregular boundary.
			PRE-GUNDER MEMBER
O	325-370+	3C	Greenish gray (5BG 5/1) silt loam; massive structure; slightly plastic consistence; sand filled pockets; common roots, some with strong brown (7.5YR 5/8) halos.

STOP 2. MUD CREEK, SIEVERS LOCALITY

Stratigraphy and Chronology

At this stop we will examine stratigraphic relationships among the Camp Creek, Roberts Creek and Gunder members of the DeForest Formation in a third-order tributary to the lower reaches of Mud Creek (Fig. 8). The Gunder Member alluvium exposed here is middle Holocene in age and has lithologic properties transitional between the Gunder and Roberts Creek members. This alluvium has been assigned to the Gunder Member because of the moderate degree of soil horizonation expressed in its upper part, and the presence of yellowish brown mottles and iron accumulations in the BC and CB horizons. These secondary iron segregations indicate that the water table has fluctuated through this part of the unit. Secondary iron segregations in the Roberts Creek Member alluvium usually exhibit redder (7.5YR and 5YR) hue. Facies represented in this Gunder Member exposure are channel belt grading upward to overbank that becomes progressively altered by pedogenesis (Fig. 9). Wood from the channel belt facies yielded a radiocarbon age of 5350±60 B.P. (Beta-39434).

A fluvial erosion surface separates the pre-Gunder from the overlying Gunder Member in this exposure. Here the pre-Gunder member exhibits sandy channel belt facies grading upward to silty overbank facies.

The Gunder Member is buried by silty levee facies of the Camp Creek Member. Two increments of the Camp Creek Member are evident, with an AC soil profile developed at the interface A channel filled with Camp Creek Member alluvium cuts out the Gunder Member on the downstream end of the exposure.

On the upstream end of the exposure a channel filled with Roberts Creek Member alluvium cuts out the Gunder Member. We will examine the Roberts Creek Member a little farther upstream where channel belt facies grade upward into overbank facies that have been pedogenically altered. Note that the channel belt facies of the Roberts Creek Member is not as coarse as it was in the Gunder Member. An authigenic organic facies dated at 690±60 B.P. (Beta-51469) is present between the channel belt and overbank facies in the Roberts Creek Member here. This zone developed when organic matter production was relatively high relative to mineral sediment accumulation at this location. The authigenic organics facies of the Roberts Creek Member is common in upper reaches of Mud Creek and its tributaries, indicating that conditions favorable for accumulation of *in situ* organic matter in the channel belt area of the upper reaches of the drainage network were widespread during the late Holocene. The channel belt facies in the Roberts Creek Member is usually not as coarse as that in the Gunder Member. This indicates that either the stream was not as competent, or that coarse sediment was not as available to the channel during accumulation of the Roberts Creek Member. The widespread distribution of the authigenic organics facies in the upper reaches, combined with finer-grained channel belt facies downstream suggests that less sediment was being delivered to the drainage network from slopes and that the channel belt was relatively stable. These interpretations are consistent with a more moist late Holocene climatic pattern that promoted less slope erosion, higher base flow, and lower peak flood flow relative to conditions when Gunder Member channel belt facies were accumulating earlier in the Holocene.

The Roberts Creek Member is buried by relatively thick, silty levee facies of the Camp Creek Member in this exposure. These deposits thin as they lap up onto the Gunder Member. The Camp Creek Member buries all floodplain surfaces in this area and masks the floodplain topography that was present in the early Historic period.

Wood collected from channel belt facies in the Roberts Creek Member downstream of the 18MS7 Gunder Member exposure yielded a radiocarbon age of 5580±70 B.P. (Beta-41177). This age is two hundred years older than that obtained from wood in adjacent channel belt facies (on the opposite side of the present channel) of the Gunder Member. The pollen and plant macrofossil assemblage in the Roberts Creek Member associated with the dated wood contrast sharply with those in the Gunder Member immediately upstream (see discussion of biotic record below). We interpret this to indicate that the dated wood in the Roberts Creek Member was reworked from organic zones in the channel belt facies of the Gunder Member. This appears to be a common occurrence in Mud Creek basin where only narrow slices of Roberts Creek Member, adjacent to former banks cut into the Gunder Member, are preserved.

Paleobotanic Record

Paleobotanical investigations at stop 2 are still in progress. Pollen and macrofossil assemblages from the

Roberts Creek Member are very different from those in the Gunder Member. The pollen is mostly nonarboreal (82%), with ragweed (36%), sunflower family (17%), grass (15%), and sedge (9%) dominant. Oak is the only common tree, and it only makes up 7% of the pollen spectrum. The macrofossils are composed of a diverse flora including many prairie elements, and willow as the only tree. This assemblage is typical of the Roberts Creek Member at Roberts Creek in northeastern Iowa, and clearly indicates a prairie vegetation for the area. A radiocarbon age of 5580 B.P. on wood from this locality is almost certainly from a reworked piece, because preliminary work on the Gunder Member exposed just upstream, dated at 5350 B.P., shows a typical Gunder Member forest assemblage: the two sites are less than 50 meters apart and could not have been so different and been the same age.

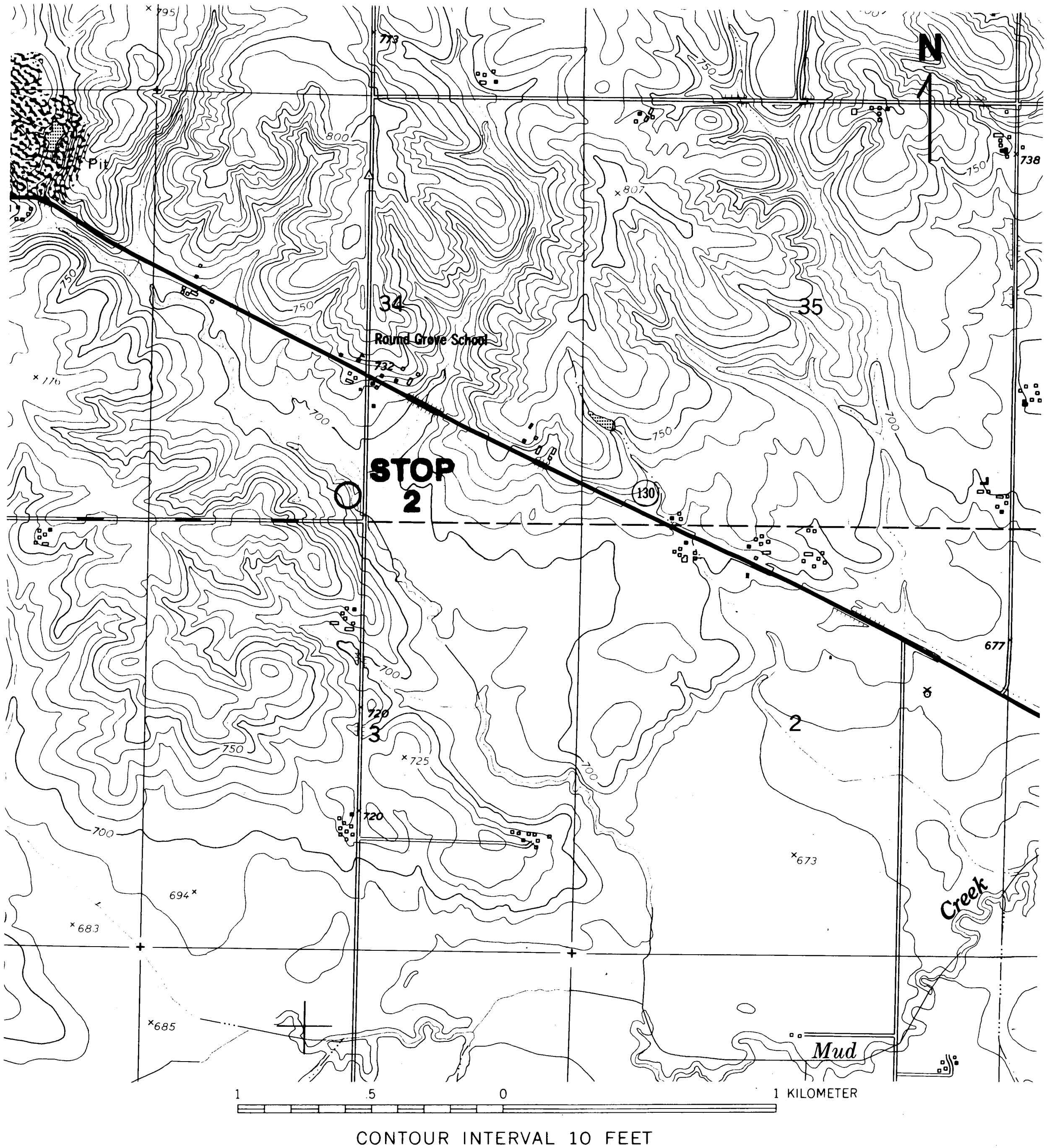


Figure 8. Topographic map showing the location of stop 2 along a tributary to the lower reaches of Mud Creek. Taken from USGS 7.5 minute Dixon, Iowa quadrangle.

Figure 9. Description of Gunder Member exposure at stop 2.

82MS 18 -- Unnamed tributary to Mud Creek, Iowa; SE 1/4, SW 1/4, Sec. 23, T.80N., R.1E., measured section from cut bank in Holocene alluvium along edge of floodplain; elevation 690 ft (210.3 m); 1-3 percent slope; site in pasture; described on 10/25/90 by E. A. Bettis; radiocarbon date on wood collected from Gunder Member 240 cm below land surface 5350 ± 60 B.P. (Beta - 39434)

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			CAMP CREEK MEMBER
L	0-55	C	Brown (10YR 4/3 - 5/3) silt loam; weak, medium, granular structure; friable consistence; planar bedded with thin very fine sand laminae below 20 cm; common to abundant roots and pores; abrupt, smooth boundary.
S ↑ L	55-80	AC	Dark brown (10YR 3/3) silt loam; moderate, medium, subangular blocky structure; friable consistence; faint planar bedding evident in lower 15 cm; abundant roots and pores; abrupt, smooth boundary.
			GUNDER MEMBER
S	80-94	A1	Very dark grayish brown to dark brown (10YR 3/2 - 3/3) loam, weak medium to coarse, granular structure; friable consistence; abundant roots and pores; gradual smooth boundary.
S	94-120	A2	Very dark grayish brown to dark brown (10YR 3/2 - 3/3) loam, moderate, medium granular structure; friable consistence; common roots and pores; gradual, smooth boundary.
S	120-136	Bt1	Dark brown (10YR 3/3) loam; moderate, medium to fine subangular blocky structure; friable consistence; common roots and pores; common, thin, discontinuous very dark grayish brown (10YR 3/2) cutans; clear, smooth boundary.
S	136-180	Bt2	Dark grayish brown (10YR 4/2) loam; moderate, medium subangular blocky structure; friable consistence; few pores; common, thin, discontinuous light brownish gray (10YR 6/2) silans; common, thin, discontinuous very dark grayish brown (10YR 3/2) cutans; gradual, smooth boundary.
S ↑ O	180-205	BC	Very dark grayish brown to dark grayish brown (10YR 3/2 - 4/2) clay loam; moderate, medium, angular blocky structure; friable consistence; abundant, medium, yellowish brown (10YR 5/6) mottles and iron accumulations; clear, smooth boundary.
O	205-220	CB	Very dark gray to dark gray (10YR 3/1 - 4/1) clay loam; weak, medium, subangular blocky structure; friable consistence; few, medium, yellowish brown (10YR 5/6) mottles; clear, smooth boundary.

O ↑ CB	220-260	C	Black to very dark gray (10YR 2/1 - 3/1) silty clay loam grading downward to stratified silty clay loam and fine to medium pebbly sand; massive structure; friable consistence; disseminated organics; large mammal bone at 227 cm; radiocarbon date on wood at 240 cm 5350 ± 60 B.P. (Beta - 39434);abrupt, smooth boundary.
			PRE-GUNDER MEMBER
O ↑ CB	260-340	2Cg	Gray (5Y 5/1) silt loam grading downward to fine to medium sandy loam; massive structure; friable consistence; common, vertical root traces; few disseminated organics; examined to 60 cm below present creek level.

STOP 3. LOWER REACHES OF CROW CREEK IN MISSISSIPPI VALLEY

The Camp Creek, Roberts Creek, and Gunder members of the DeForest Formation can be distinguished in tributaries to the master valleys of the state. The formation has not been subdivided in alluvium of the state's master valleys. At this stop we will examine the Gunder, Roberts Creek, and Camp Creek members in a large (greater than fourth-order) Mississippi tributary in the Port Byron Gorge (Fig. 10). We will also see alluvium deposited during one of the last Glacial Lake Superior-source floods to pass down the Mississippi via the St. Croix Valley.

Crow Creek drains a 48.7 km2 (18.8 mi2) basin on the dissected, loess-mantled Illinoian till plain in eastern Scott County, Iowa. The creek's lower reach passes across a 0.75 km wide bench in the Mississippi Valley before joining the Mississippi opposite Campbells Island, Illinois. The bench is cut on Devonian limestone and overlain by thin erosional remnants of Pre-Illinoian (Alburnett Formation) glacial diamicton. Outside the Holocene channel belt of Crow Creek late Wisconsinan sand and gravel bury the bench, grading upward to loamy and clayey alluvium. Colluvial wedges and small alluvial fans composed of the Corrington Member of the DeForest Formation are developed along the base of the valley wall slopes. A Savanna Terrace remnant is present on the north side of Crow Creek valley's mouth, rising 4.5 to 6.0 meters above the bench in the Mississippi Valley (Fig. 11).

The part of Crow Creek that flows across the bench was straightened as part of bridge replacements and road realignments in the 1970's. Formerly the creek flowed to the south after entering the Mississippi Valley, then turned to a northeasterly course just northeast of the Alcoa Aluminum plant southwest of Stop 3. The present wide, relatively unstable entrenched channel is a response to the increased gradient resulting from the shortening of the creek's length. This channel instability has produced steep cut banks that reveal stratigraphic relationships among DeForest Formation alluvium of Crow Creek and a regionally traceable early Holocene marker bed of the Mississippi Valley. We will examine two outcrops at this stop. The first is located on the right bank (facing downstream) of the creek upstream of the Highway 67 bridge, and the second is located along the left bank a little farther upstream.

Stop 3a. Gunder Member and Mississippi flood deposits

Stratigraphy and Chronology

At this location the Gunder Member of the DeForest Formation buries a fluvial erosion surface developed on unoxidized, unleached, loamy Alburnett Formation (Pre-Illinoian) glacial diamicton. The diamicton contains abundant wood and Pennsylvanian lithologies in this area and also exhibits small deformed (folded) sand bodies. The diamicton extends to creek level and overlies Devonian limestone on the upstream end of the exposure.

The lower part of the Gunder Member consists of relatively coarse channel belt facies grading upward to silty overbank facies (Fig. 12). About one meter below the land surface a prominent 15 to 20 cm thick bed of reddish brown silty clay is present, extending across the exposure. This bed is traceable in several exposures of the Gunder Member from this location downstream. The reddish brown silty clay is alluvium deposited in quiet water conditions resulting from ponding of tributaries during Mississippi River floods. The distinctive reddish brown silty clay lithology is characteristic of sediment from Glacial Lake Superior that entered the Mississippi as a result of discharges through the Brule spillway to the St. Croix Valley. The position of this bed low in the valley relative to Savanna Terrace remnants at the mouth of Crow Creek indicates that this bed represents an early Holocene discharge, probably dating about 9600 B.P. (Hajic, 1990a; Bettis and Hajic, 1990). This age is consistent with the stratigraphic position of the bed in the Gunder Member.

The reddish brown silty clay is buried by pedogenically altered, silty to loamy Gunder Member alluvium. The contact between the silty clay and the overlying Gunder Member has been biotically mixed.

On the upstream end of the exposure a channel filled with Camp Creek Member alluvium cuts out the Gunder Member. Roberts Creek Member alluvium, with a soil developed in its upper part is present upstream of the Camp Creek channel and is overlapped by the Camp Creek. Devonian limestone lies beneath the Roberts Creek Member.

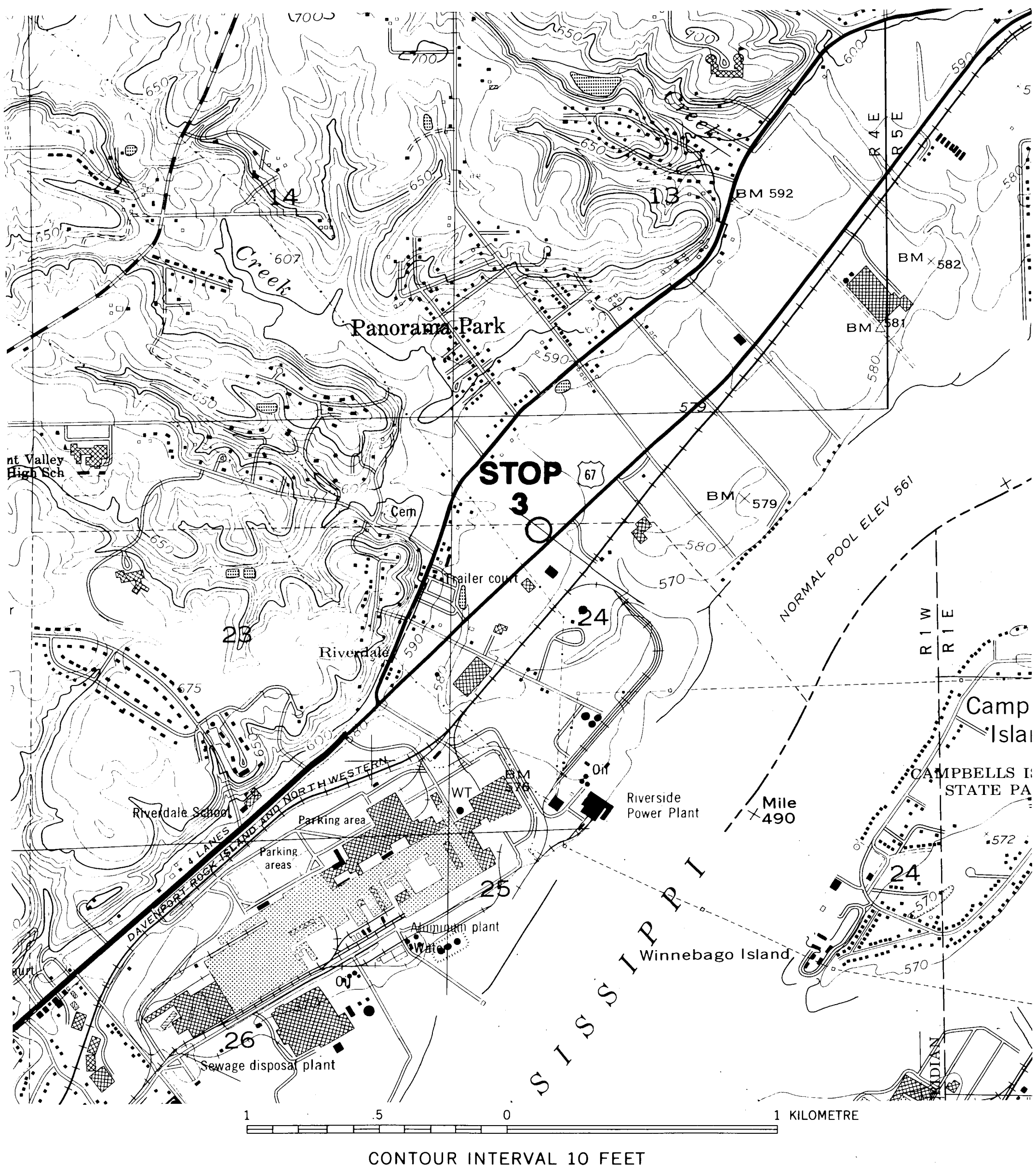


Figure 10. Topographic map showing the location of stop 3 in the Port Byron Gorge of the Mississippi Valley. Taken from USGS 7.5 minute Silvis, Iowa quadrangle.

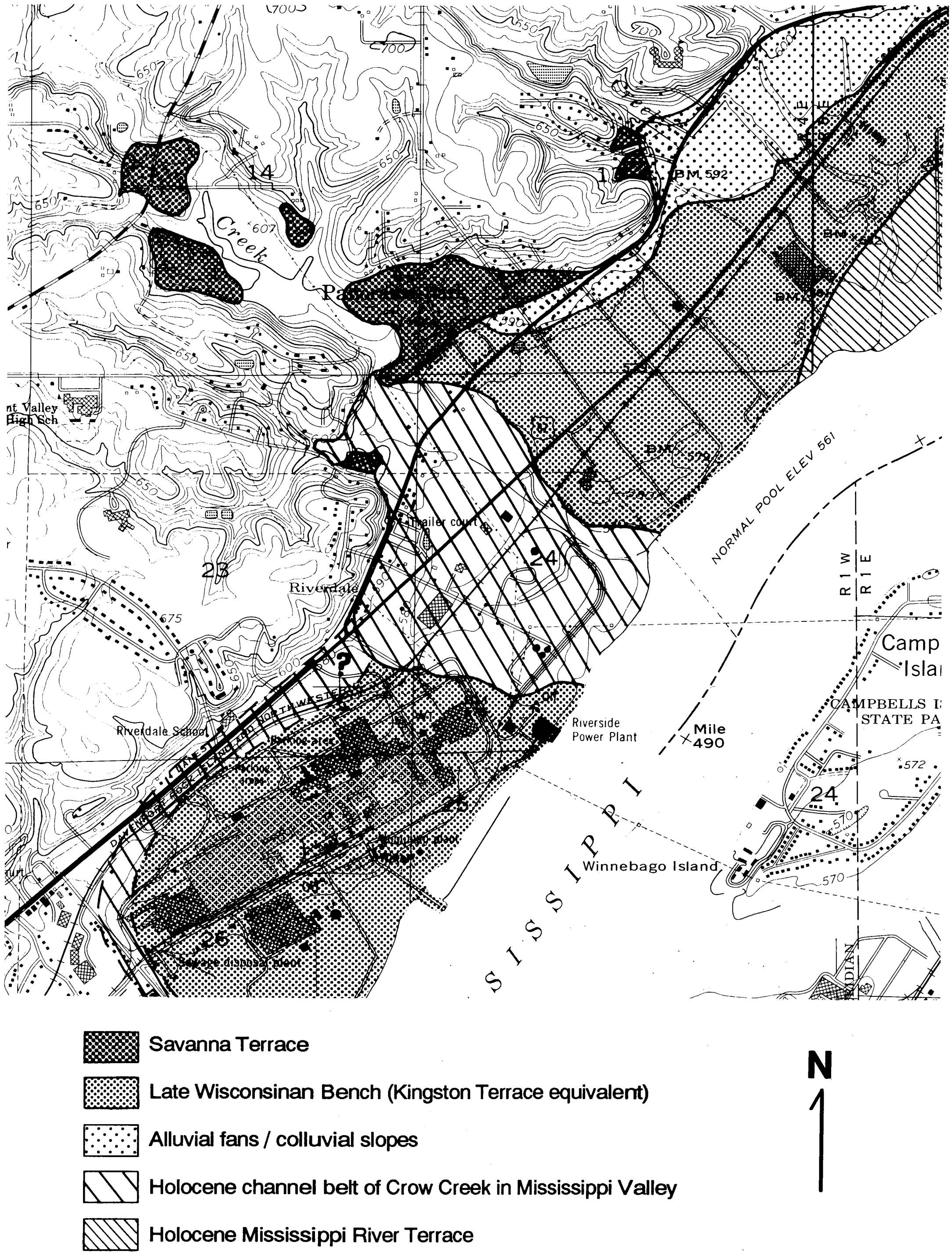


Figure 11. Surficial geology of the stop 3 area in the Port Byron Gorge of the Mississippi Valley.

Figure 12. Description of DeForest Formation and Alburnett Formation deposits exposed at stop 3.

82CC-1 -- Crow Creek, Iowa; NE 1/4 SW 1/4 NW 1/4 Sec. 24 T78N R4E; cut bank in Holocene alluvium, right bank of Crow Creek, in Mississipi Valley; elevation 580 ft (176.8 m); 0 to 1 percent slope; described on 10-1-91 by E.A. Bettis.

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			GUNDER MEMBER
S	0-23	Ap	Dark brown to brown (10YR3/3-4/3) silt loam; cloddy structure; friable consistence; noneffervscent; abrupt, smooth boundary
S	23-37	Bw1	Brown (10YR4/3) silt loam; moderate, medium to fine subangular blocky stucture; friable consistence; noneffervescent; few, thin, discontinuous light brownish gray (10YR6/2) silans; clear, smooth boundary
S	37-47	Bw2	Dark yellowish brown (10YR4/4) silt loam; weak, coarse columnar breaking to moderate, medium subangular blocky structure; friable consistence; noneffervescent; common, discontinuous patches of light brownish gray (10YR6/2) silans; common, thin, discontinuous dark brownish gray (10YR4/2) cutans in small root traces; clear, smooth boundary
S	47-65	Bt1	Yellowish brown (10YR5/4) silt loam; weak, coarse columnar breaking to moderate, medium to coarse subangular blocky structure; friable consistence; noneffervescent; common, thin, discontinuous dark grayish brown to brown (10YR4/2-4/3) cutans that are continuous in root channels; gradual, smooth boundary
S	65-82	Bt2	Dark yellowish brown (10YR4/4) silt loam with horizontal zones that contain more sand (loam) and appear to be remnant bedding; moderate, medium to coarse subangular blocky structure; friable consistence; noneffervescent; common, medium patches of light brownish gray (10YR6/2) silans; common, thin, discontinuous dark brown (10YR3/3) cutans with continuous very dark grayish brown (10YR4/2) cutans in root traces; clear, smooth boundary
S	82-93	BC	Brown (7.5YR4/4) silt loam; weak, medium to coarse subangular blocky structure; friable consistence; noneffervescent; patches of silans as above; common to abundant insect burrows filled with reddish brown (5YR4/4) silty clay; clear, smooth boundary
			MISSISSIPPI RIVER, SUPERIOR-SOURCE FLOOD DEPOSIT
O	93-103	2C1	Reddish brown (5YR4/4) silty clay loam; strong, medium columnar structure; firm consistence; noneffervescent; common insect burrows filled with overlying material in upper 3 cm, decreasing with depth; clear, smooth boundary

O	103-112	2C2	Reddish brown (5YR4/4) silty clay; strong, medium angular blocky structure; firm consistence; noneffervescent; common, disrupted pinkish gray (5YR7/2) laminae (X-ray analysis indicates these are high in kaolinite); common fine reddish brown (5YR4/4) blebs (rip-up clasts?); few, fine very dark gray (5YR3/1) accumulations (oxides); abrupt, smooth boundary
			GUNDER MEMBER
O	112-124	3C1	Dark yellowish brown to yellowish brown (10YR4/4-5/4) silt loam; weak, medium to coarse columnar structure; friable consistence; noneffervescent; upper half of horizon contains abundant reddish brown (5YR4/4) blebs of silty clay; few, thin, discontinuous brown (10YR4/3) cutans; common, medium light brownish gray (10YR5/2) mottles; clear, smooth boundary
O	124-142	3C2	Yellowish brown (10YR5/4) silt loam; weak, coarse columnar structure; friable consistence; noneffervescent; thick, continuous dark brown (10YR3/3) cutans in root channels; abundant, medium and fine grayish brown (2.5Y5/2) mottles; common, thin, discontinuous very dark grayish brown (10YR3/2) patches (oxides?) on faces of columns
O	142-160	3C3	Light brownish gray (10YR6/2) silt loam; massive structure; friable consistence; noneffervescent; cutans in root chanels as above; abundant, medium and fine olive yellow (2.5Y6/8) mottles; abundant, fine dark reddish brown (5YR2/2) accumulations (oxides); clear, smooth boundary
O	160-174	3C4	As above, but with common to abundant dark reddish brown accumulations, and common, fine brown (7.5YR4/4) mottles
O ↑ CB	174-193	3C5	Grayish brown (2.5Y5/2) silt loam; faint, horizontal bedding evident; massive structure; friable consistence; noneffervescent; mottles as above; clear, smooth boundary
O ↑ CB	193-219	3C6	Grayish brown to brown (10YR5/2-5/3) silt loam; moderate, fine columnar structure; friable consistence; noneffervescent; abundant brown (7.5YR4/4) accumulations along old root traces; common, medium yellowish brown (10YR5/6) mottles; clear, smooth boundary
CB	219-229	3C7	Gray (10YR5/1) silt loam with indisinct loamy laminae; lower 3 cm contains abundant reddish brown (5YR5/3) loam to silt loam laminae; massive structure; friable consistence; noneffervescent; mottles and brown accumulations as above; abrupt, smooth boundary
CB	229-309	4C	Oxidized, clast-supported gravel, pebbles, and coarse sand; clasts up to 20 cm in diameter present, coarsest at top and at base; single grain structure; loose consistence; noneffevescent; abrupt, smooth boundary
			ALBURNETT FORMATION GLACIAL DIAMICTON
	309-429	5C (UU)	Unoxidized and unleached, dark grayish brown (10YR4/2-2.5Y4/2) loam diamicton; contains abundant Pennsylvanian lithologes; abundant wood; 10 cm thick brown to dark yellowish brown (10YR4/3-4/4) oxidized zone at top; unit extends to creek level

Stop 3b.
Camp Creek, Roberts Creek, and Gunder members

Stratigraphy and Chronology

This stop is located a few tens of meters upstream of the first exposure along the left bank of Crow Creek just upstream of a large bend in the entrenched channel. The lower part of this exposure is very similar to that at Stop 3a; unoxidized, unleached Alburnett Formation glacial diamicton separated from coarse-grained channel belt facies of the Gunder Member by a fluvial erosion surface.

The oxidized, gravelly Gunder Member channel belt facies is abruptly overlain by darker colored, sandy, channel belt facies of the Roberts Creek Member that contain gastropod shells and zones of disseminated charcoal and wood. Two radiocarbon ages were obtained from the channel belt facies of the Roberts Creek Member, an age of 1560$\pm$90 B.P. on charcoal (Beta-49113), and 1510$\pm$80 B.P. on wood (Beta-49114). These are well within the age range of the Roberts Creek Member in Iowa (Bettis and Littke, 1987; Bettis, 1990). The Roberts Creek channel belt facies grades upward into dark colored, loamy overbank facies that have undergone slight pedogenic alteration, producing a thick AC soil profile.

Levee facies Camp Creek Member buries the soil developed in the upper part of the Roberts Creek Member. The Camp Creek Member averages about 70 cm in thickness where it buries uneroded Roberts Creek Member, and it thickens in a downstream direction as it approaches a channel filled with Camp Creek Member. Channel facies Camp Creek Member is present in the abandoned channel.

Archaeology

Surface survey of Crow Creek basin has located numerous prehistoric camp sites on the bluffs and Savanna Terrace around Panorama Park (Abbott and McKay, 1978). Most sites are of uncertain age because no temporally diagnostic artifacts have been found.

Summary
Stops 1-3.

During this first part of the trip we have seen the stratigraphic relationships and lithologies of the Gunder, Roberts Creek, and Camp Creek members of the DeForest Formation. The members are distinguished on the basis of easily observed properties. Gunder Member alluvium is oxidized to a brown color, usually exhibits 10YR hue secondary segregations of iron, and has soils with moderate horizonation developed in its upper part. Roberts Creek Member alluvium is darker colored, usually grayish brown, because it has a moderate to high organic carbon content. The Roberts Creek Member usually exhibits 7.5YR or 5YR hue iron segregations, and has soils with weak horizonation developed in its upper part. The Camp Creek Member is usually lighter colored than either the Roberts Creek or Gunder members, tends to be more stratified, and has thin soils with very weak horizonation developed in its upper part.

The Roberts Creek Member is inset into, or buries (overlaps) the Gunder Member. Soils developed in the upper part of the Gunder Member were surface soils on low terraces during accumulation of the Roberts Creek Member. In some cases these soils were built up by Roberts Creek Member aggradation. The Camp Creek Member is inset into or buries older Deforest Formation alluvium. When it overlies pre-settlement soils developed on older alluvium, the Camp Creek Member is thicker where it buries the Roberts Creek Member than where it buries the Gunder Member. In many areas pre-settlement floodplain relief has been masked by the Camp Creek Member.

Similar characteristics in the Holocene valley fill have been documented in tributaries to master streams throughout Iowa and in portions of adjacent states (Bettis, 1990; Bettis and Mandel, 1992). These relationships, and the chronologic range usually associated with each member of the formation in a given part of the drainage network reveal the generalized Holocene history of the valley fill. This history serves as a guide for studies aimed at unravelling the detailed fluvial history and archaeological and paleoecological records contained in the alluvium.

STOP 4. LUNCH ON SAVANNA TERRACE, PINE CREEK VALLEY, WILD CAT DEN STATE PARK, IOWA

Geology

The Savanna Terrace is the oldest terrace lacking a loess cover in the Upper Mississippi Valley (Flock, 1983; Bettis and Hallberg, 1985; Bettis and Hajic, 1990; Hajic, 1990a; Hajic et al., 1991). At this stop a core taken from the terrace at the lunch stop will be available for examination. The early Historic Nye Cemetery and mill are also present in this area and will be discussed briefly.

Pine Creek enters the Mississippi Valley in the Andalusia Gorge (Fig. 13). Anderson (1968) concluded that this valley segment became part of the Mississippi when Lake Milan topped the ancient Mississippi/Iowa-Cedar divide just downstream of the park at Fairport about 21,000 B.P. Since that time the Upper Mississippi has maintained its present configuration, and all western and northern-source drainage has passed through this part of the valley. The Andalusia Gorge is approximately 2.5 km wide, and incised into Pennsylvanian sandstone and shale in the Wild Cat Den vicinity. Two benches that probably reflect differential erosion of Pennsylvanian rocks are present in this part of the gorge. The surface on which Highway 22 is built is a late Wisconsinan/early Holocene bench mantled with Holocene-age alluvium. Alluvial fans and colluvial slopes composed of the Corrington Member of the DeForest Formation descend to this surface along the valley walls.

The road leading into Wild Cat Den State Park ascends approximately ten meters from the low bench in the Mississippi Valley onto a Savanna Terrace remnant at the mouth of Pine Creek (Figs. 13 and 14). Several other remnants are preserved in the lower reaches of Pine Creek and our lunch stop is on one of them. In the past the Savanna Terrace and it's main valley correlate in this area have been referred to as the "Mankato" terrace (Trowbridge, 1954; Edmund and Anderson, 1967; Anderson et al., 1982).

The core taken from the Savanna Terrace at this stop exhibits lithologies typical of sediments underlying this surface throughout the Upper Mississippi Valley. Important characteristics include multiple, thin reddish brown silty clay beds, some with associated white, coarse silt laminae; the reddish brown silty clay beds decrease in abundance with depth; gray, planar-bedded silt loam is the dominant lithology; the deposits coarsen downward irregularly; soft sediment deformation structures are common.

Deposits comprising the Savanna Terrace in tributary valleys north of the Des Moines River junction accumulated as a result of drowning of the lower reaches of the tributaries as the Mississippi floodplain aggraded between about 18,000 and 13,000 B.P. During this period large floods produced by glacial lake outbursts passed down the valley repeatedly, backflooding lower reaches of tributaries. Superior-Basin source floods carried distinctive reddish brown silty clays whereas western-source floodwaters did not. The gray silt loam and silty clay loam sediments comprising these terraces is probably a combination of western/northern source flood sediment and locally derived tributary alluvium. The deposits are silty because loess fall was occurring during the aggradation period.

Archaeology and History

The Pine Creek gristmill is located along Pine Creek at stop 4. This mill was built in 1848 by Benjamin Nye using local materials. The mill displays a post and beam construction with blind mortise joints, representative of traditional construction techniques. The mill was enlarged and updated somewhat between 1863 and 1923, but still contains remarkably intact flour milling machinery dating from the 1850's. The CCC and WPA extensively repaired the mill and dam in the 1930's. Recent floods damaged the mill's interior and state budget cuts have slowed efforts at restoration. The bridge across Pine Creek at the mill is a Pratt truss iron bridge erected about 1883.

The Nye Cemetery is one of the earliest Historic cemeteries in Muscatine County, containing burials dating as early as 1838. Some graves are marked with natural rocks having no inscriptions.

Pine Creek Mounds (13MC44) were located on the bluff overlooking Pine Creek south of its junction with the Mississippi Valley. At least 15 mounds were originally present. Excavations were conducted in 1875 by Quad-Cities enthusiasts (Lindley, 1876; Harrison, 1886) and in 1914 by Truman Michelson, on loan from the Smithsonian Institution to the Davenport Academy of Sciences. Michelson was brought in to direct excavations in an effort to improve the Davenport Academy's generally poor reputation in professional archaeological circles. He and his workers conducted a well

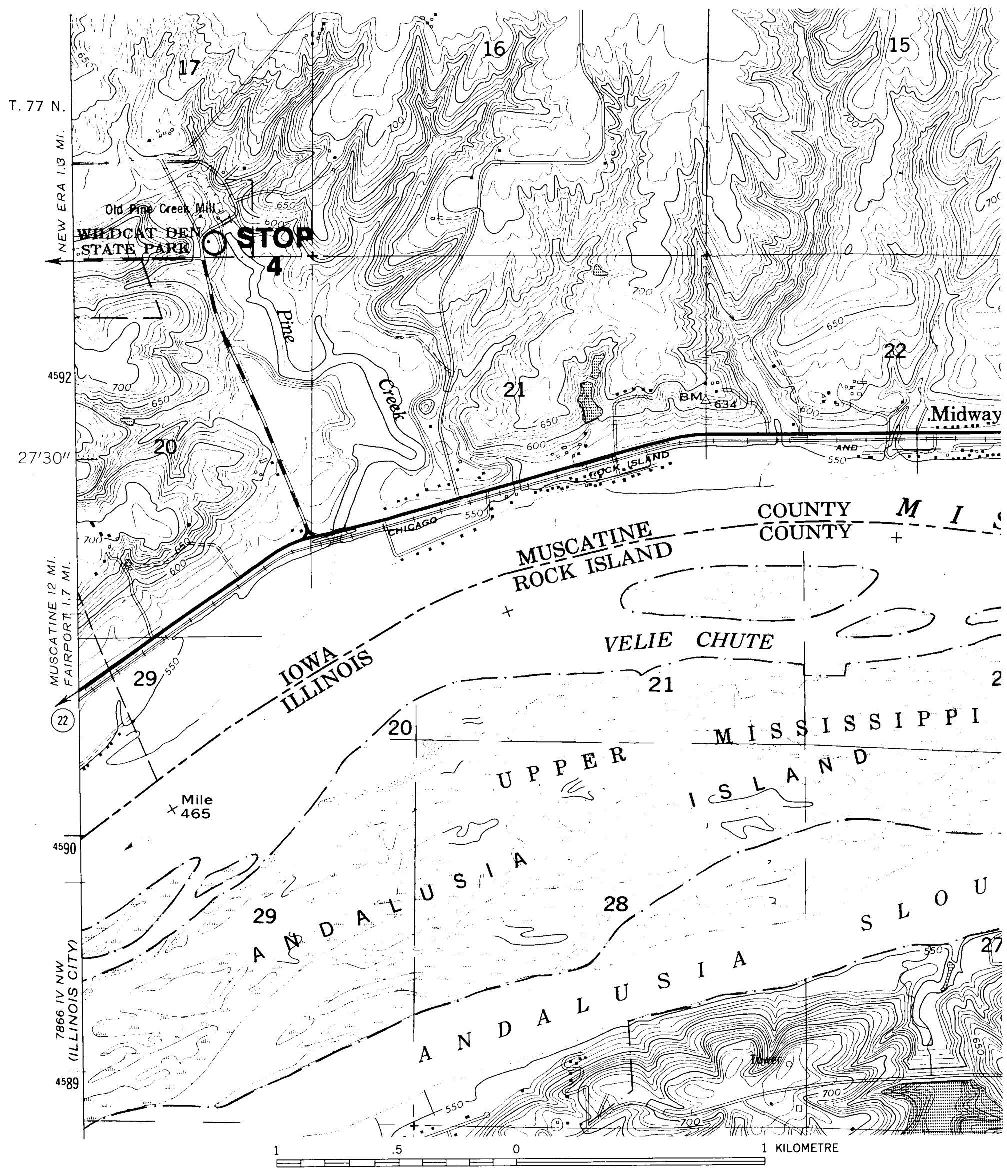


Figure 13. Topographic map showing the location of stop 4 along Pine Creek, Muscatine County, Iowa. Taken from USGS 7.5 minute Montpelier, Iowa quadrangle.

controlled, state of the art excavation, but a report was never published. Recent review of notes and materials at the Putnam Museum in Davenport will lead to preparation of a full site report. As part of this effort, the human skeletal remains recently were analyzed in detail (Hodges, 1989). Artifacts and features excavated in 1914 clearly show Hopewell affiliation and participation by local Middle Woodland residents in the Hopewell interaction network, aproximately 2100-1700 B.P. (see appendix for further discussion of the Middle Woodland period). Exotic artifacts include platform pipes and Gulf Coast marine shells. Unfortunately, the mounds were completely destroyed by bulldozing in 1972. Associated habitation sites have not yet been found.

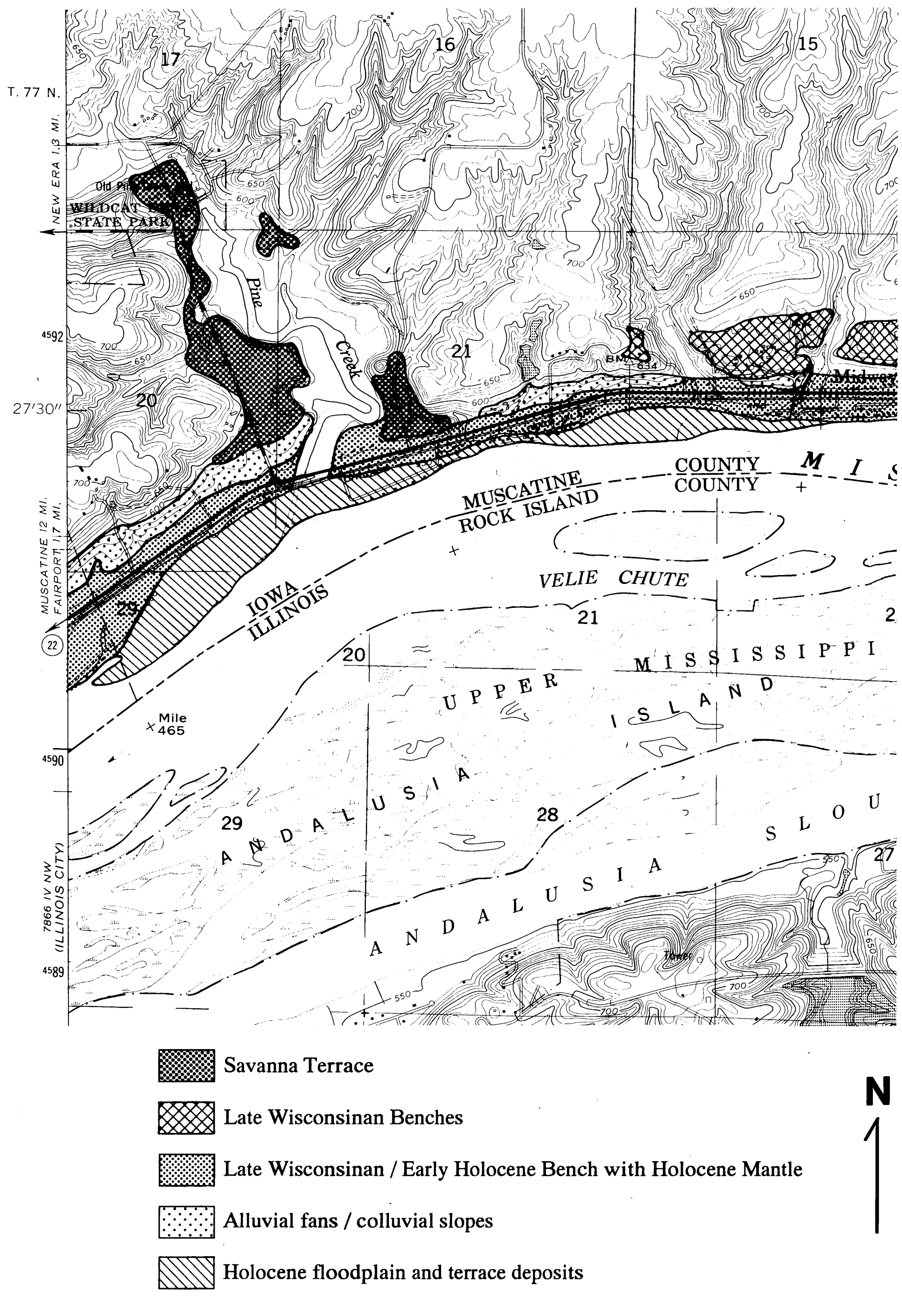


Figure 14. Map of the surficial geology in the vicinity of stop 4.

STOP 5. GAST FARM/GAST SPRING LOCALITY IN MISSISSIPPI VALLEY

This stop consists of two substops where we will examine alluvial fan sedimentary sequences, buried soils, and archaeological associations typical of the Corrington Member of the DeForest Formation in large eastern Iowa valleys. These deposits will be placed in the broader context of Mississippi Valley deposits in the Muscatine Island area. We will also discuss Holocene paleobotanical records preserved in abandoned Mississippi River channels and in buried, valley-margin wetlands. The well-dated stratigraphic and botanical records of this locality illustrate the influence of the evolving physical environment on the formation of the archaeological record.

Geology

At Muscatine the Mississippi Valley widens abruptly from about 3 km to 13 km as it leaves the Andalusia Gorge. From that point to below the Iowa River junction 38 km south, the Mississippi Valley intersects a Pre-Illinoian buried valley complex and the western valley wall consists entirely of Quaternary deposits (Benn et al., 1988).

Stop 5 is an alluvial fan complex at the base of the western valley wall south of Muscatine. West of the river the valley is known as Muscatine Island and its sandy soils have supported a local long-standing truck farm economy. The surficial geology in this area was mapped during a cultural resource investigation of pools 17 and 18 for the Rock Island District Corps of Engineers (Benn et al., 1988; Bettis and Benn, 1988). Figure 15 presents a map of the surficial geology on which the valley's deposits are grouped into landform-sediment assemblages (LSA) that are genetically and chronologically related. Biotic and archaeological records with restricted temporal ranges are associated with each LSA.

The oldest LSA in the Muscatine Island area is the Savanna Terrace, preserved as a streamlined remnant just west of the river and known locally as Big Sand Mound. Iowa-Illinois Gas and Electric Company has a large generating station on the terrace. The Savanna Terrace is also preserved along the eastern valley wall in the southern part of figure 15 and is discontinuously present along the Illinois side of the valley to the south (see Bettis and Benn, 1988, their high sandy terrace). The Savanna Terrace in the Mississippi Valley is underlain by sandy and pebbly sand channel deposits capped by a variable thickness of eolian sand. Dune topography is well expressed on this terrace, and several generations of dunes are evident. This is Leighton and Willman's "Early Mankato" terrace (1949). In this part of the valley channel deposits comprising the Savanna Terrace accumulated between about 18,000 and 12,000 B.P.

The surface of the Kingston Terrace LSA is about 12 meters (40 ft.) lower in elevation than the Savanna Terrace. Streamlined remnants of the Kingston Terrace are preserved on both sides of the valley (Fig. 15). The large remnants on the west side of the river account for the sandy nature of Muscatine Island. Sandy and pebbly sand channel deposits of the Kingston Terrace LSA are inset into the Savanna Terrace LSA. The eolian veneer on the Kingston Terrace tends to be thinner than that on the Savanna Terrace and fewer large dunes are present. On aerial photographs braid channels and overflow channels are prominent on the Kingston Terrace, but usually absent because of masking by dune topography on the Savanna Terrace. The Kingston Terrace is Leighton and Willman's "Late Mankato" terrace (1949). Alluvium of the Kingston Terrace LSA accumulated between about 12,000 and 10,000 B.P.

After about 10,500 B.P. the Mississippi's channel pattern shifted from its late glacial braided condition to an island-braided pattern that has persisted to the present in this area. The pattern shift was related to reductions in sediment load, and flood regime changes related to the rerouting of glacial meltwater through large lakes in the northern part of the basin. Though the channel's pattern has remained similar throughout the Holocene, its location has shifted considerably. The paleochannel areas shown on figure 15 consist of channel belts of various age distinguished by radiocarbon dating and by cross-cutting relationships of landforms evident on 1:80,000 scale aerial photographs (see Benn et al., 1988).

Of interest to us at this stop is the paleochannel area on the western side of the valley. The Mississippi was flowing through this channel belt between about 11,000 and 10,000 B.P. About 10,000 B.P. an avulsion occurred and the channel shifted to a location on the opposite side of the valley (paleochannel area 10,000-7,000 B.P. on figure 15). The former paleochannel area then became a large wetland with open water where deeper channels had been. This wetland, known as Muscatine Slough, was maintained by runoff from tributaries along the western valley wall

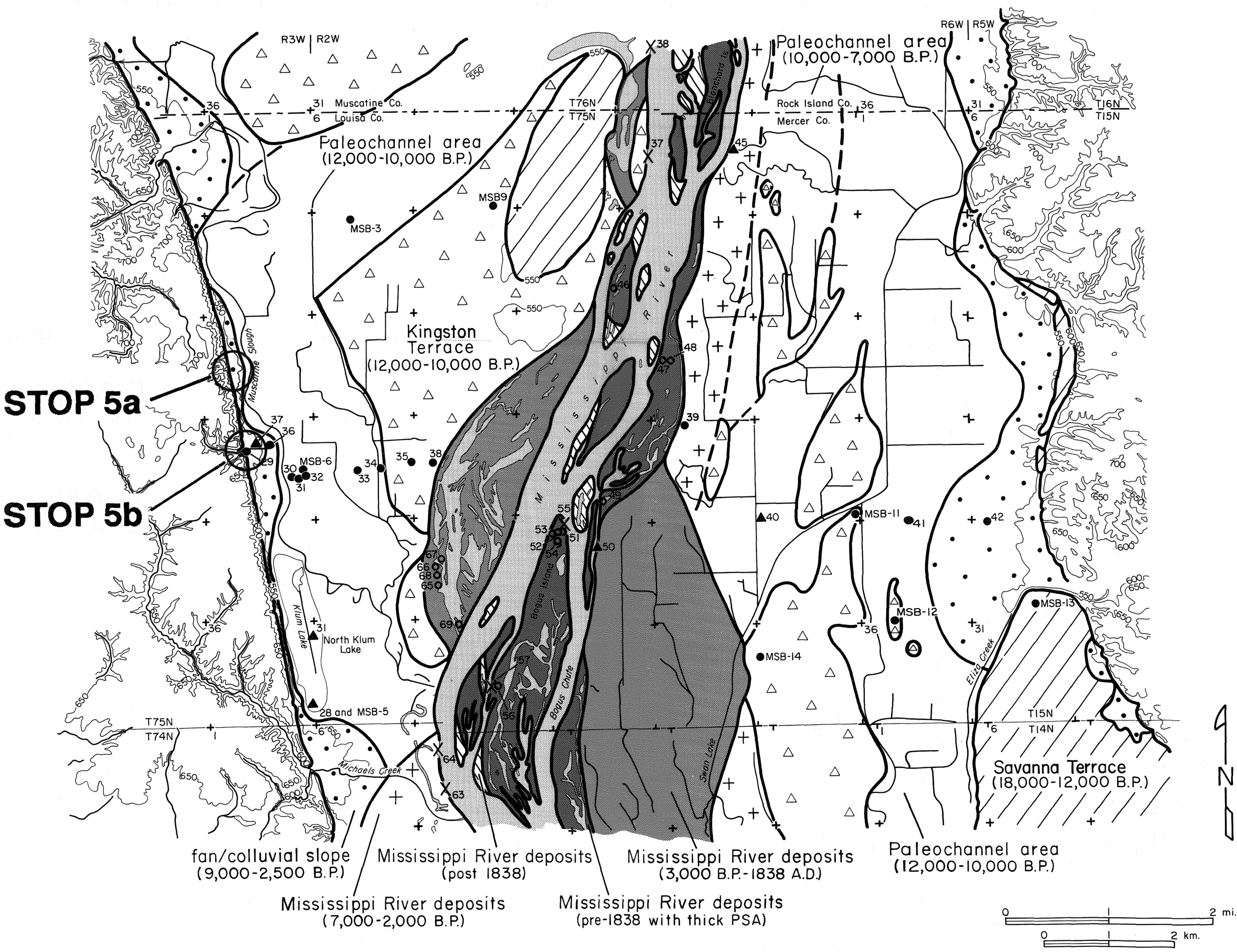


Figure 15. Surficial geology of the Mississippi valley in the stop 5 vicinity south of Muscatine, Iowa. Dark circles are locations of cores, and dark triangles are core locations with associated radiocarbon ages. Adapted from Benn et al., 1988, Fig. 2.2).

as well as by Mississippi River floodwaters.

From about 9,000 to 2,500 B.P. alluvial fans emanating from western tributaries prograded Muscatine Slough and progressively buried the wetland. Two deeper water basins persisted through this period, Keokuk Lake to the north and Klum Lake to the south. During the Holocene this valley reach contained a wide array of environments: well drained alluvial fan surfaces tucked against the valley wall, adjacent wet marshy areas, open quiet water bodies, excessively drained sandy terraces toward the valley center, and the Mississippi channel and its connected backwater areas. This environmental diversity was very attractive to prehistoric hunter-gatherers.

Stop 5a. Gast Spring Alluvial Fan

Geology

During the last two years an interdisciplinary team from the Iowa Quaternary Studies Group has been studying the geology, paleoecology, and prehistory of the Gast Spring and Gast Farm alluvial fans and Muscatine Slough (Green et al., 1990; Goldman-Finn et al., 1991; Green and Wallace, 1991). Both fans are on the Dan Gast farm and the Gast Spring fan derives it's name from a small spring/seep complex that feeds the stream draining to the fan. The Gast Farm fan is larger than the Gast Spring fan because the former has a larger contributory basin (Fig. 16). Both fans are relatively steep and prograde the Muscatine Slough wetland. At stop 5a we will examine the upper deposits of the Gast Spring alluvial fan in a trench, and deeper fan and underlying Mississippi River deposits in a core.

Figure 17 shows a cross-section of Gast Spring fan extending down the axis of the fan toward Muscatine Slough. The area labeled "trench" on the figure is the location of a trench dug in 1990. The trench we will see on this field trip is located farther up the fan, approximately at the location of core 581-2 on figure 17. Figures 18 through 21 are descriptions, particle-size and organic carbon profiles of cores 581-2, on the proximal fan, and 581-4 on the distal fan. Several important aspects of alluvial fan stratigraphy in the Muscatine Slough area are shown in the figures.

The fan consists of several upward-fining sequences with paleosols developed in their upper part. This sedimentation style is typical of the Corrington Member of the DeForest Formation and has been documented in alluvial fans and colluvial slopes throughout the Upper Midwest (Hoyer, 1980; Styles, 1985; Bettis and Hoyer, 1986; Hajic, 1990b). The sedimentation rate of the upper pedogenically altered part of the sediment package is lower than that of the underlying part of the sediment package that has not been pedogenically altered. Sediment-soil cycles began about 9000, sometime before 6200, about 6000, 4000, and 2500 B.P. This chronology is repeated over a large part of the Upper Midwest suggesting regional-scale forcing mechanisms. These regionally synchronous periods correspond with climatic changes inferred from paleoenvironmental records in the region, suggesting a direct link between climate and behavior of this part of the geomorphic/ depositional system (see Hajic 1990b for a detailed discussion of this linkage).

Fans along the western valley wall prograde an early to middle Holocene wetland formed in an abandoned late Wisconsinan to early Holocene channel belt. The oldest parts of the channel belt (under the proximal part of the Gast fans) contain reddish brown silty clay Mississippi River flood deposits that accumulated about 9500 B.P. More distal fan deposits prograde a wetland occupying a slightly younger part of the channel belt that does not contain the reddish brown silty clays. The age of the underlying wetland surface decreases down fan, and beyond the fan margins the wetland was present in the early Historic period.

Archaeology

The Gast Spring archaeological site (13LA152) is characterized by relatively sparse Woodland occupations underlain by Archaic horizons (see appendix for a discussion of the Woodland and Archaic periods). Controlled surface collections and excavations showed that surface and near surface archaeological remains are dominated by Liverpool-related Early Woodland complexes, aproximately 2300-2100 B.P. The well expressed uppermost paleosol at ca. 1 meter depth contains Early Woodland Marion ceramics and cultural features dating about 2700-2400 B.P. Archaeological deposits in the B horizon of this paleosol and deeper are aceramic and represent Archaic occupations.

Backhoe trenching in late 1991 reached a midden previously identified by coring at 4.5 to 5 meters depth (core 581-2 on figure 17). Hand excavations in the trench floor revealed a pit structure with a sub-floor pit, along with abundant charcoal, animal bone (primarily fish), and lithic artifacts. Charcoal from the sub-floor pit yielded radiocarbon ages of 5730$\pm$90 (Beta-51468) and 5680$\pm$90 (Beta-51682) B.P., making this the earliest known domestic structure in Iowa. A previously determined AMS date on charcoal (core 581-2 508-521 cm; 6215$\pm$70 B.P., Beta-41420, ETH-7191) collected from the paleosol that the structure is dug into is consistent with the dates from the structure.

Further work at Gast Spring will be conducted in stages, with one year of additional excavation of near-surface deposits, followed by large-scale machine-assisted work on the deeply buried Archaic component.

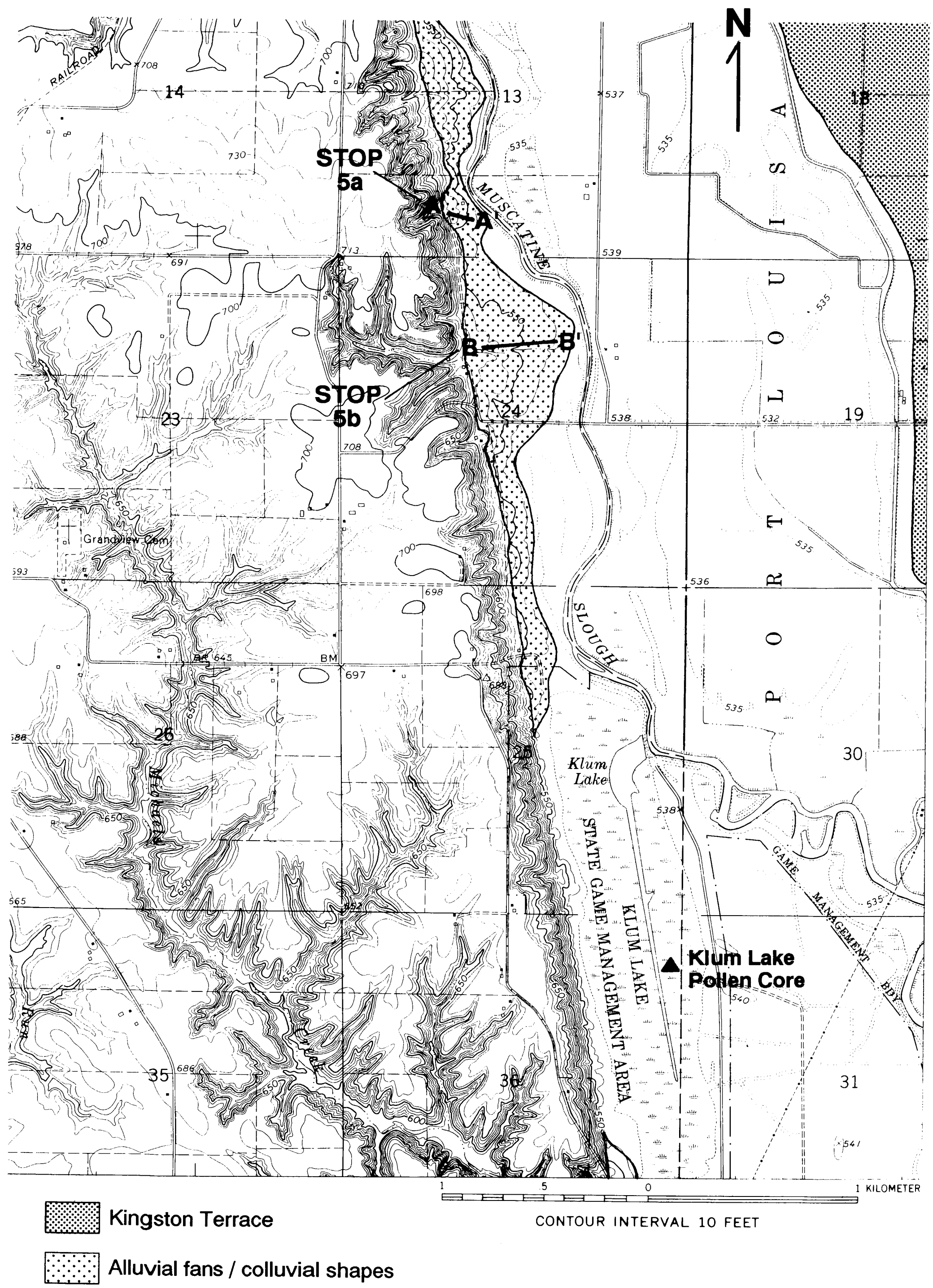


Figure 16. Topographic map of the stop 5 area along the western margin of the Mississippi Valley south of Muscatine, Iowa. Adapted from USGS 7.5 minute Letts quadrangle.

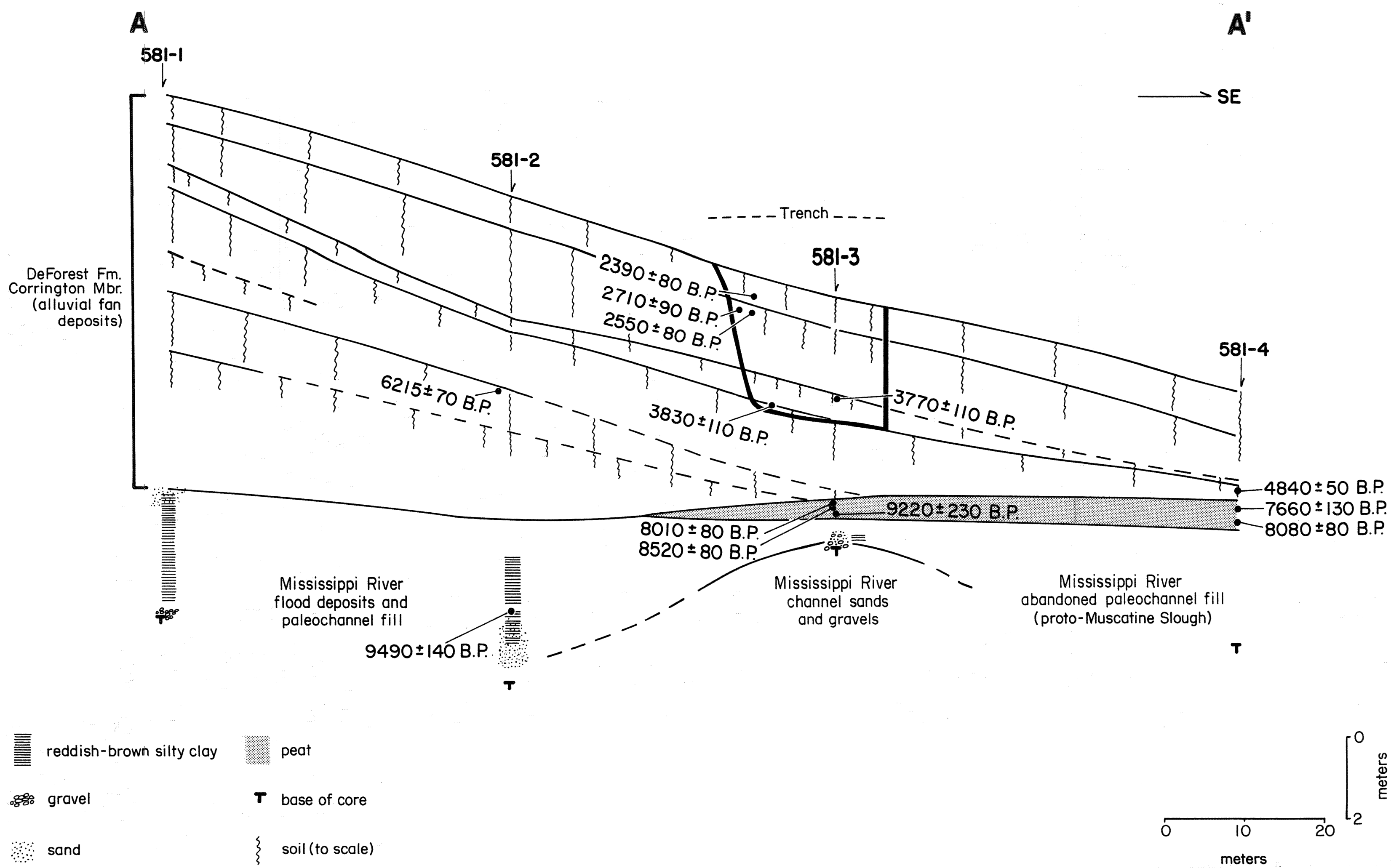


Figure 17. Cross-section of the Gast Spring alluvial fan (stop 5a) showing location of cores and radiocarbon dates.

Figure 18. Description of core 581-2 from the upper mid-fan of the Gast Spring alluvial fan.

581-2 -- Gast Spring Fan, Iowa; NW1/4, SE1/4, SW1/4, Sec. 13, T.75N, R.3W.; core from upper mid-fan part of alluvial fan on western side of Mississippi Valley; elevation 575 ft (175.7 m); 5-9 percent slope; drilled in corn field on 5-17-90 by E.A. Bettis and J.P. Littke; described by E.A. Bettis; Radiocarbon date on charcoal collected from suspected archaeological deposit (midden) 508-521 cm below land surface 6215±70 B.P. (Beta-41210, ETH-7191) and on wood collected 1026 cm below land surface 9490±140 B.P. (Beta-40091).

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CORRINGTON MEMBER
	0-15	Ap	Very dark grayish brown (10YR3/2) loam; cloddy structure; friable consistence; noneffervescent; common roots; abrupt boundary
	15-33	AB	Dark brown (10YR3/3) loam with few, fine tufa pebbles; moderate, medium subangular blocky structure; friable consistence; noneffervescent; common roots; common, thin, discontinuous very dark gray (10YR3/1) cutans; gradual boundary
	33-41	Bw1	Dark brown (10YR3/3) loam with tufa pebbles as above; moderate, medium subangular blocky structure; friable consistence; noneffervescent matrix with moderate effervescence surrounding tufa pebbles; common roots; cutans as above; clear boundary
	41-48	Bw2	Dark brown (10YR3/3) pebbly loam; moderate, medium to coarse subangular blocky structure; friable consistence; weak effervescence; abrupt boundary
	48-69	Bw3	Brown (10YR4/3) loam; moderate, medium to coarse subangular blocky structure; friable consistence; weak effervescence; few, fine charcoal flecks; very few, thin, discontinuous dark grayish brown (10YR4/2) cutans
	69-96	Bw4	Brown to dark yellowish brown (10YR4/3-4/4) loam; moderate, medium to coarse columnar structure; friable consistence; weak effervescence; cutans as above; common worm burrows filled with very dark grayish brown (10YR3/2) loam; few, coarse very dark gray (5YR3/1) streaks with brown (7.5YR4/4) halos; clear boundary
	96-117	2A1b	Very dark grayish brown (10YR3/2) loam; moderate, medium subangular blocky structure; friable consistence; weak effervescence; few krotovina filled with material from the overlying horizon; few, fine charcoal flecks; common macropores; very few manganese accumulations in pores; clear boundary
	117-140	2Akb	Very dark grayish brown to dark brown (10YR3/2-3/3) loam; weak, coarse subangular blocky breaking to moderate, medium subangular blocky structure; friable consistence; strong effervescence; common charcoal flecks; common macropores; abundant, discontinuous, soft secondary carbonate accumulations in pores; clear boundary

140-157	2ABb	Dark brown (10YR3/3) loam; moderate, medium to coarse subangular blocky structure; friable consistence; weak to moderate effervescence; few macropores; common, thin, discontinuous organs in pores; clear boundary
157-201	2Bw1b	Dark brown to brown (10YR3/3-4/3) loam with few fine pebbles; moderate, medium columnar structure; friable consistence; strong effervescence; few charcoal flecks; common, thin, discontinuous very dark grayish brown (10YR4/2) cutans; very few, fine, soft secondary carbonate accumulations; clear boundary
201-223	2Bw2b	Brown (10YR4/3-5/3) loam; weak, coarse subangular blocky structure; friable consistence; single clast thick layer of tufa pebbles at base; strong effervescence; abundant, fine, soft secondary carbonate accumulations; clear boundary
223-249	2BC1b	Dark grayish brown to brown (10YR4/2-4/3) loam with common fine pebbles; weak, medium subangular blocky structure; friable consistence; violent to strong effervescence; few, fine charcoal flecks; carbonate accumulations as above; common, fine brown (7.5YR4/4) mottles; clear boundary
249-287	2BC2b	Brown to yellowish brown (10YR4/3-5/4) loam with few, fine pebbles; weak to moderate, medium subangular blocky structure; friable consistence; noneffervescent matrix with moderate reaction in pores; few, fine, soft secondary carbonate accumulations in pores; few, fine charcoal flecks; abundant, medium to fine brown (7.5YR4/4) mottles; gradual boundary
287-310	2BC3b	Brown (10YR4/3) loam with few, fine pebbles; weak to moderate, medium subangular blocky structure; friable consistence; noneffervescent matrix with moderate reaction in pores; carbonate accumulations as above; mottles as above and continuous stains in pores; gradual boundary
310-340	3ABb	Dark grayish brown (10YR4/2) silty clay loam with few, fine pebbles; moderate, medium to coarse subangular blocky breaking to moderate, medium granular structure; friable consistence; noneffervescent; few, fine charcoal flecks; more macropores than above; common, medium to fine brown (7.5YR4/4) mottles becoming almost continuous in pores; abrupt boundary
340-356	4Ab	Very dark grayish brown to dark brown (10YR3/2-3/3) loam with few very decomposed tufa pebbles; weak, coarse subangular breaking to moderate, medium to fine subangular blocky structure; friable consistence; noneffervescent; few, medium brown (7.5YR4/4) mottles; common, medium to coarse very dark gray (7.5YR3/0) accumulations; gradual boundary
356-376	4Bwb	Dark brown (10YR3/3) loam; weak to moderate, medium subangular blocky structure; friable consistence; noneffervescent; macropores as above; common, thin, almost continuous very dark gray (10YR3/1) cutans in root channels; abrupt boundary

376-394	4BCb	Brown (10YR4/3) loam coarsening downward to sandy loam with pebble zone at base; weak, medium subangular blocky structure; friable consistence; violent effervescence; common, fine , soft secondary carbonate accumulations; abrupt boundary
394-411	4C1b	Brown (10YR4/3-5/3) sandy loam with few, fine pebbles; weak, medium subangular blocky structure; friable consistence; violent effervescence; abundant, medium to fine, soft secondary carbonate accumulations; abrupt boundary
411-427	4C2b	Brown (10YR4/3-5/3) pebbly sandy loam; massive to single grain structure; loose consistence; violent effervescence; brown to dark brown (7.5YR4/4-3/2) iron accumulation at base; abrupt boundary
427-470	4C3b	Olive brown to light olive brown (2.5Y4/4-5/4) stratified loam and sandy loam; massive and single grain structure; friable and loose consistence; violent effervescence; gastropod shells at base; abundant, medium to fine, soft secondary carbonate accumulations; common to abundant, medium dark yellowish brown (10YR4/4) mottles; dark yellowish brown iron accumulation in sandy loam beds; abrupt boundary
470-488	4C4b	Dark grayish brown (10YR4/2) loam; weak to moderate, medium subangular blocky structure; friable consistence; strong effervescence; few, fine, soft secondary carbonate accumulations; more macropores than above; common, medium dark yellowish brown (10YR4/4) mottles; abrupt boundary
488-511	5Ab	Very dark grayish brown (10YR3/2) loam; moderate, medium to fine subangular blocky structure; friable consistence; noneffervescent; abundant macropores; common charcoal and burned earth; few, medium to coarse dark brown (7.5YR3/4) mottles with black (7.5YR3/0) interiors along root channels; gradual boundary
511-544	5ABb	Very dark grayish brown (10YR3/2) loam; moderate, medium to coarse subangular blocky structure; friable consistence; noneffervescent; abundant macropores; abundant charcoal and burned earth and few blobs of ash; few, broken gastropod shells; few, thin, almost continuous very dark gray (10YR3/1) cutans in pores; abrupt boundary; this horizon appears to be an archaeological midden; radiocarbon date (AMS) on charcoal from 508-521 cm 6215$\pm$70 B.P. (Beta-41210, ETH-7191)
544-561	5Bwb	Dark brown (10YR3/3) pebbly loam with the pebbles consisting of tufa in various stages of decomposition; weak, medium to coarse subangular blocky structure; friable consistence; moderate to strong effervescence; common, thin, almost continuous secondary carbonate accumulations in pores; clear boundary; this may be a feature of human origin associated with the overlying midden
561-582	5Bt1b	Dark brown (10YR3/3) silty clay loam with few, fine pebbles; moderate, medium subangular blocky structure; friable consistence; noneffervescent; common, thin, discontinuous very dark grayish brown (10YR3/2) cutans; gradual boundary

582-599	5Bt2b	Brown (10YR4/3) silty clay loam; moderate, medium to fine subangular blocky structure; friable consistence; noneffervescent; cutans as above; few, medium to fine dark brown (7.5YR3/2) mottles; gradual boundary
599-640	5Bt3b	Brown (10YR4/3) silty clay loam with few, fine pebbles; weak, medium to coarse subangular blocky breaking to moderate, medium angular blocky structure; friable consistence; noneffervescent; abundant, thin, almost continuous very dark grayish brown to dark grayish brown (10YR3/2-4/2) cutans; mottles as above becoming continuous stains in root channels; gradual boundary
640-704	5BCb	Dark yellowish brown (10YR4/4) loam; weak to moderate, medium subangular blocky structure; friable consistence; noneffervescent; abundant, thin, almost continuous dark grayish brown (10YR4/2) cutans in root channels; mottles as above also few, fine grayish brown (10YR5/2) mottles; abundant, fine, soft manganese accumulations; gradual boundary
704-719	5C1b	Dark yellowish brown (10YR4/4) silt loam with few, fine pebbles; weak, coarse subangular blocky structure; friable consistence; moderate effervescence; abundant, medium to fine grayish brown (10YR5/2) and common, medium yellowish brown (10YR5/6) mottles; common, medium, soft manganese accumulations; clear boundary
719-749	5C2b	Yellowish brown (10YR5/4) sandy loam; massive structure; friable consistence; strong effervescence; abundant, medium, soft secondary carbonate accumulations; common, medium grayish brown (10YR5/2) mottles with yellowish brown (10YR5/6) halos; gradual boundary
749-792	5C3b	Yellowish brown (10YR5/4) burrowed, stratified sandy loam and silty clay loam; massive structure; friable consistence; violent effervescence; few, unbroken gastropod shells; abundant, soft secondary carbonate acumulations in pores; abundant, medium and coarse grayish brown (10YR5/2) mottles with strong brown (&.5YR4/6) halos; abrupt boundary
792-813	5C4b	Yellowish brown (10YR5/4) sandy loam; massive structure; friable consistence; violent effervescence; common, coarse grayish brown (10YR5/2) mottles with brown (7.5YR4/4) halos; abrupt boundary
813-825	5C5b	Light olive brown (2.5Y5/4) sandy loam; massive structure; friable consistence; strong to moderate effervescence; abundant, soft secondary carbonate accumulations in pores; abundant, fine dark yellowish brown (10YR4/6) and common, medium grayish brown (10YR5/2) mottles; abrupt boundary
825-884	6C1	Light olive brown (2.5Y5/4) and reddish brown (5YR4/3) stratified silt loam; beds are approximately 4 cm thick and disrupted by rooting; massive structure; friable consistence; noneffervescent; few, fine, soft secondary carbonate acumulations in light olive brown beds; abundant, medium to fine dark yellowish brown (10YR4/4) mottles in light olive brown beds; common, fine manganese accumulations; abrupt boundary

884-897	6C2	Light olive brown (2.5Y5/4) and reddish brown (5YR4/3) stratified sandy loam; massive structure; friable consistence; noneffervescent; mottles and accumulations as above; abrupt boundary
		MISSISSIPPI RIVER ABANDONED CHANNEL FILL AND SUPERIOR-SOURCE FLOOD DEPOSITS
897-942	7C1	Brown (7.5YR5/4) stratified silt loam with thin reddish brown (5YR5/3) silty clay beds; massive structure; friable consistence; noneffervescent; abundant strong brown and brown (7.5YR4/6 and 5/2) streaks; common, medium, soft manganese acumulations; clear boundary
942-967	7C2	As above but with moderate to strong effervescence, and few, medium, soft manganese accumulations; abrupt boundary
967-1008	7C3	Brown (7.5YR4/2) laminated silt loam with common 1-2 cm thick reddish brown (5YR4/3) silty clay laminae; massive structure; friable consistence; strong effervescence; clear boundary
1008-1018	7C4	Brown (7.5YR4/2), very dark gray and gray (5YR3/1 and 5/1) laminated silt loam with dark reddish brown (5YR3/3) silty clay bed at top; massive structure; friable consistence; violent effervescence; abrupt boundary
1018-1054	7C5	Stratified dark reddish brown (5YR3/3) silty clay with dark grayish brown and light gray (10YR4/2 and 6/1) silt loam laminae; six reddish brown silty clay beds in this horizon; silty clay beds break into strong, fine, subangular blocky to granular aggregates (clasts?); sticky and plastic consistence; violent effervescence; abrupt boundary; radiocarbon date on wood from within reddish brown silty clay bed 1026 cm below land surface 9490$\pm$140 B.P. (Beta-40091)
1054-1074	7C6	Dark reddish brown and dark reddish gray (5YR3/3 and 4/2) silty clay loam; massive structure; friable consistence; violent effervescence; bioturbated; abrupt boundary
1074-1085	7C7	Very dark gray (10YR3/1) silt loam with few dark reddish brown (5YR3/3) silty clay laminae and very few thin beds of medium to fine sand with small clay balls; massive structure; friable consistence; violent efervescence; abundant carbonized plant remains along bedding planes; clear boundary
1085-1179	7C8	Two upward-fining sequences consisting of a dark gray (5Y4/1), 20 cm thick medium to coarse sand grading upward to laminated dark greenish gray and greenish gray (5GY4/1 and 5/1) silt loam; single grain and massive structure; loose and friable consistence; violent effervescence; 2 cm thick dark reddish brown (5YR3/3) silty clay bed at 1128 cm within laminated silts; few disseminated organics in laminated silts; abrupt boundary
1179-base (1206)	7C9	Grayish green (5G4/2) silt loam; massive structure; friable consistence; noneffervescent

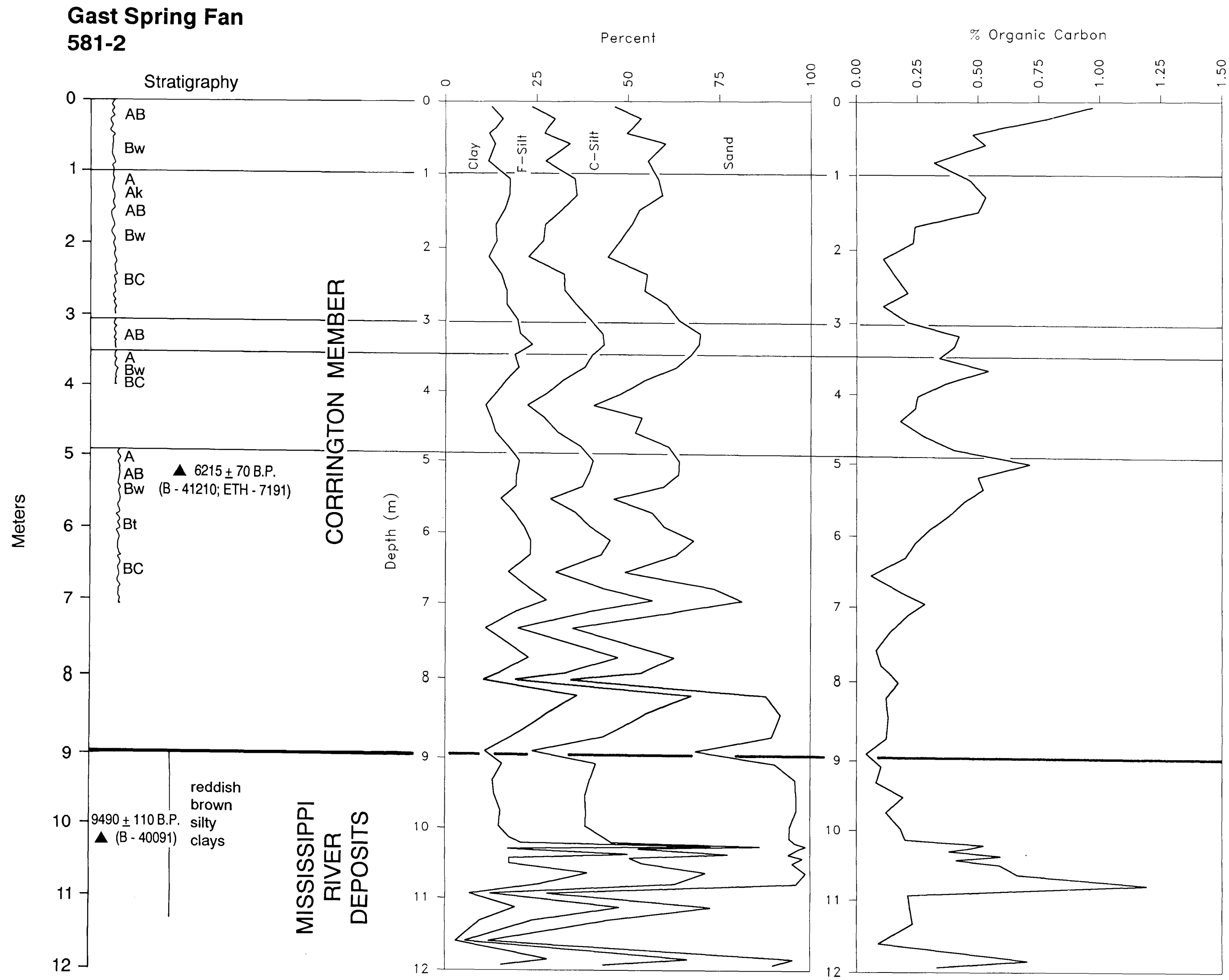


Figure 19. Laboratory data and soil stratigraphy from core 581-2, Gast Spring alluvial fan.

Figure 20. Description of core 581-4 from the distal portion of the Gast Spring alluvial fan.

581-4 -- Gast Spring Fan, Iowa; NW1/4, SE1/4, SW1/4, Sec. 13, T.75N., R.3W.; core from distal part of alluvial fan on western side of Mississippi Valley; elevation 550 ft (167.7 m); 2-5 percent slope; drilled in corn field on 11-28-90 by E. A. Bettis and J.P. Littke; described by E.A. Bettis; Radiocarbon dates on plant remains from Proto-Muscatine slough beneath fan collected 237 to 242 cm below land surface 4840 ± 50 B.P. (Beta - 44380), 291 to 296 cm below land surface 7660 ± 130 B.P. (Beta 41520), and 335 to 340 cm below land surface 8080 ± 80 B.P. (Beta - 41211).

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CORRINGTON MEMBER
	0-31	Ap	Very dark grayish brown to dark brown (10YR3/2-3/3) loam; cloddy structure; friable consistence; noneffervescent; abundant roots and pores; abrupt boundary
	31-70	Bw1	Very dark grayish brown (10YR3/2) loam; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; common, medium and fine dark yellowish brown (10YR4/6) mottles; very few thin discontinuous very dark grayish brown (10YR3/2) cutans; clear boundary
	70-104	Bw2	Dark grayish brown to brown (10YR4/2-4/3) loam; weak, medium to coarse columnar structure; friable consistence; noneffervescent; common, medium and fine dark yellowish brown (10YR4/6) and few, fine brown (7.5YR4/4) mottles; gradual boundary
	104-118	BC	Dark grayish brown and grayish brown (10YR4/2-5/2) loam; weak, medium to fine subangular blocky structure; friable consistence; noneffervescent; mottles as above; abundant krotovina; clear boundary; this is a mixing zone between overlying and underlying horizons.
	118-130	2Ab	Very dark grayish brown to dark grayish brown (10YR3/2-4/2) loam; weak, medium subangular blocky structure; friable consistence; weak effervescence; few, fine, dark yellowish brown (10YR4/6) mottles; common insect burrows filled with grayish brown (10YR5/2) loam; common shells of terrestrial gastropods; clear boundary
	130-144	2Bw1b	Dark grayish brown (10YR4/2), loam with common, coarse very dark grayish brown (10YR3/2) patches; weak to moderate, medium, columnar structure; friable consistence; noneffervescent matrix; common, fine secondary carbonate accumulations; mottles as above, gradual boundary
	144-158	2Bw2b	Dark grayish brown (10YR4/2), loam with very dark grayish brown (10YR3/2) patches; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; mottles as above; common krotovina; clear boundary
	158-195	2C	Light brownish gray to pale brown (10YR6/2-6/3), thinly bedded loam and very fine sand; massive structure; friable consistence; weak effervescence; few, medium, yellowish brown (10YR5/6) mottles;

		common, fine secondary carbonate accumulations; upper third of horizon is burrowed, lower two-thirds is not; abrupt boundary
195-207	3C1	Gray (10YR5/1), thinly bedded clay loam; weak, coarse, columnar structure with slickensides; friable consistence; noneffervescent; gradual boundary
207-230	3C2	Black (10YR2/1), thinly bedded, organic rich clay loam with few, thin, pale brown (10YR6/3) laminae; massive structure; slightly sticky, plastic consistence; noneffervescent; abundant, fine pale brown (10YR6/3) rip-up clasts in upper 7 cm; abrupt boundary
230-237	3C3	Pale brown to very pale brown (10YR6/3-7/3), silt loam; massive structure; friable consistence; noneffervescent; common burrows filled with black (10YR2/1) clay loam; abrupt boundary
		PROTO-MUSCATINE SLOUGH
237-250	4Ab	Black (10YR2/1), organic rich clay loam with few, fine sand laminae and rare plant remains; weak, fine, subangular blocky to massive structure; friable to firm consistence; noneffervescent; few root traces; abundant, fine gastropod shells; radiocarbon date on plant remains 4840 ± 50 B.P. (Beta 44380); gradual boundary
250-270	4ACb	Black (10YR2/1) organic rich silt loam with few fine sand laminae; weak, fine, subangular blocky to massive structure; friable consistence; noneffervescent; few, fine, brown (7.5YR4/4) mottles; more pores than above; clear boundary
270-291	4Oab	Black to very dark grayish brown (10YR2/1-3/2), silt loam muck; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; abundant, medium gray (10YR5/1) mottles; few visible sedge fragments; abrupt boundary
291-302	5Oab	Very dark brown (10YR2/2), sapric peat; massive structure; nonsticky consistence; noneffervescent; radiocarbon date on plant remains 7660 ± 130 B.P. (Beta 41520); abrupt boundary
302-320	5Oi1b	Very dark grayish brown to dark brown (10YR3/2-3/3), fibric peat; sedges dominant; massive, breaks to thin plates; noneffervescent; abrupt boundary
320-330	5Oi2b	As above with medium sand laminae at 322, 328, and 330 cm
330-340	5Oi3b	Dark yellowish brown (10YR3/4), fibric peat; sedges dominant; massive, breaks to thick plates, noneffervescent; radiocarbon date on sedge fragments 8080 ± 80 B.P. (Beta - 41519); abrupt boundary
340-343	5C	Dark gray (5Y4/1), silt loam; massive structure; slightly sticky, nonplastic consistence; noneffervescent; abrupt boundary

343-355	5Oi´	Dark yellowish brown (10YR3/4), fibric peat; sedges dominant; massive, breaks to thick plates; noneffervescent; clear boundary
355-364	5Oa´	Black (10YR2/1), sapric peat; massive structure; nonsticky, nonplastic consistence; noneffervescent; abrupt boundary
		MISSISSIPPI RIVER PALEOCHANNEL DEPOSITS
364-393	6ACb	Black (10YR2/1), pebbly loam to sandy loam; weak, medium to fine, granular structure; friable consistence; violent effervescence; clear boundary
393-396	6C	Dark gray (10YR4/1), pebbly medium to fine sand; single grain structure; loose consistence; strong effervescence; abrupt boundary
396-456	6AC´	Black to very dark gray (10YR2/1-3/1), loam; massive structure; friable consistence; violent effervescence; abundant shells of aquatic snails; clear boundary
456-base (610)	6C	Dark gray (N4/), sandy loam; massive structure; nonsticky, nonplastic consistence; violent effervescent; occasional organics

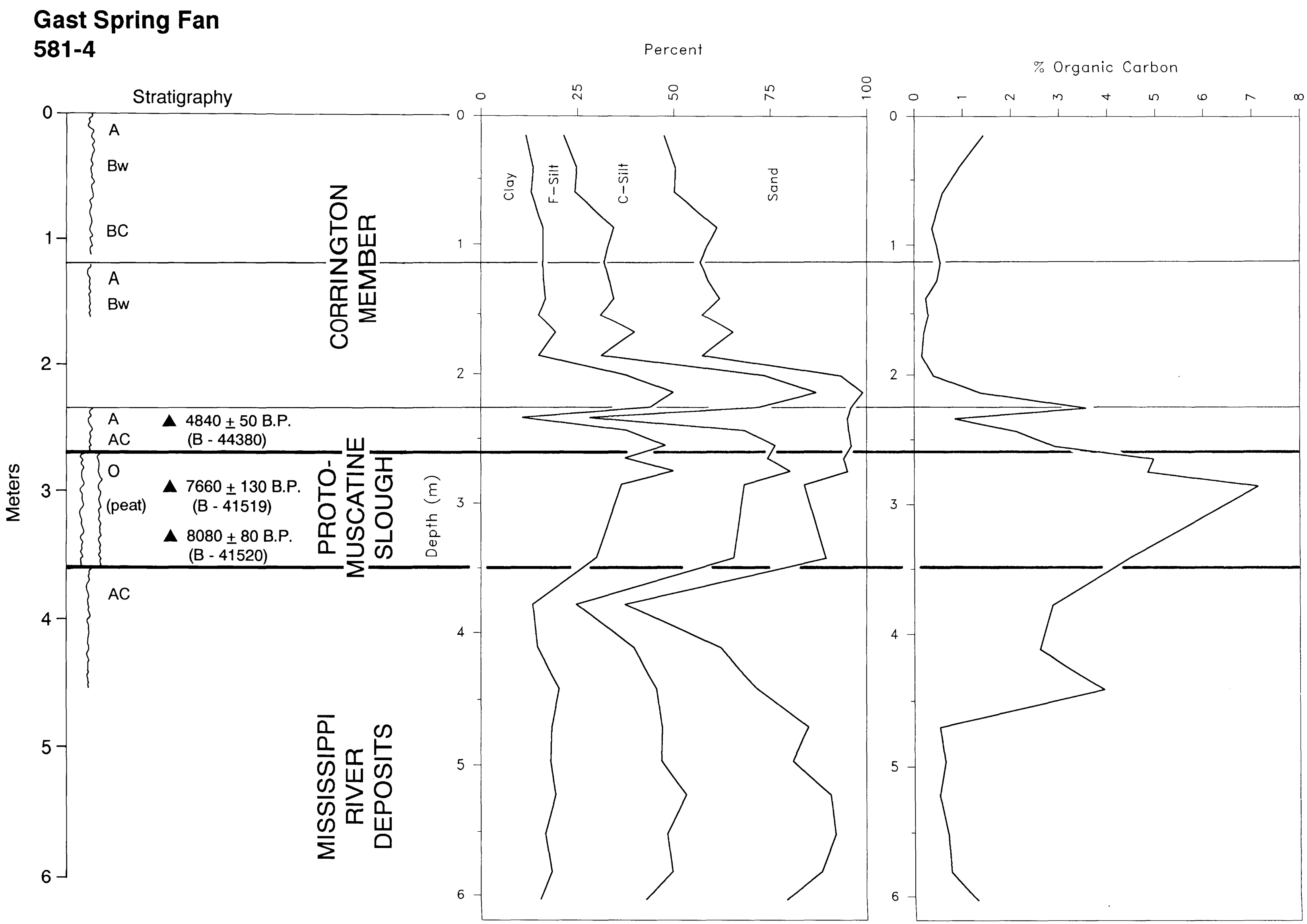


Figure 21. Laboratory data and soil stratigraphy from core 581-4, Gast Spring alluvial fan.

Stop 5b.
Gast Farm Fan

Geology

Figure 22 shows a cross-section along the axis of Gast Farm fan. The stratigraphy of this larger fan is similar to that of the Gast Spring fan. Gast Farm fan contains more sandy and pebbly sand feeder channel deposits than Gast Spring fan, and erosional unconformities are more common in the larger fan (Fig. 23). Although this fan has not been dated in great detail the basal ages and archaeological associations indicate that its chronology is very similar to that of the Gast Spring fan.

Archaeology

The Gast Farm archaeological site (13LA12) occupies the southern half of the Gast Farm fan. Controlled surface collections, deep coring, hand excavations, and aerial photography were conducted in 1990 and 1991 to define the site's near-surface and subsurface character. The western portion of the site contains a donut-shaped "ring midden" community of the early Late Woodland period Weaver culture, ca. 1600-1400 B.P., at and near the modern surface. Cultural features of this midden extend to a depth of about 1 meter. Plant and animal remains are well preserved and provide comprehensive records of prehistoric subsistence economy and paleoecological conditions. Site inhabitants exploited upland forests for nuts, and cultivated native seed crops including goosefoot (*Chenopodium* cf. *berlandieri*), knotweed (*Polygonum erectum*), and little barley (*Hordeum pusillum*). Fish are the most abundant vertebrates represented in the large faunal sample recovered during the 1991 excavations. Species are primarily Ictalurids (catfish, bullhead) and assorted suckers, with lesser amounts of bowfin (*Amia calva*), freshwater drum (*Aplodinotus grunniens*), and gar (*Lepisosteus* sp.). A wide variety of sizes are present, suggesting non-selective harvesting from slow backwater environments. The mammalian assemblage is dominated by deer (*Odocoileus virginianus*) with much lesser amounts of elk (*Cervus canadensis*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), raccoon (*Procyon lotor*), and dog (*Canis familiarus*). Turtles were commonly harvested (including painted *Chrysemys picta*; snapper *Chelydra serpentina*; and softshell *Trionyx* sp.). The majority of the turtle fragments are carapace and plastron elements, and a relatively high proportion have polish and striations consistent with use as bowls or rattles. Curiously, the bird sample is extremely small. This is not a preservation bias (which was quite good, given the amount and condition of the fish sample) but perhaps indicates seasonal site abandonment or scheduling conflicts during periods of waterfowl migration. In general the faunal assemblage indicates local exploitation of wetland, forest and prairie habitats.

The site's central portion contained a Hopewell burial mound (ca. 2100-1700 B.P.), now leveled but visible as a lighter colored, pebbly and clayey area in the field. Surface artifacts from the central part of the site are principally Early Woodland Liverpool (pre-Hopewell) ceramics, ca. 2300-2100 B.P., indicating either that the location chosen for the mound had previously served as an Early Woodland settlement, or that the fill which comprised the mound was borrowed from an Early Woodland occupation area elsewhere on the fan or nearby.

The eastern part of the Gast Farm site, located on distal parts of the fan, is dominated by Hopewell-related Middle Woodland domestic debris (ca. 2100-1700 B.P.), although Early Woodland artifacts dating to ca. 2300 or even 2500 B.P. also are present in some quantities. Excavations in 1991 revealed abundant evidence of interaction within the Hopewell network.

Deep coring at Gast Farm has shown that pre-Woodland archaeological remains are likely to occur throughout the fan. However, the density of near-surface Woodland material makes it logistically very difficult to excavate large samples of the earlier components. Consequently, even though archaeological work continues on the Woodland communities at Gast Farm, efforts to study the Archaic focus on Gast Spring.

Paleobotanic record

Although paleoecological work in the Muscatine Slough area is in an early stage, a pattern is beginning to emerge. Pollen records from nearby Klum Lake (see location on Fig. 16; Nations et al., 1989), from beneath the Gast Farm fan, from the Cattail Channel north of the Quad-Cities (Kim, 1982), and from the Savanna site at Savanna Illinois (Nations and Bettis, unpublished data), show the major changes in Holocene vegetation in the area. The interval from 225 to 600 cm in core 581-4 from the distal part of the Gast Spring fan contains a fairly complete record of early to middle Holocene paleoenvironments (Figs. 20 and 24). The sediments were deposited in an abandoned Mississippi River channel that harbored first a pond, and then a fen or

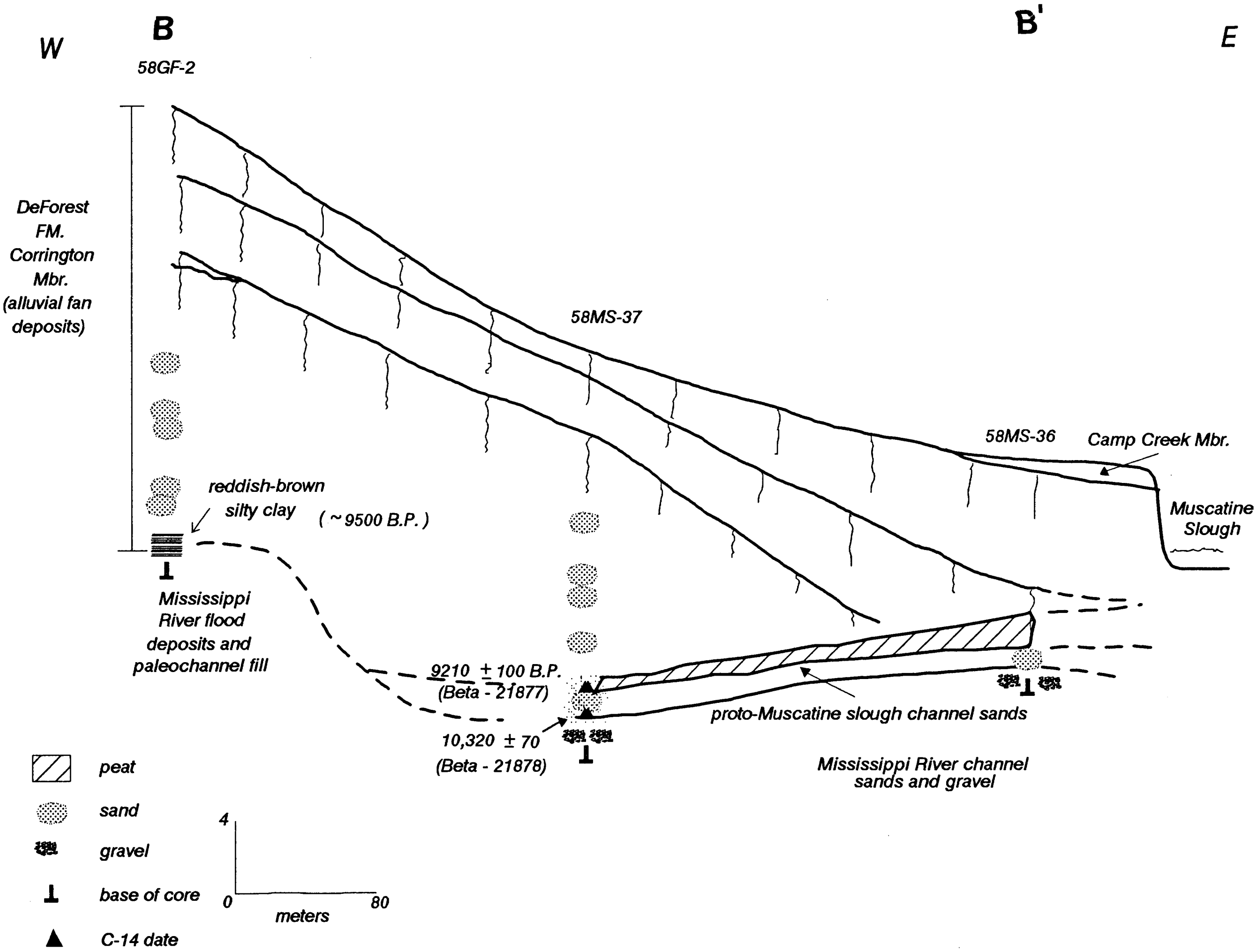


Figure 22. Cross-section of the Gast Farm alluvial fan (stop 5b) showing core locations and radiocarbon dates.

marsh prior to being buried by fan sediments about 4800 B.P. (Fig. 17).

The oldest samples date from 10,000 to 11,000 B.P. (by correlation with other sites) and most of these contain significant percentages of spruce (*Picea*), larch (*Larix*) and fir (*Abies*) pollen (Fig. 24). Spruce and larch had disappeared from upland sites in the area by 10,000 B.P., and their sporadic occurrence in the Mississippi Valley wetlands suggests that they remained as relicts for a time in these cool microhabitats. Upland forests were apparently a mix of conifers, especially fir, with deciduous trees. The relatively high percentages of chenopod pollen at Gast Spring are not duplicated at other sites in the area, and they must represent locally disturbed open areas, perhaps in the recently abandoned channel belt.

The overlying zone is dominated by oak (*Quercus*) and elm (*Ulmus*) pollen, along with low percentages of other deciduous forest trees. This early Holocene oak-elm zone is widely recognized throughout the Midwest, and it represents a relatively mesic deciduous forest. At Gast Spring and Klum Lake it lasted from about 10,000 to at least 7500 B.P. Butternut (*Juglans cinerea*) was locally abundant during the early phases of this interval, and hickory (*Carya*) became a co-dominant sometime before 8000 B.P. (Fig. 24; Bettis et al., 1990).

Tree pollen decreased markedly sometime after 7600 B.P. at the Gast Spring site (and after 7300 B.P. at Klum Lake), and nonarboreal pollen (NAP) became dominant. Grass (Gramineae) and chenopods or goosefoot (Chenopodiineae) were the dominant taxa, with ragweed (*Ambrosia*) and composite or sunflower family (Compositae) also significantly present. This com-

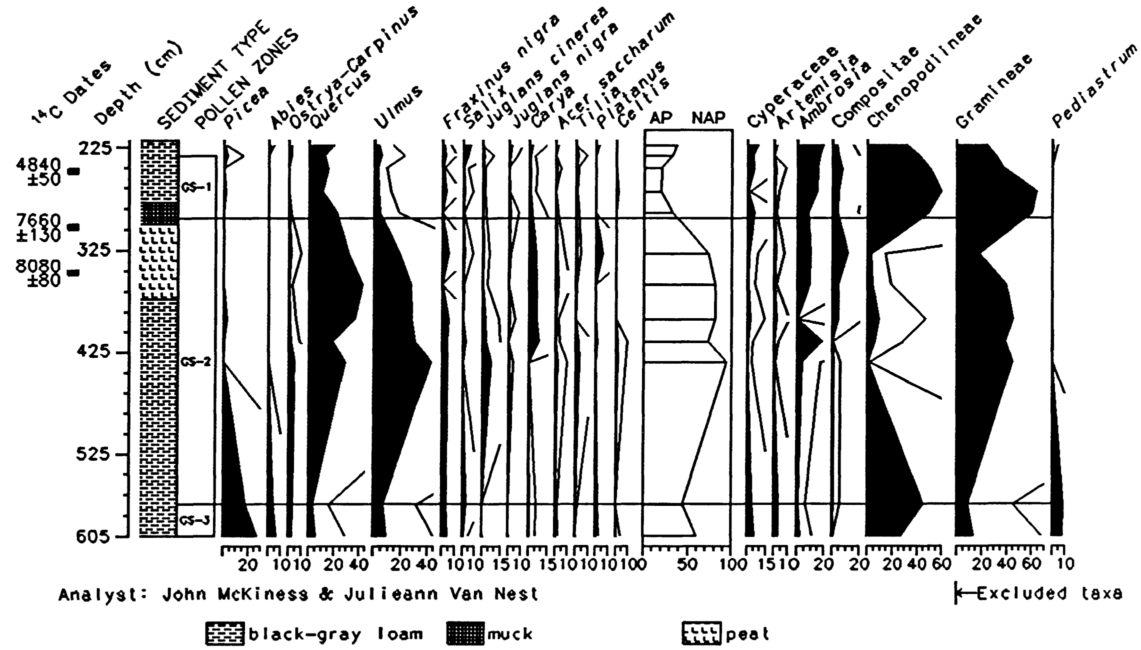
Figure 23. Description of core 58GF-2 from the upper mid-fan of the Gast Farm alluvial fan.

58GF-2 -- Gast Farm fan, Iowa; NE 1/4 SE 1/4 NW 1/4 Sec. 24 T75N R3W; core drilled on proximal part of alluvial fan 3 meters east of drive and east of southern side of farm house; elevation 572 ft (174.3 m); drilled and described by E. A. Bettis on 5-15-91.

LITHO-FACIES	DEPTH (cm)	SOIL HORIZON	DESCRIPTION
			DEFOREST FORMATION
			CORRINGTON MEMBER
	0-30	Ap	Very dark gray to very dark grayish brown (10YR3/1-3/2) loam; cloddy structure; friable consistence; noneffervescent; abrupt boundary
	30-91	A	Very dark gray to very dark grayish brown (10YR3/1-3/2) loam; weak, medium, graunlar structure; friable consistence; noneffervescent; common charcoal and burned earth; this horizon is a Woodland midden; gradual boundary
	91-132	Bt1	Dark brown (10YR3/3) loam; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; common, thin, almost continuous very dark grayish brown (10YR3/2) cutans; common charcoal, burned earth, and fine pebbles; gradual boundary
	132-150	Bt2	Dark yellowish brown to yellowish brown (10YR4/4-5/4) loam; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; common, thin, continuous dark brown (10YR3/3) cutans; few, fine charcoal flecks; clear boundary
	150-158	BC	Yellowish brown (10YR5/4) pebbly sandy loam; weak, medium subangular blocky structure; very friable consistence; noneffervescent; abrupt boundary
	158-201	Bt3	Dark yellowish brown to yellowish brown (10YR4/4-5/4) loam with few, fine pebbles; moderate, medium to coarse, subangular blocky structure; friable consistence; noneffervescent; few, fine manganese accumulations; common, thick, continuous dark brown (10YR3/3) cutans; clear boundary; Woodland pottery sherd at 198 cm
	201-221	2Ab	Very dark grayish brown (10YR3/2) heavy loam; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; common, thin, continuous very dark gray (10YR3/1) cutans; common charcoal and burned earth; gradual boundary
	221-249	2ABtb	Very dark grayish brown to dark brown (10Yr3/2-3/3) clay loam; moderate, medium to coarse, columnar breaking to moderate, medium, subangular blocky structure; friable consistence; noneffervescent; common, thin, almost continuous very dark grayish brown (10YR3/2) cutans; few flecks of charcoal and burned earth in upper half of horizon; clear boundary

249-284	2Bt1b	Yellowish brown (10YR5/4) loam with abundant fine pebbles; weak, medium to coarse, subangular blocky structure; friable consistence; noneffervescent; few, fine manganese accumulations; common, thin, discontinuous brown (10YR4/3) cutans; clear boundary
284-317	2Bt2b	Brown (10YR4/3-5/3) clay loam with few, fine pebbles; moderate, coarse, subangular blocky structure; friable consistence; noneffervescent; few, fine manganese accumulations; common, thin, almost continuous dark brown (10YR3/3) cutans; gradual boundary
317-381	2BCb	Yellowish brown (10YR5/4) loam; weak to moderate, medium, subangular blocky structure; friable consistence; noneffervescent; few, fine manganese accumulations; very few, thin, discontinuous brown (10YR4/3) cutans; few charcoal flecks; gradual boundary
381-434	2CBb	Yellowish brown (10YR5/4) loam; very weak, medium, subangular blocky structure; friable consistence; noneffervescent; few, fine yellowish brown (10YR5/6) mottles; few, fine manganese accumulations; very few, thin,discontinuous brown (10YR4/3) cutans; gradual boundary
434-465	2C	Yellowish brown (10YR5/4) sandy loam; weak, medium, subangular blocky structure; friable consistence; noneffervescent; very few, fine yellowish brown (10YR5/4) mottles; few, fine manganese accumulations; clear boundary
465-533	3Btb	Yellowish brown (10YR5/4) silt loam; moderate, medium, subangular blocky structure; friable consistence; noneffervescent; common, thin, discontinuous dark yellowish brown (10YR4/4) cutans, thick and continuous in macropores; gradual boundary
533-632	3BCb	Yellowish brown (10YR5/4) silt loam; moderate, medium to coarse, subangular blocky structure; friable consistence; noneffervescent; few, fine manganese accumulations; very few, thin, discontinuous dark yellowish brown (10YR4/4) cutans, thick and continuous in macropores; clear boundary
632-670	3C1	Yellowish brown (10YR5/4) loam; very weak, medium, subangular blocky structure; friable consistence; strong to violent effervescence; common, medium to fine dark yellowish brown (10YR4/4) mottles; common, medium manganese accumulations; abrupt boundary
670-1270	3C2	Yellowish brown (10YR5/4) and grayish brown (2.5Y5/2) stratified medium to coarse sand, loam, silt loam, and medium to coarse pebbles; massive and single grain structure; slightly sticky, nonplastic, and loose consistence; strong to violent effervescence; abundant, medium brown (7.5YR4/4) mottles in silts and loams; abrupt boundary
1270-base 1280)	4C	Reddish brown (2.5YR4/4) thinly bedded silty clay; massive structure; firm consistence; strong effervescence; hole collapsed

Gast Spring Fan
Louisa Co. Iowa
Pollen Percentage Diagram



North Klum Lake
Louisa Co. Iowa
Pollen Percentage Diagram

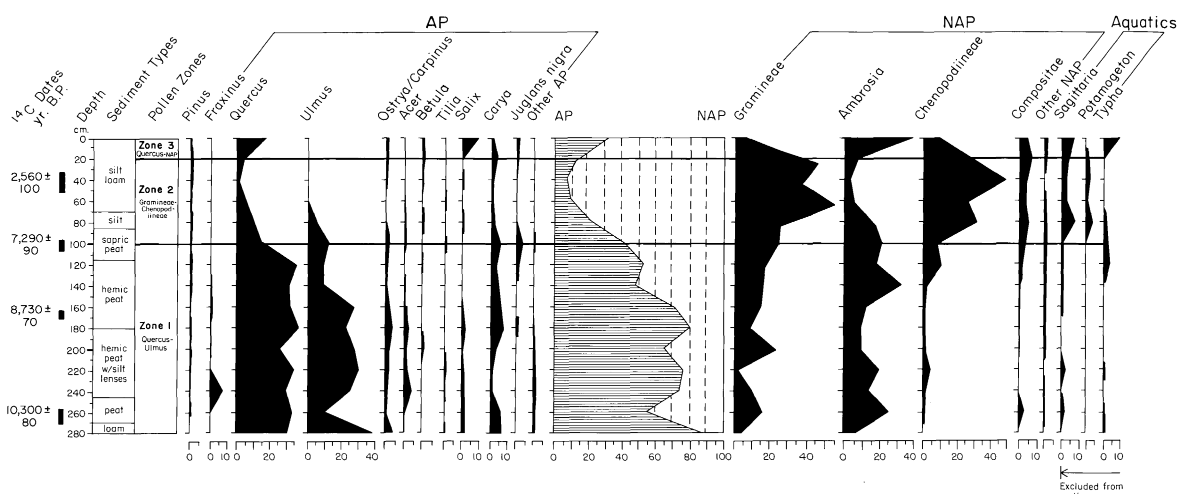


Figure 24. Pollen diagrams of wetland beneath Gast Spring fan (core 581-4) and Klum Lake.

bination suggests that prairie replaced the forest along the western side of the valley. This conclusion seems a bit surprising in a major river valley, where water would be available during all seasons. On the Great Plains, major river valleys presently support forests even though uplands are covered by prairie vegetation. However, these valleys lost most of their trees in the drought of the 1930's. Perhaps the width of the Mississippi Valley in combination with the presence of large sandy terrace tracts aided the spread of prairie in this area.

The timing of this apparent prairie incursion is uncertain. Over 3000 years is represented by less than a meter of sediment (325-225 cm in figure 24). Sedimentation rates either decreased markedly after 7600 B.P., or a hiatus may be present in the section. The muck at the top of the peat at Gast Spring is suggestive of an interruption of organic deposition, and in other sites muck often represents a gap in the record. If this is true at Gast Spring, it is uncertain what interval between 7660 and 4840 B.P. is missing. A similar hiatus may be present at Klum Lake between 7290 and 2560 B.P. (Fig. 24). Thus the prairie expansion cannot be dated precisely at these two sites. The timing is important to answer two questions in this area: 1) Does the late expansion of the Prairie Peninsula seen at Mud Creek also affect the Mississippi Valley? 2) Given that prehistoric people relied on the local environment for subsistence, how did the shift from deciduous forest to prairie affect the resource base of the valley, and what effect did these changes have on the people using the valley. Further coring in the area is planned to address these problems.

Macrofossils preserved in the organic-rich wetland sediments provide a detailed picture of plants locally present. At Klum Lake Nations and Baker (1988) found that potential food resources such as goosefoot, wild rice, nettle, and cattail were present in the wetland during the Holocene. In another wetland on the Illinois side of the river Bettis and others (1990) found a pecan nut that yielded a radiocarbon age of 7280 B.P., indicating that pecan groves were present by that time. Ongoing studies in the Muscatine Slough area are also examining the plant macrofossil record in order to provide a more accurate picture of the local resource base.

In addition to providing information on the resource base in individual wetlands, macrofossil studies can also give us insights into the vegetational evolution of these riverine wetlands. By investigating several wetlands with different ages it may be possible to formulate a picture of areal variations in the resource base through the Holocene. This, in turn, may shed light on some aspects of archaeological site distributions in the valley.

Summary
Stops 4 and 5.

The late Wisconsinan and Holocene history of the Mississippi valley in eastern Iowa and adjacent Illinois is complex. By about 11,000 years ago the river had incised to approximately its modern level and remnants of two late glacial floodplains remained as sandy terraces in the valley. The older of these (the Savanna Terrace) was temporally related to fine-grained sediments comprising a high terrace (also the Savanna Terrace) found in the lower reaches of tributary valleys.

Shortly after 11,000 years ago the channel pattern of the Mississippi River south of Muscatine shifted to an island-braided pattern that persisted to the Historic period. Between about 10,000 and 7000 years ago avulsions left a series of abandoned meanderbelts that now occupy a large percentage of the valley floor. The wide array of edaphic conditions produced by this dynamic fluvial system fostered a rich and varied biotic environment that was very attractive to prehistoric hunter-gatherers. Valley margins were especially attractive because they afforded well-drained alluvial fan and colluvial slope locations with ready access to both riverine wetlands and tributary valley mesic deciduous forests. Episodic aggradation and progradation of the fans and colluvial slopes during the early and middle Holocene preserved a record of Archaic period adaptations to the changing Holocene environment.

With a return to more moist conditions during the late Holocene, sedimentation on fans and colluvial slopes decreased considerably. This change in the rate of sediment accumulation, in conjunction with population increases and shifts to more sedentary lifestyles, led to the development of extensive middens and dense artifact scatters on the colluvial slope and fan aprons along the valley margin.

WRAP UP

On this trip we have taken a brief glimpse at the Holocene alluvial stratigraphic record of eastern Iowa and some of its paleoecological and archaeological associations. When analyzed in an interdisciplinary fashion these records provide a detailed picture of the evolving Holocene environment and human adaptations. This kind of analysis is in its infancy in eastern Iowa. The information summarized in the preceding pages and in the appendix that follows indicates that a great potential for addressing a wide array of ecological, geological, and anthropological questions exists in eastern Iowa. We are on the verge of a new, more detailed view of the past made available by stepping across traditional discipline boundaries toward a holistic view of the past.

ACKNOWLEDGMENTS

Studies in eastern Iowa would not have been possible without the cooperation of landowners in the Mud and Crow Creek basins. We are especially appreciative of Dan Gast's cooperation and patience with our studies on his farm. Whitney Autin, Louisiana Geological Survey, conducted a large part of the Mud Creek basin investigation. His discussions and perspectives are greatly appreciated. We thank Sandy Rhodes, University of Iowa, for his enlightening discussions of the Mud Creek area, and Lon Drake, University of Iowa, for bringing the area to our attention. Patricia Witinok, University of Iowa, has maintained a keen interest in the biotic record of Mud Creek and conducted some of the initial macrofossil studies of the area. John Littke, USDA-Soil Conservation Service, drilled many of the holes in the Mud Creek and Gast Farm areas and helped ponder the meaning of the revealed sequences. Tim Kemmis, IDNR, Geological Survey Bureau, helped with some of the coring and was a sounding board during the evolution of our ideas about the DeForest Formation. Brenda Nations, IDNR-Geological Survey Bureau, conducted the pollen studies at Klum Lake and the Savanna site. Nurit Goldman-Finn, University of Michigan, and Blane Nansel, University of Wisconsin-Madison, supervised the archaeological investigations at Gast Spring and Gast Farm fans. Parts of this research were supported by NSF grant ATM-88-06482 to Baker, Chumbley, and Bettis; Iowa Science Foundation grant ISF-90-24 to Whelan; U.S. Army-Corps of Engineers contract DACW25-87-C-0017 to the Center for Archaeological Research, Southwest Missouri State University, Springfield; and Louisiana State University Board of Regents LaSER Program grant NSF/LaSER(1990)RFAP-01 to W. Autin.

REFERENCES

Abbott, L., and McKay J.,. 1978, A Cultural Inventory for the Crow Creek Expanded Flood Plain Information Study, Scott County, Iowa: Contract Completion Report 140, Office of the State Archaeologist, Iowa City.

Anderson, R.C., 1968. Drainage evolution in the Rock Island area, western Illinois and eastern Iowa, ***in***: The Quaternary of Illinois, University of Illinois, Urbana, College of Agriculture, Special Publication 14 , p. 11-18.

Anderson, R.C., Tyler, R.D., and Hammer, W.R., 1982, The Mississippi River Arch Quad-Cities Region, 46th Annual Tri-State Geological Field Conference Guidebook, Augustana College, Rock Island, Illinois.

Autin, W.J., and Bettis, E.A., III, 1991, Quaternary Geology of Mud Creek, Eastern Iowa: Report Submitted to the Louisiana State Univ. Board of Regents, LaSER Program, Baton Rouge.

Autin, W.J., and Bettis, E.A., III, 1992, Post-Illinoian alluvial stratigraphy of Mud Creek, eastern Iowa: Geological Society of America, North-central section meeting. Abstracts with Program v.24 (abstract #23503).

Baker, R.G., Chumbley, C.A., Witinok, P.M., and Kim, H.K.. 1990, Holocene vegetational changes in eastern Iowa: The Journal of the Iowa Academy of Science, v. 97, no. 4, p. 167-177.

Baker, R.G., Maher, L.J., Chumbley, C.A., and Van Zant., K.A., 1992, Patterns of Holocene environmental change in the Midwest: Quaternary Research.

Benn, D.W., Bettis, E.A., III, and Vogel, R.C., 1988, Archaeology and Geomorphology in Pools 17-18, Upper Mississippi River: Center for Archaeological Research Report no. 714. Southwest Missouri State University, Springfield.

Bettis, E.A,. III (editor), 1990, Holocene alluvial stratigraphy and selected aspects of the Quaternary history of western Iowa: Midwest Friends of the Pleistocene 37th Field Conference Guidebook.

Bettis, E.A., III, and Thompson, D.M., 1981, Holocene landscape evolution in western Iowa - concepts, methods, and implications for archaeology: *in* Selected Papers from the Mankato Conference, Anfinson, S.F., (ed.) Occasional Publications in Minnesota Anthropology, 9, Minnesota Archaeological Society, St. Paul, p. 1-14.

Bettis, E.A., III, Baker, R.G., Nations, B.K., and Benn, D.W., 1990, Early Holocene Pecan, *Carya illinoensis,* in the Mississippi River valley near Muscatine, Iowa: Quaternary Research, v. 33, p. 102-107.

Bettis, E.A., III, and Benn, D.W., 1988, Landscapes and man in pools in 17-18 Upper Mississippi River: Illinois Archaeological Survey Newsletter, v. 3, no. 2, p. 3-9.

Bettis, E.A., III, and Hajic, E.R, 1990, STOP 5 — Savanna Terrace exposure north of Sabula, Iowa: *in* Geology Field Guidebook, Hammer, W., and Hess, D.F. (eds.), 24th Annual Meeting of the North-Central Section, Geological Society of America, Macomb, p. F-19 - F-25.

Bettis, E.A., III, and Hallberg, G.R., 1985, The Savanna (Zwingle) Terrace and "red clays" in the Upper Mississippi River valley: Stratigraphy and chronology: *in* Pleistocene Geology and Evolution of the Upper Mississippi Valley: A Working Conference, Programs, Abstracts, Field Guide, Winona State University, Winona, p. 41-43.

Bettis., E.A., III, and Hoyer, B.E., 1986, Late Wisconsinan and Holocene Landscape Evolution and Alluvial Stratigraphy in the Saylorville Lake Area, Central Des Moines River Valley, Iowa: Iowa Geological Survey, Open File Report 86-1.

Bettis. E.A., III, and Littke, J.P., 1987, Holocene alluvial stratigraphy and landscape development in Soap Creek Watershed, Appanoose, Davis, Monroe, and Wapello Counties, Iowa: Iowa DNR-Geological Survey Bureau, Open File Report 87-2.

Chumbley, C.A, Baker, R.G., and Bettis, E.A., III, 1990, Midwestern Holocene paleoenvironments revealed by floodplain deposits in northeastern Iowa: Science, v. 249 p. 272-274.

Daniels, R.B., Rubin, M., and Simonson, G.H., 1963, Alluvial chronology of the Thompson Creek watershed, Harrison County, Iowa: American Journal of Science, v. 261, p. 473-848.

Edmund, R.W., and Anderson, R.C., 1967, The Mississippi River Arch: 31st. Annual Tri-State Geological Conference Guidebook, Augustana College, Rock Island.

Flock, M.A., 1983, The late Wisconsinan Savanna Terrace in tributaries to the Upper Mississippi River: Quaternary Research, v. 20, p. 165-167.

Hajic, E.R., 1990a, Late Pleistocene and Holocene landscape evolution, depositional subsystems, and stratigraphy in the Lower Illinois River valley and adjacent central Mississippi River valley: unpublished Ph.D. dissertation, University of Illinois at Urbana-Champaign, Urbana.

Hajic, E.R., 1990b, Koster Site Archaeology I: Stratigraphy and Landscape Evolution: Kampsville Archaeological Center, Center For American Archaeology, Research Series, v. 8.

Hajic, E.R., Johnson, W.H., and Follmer, L.R., 1991, Quaternary deposits and landforms, confluence region of the Mississippi, Missouri, and Illinois rivers, Missouri and Illinois: Terraces and terrace problems, Midwest Friends of the Pleistocene, 38th Field Conference Guidebook.

Harrison, C.E., 1886, Report of Mound Exploration near Pine Creek, Muscatine County, Iowa: Proceedings of the Davenport Academy of Natural Sciences, v. 4, p. 197-198.

Hodges, D.C., 1989, Pine Creek Mounds: Office of the State Archaeologist, Iowa City, Research Papers, v. 14, no 3, p. 15-56.

Hoyer, B.E., 1980, The Geology of the Cherokee Sewer Site: *in* The Cherokee Excavations: Holocene Ecology and Human Adaptations in Northwestern Iowa, Anderson, D.C., and Semken, H.A., Jr. (eds.), Academic Press, New York, p. 21-26.

Kim, H.K., 1982, Late-glacial and postglacial pollen studies from the Zuehl farm site, north-central Iowa and the Cattail Channel Bog, northwestern Illinois: unpublished M.S. thesis, University of Iowa.

Kramer, T.L, 1972, The paleoecology of the postglacial Mud Creek biota, Cedar and Scott counties, Iowa: unpublished M.S. thesis, University of Iowa.

Leighton, M.M,. and Willman, H.B., 1949, Itinerary of Field Conference, Late Cenozoic Geology of Mississippi Valley, southeastern Iowa to central Louisiana: Urbana.

Lindley, C., 1876, Mound Exploration in 1875: Proceedings of the Davenport Academy of Natural Sciences, v. 1, p. 111-113.

Mandel, R.D., and Bettis, E.A., III, 1992, Recognition of the DeForest Formation in the east-central Plains: Implications for archaeological research, Geological Society of America North-Central section meeting, Abstracts with Program, v. 24 (abstract #15034).

Nations, B.K., and Baker, R.G., 1988, Klum Lake pollen cores. Appendix F: *in* Benn, D.W., Bettis, E.A., III, and Vogel, R.C., 1988, Archaeology and Geomorphology in Pools 17-18, Upper Mississippi River: Center for Archaeological Research Report no. 714. Southwest Missouri State University, Springfield.

Nations, B.K., Baker, R.G., and Bettis, E.A., III, 1989, A Holocene pollen and plant macrofossil record from the Upper Mississippi Valley: Current Research in the Pleistocene, v. 6,p. 58-59.

Prior, J C., 1991, Landforms of Iowa: University of Iowa Press, Iowa City.

Styles, T.R., 1985, Holocene and Late Pleistocene Geology of the Napoleon Hollow Site in the Lower Illinois Valley: Kampsville Archaeology Center, Center for American Archaeology, Research Series, v. 5.

Trowbridge, A.C., 1954, Mississippi River and Gulf Coast terraces and sediments as related to Pleistocene history - a problem: Geological Society of America Bulletin, v. 65, p. 793-812.

VanNest, J., and Bettis, E.A., III., 1990, Postglacial response of a stream in central Iowa to changes in climate and drainage basin factors: Quaternary Research, v. 33, p. 73-85.

Webb, T., III, Cushing, E.J., and Wright, H.E, Jr., 1983, Holocene changes in the vegetation of the Midwest: *in* Late-Quaternary Environments of the United States, vol. 2., The Holocene, Wright, H.E., Jr. (ed.), University of Minnesota Press, Minneapolis, p. 142-165.

Winkler, M.G., Swain, A.M., and Kutzbach, J.E., 1986, Middle Holocene dry period in the northern Midwestern United States: Lake levels and pollen stratigraphy: Quaternary Research, v. 25, p. 235-250.

APPENDIX:

ARCHAEOLOGICAL OVERVIEW OF THE UPPER MISSISSIPPI RIVER VALLEY, ROCK ISLAND DISTRICT

by

David W. Benn
Lansing, Michigan

PREVIOUS INVESTIGATIONS

The period of navigation effects on the Upper Mississippi floodplain began in 1878 when congress authorized the creation of a 4.5ft navigation channel (Great River Environmental Action Team 1980). Landowners in the bottoms and local governments commenced construction of a system of drains and levees to restrict the floodwaters of the Mississippi River. In 1907 the channel depth was authorized at 6 ft. Initially, minimum channel depths were achieved by closing chutes, bank revetment and by constricting the main channel with rock wing dams. A channel 9 ft deep and 300 ft wide was authorized in 1930 to extend from St. Louis to St. Paul, Minnesota by constructing 27 lock and dam structures to pool waters with periodic dredging of the main channel. The overall effects of leveeing the river and pooling its waters include maintenance of an artificially "high" water level, aggradation of the floodplain in the lower half of each pool, and bank erosion at the upper end of pools.

The earliest archaeological investigations were strictly antiquarian in interest and approach (Willey and Sabloff 1974). Local people collected artifacts that tumbled from cutbanks or floated to the surfaces of plowed fields. Artifacts were prolific in the virgin land. Most of these early collections have been lost or dispersed; others are displayed today as fragments without context. Records of the earliest excavations appeared in the publications of antiquarian scientific societies run by the Victorian-age gentry of the nineteenth century. Authors of the articles represented only a few of the many people involved in mostly "weekend" digging. Some of the writers were: Gass (1880, 1881, 1883), Lindley (1876), Lynch et al (1893), McWorter (1875), Starr (1897a,b) and Thompson (1879). The Rev. Gass (1881:140-6; 183-4; 189-190; 191-2) and Frederick Starr (1897b) provided the most informative studies because of their participation in many of the Davenport Academy of Natural Science-sponsored mound excavations. Gass, for instance, reports excavating 75 mounds in the vicinity of Muscatine, most of which were conicals on benches and terraces--not the same mounds preserved today on blufftops.

The nineteenth-century excavators destroyed many earthen mounds in their exuberant quest for the "Mound Builders," a myth about ancient civilized people who had been replaced by American Indians. On the positive side early excavators recorded sites and objects which have vanished or are out of context today. For instance, Starr (1897b:95) provided a description of the excavation and contents of the Toolesboro mounds (13LA29). These Havana-Hopewell mounds yielded log tombs with animal effigy pipes, copper and shell beads, obsidian, conch shell and copper axes and awls. During the latter part of this period W. B. Nickerson, who directed the last Davenport Academy season at Albany, carried out a series of careful excavations in Jo Daviess County, including a mound on the Savanna Army Depot (Bennett 1952; 1945:66-68).

Little published archaeological work was done in the Upper Mississippi Valley during the first two decades of the twentieth century. The surveys and excavations by Cyrus Thomas and Theodore Lewis extended around the area, with only one foray into Jackson County, Iowa, by Lewis (1885:notebook 36, pg. 6). In retrospect this period of waning interest in mound digging promoted the preservation of some mounds today.

The next archaeological field work in the area to appear in the literature is that of the University of Chicago under the general direction of Fay-Cooper Cole between 1926 and 1931. The project was initiated on a small scale when two graduate students began what was apparently to be a thorough survey of Illinois beginning at the northwest corner and sweeping southwest. Though most of the work in the region was in Jo Daviess County, they did work on the Savanna Proving Ground Village site with its puzzling combination of Middle Mississippian and Oneota traits (Bennett 1945; Cole 1945), and conducted limited surveys in other parts of the valley.

The beginning of archaeological scholarship in Iowa dates to the 1920s when Charles R. Keyes was appointed director of the Iowa Archaeological Survey and started publishing a prehistory of cultures in the state (McKusick 1975:44). Keyes' best chronology of Iowa cultures was published in 1927 and included four episodes relevant to the Upper Mississippi Basin: 1) Algonkian culture, 2) Hopewell, 3) Effigy Mound culture, 4) Oneota culture. He hired Ellison Orr, a retired businessman from Waukon, Iowa, to conduct a state-wide survey with some excavation. Orr ranged down the Mississippi Valley from the Upper Iowa River, recording habitation sites and mound groups and excavating in many mounds as far south as the Muscatine area (e.g., Toolesboro, the Malchow mound group (13DM4) and mounds and villages on the north side of Burlington; Keyes manuscripts at the State Historic Society of Iowa, Iowa City; Orr 1935; Tiffany 1981). His field records were compiled in 10 notebooks, with an original copy being housed at Effigy Mounds National Monument (Orr 1935) and published in the Archives of Archaeology (Orr 1963). As surveyors, Keyes and Orr added immeasurable information to Iowa's site records, because they encountered sites that have since been destroyed. As an excavator, Orr does not measure up to the caliber of other contemporaries in the United States (McKusick 1979:17). He was not trained to recognize features and strata and missed many details of mound and habitation site stratigraphy.

There was another hiatus of activity after Charles Keyes finished his work, then the modern era of intensive archaeological activities began in the 1950s. Investigations were sporadic and descriptive at first but built to a crescendo of contract archaeology by the 1980s. The increase in activity corresponded to the advent of the Explanatory period in American Archaeology (ca. 1960-; Willey and Sabloff 1974), to a proliferation of students in anthropology departments of major universities and to the passing of the 1966 National Historic Preservation Act and subsequent regulations, which require Federal agencies to inventory and manage their historic properties. The search for explanations of prehistoric evidence led to the development of scientific field methods (e.g. flotation, systematic sample surveys, micro-analysis of artifact use-wear) and the application of human behavioral models.

Survey and recording of sites coupled with excavations started in 1958 on the Iowa side with a project by R. J. Ruppe' of the University of Iowa. Ruppe' and his students, Adrian Anderson, Dale Henning and James Scholtz, recorded many of the most significant sites in Louisa and Des Moines counties. Local individuals such as Donald Parson (Wapello) assisted the archaeologists in identifying major sites. Complete analysis of these investigations was not accomplished, although students at the University of Iowa are returning to analyze these materials at the present time. On the Illinois side, archaeological activities began with test excavations on the Putneys Landing site (11HE3; Lippincott and Herold 1965), a major Havana village and mound group (also Late Woodland) mentioned in other overviews of Hopewellian sites (cf. Struever and Houart 1972). Local collectors primarily belonging to the Quad-Cities Chapter of the Iowa Archaeological Society also recorded many sites during the late 1960s and 1970s.

A major publication pertaining to the study area but not involving fieldwork was Elaine Herold's (1971) compilation of late nineteenth and early twentieth century investigations at the Albany mounds (11CA1). This study was followed by survey work and test excavations in the Albany village site, which was done in conjunction with planning for the Meredosia Levee project (Benchley and Gregg 1975; Benchley, Gregg and Dudzik 1977). In 1987, excavations were conducted at Albany mounds to evaluate and partially mitigate the damage done to a mound by vandals. This (unpublished) work was funded by the Illinois Office of Historic Preservation.

The most significant survey on the Illinois site was part of the UWM Archaeology Laboratory's reconnaissance survey of the Mississippi Valley on the Illinois side from the mouth of the Des Moines River to the Wisconsin border (Fowler 1971; Gregg 1972). Fieldwork consisted mostly of contacting landowners and local collectors, who would point out sites; then the field crew walked and recorded the sites. This investigation identified many of the largest and most prolific sites and probably tripled the number of site records.

The UWM reconnaissance survey generated several overviews of prehistoric cultures. Mark Dudzik's Masters Thesis (1974) was the most comprehensive and thoughtful because he utilized the state site records to develop settlement patterns for every prehistoric period, then compared cultural models by other writers to his data base. Dudzik's analysis is structured around environmental variables. Another overview for all of northern Illinois (Billeck and Benchley 1982) drew general conclusions about all culture periods. The UWM site data formed the basis for site locational models which became part of a volume on Predictive Models in Illinois (Brown ed. 1981). The model for the Upper Mississippi River (Benchley et al, 1981; see also Benchley 1978) did not analyze sites according to culture period. Instead, site probabilities were calculated for four floodplain environments: bottomland prairie and timber, terrace prairie and timber. The prairie environment scored extremely high.

In 1984 the Office of the State Archaeologist of Iowa conducted survey and testing at 17 Corps recreation areas along the Mississippi River (Johnson et al. 1985). They employed bank survey, shovel-testing and one meter unit excavations to investigate the geology and archaeology of specific locations in the valley. The reader is advised to recheck all information presented in the Johnson et al. (1985) text, as it contains errors of site attributions, artifact identifications and geomorphological interpretations.

The most comprehensive survey of sites on the Iowa side was produced by the initial Great River Road project (e.g., Hotopp ed. 1977). This survey followed part of the existing right-of-way of Highway 61 and other state and county highways and roads along the Mississippi bluffline and valley floor from Ft. Madison to Dubuque. The field crew also made forays off the right-of-way to record major sites identified by landowners and collectors. Sections of the report on Muscatine, Louisa and Des Moines counties by Anton Till (Ibid.) were descriptive and provided useful information about the history of past investigations on many sites. Overall, the early Great River Road survey reports lack analysis of the collections as well as an overview of culture history developed from the new survey data, while later reports contain more sophisticated analyses.

Site excavations in Iowa in the 1970s were precipitated by an interest in Oneota culture and in salvaging site information being eroded by the Iowa River. The University of Iowa/Office of the State Archaeologist directed field schools at the McKinney Oneota site (13LA1; Slattery, Horton and Ruppert 1975), the Poison Ivy site (13LA84; Alex 1978) and at the Helen Smith site (13LA71). Some analysis of the Oneota materials was used by Tiffany (1979, 1982) in his overview of southeastern Iowa Oneota culture. The first large excavation project was at Michaels Creek, where six National Register eligible sites (13LA55, -56, -60, -140, -249, -250) were examined by Louis Berger and Associates (Fokken and Finn 1984) for a road project. Stratified Woodland and Oneota materials were encountered, and the writers expended considerable effort to model the subsistence and settlement strategies of prehistoric peoples from analysis of the site assemblages.

During the late 1970s many federal agencies, including the Corps of Engineers, began the process of indexing the known and potential cultural resources on property under their jurisdiction (viz. EO-11593, National Historic Preservation Act 1966 amend ed; see Eichorn 1983). Evaluations of the Upper Mississippi commenced with an extensive literature search (Petersen 1978), with formation of the Great River Environmental Action Team II (Great II) in the 1970s and with the St. Louis workshop on cultural resources sponsored by the Upper Mississippi River Basin Commission (Gramman 1981). Actual ground survey was initiated in the 1980s to develop an adequate data base for formulating management strategies. Pools 11, 12, 13, 14, 16, 17 and 18 in the Rock Island District have been surveyed, and background studies of geology and history have been done for Pool 21. Farther north in Iowa and Wisconsin, Pools 10 and 11 in the St. Paul District also were surveyed. The surveys of Pools 10 and 11 by the Great Lakes Archaeological Research Center (Overstreet 1984a, 1985) were done concurrently with the surface geomorphology for Pool 10 (Church 1984). Overstreet's investigations included a detailed cultural overview, survey of cutbanks in the pool and limited subsurface probing by core, shovel, and remote sensing. The potential for buried sites in both pools was carefully assessed.

Overstreet built upon previous experience when he undertook the surveys in Pools 10 and 11. The earlier survey of Pool 12 by his organization (Boszhardt and Overstreet 1983) contained only descriptions of sites and two terrace levels (i.e. Pleistocene terraces, floodplain) and lacked the detailed landscape context that the later work has. Likewise, the survey report for Pool 16 (Barnhardt et al, 1983) gave similar types of information. The inclusion of a few sediment profiles from archaeological sites in Pools 16 is not helpful, even with two radiocarbon dates, when the pedogenic horizons are not described with standard soil terminology.

The first of the major data recovery excavations sponsored by the Corps of Engineers was conducted on the Osceola site in Grant County Wisconsin (Overstreet 1984b). The investigators attempted to resolve issues about the cultural stratigraphy of late Middle Archaic and Woodland components through the careful application of soils and geomorphological analyses.

In 1985, sites along Sand Run Slough were brought to the attention of the Corps of Engineers (Smith and Barr 1985) by local collectors and the Office of the State Archaeologist of Iowa. Sites 13LA30 and 13LA38 were determined eligible for nomination to the National Register, and the latter site was excavated in 1986 (Benn ed. 1987).

The Putneys Landing site (11HE3) has been the other subject of intensive work on the Illinois side. The site was tested in the 1960s (Lippincott and Herold 1965), and portions of the village adjacent to Campbell Slough were excavated by Charles Markman (1988), Northern Illinois University, for the Corps of Engineers. For the latter project a multi-disciplinary report covering every aspect of preserved materials was produced. Markman found that the village was intensively occupied, not merely a burial camp for the nearby mounds.

The Rock Island District office continued to contract for pool wide geological and archaeological investigations in Pool 21 in 1987 (Anderson, Green and Vogel 1988). This project included fieldwork to construct a series of geomorphic maps and an archival search of the prehistoric and historic data base.

The 1987 large-scale archaeological and geological survey in Pools 17-18 (Muscatine to Burlington) covered 4695 acres of cultivated surfaces and 50.2

miles of shoreline (Benn, Bettis and Vogel 1988). A total of 158 sites was visited or otherwise studied in some fashion. The 1988-89 survey of Pools 13-14 (Belleview to Clinton) covered 583 acres and 12 linear miles of pedestrian floodplain survey, and 72 miles of bank survey (Benn et al. 1989). A total of 58 sites was recorded and studied. Together, these pool surveys represent the most systematic, combined archaeological/geological investigation of the Mississippi Valley within the Rock Island District. This information provides the basis for the following cultural overview.

PREHISTORIC CULTURAL OVERVIEW

Human beings have lived in the Mississippi River valley and gathered its rich natural resources for more than 12,000 years. The cultures of those people were rich and varied, and we as archaeologists can trace the record of culture change from the earliest age through to the modern era. If merely by stating these facts it would be this simple to reconstruct prehistoric and historic cultures by finding and excavating all past human records, I would present now a complete cultural record in this overview. Alas, the archaeological record is complicated by massive changes in the landscape on the floor of the Mississippi valley during the last 18,000 years, and site distributions been drastically affected by fluvial processes in the valley. Changes in the landscape affect the cultural record in two ways. First, humans choose where they will live and work because of the shape of the landscape. Therefore, prehistoric settlement patterns must be analyzed within the context of the contemporary landscape. Second, major changes in the fluvial system can wipe out or bury the evidence for human activities, forcing archaeologists to consider the bias of differential site preservation in reconstructing the human past. We are only beginning to understand through wide-ranging geomorphic and archaeological surveys how changes in the landscape have affected the cultural record. This overview will reflect the youthful state of our knowledge about the valley and its past cultures.

18,000-12,000 B.P. (Early Man period)

Evidence for cultural material that predates the lanceolate projectile point hunting traditions in the Americans is scarce and controversial. None has been found in the Midwest. For Early Man evidence to be authentic, it must have a secure stratigraphic context and dating. Context is most important because the types of non-projectile point industries thought to belong to this period, e.g. chopper/heavy flake technology or blade core/retouched flake technology, are elements of later cultural traditions as well. Essentially, locating Early Man sites is a geological issue.

Big game animals must have utilized the Mississippi Valley floor as a source of food and water, and human hunters, if present, surely preyed on these animals. However, it is doubtful that people camped permanently in the unstable floodplain, since periodic pulses of meltwater from glaciers would have inundated the entire valley and destroyed all sites. People could have resided on the high terraces and blufftops. Since the valley was the source for blowsand and loess, the highest terraces have sand dunes and the bluffline has a substantial layer of loess predating ca. 12,500 B.P. Archaeologists might look for Early Humans within the loess and beneath dunes.

A question worth asking is whether the main valley was even a place that attracted early hunters. During the Holocene (see below) humans tended not to live along the main channel, preferring instead the backwater lakes and sloughs. The scale of the late Wisconsinan channel belt was much larger, with the bluffline and highest terraces functioning as the river "bank." There were backwater lakes only between flood surges. Frankly, the valleys of smaller streams and upland lakes probably offered less challenging environments to early hunters.

Paleo-Indian/Dalton Period

The most complex processes of valley bottom formation occurred during this time span (ca. 12,500-9500 B.P.), but this is a difficult period to study geomorphologically and archaeologically. Diagnostic artifacts are sparse, and material for radiocarbon dates is hard to obtain from specified contexts.

At the end of the Wisconsinan glacial episode in the Midwest there was an overall downcutting by streams. During most of the Holocene period, valley floors underwent long periods of aggradation punctuated by downcutting. The sum total of Holocene geomorphic activities has been the buried and/or destruction of much of the early Holocene valley landscape. In Pools 17-18 a sandy and loamy Holocene terrace complex rises about 1-2m above current water levels, except where fans have accumulated to depths of 5-10 m. The early Holocene floodplain "surface" lies below the current river level close to or within the permanent groundwater table.

The general consensus of archaeologists is that

Paleo-Indians concentrated on game as their principal food source. They possessed a sophisticated lithic technology based on the manufacture of blade flakes, bifacial knives and weapon tips by softhammer percussion and pressure techniques (cf. Bryan ed. 1978). Their distinctive assemblage of tools--e.g. lanceolate projectile points, fluting, burinated tools, gravers, spurred end scrapers, wedges--renders their sites highly visible. The Paleo-Indian period may be roughly divided into two traditions. The first (ca. 12,500-10,500 B.P.) is characterized by lanceolate points with basal thinning flakes that evolved into more sophisticated fluting techniques, called Clovis and Folsom. The second (ca. 10,500-9500 B.P.) encompasses a wide variety of lanceolate point types without formal flutes but are finished with careful, collateral pressure flaking and an array of haft forms (e.g. Dalton, Scottsbluff, Eden, Hixton, Beaver Lake; see Wormington 1964; Goodyear 1982). One notable Dalton point from the Bay Bottoms below Muscatine is made from Crowley's Ridge chert, a raw material from the heartland of the Dalton culture in northeastern Arkansas.

Paleo-Indian and Dalton sites in the Upper Mississippi Valley have yielded isolated points from multi-component cultural scatters. Local collectors do not seem to know of any sites which have yielded paleo-points season after collecting season, nor have recent surveys picked up scraping, graving or retouched flake tools that could be interpreted as part of a complete Paleo-Indian complex.

We must prioritize the approach to analysis of Paleo-Indian culture by realizing that the contemporary landscape is the most important variable that determined what has been preserved. On upland ridges where Paleo-Indian sites are most common, there is a blanket of loess which may hide some sites beneath the plowzone. Severe erosion has brought most of these sites to the surface, as people who collect on the bluffline have discovered. Recently, lanceolate points have been observed in the possession of landowners who find material on the highest Wisconsinan terrace (Savanna). Only where eolian sand is present will sites on this terrace be buried. The Mississippi floodplain presents a completely different archaeological problem. Here, except for sand ridges the surface of late Paleo-Indian/Dalton times is either buried or has been destroyed by subsequent fluvial activity. We might expect to find temporary kill/butchering sites in the floodplain, but the site excavations will be done under wet conditions.

Early Archaic Period

A long episode of floodplain aggradation began during this period. Aggradation continued into the Hypsithermal climatic episode that postdated the Early Archaic period; thus, much of the Early Archaic landscape is buried on the valley floor. Only sandy Wisconsinan terraces (Savanna or Kingston) poke above the Holocene alluvium. These high points are where Early Archaic artifacts have been found. Elsewhere in Iowa the Gunder Member (Bettis and Littke 1987) and the Corrington (fan) Member (see also Wiant et al, 1986:106) of the DeForest Formation, and the High Terrace in the central Des Moines River Valley (Bettis and Hoyer 1986) often have a buried soil near the base of the fill. This soil was contemporary with the Early Archaic period. A similar alluvial fill/pedogenic context probably exists in the Mississippi Valley and could contain buried artifacts.

Recognition of the Early Archaic period (ca. 9500-8000 B.P.) is based largely on the typological evidence of projectile points, which have been dated elsewhere (Luchterhand 1970; Goodyear 1982; Brown and Vierra 1983; Stoltman 1986b). Private collections from Mississippi survey areas below Rock Island contain the point types, Thebes/Grundy and Hardin, and more careful study of these collections probably would reveal the presence of St. Charles and Kirk Cluster types. These point types are not seen as frequently north of Clinton. Bifurcate base points of the types LeCroy and St. Albans, and side notched Graham Cave points were not noticed in private collections.

The remainder of the Early Archaic assemblage consists of bifacial knives, end and side scrapers, drills, choppers, a wide range of flake tools, and grinding equipment (Brown and Vierra 1983:181; Klippel and Maddox 1977; Esarey 1987). This assemblage is more varied and less specialized than the Paleo-Indian assemblages. Diversification of the tool inventory has been related to the subsistence patterns, which was based on seasonal exploitation of most of the plants and animals of the oak-hickory forest and riparian biomes (Luchterhand 1970; Klippel and Maddox 1977; Stoltman 1986b). Authors recognize large, base camp ("habitation") sites as well as smaller, presumably temporary, sites for the procurement of particular resources. No distinct tool assemblages and site types of this period can be confirmed in the sites in the Upper Mississippi Valley project areas, because all of the Early Archaic points come from multi-component sites. One observation may be viable: none of the Early Archaic components seems to yield large numbers of points.

Therefore, no large base camps are anticipated, unless they are buried.

Authors (e.g. Luchterhand 1970; Klippel and Maddox 1977; Springer and Harrison 1979; Esarey 1987) have been concerned with the advance of the prairie during the early half of the Holocene and what effect this had on human settlement patterns. The Archaic population shunned the upland plain in Illinois as the prairie expanded after ca. 9000 B.P. (Wright 1978; Wendland 1978; King 1981; McMillan and Klippel 1981). These archaeologists view the expansion of prairie as a constraint on the Archaic subsistence system. However, no such environmental constraint is perceived within the Mississippi River valley. At 9000 B.P. the valley was covered by oak-hickory and mesic maple forest. Most known Early Archaic sites were positioned on sand ridges adjacent to backwater sloughs and lakes, not the main channel. This is the same locational pattern of later Archaic and Woodland periods as well as the Paleo-Indian/Dalton pattern.

The relatively stable pattern of site locations just cited brings us to a general proposition: 1) given that the Upper Mississippi Valley floor is a mosaic of environmental zones, all of which are within an hour or two walking distance, and 2) given that there are preferred locations for habitation (i.e., better drained, elevated above floods) adjacent to the most prolific backwaters, then settlements at such prime locations would be the expected pattern for all hunters and gatherers during all prehistoric periods. Major deviations from this basic settlement system would have to be a reflections of significant socio-political and economic change.

Middle Archaic Period

The Middle Archaic period dates between ca. 8000 and 4500 B.P. Point types from the early portion of this period include Helton and Rice Corner Notched types (Brown and Vierra 1983:183) and small side notched points with concave bases, such as Tama and Little Sioux (Anderson 1980; Benn and Rogers 1985:30). The remainder of the Middle Archaic period in the Midwest was dominated by side notched forms with names, but Matanzas, Godar, Raddatz and Osceola are the most common. Significant numbers of side notched points come from sites on sand rises with artifact scatters of one or more acres in extent. Fire-cracked rocks and lithic debris are very common. Private collections from the sites in the valley contain many winged ("T") drills, ground stone including grooved axes, many types of bifaces and large, unifacial scrapers. Elsewhere (Benn, Bettis and Vogel 1988:145-6), it has been argued that finely made artifacts and items fashioned from exotic materials represented surplus labor value expended to satisfy social obligations ("debts"; cf, Bender 19 85).

Private collections from the Iowa side south of Muscatine contain a complex of side notched points (Godar, Matanzas, Raddatz) which appear to be infrequent or missing in the areas north of Clinton. Finely shaped axes, plummets, hematite and banner stones also are rare or absent in the northern reaches. This may reflect a cultural phenomenon, not a collectors' bias, since these objects are highly prized in today's private markets. The area north of Clinton might have been in a different cultural zone than the areas to the south up to ca. 4500 B.P. Later than ca. 4500 B.P. the entire Upper Mississippi Valley was involved with the cultural tradition distinguished by the Osceola point style.

Middle Archaic sites are the earliest manifestations in the prehistoric sequence to be recorded in buried contexts on the valley floor. This happens because they lie in the upper half of the Holocene alluvial sequence above the normal water table. Buried Middle Archaic sites can have both dense and light artifact scatters suggesting dichotomous site types, which may be either the direct result of the length of occupation or a secondary result of the way the site was buried by sediment. Light scatters, which have not been excavated, appear to consist of fire-cracked rocks and flakes. If these sites fail to yield diagnostic artifacts, they can only be related to a cultural system and period of time by geomorphic context or radiocarbon dates. The heavy scatters, such as the one in Sand Run West site, block C (Benn ed. 1987), are dark middens with roasting pits, trash-filled pits, masses of chipped and ground stone tools, fire-cracked rocks and organic remains of fish, mammals, nuts and seeds (including wild rice). Where this type of dense midden is in a fan sediment with more rapid accretion, as in block B at Sand Run West, the density of tools is much lower. In this case our perception of site density, therefore occupation permanence, is influenced by relative rates of sediment accumulation.

Middle Archaic sites are situated along backwater sloughs and lakes. Even those along relict Mississippi channels were not contemporary with the active channel. When prairie invaded the valley floor after ca. 7500 B.P., sites on sand ridges were within the prairie. A general correlation between archaeological sites and prairie on the valley floor was noticed by Benchley and others (1981:11) when they compiled survey data for the Upper Mississippi River. However, the aboriginals' occupational preference may not have been the prairie but instead the well drained alluvial soils which happened to be favored by prairie plants.

The Middle Archaic settlement pattern also includes sites on the blufftop ridges and on the broad uplands back from the river. Local collectors who roam the uplands have gathered a tremendous quantity of grooved axes, hematite plummets, bannerstones and side notched projectile points, scrapers and lithic debris. This situation is true for both the Illinois and Iowa sides of the river. Based on simple artifact densities and types, some upland sites should be classified as base camps like sites on the valley floor. Others with axes, bannerstones, plummets and points but little else might have been mortuary sites like the one beneath the Elizabeth Mounds in the Lower Illinois River valley (Charles, Leigh and Buikstra 1988).

Another type of mortuary site was recently excavated at Sand Run West (Benn, Schermer and Sellars 1992). This bluff-based site was utilized as a cemetery immediately following the occupation of ca. 4200 B.P. No grave goods were placed with the individuals, who had been deposited in flexed positions and as bundled bones. Burial sites in deeply buried occupation sites are difficult for archaeologists to locate and may be more common than blufftop cemeteries. The Osceola site in southwestern Wisconsin (Overstreet 1984b) and the Bullseye site in the Lower Illinois River valley (Hassen and Farnsworth 1987) are examples of other Middle Archaic cemeteries in occupation sites, although these have yielded tremendous numbers of axes and other elaborate artifacts.

The other impression about Middle Archaic materials from recent survey data is that the numbers of components increased through time. Osceola points are to be found in practically every private collection. Perhaps their large size and distinctive basal configuration makes them more conspicuous when collections are merely perused by survey archaeologists. There is no doubt, however, that there are more Middle Archaic point finds than Early Archaic finds, and the Osceola type is widespread in upland and valley contexts.

Late Archaic Period

Projectile points of the Late Archaic period are very numerous in private collections. The proliferation of Late Archaic components is a fact noted by other researchers in cultural overviews of the Upper Mississippi River valley (Dudzik 1974:16; Billeck and Benchley 1982:7; McElrath et al, 1984), but it was not confirmed by initial intensive surveys in the floodplain. For instance, no Archaic sites were found in Pool 12 (Boszhardt and Overstreet 1983), and only two purported Archaic shell middens were located in Pool 16 (Barnhardt et al, 1983:53-57). Overstreet (1984:13; 1985:153) reasons that Archaic sites are deeply buried (15ft or more) in Pools 10 and 11 and will be difficult to find below the navigation water level.

The observations in the preceding paragraph would generate equivocal conclusions if the cultural data were not considered within a regional geomorphic/pedogenic context. By recognizing the Odessa stratigraphic sequence (see "Early Woodland Period"), it is possible to predict that Middle-Late Archaic materials will occur either beneath the second (buried) Woodland-bearing solum in vertical accretion deposits or at the A/B horizon interface of thick soils at the surface of horizontal accretion deposits. When these contexts were examined in Pools 17-18, two types of Late Archaic deposits were found about 1-2m below the ground surface in the northern two-thirds of the pools. One type of site (e.g. 13LA38; Benn ed. 1987) has a dense midden of artifacts, features and organic remains. Similar sites occur on the plowed surfaces of sand ridges in the bottoms. The other more common site type in buried contexts is represented by a thin scatter of fire-cracked rocks and flakes occasionally with a diagnostic artifact. These sites appear to have been temporary camps and resource procurement stations on the floodplain at the time of occupation.

The settlement pattern of large, base camp sites on well drained landforms and temporary camps on the floodplain is not a revelation. Since Caldwell (1958) theorized about the Archaic tradition, this has been the assumed settlement pattern for intensive hunting and gathering subsistence in large river valleys. Blufftop cemeteries and habitations also were part of this pattern. The proliferation of Late Archaic over Middle Archaic components in Pools 17-18, given similar adaptations and geomorphic circumstances, suggests the Late Archaic people were filling territories. Brown and Vierra (1983) and others (cf. Price and Brown ed. 1985) have described the Middle and Late Archaic periods as a time of cultural expansion and intensification. Organic data pertaining to Archaic subsistence in the Upper Mississippi Valley is not adequate to test this hypothesis, although the processing of aquatic resources, mammals, nuts, wild rice and the cultivated seed complex at the Sand Run West site lends initial confirmation (Lopinot in Benn ed. 1987; Benn and Kelly in Benn ed. 1987).

Some evidence for increasing regional and chronological variation, perhaps indicating more complex social interaction, is demonstrated in the artifacts. Styles of projectile points seem to have changed with sufficient unity so that at least three complexes may be identified. The earliest complex was transitional with the Middle Archaic period. It consisted of small to medium sized side notched points like Matanzas and Godar mixed with more of the large Osceola points. Winged T-drills and grooved axes also belong to this complex, which was dated between 4140+110 (Beta-18293) and 4270+90 B.P. (Beta-17937) at Sand Run West (13LA38). Conrad (1981) has named the Hemphill phase (ca. 4950-4250 B.P.) in west-central Illinois for a complex like this. The second complex appears to be like the Titterington phase (ca., 4200-3800 B.P.) of the Lower Illinois River valley (Cook 1976) and the Sedalia complex in northeastern Missouri (Chapman 1975:203). Diagnostic points/bifaces include Wadlow, Karnak, Sedalia, Etley/Atalissa and Nebo Hill types, with gouges, drills, heavy scrapers, axes and grinding equipment rounding out the inventory. The third, unnamed complex is identified by stemmed point types (e.g. Table Rock Stemmed, Springly, Durst Stemmed, Robbins, Tipton, Merom) and by broad side notched point types (e.g. Fort Dodge, Conrad). The first two point types have been dated early in the third millenium (Lensink ed. 1986:198; Emerson and Fortier 1986:481).

Many varieties of stemmed points typical of the period after ca. 3500 B.P. as well as Titterington-like materials occur in Pools 13-14. These preliminary findings suggest there were strong cultural relationships among Late Archaic peoples of the Missississippi valley along the entire border of eastern Iowa, thereby eliminating the north-south cultural dichotomy of the Middle Archaic period.

Price and Brown (1985:8) propose three conditions that fostered the development of complexity during the Middle and Late Archaic periods. 1) Social circumscription happened when productive units became packed in territories and opportunities for emigration grew increasingly limited. 2) Abundant resources allowed for the creation of annual surpluses. 3) Rising population placed stress on subsistence strategies based on foraging for natural resources. Archaic societies' response to subsistence stress was to focus on a narrow range of resources, i.e., the most productive "patches," by occupying residential sites for longer periods and by developing more intensive food production systems through logistical organization of settlements (Warren and O'Brien 1982a:94; Brown and Vierra 1983:168-169). Elaborate artifacts, such as bannerstones, plummets, exotic materials, etc., indicate a response to socio-economic stress. The production of "surplus" objects was intended to fulfill obligations ("debts"; see Bender 1985) which functioned as a banking system against future stress.

Early Woodland Period

The valley floor of this period (ca. 2400-1950 B.P.) was very similar to the present day configuration (Figure 2.13). The Mississippi River meanderbelt was the same with some abandoned channels and levees along terraces still forming. Older islands were already in place. Vegetation patterns consisted of prairie cover on well drained terraces, wooded fringes along sloughs, mesic forest on the seasonally inundated floodplain, and marsh-dominated wetlands.

In the wetland zone there are regularities in the co-occurrence of paleo- and modern soil horizons and Late Archaic through Woodland period artifacts (Benn ed. 1987:238-9). These relationships are termed the Odessa sequence after a survey transect in Pool 17. Essentially, the Odessa sequence is composed of a sequence of Mississippi alluvial deposits encompassing 2-3 major soil forming episodes. The surface soil, which often occurs beneath a mantle of post-settlement alluvium (PSA), contains the late Late Woodland, Oneota and Historic components (ca. 1500-100 B.P.). The Early and Middle Woodland components (ca. 2500-1500 B.P.) are found in the A horizon of the first buried soil. Late Archaic and late Middle Archaic components (ca. 5000-2500 B.P.) occur beneath the buried soil either in a second buried soil (i.e. 3A/Bb) or in sandy, lateral accretion deposits. Distribution of the third, lowest soil probably depends on the age of the landform and its proximity to the former river channel.

A complete range of Marion and Liverpool ceramics and stemmed points (e.g. Dickson, Belknap, Waubesa, Kramer, Robbins) is evident from the pool survey data below Muscatine. The Pools 17-18 sites with large surface collections yield a conjunction of stemmed points and ceramics. Unfortunately, these materials have not been excavated from sealed stratigraphic contexts. North of Clinton no Early Woodland sites have been found, although points of this age occur in private collections (Benn et al. 1989), until one reaches Pools 10 and 11, where Early Woodland sites of the Prairie phase have been located and excavated in the floodplain (Theler 1983; Stoltman 1986).

The apparent absence of Early Woodland sites in Pools 13-14 correlates with what Fokken and Finn (1984:6-5) visualized as a decline in the Early Woodland population level in Pool 17 based on fewer sites relative to the Late Archaic period. This appears to be a case of actual geomorphic processes influencing the cultural interpretations of archaeologists. The primary hindrance to identifying an Early Woodland assemblage is the mixing of components. Again and again the most prolific sites adjacent to backwater sloughs in Pools 17-18 were occupied throughout the Holocene period. These are the highly visible sites on sand ridges familiar to most archaeologists (cf. Struever 1968). Only when slough margins in the floodplain are carefully surveyed and sites are dug deeply, does one happen onto buried Early Woodland components (Theler 1983).

That portion of the settlement pattern visible today in Pools 17-18 exhibits a few tendencies which may be culturally related, not merely figments of survey bias and preservation factors. The sites with Marion Thick ceramics are grouped in two clusters surrounded by well surveyed sites. One group is on the sand ridges in the Bay Bottom in Illinois, and the other is along the shoreline of Lake Odessa and Muscatine Slough on the Iowa side. Black Sand tradition sites cluster in the same way, although the distribution of Black Sand materials covers a larger zone in the sloughs on the Iowa side. A similar clustering of Early Woodland Black Sand sites was noted in the central Des Moines River valley (Benn and Rogers 1985:36-40). The apparent discreteness of Early Woodland settlement clusters contrasts to some degree with assumptions by others (Dudzik 1974:16; Munson 1982; Lewis 1986:176) that the settlement pattern did not change much from the Late Archaic pattern, but clustering is more in keeping with cultural boundaries summarized by Farnsworth and Asch (1986:434-447; see also Fortier, Emerson and Finney 1984) for the American Bottom and Lower Illinois River valley.

Mounds and mortuary sites in general are not integrated with the known Early Woodland settlement patterns, principally because there is too little data. We should be vigilant of this gap in the data because an Early Woodland burial complex, the Ryan phase (Logan 1976), exists in northeastern Iowa. The Turkey River mound group in Clayton County contains the best evidence for this complex, including the liberal use of red ocher on bones and the importation of unusual materials in the form of "cult" artifacts, such as the Turkey Tail biface and bar amulet (Green ed. 1988:156-161). While this component of the Turkey River mounds dates to the onset of the Early Woodland period, we are reminded that participation in the Red Ocher mortuary complex "'sets the stage'...for the better known Middle Woodland Hopewell Interaction Sphere." (op.cit.:160)

One general pattern observed throughout the Midwest is that Marion, Black Sand and Havana tradition materials often occur on the same sites. This evidence has lulled researchers into presuming continuity between these traditions, a theory which has been bolstered by widely accepted ceramic analyses (cf. Griffin 1952). Patrick Munson (1982, 1986) disrupted this normative view by proposing that there was continuity between the Marion complex and the Havana tradition but that the Black Sand tradition was separate and peripheral to Havana. Munson saw the Black Sand tradition extending west across the prairies and north into the upper reaches of the Mississippi River Basin, while Marion was confined to the Illinois and lower-middle reaches of the Upper Mississippi River valley. Evidence from 13LA38, other Iowa sites (cf. Benn and Rogers 1985; Benn ed. 1987) and from Wisconsin (cf. Stoltman 1986a) tends to confirm Munson's view.

Middle Woodland Period

The Havana tradition is employed to designate Middle Woodland occupation (ca. 2200-1600 B.P.) at least as far north as the Albany mounds on the Illinois side south of Clinton. A complete manifestation of this tradition in all of Munson's (1986) named phases (i.e. Marion/Morton, Morton/Caldwell, Fulton, Ogden, Frazier, Weaver) is evidenced by the ceramics, lithics and Hopewellian interaction items.

When alluvial fans are cultivated major Havana components are brought to the surface. Indeed, most substantial Havana components seem to be at or near the surface in the Upper Mississippi Valley. One problematical piece of evidence, a Middle Woodland period radiocarbon date at 11MC102 in Pool 17, indicates there are buried Havana sites in the floodplain, but this site looks like a temporary camp. In general, the most significant part of the Havana settlement pattern seems to be at the ground surface. Much of it is known only to local collectors and has yet to be officially recorded, however.

Middle Woodland site patterns in the Upper Mississippi Valley have some of the aspects of Struever's (1968) original settlement model for the Lower Illinois Valley. Sites like Sand Run West (13LA38) and Putneys Landing (11HE3) were situated on backwater channels where there was ready access to aquatic and forest resources. Such sites, termed base settlements by Struever, have evidence of permanent occupations that encompassed a wide range of task activities, including the native seed horticultural complex (Benn ed. 1987:245; Markman 1988). All of the largest Havana sites in Pools 13-14 and 17-18 qualify as base settlements on the basis of artifact content and positioning next to backwaters. The difficulty in terms of the Struever model with calling all of these sites "base settlements" is that some are in the bottoms, not at the bluff base. Struever recognized a second site type, summer agricultural camps, which were "proximal to former lake shorelines" (Struever 1968:307)--the same locations as the mid-valley, bottomland sites. However, the bottomland sites have too much material, including interaction sphere objects, to qualify as seasonal camps (see Bailey 1977). The other bottomland site type in Pools 17-18, the temporary camp/resource extraction site, is not part of Struever's model but has been recognized in the American Bottom (Fortier, Emerson and Finney 1984). Struever's settlement model cannot be applied absolutely, perhaps because other social and political factors influenced locations for habitation.

The other half of Struever's settlement model proposed that there were regional exchange centers along major water courses where commodities passed through the interaction system. And, he named mortuary camps as the fourth settlement type, where there were temporary occupations associated with mortuary activities at mounds. Building on Gregg's (1974) initial examination of Struever's model, it is possible now to delineate a pattern of major habitation/burial sites from records in the Pools 17-18 area. Sites which have yielded large amounts of Havana pottery and lithics, burials/mounds and interaction sphere items (e.g. platform pipes, copper, galena, Hopewell vessels, marine shell) are spaced about 6-15 miles apart, depending on local topography.

If collector information, the Davenport Academy mound excavations and recent overviews (Struever and Houart 1972; Seeman 1979; Benchley, Hassen and Billeck 1979) are good indicators of Havana-Hopewell distributions, then a settlement pattern of regularly-spaced village/mound centers and habitations sites like the one discussed above is present throughout the Three Rivers region of the Upper Mississippi Basin. This writer would hesitate at imposing a hierarchy on the Havana sites within the region, as the Struever and Houart (1972) model attempted to do. Rather, the spacing of major Havana sites seems to be an expression of territorial organization.

The Albany site is one of the most important Havana tradition sites in the Upper Mississippi basin by virtue of its size (81 mounds and one or more villages) and its assemblage of interaction sphere artifacts. Seeman (1979:396) places Albany as a third order mortuary site in his measure of complexity. Judging from the site owner's large collection of exotic materials from the village site, Albany may have been a more significant stop within the exchange sphere than Seeman calculates from the mound data alone.

South of Albany there are only a few mounds that could be attributed to the Middle Woodland period, e.g., the now destroyed mound at Princeton. North of Albany several loci of activity around Thomson include mounds at 11CA11 and 11CA21 and village sites (11CA10) that have yielded interaction sphere materials, according to local collectors. The Apple River mouth has a concentration of village sites and mounds which have been recognized as Middle Woodland sites since Bennett (1945:66) reported them. On the Iowa side there are Middle Woodland mounds at Pleasant Creek and probably at Sabula and Bellevue. If we accept the regularity of site spacing implicit in the Struever and Houart (1972) model of hierarchical settlement patterning, as derived from the pattern of interaction sphere items (see Seeman 1979), then the Middle Woodland site distribution seems to be similar in Pools 13-14 and 17-18.

Pottery types are an aspect of the Pools 13-14 sites which might be informative about the character of Middle Woodland culture in the Upper Mississippi Valley. Linn ware types are common in the assemblages from Albany and the Thomson area sites. This ware is far less common south of Muscatine, where Havana ware predominates and Pike-like and Baehr ceramics occur. We suspect, as Will Logan (1976) also did, that a major division in Middle Woodland culture types falls somewhere within or south of Jackson County, Iowa, on the Mississippi River. This would be the northern limit of the Three Rivers region.

Societies related to the Havana tradition also extend into the interior of eastern Iowa (Perry 1991). Perry demonstrates that the information about these Middle Woodland period societies is inadequate for thorough classification, though diagnostic artifacts of the latter half of the tradition (i.e., Fulton through Weaver phases in Illinois) seem to be the principal evidence. Elaborate, exotic artifacts of the Hopewell Interaction Sphere are not common in the interior. There is substantial evidence for the movement of nonlocal materials, especially chert (e.g., Warsaw Tabular), and the manufacture of Havana-style artifacts (e.g., blades, biface forms, zone decorated ceramics, etc.) in cultures which reflect ceramic influences from Baehr/Pike and Weaver manifestations in Illinois. These influences are expressed most in the Linn ware ceramic series (Logan 1976; Benn 1978; Perry 1991).

Late Woodland Period

The valley floor landscape and activities of the rivers were the same for this period as the previous one. Late Woodland sites are distributed on all types of landforms throughout the project area. The relative density of sites appears to be determined by the intensity of survey coverage and the visibility of Woodland ceramics, which decompose rapidly in the plowzone of sandy soils. Alluvial burial of sites probably is not a significant factor in their visibility, except in forested areas where Late Woodland sherds are usually found on cutbanks. The other observation about Late Woodland sites is that most occur along sloughs and backwater lakes, and very few are on the Mississippi River channel or within the modern channelbelt. Therefore, destruction of sites by fluvial erosion probably has not occurred.

The early Late Woodland period (ca. 1600-1300 B.P.) begins during the Weaver phase south of Clinton and the Allamakee phase north of Clinton (an arbitrary dividing line). Weaver ceramics tend to be plain surfaced with decorations limited to lip margins. Linn ware of the Allamakee phase has much more decoration, usually of stamped or cord impressed zoned decorations. Steuben Stemmed and corner notched points, which were carryovers from the Middle Woodland period, characterize Weaver and Allamakee assemblages. Flake tool and small core lithic technology also continued after the Havana tradition. Interestingly, Hopewellian items like copper, galena and imported cherts (e.g. Warsaw Tabular) continued to be utilized during both phases. Weaver and Allamakee site distributions cannot be characterized in a definitive manner. Some components occur with large Havana villages, including a possible midden "ring" at the Gast Farm site (Green et al. 1990). But more early Late Woodland sites are scattered in the center of the bottoms, unlike Havana settlement patterns. Ceramic complexes similar to Weaver also extend into the interior of Iowa, where the one example in southeastern Iowa has been termed Henry ware (Perry 1987).

Cultural manifestations that followed the Weaver and Allamakee phases are unnamed, yet paradoxically their remains occur in more places in the valley than sites of all previous or later periods. Almost 120 "Woodland" sites are recorded in Pools 17-18; at least 62 sites definitely belong to the post-Weaver time period. Ceramics are the most reliable indicators of the late Late Woodland period (ca. 1300-950 B.P.). The period opened with a dramatic shift to cord-decorated ceramics. Cordage impressions cover the exterior surface in a fine textured, low-relief mat (termed cord roughening or cord marking), and rims often have geometric designs done in individual cords. In the Three Rivers region and adjacent areas of western Illinois and southeastern Iowa this pottery ware remains unnamed but occurs as two types: "cordmarked" (undecorated) and "cord-impressed" (Riggle 1981; Morgan 1986). Analogous, contemporary ceramic wares were made to the north (i.e. Madison ware, Hurley 1975; Benn 1980), west (i.e. Loseke, Benn and Rogers 1985) and south east (i.e. Sepo, Harn 1975; White 1985:96; Bauer Branch, Green 1987).

The corded wares lasted 200-300 years, then ceramics with plain rim surfaces and either corded or no decorations were manufactured. Along the Mississippi Valley in eastern Iowa the plain pottery ware probably is Minotts (Logan 1976; Benn ed. 1987:66). Farther east in Illinois it is called Maples Mills (Fowler 1955; White 1985:96), and to the north in the Upper Iowa River valley the contemporary ware is the Hartley ceramic series (Tiffany 1982a). No cultural interpretations can be developed from a discussion of the typology of plain rim wares because too little is known about their geographic distribution and temporal range. Furthermore, this pottery's typological attributes are not yet fully described in print, including what this writer believes is a critical issue: rim form. Refinements in the technology of pottery making, which began to appear in Weaver ceramics as thinner walls and globular body forms, had the effect of making Minotts vessels more effective boiling containers (cf. Braun 1983).

Other characteristics of the late Late Woodland period included a lithic industry that emphasized small cores, triangular points and delicate, hafted flake tools (Stanley and Hoppin in Benn ed. 1987). Low earthen mounds containing domestic items, ro cks and small features were constructed, and the native horticultural complex expanded to incorporate maize production (N. Asch and D. Asch 1985). Together, these Late Woodland characters suggest there was a profound shift in the allocation of labor following the Havana-Hopewell horizon in the Midwest. For instance, the lavish Havana lithic technology was reduced to an expedient flake industry of the Late Woodland period, and much less surplus labor went into the building and furnishing of smal ler mounds. Pottery production focused on the manufacture of more uniform, thin-walled vessels rather than on production of a diversified ceramic assemblage during Havana times. In addition, there was a significant expenditure of labor on the fiber technology. Most important of all changes was the increase investment in maize gardening, which developed between ca. 1350-950 B.P.

The overall trend in the changes in labor allocations was toward activities which could be accomplished by smaller sized producer units. The purported fissioning of productive units during the Late Woodland period has been described by others (e.g. Hall 1980; Kelly et al. 1984a; McConnaughy, Jackson and King 1985; N. Asch and D. Asch 1985; Benn and Rogers 1985; Markman 1986; Green 1987), and it is evident in the settlement data from Pools 13-14 and 17-18. Late Woodland people occupied all parts o f the valley floor (Dudzik 1974:22; Billeck and Benchley 1982:11). The surface evidence from small, thin artifact scatters also suggests these sites were smaller.

This trend toward smaller dispersed settlements extends into the dissected interior of the Paleozoic Plateau in northeastern Iowa. Lacking broad settlement analysis in Iowa, we may wish to consider as a model for the interior settlement pattern the one desc ribed for the Bauer Branch phase in west-central Illinois (Green 1987). The Bauer Branch people occupied tributary stream valleys and headvalleys and retained an intensive hunting and gathering subsistence base typical of the Middle Woodland period. One significant cultural boundary in the Upper Mississippi Valley is indicated by the distribution of recorded Effigy mounds, which do not extend south of Dubuque (Mallam 1976). Rumors of Effigy mounds in Pool 13 were not confirmed by the 1988 survey, although Late Woodland mound complexes were present. The Pool 13 area appears to represent the southern boundary of the Effigy Mounds tradition, which was distibuted solely within the Paleozoic Plateau in Iowa (Mallam 1976). Like the Bauer Branch people, Effigy Mounds culture seems to have survived in the dissected topography of eastern Iowa when other Late Woodland peoples around them were undergoing more rapid culture change in the direction of tribal political systems.

Mississippian Period

In terms of geomorphic context the landscape and site potentials are the same for the Late Woodland and Oneota/Mississippian periods. These manifestations occur in the same topsoil layer on the terraces and in the floodplain. They have the same visibility factors in terms of the effects of plowing and forest cover. The distribution of Oneota and Mississippian sites is different than Woodland, however. Sites of the later period are clustered, but it is uncertain if this is a figment of survey biases or actual human preferences.

There are three cultural traditions within this period (ca. 950-350 B.P.) in the Upper Mississippi Valley. The first is represented by a collections of grit tempered, collared rims and Ramey Incised or Powell Plain-like ceramics from the surface of the Gast Farm site (13LA12) in Pool 17 and from the Apple River mouth in Pool 13 (Bennett 1945; Emerson 1991). These materials relate best to the Spoon River culture of central Illinois (Emerson 1991), to the Langford tradition of northern Illinois (Brown et al, 1967; Markman 1987), and to the Aztalan site in south-central Wisconsin (Barrett 1933).

The Langford-like pottery and (Cahokia?) Mississippian vessels from 13LA12 are not isolated in eastern Iowa. The Mouse Hollow rock shelter in interior eastern Iowa (Jackson County) yielded a few of the same kinds of rims from a mixed Woodland context (Logan 1976:79-80). If there are other unrecorded "Langford" sites to fill in the gaps between far-flung occurrences, they must await future intensive surveys. The late Late Woodland period was a time when a patchwork of structurally similar cultural manifestations, differing subtly in ceramic varieties, covered the area (cf. Braun and Plog 1982; Green 1987). These likely were independent polities ("tribes"), and they probably spawned another phase of political units during the Mississippian period. Langford was one of the Upper Mississippi groups sharing the Midwest, perhaps occupying a specific ecological niche, i.e. forested river valleys (Markman 1987a).

The Oneota tradition was another Upper Mississippian political development concentrated on the Prairie Peninsula (Gibbon 1972). The Oneota were hunters, gatherers and cultivators whose tradition is recognized by shell tempered ceramics and a flake tool lithic technology. Joseph Tiffany (1979, 1982b) has provided a bibliography, ceramic analysis and overview of 22 Oneota sites in southeastern Iowa where he recognized two phases based on ceramic varieties: Burlington (1300s A.D.) and Kelley (1500s A.D.; Tiffany 1979:100).

Through catchment analysis methods Tiffany concluded that Oneota subsistence patterns were oriented toward woodland and riverine environments with four corrolaries to his reconstruction (1982b:13). 1) Both upland and valley floor site locations provided immediate access to forest and river resources. 2) People may have moved seasonally between upland and valley sites. 3) Sites were positioned to maximize access to the richest natural resources. 4) Sites were clustered, and their overall placement appears to have occurred for reasons other than subsistence, e.g. "access to chert resources, view, communication, trade and defense."(Ibid) Tiffany did not attempt to analyze Oneota sites according to size, density of materials and content.

This Oneota pattern of large villages and small, seasonal sites has been found by Gibbon (1983:9) in the Blue Earth-Correctionville phase in southern Minnesota. Likewise, the pattern was found in the Moingona-Burlington phase in the Red Rock area of south-central Iowa (Rogers, Stanley and Anderson 1987) and in the central Des Moines Valley (Benn and Rogers 1985:59). Briefly, the Oneota settlement pattern was designed to dominate a huge territory but not necessarily to fill every part of that area with seasonal or permanent sites. The common pattern consisted of a cluster of large villages, perhaps occupied cyclically over hundreds of years associated with a corona of seasonal sites dispersed across the prairies and river valleys. We might choose to adopt the term "community" to describe the residential group which occupied the large village and utilized the expansive territory. The community pattern is presumed to have been a material manifestation of politico-economic hegemony employed by the Oneota to dominate others (Benn 1984).

The third culture settled on the east side of the Mississippi River in discrete clusters of large villages and temporary sites. Mississippian site clusters have been recorded around New Boston in Pools 17-18, at Clinton and at the Apple River mound in Pool 13. Since intensive surveys throughout Pools 13-14 and 17-18 failed to locate other site clusters or Oneota materials, the Middle Mississippian occupation looks like discrete groups moving their main villages. The smaller sites could have been single house places or procurement camps.

Mississippian sites at the mouth of the Apple River (Bennett 1945) apparently began with an intrusion of Cahokia-oriented, Spoon River people by the middle of the eleventh century A.D. (Emerson 1991). The Mississippian habitations show little influence from Oneota culture but appear to have amalgamated some influences from surrounding Late Woodland populations and from the Spoon River culture in the Illinois River valley. The settlement pattern in the Apple River locality consists of a central temple town (Mills village) and surrounding hamlets and house sites.

Oneota communities occur only on the Iowa side in the surveyed portions of the Mississippi Valley. In the northern reaches of the valley, ceramics come from the Pleasant Creek site (13JK91) and from the Sabula locality, which probably contained at least one large Oneota site (13JK146). The few ceramics seen by this writer appear to be more similar to those from the Moigona/Burlington manifestation in southeastern Iowa rather than the Orr phase in northeastern Iowa (see Tiffany 1979; Henning 1985 :52). This distribution of Oneota materials sits directly opposite the major Middle Mississippian occupation at the Apple River.

The absence of chronology for the Langford-like and Middle Mississippian occupations prohibits conclusive interpretation about the circumstances of the Oneota occupation in the valley. That the Mississippi channel appears to have been a boundary between the Oneota and Mississippian sites is an intriguing issue. Considering the aggressive nature of the Oneota system and Tiffany's chronology for the Oneota phases, the Langford-like tradition at 13LA12 probably preceded the Oneota occupation. Perhaps they were repelled northward by an Oneota intrusion into southeastern Iowa sometime after 850 B.P. Moreover, it is doubtful that the Middle Mississippian enclaves on the Illinois side found coexistence with the Oneota, if that is what happened, to be comfortable (Santure, Harn and Esarey 1990; Milner, Anderson and Smith 1991). Some interaction between Oneota and Middle Mississippian groups during the sixteenth century is indicated by a few Cahokia-style ceramics at the Kelley site (Tiffany 1979:99), but as Markman (1987:22) stresses the interactions with the Cahokia heartland did not translate into direct influences with many groups in the upper Midwest (cf. Tiffany 1991:189).

REFERENCES CITED

Alex, L., 1978, The Poison Ivy site: a new Oneota site in southeastern Iowa: Journal of the Iowa Archeological Society, v. 25, p. 78-91.

Anderson, D.C., 1980, The stone tool assemblages at the Cherokee site: *in* The Cherokee Excavations, Anderson, D.C., and Semken, H.A., Jr. (eds.), Academic Press, New York, p. 197-238.

Anderson, J.D., Green, W., and Vogel, R.C., 1987, Geomorphological Investigations: Mississippi River Pool 21, Illinois and Missouri with Archaeological & Historical Overviews: Donohue & Associates, Inc., Sheboygan.

Asch, N.B., and Asch, D.L., 1985, Archeobotany: *in* Deer Track: A Late Woodland Village in the Mississippi Valley, McGimsey, C.R., and Conner, M.C. (eds.), Center for American Archeology, Kampsville Archeological Center, Technical Report no. 1, p. 44-117.

Bailey, A.W., 1977, A Report on the Bennett-Roth Site, 11HE62: A Surface-Collected Site in Henderson County, Illinois: unpublished Masters Thesis, Department of Anthropology, Northern Illinois University, DeKalb.

Barnhardt, M.L., Dycus, D.C., Jelks, E.B., Lange, F.W., Mansberger, F.R., Phillippe, J.S, and Thomas, F.S., 1983, Preliminary cultural resource survey and geomorphological assessment of selected areas in navigation Pool 16, Mississippi River: The Wisconsin Archeologist, v. 64, nos. 1 & 2, p. 9-110.

Barrett, S.A., 1933, Ancient Aztalan: Bulletin of the Public Museum of the City of Milwaukee 13.

Benchley, E., 1978, Predictive models for archaeological site locations, Upper Mississippi River drainage, Illinois: *in* Predictive Models in Archaeological Resource Management,Brown, M.K. (ed.), Illinois Archaeological Survey Circular 3, p. 33-36.

Benchley, E., and Gregg, M.L., 1975, Final Report of an Intensive Archaeological Survey of the Meredosia Levee Project: Archaeological Research Laboratories, University of Wisconsin, Milwaukee.

Benchley, E., Gregg, M., and Dudzik, M.J., 1977, Recent investigations at Albany Mounds, Whiteside County, Illinois: Illinois Archaeological Survey Circular no. 2, Urbana.

Benchley, E., Hassen, H., and Billeck, W., 1979, Final report of archaeological investigations at the Sloan site (11-Mc-86) FAS Project 1210, Mercer County, Illinois: Archaeological Research Laboratory Report of Investigations no. 36, Milwaukee.

Benchley, E., et al., 1981, Rock River, Upper Mississippi River, Little Wabash River, Lower Wabash River Units (I, III-north, and VIII): *in* Predictive Models in Illinois Archaeology,. Brown, M.K., (ed.), Illinois Department of Conservation, p. 1-20.

Bender, B., 1985, Emergent tribal formations in the American midcontinent: American Antiquity, v. 50, no. 1, p. 52-62.

Benn, D.W., 1978, The Woodland ceramic sequence in the culture history of northeastern Iowa: Midcontinental Journal of Archaeology, v. 3, no. 2, p.215-284.

Benn, D.W., 1980, Hadfields Cave: Office of the State Archaeologist of Iowa, Report 13, Iowa City.

Benn, D.W., 1984, Excavations at the Christenson Oneota Site (13PK407), Central Des Moines River Valley, Iowa. Saylorville Lake, Iowa: Research Report No. 592, Center for Archaeological Research, Southwest Missouri State University, Springfield.

Benn, D.W., Anderson, J.D., Vogel, R.C. and Conrad, L., 1989, Archaeology, Geomorphology and Historic Surveys in Pools 13-14, Upper Mississippi River: Center for Archaeological Research Report no. 752, Springfield.

Benn, D.W., Bettis, E.A., III, and Vogel, R.C., 1988, Archaeology and Geomorphology in Pools 17-18, Upper Mississippi River: Center for Archaeological Research Report no. 714, Springfield.

Benn, D.W., and Rogers, L.D., 1985, Interpretive Overview of Cultural Resources in Saylorville Lake, Iowa: Center for Archaeological Research Project 627-II, Springfield.

Benn, D.W., Schermer, S., and Sellars, J., 1992, Excavations of Human Remains from the Sand Run West Site (13LA38), Louisa County, Iowa: Bear Creek Archeology Report no. 150, Decorah.

Benn, D.W. (ed.), 1987, Archaeology in the Mississippi River Floodplain at Sand Run Slough, Iowa: Report no. 690, Center for Archaeological Research, Southwest Missouri State University, Springfield.

Bennett, J.W., 1945, Archaeological Explorations in Jo Daviess County, Illinois: University of Chicago Press, Chicago.

Bennett, J.W., 1952, The Prehistory of the Northern Mississippi Valley: *in* Archeology of Eastern United States, Griffin, J.B. (ed.), University of

Chicago Press.

Bettis, E.A., III, and Hoyer, B.E., 1986, Late Wisconsinan and Holocene landscape evolution and alluvial stratigraphy in the Saylorville Lake area, Central Des Moines River Valley, Iowa: Iowa Geological Survey, Open File Report 86-1.

Bettis, E.A., III, and Littke, J.P., 1987, Holocene Alluvial Stratigraphy and Landscape Development in Soap Creek Watershed, Appanoose, Davis, Monroe, and Wapello Counties, Iowa: Open File Report 87-2, Iowa Quaternary Studies Groups Contribution no. 14, Iowa Geological Survey Bureau, Iowa City.

Billeck, W.T., and Benchley, E.D., 1982, Regional summary Northern Illinois: University of Wisconsin-Milwaukee, Archaeological Research Laboratory.

Boszhardt, R.F., and Overstreet, D.F., 1983, Preliminary investigations: Archaeology and sediment geomorphology, navigation Pool 12, Upper Mississippi River: The Wisconsin Archeologist, v. 64, nos. 1 & 2, p. 111-183.

Braun, D.P., 1983, Pots as tools: *in* The Hammer Theory of Archaeological Research, Moore, J.A., and Keene, A.S. (eds.), Academic Press, New York, p. 107-134.

Braun, D.P., 1986, Midwestern Hopewellian exchange and supralocal interaction: *in* Peer Polity Interaction and Socio-Political Change, Renfrew, C., and Cherry, J.F. (eds.), Cambridge University Press, Cambridge, p. 117-126.

Braun, D.P., and Plog, S., 1982, Evolution of 'tribal' social networks: Theory and prehistoric North American evidence: American Antiquity, v. 47, p. 504-525.

Braun, D.P., and Plog, S., 1986, Early ceramics and culture: A review of interpretations: *in* Early Woodland Archeology, Farnsworth, K.B., and Emerson T.E. (eds.), Center for American Archeology, Kampsville Seminars in Archeology no. 2, Kampsville, p. 598-608.

Brown, J.A., and Vierra, R.K., 1983, What happened in the Middle Archaic? Introduction to an ecological approach to Koster site archaeology: *in* Archaic Hunters and Gatherers in the American Midwest, Phillips, J.L., and Brown, J A. (eds.), Academic Press, New York, p. 165-195.

Brown, J.A., et. al., 1967, The Gentleman Farm site, LaSalle County, Illinois: Illinois State Museum Reports of Investigations 12, Springfield.

Brown, M.K. (ed.), 1981, Predictive Models in Illinois Archaeology: Illinois Department of Conservation.

Bryan, A.L. (ed.), 1978, Early Man in America: Occasional Papers no. 1, Department of Anthropology, University of Alberta, Edmonton.

Caldwell, J.R., 1958, Trend and Tradition in the Prehistory of the Eastern United States: Memoir 88, American Anthropological Association.

Chapman, C.H., 1975, Archeology of Missouri, Vol. I: University of Missouri Press, Columbia.

Charles, D.K., Leigh, S.R., and Buikstra, J.E. (eds.), 1988, The Archaic and Woodland cemeteries at the Elizabeth Site in the Lower Illinois Valley: Kampsville Archeological Center Research Series 7, Center for American Archeology, Kampsville.

Church, P.E., 1984, The Archaeological Potential of Pool no. 10, Upper Mississippi River; a Geomorphological Perspective: U.S. Army Engineers Waterways Experiment Station, Vicksburg.

Cole, F.C., 1945, Preface. Archeological Investigations in Jo Davies County, Illinois: University of Chicago Press.

Conrad, L.A., 1981, An introduction to the archaeology of upland west central Illinois: A preliminary archaeological survey of the Canton to Quincy corridor for the proposed FAP-407 highway project: Archaeological Research Laboratory, Western Illinois University, Report of Investigations 2.

Cook, T.G., 1976, Koster: An Artifact Analysis of Two Archaic Phases in West-central Illinois: Northwestern Archeological Program Prehistoric Records no. 1, Evanston.

Dudzik, M.J., 1974, Aboriginal Subsistence- settlement Systems in the Upper Mississippi River Valley: unpublished Masters Thesis, Department of Anthropology, University of Wisconsin, Milwaukee.

Eichhorn, R., 1983, Foreward: Archaeological surveys in navigation Pools 12 and 16, Upper Mississippi River valley: The Wisconsin Archeologist, v. 64, nos. 1 & 2, p. 1-8.

Emerson, T.E., 1991, The Apple River Mississippian culture of northwestern Illinois: *in* Cahokia and the Hinterlands, Emerson, T.E., and Lewis, R.B. (eds.), University of Illinois Press, Urbana, p. 164-182..

Emerson, T.E., and Fortier, A.C., 1986, Early Woodland cultural variation, subsistence and settlement in the American Bottom: *in* Early Woodland Archeology, Farnsworth, K.B., and Emerson T.E. (eds.), Center for American Archeology, Kampsville Seminars in Archeology no. 2, Kampsville, p. 475-522.

Esarey, D., 1987, The Town Branch sites: Archaic encampments on the Bushnell Prairie of west central Illinois: The Wisconsin Archeologist, v. 68, no. 2, p. 95-124.

Fokken, M.J., and Finn, M.R., 1984, Iowa's Great River Road, Louisa County: The Cultural Resource Group, Louis Berger & Associates, Inc., East Orange, N.J.

Fortier, A.C., Emerson, T.E., and Finney, F.A., 1984, Early Woodland and Middle Woodland Periods: *in* American Bottom Archaeology, Bareis, C.J., and Porter, J.W. (eds.), University of Chicago Press, Chicago, p. 59-103..

Fowler, M.L., 1955, Ware groupings and decorations of Woodland ceramics in Illinois: American Antiquity, v. 20, no 3, p. 213-225.

Fowler, M.L., 1971, An archaeological survey of the Illinois side of the Mississippi River valley from the mouth of the Des Moines River to the Wisconsin border: *in* Preliminary Report of 1971 Historic Sites Survey Archaeological Reconnaissance of Selected Areas in the State of Illinois, part I, Summary, p. 83-84, Department of Anthropology, University of Wisconsin, Milwaukee.

Gass, Reverend J., 1880, Report of exploration of Indian graves: Proceedings of the Davenport Academy of Natural Sciences, v. 2, p. 291-293.

Gass, Reverend J., 1881, Explorations of mounds in Louisa County, Iowa: p. 140-146; Ancient Fortifications in Louisa County, Iowa: p. 183-184; Mounds in Louisa County, Iowa: p. 189-190; Proceedings of the Davenport Academy of Natural Sciences 3.

Gass, Reverend J., 1883, Explorations of mounds in Mercer County, Illinois: Proceedings of the Davenport Academy of Natural Sciences, v. 3, p. 147-148.

Gibbon, G., 1972, Cultural dynamics and the development of the Oneota lifeway in Wisconsin: American Antiquity, v. 37, p. 166-185.

Gibbon, G., 1983, The Blue Earth phase of southern Minnesota: Journal of the Iowa Archeological Society, v. 30, p. 1-84.

Goodyear, A.C., 1982, The chronological position of the Dalton horizon in the southeastern United States: American Antiquity, v. 47, p. 382-395.

Gramman, J., 1981, Assessing navigation-related impacts on cultural resources of the Upper Mississippi River system: Paper presented at the Midwestern Archaeological Conference, Madison.

Great River Environmental Action Team, 1980, Main Report: Great II Upper Mississippi River, U.S. Army Corps of Engineers.

Green, W., 1987, Between Hopewell and Mississippian: Late Woodland in the Prairie Peninsula as Viewed from the Western Illinois Uplands: unpublished Ph.D. Thesis, Department of Anthropology, University of Wisconsin, Madison.

Green, W. (ed.), 1988, Archaeological and Peleoenvironmental Studies in the Turkey River Valley, Northeastern Iowa: Research Papers Series 13(1), Office of the State Archaeologist, Iowa City.

Green, W., Nansel, B., Bettis, E.A., III, and Whelan, M.K., 1990, IAS field school surveyed southest Iowa: Iowa Archeological Society Newsletter, v. 40, no . 3, p. 3-4.

Gregg, M.L., 1972, An archaeological survey of the Illinois side of the Mississippi River valley from the mouth of the Des Moines River to the Wisconsin border: *in* Preliminary Report of 1972 Historic Sites Survey Archaeological Reconnaissance of Selected Areas in the State of Illinois, part I, Summary Section B. p. 83-90, Department of Anthropology, University of Wisconsin, Milwaukee.

Gregg, M.L., 1974, Three Middle Woodland sites from Henderson County: An apparent congruity with Middle Woodland subsistence settlement systems in the Lower Illinois valley: The Wisconsin Archeologist, v. 55, no. 3, p. 231-245.

Griffin, J.B., 1952, Some Early and Middle Woodland pottery types in Illinois: *in* Hopewellian Communities in Illinois, Deuel, T. (ed.), p. 95-129, Illinois State Museum Scientific Papers no. 5, Springfield.

Hall, R.L., 1980, An interpretation of the two-climax model of Illinois prehistory: *in* Early Native Americans: Prehistoric Demography, Economy, and Technology, Browman, D.L. (ed.), p. 401-462, Mouton Publishers, The Hague.

Harn, A.D., 1975, Cahokia and Mississippian emergence in the Spoon River area of Illinois: Transactions of the Illinois Academy of Science, v. 68, p. 414-434.

Hassen, H., and Farnsworth, K.B., 1987, The Bullseye Site: Illinois State Museum Reports of Investigations no. 42, Springfield.

Henning, E.R.P., 1985, Initiating the Resource Protection Planning Process in Iowa: Iowa State Historical Department, Office of Historic Preservation, Des Moines.

Herold, E.B. (ed.), 1971, The Indian Mounds at Albany, Illinois: Davenport Museum Anthropological Papers no. 1, Davenport.

Hotopp, J. (ed.), 1977, Iowa's Great River Road Cultural-Natural Resources, Vol. II: Archaeology, Geology and Natural Areas: Iowa Department of Transportation.

Hurley, W.M., 1975, An analysis of Effigy Mound complexes in Wisconsin: Museum of Anthropology, University of Michigan, Anthropological Papers no. 59. Ann Arbor.

Johnson, R.D., et. al., 1985, Cultural resources investigation for 17 public recreation areas, Navigation Pools 13-24, Mississippi River, Iowa, Illinois and Missouri: Contract Completion Report 217, Office of the State Archaeologist of Iowa, Iowa City.

Kelly, J.E., et. al., 1984, Late Woodland period: *in* American Bottom Archaeology, Bareis, C.J., and Porter, J.W. (eds.), University of Illinois Press, Urbana, p. 104-127.

King, J.E., 1981, Late Quaternary vegetational history of Illinois: Ecological Monographs, v. 51, p. 43-62.

Klippel, W.E., and Maddox, J., 1977, The Early Archaic of Willow Branch: Midcontinental Journal of Archaeology, v. 2, p. 99-130.

Lensink, S.C. (ed.), 1986, Archaeological Investigations along the F-518 Corridor: Phase III Mitigation of 12WS61, 13WS65, 13WS122, 13WS126: Iowa Quaternary Studies Contribution 9, University of Iowa, Iowa City.

Lewis, T.H., 1885, Northwestern Archaeological Surveys: Notebook no. 36, Copy on file in archives of the Minnesota State Historical Society, St. Paul.

Lindley, C.T., 1877, Mound explorations in Jackson County, Iowa: Proceedings of the Davenport Academy of Natural Sciences, v. II, no. 1, p. 83-84, Davenport.

Lindley, C., 1876, Mound explorations in 1875: Proceedings of the Davenport Academy of Natural Sciences 1.

Lippincott, K.A., and Herold E.B., 1965, Archaeological investigation along Henderson Creek drainage projects, Henderson County, Illinois: *in* Middle Woodland Sites in Illinois, Illinois Archaeological Survey, Bulletin no. 5, p. 95-128.

Logan, W.D., 1976, Woodland Complexes in Northeastern Iowa: Publications in Archaeology 15, National Park Service, Washington, D.C.

Luchterhand, K., 1970, Early Archaic Projectile Points and Hunting Patterns in the Lower Illinois Valley: Illinois Archaeological Survey Memoir 2.

Lynch, E.P., et. al., 1893, Mound explorations at Toolesboro, Louisa Couty, Iowa: Proceedings of the Davenport Academy of Natural Sciences, v. 5, p. 37-44.

McConaughy, M.A., Jackson, C.V., and King, F.B., 1985, Two Early Mississippian period structures from the Rench site (11P4), Peoria County, Illinois: Midcontinental Journal of Archaeology, v. 10, no. 2, p. 171-194.

McElrath, D.L., et. al., 1984, Late Archaic period: *in* American Bottom Archaeology, Bareis, C.J., and Porter, J W. (eds.), University of Illinois Press, Urbana. p. 36-58.

McKusick, M., 1975, A perspective of Iowa prehistory 1841-1928: The Wisconsin Archeologist, v. 56, no. 1, p. 16-54.

McKusick, M., 1979, Documenting Iowa prehistory: 1928-1964: The Wisconsin Archeologist, v. 60, no. 1, p. 3-25.

McMillan, R.B., and Klippel, W.E., 1981, Post-glacial environmental change and hunting-gathering societies of the southern Prairie Peninsula: Journal of Archaeological Science, v. 8, p. 215-245.

McWorter, T., 1875, Ancient mounds of Mercer County, Illinois: Annual Report of the Smithsonian Institution for 1874, p. 351-535.

Mallam, R.C., 1976, The Iowa Effigy Mound Manifestation: An Interpretive Model: Report no. 9, Office of the State Archaeologist, Iowa City.

Markman, C.W., 1987, Above the American Bottom: The Late Woodland-Mississippian Transition in Northeastern Illinois: Paper presented at the Society for American Archaeology Meeting, New Orleans.

Markman, C.W., 1988, Putney Landing: Archaeological Investigations at a Havana-Hopewell Settlement on the Mississippi River, West-Central Illinois: Northern Illinois University Archaeological Research Series No. 2, DeKalb.

Milner, G.R., Anderson, E. and Smith, V.G., 1991, Warefare in late prehistoric west-central Illinois: American Antiquity, v. 56, no. 4, p. 581-603.

Morgan, D.T., 1985, Late Woodland ceramics from the Fall Creek locality, Adams County, Illinois: The Wisconsin Archeologist, v. 66, no. 3, p. 265-281.

Munson, P.J., 1982, Marion, Black Sand, Morton and Havana relationships: An Illinois valley perspective: The Wisconsin Archeologist, v. 63, no. 1, p. 1-17.

Munson, P.J., 1986, Black Sand and Havana tradition ceramic assemblages and culture history in the Central Illinois River valley: *in* Early Woodland Archeology, Farnsworth, K.B. and Emerson T.E. (eds.), Center for American Archeology, Kampsville Seminars in Archeology no. 2, Kampsville, p. 280-300.

Orr, E., 1935, Report of a state-wide reconnaissance survey of Indian mound groups and excavation of camp sites, under project 1047 of the Iowa Planning Board, Vol. 2: Manuscript on file at the Office of the State Archaeologist, Iowa City.

Orr, E., 1963, Iowa Archaeological Reports 1934-1939 with an Evaluation and Index by Marshall McKusick: Archives of Archaeology, Microcard Series 20, Society for American Archaeology, Baerreis, D. (ed.), University of Wisconsin Press, Madison.

Osborn, N.M., and Gradwohl, D.M., 1981, Saylorville Stage 2 Contract Completion Report: Archaeological Investigations in the Saylorville Lake Project, Iowa: Iowa State University Archaeological Laboratory, Ames.

Overstreet, D.F., 1984a, Archaeological Reconnaissance Survey of Pool 10, Upper Mississippi River, Grant and Crawford Counties, Wisconsin, and Allamakee and Clayton Counties, Iowa: Reports of Investigations no. 139, Great Lakes Archaeological Research Center, Wauwatosa.

Overstreet, D.F., 1984b, Archaeological Investigations at the Grant River Public Use Area: Great Lakes Archaeological Research Center, Inc., Reports of Investigations No. 149, Wauwatosa.

Overstreet, D.F., 1985, Archaeological Investigations, Navigation Pool 11, Upper Mississippi River Basin: Great Lakes Archaeological Research Center, Inc., Reports of Investigation No. 151, Wauwatosa.

Perry, M.J., 1982, Phase II investigation Louisa County: Office of the State Archaeologist, Contract Completion Report no. 5 (41), Iowa City.

Perry, M.J., 1987, Late Woodland ceramics in southeastern Iowa: A perspective from the lower Skunk Valley: Journal of the Iowa Archeological Society, v. 34, p. 57-69.

Perry, M.J., 1991, Middle Woodland field camps in the Cedar Valley: Journal of the Iowa Academy of Science, v. 98, no. 3, p. 109-117.

Petersen, R.W., 1978, Cultural Resources of the Upper Mississippi Valley: Guttenberg, Iowa to Saverton, Missouri, Volume I: Iowa Division of Historic Preservation, Iowa City.

Price, T.D., and Brown, J.A., 1985, Aspects of Hunter-Gatherer Complexity: In Prehistoric Hunters-Gatherers, Price, T.D., and Brown, J.A.. (eds.), Academic Press, New York, p. 3-20..

Riggle, S., 1981, The Late Woodland Transition in the central Mississippi valley: AD 700-1100: South Dakota Archaeology 5.

Rogers, L.D., Stanley, D.G., and. Anderson, J.D, 1987, Archaeological Testing, NRHP Eligibility Determination and Impact Assessment, Lake Red Rock, Iowa, Pool Raise Project: Cultural Resources Management Report no. 127, American Resources Groups, Ltd., Carbondale, (draft)

Santure, S.K., Harn, A.D., and Esarey, D., 1990, Archaeological Investigations at the Morton Village and Norris Farms 36 Cemetery: Illinois State Museum Reports of Investigations No. 45, Springfield.

Seeman, M.F., 1979, The Hopewell Interaction Sphere: The evidence for interregional trade and structural complexity: Indiana Historical Society, Prehistory Research Series V(2), Indianapolis.

Slattery, R.G., Horton, G.A. and Ruppert, M.E., 1975, The McKinney Village site: An Oneota site in southeastern Iowa: Journal of the Iowa Archeological Society, v. 22, p. 35-61.

Smith, C., and Barr, K., 1985, Cultural Resources Reconnaissance at Prehistoric Sites 13LA30 and 13LA38, Sand Run Slough, Mississippi River Louisa County, Iowa: Report on file, U.S. Army Engineer District, Rock Island.

Springer, J.W., and Harrison, W.F., 1979, Archaeological remains in an upland locality of the Kishwaukee River drainage, northern Illinois: The Wisconsin Archeologist, v. 60, p. 295-329.

Starr, F., 1897a, Bibliography of Iowa antiquities (p. 1-24).

Starr, F., 1897b, Summary of the archaeology of Iowa: Proceedings of the Davenport Academy of Natural Sciences 6, p. 53-124..

Stoltman, J.B., 1986a, The Prairie phase: An Early Woodland manifestation in the Upper Mississippi valley: *in* Early Woodland Archeology, Farnsworth, K.B., and Emerson, T.E. (eds.), Center for American Archeology, Kampsville Seminars in Archeology no. 2, Kampsville, p. 121-136.

Stoltman, J.B., 1986b, The Archaic tradition: *in* Introduction to Wisconsin Archaeology, Green, W., Stoltman, J.B., and Kehoe, A.B. (eds.), The Wisconsin Archeologist, v. 67, nos. 3 & 4, p. 207-238.

Struever, S., 1968, Woodland Subsistence-Settlement Systems in the Lower Illinois River Valley: *in* New Perspectives in Archeology, Binford, S.R. and Binford, L.R. (eds.), Aldine Publishing Co., Chicago, p. 285-312.

Struever, S., and Houart, G.L., 1972, An analysis of the Hopewell Interaction Sphere: *in* Social Exchange and Interaction, Wilmsen, E. (ed.), Museum of Anthropology, University of Michigan, Anthropological Papers no. 46, Ann Arbor, p. 47-79.

Theler, J.L., 1983, Woodland Tradition Economic Strategies: Animal Resource Utilization in Southwestern Wisconsin and Northeastern Iowa: unpublished Ph.D. Thesis, University of Wisconsin, Madison.

Thompson, T., 1879, Mounds in Muscatine, Iowa & Rock County, Illinois: Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1879. p. 359-363.

Tiffany, J.A., 1979, An overview of Oneota sites in southeastern Iowa: A perspective from the ceramic analysis of the Schmeiser site, 13DM101, Des Moines County, Iowa: Proceedings of the Iowa Academy of Science, v. 86, no. 3, p. 89-101.

Tiffany, J.A., 1981, The Keyes Archaeological Collection: A Finders Guide: Iowa State Historical Department, Division of the State Historical Society, Iowa City.

Tiffany, J.A., 1982a, Hartley Fort ceramics: Proceedings of the Iowa Academy of Science, v. 89, p. 133-150.

Tiffany, J.A., 1982b, Site catchment analysis of southeast Iowa Oneota sites: *in* Oneota Studies, Gibbon, G. (ed.), University of Minnesota Publications in Anthropology no. 1, Minneapolis, p. 1-14.

Tiffany, J.A., 1991, Models of Mississippian culture history in the Western Prairie Peninsula: A perspective from Iowa: *in* Cahokia and the Hinterlands, Emerson, T.E., and Lewis, R.B. (eds.), University of Illinois Press, Urbana, p. 183-192.

Warren, R.E., and. O'Brien, M.J, 1982a, Models of adaptation and change: p. 85-100.

Warren, R.E., and. O'Brien, M.J, 1982b, Conclusions: *in* The Cannon Reservoir Human Ecology Project, O'Brien, M.J., Warren, R.E., and Lewarch D.E. (eds.), Academic Press, New York, p. 391-394.

Wendland, W.M., 1978, Holocene man in North America: The ecological setting and climatic background: Plains Anthropologist, v. 23, no. 82, pt.1, p. 278-287.

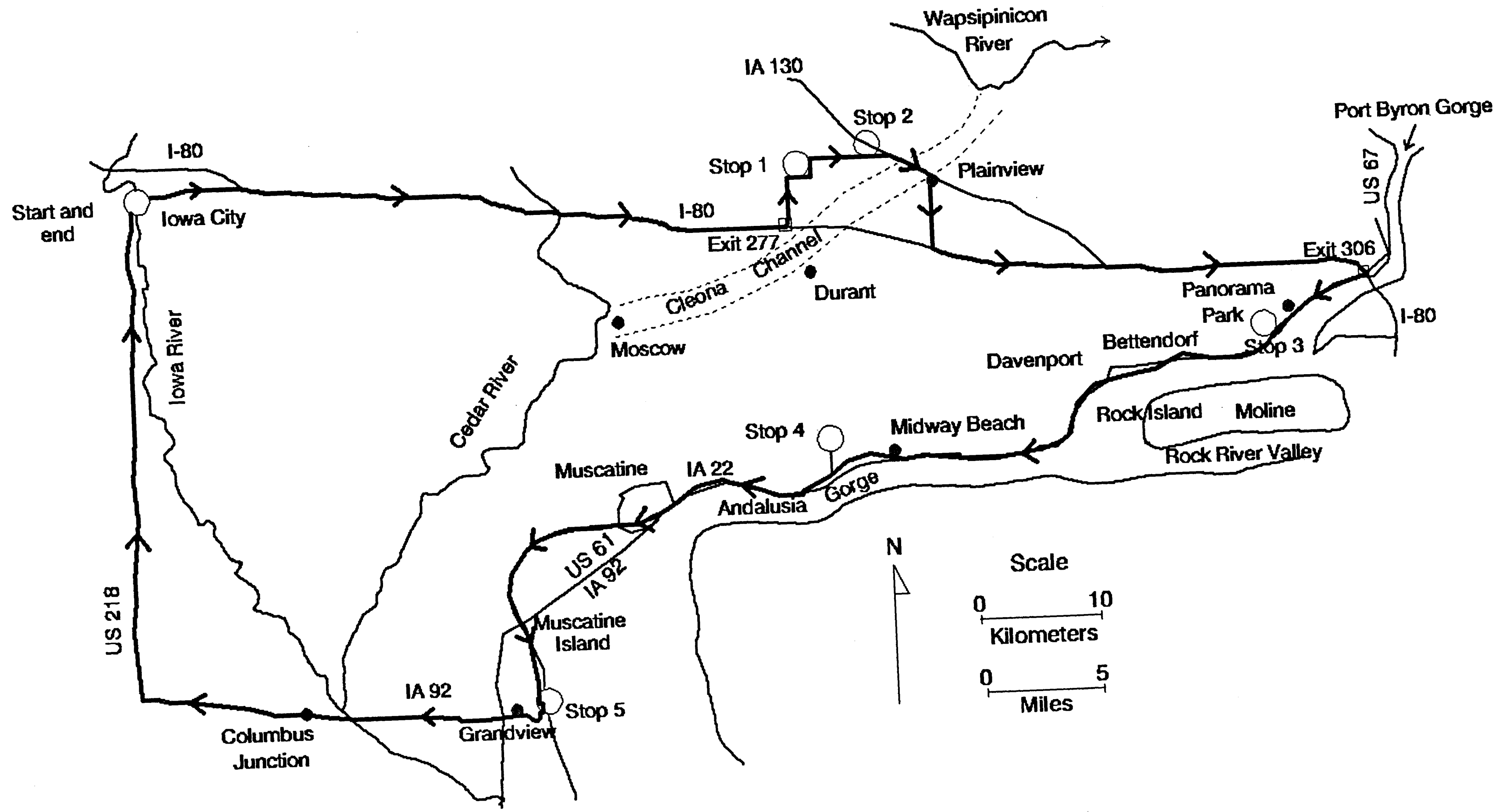
White, J.K., 1985, Ceramics: *in* Deer Track: A Late Woodland Village in the Mississippi Valley, McGimsey, C.R., and Conner, M.D. (eds.), Center for American Archeology, Kampsville Archeological Center, Technical Report no. 1 p. 27-43.

Wiant, M.D., et. al., 1986, Geology and archaeology of a Holocene alluvial/colluvial fan at the Koster site: *in* Quaternary Records in Southwestern Illinois and Adjacent Missouri, Field Guide, American Quaternary Association, Ninth Biennial Meeting, Urbana, p. 98-111.

Willey, G.R., and Sabloff, J.A., 1974, A History of American Archaeology: W.H. Freeman and Company, San Francicso.

Wormington, H.M., 1964, Ancient Man in North America: Denver Museum of Natural History Popular Series no. 4 (fourth edition).

Wright, H.E., Jr., 1968, History of the Prairie Peninsula: *in* The Quaternary of Illinois, University of Illinois College of Agriculture Special Publications 14, p. 77-88.



Wapsipinicon
River
IA 130
Stop 2
Port Byron Gorge
Stop 1
Plainview
I-80
US 67
Start and
end
Iowa City
I-80
Exit 277
Channel
Exit 306
Cleona
Durant
Panorama
Park
I-80
Moscow
Bettendorf
Stop 3
Davenport
Iowa River
Cedar River
Rock Island
Moline
Stop 4
Midway Beach
Rock River Valley
Muscatine
IA 22
Gorge
Andalusia
N
Scale
US 61
IA 92
0
10
Kilometers
US 218
Muscatine
Island
0
5
Miles
IA 92
Stop 5
Columbus
Junction
Grandview

Iowa Department of Natural Resources
Energy and Geological Resources Division
Geological Survey Bureau
109 Trowbridge Hall
Iowa City, Iowa 52242-1319
(319) 335-1575