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Geologic History of the Mackinaw Member of the Henry Formation in the Illinois River Valley in Tazewell County, Illinois

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ABSTRACT

In the Illinois River valley the Mackinaw Member of the Henry Formation consists of outwash gravels and sands of Woodfordian (Wisconsinan) age. Although the earliest outwash is buried, the upper 50 to 75 feet are exposed in several areas. The following history is based on bedding structures, lithologies of clasts, and textures. The lowest exposed units are planar cross-bedded clean quartz sands with a few scattered pebbles. A series of gravels with prominent scour and fill cross-bedding that contain large clasts of black shale, coal, and armored mudballs lie on the eroded surface of these sands. Flat-bedded sandy gravels devoid of black shale and coal succeed these deposits. These three series of sediments indicate initial low water velocities followed by a sudden rapid increase to very high velocities and a final decrease to moderate velocities. Floodplain alluvium rests on the flat-bedded gravels. A great flood swept over the floodplain, eroded broad channels, removed all fine material, and left an aggregate of rounded cobbles and boulders. Prominent lithologies among these lag deposits are black shale, coal, and armored mudballs. Floodplain alluvial deposition resumed as the flood waned.

INTRODUCTION

The Henry Formation, named for Henry, Marshall County, (Willman and Frye, 1970) consists of sand and gravel outwash deposits that are Woodfordian (Wisconsinan) in age. On the basis of lithology and origin, the formation is subdivided into three members, the Batavia, the Wasco, and the Mackinaw. Outwash plains are included in the Batavia, ice contact deposits comprise the Wasco, and valley trains make up the Mackinaw. The deposits in the Illinois River valley in Tazewell County make up a portion of a large valley train that are included in the Mackinaw Member, named for Mackinaw, Tazewell County (Willman and Frye, 1970).

In the Illinois River valley in Tazewell County only the upper 50 to 75 feet of the Mackinaw Member are exposed in surface outcrops, and, therefore, this discussion is restricted to this portion of the valley train. Concentrations of lithologic types, sizes of particles, and primary bedding structures were found to be the best keys to the depositional history of the Mackinaw Member.

PREVIOUS WORK

The sand and gravel deposits in Tazewell County have been described in a number of previous investigations. However, most of these are either regional studies that cover the geology of the county in a general way or deal with the economic aspects of the deposits rather than the depositional history of them. Bannister (1870) discussed the geology of west-central Illinois and included the floodplain gravels along the Illinois River. Leverett (1899) included Tazewell County in his description of the deposits of the Illinois glacial lobe. The northern part of the county was covered by Barrows (1910) in his geographic study of the Middle Illinois valley. The geology and mineral resources of that portion of Tazewell County within the Peoria 15′ Quadrangle was discussed by Udden (1912). Horber (1950) and Piskin (1967) discussed the bedrock valleys in the county and described the sand and gravel deposits that fill them. Horberg *et al.* (1950) and Walter *et al.* (1965) discussed the sands and gravels of parts of the county as sources of ground water. Wanless (1957) described the deposits in the Illinois River valley in Mason and Tazewell Counties and interpreted the geologic history of the area. The sand and gravel deposits of the county were studied in detail as potential economic resources by Hunter (1966). Willman and Frye (1970) classified the Pleistocene deposits in Illinois and established the formal stratigraphic nomenclature used throughout the state. Willman (1973) summarized the stratigraphy and geologic history of the Illinois Waterway including Tazewell County.

BEDROCK GEOLOGY

The prePleistocene surface in Tazewell County is dominated by the broad valleys of the ancestral Mississippi River, the Mackinaw Bedrock valley, and the Teays River, the Mahomet Bedrock valley (Figs. 1 and 2). Intervalley areas are restricted to several hills that form islands between the valleys. Exposures of bedrock are restricted to a few small stream cuts in the western part of the county (Fig. 2). The preglacial valleys were filled with Pleistocene tills and outwash and have no surface expression in the eastern part of the county.

The modern Illinois River has established its channel in part on fill within the bedrock valleys and in part on glacial deposits that covered the bedrock upland west of the valleys. Above Peoria the river flows along the west side of the broad Mackinaw Bedrock valley. Between Peoria and Pekin the valley has been incised into bedrock, producing the narrow Pekin-Sankoty Channel. Below Pekin the channel is along the west side of the broad valley below the confluence of the ancestral Mississippi and Teays Rivers (Fig. 2). Thus the width and character of the modern Illinois River valley is controlled by the type of material into which it is eroded.

In this study two segments of the Illinois River valley are of importance. The upper segment, the Pekin-Sankoty Channel, is cut into typical Pennsylvanian cyclic strata, producing a narrow rock-walled valley approximately one and one half miles wide. In the lower segment the valley widens to as much as twenty miles in the southwestern portion of the county. The western boundary of the valley is a series of bluffs that, like the narrows above, are Pennsylvanian bedrock. The eastern bedrock valley wall is the burried eastern limit of the Mackinaw Bedrock valley so that the eastern side of the modern Illinois River valley is composed of Pleistocene sediments. These relationships are illustrated in Figure 3.

SURFICIAL GEOLOGY

With the exception of the few small exposures shown in Figure 2, the bedrock surface in Tazewell County is covered by glacial and glacial-fluvial deposits (Figs. 3 and 4). Uplands are dominantly Illinoian till plains overlain by Wisconsinan till plains, end moraines, and loess (Fig. 4). The Illinois River valley is partially filled with a series of gravel and sand outwash deposits overlain by alluvium along the Illinois and Mackinaw Rivers and dune sands elsewhere (Figs. 3 and 4). The Mackinaw Member of the Henry Formation is a complex valley train that makes up the youngest outwash deposits in the valley fill. Wanless (1957, Fig. 58) reconstructed the original surface of the valley train. He estimated elevations of 640 feet at the proximal end near Peoria and 480 feet at the distal end in southwestern Mason County. The maximum valley fill (Fig. 5) was calculated from the differences in elevations between the bedrock surface (Fig. 2) and the original surface of the valley train constructed by Wanless (1957). Valley fill is thickest in two areas. Deposits more than 240 feet thick fill the old Mackinaw-Mahomet Bedrock valleys. However, these deposits are not aligned with the only Wisconsinan drainage in the vicinity, the modern Mackinaw River valley, and, therefore, must be largely older than the Henry Formation. The second area of thick outwash is in and below the Pekin-Sankoty Channel. Here sediments exceed 220 feet in thickness and are in the primary site of deposition of the Henry Formation (Willman and Frye, 1970, and Willman, 1973). Surface outcrops expose only the upper 50-75 feet of Wisconsinan sediments so the stratigraphic sequence of the entire valley fill cannot be determined. Based on well records, Horberg (1950) indicates that at least the lower portion of the valley fill is preWisconsinan in age.

The original surface of the Mackinaw Member has been greatly reduced by erosion to a series of three terraces (Fig. 4). Wanless (1957) designated the terraces, the Manito, Havana, and Bath named for towns in the area. The highest terrace, the Manito, ranges in elevation from approximately 540 feet in the north to approximately 510 feet in the south. The intermediate terrace, the Havana, is slightly lower than the Manito and ranges in elevation from approximately 500 feet in the north to 480 feet in the south. The lowest terrace, the Bath, lies between the modern floodplain of the Illinois River and the Havana terrace and averages 470 feet in elevation.

The youngest sediments deposited on the surface of the valley train are wind deposited dune sands and modern stream alluvium and peat. The dunes are most abundant on the Manito terrace, but are also common on the Havana terrace and on the western borders of the uplands to the east beyond the limits of the valley fill. Modern alluvium has been deposited by both the Illinois and Mackinaw Rivers (Fig. 4). Peat beds of limited areal extent occur on the floodplain of the Mackinaw River.

PETROLOGY

The Mackinaw Member is composed of interbedded gravels and sands. Although the gravels consist of clasts that range in size from pebbles as small as five millimeters to boulders several meters in diameter, pebbles and small cobbles are most abundant. Lithologically the gravels are highly variable, and all of the major rocks groups, sedimentary, igenous, and metamorphic, are present. Limestones, dolomites, sandstones, and granitic igneous clasts are the most common varieties. However, black shales, coals, and armored mudballs are locally very abundant near the head of the valley fill. The largest boulders occur in and near the Pekin-Sankoty Channel. Down valley there is a rapid decrease in the sizes of the largest clasts so that near the southern border of the county only small to medium pebbles are found.

The sand deposits as well as the sand fractions in the gravels are composed predominantly of quartz. Other minerals present in measurable quantities derived from igneous, sedimentary, and metamorphic terraines are typical of deposits related to the glaciation of Illinois. Willman and Frye (1970) list the complete mineralogy of the sands in the Henry Formation. Measurements of the median and mean diameters of the sands indicate a progressive decrease in grain sizes down valley. Thus measurements of both the largest clasts and sands indicate a loss of current velocity away from the source of the valley train.

Primary bedding structures are good indicators of the relative velocities of the currents that transported and deposited the sands and gravels. Several gravel pits in and near the proximal portion of the valley train expose bedding in the upper 50 to 75 feet of outwash. Scour and fill cross-bedding is the most common structure, but planar cross-bedding and flat-bedding are also present.

DEPOSITIONAL HISTORY

The most important keys to the depositional history of the Mackinaw Member of the Henry Formation are concentrations of lithologic types and primary bedding structures. Since only the upper portion of the valley train is exposed, the discussion of the depositional history is restricted to this portion. As shown in Figure 6, the upper part of the Mackinaw Member can be subdivided into a series of five deposits that are internally related. The earliest exposed deposit is clean quartz sand with a few scattered well-rounded pebbles. The dominant sedimentary structure is uniform planar cross-bedding in which foresets dip approximately 35 degrees. The surface of this sand body is extensively scoured, and gravel and sand deposits with prominent scour and fill cross-bedding rest on the eroded surface. Three lithologic types, coal, black shale, and rounded mudballs armored with small pebbles are very abundant. The coal and black shale give these deposits a distinctive dark color. The third deposit is sand and gravel which is largely flat-bedded and has only minor planar cross-bedding. These sands and gravels are devoid of coal and black shale clasts and have only a few small armored mudballs in them. Poorly bedded deposits of silt, clay, fine sand, and very small pebbles locally rich in organic matter overlie the flat-bedded sand and gravel. This is typical stream alluvium deposited by overbank flooding. Broad shallow channels filled with cobbles and small boulders lie in the alluvium. The clasts are generally well rounded and contain all lithologic types found in the valley train. Coal, black shale, and armored mudballs are particularly notable lithologic types. During periods of high ground water levels a water table was established on the underlying alluvium so that the cobble-boulder gravel was saturated. During these periods calcium carbonate was deposited as cement to form a local conglomerate. The last water laid deposits in the valley train are alluvium similar to the alluvium beneath the channel fills. In areas outside the channels, the two deposits of alluvium are separated by a soil zone.

The earliest deposit at the head of the valley train is interpreted as outwash deposited during the advances of the early Woodfordian glaciers. The textures and planar cross-bedding of these deposits indicate transport by water with moderate current velocities. These velocities were great enough to produce cross-bedding, but were insufficient to cause erosion. The overlying gravels and sands with scour and fill cross-bedding appear to be closely related to the Woodfordian end moraines on the uplands shown in Figure 4. The crossing of the Illinois River valley by these moraines blocked the valley and ponded glacial meltwaters into a large deep lake (Wanless, 1957). Because of the depth of the water, only fine silt and clay were deposited on the lake floor. Finally the lake overflowed the dam, and the morainal material was swept away downstream. The outrushing water eroded the surface of the earlier outwash, producing an irregular surface. Bedrock was stripped from the walls of the Pekin-Sankoty Channel, and coal and black shale were deposited in the headward portion of the train. As the lake drained, mud on the lake floor was stripped away in blocks which were rolled down stream and picked up coatings of pebbles. Water velocities were so great at this time that deposits with scour and fill cross-bedding were laid down on top of each other and clasts as large as boulders greater than one meter in length were transported. As the flood waters waned, flow velocities decreased and flat-bed structures were produced. When the lake was completely drained, the surface of the valley train was above water level. The accumulation of floodplain alluvium appears to mark a period of fluctuating water levels in the Illinois River. It seems reasonable to assume that the fluctuations in the river level represent the advances and retreats of the Woodfordian glaciers after deposition of the moraines that formed the lake. After the period of floodplain deposition, a great flood poured through the Pekin-Sankoty Channel. This flood is attributed to great melting of the glaciers in late Woodfordian time, the Kankakee Torrent (Wanless, 1957). The narrows of the Pekin-Sankoty Channel constricted the meltwaters and formed a bottleneck that produced an outflow of great velocity and depth. This flood of water eroded much of the proximal end of the valley train, again eroded the bedrock walls of the Pekin-Sankoty Channel, and stripped more of the mud deposits from the old lake floor. Water velocity was so great that all material finer than cobbles was transported down stream leaving only the larger material as a lag deposit. Below the head of the valley train the flood waters carved the successive terraces on the surface of the valley train discussed above and illustrated in Figure 4. Finally, when the Kankakee flood had waned, the surface of the valley fill was covered with water only during periods of flooding of the Illinois River.

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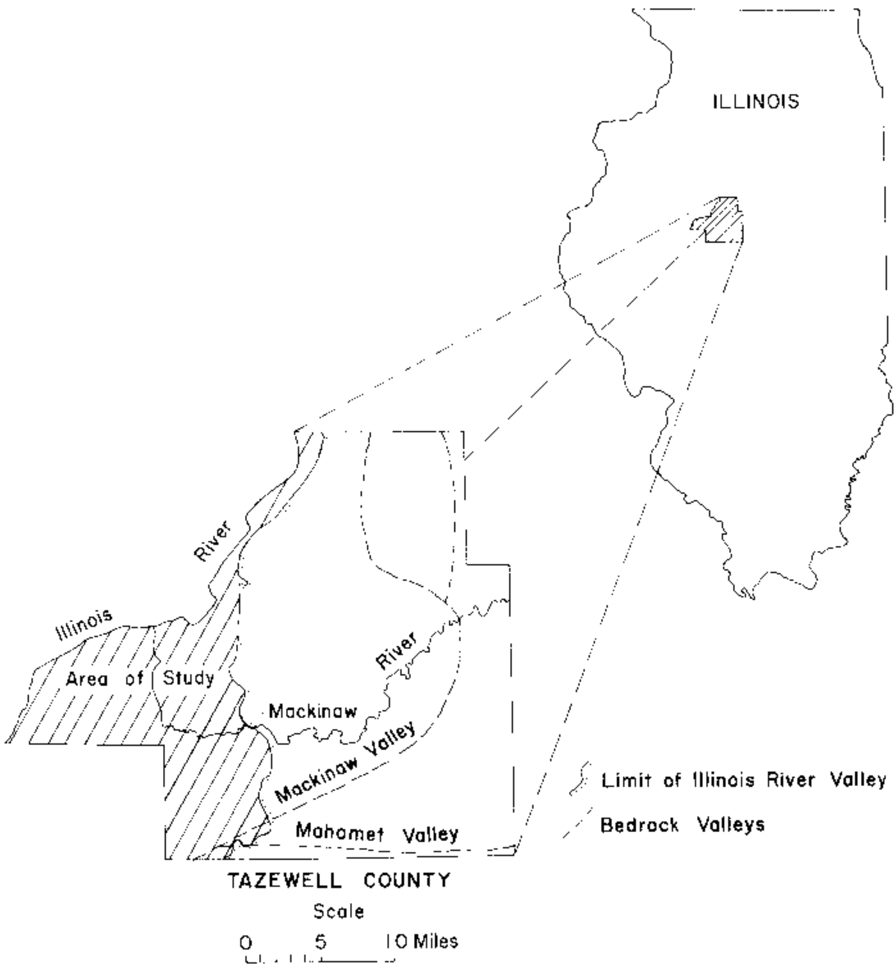

Fig. 1. Location map showing area of study and axis of Mackinaw and Mahomet Bedrock valleys.

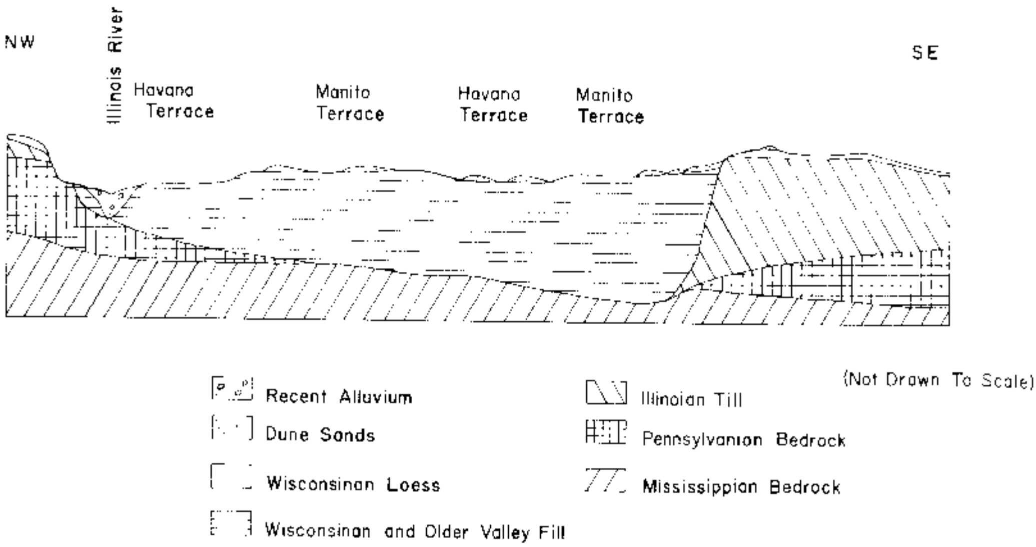

Fig. 2. Bedrock topography and bedrock exposures in Tazewell and Mason Counties.

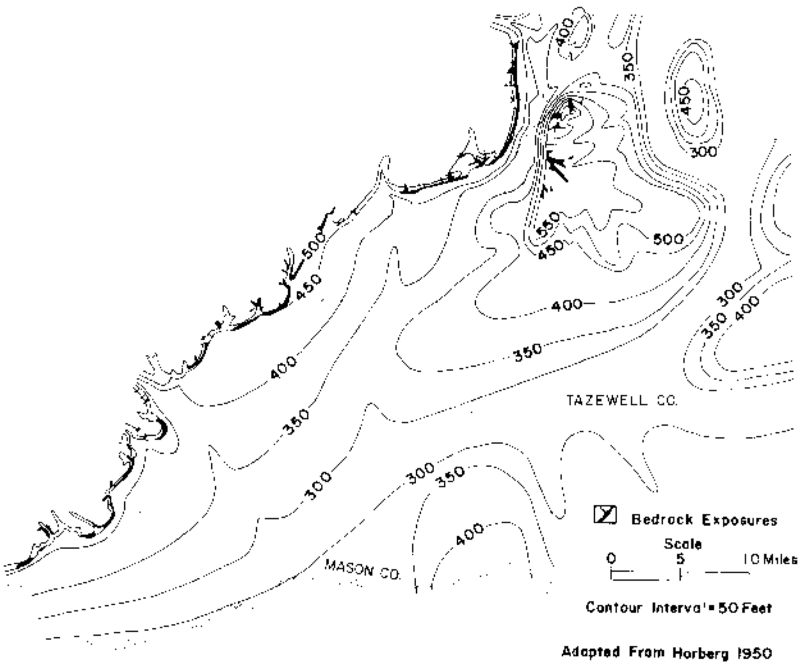

Fig. 3. Generalized cross section of the Illinois River valley in southern Tazewell County.

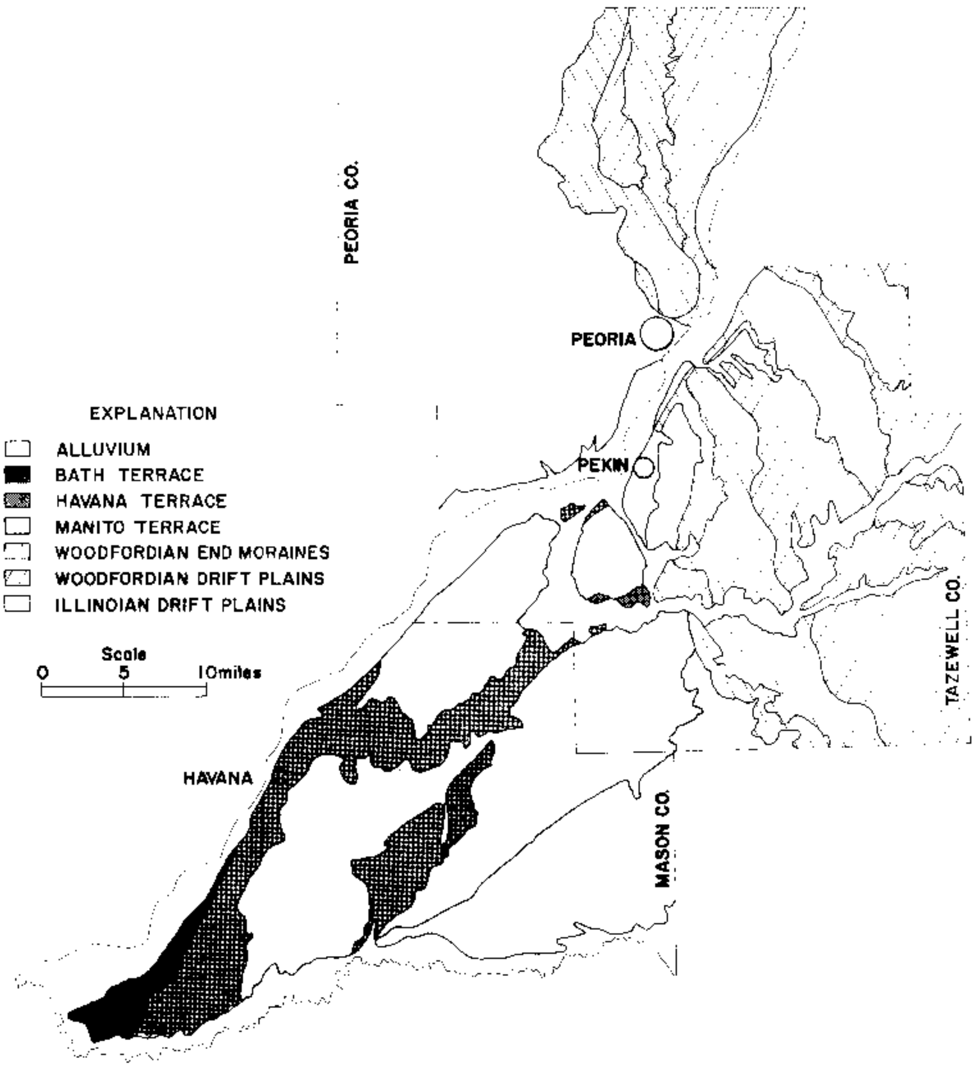

Fig. 4. Generalized surficial geologic map of Peoria, Tazewell, and Mason Counties.

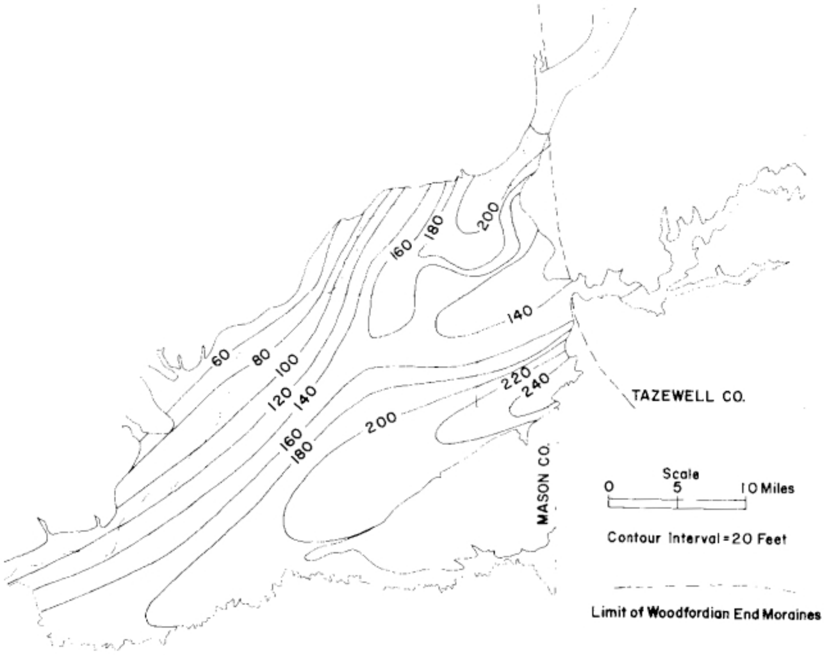

Fig. 5. Maximum thickness of fill in the Illinois River valley in Tazewell and Mason Counties.

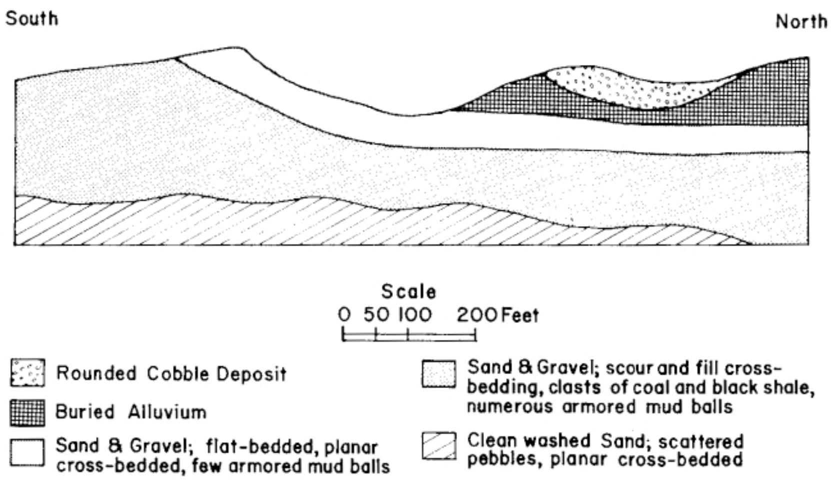

Fig. 6. Diagrammatic cross section of Woodfordian deposits in the Illinois River valley south of Pekin.