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## The Pleistocene Geology of the Middle Portion of the Elkhorn River Valley

W. D. Frankforter

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**The Pleistocene Geology  
of the  
Middle Portion of the Elkhorn River Valley**



**W. D. FRANKFORTER**



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**UNIVERSITY OF NEBRASKA STUDIES**

July 1950

NEW SERIES NO. 5

# University of Nebraska Studies

July 1950

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## THE PLEISTOCENE GEOLOGY OF THE MIDDLE PORTION OF THE ELKHORN RIVER VALLEY

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W. D. FRANKFORTER

NEW SERIES NO. 5

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PUBLISHED BY THE UNIVERSITY AT LINCOLN, NEBRASKA

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## INTRODUCTION

The present report is a physiographic and paleontologic approach to the Pleistocene history of a portion of the Elkhorn River Valley in parts of Dodge, Cuming and Stanton counties in northeastern Nebraska. The area is important for correlation of deposits between the glacial and periglacial regions. Some of the critical stratigraphic units used for correlation in the Pleistocene of these regions are present in close association with the tills and contain fossils which make possible reliable statements on contemporaneity of deposits. The subsequent geologic history and present physiographic expression of this area have been greatly controlled and influenced by the Nebraskan and Kansan tills.

It is hoped that this study will form a basis for further investigation of an area for which the geology has been largely unreported. J. E. Todd in 1899 described several exposures in the vicinity of West Point which are incorporated into this report. A. L. Lugin (1935) reported a gravel pit section within the borders of this report east of Norfolk and made general comments on Pleistocene deposits along the Elkhorn River to the east. The area has not been test drilled and, therefore, subsurface information is most limited. In a few cases information from commercial water-well drillers and others has been utilized. Fortunately, the lower part of the Elkhorn drainage has been investigated and reported (Lueninghoener 1947) and this information facilitates this present work. Lueninghoener's treatment of the lower Platte River region presents the geologic information in a most satisfactory way. For this reason and because it will be convenient for future work in these contiguous areas, this report follows the general method of presentation employed in his paper.

## PROCEDURE

The writer was somewhat familiar with the area investigated before it was selected as the subject of this report. Several trips had been made to the gravel pits in this region for the purpose of collecting fossils which proved to be of great value in dating geological deposits. When it was decided to report upon the physiographic history and paleontology of the area, a reconnaissance trip covering the entire area was made. General observations, as well as detailed notes on seemingly critical situations were recorded. Next, through the use of county soil maps in conjunction with Agricultural Adjustment Administration aerial photographs viewed stereoscopically the entire area was inspected for evidence of outcrops and terrace surfaces. It was discovered that certain soil types are confined essentially to certain terrace levels. However, in many cases, the aerial photographs suggested that the same soil type occurred on two different terrace levels and this was later verified in the field. The information taken from the aerial photographs was transferred to the soil maps which were used as a base map for the subsequent investigation. The value of aerial photographs in the initial stages of investigation of a new region is inestimable. The existence of the ET-4 surface in this report was first discovered through the use of aerial photographs.

The field work consisted of visiting all outcrops that could be discovered in the region and making detailed notes. Many places were visited several times as the investigation proceeded in order to re-examine earlier interpretations in the light of new evidence. Geologic sections were drawn for the critical outcrops and detailed descriptions were made. In addition, the terrace borders as delineated from aerial photographs were checked and alterations made where necessary. A map to a scale of one-half inch per mile has been prepared and the various terrace surfaces and till outcrops are indicated with conventional symbols. Each geologic section has been given a number and a name corresponding to its proximity to some town, stream or some fairly permanent feature. In some cases the name of the owner of the land was used. The geologic sections are indicated on the map and a geographic location by section, township and range, and its approximate location in relation to a nearby town is given under the location of each exposure.

## PHYSIOGRAPHIC DESCRIPTION

This report covers an area of 498 square miles (96 square miles in Stanton County, 360 square miles in Cuming County, and 42 square miles in Dodge County) mainly confined to the Elkhorn River Valley. Although the region investigated included a much larger area, it seemed advisable to restrict the report to the critical situations. Much of the country back from the Elkhorn River is a dissected upland and the streams either have no terraces developed or contain only the most recent fills which are not essential to a discussion and interpretation of the main events in the Pleistocene.

The Elkhorn River flows toward the northeast in the eastern part of Stanton County and the main tributary in that area is Humbug Creek which flows toward the southeast joining the Elkhorn about one mile west of Pilger. Two distinct terrace levels are developed on the north side of the Elkhorn southwest of Pilger and one of these can be traced into Humbug Creek where it forms the valley floor.

In Cuming County the Elkhorn River flows diagonally toward the southeast to about West Point where it turns and flows almost straight south. The main tributaries included in this report are Plum Creek and Cuming Creek which flow almost parallel to the direction of the Elkhorn. The whole drainage pattern of the county trends from northwest to southeast and the main tributaries are separated from the Elkhorn River by only four to five miles at the most. Thus the minor tributaries of the Elkhorn River are extremely short, heading within a distance of one to three miles of the river. Various terrace levels are well-developed in this county and comprise some of the best farm land. Notable areas are (1) across the river to the west from West Point, (2) a high level just up stream from (1) on the same side of the river, and (3) the terrace upon which the town of Beemer is situated. An area of extremely sandy material lies to the east and southeast of West Point and is bounded by the Elkhorn River on the west and Cuming Creek on the east. This area appears to have had a unique history which is discussed in detail in the text.

A part of Dodge County has been considered in this report because some of the important deposits extend into this county. This region of the study has been reported by Lueninghoener (1947) and in the light of new evidence different conclusions have been reached for part of this area. It should be emphasized that detailed subsurface information may give a different interpretation for some of these deposits and

that age designations are necessarily subject to revision when new lines of evidence afford a better understanding of stratigraphic sequences.

The terraces have been designated by number starting with the recent flood plain and numbering in order from the lowest to the highest in agreement with the usual method employed in Nebraska (Schultz and Stout, 1945). In addition, since the correlations with other drainages in Nebraska are still tentative, a prefix abbreviation of "Elkhorn Terrace" has been added, for example, (ET-2) = (Elkhorn Terrace-2).

As will be noticed, the terrace numbers used in this report do not correspond to numbers of equivalent terraces in Lueninghoener's (1947) report of the adjacent lower Platte River drainage. This difference is unavoidable because of different age interpretations for the various fills. In order that the maps of the two reports may be used together without confusion as to correlation of terraces, surfaces believed to be equivalent (although of different number) have been designated with the same cross-hatch symbol.

## STRATIGRAPHIC UNITS

The stratigraphic units recognized in this paper are as follows:

1. ET-0 Fill (Elkhorn Terrace—Number Zero). This is a dark brown to black fill from 0 to 15 feet thick mainly confined to the present floodplain except where the artificial straightening of channels on tributaries to the Elkhorn River has increased the gradient and caused dissection. This recent cutting has exposed the base of the fill and on Humbug Creek has resulted in eroding out many bison skulls and skeletal parts.
2. ET-1 Fill (Elkhorn Terrace—Number One). This is a dark buff, mottled loessic silt containing numerous dark humic layers at varying heights where observed on the tributaries to the Elkhorn River. Only one good exposure of this terrace was found on the Elkhorn River itself and there the dark layers were lacking. Its undissected surface is between 30 to 35 feet above the present river water level.
3. ET-2 Fill (Elkhorn Terrace—Number Two). The fill which makes up this terrace is a yellow-buff loessic silt so far as could be determined. Although it is extensively developed along the Elkhorn River, it is often bordered by the ET-1 fill and good exposures are lacking. Roadside exposures were the main means of investigating the content of the terrace but the surface forms

a definite physiographic feature at about 60 feet above the present normal river level.

4. ET-3 Fill (Elkhorn Terrace—Number Three). It may seem, at first sight, rather peculiar to designate a level which apparently does not occur in this portion of the Elkhorn River Valley, but it is undeniably present just outside of the area investigated. As is suggested in this report, it may be present and unrecognized because of severe erosion and mantling by younger deposits or it may have been swept out of this portion of the valley entirely. In any case, it must be considered in the general history of the valley.
5. Middle to Late-Wisconsin loess. This deposit forms a loess lip on top of ET-4 and is considered to be subsequent to the formation of that terrace as a physiographic form. It is a yellow-buff loess which has blown up onto the edge of the terrace and surrounding uplands from the valleys.
6. Early-Wisconsin loess. This is a light buff, sandy, silty loess which underlies the later loesses and usually makes a definite contrast in color and lithology. It forms a slight shoulder in some places. This is considered to be Iowan in age and perhaps equivalent, in part, to the loessic silt and sand deposit east and southeast of West Point. This is considered to be the last deposit in the sequence of beds which, through several periods of alluviation and erosion, built sediments up to a point now approximately 120 feet above the present river level.
7. Loveland soil. In this region this is usually a dark pinkish-red soil developed on the Loveland loessic silt or contemporaneously on older deposits.
8. Loveland formation. In this region this formation is a loessic silt where seen in the valley and a very sandy silt often apparently of reworked local sediments on the uplands bordering the valley. This formation is not as thick in this area as it is in many parts of the Great Plains region.
9. Sappa formation (Reed, 1948 and Condra, Reed and Gordon, 1950). This deposit is made up of greenish-gray silts, clays, and marls in which ostracods occur. It also is reported to contain a bed of volcanic ash in restricted areas. Sands and gravels occur in the basal portion which may extend beneath the present valley floor.

10. Kansan till. This is a weathered and leached glacial boulder clay, gray toward the base and grading up into yellow and red.
11. Early Kansan sands and gravels. This deposit tends to be coarser near the bottom and finer above, with some silty bands toward the top. A mixed zone of sand, gravel, clay balls, and glacial boulders separates this bed from the overlying till in many places. This is thought to be the result of slight reworking of the upper few feet of gravel in front of the advancing glacier.
12. Nebraskan till. A typical glacial boulder clay deeply weathered. The basal unweathered portion is a dark blue-gray, grading into a yellow oxidized zone above. It contains large frigites of soft brown sand in some exposures.

## GEOLOGIC SECTIONS

### SECTION NO. 1 (NORFOLK-NORTH GRAVEL PIT)

#### LOCATION

Near center S edge, SW $\frac{1}{4}$ , sec. 30, T. 24 N., R. 1 E., Stanton County. This is about two miles southeast of Norfolk, Madison County, on the north side of State Highway 275.

#### SECTION

	Feet
1. Wisconsin loess, yellow-buff (probably much removed through erosion) .....	0-8
2. Kansan till (gray below to yellow above with a red zone at top, deeply weathered).....	0-40
3. Early Kansan sandy silt, sand, and gravel.....	35-40

The base of the section is at water level.

#### DISCUSSION

This exposure (Fig. 1) is at the edge of the Elkhorn River Valley and is the result of excavation for gravel. Only small amounts of gravel are being removed at present, but extensive work was done a few years ago which resulted in exposing a face approximately 300 feet long facing the west. Slumping is rapidly building up a talus slope which will eventually cover the lower part of the exposure. A deep excavation near the center of the pit contains water and since it lies below the level of the valley surface to the west it is thought this approximately represents the river level. For that reason this water level was used as a starting point for the measurements at this exposure.

Above the water level there is a 35 to 40 foot bed of stratified sand, gravel and silty sand. The gravel grades laterally into a white-buff sand and there is a great amount of intermingling of sands and gravels and much textural change throughout. Above this is a 40 foot layer of till, gray in the lower ten to twelve feet grading upward into a yellow color, becoming dark red in the upper few feet. Between the till and the underlying sand and gravel is a heavily iron-stained streak. The base of the till slopes slightly to the south. The till is deeply weathered as may be seen in Fig. 2. The zones of weathering penetrate to the base and are normally about four or five inches wide. These zones run in all directions from vertical to horizontal. The center  $\frac{1}{4}$  to  $\frac{1}{2}$  inch is a light gray with sometimes a dark line down the center. On each side of the gray is a zone two to three inches wide oxidized to a yellow color. Often the outer edge is a deep yellow to orange color. Beyond this is the buff-gray (dry), calcareous till. Calcareous seams cross the till in many directions and calcareous concretions occur scattered uniformly throughout. Occasionally, boulders occur in the till, and while these are mainly granites and limestones, a small amount of red (Sioux) quartzite is present. Above the till at this spot there is about eight feet of yellow loess. The upper part of this section was measured in a plowed field back of the edge of the gravel pit excavation and so observations on the loess were difficult. At the north end of the pit the till and gravel have been cut by erosion and a yellow loessic silt lies on this eroded surface. Where this deposit thins out against the till and gravel it contains much sand and gravel and some reworked till.

The till at this exposure is thought to be Kansan on the basis of the (1) deep weathering, (2) lack of a more recent till over it which might be expected were it the Nebraskan, (3) presence of some (although unusually little) red (Sioux) quartzite, thought to be common in the Kansan till, and (4) relatively high topographic position. The weathering, as mentioned above, reaches to the base and evidently is the result of long exposure of the till surface. It has above it only a yellow loess deposited during some phase of the Wisconsin glacial age, thus leaving the interval from Kansan glaciation until the deposition of the loess for the weathering to occur. This seems adequate time for the degree of weathering and leaching accomplished. The upper part of the sands and gravels below the till are believed to be closely associated with the till and appear to be the outwash of the advancing Kansan glacier. More evidence to support this conclusion will be

reviewed when other exposures are considered. However, at this spot the lack of any erosion of the sand surface or evidence of weathering at the contact with the till indicates a close temporal relationship between this Early Kansan sand-gravel deposit and the Kansan till.

## SECTION NO. 2 (NORFOLK-SOUTH GRAVEL PIT SECTION)

### LOCATION

Center, north line, NW $\frac{1}{4}$ , sec. 31, T. 24 N., R. 1 E., Stanton County. Approximately two miles southeast of Norfolk, Madison County, on the south side of State Highway 275.

SECTION	Feet
1. Wisconsin loess or loessic silt, yellow-buff and containing invertebrates. This is in the form of a valley fill.....	0-18
2. Loveland sandy loess and reworked till. This is also a fill in the eroded till and may include some younger material in the upper part.....	0-15
3. Kansan till (measured to hill north of highway).....	0-40
4. Early Kansan sandy silt, sand and gravel.....	35-45
The base of the section is at water level.	

### DISCUSSION

This exposure (Fig. 3) is across the highway south from Section No. 1. The city of Norfolk is at present removing an excellent grade of gravel from this pit. The removal of gravel continues to maintain a clean exposure affording one a better view of the sequence of beds than is present in Section No. 1. The pit is approximately 200 feet by 200 feet and the exposed face forms an arc open to the west.

At the base along this entire exposure is the same bed of gravels, sands and silty sands as is exposed across the road to the north. Here, these deposits are usually free of talus cover and exhibit excellent cross-bedding and stratification. The silty to silty sand horizons form prominent ledges across the face of the exposure and illustrate how closely the bedding planes of these lower deposits parallel the base of the till. At one spot in this pit, excavation is carried to the water level and affords a view lower in the section than seen in Section No. 1. The sands and gravels continue to the water level and include a zone containing brownish pink and buff-gray clay balls mixed with gravel. The overlying till, which was recently undermined, breaks off in great slabs leaving perpendicular faces eight to ten feet or more in height. These faces are coated with a red hematitic deposit down to the sand.



The till here is also deeply weathered and obviously is a continuation of that in Section No. 1, only a few yards north since it is also exposed in the road cut between the two pits. The base of the till dips slightly to the northwest.

Erosion has cut the till surface at several points and on the east has cut through to the gravel. On this eroded surface is a deposit of yellowish red sandy to gravelly silt up to fifteen feet thick which becomes dark toward the top where an old soil was developed. In some cases this soil development took place directly on the till surface or upon a few inches of reworked till lying on the till surface. This whole reddish-colored deposit appears to be made up of reworked till with, perhaps, some loessic addition. Near the road to the north (left side, Fig. 3) the lower part of this deposit is a buff-colored silty gravel capped by a deep red zone.

A later dissection has cut through the reddish material and till into the gravels. This was then filled with a yellow-buff, silty loess 18 feet thick in this exposure and containing invertebrates.

The close relationship of the sand-gravel and till beds seems more obvious here. The bedding planes of the sands, silty sands and gravel are essentially parallel to the base of the till. This basal deposit is considered to be Early Kansan inwash-outwash. The till is designated as Kansan for the reasons mentioned in Section No. 1, i.e., deep weathering and leaching, presence of some red quartzite, high topographic position, and red oxidized zone on the till. In addition to this red zone there is a deposit succeeding the erosion of the till and antedating or contemporaneous with the formation of the soil which caps the till. This is thought to be a Loveland deposit and the time of this main soil formation is considered to be post-Loveland or Sangamon. The relation of the Wisconsin deposits to the earlier deposits is well illustrated by the deep dissection of the till by a small upland tributary to the Elkhorn and a subsequent filling by probably a Late Wisconsin loess. A thin soil is developed on this Wisconsin fill while the soil in the upper part of the Loveland deposit is extremely deep indicating exposure of this surface for a relatively much longer time.

### **SECTION NO. 3 (NORFOLK-EAST GRAVEL PIT SECTION)**

#### **LOCATION**

SW corner, SE $\frac{1}{4}$ , sec. 30, T. 24 N., R. 1 E., Stanton County. This pit is slightly more than two miles southeast of Norfolk, Madison County, on the north side of State Highway 275.

**DISCUSSION**

This abandoned pit east of Section No. 1 exhibits a similar relationship of till to underlying gravel. See Lugn (1935, p. 65). The deeply iron-stained zone at the contact of the till and gravel beds seems to be characteristic and at one spot in this pit the sand is cemented into a resistant layer which is stained a deep red-brown. It is probable that this ferruginous zone is caused from water seeping down through the loess and till, taking iron into solution, then depositing it upon reaching the sand.

**SECTION NO. 4 (WAGNER GRAVEL PIT SECTION)****LOCATION**

At the W edge of the NE $\frac{1}{4}$ , sec. 31, T. 24 N., R. 1 E., Stanton County. This pit is located about two and one-half miles southeast of Norfolk, Madison County.

**DISCUSSION**

A pit has been opened recently by Mr. Erhardt Wagner, the owner. The exposure is similar to those in the near-by gravel pits already discussed and does not warrant a detailed description. A bed of sand and gravel, containing many clay balls, is overlain by Kansan till and Wisconsin loess.

Other exposures of till are not encountered until one reaches the eastern edge of Stanton County. However, information obtained from Mr. Conrad Wagner, a well driller, who is familiar with the subsurface deposits in the intervening area, reveals that the loess and till sequence is encountered across Stanton County. A sand below the till is present in some places. Occasionally only loess and sand are present but in each case these wells are located on a terrace or along a drainage and the absence of till can be explained by subsequent erosion. Since this area has not yet been drilled by the Nebraska Geological Survey, the information mentioned above is utilized with special acknowledgment to Mr. Conrad Wagner.

**SECTION NO. 5 (TIETJEN GRAVEL PIT SECTION)****LOCATION**

Near center, north line, SE $\frac{1}{4}$ , sec. 26, T. 24 N., R. 3 E., Stanton County. This exposure is about one mile northeast of Pilger, Stanton County.

**DISCUSSION**

On the William Tietjen farm is another abandoned gravel pit exhibiting good exposures. At this locality, the sand-gravel bed is

horizontally stratified, as elsewhere, and is quite deeply iron-stained. The contact with the till is, in most places, separated by a mixed zone of sand, gravel, clay balls and red quartzite boulders. See Fig. 4. Apparently, this mixed zone represents a period of intensive erosion and outwash just in front of the glacier. The red quartzite boulders are quite numerous in this pit and it was noted that they occur, generally, in the mixed zone below the till or at the contact of the till with this zone. The till has a pinkish brown weathered zone in the upper portion and where pre-Sangamon erosion had cut through the till into the sand and gravel the red zone is developed in the sand-gravel body. On top of this red oxidized zone is a deposit of yellow-buff loess. The sequence of beds seems to be the same as described at the exposures in the western part of the county, Early Kansan sands-gravels, Kansan till, Loveland soil and later loess.

#### SECTION NO. 6 (EINUNG GRAVEL PIT SECTION)

##### LOCATION

Center of N $\frac{1}{2}$ , NW $\frac{1}{4}$ , sec. 30, T. 24 N., R. 4 E., Cuming County. This pit is in the western edge of Cuming County about two miles east and one and one-half miles north of Pilger, Stanton County.

##### DISCUSSION

This excavation for the recovery of gravel has cut deeply into the north wall of the Elkhorn River Valley and is approximately 800 feet in length, east to west, and 300 feet wide. Excavation started at the east end (Fig. 5) and the pit has been and is still being extended toward the west.

The lowest member in this exposure is a sand-gravel deposit, essentially horizontally bedded with individual zones cross-bedded. The horizontal bedding is strikingly exhibited at the west end of the pit due to the differential resistance of the sand and silty sand layers. This deposit is from 45 to over 60 feet thick at some points. There is very much change in texture both laterally and vertically. The west end of the pit tends toward more fine white-buff sand while the east end contains more gravelly material with clay ball inclusions. The two parts have been separated by a more recent erosion and fill, and now, in addition, much discarded sand and loess have been dumped in this area so that at present there is no visible connection between the two ends. However, the operators of the pit state that the bed of gravel was continuous from one end to the other and there is no reason to believe that the two parts are not equivalent.

Fossil horse (*Equus*) teeth have been recovered from the sand-gravel bed, possibly from near the base of the exposure and probably from even lower than anything now exposed since that is the zone from which most of the gravel is obtained in this pit. Although the general development of the horse is familiar to scientist and layman alike, the detailed phylogenetic history is, as yet, little understood. The significance of differences in tooth pattern, for instance, is not yet known. Therefore, the fact that the horse teeth from this exposure resembles those from early Pleistocene deposits elsewhere is only supporting, not conclusive evidence for age designation. Less controversial fossil evidence from nearby equivalent deposits will be presented.

At both ends of the pit the sand-gravel deposit is capped by a till, gray below to yellow above, at least 40 feet thick, as determined by measuring to the highest point at which boulders occur in the field to the north of this gravel pit. At the contact of the till and gravel many red quartzite boulders are present and they, also, occur down in the gravel for a short distance. There is nearly everywhere a zone of mixed sand, clay balls and boulders between the horizontally stratified sand and the till. (Fig. 6.) The upper surface of the till is overlain by a yellow loess but this occurs in pastures and plowed fields where it is impossible to make accurate observations except for thicknesses.

Toward the southeastern end of the excavation a body of till resembling that directly to the north lies 25 to 30 feet lower on the side of the sand-gravel bed. On first inspection it appeared to be in position as deposited originally but careful investigation of its contact with the sand-gravel bed reveals numerous small normal faults and evidence of vertical movement (Fig. 7) in the mixed zone between the sand and till. This indicates that in all probability, it reached its present position as the result of a landslide down the face of the unconsolidated sands and gravels. This probably occurred at a time when the Elkhorn River was cutting into the north valley wall at this point washing away the unconsolidated sand and gravel and undermining the till. The lower block of till does not have exposed a direct connection with the till body higher to the north but is separated by an area of sand and gravel upon which a soil has formed.

This exposure not only agrees with the sections described previously but constitutes a more convincing argument for the close time association deduced for the sand-gravel bed and till in the former exposures. The upper part of the sand deposit is considered to be Early Kansan outwash deposited immediately ahead of the advancing

Kansan glacier. Its intimate relation with the overlying till, the presence of numerous red (Sioux) quartzite boulders in its upper portion, as well as in the mixed zone between the horizontally bedded sand and the Kansan till, and the presence of fossil horses similar to the early Pleistocene (Broadwater) forms all argue for the above mentioned dating. The overlying till is deeply weathered, indicating considerable time since its deposition. Zones of oxidation extend down to its base and resemble those present in the till at Sections Nos. 1 and 2, near Norfolk. A Kansan age seems logical for the till at this exposure. A red weathered zone on the till was not observed at this section since its upper surface occurs in a pasture but it probably is present judging from the deep weathering of the lower portion of the till. The loess over the till appears to be a Wisconsin loess but more precise designation is impossible since it also occurs in a pasture. At the west end of this pit, sloping down toward the south, is a yellow, sandy, loessic silt fill which rests unconformably on the Early Kansan sand and gravel. Apparently the same material occurs about the center of the excavation as a small tributary fill which has a relatively level surface and may represent a terrace remnant whose connection with equivalent deposits has been destroyed through erosion and excavation for gravel. On the basis of its color and lithology it is tentatively considered an ET-1 equivalent.

A more recent cutting and filling episode is exhibited about the center of the north side of the excavation. This fill is a dark brownish black silt typical of the ET-0 fill, to which it is referred.

#### **SECTION NO. 7 (LUESHAN GRAVEL PIT SECTION)**

##### **LOCATION**

Center, NW $\frac{1}{4}$ , NE $\frac{1}{4}$ , sec. 30, T. 24 N., R. 4 E., Cuming County. This gravel pit is in the western edge of Cuming County about two miles east and one and one-half miles north of Pilger, Stanton County.

##### **DISCUSSION**

This is another section exposed by the excavation for gravel. Although it has not been worked for several years there are still excellent exposures. It lies just a few hundred feet east of Section No. 6 and has essentially the same, if not a somewhat more complete sequence of beds. It was in this exposure that the presence of the Kansan till was first discovered in this group of related exposures between Pilger and Wisner. Only that portion of till which has slipped down the hillside is exposed here, the upper undisturbed portion occurring on the hillside back of the edge of the excavation.

The basal deposit is the same sand and gravel, horizontally stratified, that appears below the till in the other outcrops described previously. There is here, as elsewhere, much gradation from fine to coarse texture. In some areas the deposit is predominantly fine sand to fine sandy gravel while a short distance away it may become fine to coarse gravel. This is a condition which might be expected in the outwash of an advancing glacier which is releasing materials of all size grades.

Horse teeth similar to those from the gravel deposit in Section No. 6 have been found in this exposure and in addition the proximal portion of a camel metacarpus was discovered.

At the west end of this exposure and immediately opposite the till body that has slid down the face of the Early Kansan gravel bed at Section No. 6, is an exposure of till which also appears to have moved down the face of the gravel. This till is separated from the sand-gravel by a mixed zone showing evidence of sliding and is underlain in part by silty clay. The till is identical with that to the west and lies at approximately the same level and is, therefore, thought to be part of the same block with history similar to that in Section No. 6.

A deposit of red silty sand lies unconformably on the Early Kansan sand-gravel bed. This color appears to be due to the long weathering and formation of soil which took place upon it. This deposit is discontinuous, occurring in a few spots and being absent where later episodes of cutting and filling removed it. The sandy silt deposit is probably material worked out of the till, incorporating Loveland loess and forming a side hill colluvial wash similar to that seen at Sections Nos. 2 and 3. A period of soil formation followed during which this colluvial material as well as the underlying sand-gravel and till surfaces, where exposed, were oxidized to a red color.

The Wisconsin loesses were deposited next and form a mantling over the underlying deposits. The present soil on the slopes is a very sandy, dark buff, loessic silt, probably colluvial in part.

#### **SECTION NO. 8 (BEERBOHM GRAVEL PIT SECTION)**

##### **LOCATION**

NW corner, NE $\frac{1}{4}$ , NE $\frac{1}{4}$ , sec. 30, T. 24 N., R. 4 E., Cuming County. This exposure is in the western edge of Cuming County about two and one-half miles east and one and one-half miles north of Pilger, Stanton County. This pit is directly east of the Lueshan Pit (Section No. 7).

##### **DISCUSSION**

This excavation for gravel reveals the valley side relationship of several of the members mentioned in previous sections.

The basal deposit is again the Early Kansan sand and gravel bed, somewhat coarser than seen heretofore. This is overlain by a red sandy silt (Loveland) whose planes of stratification follow the sloping surface of the underlying gravel and indicate that this was mainly a colluvial deposit. Above the red colluvial silt and following practically the same contour is the yellow-buff, sandy, loessic material which appeared in the other exposures to the west.

An important specimen was collected in this pit from the discarded gravel. It is the fourth premolar (No. UNSM 5450) from the lower left ramus of an ancestral giant beaver, *Procastoroides sweeti* Barbour and Schultz (1937). The type of *P. sweeti* was collected from UNSM Loc. Mo-6 in western Nebraska from the Broadwater formation which has been considered early Pleistocene by some and late Pliocene by others. This specimen is similar to the corresponding tooth in the type specimen. This line of beavers was changing so rapidly that those found in deposits following the Kansan glaciation are much larger and have changed considerably. Therefore, based on this and other faunal evidence, it seems positive that the lower part of this gravel and sand deposit is an almost exact correlative of the Broadwater formation. The basal gravel in this pit and those pits associated form a continuous lithologic unit with the sands above which, apparently in the upper part, were the outwash from the Kansan glacier which overrode the deposit. Thus, one has very strong evidence for the early Pleistocene age of the Broadwater formation. This is the first time in Nebraska, so far as can be determined, that identifiable fossils have been recovered from deposits whose exact relationship to the Kansan till is known and it illustrates the important role that vertebrate paleontology can play in the precise dating and correlation of deposits away from the tills themselves.

### SECTION NO. 9 (SCHOOLHOUSE GRAVEL PIT SECTION)

#### LOCATION

About center, west line, NE $\frac{1}{4}$ , sec. 34, T. 24 N., R. 4 E., Cuming County. This is about two miles northwest of Wisner, Cuming County, just south of a country school.

#### DISCUSSION

This exposure (Figs. 8 and 13) agrees with the deposits seen in the gravel pits already described. In the north part of the pit a stratified, fine, buff-white sand is present and contains a channel of gravel in its upper portion. Only a small remnant of this channel is preserved

perched at the top of a very narrow ridge of the buff-white sand. The gravel deposit is present a few feet to the east at a lower level where it lies on top of the sand and is covered by a sandy clay deposit. Above this is about nine feet of what appears to be till toward the base but changes imperceptibly toward the top into a soft, sandy silt becoming dark red in color. The upper portion may be the result of extreme weathering of the till with some loessic or colluvial addition. The dark red zone is covered by about 7 feet of sandy, loessic silt, orange and yellow mottled, containing pebbles and concretions. A heavy zone of concretions lies about the center of this deposit as exposed at this point. The upper part of this deposit has a soil about one and one-half feet thick developed in it. To the south the till and sand have been eroded and the upper deposit thickens and becomes a gray-yellow loess containing invertebrates.

Two types of proboscidean teeth have been recovered from this exposure. Two teeth (No. UNSM 5451) of a small form of the American Mastodon (*Mammot americanus*) more nearly like that from the early Pleistocene (Broadwater) deposits of the western part of Nebraska than from the Sappa have been found in this pit. The other is a tooth (No. UNSM 5452) of a *Stegomastodon* similar to *Stegomastodon mirificus* from the Broadwater formation. It is difficult to state that this specimen is absolutely identical with those from the early Pleistocene deposits but it is significant that this genus is not known from deposits post-dating the Kansan glaciation. The specimen from these gravels is similar to a tooth found in topographically high gravels reported (Schultz, Lueninghoener and Frankforter, 1948) in the hills north of the Republican River in Webster County, Nebraska. These high gravels along the Republican were considered on stratigraphic and paleontological evidence equivalent to the upper part of the Broadwater formation (Schultz and Stout, 1945, p. 232). Now it appears that the age of those gravels can be more definitely established through the comparison of paleontological material from the Republican River locality (University of Nebraska State Museum Locality Wt-14) and this section. Again, fossil evidence is important for correlating relatively distant deposits.

#### SECTION NO. 10 (TUCKER GRAVEL PIT SECTION)

##### LOCATION

W of center of east line, NW $\frac{1}{4}$ , sec. 34, T. 24 N., R. 4 E., Cuming County. This pit is just across the road to the west of Section No. 9, about two miles northwest of Wisner, Cuming County.



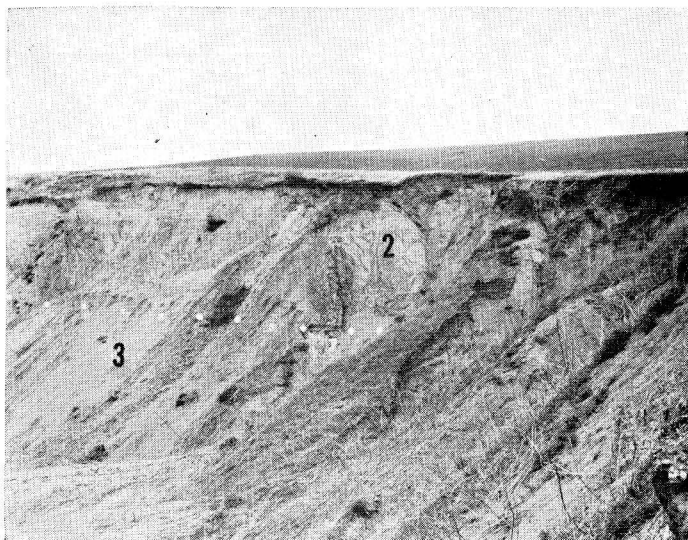


FIG. 1.—View of Section No. 1 (Norfolk—North Gravel Pit Section). Although this exposure is badly slumped, the contact between the Early Kansan gravels (3) and the Kansan till (2) can be seen in several places. The till extends back into the field above and is capped by a thin mantle of Wisconsin loess (1).



FIG. 2.—Section No. 1 (Norfolk—North Gravel Pit Section). This is a close-up of the central portion of Figure 1. The weathered zones in the Kansan till extend to the base and are about four to five inches wide.



FIG. 3.—Section No. 2 (Norfolk—South Gravel Pit Section). The base of the Kansan till (3) is exposed resting on Early Kansan outwash gravels (4). About the center of the photograph is a red Loveland fill (2). At the extreme right a yellow loessic-silt (Wisconsin) fill (1) lies against the older beds.

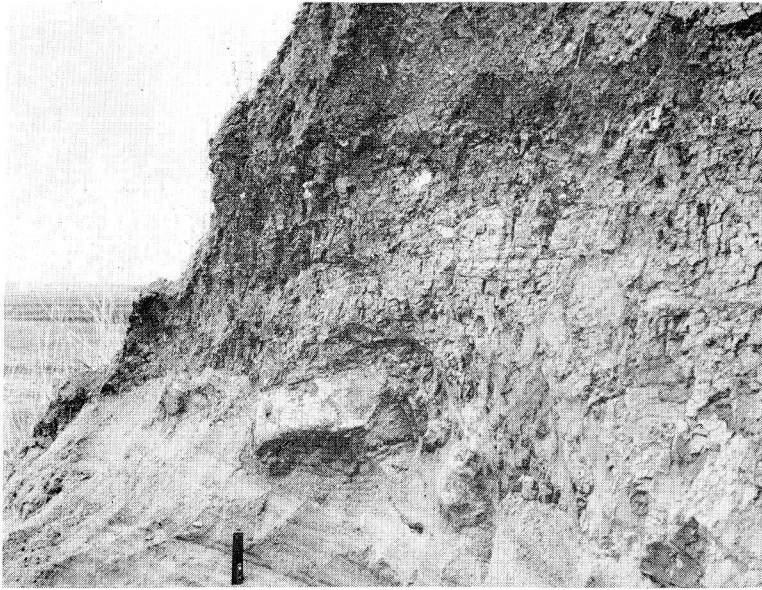


FIG. 4.—Section No. 5 (Tietjen Gravel Pit Section). A typical occurrence of the red (Sioux) quartzite boulders in the mixed zone between the Early Kansan sands and Kansan till.



FIG. 5.—Section No. 6 (Einung Gravel Pit). A film of till and loess obscures the true sandy lithology of the lower bed at the east end of this pit. The dotted line follows the contact of the Kansan till (1) and distorted zone between the till and underlying Early Kansan gravel (2).



FIG. 6.—Section 6 (Einung Gravel Pit Section). This is a close-up of the contact between the mixed zone of sand and clay and the overlying Kansan till.



FIG. 7.—The contact between the horizontally stratified Early Kansan sands and gravels (1) and the mixed and faulted zone (2) resulting from a landslide of till is shown along the line of dots.



FIG. 8.—Section No. 9 (Schoolhouse Section). A fine sand phase of the Early Kansan deposit is in the foreground. Back of it is the Kansan till and weathered till.

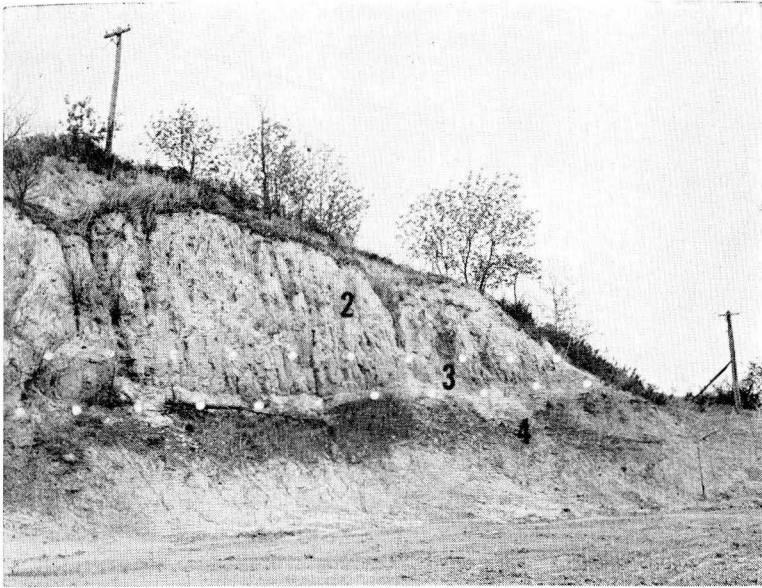


FIG. 9.—Lower part of exposure at Section No. 11 (West Point Section). The till (4) is present at the base of the exposure. The dark zone just above the talus slope is the Loveland silt and soil (3). Bed 2 is the lower part of the Wisconsin loessic silts and sands which continue up into the base of Figure 10.

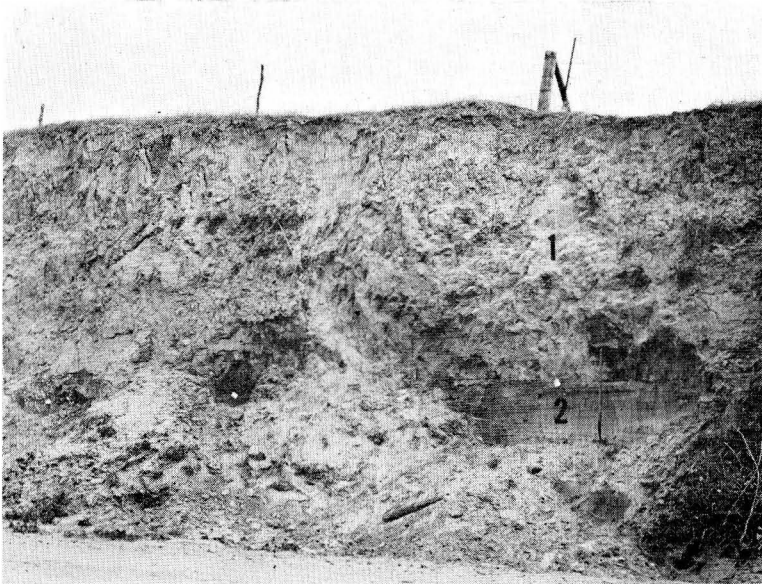


FIG. 10.—View of the upper portion of Section No. 11 southeast of West Point, Nebraska. The sloping contact of the sand (2) and silty loess (1) is indicated by the white cards. The top of the loess is 167 feet above the normal Elkhorn River level.

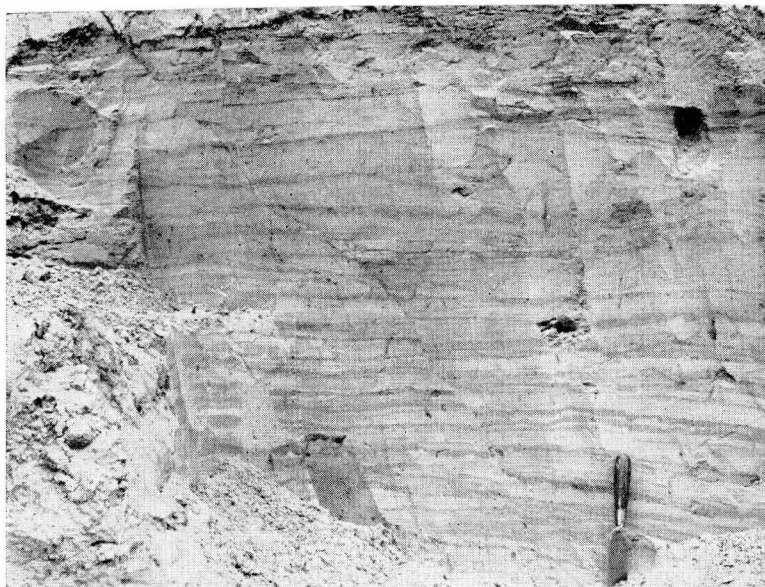


FIG. 11.—Close-up view of a portion of Figure 10. A small normal or gravity fault cuts the laminated sand.



FIG. 12.—View of Section No. 14 (Beemer Section) showing succession of beds from Nebraska till (4) through Sappa marls and silts (3), Loveland loessic silt (2), and Early Wisconsin loess (1). The top of the Loveland is 82 feet above the normal river level at this point.

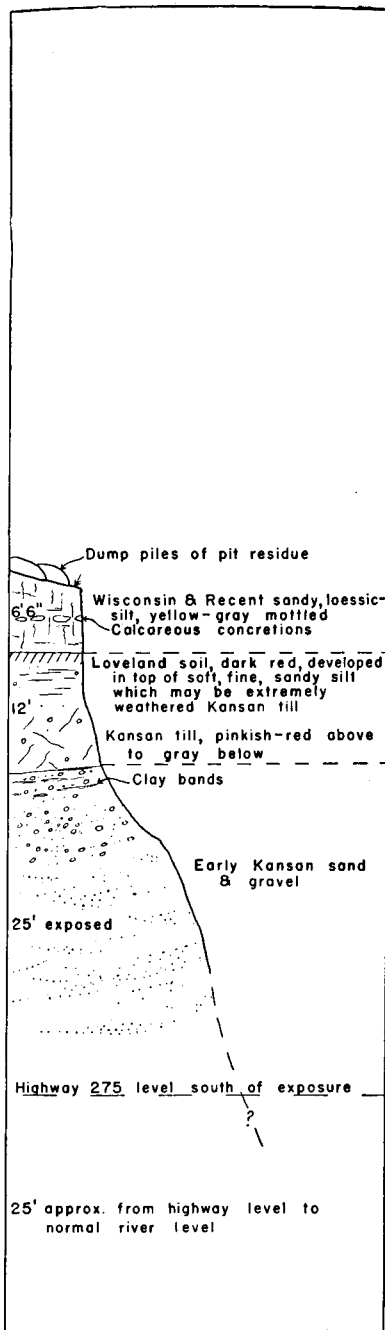


FIG 13.—Section No. 9 (Schoolhouse Section).

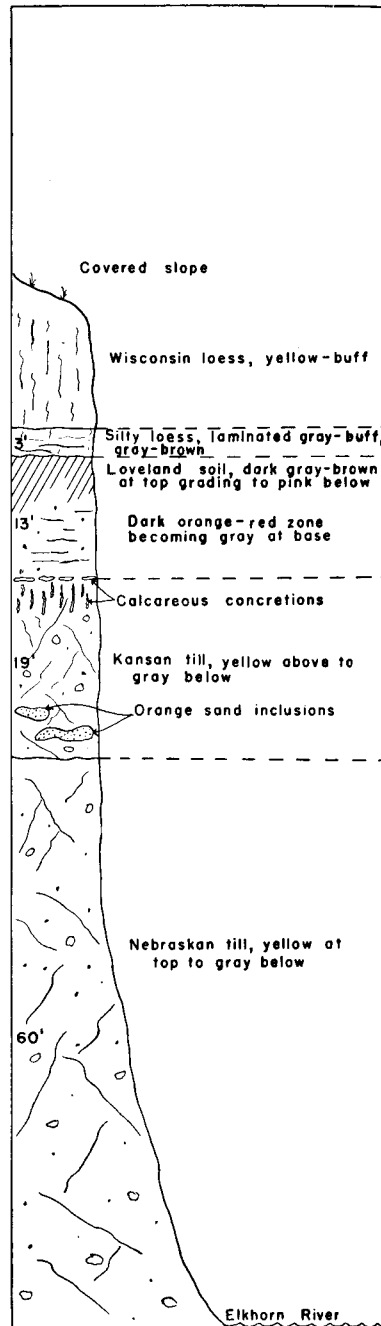


FIG 14.—Section No. 18 (Holtz Farm Section).

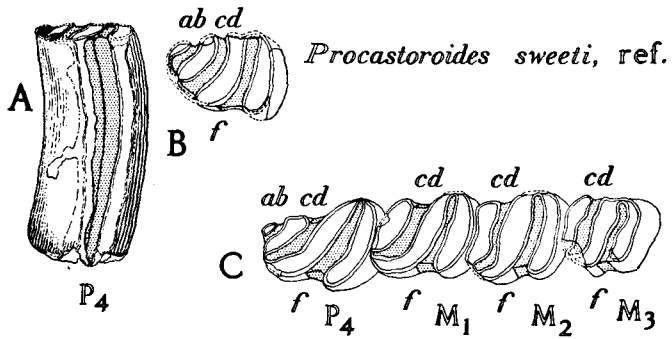


FIG. 15.—*Procastoroides sweeti*, ref. A and B, (UNSM 5450) buccal and occlusal views of fossil beaver P/4 from base of Early Kansan gravels in Section No. 8 (Beerbohm Gravel Pit Section). C, (UNSM 5453) occlusal view of lower left dentition of cotype from Lisco member of Broadwater formation at UNSM Loc. Mo.-6. (Drawings XI, by T. M. Stout.)



**DISCUSSION**

This exposure is very similar to that in Section No. 9 except that the sand and gravel bed seems somewhat coarser. It is overlain by the Kansan till, deeply weathered and very red in color with a dark soil developed in its upper two feet suggesting a long period of soil formation directly on the till. A yellow-buff Wisconsin loess to loessic silt lies over the soil zone and on the eroded flanks of the till. The surface of this loess slopes toward the river and may have continued out into the valley as a terrace fill but this cannot be substantiated by its present topographic expression.

**SECTION NO. 11 (WEST POINT SECTION)****LOCATION**

About center  $N1\frac{1}{2}$ ,  $SW\frac{1}{4}$ , sec. 35, T. 22 N., R. 6 E., Cuming County. This exposure is at the southeastern edge of the town of West Point.

**SECTION**

Feet

1. Middle to Late Wisconsin loesses.....	0-22
2. Early Wisconsin sand and sandy silt.....	71
3. Loveland silt and weathered till with a soil 1 foot to 2 feet 6 inches thick developed on it. The soil developed on the Loveland is 74 feet above the Elkhorn River.....	1-5
4. Kansan till exposed portion (base unknown).....	15

**DISCUSSION**

This exposure has been made in part by a road cut and also through an excavation to level a place for gasoline storage tanks. It is, therefore, a composite section but additional exposures along a drainage to the northeast in the hills seems to verify the relationships as described here.

The full thickness of the till is not known at this exposure (Fig. 9). In appearance, it resembles the Kansan till along the north side of the Elkhorn Valley between Wisner and Pilger described above in that it is deeply weathered to a yellow-gray color above, becoming somewhat more gray toward the base of the exposure which is probably not the base of the till itself. It contains much sand and gravel and some larger boulders among which are red quartzite pieces. Apparently, here, as in other places, the surface of this till was exposed for a long period allowing weathering processes to penetrate deeply. The top of the till slopes to the north and is overlain by one to five feet of red sandy silt with no pebbles apparent. This is considered to be the Love-

land formation. The upper portion has a pinkish brown soil developed in it whose surface is practically horizontal. Above this soil there is a deposit of yellow-buff sandy clay grading up into more and more sandy silt until finally it becomes completely sand. The top of the hill immediately back of this portion of the exposure has been removed for several hundred feet to the east and the sand appears to continue up the slope. At the top of the hill to the southeast, a road cut (Fig. 10) 25 to 30 feet deep through a loess has exposed a stratified sand and sandy silt believed to be a continuation of this same sand and silt deposit that overlies the Loveland surface farther down the hill. An interesting feature is a small normal gravity fault (Fig. 11) with a throw of slightly more than one inch in the sand and loess. The sand is capped by a massive gray-buff loess approximately 22 feet thick at its thickest point in this road cut. The contact of the sand and loess slopes down (Fig. 10) toward the river to the west, dropping about two to three feet in about 100 feet. The loess resembles the Middle to Late Wisconsin loesses seen at several points on the south side of the Elkhorn River in sections yet to be described. Thus, the sand and sandy silt deposit is apparently younger than Loveland soil formation and yet older than Middle to Late Wisconsin loess, making it Early Wisconsin in time. Before discussing this further it will be necessary to describe the other sections in this vicinity.

### SECTION NO. 12 (WEST POINT-CREEK SECTION)

#### LOCATION

About center, S $\frac{1}{2}$ , sec. 35, T. 22 N., R. 6 E., Cuming County. This exposure is almost straight east of Section No. 11, southeast of West Point, Cuming County.

#### SECTION

	Feet
1. Early Wisconsin sand and sandy silt.....	8
2. Loveland silty clay with a soil 1½ feet thick developed on it. The soil developed on the Loveland is 69 feet above the Elkhorn River level at this exposure.....	4½
3. Kansan till with a soil developed on it.....	7½
The till undoubtedly extends down below the base of the exposure.	

#### DISCUSSION

This section is in the north bank of a small drainage. This exposure shows the same relationship to the sand above as at Section No. 11. The height of the till at this section was determined to be approxi-

mately the same as that in Section No. 11 by handleveling to the top of that section which is nearby. About  $7\frac{1}{2}$  feet of till is exposed here, the lower 6 feet containing numerous calcareous concretions. A  $4\frac{1}{2}$  foot layer of silty clay containing pebbles near the base lies on top of the till. The upper  $1\frac{1}{2}$  feet is dark grayish pink grading down into an orange and pinkish orange color. It is possible that all described so far was originally till and that the long period of time from the retreat of the Kansan glacier through Sangamon is represented here only by soil development on the till. This was followed by a deposit of yellow-buff and orange, laminated sandy loess, only about 8 feet of which is exposed in this section. From an investigation of other exposures along this drainage it was determined that a deposit of sand followed the sandy loess phase.

Farther up the drainage to the northeast the sand equivalent to that overlying the Loveland soil can be traced all along the sides of the creek. It thickens as one reaches the head of the drainage and about the center of the NE $\frac{1}{4}$ , sec. 35, T. 24 N., R. 6 E., is found approximately 190 feet above the Elkhorn River level. There is very little loess over the sand at this point. Farther to the northeast the hill rises to approximately 230 feet above river level and it seems possible that the sand may rise to near this height. Prior to the deposition of the loess the upper portion of the sand appears to have been whipped into dunes trending in a general northwest to southeast direction. The sand is quite highly stained with limonite, especially in a zone which follows the approximate contour of the surface. This may represent a recently abandoned water table.

### SECTION NO. 13 (JERMAN FARM SECTION)

#### LOCATION

S $\frac{1}{2}$ , NW $\frac{1}{4}$ , sec. 1, T. 21 N., R. 6 E., Cuming County. This exposure is about 1 mile southeast of West Point, Cuming County.

#### DISCUSSION

The deposits here have been exposed through deep dissection by a short tributary to the Elkhorn. Although the till was not discovered, a red quartzite glacial boulder was observed in the creek near the base of a gray clay which has a red weathered zone at its top. This was capped by a black peat bed varying from one to three feet in thickness. Above the peat is a sand layer similar to that overlying the Loveland in nearby deposits. This succession of beds would agree with adjacent deposits in general.

### DISCUSSION OF ELKHORN TERRACE-4

This terrace is made up of several Medial to Late Pleistocene deposits. The last deposit in this terrace before its major dissection seems to have been the Early Wisconsin fill.

This terrace level along the Elkhorn drainage was first discovered through the use of aerial photographs viewed stereoscopically. Although on the soil survey map it was mapped as Marshall silt loam, which is the common upland soil, there appeared on the aerial photographs a subtle development of a high level area approximately five miles long extending northwest to southeast, by a mile and one-half to two miles wide, becoming narrower at both ends. This area lies on the southwest side of the Elkhorn between West Point and Beemer, beginning about two miles northwest of West Point and extending northwest to about one and one-half miles southwest of Beemer where its border becomes almost indistinguishable from the upland due to a heavy loess lip which occurs along the entire front bordering on the Elkhorn River Valley. After its presence had been suspected from aerial photograph observations it was learned that J. E. Todd (1899, p. 77) had reported a volcanic ash deposit in the area northwest of West Point. Upon investigation of his report it was discovered that his section containing the volcanic ash was located along the Elkhorn River in the area suspected to be the terrace remnant. The significance of this ash deposit and section reported by Todd is that it agrees, in detail, with the make-up of this same terrace known from its occurrence in other parts of Nebraska. When investigated in the field, the level suggested on the aerial photographs proved definitely to exist. An investigation of the outcrops agreed closely with the sections as reported by Todd. The following sections (Nos. 14 through 18) are of exposures along this terrace.

#### SECTION NO. 14 (BEEMER SECTION)

##### LOCATION

West line, SW $\frac{1}{4}$ , SE $\frac{1}{4}$ , sec. 2, T. 22 N., R. 5 E., Cuming County. This exposure is about one and one-half miles south of Beemer, Cuming County.

##### SECTION

Feet

1. Wisconsin loess. The upper part is a yellow-buff loess lip showing wind deposit characteristics. Toward the bottom it becomes buff, stratified, with some limonitic staining .....

94

2. Loveland loessic silt. 1½ foot soil at top, reddish brown, grading downward into red and buff mottled, friable, silty clay .....	5
3. Sappa silts, clays and marls. Upper 2 feet contains black staining, grading downward into gray silty clay and finally into a silty marl containing ostracods at base. The lower 5½ feet contain large calcareous concretions	10
4. Nebraskan till. Yellow above to gray below.....	10
5. Unexposed slope to river (probably all till).....	57

### DISCUSSION

This section (Fig. 12) is exposed as the result of a road cut which was made from the top of the terrace down into the valley. Part way down the hill an area on the east side of the road has been cleared of vegetation. A cross-section of the beds is exposed along the east side of the east ditch and toward the top of the terrace the loess is exposed in high vertical banks on both sides of the road.

The till surface is at a height of 67 feet above the Elkhorn River level at this exposure. Down stream about a quarter of a mile to the east a practically vertical face of till was observed rising to approximately 70 feet. It has weathered zones eight to ten inches wide, penetrating to the base of the exposure which is at water level. How far below the water the till extends is not known. This till is dark blue-black in its unweathered portions. It contains large frigites of soft brown sand. The frigites are often as much as six feet long and one to two feet wide and lie at varying angles with the horizontal. This till, on the basis of the characteristics mentioned and its topographic position, is tentatively considered Nebraskan in age. In Section No. 14 the till is overlain by a gray silty clay which contains in its base about two feet of silty marl, much lighter in color than the silts above. This marl contains very fine sand and clay and ostracods are quite numerous. There is no evidence of volcanic ash in this zone which is believed to be equivalent to the ash layer reported to be in this area (Todd, 1899). Grading upward is typical Sappa silty clay, gray-green in color. The lower part contains large white calcareous concretions. The top of this member contains a dark zone which represents a buried soil. Next above is about five feet of red and buff mottled, friable, silty clay thought to be Loveland with a well-developed soil in the upper one and one-half feet. The red coloring increases toward the soil and is believed to be the result of prolonged soil formation. At the base of

the next member above is a small zone of banded dark gray and buff silt which may represent a slight reworking of the Loveland soil. This grades into a buff loessic silt and loess, stratified, and containing some limonitic stain. It is correlated with the waning stages of the Iowan glacier. Above this is a massive loess, more yellow-buff, which composes the loess lip built up above the true level of the terrace. It is thickest in this area, thinning to the southeast.

### SECTION NO. 15 (IDEN FARM SECTION)

#### LOCATION

About center, sec. 7, T. 22 N., R. 6 E., Cuming County. This section is located about three miles west and three and one-half miles north of West Point, Cuming County.

#### DISCUSSION

The upper portion of the section is at a point where the high power line drops from the terrace edge into the valley while the basal portion is a few hundred yards southeast where a spring emanates from the gravels directly above the till. These springs have been utilized at several points along this terrace face for watering cattle. Some of the wells drilled on the terrace evidently also tap this zone.

At this locality the till has been eroded almost to water level but persists all along the face of the exposure. It has above it in each case a bed of gravel and sand grading from coarse at the bottom to finer above. The springs are restricted to the lower one to two feet. The contact of the sand and loess is covered and could not be determined. Up stream several hundred feet the loessic part of the section is exposed. Here, there is a talus slope rising to a point about fifty feet above the river. The lower portion of the material exposed above the talus is a buff, sandy loess. This forms a slight shoulder at its contact with the overlying yellow-buff loess, which is more columnar in structure. The lower portion is considered the Iowan or perhaps a later loess, while the upper loess is thought to be the loess-lip material equivalent to that in Section No. 14. Todd's (1899, p. 77) comments and section probably made near the above exposure are as follows:

"Four or 5 miles northwest of West Point are two bends in the Elkhorn which cut deeply into its western bank. The upper one is the more complete. It displays the formation from the general level of the country down to the level of the stream, as follows:

**Section on the Elkhorn**  
**4 or 5 miles northwest of West Point, Nebraska**

	Feet	In.
Loess, its lower surface horizontal and distinct; just above it 3 or 4 feet of compact clayey layer, with a stratum in its upper portion about 8 inches thick blotched with blackish, doubtless due to carbonaceous matter.....	50	0
Red clay, its upper half more loamy, homogeneous and without pebbles. The first 6 feet above its base presents four horizontal bands of checky clay 8 to 10 inches thick, and the next 6 feet above four more thin ones of similar character. These all alternate with sandy or loamy layers. Pebbles of red quartzite are occasionally found in thin, short layers, which occur as high as 20 feet from the base....	45	0
Whitish clay .....	4	0
White clay or marl.....	2	0
These last two pass laterally into a stratum of volcanic ashes a few rods farther west, away from the river. This volcanic ash bed is horizontally stratified in very thin layers, its texture as fine as flour; its color, for the most part grayish white with yellowish streaks in its upper portion.		
Muddy sand, passing laterally into obliquely stratified sand with bowlders below.....	2½	
Fine greenish clay, thicker at some points.....	0	6
Yellow till .....	4	0
Compact blue till.....	5	0
Level of the river."		

**SECTION NO. 16 (SCHADEMANN FARM SECTION)**

**LOCATION**

About center, north line, NE¼, sec. 18, T. 22 N., R. 6 E., Cuming County. This is about three miles west and three miles north of West Point, Cuming County.

**SECTION**

	Feet
1. Wisconsin loesses. Mostly covered slope.....	75
2. Loveland. Red loessic silt with soil at top.....	9
3. Sappa. Soil developed in its upper portion. Below is buff-gray, sandy silt with pink zone in center.....	2-8

	Feet In.
4. Early Kansan sands, white to buff, containing iron-stained zones and grading up into a yellow-gray loessic silt with a 1 foot dark zone at the top.....	0-12
5. Nebraskan till .....	2-4

#### DISCUSSION

Until recently when it was diverted, the river cut into the terrace face at this point and exposed a section about 100 feet high. This is probably the most complete exposure of the basal members of the terrace-fill now to be found. Since the river channel has been changed the lower portion of this exposure will soon be covered by slumping of the upper members.

The Nebraskan till rises three to four feet above the river level and, undoubtedly, continues some distance below the base of the present exposure. The sands above the till resemble the finer portions of the sand deposit under the Kansan till in some of the gravel pits on the north side of the valley. Next above is the bed correlated with the Sappa silts. The marl-volcanic ash bed was not distinguished in this exposure. The top of the Sappa deposits has a soil developed in it. Above this is about 9 feet of reddish sandy silt representing the Loveland. Above the Loveland stratum is the buff Wisconsin loessic silt, the upper portion of which is slumped and grass covered.

#### SECTION NO. 17 (ROPERS FARM SECTION)

##### LOCATION

North part of SE $\frac{1}{4}$ , NE $\frac{1}{4}$ , sec. 18, T. 22 N., R. 6 E., Cuming County. It is about four miles northwest of West Point, Cuming County.

##### DISCUSSION

This and Section No. 16 resemble the "lower bend" section, mentioned by Todd (1899, p. 78) with which they agree in general. River erosion was active along this section until 1948 when the channel was straightened and so the section measured by Todd has long since been removed. This is the farthest down stream exposure of this ET-4 remnant which stands approximately 120 feet above river at this point. Its eastern edge reveals some of the more recent history of the Elkhorn River Valley in the form of cuts and fills described below. A short drainage has cut to water level in the eastern part of this section but the beds can be traced across the interval. Two dams have been constructed in the past year in this drainage in an effort to control erosion; therefore the beds can be traced only a few yards up this cut.



Till was reported (Todd, 1899, p. 77) as "scarcely exposed above the surface of the water" at or near this section. It is not found here but is exposed at Section No. 16. There is approximately 30 feet of Loveland yellow-red to orange-red loessic silt exposed with a practically horizontal surface upon which a dark pinkish red soil is developed. Toward the east edge of the exposure this stratum has been completely removed and a late Pleistocene loessic silt deposited. Above the Loveland about 30 feet of Early Wisconsin loess is exposed, which appears to rise higher up stream. Next above is a yellow-buff loessic deposit containing dark streaks where it slopes down toward the stream.

Apparently, at this spot post-Nebraskan pre-Loveland erosion removed any intervening deposits and the Loveland sediment was deposited low in the valley.

The following is Todd's comment on an exposure in this area (Todd, 1899, p. 78).

"In the lower bend the top of the till is scarcely exposed above the surface of the water. No distinct trace of the ash stratum has been found there, and the horizontal base of the loess, which is very distinctly exposed, showing above the carbonaceous layer, is only about 50 feet above the stream."

#### SECTION NO. 18 (HOLTZ FARM SECTION)

##### LOCATION

About center, north line, sec. 12, T. 22 N., R. 5 E., Cuming County. This exposure is about two miles south and one mile east of Beemer, Cuming County.

##### SECTION

	Feet
1. Wisconsin loess, yellow-buff. The lower 3 feet are set off rather distinctly as a laminated gray-buff and gray-brown silty loess containing orange colored streaks and limy streaks .....	15
2. Loveland loessic silt at top and probably weathered Kansan till at bottom. A buried soil 3 to 7 feet thick is present and is dark gray-brown at the top grading to pink below .....	13
3. Kansan till. Upper 7 feet yellow grading down into about 12 feet gray in color.....	19
4. Nebraskan till. Yellow at top to gray below.....	60

##### DISCUSSION

The bend of the river which exposed this section (Fig. 14) has been abandoned but a fresh exposure rising over 100 feet from water level

is still available. Two tills appear to be present, one resting directly on the other. The lower, which has been considered Nebraskan in nearby exposures, rises to about 60 feet above water level and is gray below to yellow above. On top of this is a till approximately 19 feet thick. The lower 12 feet, containing areas of orange sand, is gray in color and grades into about 7 feet of yellow colored till. The top of this till carries a heavy layer of calcareous concretions with calcareous streaks running down 3 to 4 feet. About 13 feet of silt or perhaps deeply weathered till dark orange-red above and gray toward the base lies above the upper till. A soil is developed in the upper portion, dark gray-brown at the top grading to orange-pink below. Fresh surfaces are friable and exhibit flecks colored gray-buff, gray-pink and orange. A laminated, gray-buff and gray-brown silty loess about 3 feet thick containing iron and calcareous streaks lies above the buried soil. Above this is a yellow-buff Wisconsin loess with its upper portion a covered slope.

#### **DISCUSSION OF ELKHORN TERRACE-3**

The Todd Valley terrace development as well as later Pleistocene and Recent terraces have been admirably delineated and described by G. C. Lueninghoener (1947) in his report on the post-Kansan history of the lower Platte Valley. The writer has become familiar with his work since the northern part of the area on which he reported is included in this report and also has been fortunate enough to have accompanied him on numerous field trips in this general area. It has been necessary to cover in some detail the area of the Todd Valley Terrace and other terraces from south of Hooper and Winslow to the northern edge of the area reported by Lueninghoener in order to determine how the terrace development up stream correlates with that lower down. In some instances different conclusions have been reached on some terrace remnants which will be presented in the following discussion of the late Pleistocene terraces.

There appears to be no development of the Middle Wisconsin (ET-3) terrace in the middle portion of the Elkhorn River until one gets south of Scribner. An area of extremely sandy ground lies east and south of West Point and extends as far south as Scribner. The history of this area may be closely associated with the development of ET-3 but a positive correlation could not be established.

#### **DISCUSSION OF ELKHORN TERRACE-2**

Elkhorn Terrace-Two is well developed at several spots in this portion of the Elkhorn River Valley and forms a persistent and uni-

form level throughout. It is approximately 60 feet from the present river level to the top of the terrace. Measurements were made from the flood-plain surface in most cases and then the vertical distance from that surface to the water level (approximately 12 feet to 15 feet) was added. The exposures of this terrace are exceedingly difficult to discover. Most observations were made in roadcuts which revealed only the upper portion of the terrace. Information from farmers, familiar with material penetrated in wells dug through this terrace, reveals that its make-up is uniform from top to bottom. It is a dark yellow-buff loessic silt and contains many calcareous concretions. There is no sand exposed in its lower portion while the Todd Valley Terrace (ET-3) farther down stream consistently contains sand exposed at its base.

The farthest up stream development of this terrace (ET-2) is on the north side of the Elkhorn Valley between Stanton and Pilger in Stanton County. This area is about three miles long and three quarters of a mile wide at its widest point, tapering to a point at each end. This terrace remnant is divided by a recent drainage into three areas which were continuous originally. Measurement was made from the valley floor at the base of the terrace at the NE corner, SE $\frac{1}{4}$ , SE $\frac{1}{4}$ , sec. 1, T. 23 N., R. 2 E., and it was found to be 48 feet to the top from this point. At least twelve feet, and perhaps fifteen feet more can be added to this figure for its true height above the present river level, thus agreeing with heights farther down. The upper portion of the terrace is composed of a dark yellow-buff silt which can be seen in the ditch on either side of the road. Information concerning the basal portion was obtained from Mr. Harry Nicholas, Stanton, Nebraska, who helped dig a well to a depth of 75 feet in this terrace. He reports the basal material is similar to that in the upper part.

The next remnant of ET-2 is in Cuming County between Wisner and Beemer on the south side of the Elkhorn River. This is a small area about two and one-half miles long by one-fourth to one-half mile wide. This terrace was measured at about the center of the south line, SW $\frac{1}{4}$ , sec. 33, T. 23 N., R. 5 E. Measured from the valley floor it was found to be 42 feet high but since this point is at least a mile and a half from the river probably more than the average of twelve to fifteen feet can be added to this fill, thus bringing its true thickness to near 60 feet.

The largest development of ET-2 occurs in an area roughly eight miles long and from one-fourth of a mile to two miles wide, located on the north side of the river with the town of Beemer in approxi-

mately the center. The height of this terrace was measured at the center of the west line, SW $\frac{1}{4}$ , sec. 22, T. 23 N., R. 5 E., and was found to be 48 feet, again agreeing with this terrace level at other points mentioned. The road has cut into the terrace at this point and exposes the upper part of the terrace which is a yellow-buff, silty loess, rather soft and somewhat sandy. A low area runs along the southwestern edge and partially back of the edge of this terrace throughout much of its length in this particular remnant. It appears to be a relatively flat area which varies in width from one-fourth to one-half mile and pinches out to the northwest. It may represent an eroded and alluviated valley of a later cycle (perhaps ET-1) but no exposures in it were discovered in order to determine its composition. In places it is from twelve to fifteen feet lower than the ET-2 surface in this area.

A fourth area with good development of ET-2 is directly across the river from West Point and is about two and one-half miles long and from one-half to one mile wide. Again the exposures in the roadside ditches were the only means of viewing the materials making up the terrace. So far as could be determined, the lithology agrees with the previous localities inspected. This terrace surface was found to be 46 feet above the valley floor at the center of N line, NW $\frac{1}{4}$ , sec. 33, T. 22 N., R. 6 E.

The fifth development is west and north of Scribner, Dodge County. This area is roughly a triangle one and one-half miles on a side lying between the Elkhorn River and Pebble Creek. It was measured at the center of the N line, sec. 26, T. 20 N., R. 6 E., and found to be 42 feet from the ET-0 surface which is all of twelve to fifteen feet thick along the river which is over a mile away. Therefore, this seemingly low elevation can be increased to nearly 60 feet which still does not approach the height of the Todd Valley Terrace in the Hooper-Winslow area. Mr. Roy Petz who owns the farm on the south side of the road where the section was measured, states that there is no sand exposed in the base of this terrace, such as occurs less than three miles to the southeast, about a mile south of Scribner. Therefore, on the basis of the absence of basal sands, its lithologic characteristics, and its relatively low height, this terrace remnant is considered to be ET-2 rather than the Todd Valley Terrace (ET-3) as it has been thought previously (Lueninghoener, 1947).

#### DISCUSSION OF ELKHORN TERRACE-1

Elkhorn Terrace-One remnants are quite numerous although usually much restricted in individual areal extent. They occur along

the edges of all the ET-2 deposits except the area just discussed across the Elkhorn River west of Scribner. Also, this terrace can be found along some of the tributaries of the Elkhorn River such as Plum Creek, Pebble Creek, Cuming Creek and Humbug Creek. Only the latter will be discussed.

West of Pilger along the north side of the Elkhorn River Valley in an area approximately three miles by one-half mile ET-1 is very well developed. It runs up to the mouth of Humbug Creek and coincides with the main valley level of that creek. An excellent cut in this terrace was discovered along the east side of the road at about center of W line, SW $\frac{1}{4}$ , NW $\frac{1}{4}$ , sec. 5, T. 23 N., R. 3 E. This is just across the road and north of Clinton School. Recent erosion has cut at least 20 feet into the terrace which was measured from the water level of a drainage beneath a small railroad bridge a half mile to the south and found to be about 32 feet high. This may represent almost the true height. It is composed of a gray-buff loessic silt with many flecks of organic material and limonite staining. It contains invertebrates from about eight feet below the surface to the base of the exposure. A soil varying in thickness from two feet to four and one-half feet is developed on it. Back toward its contact with older deposits where a small drainage has developed, it is covered by one foot of dark brown to black silt, probably equivalent to ET-0. This terrace appears to become lower toward the east. This may be due, in part, to erosion and to the fact that the ET-0 surface appears to be higher at the mouth of Humbug Creek where a sort of alluvial fan has developed which buries the base of ET-1. Along the Humbug Creek drainage ditch which cuts the old Humbug Creek drainage at numerous spots one can see the relationship of ET-1 and ET-0. ET-1 has much the appearance of the same terrace described near the Clinton School except that here it contains bands of dark silt at various levels.

#### DISCUSSION OF ELKHORN TERRACE-0

The Elkhorn Terrace-Zero deposits are dark gray to black silts and were deposited in channels cut 25 to 30 feet into the ET-1 fill along Humbug Creek. Many bison skulls and skeletal parts have been found in and eroding out of the basal portion of the ET-0 fill along this creek. Also, cucurbit seeds and other partially decomposed vegetable matter is occasionally preserved in this fill.

Most of the ET-0 fill makes up the valley floor of the Elkhorn River and is seldom seen in relation to older deposits except in such

cases as Humbug Creek where the channel has been artificially straightened, causing local dissection.

### DISCUSSION OF WET GRAVEL PITS

The wet gravel pits are discussed separately because they contain deposits which have no observable connections with overlying strata. A great amount of Sioux quartzite, probably reworked from the Kansan till and associated deposits, is pumped out of these pits. That these deposits are of more than one age can be demonstrated through paleontological evidence and thus, our understanding of the sedimentational history of this region is increased.

Large collections of fossil vertebrates have been recovered from three gravel pits near West Point and one near Wisner. These specimens are of importance because they are a key to the age of the deposits which lie below the valley floor. A faunal list has been compiled which is included in this report. These fossils are pumped up by the gravel pumps which reach a depth of from 40 to 60 feet. There is, naturally, a mixing of material so that stratigraphic information regarding the depths of various beds is seldom obtained and is of limited use in dating the fossils. Conversely, the fossils can be used to date the gravel beds.

Middle to Late Wisconsin and Recent faunas can be distinguished. In one pit (University of Nebraska State Museum Locality Cm-1) at a depth of about 40 feet, a peat bed was encountered which contained many bones. The fossils from this horizon have a characteristic black to dark gray-brown preservation which can be relied upon to some extent to signify contemporaneity of most fossils of that color.

There appears to be nothing older than a Middle to Late Wisconsin fauna in this valley fill with the exception of some specimens which appear to be Pliocene in age. These latter are water-worn and give every indication of having been reworked into the younger gravels.

This paleontological evidence strengthens the belief that the post-Early Wisconsin (Iowan) dissection was of great intensity, apparently cutting 40 to 60 feet below the present river level.

## SUMMARY OF THE PLEISTOCENE GEOLOGIC HISTORY OF THE MIDDLE PORTION OF THE ELKHORN RIVER VALLEY

The following is a summary of the Pleistocene geologic history of the middle portion of the Elkhorn River Valley as determined from a consideration of stratigraphic evidence exhibited by the outcrops and terrace relations discussed in the preceding pages. The sequence of events will be discussed chronologically beginning with the deposition of the Nebraskan till since it is the oldest material observed to outcrop in this area.

### NEBRASKAN GLACIATION

The outcrop assigned a Nebraskan age is present in the ET-4 base on the southwest side of the Elkhorn between West Point and Beemer. The reasons for believing this to be older than the Kansan till were outlined in the discussion of Section No. 12. The remnant apparently was at one time as thick or thicker throughout as its present greatest thickness toward the north part of the area. Post-Nebraskan erosion undoubtedly removed much of it as did later erosional episodes. The position of the immediate post-Nebraskan drainage can only be speculative but apparently at least a portion of the present Elkhorn Valley was the course of the river during Aftonian time. It is possible that the till in the base of Lueninghoener's Section No. 7 near Crowell, Dodge County, is the same till. The exact age of this till designated as Nebraskan has little significance so far as the subsequent history of the area is concerned since it acts only as a bedrock for a small portion of the later deposits.

### KANSAN GLACIATION

The retreat of the Nebraskan glacier was followed by dissection of the till and the ancient Elkhorn River must have entrenched itself essentially in the course of the present river. This is supported by the fact that Early Kansan sands and gravels are found along the edge of the valley in several places at present river level and below. According to information furnished by Mr. Conrad Wagner, well driller, the gravels occur under the till in some places along the north side of the Elkhorn River Valley in Stanton County and they were observed by the writer in the western part of Cuming County. This deposit, where fossiliferous, was not observed lying upon Nebraskan till. However, the presence of Sioux quartzite and other glacial boulders in the basal portion (from which the fossils are recovered) is conclusive evidence

that this deposit post-dates a glaciation, surely Nebraskan, since Kansan till overlies it. The dating of these gravels is supported by the fossil beaver, horse, and proboscidean remains recovered from them. It is significant that mammoth and bison remains are completely lacking from these deposits, another point of agreement with the Broadwater formation of western Nebraska and other equivalent Great Plains deposits; for example, the Sand Draw locality (McGrew, 1944) in Brown County. The streams must have been choked not only with the outwash of the advancing glacier but also by the sands washing in from the west in the already established Elkhorn drainage. This resulted in thick deposits of silty sands, sands and gravels and would explain the presence of stratified lenses of red (Sioux) quartzite boulders which were worked out of the advancing glacier into the top of the Early Kansan gravels. The Kansan ice advanced over the outwash material, reworking a zone in the upper portion of the gravel, here called the "mixed zone" which contains clay balls, sand, gravel and red quartzite. At some spots, for example, the Norfolk pit (Section No. 2), the till appears to rest almost conformably on the gravel outwash below.

#### POST-KANSAN YARMOUTH CYCLE

Following the retreat of the Kansan glacier a vigorous period of erosion began removing much of the till and earlier deposits. The areas of till which were not removed were exposed and subject to weathering. The valley situation is well illustrated by the ET-4 remnant between West Point and Beemer. This area was first investigated by Todd (1899), whose description of an exposure was quoted in Section No. 15. Following the post-Kansan erosion, gravels were deposited in the deepened valleys and a thin layer was deposited on some higher till surface, as in the base of ET-4. This gravel grades up into sand and sandy silt and is capped by a soil. Within this silt a marl bed was reported (Todd 1899), which grades "laterally into a stratum of volcanic ashes a few rods farther west, away from the river." Following the deposition of the silt there was a period of soil formation. On the uplands, during the deposition of the gravels and sands the Kansan till was being subjected to erosion and weathering. Then, apparently, about the time of the formation of the marl beds in the valley conditions were conducive, locally, to the formation of marls on the higher till surface also. (See Section No. 14.) This section south of Beemer shows the marls directly on the weathered till surface and grading up into gray silty clay with a soil developed on it. In some



places this interval is represented by a soil developed directly on the weathered till.

### ILLINOIAN CYCLE

After the formation of the soil on the Sappa the effect of the Illinoian glaciation was felt in this area. There seems to have been slight pre-Loveland dissection since Section No. 17 on the Ropers farm exhibits red Loveland silty clay coming down near the water level. There was approximately 30 feet of Loveland deposited at this locality. Elsewhere the Loveland is represented by a few feet of silty clays on top of the Sappa and in some places, such as in the gravel pit exposures, it was a sandy, silty, colluvial deposit. Following and perhaps even contemporaneous with the latter part of Loveland deposition, dissection removed most of the Loveland valley fill. A long episode of soil formation during the following interglacial period (Sangamon) produced a deep reddish brown weathered zone on most exposed surfaces, irrespective of parent material.

### EARLY WISCONSIN (IOWAN-TAZEWELL COMPLEX) CYCLE

A new cycle began with the advent of another glacial period. Alluviation of the valleys occurred, filling them with fine sands for which the name Todd Valley was proposed by Lugn (1935) and modified by Lueninghoener (1947). Equivalent fills in other drainages are also recognized (Schultz, Lueninghoener and Frankforter, 1948). If there were an ET-3 fill in the middle region of the Elkhorn River drainage it has been completely removed through subsequent erosion or else is camouflaged because of dissection and mantling by younger deposits. It is possible that the flat valley areas trending northwest-southeast across the sandy area between Scribner and West Point, bordered by Cuming Creek and the Elkhorn River, are equivalent to ET-3. The surface of these areas lies only between 45 and 50 feet above the present river level, therefore much lower than the Todd Valley Terrace. However, a basal sand rises 35 to 40 feet in the terrace agreeing approximately in height with the sand in the basal portion of the Todd Terrace. The sands are red and silty toward the top but the color seems to be a secondary condition. Low in the exposures the sand is a buff-white. This whole sandy area appears to have had a unique history during Late Wisconsin and later times in that most of the deposits made along its edges have been made up of materials derived from the area itself rather than the river. The sands in the terrace level exposed at Dead Timber Park are also present south of the cemetery at the

south edge of West Point and occur in a roadside exposure about one-half mile northeast of Scribner.

In addition, a light buff, sandy, loessic silt believed to be Early Wisconsin was deposited on the Loveland soil in the ET-4 area. Apparently contemporaneous, in the West Point area, is a thick bed of stratified loessic silt and sand the base of which rests on the Loveland soil approximately 70 feet above the present river level. This deposit is a loessic silt at the base grading into sand and silt above. The top of the sand is 145 feet above the river level in the road cut southeast of West Point Section No. 11 and goes even higher to the north. Todd (1899, p. 64) has suggested that this sand and silt has all blown up out of the river valley but it seems very probable that the basal portion was partially stream deposited. The possibility of a glacial source for this sand was considered since a till more recent than Kansan is known only about 40 miles to the north near Coleridge, Nebraska (Frye, Swineford, and Leonard, 1947, p. 506) and it is possible that a lobe might have extended farther south at some point. However, in the upper part of the exposures of this sand the uniform sorting of the particles and lack of cross-bedding structure (Fig. 11) suggest an eolian origin with modification by colluvial action. It is hoped that drilling in this area in the future will cast some light upon this situation.

Toward the end of the Early Wisconsin glacial retreat a vigorous period of dissection occurred, reaching a depth 40 to 60 feet below present river level. A lag concentrate of gravel was deposited. This gravel and more recent deposits are the main source of the gravel now being removed from the wet gravel pits in this portion of the Elkhorn River.

During the following interglacial period soil formation took place and in the valleys peat bogs were not uncommon, as is indicated by the presence of peaty material reached at considerable depth by the gravel pumps. As noted in the discussion of wet gravel pits, many of the fossil bones from the peat layer are stained a dark brown.

#### **MEDIAL TO LATE WISCONSIN (CARY-MANKATO COMPLEX) CYCLE**

With the approach of another glacial episode following the interglacial after the Early Wisconsin glaciation, the valleys again were alluviated. This fill, which may be a complex, consists of dark yellow-buff, silty loess, near its top. Exposures in this fill are limited but information from wells in it indicates relatively the same type of

material toward its base. Dissection at the end of the glaciation reached below present water level. Terrace remnants of this alluviation stand about 60 feet above the present river level.

In the vicinity of Beemer this terrace is well developed and it appears that this region was the location of the river up until post-Mankato time when it started cutting into the south bank, thus exposing the ET-4 terrace fill. The ET-2 remnant at Beemer has some depressions on its surface which suggest the undulating surface of the Todd Valley Terrace but the sands so characteristic of the Todd Terrace in this region were not observed in its base. Although these basal sands would not have to be present in the base of the terrace equivalent to the Todd Valley Terrace in all regions, it is very likely that along a single drainage the composition of the terrace would agree. In addition, the height above the present water level of this terrace remnant agrees with the other ET-2 remnants in the Elkhorn River Valley and is lower than the Todd Terrace.

#### EARLY RECENT CYCLE

Dissection again occurred to about the present river level following the ET-2 fill and the valleys were widened to almost their present width. During the next period of alluviation darker material than ET-2 was deposited, approaching a yellowish gray-buff. Except for one area about three miles long and one-half mile wide west of Pilger, Stanton County, the remnants of this terrace are of small extent and confined mainly to the edges of ET-2. This terrace is well exposed in the sides of the drainage ditch which straightened Humbug Creek channel. In this small valley the ET-1 fill exhibits several silty bands in its make-up, a characteristic observed in equivalent terraces on other drainages. The exposure of this terrace-fill on the Elkhorn River proper does not contain these dark bands. It is thought that the position and thickness of these dark layers varies considerably from drainage to drainage and even from one exposure to another along the same drainage and that they are due to local soil formation in some cases and deposition of humic silt from flooding in other instances.

#### RECENT CYCLE

Following widespread dissection and removal of ET-1 a dark fill was deposited. This fill does not form a prominent level above the Elkhorn River Valley floor but, rather, is hardly differentiated from the very low surfaces formed from even more recent episodes of erosion and deposition. It is still subject to seasonal flooding except for those

areas some distance from the river which have been built up, in part, as a result of colluvial wash from the surrounding valley edges. Scribner and Pilger, which are located on this terrace which is about twelve to fifteen feet above the present river level, have been flooded several times in the past few years. On Humbug Creek, where the drainage ditch has cut across the ET-0 channels of the former course of the Humbug, this Recent fill is well exposed deposited in channels cut into ET-1. A large collection of bison skulls and skeletal parts has been recovered from the basal portion of this terrace along with cucurbit seeds and other vegetable matter. The bison appears to be *Bison bison*, presenting additional proof of the relatively Recent age of this fill.

TABLE 1

FAUNAL LIST FOR CUMING COUNTY WET GRAVEL PITS

	Cm-1	Cm-2	Cm-3	Cm-5
<b>EDENTATA</b>				
<i>Paramylodon</i> sp.**	.....	.....		
<i>Megalonyx jeffersoni</i> , ref.**	.....	.....		
Megalonychid	.....			
<b>PRIMATES</b>				
<i>Homo sapiens</i> * and **	.....	.....		
<b>RODENTIA</b>				
<i>Castor canadensis</i> *	.....			
<b>CARNIVORA</b>				
<i>Canis</i> sp.	.....	.....		
<i>Canis latrans</i> *	.....	.....		
<i>Canis lupus</i> *	.....	.....		
<i>Arctodus</i> sp.**	.....		.....	
<b>PROBOSCIDEA</b>				
<i>Mammut americanus</i> **	.....	.....		
<i>Parelephas</i> sp.**	.....	.....	.....	
<i>Mammuthus primigenius</i> **	.....	.....	.....	
<i>Mammuthus</i> sp.**	.....		.....	.....
<b>PERISSODACTYLA</b>				
Horse (reworked out of Pliocene deposits)	.....	.....		
<b>ARTIODACTYLA</b>				
Camel	.....			
<i>Cervus</i> sp.*	.....	.....		.....
<i>Odocoileus</i> sp.	.....	.....	.....	.....
<i>Odocoileus hemonius</i> *	.....	.....	.....	.....
<i>Cervalces</i> sp.**	.....	.....	.....	.....
<i>Alce</i> sp.*	.....	.....	.....	.....
<i>Bison bison</i> *	.....	.....	.....	.....
<i>Bison antiquus</i> , ref.**	.....	.....	.....	.....
<i>Bison alleni</i> , ref.**	.....	.....	.....	.....
<i>Bison</i> sp. (large)	.....	.....	.....	.....
<i>Bootherium</i> sp.**	.....	.....	.....	.....
<i>Symbos cavifrons</i> **	.....	.....	.....	.....
<b>CHELONIA</b>				
Turtle	.....	.....		
* Recent				
** Middle to Late Wisconsin				

LOCATION OF WET GRAVEL PITS

- Cm-1: NE¼, SE¼, sec. 21, T. 22 N., R. 6 E., about 2 mi. N, 1 mi. W of West Point, Cuming County.  
 Cm-2: Center S½, SE¼, sec. 16, T. 22 N., R. 6 E., about 2½ mi. N, 1 mi. W of West Point, Cuming County.  
 Cm-3: SW¼, NW¼, sec. 34, T. 22 N., R. 6 E., at west edge of West Point, Cuming County.  
 Cm-5: About center SE¼, sec. 18, T. 23 N., R. 5 E., 2 mi. SE of Wisner, Cuming County.

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