

NEBRASKAN TILL IN FULTON COUNTY, ILLINOIS.¹

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The records of five glacial epochs in the Pleistocene period are preserved in the Mississippi Valley. These are, beginning with the oldest, Nebraskan, Kansan, Illinoian, Iowan and Wisconsin. The deposits of the Wisconsin, Iowan and Illinoian glaciers cover extensive surface areas in Illinois, but pre-Illinoian glacial deposits, which were overridden and buried by the ice of one of the three later glacial epochs, are known in Illinois only from scattered exposures. Buried pre-Illinoian till, usually assigned to the Kansan epoch, is known in western Illinois.

During the mapping of the Havana quadrangle for the State Geological Survey, two exposures were discovered in the southern part of Fulton County, which show evidence of three distinct tills in an area where the youngest till is known to be Illinoian in age. The interpretation offered is that the two buried tills represent both of the pre-Illinoian epochs of glaciation, the Kansan and the Nebraskan. These are the first exposures so far known in Illinois in which the Nebraskan age of a till has been proved by its relations to two later tills. Other exposures in eastern Illinois have been considered Nebraskan in age, although they directly underlie the Illinoian till.

Acknowledgment is made to Mr. H. B. Willman, who assisted in the mapping, and discovered one of the exposures, and to Dr. M. M. Leighton, Chief of the State Survey, who visited these exposures with the writer, and has made many valuable suggestions for their interpretation.

Recognition of Buried Drift Sheets.

The presence of glacial deposits older than those of the last glacier which covered this area is proved by: (1) a buried soil profile² on the older drift, (2) loess on the older drift, (3)

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² The soil profile has been recently classified into zones, as follows: (1) an A zone in which the material is completely oxidized and leached of calcareous matter, usually dark colored and loose in texture; (2) a B zone, which is completely oxidized and leached, and is compact in texture; (3) a C zone, which is completely oxidized and leached, with a texture intermediate between the A and B zones; (4) a D zone, which is oxidized and calcareous; and (5) an E zone, unoxidized and calcareous, the unaltered material.

weathered sands, gravels, or water-laid silts on the older drift, and (4) calcareous and unoxidized till overlying the interglacial materials.

A comparison of the pebble counts made from glacial tills of different ages shows the proportion of different kinds of rocks present, thus giving information as to the kind of bedrock over which the glacier advanced, and therefore information as to the direction from which the ice came. Such pebble counts were made of the three tills described below.

Pleistocene Succession of Southern Fulton County.

The complete succession of glacial and interglacial epochs in the Mississippi Valley, as known at present, together with their representative deposits in Southern Fulton County, is as follows:

Wisconsin glacial epoch (outwash sands and silts, and wind-deposited loess).

Peorian interglacial epoch (wind-deposited loess).

Iowan glacial epoch.

Sangamon interglacial epoch (wind-deposited loess, weathered before Peorian time).

Illinoian glacial epoch (glacial drift, sand, gravel and loess).

Yarmouth interglacial epoch (wind-deposited loess, silt, sand and gravel).

Kansan glacial epoch (glacial drift).

Aftonian interglacial epoch (sand and loess).

Nebraskan glacial epoch (glacial drift).

Description of Exposures.

The Illinoian glacier was the last to cover Fulton County, and its till is present over nearly all the area. There are two exposures in which two pre-Illinoian tills have been recognized, (1) in a ravine on the west side of Otter Creek in the N. E. $\frac{1}{4}$ N. E. $\frac{1}{4}$ Sec. 5, T. 3 N., R. 3 E. (Kerton) and (2) in a ravine on west side of Otter Creek in the S. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ Sec. 32, T. 4 N., R. 3 E. (Isabel). The second exposure is about one-half mile northwest of the first, and each of the exposures is within one mile of the hamlet of Enion. The locations of these exposures are marked on the accompanying sketch map (fig. 1).

Exposure (1) in ravine in Sec. 5, T. 3 N., R. 3 E.

The succession of Pleistocene formation in the largest ravine in the N. E. $\frac{1}{4}$ Sec. 5, T. 3 N., R. 3 E. (Kerton) is described from

a short gully (a) on the south side of the ravine about 200 feet northeast of the junction of three main head forks, and (b) from a cut bank on the north side of the ravine about 200 feet northeast of the gully section.

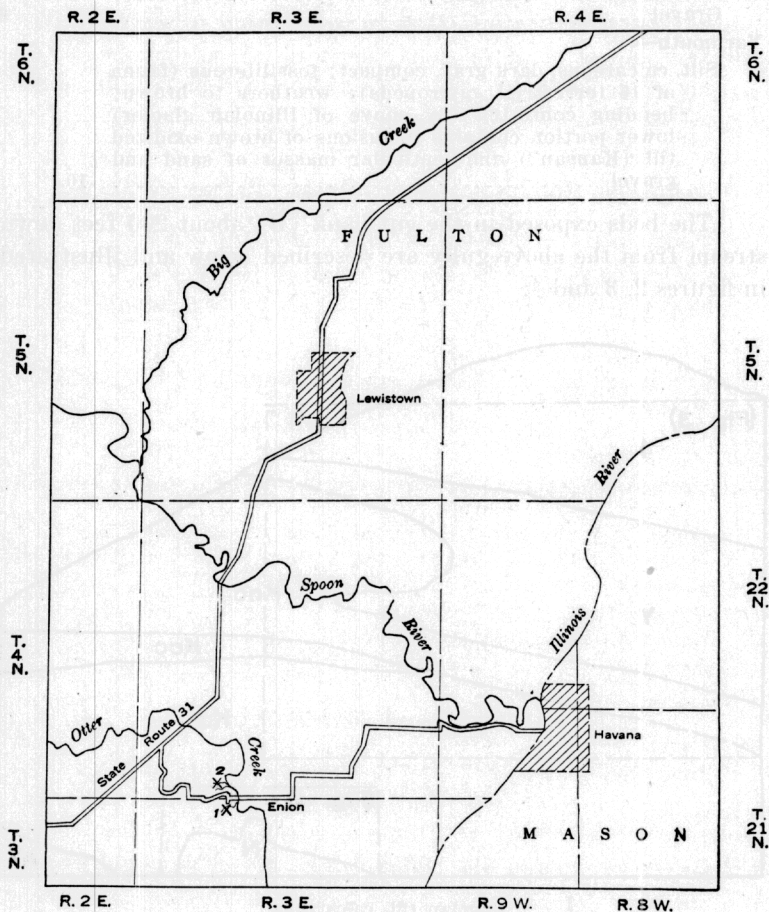


FIG. 1.—Outline map of Havana quadrangle, showing locations of exposures of Nebraskan till described in this paper, and routes by which they may be reached from Havana or Lewistown, Illinois.

The gully exposure (a) shows the following beds:

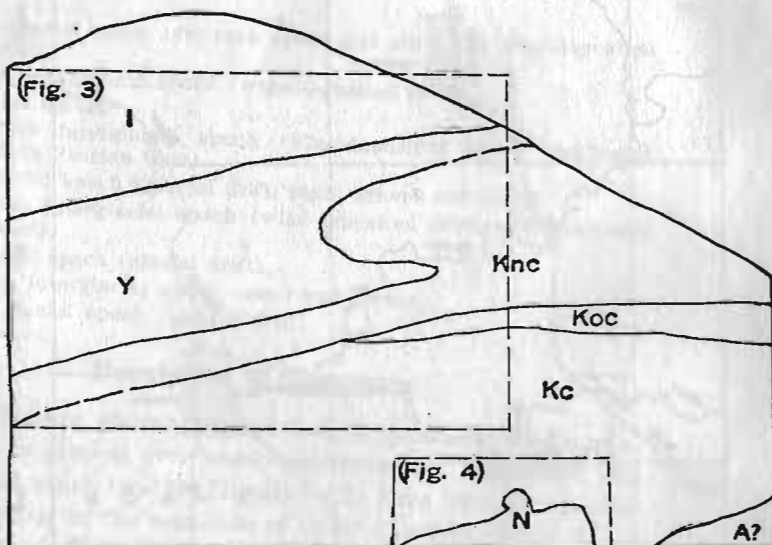
	Thickness Feet Inches
Peorian and Sangamon—	
Loess and silt, loess-like, poorly exposed.....	25
Illinoian—	
Till, calcareous, gray, upper part covered.....	8
Gravel, calcareous, well assorted	6-12

Silt, calcareous, gray, fine grained; compact; non-fossiliferous; not distinctly bedded (resembles a loess in texture and structure); weathers to yellowish brown	1	6
Till, interbedded with assorted sand and gravel, reddish brown	2	
Till, calcareous, light gray	5	
Gravel		6

Yarmouth—

Silt, calcareous, dark gray, compact; fossiliferous (fauna of 16 terrestrial gastropods); weathers to brown; bedding contorted (by shove of Illinoian glacier) lower portion contains inclusions of brown oxidized till (Kansan?) and lenticular masses of sand and gravel	10
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The beds exposed in the cut bank (B) about 200 feet down stream from the above gully are described below and illustrated in figures 2, 3 and 4.



I	Illinoian till, calcareous
Y	Yarmouth fossiliferous loess
Knc	Kansan till, noncalcareous
Koc	Kansan till, calcareous, oxidized
Kc	Kansan till, calcareous
A?	Aftonian? sand, calcareous, oxidized
N	Nebraskan till, calcareous, oxidized

FIG. 2.—Diagram of cut bank on north side of ravine near center of NE $\frac{1}{4}$ sec. 5, T. 3 N., R. 3 E. (Kerton.) Areas included in figures 3 and 4 are outlined with dotted lines.

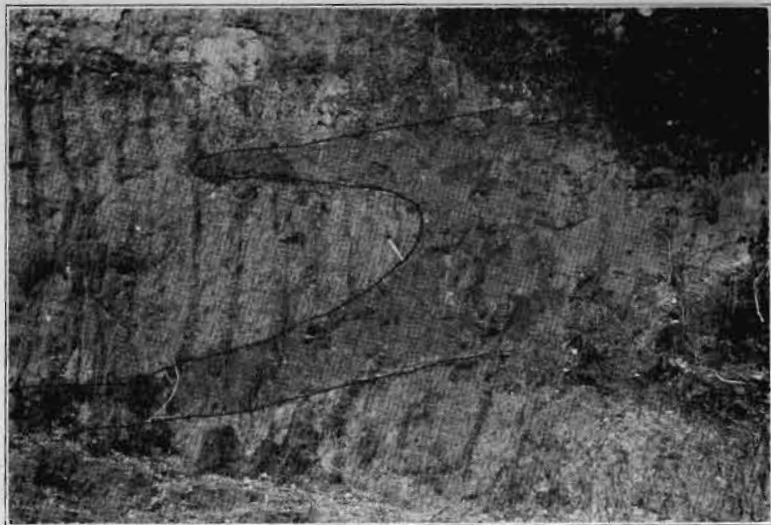


FIG. 3.—Upper portion of cut bank sketched in figure 2, showing dark compact fossiliferous late Yarmouth loess, lying between calcareous Illinoian till above and non-calcareous till below. Yarmouth silt is outlined.



FIG. 4.—Detail of lower portion of cut bank sketched in figure 2, showing rolled mass of calcareous oxidized Nebraskan till incorporated in unoxidized calcareous Kansan till.

	Thickness Feet Inches	
Top of bank covered with vegetation and slumped soil.....	3-4	
Illinoian—		
Till, calcareous, light gray.....	12	6
Yarmouth—		
Calcareous concentration, white, in clay.....		1
Silt, calcareous, bluish to dark blue-gray, compact, fossiliferous (containing a loess or terrestrial fauna); not distinctly bedded; contains numerous iron stained concretions of irregular shape as large as 1 foot 6 inches diameter; weathers to dark chocolate-brown; smoothed upper surface; shows a lenticular mass of noncalcareous Kansan till thrust into it (fig. 3).....	6	
Kansan—		
Till, noncalcareous, gray (B or C zone of buried soil profile); including 3-foot lenticular mass thrust into Yarmouth silt	6	6
Till, calcareous, rusty colored (D zone of buried soil profile)		6
Till, calcareous, dark blue-gray, to stream level.....	3	3
Aftonian?		
Sand, calcareous, yellow-brown (at east end of cut)....	2	
Nebraskan—		
Till, calcareous, oxidized, brown; a rounded ball with projecting knob, surrounded by dark blue-gray, unoxidized Kansas till (figs. 2 and 4).		

About 200 yards east of the above cut, yellow-brown, calcareous Aftonian (?) sand is exposed above brown oxidized, calcareous till, like the rolled ball of Nebraskan till incorporated in the Kansan till.

Exposure (2) in ravine in Sec. 32, T. 4 N., R. 3 E.

The succession of Pleistocene formations in the ravine west of Otter Creek in the N. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ Sec. 32, T. 4 N., R. 3 W. (Isabel) is described from (a) a sharply cut gully on the west side of the ravine, (b) outcrops along the ravine about 150 yards below the gully and (c) a high cut bank on the southwest side of the ravine at the lower end of the main ravine outcrop (b).

The gully exposure (a) shows the following beds. The top of the cut in the gully is 22 feet below level upland.

	Thickness Feet Inches	
Peorian—		
Loess, noncalcareous, gray, buff above; with reddish brown spots along joints and root canals.....	3	4
Loess, calcareous, gray; some ferruginous concretions and a few kindchen	7	6

Sangamon—

Loess, noncalcareous, reddish; some carbonized wood fragments; lower surface dips north.....	3	3
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Illinoian—

Silt, slightly calcareous (probably around local centers such as root canals); pink and gray laminated; pebble concentrated at top; thins and disappears to north	1	
Till, noncalcareous, brownish-gray (B zone of buried soil profile	2	9
Sand and gravel, noncalcareous.....	2	6
Till, slightly calcareous above, more calcareous below; reddish brown; (lower part of C zone and D zone of buried soil profile	1	6
Till, calcareous, light gray.....	15	

Yarmouth—

Sand, noncalcareous, yellowish, very fine; gravel concentrate at top.....	6-8	
Gravel, noncalcareous, brownish; including some beds of coarse reddish sand.....	5	6

About 100 feet west of this gully up main ravine, one foot of gray calcareous silt or loess overlies sand and fine gravel corresponding in altitude to the Yarmouth beds above.

The exposure along the main ravine (b) below the side gully shows the following beds below those described in (a):

Thickness
Feet Inches

Yarmouth—

Gravel and sand, noncalcareous, brown and reddish-brown; similar to but below basal bed in (a)....	10
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Kansan—

Till, calcareous, dark gray, bouldery; deformed into sharp folds (by shove of Illinoian glacier, see fig. 6); containing the following kinds of inclusions: (1) numerous large blocks of well preserved wood (fig. 5); (2) large blocks of thoroughly oxidized and leached till (Nebraskan); (3) numerous blocks of blue-gray, calcareous, fossiliferous loess (Aftonian); and (4) numerous blocks of dark forest soil, with small fragments of carbonized wood....	12
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The exposure in the high cut bank (c) on the southwest side of the ravine is as follows. (Figs. 6 and 7.)

Thickness
Feet Inches

Recent—

Soil and slump.....	2
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Kansan—

Till, with slight concentration of sand and gravel above; calcareous, dark blue-gray; rests on very irregular surface inclined toward west.....	12
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Nebraskan—

Till, noncalcareous, brownish-gray; including a large mass 2 feet 6 inches thick, projecting into sand below; separated by sharp contact from till above (Figs. 6 and 7).....	1-1	6
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FIG. 5.—Kansan till contorted into sharp folds by overriding Illinoian ice, in bank of the same ravine shown in figure 5.

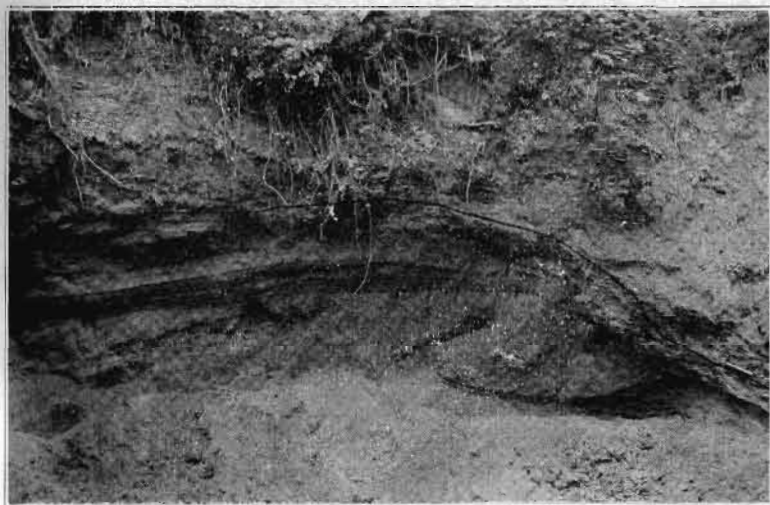


FIG. 6.—Photograph of cut bank exposure sketched in figure 7. The boundary between the Kansan and Nebraskan tills is marked by a line.

Sand, noncalcareous, light buff, somewhat cross-bedded; foreset beds dip east; includes several lens-like masses of weathered coal.....	2
Gravel, noncalcareous, lenticular	1
Sand, noncalcareous, to base of cut.....	4
Till, noncalcareous, brownish; exposed by digging; may be lenticular	6

Between the cut described above and the lower end of the ravine there are several remnants of terrace deposits, formed during the early Wisconsin glacial stage, and consisting of finely laminated fossiliferous silts and sands.

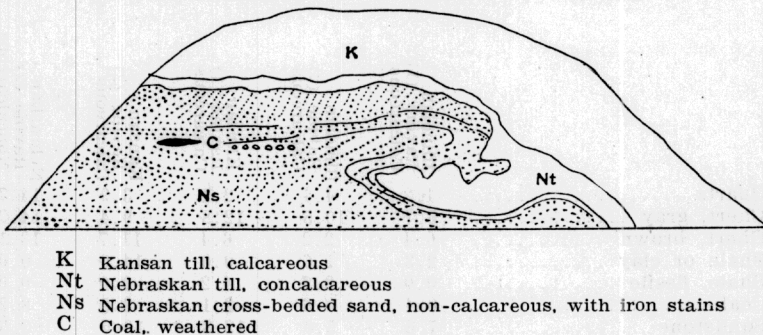


FIG. 7.—Diagram of cut bank on southwest side of ravine in SW. $\frac{1}{4}$ SE. $\frac{1}{4}$ sec. 32, T. 4 N., R. 3 E. (Isabel), showing unoxidized calcareous Kansan till overlying oxidized non-calcareous till and cross-bedded sand. Figure 6 is a photograph of this cut bank.

Comparison of the Illinoian, Kansan and Nebraskan Till.

In the absence of striated surfaces on the bed rock and lack of systems of morainic ridges, the most satisfactory data on the direction of advance of an ice sheet may be obtained from a study of the rock fragments incorporated in the till. A pebble count is made by lining out an area of one or two square feet and picking up all pebbles larger than the size of a pea within this area. This gives representative proportions of the different kinds of rocks incorporated in the till.

Fresh till in this region is calcareous. A noncalcareous till has been leached of all of its limestone and dolomite pebbles and many sandstone and shale pebbles have also become disintegrated, hence its pebbles consist principally of the rocks which are most resistant to weathering, such as quartz, chert, and igneous and metamorphic rocks.

Pebble counts were made from the Illinoian and Kansan tills in the first ravine and from all three tills in the second

ravine. The pebble count from the Nebraskan till can not be closely compared with those from the other tills because the Nebraskan is noncalcareous where the pebble count was made, whereas the other tills are calcareous. The percentages of rocks in the Illinoian and Kansan tills were recalculated excluding the limestone and dolomite pebbles from consideration, to permit a comparison of these tills with the noncalcareous Nebraskan till.

TABULATION OF PEBBLE COUNTS FROM ILLINOIAN, KANSAN AND NEBRASKAN TILLS.

(Figures are percentages of total number of pebbles.)

	Illinoian Ravine (1) Calcareous	Illinoian Ravine (2) Calcareous	Kansan Ravine (1) Calcareous	Kansan Ravine (2) Calcareous	Nebraskan Ravine (2) Noncalcareous
Quartz	4.2	4.4	2.1	3.9	14.7
Chert, gray	5.7	10.5	12.8	9.4	14.7
Chert, brown	0.4	2.2	6.4	11.7	13.1
Shale or clay	2.3	1.6	0.0	14.0	0.0
Shale, fissile	0.0	2.7	4.2	0.0	0.0
Coal	0.4	0.6	2.1	3.9	8.2
Sandstone	7.6	5.0	12.8	19.5	3.3
Ironstone concretions.....	7.2	4.4	4.2	2.3	1.6
Limestone	32.7	29.8	31.9	15.6	0.0
Dolomite	26.2	25.4	10.6	3.9	0.0
Granite and syenite.....	1.6	2.2	6.4	3.1	8.2
Diorite and gabbro.....	2.0	0.0	2.1	0.8	0.0
Rhyolite and quartz porphyry	0.0	0.0	0.0	0.8	1.6
Basalt	7.2	9.4	2.1	7.0	22.9
Quartzite and graywacke..	1.6	1.6	2.1	3.1	3.2
Gneiss	0.4	0.0	0.0	0.0	0.0
Jasper	0.0	0.0	0.0	0.8	4.9
Orthoclase	0.0	0.0	0.0	0.0	3.3
Hematite	0.8	0.0	0.0	0.0	0.0

The small number of counts given here makes it impossible to draw final conclusions regarding general differences in the characters of the three drift sheets, or regarding the direction of advance of the Nebraskan ice over this region. The following characteristics of the tills, as shown by pebble counts, are worthy of mention:

The Illinoian till contains on the average more dolomite and basalt than the Kansan.

The Kansan till contains more chert, more shale, and much more sandstone than the Illinoian, and nearly as much limestone.

The Nebraskan till has lost all limestone and dolomite, and much of its shale and sandstone through weathering. Its pebbles consist mostly of quartz and chert, and basalt and other igneous and metamorphic rocks. The percentage of these rocks in the Nebraskan till exceeds those in either of the other tills, even when the limestone and dolomite pebbles in the Kansan and Illinoian tills are excluded from consideration.

Sources of the Three Tills.

The Illinoian glacier came from the Labradorean center of glaciation and locally advanced southwest, down the broad valley of Illinois River. The dolomite fragments which are abundant in, and characteristic of this drift, were derived largely from the Ordovician (Galena dolomite) and Silurian (Niagaran dolomite) areas of northern Illinois.

The Kansan glacier is believed to have come from the Keewatin lobe, and to have spread eastward into Illinois from north central Missouri and southern Iowa. Its numerous fragments of shale, sandstone and coal (Pennsylvanian) were probably picked up locally, as there are widespread exposures of such rocks within a distance of a few miles. Numerous fragments of compact limestone in the Kansan drift may have come from the Mississippian (Salem and St. Louis) limestones, west and southwest of this area.

The Nebraskan glacier may have come from either the Labradorean or Keewatin center of glaciation, so far as the pebble count made here affords information. The abundance of rounded quartz and chert fragments in the Nebraskan till probably points to the wide surface distribution of these materials in Tertiary concentrations before the time of the first glaciation.

Evidence of Nebraskan Age of the Oldest Till.

The youngest till in the area investigated is known to be Illinoian in age because of its position below calcareous Peorian loess and noncalcareous Sangamon loess, materials which overlie the Illinoian till in extensive areas of western Illinois.

In the first ravine described, a second till is identified by its separation from the Illinoian till by an interglacial, fossiliferous loess, and an old soil profile on the till below the loess. A third till is here distinguished by the complete oxidation of masses of till which were later incorporated in the second till, and are now surrounded by unoxidized or unweathered till.

In the second ravine described the second till is separated from the Illinoian by an interglacial unfossiliferous loess and by 15 feet of oxidized and leached gravel, and is further distinguished by darker color, and the inclusion of fragments of old soil, fossiliferous loess, noncalcareous till, and logs, and by its contorted structure. The third till is again distinguished from the second by its complete leaching and oxidation and its position directly below the calcareous, unoxidized, second till.

The second till resembles the buried Kansan of many other exposures in western Illinois in character, and in its position below a compacted fossiliferous Yarmouth loess, the fauna of which contains a few species known to be characteristic of the Yarmouth epoch.

The third and oldest till is therefore assigned to the only known glacial epoch previous to the Kansan, the Nebraskan epoch, which has not heretofore been recognized in western Illinois.