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GEOLOGY OF BUDA QUADRANGLE, ILLINOIS

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ABSTRACT

The Buda quadrangle in northwestern Illinois is along the north border of the region underlain by strata of Pennsylvanian age, but in the quadrangle only strata from Herrin (No. 6) Coal to Trivoli (No. 8) Coal are exposed.

The quadrangle contains a complex sequence of glacial deposits of the Kansan, Illinoian, and Wisconsin Stages. Kansan, and possibly also Nebraskan, deposits are not exposed but are a major part of the filling of the bedrock valleys, which include the deep valley of the Ancient Mississippi River. A north-facing escarpment on the south side of that valley diverted early Wisconsin ice westward into the Green River Lowland, forming the Green River lobe. The ice margin ascended the escarpment, which explains why the crests of the moraines are as much as 200 feet higher on the upland than in the lowland.

In the relatively low area where the moraines cross the partially buried valley, features left by stagnant ice are prominent and contrast with the more typical morainal typography in adjacent areas. The Shelbyville and Bloomington morainic systems are part of the Tazewell drift.

INTRODUCTION

The Buda quadrangle (pl. 1) is a rectangular area approximately 13 miles wide and 17 miles long in Bureau County in the northwestern part of Illinois (fig. 1). Strata of Pennsylvanian age are well exposed in the area, but the complex sequence of glacial deposits, representing three glacial stages and ice invasions from east and west, is of particular interest.

The area is known chiefly as an agricultural district. The gently rolling surface, the deep fertile soil, and the warm moist summers combine to make it a valuble farming region. In addition, the area contains a variety of mineral resources, several of which have been worked commercially for many years. Coal, clay products, sand and gravel, and molding sand are the major mineral products. Abundant supplies of ground water contribute to the economic development of agriculture and mineral industries.

Field work was started in the Buda quadrangle by Paul MacClintock in 1921. After additional field work in 1935, he prepared a detailed report that has been on open file at the Illinois State Geological Survey. The present report also incorporates studies of the Pennsylvanian strata by J. Marvin Weller, H. R. Wanless, and Louis C. McCabe, and of the glacial deposits by George E. Ekblaw and H. A. Sellin. The mapping was revised by H. B. Willman in 1958. This brief report

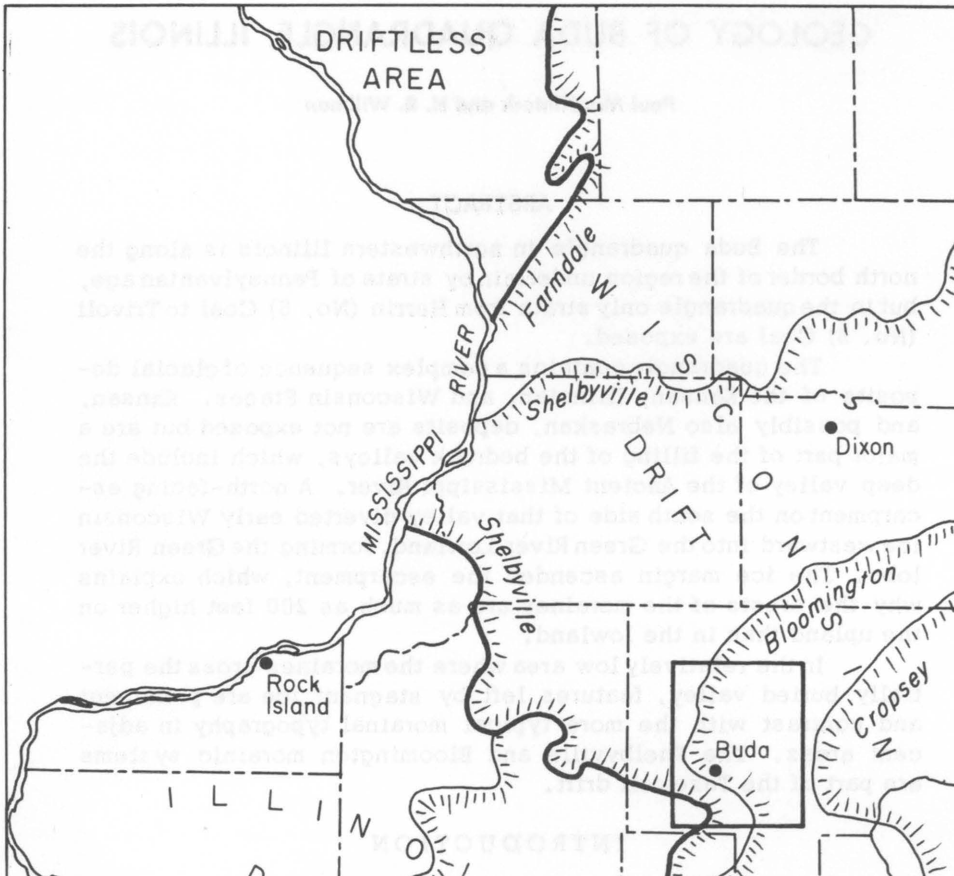


Fig. 1. - Part of northwestern Illinois showing the location of the Buda quadrangle and the positions of major stands of the ice front during Pleistocene glaciation.

summarizes the major aspects of the geology of the quadrangle. The more detailed manuscript, notes, and drill records may be consulted in the technical files of the Geological Survey at Urbana.

For assistance in the original study, the senior author expresses gratitude to Ernest Obering, his field assistant, H. E. Culver, Stuart Weller, F. C. Baker, Gilbert H. Cady, J. Marvin Weller, L. E. Workman, George E. Ekblaw, and M. M. Leighton.

PHYSIOGRAPHY

The Buda quadrangle lies largely in the Bloomington Ridged Plain, characterized by broad, gentle, sloped ridges of glacial drift (pl. 1). In general, the drift retains the distinctive physiographic features of glacial deposition. The major feature of the area is the Bloomington morainic system, which consists of three closely spaced moraines that cross the area from north to south and are lobed slightly westward into the Green River Lowland. The distinctive glacial topography of the moraines west of Wyanet, where kames, eskers, ice block depressions, and sharp morainic hills look almost as fresh as modern features, suggests that the more gently rounded hills of moraines, both north and south of Wyanet, are an original characteristic and have not been modified significantly by post-glacial erosion.

A small area in the southwest corner of the quadrangle lies in the Galesburg Plain, an area of Illinoian drift characterized by much weaker development of glacial features and greater dissection than are found on the Wisconsin drift.

In the northwest corner of the quadrangle the Bloomington Ridged Plain is bordered by the Green River Lowland, a relatively flat outwash plain covered in many places by sand dunes, some as high as 50 feet.

The major valleys in the area are those of Bureau Creek and its tributary, West Bureau Creek. Bureau Creek joins Illinois River about eight miles east of the quadrangle. Both creeks are entrenched in the relatively flat till plain behind the Bloomington morainic system. As each follows a course parallel to the curve of the moraines, their positions are related to positions once occupied by the waning ice front.

The highest elevation in the area is about 950 feet above sea level on the crest of the moraine near Providence in the southwest part of the quadrangle. The lowest point, about 520 feet, is along Bureau Creek where it leaves the quadrangle, a relief of 430 feet in four miles.

STRATIGRAPHY

In the Buda quadrangle stratified or sedimentary rocks, perhaps 3,500 to 4,000 feet thick, overlie granite and other rocks of Precambrian age (fig. 2). Of the bedrock formations, only about 175 feet of beds of Pennsylvanian age are exposed. The bedrock is overlain by glacial deposits which locally are as much as 500 feet thick.

The deepest well in the quadrangle, at Buda, is 1,631 feet deep and penetrates the top of the Shakopee Dolomite. Information on older formations is based on deeper wells in the surrounding region, including a boring at Amboy, 15 miles northeast of the quadrangle, that enters the Precambrian granite.

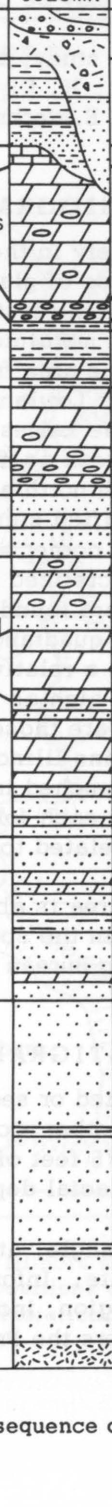
System	Formation	Rock Column	Thickness (Feet)	General Character
PLEISTOCENE SERIES			0-500	Till, gravel, sand, silt, peat
PENNSYLVANIAN			0-550	Shale, sandstone, coal, clay, limestone
DEVONIAN			0-60	Limestone
SILURIAN	Niagaran series		300-400	Dolomite, part cherty
	Kankakee		50	Dolomite, very cherty
	Edgewood		20	Dolomite, silty
ORDOVICIAN	Maquoketa		175-200	Shale, dolomite
	Galena		225	Dolomite, medium-grained, partly cherty
	Platteville		110	Dolomite, fine-grained, cherty
	Glenwood		100	Sandstone, dolomite, shale
	St. Peter		85	Sandstone
	Shakopee		100-150	Dolomite, cherty, few sandstone beds
	New Richmond		50	Sandstone
	Oneota		200	Dolomite, cherty
	Gunter		50	Dolomite, sandy, silty
CAMBRIAN	Trempealeau		200	Dolomite, drusy quartz
	Franconia		150	Sandstone, glauconitic, dolomite
	Galesville		100	Sandstone
	Eau Claire		400	Sandstone, dolomite, shale
	Mt. Simon		1000-2000	Sandstone, few shale beds
PRECAMBRIAN				Granite

Fig. 2. - Generalized sequence of strata in the Buda quadrangle.

CAMBRIAN AND ORDOVICIAN SYSTEMS

The sequence of Cambrian and Ordovician rocks underlying the area is shown in figure 2. Further information on the character of these formations in this region is given in reports by Workman and Bell (1948), Foster (1956), and Hackett and Bergstrom (1956). The general character of the Ordovician units in Buda City Well No. 2 is summarized in table 1.

SILURIAN SYSTEM

Formations of Silurian age do not crop out in the Buda quadrangle, but they directly underlie the glacial drift along the buried valley of the Ancient Mississippi River in the central and northern part of the quadrangle (fig. 3). The Silurian rocks consist almost entirely of dolomite, the lower part of which is generally cherty and argillaceous. The upper part is much purer and probably contains reefs.

Where overlain by Devonian rocks in the southern part of the quadrangle, the dolomite of Silurian age is about 500 feet thick. Wells in adjoining areas show that both the Silurian and Devonian Systems are truncated at a low angle by Pennsylvanian rocks which overlap them in a northerly direction. Where Silurian rocks are directly overlain by Pennsylvanian beds in the northern part of the quadrangle, the Silurian is progressively thinned to about 400 feet. Along the Ancient Mississippi Valley, where Pennsylvanian beds are cut away, the upper 100 feet or more of the Silurian is probably eroded, reducing its thickness to 300 feet or less.

DEVONIAN SYSTEM

In the Buda quadrangle Devonian rocks are penetrated only in wells at Buda (table 1). The presence of a few feet of Devonian age limestone at Mineral, four miles west of the quadrangle, about 30 feet near Bureau, five miles east of the quadrangle, and 60 feet about three miles southeast of the southeast corner of the quadrangle, suggests that Devonian strata will be found throughout perhaps the southern four or five miles of the quadrangle. The Devonian rocks in this region consist largely of light gray, fine-grained to sublithographic limestone, but may include some thin beds of shale.

Table 1 - Log of Buda City Well No. 2
SW$\frac{1}{4}$ NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 34, T. 16 N., R. 7 E., Bureau County

Elevation 767 feet above sea level

Summarized from description of samples by Elwood Atherton

	Thickness Ft.	Depth Ft.
Pleistocene Series	310	310
Pennsylvanian System	110	420
Limestone, light gray, sublithographic; little clay shale, reddish gray	15	435
Limestone, light gray, sublithographic	10	445
Dolomite, sandy, light gray, brownish gray, very fine to fine, with fine to medium rounded sand grains	5	450

Table 1. - Continued

	Thickness Ft.	Depth Ft.
Silurian System		
Niagaran Series		
No samples	10	460
Dolomite, light gray, very fine	10	470
No sample	5	475
Dolomite, light brownish gray and light gray, very fine	120	595
Dolomite, slightly cherty, light brownish gray, very fine, slightly vesicular	70	665
Dolomite, light brownish gray, very fine; dolomite, white, very fine; trace of quartz and sphalerite	10	675
Dolomite, light brownish gray, very fine, slightly cherty	20	695
Dolomite, light brownish gray, very fine	30	725
Dolomite, light brownish gray and light gray, very fine to fine, vesicular	80	805
Dolomite, slightly cherty, light gray, very fine to fine	15	820
Dolomite, gray, very fine to fine	30	850
Dolomite, light brownish gray, fine to coarse	9	859
Alexandrian Series		
Kankakee Formation		
Dolomite, cherty, light brownish gray, very fine to medium	36	895
Dolomite, cherty to very cherty, light brownish gray, very fine to fine, trace glauconite	13	908
Edgewood Formation		
Siltstone, dolomitic, greenish gray and brownish gray, black specks, pyritic	19	927
Ordovician System		
Maquoketa Formation		
Dolomite, silty, gray, brownish gray, very fine; dolomite, gray, black, fine to coarse, fossiliferous	8	935
Shale, slightly dolomitic, greenish gray, brown, weak; little dolomite, dark gray	50	985
Dolomite, gray, brownish gray, black specks, fossiliferous; little shale as above	10	995
Shale, slightly dolomitic, greenish gray, weak	5	1000
Dolomite, gray, black grains and specks, fossiliferous	5	1005
Dolomite, cherty, gray, very fine to fine, black specks	10	1015

Table 1. - Continued

	Thickness Ft.	Depth Ft.
Dolomite, as above; dolomite, shaly, olive gray, very fine	10	1025
Dolomite, light gray, gray, fine to coarse, black grains, in part with red specks	27	1052
Dolomite, argillaceous, dark olive, mostly very fine, few black fossils; little shale, dolomitic, dark brownish gray	28	1080
Shale, dolomitic, olive gray to black, weak; little siltstone, gray, pyritic	30	1110
Galena Formation		
Dolomite, gray, fine to medium, pyritic	5	1115
Dolomite, light brownish gray, fine; partly with abundant red specks	5	1120
Dolomite, light brownish gray, fine	15	1135
Dolomite, light brownish gray, fine to medium, vesicular in part	90	1225
Dolomite, light gray, fine to medium	50	1275
Dolomite, light brownish gray, little gray, fine to medium, vesicular in part, cherty at base	25	1300
Dolomite, light gray, light brownish gray, fine to medium	25	1325
Dolomite, cherty, light brownish gray, fine to medium	15	1340
Platteville Formation		
Dolomite, light grayish brown, very fine	10	1350
Dolomite, slightly cherty; trace of grayish green shale	10	1360
Dolomite, very cherty, light grayish brown, very fine to fine	30	1390
Dolomite, grayish brown, trace of chert, very fine to fine, dense	40	1430
Dolomite, brown, very fine; little dolomite, light gray	20	1450
Glenwood Formation		
Sandstone, white, medium to coarse, little fine to coarse, friable, rounded, and frosted grains	85	1535
Dolomite, light gray, very fine; sandstone, white, medium to coarse, friable; shale, green; shale greenish gray, very sandy	10	1545
St. Peter Formation		
Sandstone, white, fine to coarse, mostly fine, friable	20	1565
Same, more medium sand	30	1595
No sample	5	1600

Table 1. - Continued

	Thickness Ft.	Depth Ft.
Sandstone, as above; little green shale	5	1605
Shale, light greenish gray, weak; clay, light brownish gray, pyritic; chert	5	1610
Shale, light gray, sandy, weak; sandstone, white, fine to coarse, very pyritic	18	1628
Shakopee Formation		
Dolomite, very sandy, light brownish gray; may be boulders in basal St. Peter	3	1631
		Total depth

PENNSYLVANIAN SYSTEM

The Pennsylvanian System consists largely of alternating beds of shale, sandstone, and relatively thin beds of coal, limestone, clay, and black slaty shale. They have the typical cyclical arrangement that has been described for nearby areas (Udden, 1912; Wanless, 1929, 1957; Willman and Payne, 1942). Probably 12 to 15 cyclothems are represented in the area. The sequence has a maximum thickness of about 550 feet in the southern part of the quadrangle, but it is completely eroded along the Ancient Mississippi Valley in the northern part of the quadrangle.

As wells do not reach the bedrock along the deep part of the valley, the extent of the Pennsylvanian beds (fig. 3) is largely based on projection of the elevation of the base of the Pennsylvanian from wells a few miles north of the quadrangle and others near Princeton and Bureau east of the quadrangle. As the exact position of the deep part of the valley and its depth is also projected, the extent of the Pennsylvanian beds is indefinite.

Although the southeastward dip of the strata exceeds the slope of the valley bottom, the place where the Silurian-Pennsylvanian contact crosses the valley is not known, and Silurian rocks may form the valley floor entirely across the quadrangle. Also, the south wall of the valley probably is much sharper and more irregular than shown in the generalized reconstruction (fig. 4).

The strata of Pennsylvanian age in this area are classified into three groups: Tradewater, Carbondale, and McLeansboro. Only the McLeansboro Group and the uppermost part of the Carbondale Group are exposed. Many of the units are better exposed in the LaSalle and Hennepin quadrangles to the east (Cady, 1919).

Tradewater Group

The Tradewater Group includes all the strata of Pennsylvanian age underlying the Isabel Sandstone, which occurs only a few feet below the widely persistent Colchester (No. 2) Coal. Tradewater strata are not well known in the Buda quadrangle, but they probably include representatives of five or six cyclothems. Judging from records in adjacent areas, they may be as much as 150 feet thick, perhaps 200 feet locally. The Rock Island (No. 1) Coal probably is present in places, but it appears to be generally less than 2 feet thick in this region. The character of the upper part of the Tradewater Group is shown by the log of a boring near Sheffield (table 2).

Carbondale Group

The Carbondale Group includes the strata overlying the Tradewater to the base of the Copperas Creek Sandstone,which is commonly only a few feet above the Herrin (No. 6) Coal. The character of the Carbondale sequence is shown by several coal test borings in the vicinity of Sheffield. Except for minor variations the sequence is typical of that found in areas where these strata crop out to the east, south, and west. The group is 225 to 250 feet thick. The Liverpool (at the base), Summum, St. David, and Brereton Cyclothems are present, and many of the individual members can be recognized in the borings (table 2). Only the Brereton Cyclothem is exposed.

Table 2. - Logs of Boring No. 1, SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 24, and Boring No. 2, NE corner SW$\frac{1}{4}$ sec. 25, T. 16 N., R. 6 E., Bureau County, of the Sheffield Mining and Transportation Company

Drilled about 1870

Elevation: Boring No. 1, 680 feet above sea level; Boring No. 2, 740 feet, estimated from topographic map

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Boring No. 2				
Pleistocene System				
Soil and clay	14		14	
Pennsylvanian System				
McLeansboro Group				
Sparland Cyclothem				
Farmington Shale, light	4		18	
Sparland (No. 7) Coal	2		20	
Shale, clayey	10		30	
Copperas Creek Sandstone				
Shale, sandy, light	8		38	
Sandstone	5		43	
Carbondale Group				
Brereton Cyclothem				
Sheffield Shale, sandy, light	16		59	
Shale, dark	5	2	64	2
Herrin (No. 6) Coal	3	6	67	8
Vermilionville Sandstone				
Limestone (calcareous sandstone)	5	4	73	
Limestone (calcareous sandstone) and shale	14		87	
Sandstone and clay	25		112	
St. David Cyclothem				
Canton Shale				
Shale, dark, and limestone	25		137	
Shale, light, and limestone	10		147	
Shale, dark, and limestone	3		150	
Shale, light, and limestone	3		153	
Sandstone and limestone	6		159	
Shale, dark	4		163	

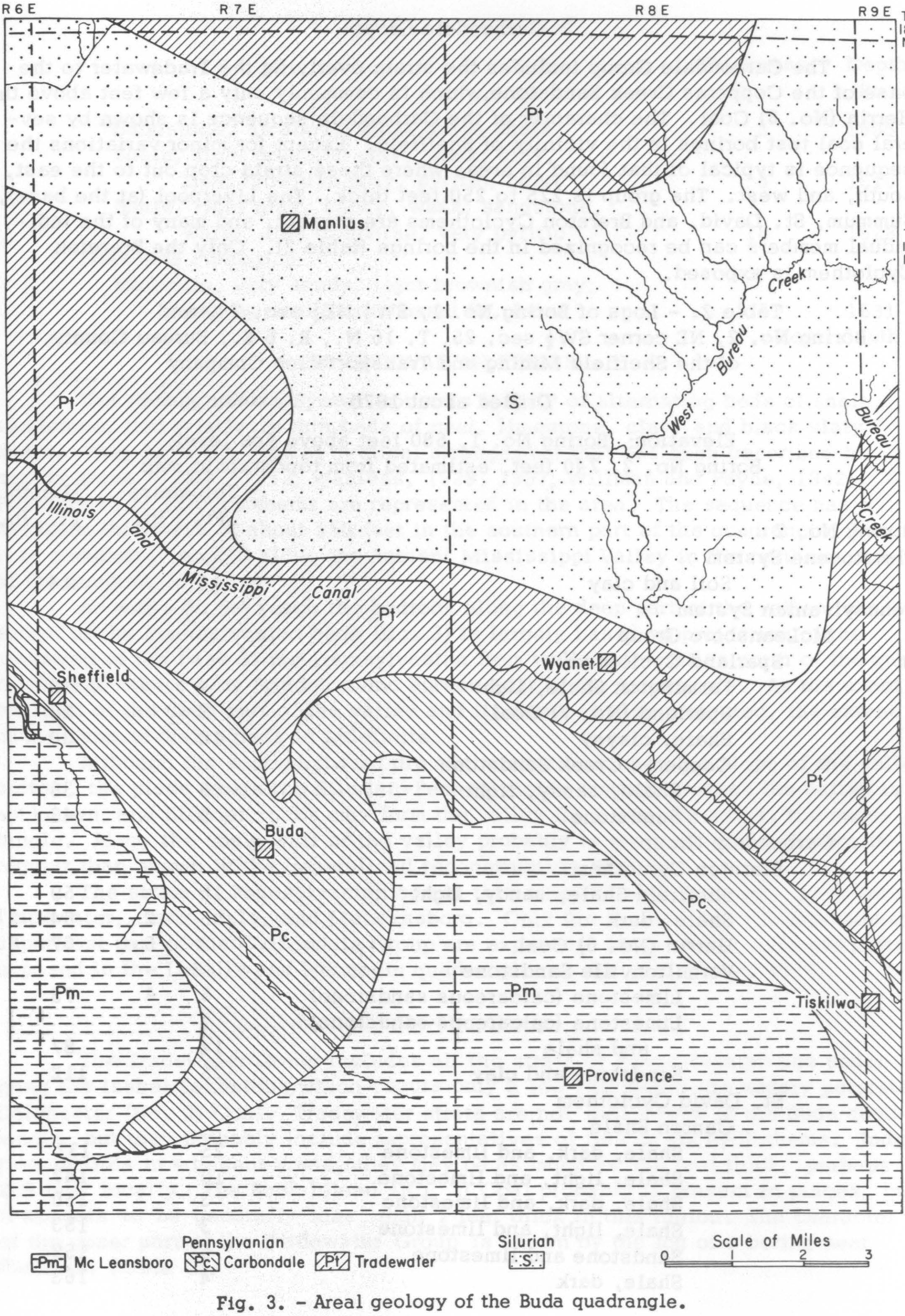


Fig. 3. - Areal geology of the Buda quadrangle.

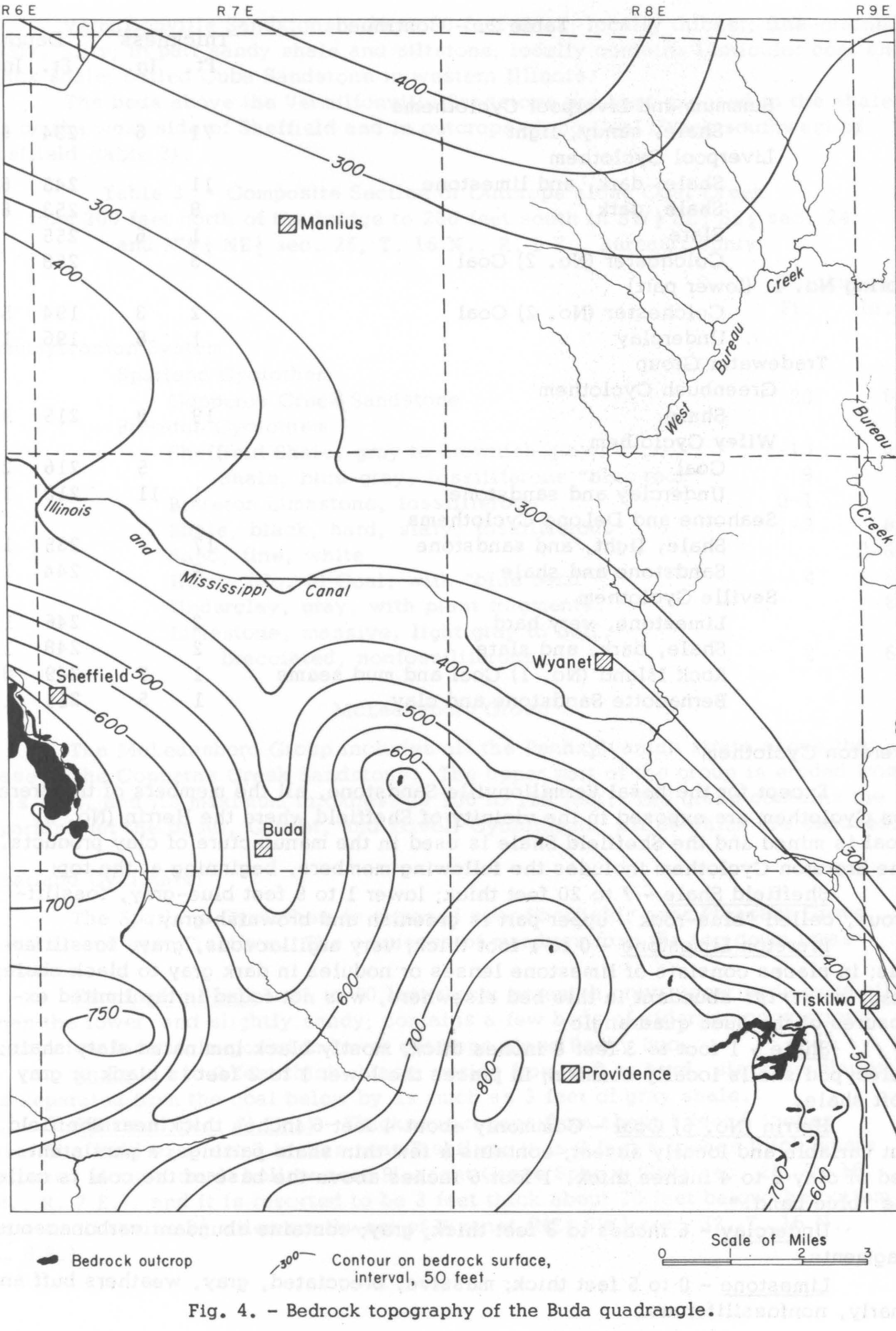


Fig. 4. - Bedrock topography of the Buda quadrangle.

Table 2. - Continued

	Thickness Ft.	Thickness In.	Depth Ft.	Depth In.
Summum and Liverpool Cyclothems				
Shale, sandy, light	71	6	234	6
Liverpool Cyclothem				
Shale, dark, and limestone	11		245	6
Shale, dark	8		253	6
Slate	1	6	255	
Colchester (No. 2) Coal	3		258	
Boring No. 1 (lower part)				
Colchester (No. 2) Coal	2	3	194	5
Underclay	1	8	196	1
Tradewater Group				
Greenbush Cyclothem				
Shale	19	8	215	9
Wiley Cyclothem				
Coal		5	216	2
Underclay and sandstone	1	11	218	1
Seahorne and DeLong Cyclothems				
Shale, light, and sandstone	17		235	1
Sandstone and shale	9		244	1
Seville Cyclothem				
Limestone, very hard	2		246	1
Shale, dark, and slate	2		248	1
Rock Island (No. 1) Coal and mud seams	1	7	249	8
Bernadotte Sandstone and clay	1	5	251	1

Brereton Cyclothem

Except for the basal Vermilionville Sandstone, all the members of the Brereton Cyclothem are exposed in the vicinity of Sheffield where the Herrin (No. 6) Coal is mined and the Sheffield Shale is used in the manufacture of clay products. The Brereton Cyclothem includes the following members, beginning at the top:

Sheffield Shale - 7 to 20 feet thick; lower 1 to 9 feet blue-gray, fossiliferous, called "blue-rock"; upper part is greenish and brownish gray.

Brereton Limestone - 0 to 1 foot thick; very argillaceous, gray, fossiliferous: in places consists of limestone lenses or nodules in dark gray to black shale; *Fusulina girtyi* abundant in this bed elsewhere, was not found in the limited exposures of the Buda quadrangle.

Shale - 1 foot to 3 feet 8 inches thick; mostly black laminated slaty shale; pelecypod shells locally common; in places the lower 1 to 2 feet is black or gray soft shale.

Herrin (No. 6) Coal - Commonly about 4 feet 6 inches thick near Sheffield, but variable and locally absent; contains a few thin shale partings; a persistent bed of clay 2 to 4 inches thick, 1 foot 6 inches above the base of the coal is called the "blue band."

Underclay - 6 inches to 3 feet thick; gray; contains abundant carbonaceous fragments.

Limestone - 0 to 5 feet thick; massive, brecciated, gray, weathers buff and gnarly, nonfossiliferous.

Vermilionville Sandstone - 30 to 50 feet thick; locally thicker; fine-grained, shaly, silty; in part sandy shale and siltstone; locally contains lenticular coal and black shale; called Cuba Sandstone in western Illinois.

The beds above the Vermilionville Sandstone are best exposed in the shale pit on the west side of Sheffield and in outcrops along Coal Creek southwest of Sheffield (table 3).

Table 3. - Composite Section of Outcrops along Coal Creek from 200 feet north of the bridge to 200 feet south in SW$\frac{1}{4}$ SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 24 and NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 25, T. 16 N., R. 6 E., Bureau County

	Thickness Ft.	In.
Pennsylvanian System		
Sparland Cyclothem		
Copperas Creek Sandstone	20	8
Brereton Cyclothem		
Sheffield Shale, gray to brownish gray	4-13	6
Shale, blue-gray, fossiliferous "blue rock"	9	
Brereton Limestone, fossiliferous	0-1	
Shale, black, hard, slaty, fossiliferous	1-2	8
Sand, fine, white		0-6
Herrin (No. 6) Coal, with "blue band"	4	6
Underclay, gray, with plant fragments		8
Limestone, massive, light gray to buff, brecciated, nonfossiliferous	2	6

McLeansboro Group

The McLeansboro Group includes all the Pennsylvanian strata above the base of the Copperas Creek Sandstone. The upper part of the group is eroded from this area, and its maximum thickness is 100 to 125 feet. The group contains the Sparland (at the base), Gimlet, and Trivoli Cyclothems, all of which are exposed.

Sparland Cyclothem

The Sparland Cyclothem is exposed near Sheffield, near Pleasant Grove School, and near Tiskilwa. The sequence of members from the top down is as follows:

Farmington Shale - 25 to 40 feet thick; greenish gray; upper beds more silty than the lower and slightly sandy; contains a few beds of sideritic concretions with a few fossils; exposed in lower outcrops along Rocky Run.

Shale - 1 to 2 feet thick; black; varies from soft to hard, slaty; in places is separated from the coal below by as much as 3 feet of gray shale.

Sparland (No. 7) Coal - Thickness ranges from about 1 foot 6 inches near Sheffield to 3 feet 2 inches near Tiskilwa; it is 2 feet 6 inches thick where exposed along a small hollow near Pleasant Grove School (SW$\frac{1}{4}$ sec. 25, T. 16 N., R. 7 E.), and it is reported to be 3 feet thick about 30 feet below the bottom of a small ravine 2$\frac{1}{2}$ miles southwest of Wyanet (NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32, T. 16 N., R. 8 E.).

Underclay - 10 to 15 feet thick; light gray; upper 3 feet noncalcareous, lower part calcareous and contains limestone nodules.

Limestone - 0 to 5 feet thick; nodules in shale.

Copperas Creek Sandstone - 20 to 30 feet thick; fine-grained, micaceous, silty, argillaceous; in places mostly sandy shale with interbeds of sandstone.

The basal Copperas Creek Sandstone is best exposed at Sheffield, but the higher members are well exposed only southwest of Tiskilwa in Rocky Run (table 4) and about a mile farther south in Plow Hollow.

Table 4. - Outcrops in South Branch of Rocky Run
NE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 14, T. 15 N., R. 8 E., Bureau County

	Thickness Ft.	Thickness In.
Pennsylvanian System		
Sparland Cyclothem		
Farmington Shale		
Shale, gray, soft; includes several bands of ironstone concretions which contain a few marine fossils	30-35	
Shale, bluish gray	2	
Sparland (No. 7) Coal	2	3
Underclay, light gray streaked with yellow; upper 3 feet noncalcareous; lower 7 feet calcareous and contains limestone concretions	10	
Underclay limestone, dark yellowish gray, hard, poorly bedded, concretionary	1	6
Shale, silty, noncalcareous, light gray, poorly bedded	2	4
Underclay limestone, light bluish gray, nodular, interbedded with shale	1	3
Copperas Creek Sandstone		
Shale, sandy, bluish gray, micaceous; contains small calcareous concretions	3	6
Shale, noncalcareous, olive-gray, thin-bedded at top, more massive below	5	
Base concealed (7 feet of Copperas Creek Sandstone, buff, micaceous, thick-bedded, is exposed nearby in a small tributary in NW$\frac{1}{4}$ sec. 13).		

Gimlet Cyclothem

The Gimlet Cyclothem is exposed only along Rocky Hollow and Plow Hollow. It consists of the following members from the top:

Shale - 10 to 20 feet thick; mostly gray to greenish gray but some beds are red and red mottled; some basal beds are strongly calcareous and grade laterally through a nodular zone to very fossiliferous, crinoidal limestone that, in places, may be part of the underlying limestone.

Lonsdale Limestone - 2 to 10 feet thick; varies from gnarly-shaped, light greenish gray, limestone nodules in gray shale to massive, brecciated, or conglomeratic, very fine-grained to lithographic limestone; variable light to dark gray but mostly weathers whitish; very fossiliferous in places with gastropods particularly abundant; where thick it commonly is in two benches separated by 1 to 2 feet of shale. The Lonsdale Limestone in places cuts deeply into the underlying beds, and in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 14, T. 15 N., R. 8 E., it appears to occupy a channel that cuts through all the underlying Gimlet members and six feet into the Farmington Shale. In the NW$\frac{1}{4}$ sec. 14 it rests directly on the Gimlet Sandstone, cutting out the coal and underclay which are present nearby.

Shale - 0 to 9 feet thick; gray, red, and dark gray to black; 2 inches of soft black shale locally at the base may be equivalent to a coal elsewhere.

Clay - 0 to 5 feet thick; light greenish gray; lower part contains rough-surfaced masses of dark greenish gray, brecciated, nonfossiliferous limestone.

Gimlet Sandstone - 0 to 20 feet thick; gray, fine-grained, micaceous, thin-bedded to shaly.

The best exposures are near the center of the S$\frac{1}{2}$ sec. 14 (table 5), except the massive phase of the Lonsdale Limestone which crops out in a small ravine near the cemetery in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 14. The Lonsdale is also exposed along the northern branch of Plow Hollow in SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 24, T. 15 N., R. 8 E.

Table 5. - Outcrop along a Ravine Tributary to Rocky Run in the middle of the S$\frac{1}{2}$ sec. 14, T. 15 N., R. 8 E., Bureau County

	Thickness Ft.	In.
Pennsylvanian System		
Gimlet Cyclothem		
Shale, calcareous, greenish gray with reddish mottling, slightly micaceous, contains limestone concretions	14	
Lonsdale Limestone Member, shale, calcareous, gray to dark gray; contains large, irregular, fossiliferous limestone nodules	1	6
Shale, noncalcareous, bluish gray	1	3
Shale, dark gray, micaceous		1
Shale or clay, dark gray; contains plant stem impressions and may mark the position of a coal		1
Underclay, greenish gray; part faintly calcareous; contains nodules of conglomeratic, pisolitic, nonfossiliferous, greenish gray, silty limestone, 10 inches to several feet in diameter	7	
Base concealed		

Trivoli Cyclothem

The Trivoli Cyclothem is exposed only along Rocky Run and Plow Hollow and includes the youngest bedrock strata exposed in the Buda quadrangle. The cyclothem has no basal sandstone in this area. It contains the following members, from the top:

Shale - About 7 feet exposed; greenish gray, part locally streaked with red; calcareous, limestone nodules common.

Trivoli Limestone - 2 feet thick; gray; locally contains shale partings, crinoidal beds, and black limestone pebbles; very fossiliferous.

Shale - 2 to 8 feet thick; brownish green, calcareous, fossiliferous; contains limestone nodules.

Trivoli (No. 8) Coal - 0 to 1 foot 5 inches thick; mostly coaly black shale but in places consists of coal with a clay parting.

Underclay - 2 to 10 feet thick; gray, locally reddish in lower part, slightly calcareous.

The best exposures are along the south branch of Rocky Run near the center of the SE$\frac{1}{4}$ sec. 14 (table 6).

Table 6. - Outcrop along Rocky Run northwest of cen. SE$\frac{1}{4}$ sec. 14, T. 15 N., R. 8 E., Bureau County

	Thickness Ft.	Thickness In.
Pennsylvanian System		
Trivoli Cyclothem		
Trivoli Limestone, crinoidal 1-4 inch beds; contains shale partings, including a 6-inch bed in middle	1	4
Shale, brownish green, calcareous, fossiliferous; contains many limestone nodules	7	6
Trivoli (No. 8) Coal; shale, black, with contorted coaly streaks		1-5
Underclay, gray, slightly calcareous	9	6
Gimlet Cyclothem		
Shale, dark greenish gray		8
Shale, yellowish gray; contains many gray whitish-weathering limestone nodules	2	10
Shale, dark red; contains greenish streaks near base, grayish at top	2	6
Shale, gray, mottled red	1	
Lonsdale Limestone		
Shale, light greenish gray; grades laterally to calcareous shale to shaly limestone with abundant fossils; in places contains beds of fossiliferous crinoidal limestone	4	
Shale, greenish gray, with limestone nodules and beds 2-6 inches thick	4	
Shale, red with green splotches; contains red limestone nodules	1	6
Shale, light greenish gray; contains reddish splotches near top and a few large dark gray concretions	5	
Base concealed		

PLEISTOCENE SERIES

Rocks of Mesozoic and Tertiary age are not found in the Buda quadrangle, and the Pennsylvanian and Silurian bedrock formations are directly overlain by unconsolidated deposits of Pleistocene age. The area contains an extremely complex sequence of Pleistocene deposits related largely to glaciation. They consist of till of several ice invasions with closely associated gravel, sand, and silt deposits, a widespread mantle of loess deposits, numerous sand dunes, and lake, swamp, and stream deposits.

The Pleistocene deposits are probably more than 500 feet thick in the north part of the area. They include extensive deposits of the Kansan, Illinoian, and Wisconsin glaciers. Kansan, and possibly older, deposits are not exposed, but the Illinoian till plain is present in the southwest part of the quadrangle (pl. 1). The outstanding feature of the Wisconsin deposits is the massive Bloomington morainic system composed of three closely associated moraines that cross the area from north to south with striking change in aspect as they descend into the partially filled valley of the Ancient Mississippi River.

Bedrock Surface

The bedrock surface on which the Pleistocene deposits rest has a relief of more than 500 feet (fig. 4), and shows the junctions of several valley systems now largely buried by the glacial deposits. The bedrock valleys are called Princeton Bedrock Valley, which was the main channel of the Ancient Mississippi River that flowed northwest to southeast across the area; Paw Paw Bedrock Valley, which is the valley of the Ancient Rock River that joined the Mississippi from the northeast along or just east of the east boundary of the quadrangle; Buda Bedrock Valley, a sharply entrenched tributary of the Ancient Mississippi from the south; and Mud Creek Bedrock Valley, an ancient tributary from the west (Horberg, 1950b, p. 48-54, 64, pl. 2).

The bedrock exposures in the area between Sheffield and Tiskilwa are in the upper part of an escarpment that, previous to glaciation, bounded an upland region of Pennsylvanian rocks and faced northward over the Green River Lowland, a plain mostly underlain by Silurian rocks.

The age of the bedrock surface is controversial. The upland surface on the Pennsylvanian rocks is an old erosional surface, probably late Tertiary in age. Chert gravel lacking glacial materials occurs on this surface 15 miles west of the Buda quadrangle (Horberg, 1950a). Horberg (1950b, p. 93) considered the Green River Lowland to be part of the preglacial Havana Strath and the deeply entrenched valleys likewise to be preglacial in age, although the latter were widened and perhaps deepened by glacial melt water. Others believe that the deep channels, and perhaps most of the relief of the bedrock surface, are the product of early Pleistocene erosion. In this and other areas the presence of Kansan drift in the valleys dates the major entrenchment of the valleys as early Kansan or older.

Pre-Kansan Drift

Noncalcareous silt and till-like material 12 feet thick were encountered at a depth of 263 feet beneath calcareous drift, believed to be of Kansan age, in a well at Buda, in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 34, T. 16 N., R. 7 E. Although this introduces the possibility of Nebraskan glaciation of the area, similar material was not encountered in nearby wells, and it is not accepted as definite evidence of Nebraskan glaciation. Northwest of this region in Iowa the Ancient Mississippi Valley is believed to be marginal to the eastern limit of Nebraskan ice, and scanty evidence favors this relation farther south in Illinois, so that Nebraskan ice may have reached this area.

The thick sand deposits that fill the lower part of the Princeton Bedrock Valley contain the abundant polished pink quartz sand grains that characterize the Sankoty sand, a deposit widely present along the Ancient Mississippi Valley. The Sankoty sand is believed to be at least as old as early Kansan and is possibly Nebraskan in age (Horberg, 1950c, p. 34-36; 1953). Along much of Princeton Bedrock Valley in this area, Wisconsin deposits appear to rest directly on the Sankoty sand, but the sand underlying Kansan till in the wells at Buda is of the Sankoty type and is as low as the upper part of the Sankoty sand in Princeton Valley.

Kansan Stage

Kansan ice invaded the Buda quadrangle from the west or northwest. It probably covered the area completely, although the northeastern limit of the lobe is poorly known. Drift of Kansan age is preserved mainly in the bedrock valleys. Borings in Buda Bedrock Valley at Buda (table 7) encountered two soil zones beneath Wisconsin deposits, and the 100 feet of till, gravel, and sand underlying the lower soil is probably Kansan.

Table 7. - Log of Buda City Test Boring
NE$\frac{1}{4}$ SW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 34, T. 16 N., R. 7 E., Bureau County

Elevation 740 feet above sea level, estimated from topographic map.

Samples studied by M. P. Meyer.

	Thickness Ft.	Depth to Bottom Ft.
Pleistocene Series		
Wisconsin Stage		
Loess, yellow, noncalcareous	5	5
Till, yellow, oxidized, calcareous	10	15
Till, brownish gray, calcareous	40	55
Sand, silty, gray, medium to very coarse, calcareous	5	60
Till, as above	90	150
Illinoian Stage		
Soil, grayish brown	1	151
Till, gray to brownish gray, calcareous	59	210
Till, gray, some pinkish, calcareous	9	219
Kansan Stage		
Soil, dark brown, calcareous	1	220
Till, gray, brownish gray at top, some pink, calcareous; some clayey, brown calcareous at base	15	235
Sand and granule gravel, silty, clayey, calcareous	15	250
Same; not clayey	25	275
Same; clay, sandy, calcareous, gray	5	280
Sand and gravel, slightly silty	9	289

Yarmouth Stage

The Yarmouth Stage is represented only by the brown soil reported in the wells at Buda.

Illinoian Stage

In Illinoian time glaciers advanced from the east and northeast, and the Buda quadrangle was probably covered during at least two of the three substages recognized in Illinois. The drift in this area is part of the till plain behind the Buffalo Hart moraine (Ekblaw, G. E., *in* Wanless, 1957, fig. 54, p. 134). Illinoian drift directly underlies Wisconsin loess and is exposed in numerous road and stream cuts in the southwest part of the quadrangle (pl. 1). The till is a compact, dark gray, clayey silt that weathers yellow brown. It contains scattered sand grains, pebbles, and cobbles. Beds and lenses of sand and gravel are common. Illinoian drift contributed to the filling of the bedrock valleys, but Princeton Bedrock Valley was not completely filled because the Mississippi River reoccupied it when the Illinoian ice melted.

A piece of native copper found in this drift in a well in the SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 6, T. 15 N., R. 7 E., appears to have been transported eastward from its parent ledges in the Keweenaw Peninsula by a pre-Illinoian glacier and then brought southwestward to its present location by Illinoian ice.

The composition of the pebbles in the drift is shown by a count of pebbles in an exposure of Illinoian till along Spoon River in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 30, T. 15 N., R. 7 E., Bureau County, as follows:

Sedimentary Rocks	Number	Percent
Limestone	161	30.0
Dolomite	98	18.0
Chert	131	24.1
Sandstone	25	4.4
Shale	8	1.4
Coal	1	0.2
Quartz	18	3.3
Ironstone concretion	6	1.1
Igneous Rocks		
Basalt	23	4.2
Granite	21	3.9
Diorite	13	2.4
Felsite	9	1.5
Greenstone	7	1.3
Metamorphic Rocks		
Quartzite	15	2.9
Argillite	9	1.5
Schist	2	0.3
Gneiss	1	0.2
Total	548	100.7

The dominance of sedimentary rocks, which compose about 83 percent of the pebbles, shows that much of the glacial drift was eroded from bedrock formations south of the Canadian Shield, from which the igneous and metamorphic rocks were derived. The presence of more limestone than dolomite pebbles is unusual, as pebble counts of Illinoian drift in other areas show a preponderance of dolomite. This could result from a local concentration of limestone pebbles derived from outcrops of Devonian and Mississippian limestone in northern Michigan. It also may indicate the presence of Kansan drift from western sources, as the latter contains limestone in greater abundance than dolomite.

Sangamon Stage

The Illinoian drift was deeply weathered during Sangamon time, and the 2 to 3 feet of clayey soil developed on the drift generally serves to differentiate Illinoian from younger drift. In places the upper part of the Illinoian drift is a dark gray to dark brownish gray very clayey material, commonly described as "gumbotil" because of its sticky character. The Illinoian drift is leached of carbonates to an average depth of 5 feet below the overlying loess, whereas the Wisconsin drift, where overlain by calcareous loess, is calcareous to the top. Along the Princeton Bedrock Valley the Sangamon soil and most of the Illinoian drift appear to be cut out by Wisconsin drift (Horberg, 1953, pl. 1, D-D).

Wisconsin Stage

The glaciers that invaded the Buda quadrangle during Wisconsin time came from the east and northeast and were part of the spreading Michigan lobe. The earliest Wisconsin glaciation recognized in this general region is the Farmdale, which is believed to have covered the northern part of Illinois and may have reached southward to this area (Shaffer, 1956). However, the Farmdale ice apparently did not reach the southern part of the quadrangle because loess believed to be of Farmdale age rests directly on the uneroded Sangamon soil.

Farmdale Substage

Numerous auger borings and a few exposures in road cuts and along Spoon River indicate that the Farmdale loess is widely present in the area of Illinoian drift. The Farmdale loess generally consists of 2 to 4, locally 7, feet of brown noncalcareous loess that varies from chocolate brown to a pinkish or purplish brown. It commonly grades through a transition zone with scattered pebbles and increasing clay content to the weathered till below, but it is generally sharply defined from the lighter, buff-colored, calcareous Peorian loess above. In several localities from 2 to 7 feet of sand and fine gravel separates the Farmdale and Peorian loesses and apparently represents outwash from the nearby Shelbyville ice.

In an exposure along the east side of Spoon River near the center of sec. 30, T. 15 N., R. 7 E., 6 to 8 inches of leached water-laid sand and silt underlies calcareous fossiliferous Peorian loess and overlies Farmdale loess. The upper 1 foot 6 inches of the Farmdale is noncalcareous but the underlying part is calcareous and fossiliferous.

Tazewell Substage

When the advancing Tazewell ice reached this region, the north-facing escarpment of Pennsylvanian rocks appears to have diverted ice southward down the Ancient Mississippi Valley, along what is now Illinois Valley, and northwestward up the valley. The westward lobe spread out in the Green River Lowland and is called the Green River lobe (Leighton, 1923). It blocked the Mississippi River, forming Lake Savanna (Shaffer, 1954), which found an outlet along the present course of the river from Rock Island to Muscatine. At its maximum the Green River lobe extended westward into eastern Iowa. The Buda quadrangle is largely within the area covered by the Green River lobe. The most advanced drift of the lobe is believed to correlate with the Shelbyville drift farther south and to be nearly contemporaneous with the Iowan glaciation in Iowa (Shaffer, 1954). The succeeding Bloomington drift likewise shows a lobate projection of the ice into the Green River Lowland but to a much smaller extent.

Succeeding advances of the ice during Tazewell time did not reach the Buda quadrangle, but outwash from the ice front when it stood at the Dover and Arlington moraines just east of the quadrangle formed valley trains now represented by terraces along Bureau Creek.

Shelbyville Drift. - The oldest and outermost Wisconsin drift in this area is correlated with the Shelbyville of the central Illinois lobe. It consists largely of gray till with a buffish or slightly pinkish tinge that serves to distinguish it from the predominantly pink till of the younger Bloomington drift. Although the Bloomington front can be traced with confidence directly to Bloomington, it locally overlaps the outer Wisconsin drift north of Peoria, as it nearly does in the Buda quadrangle, so that outside the Bloomington front the older Wisconsin moraines cannot be directly traced. The gray Wisconsin drift outside the Bloomington in the Buda area may in part correlate with the LeRoy or Champaign moraines (Wanless, 1957, p. 140), but assuming that the maximum extent of Wisconsin ice was contemporaneous in closely related lobes, the name Shelbyville is commonly applied to the pre-Bloomington drift of the Green River lobe.

The Shelbyville drift is commonly only 10 to 20 feet thick and the absence of morainic features suggests that the ice front did not stand long at its position of maximum advance. The ice itself may have been unusually thin at the margin because it appears to have flowed around a hill of Illinoian drift only about 75 feet high four miles south of Sheffield (pl. 1). The margin of the Shelbyville drift cannot generally be recognized from the topography, but it is mapped on the basis of scattered exposures and auger borings. Auger borings indicate that Shelbyville till is locally present beneath outwash in the southwest part of the quadrangle, but in places the outwash rests directly on Illinoian drift.

The most distinctive features of the Shelbyville drift are the gravel hills near Burnett and Three Bridges School, three miles south of Buda, that appear to be kames formed in the reentrant in the ice at the place of diversion of the Green River ice. These hills are 40 to 60 feet high and show irregular mixing of gravel and till. Melt water flowing from this reentrant in the ice formed the headwaters of Spoon River.

Shelbyville till underlies Bloomington outwash, loess, and sand dunes in the northwest part of the quadrangle outside the Bloomington moraines. At places it is encountered in borings only 3 to 5 feet below the surface, but generally it is more deeply buried.

Bloomington Morainic System. - The Bloomington morainic system consists of three partially overlapping moraines that combine to make one of the most prominent morainic ridges in Illinois. Although the individual moraines have a relief of only 50 to 75 feet, the highest crest is 150 to 200 feet above the general level of the till plain to the west. The three moraines are named for localities in the Buda quadrangle and are the Sheffield moraine (outer Bloomington), Buda moraine (middle Bloomington), and Providence moraine (inner Bloomington).

The Bloomington morainic system is characterized in this region by the strong pinkish gray color of its till and clayey or silty outwash. The pink color generally distinguishes Bloomington drift from the dark gray Illinoian till, the tan or buffish gray Shelbyville till, and the yellowish gray till of the younger Cropsey till a short distance east in the Hennepin quadrangle.

In deep, fresh exposures and in borings, the Bloomington till, when moist, commonly is purplish gray to brick red. When it is relatively dry it is pink and the color seems stronger on slightly weathered surfaces.

A striking characteristic of all three of the Bloomington moraines is their change in character in the central part of the quadrangle where they cross the buried Princeton Bedrock Valley. In a sharp descent northward from closely spaced positions on top of the Pennsylvanian escarpment south of the old valley, the Sheffield moraine declines about 100 feet, the Buda moraine about 150 feet, and the Providence moraine about 200 feet. North of the valley the moraines are more widely spread, the Sheffield moraine remains relatively low and rises only about 50 feet, but both the Buda and Providence crests rise to within 50 feet of the levels south of the valley.

In the areas bordering the buried valley the moraines are dominantly till and have a topography and composition typical of Tazewell moraines. In the area where they cross the buried valley the moraines have a much greater amount of gravel and sand and a much more irregular topography, and the surface slopes generally have a much sharper relief. This area is differentiated on plate 1 by the dotted overprint.

In the low area many flat-surfaced tracts underlain by lake and swamp sediments occur among the hills or surrounding them. Many steep-sided slopes bordering depressions appear to be the contact faces of sediments deposited against ice blocks. Several kames occur in the area. A group of eskers, one of which is about three miles long, is present southwest of Wyanet (pl. 1).

Although streams of melt water may have been concentrated in the low area at the nose of the lobe, the topography does not suggest the presence of large through-flowing subglacial streams. However, melt water flowing from each of the three stands of the ice front contributed to the building of an extensive outwash plain along the front of the moraine in the Green River Lowland in the northwest part of the quadrangle. An outwash plain was also built into the upper reaches of Spoon River in the southwest part of the quadrangle.

Melt waters were discharged from all three stands of the ice front along two major channels which are partially filled with sand and gravel. One channel is about three miles north of Sheffield and the other two miles south of Manlius. These may have started as subglacial drainage channels.

In general the drift in this area has many aspects of drift deposited by inactive or stagnating ice. The distinctive aspects of this drift represent only the final episode in building the moraines. The absence of stagnation features elsewhere along the moraines suggests that either the ice front melted back first from the higher part of the inner moraine or that a minor pulsation early in withdrawal pushed ice into the low area. In either case, continued withdrawal resulted in isolation and stagnation of the ice in the low area. Lake deposits on the back slope of the moraine at levels higher than the general surface in the low area seem to require that ice occupied the low area after it had at least partially withdrawn from the higher morainal areas.

Sheffield Drift. - The outer moraine of the Bloomington morainic system is named Sheffield from the town of Sheffield, which is located on the moraine (pl. 1). The typical pink till is overlain by about 20 feet of loess in the vicinity of Buda, but near Sheffield and farther north the loess in places is only a foot or two thick. Boulders are common on the surface where the loess is thin. The character of the pebbles in the till is shown by a count of pebbles from the SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 28, T. 16 N., R. 7 E., as follows:

	Percent
Dolomite	72
Chert	8
Granite	4
Basalt	4
Diorite	3
Ironstone	3
Sandstone	2
Limestone	2
Quartzite	1
Rhyolite	1
	100

The presence of only 13 percent of pebbles derived from the Canadian Shield and the dominance of dolomite are characteristic of most of the drift of the Michigan lobe.

Buda Drift. - The middle moraine of the Bloomington morainic system is named for the town of Buda, which is partly on the moraine, although more of the town is on the Sheffield moraine (pl. 1). Boulders are common in the pink till and a count of the boulders concentrated on the moraine in the SE$\frac{1}{4}$ sec. 17, T. 16 N., R. 7 E., is as follows:

Kind of rock	Number of boulders of various sizes				Total number of boulders
	1 ft.	2 ft.	3 ft.	4 ft.	
Diorite-gabbro	33	20	12	2	67
Granite	24	24	10	2	60
Basalt	10	10	3	0	23
Gneiss	2	5	2	1	10
Syenite	1	0	0	0	1
Rhyolite-porphyry	0	1	0	0	1
Pegmatite	0	1	0	0	1
Perkinite	0	0	1	0	1
Dolomite	0	1	0	0	1
				Total	165

Of the 165 boulders counted, all but one (dolomite) are from rocks which crop out no closer than the Lake Superior region. Local materials increase in abundance with decreasing size because 87 percent of pebbles in the Sheffield district come from bedrock formations south of Lake Superior. The dominant dolomite in the pebble size could come largely from the Ordovician and Silurian rocks of northern Illinois. On the other hand the quartz grains that dominate the sand fraction must originally come in large part from formations north of Illinois. However, they can be derived largely from older drift. Bedrock formations within 200 miles appear to be the source for a high proportion of the drift materials.

Providence Drift. - The inner moraine of the Bloomington morainic system is named the Providence moraine for the village of Providence on the crest of the moraine in the southern part of the Buda quadrangle. The Providence moraine may be equivalent to the Metamora moraine which, in the Bloomington-Peoria region, lies behind the Bloomington moraine and in front of the Normal moraine. However, it has not been traced definitely through the complex morainic region north of Peoria, and the use of a local name seem preferable.

The stagnation complex of gravel, sand, and lake beds of clay and silt intermixed with till is particularly well developed in the segment of the Providence moraine from Wyanet south to Union School and west to the margin of the moraine.

In the relatively flat area of till plain east of the Providence moraine, sand and gravel outwash and silt and clay lake beds overlie pink till in many places. Exposures of interlaminated clay and silt are found at several places, mostly close to the moraine. About four miles north of Wyanet as much as 12 feet of lake sediments occurs in the NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 32, T. 17 N., R. 8 E., and 8 feet occurs in the NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 27, T. 17 N., R. 8 E. Two miles south of Tiskilwa 10 to 12 feet of lake sediments are exposed along Plow Hollow in SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 30, T. 15 N., R. 9 E. The lake beds are mostly calcareous and pink and directly overlie calcareous pink till. These deposits occur at elevations from 610 to 670 feet and appear to have been deposited in lakes temporarily formed between the moraine and the retreating ice front. Many of the deposits are overlain by a few feet of sand and gravel, which suggests that the ice was still nearby when the lakes were drained.

Cutbanks along Bureau and West Bureau Creek locally expose sand and gravel directly beneath loess and overlying till. The deposits are commonly 5 to 10 feet thick, rarely as much as 20 feet. They appear to be outwash deposited during the withdrawal of the ice before drainage lines were deeply entrenched.

Peorian and Tazewell Loess. - Most of the glacial drift in this area is covered with loess that appears to have been blown from outwash plains in the Green River Lowland west of the Bloomington moraines. Because of the rough topography, the loess varies considerably in thickness. Areas with thin loess may have been more exposed to the winds, whereas others, which were more protected, favored accumulation of thicker deposits. Stream cutting, slope wash, and slumping have all functioned locally to modify the original thickness. The thickest loess observed is about 20 feet in a railroad cut at Buda. An original thickness of 10 to 12 feet was probably more common. In general the loess thins eastward.

Most of the loess is a light buff, well sorted silt where calcareous, a darker brownish gray, clayey silt where leached. Generally the loess is all leached unless it is more than 6 feet thick, although exceptions occur where the leached zone has been partially eroded. The calcareous loess contains abundant snail shells in a few localities.

In the southwestern part of the quadrangle, outside the area of Shelbyville drift, the loess rests on Farmdale loess, or on the weathered zone of the Illinoian drift where the Farmdale is absent. In that area the loess represents the accumulation of all the post-Farmdale Wisconsin loesses and is called Peorian loess.

The loess resting on the Wisconsin drift accumulated during Tazewell time and is referred to as Tazewell loess. The Peorian loess differs from the Tazewell loess on the Shelbyville drift only in the possible presence in the basal Peorian of loess that accumulated during the Iowan or Shelbyville advances. Such loess, called Iowan loess in many reports, is present nearby but was not definitely recognized in the Buda quadrangle.

Although a minor amount of loess may have been added during the later Wisconsin (Cary and Mankato) time, the unweathered character of the Wisconsin tills where overlain by calcareous loess shows that loess accumulation began soon after ice withdrawal, and the major intervals of loess accumulation are believed to have been early in Wisconsin time. Some borings in the northwest part of the quadrangle outside the Bloomington moraine encountered 4 to 8 feet of calcareous loess overlying Shelbyville till and overlain by Bloomington outwash.

The presence of snails in the loess suggests that loess deposition probably started as soon as a vegetation cover was established. The vegetation served both to lodge blowing silt and to provide a suitable environment for land-dwelling snails.

Tazewell Dune Sand. - The principal areas of sand dunes are on the Bloomington outwash about three miles west of Manlius and on the east slope of the Providence moraine, $2\frac{1}{2}$ miles east of Manlius (pl. 1). In both areas the dunes have a well developed soil cover except for a few relatively small blow-outs. They directly overlie calcareous loess and, like the loess, appear to have formed soon after glaciation.

The dunes on the Bloomington outwash are continuous with the large tracts of dunes found throughout the Green River Lowland extending both north and west from this area. Similar sands within a few miles of the Buda quadrangle at Annawan and Normandy generally consist of 50 percent or more medium-sized grains, and average about 75 percent quartz, 15 percent feldspar, and 10 percent shale, chert, heavy minerals, and other grains (Willman, 1942, p. 43, 55, 72-73). Several of the dunes are 40 to 50 feet high. The prevalence of gentle westward and steep eastward slopes show that the winds which piled up the sand in the dunes were dominantly from the west and northwest. The sand was derived from the sandy outwash plains.

The source of the sand in the dune areas east of Manlius is less certain. This sand may have migrated from the Green River Lowland and mostly lodged in the lee of the crest of the moraine. Some of the sand continued eastward to West Bureau Creek along relatively narrow belts extending from both ends of the major sand tract. The presence of lake beds in the lower slopes of the moraine immediately to the east suggests the alternative that the dunes are derived from local beach and outwash sands. However, the dunes occur close to the crest of the moraine and would not likely have moved westward. Further, the beach and dune sands should have been mantled by loess, rather than the reverse. Although the presence of very little wind-blown sand in the intervening area makes the Green River Lowland look like a distant source, the open exposure of the west-facing slopes of the moraine to the wind, and the presence of a soil cover on the loess might permit the winds to sweep the surface fairly clean. The surface over which the dunes migrated would now be buried in the loess.

The dune sand in the elongate area north of Wyanet likewise appears to be post-loess in deposition, because a boring near the west end of the area, in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 7, T. 16 N., R. 8 E., encountered 10 feet of calcareous fossiliferous loess beneath the dune sand and overlying pink till.

Tazewell Terrace Deposits. - In the valleys of Bureau and West Bureau Creeks,terraces capped by sand and gravel occur at two levels. The upper terrace rises from about 600 feet elevation to 660 feet, going upstream. Farther east it merges with outwash plains in front of the Dover Moraine in the Hennepin and Amboy quadrangles. Drainage from the next younger moraine, the Arlington, also locally discharged into Bureau Creek. In the Buda quadrangle 5 to 10 feet of medium to coarse gravel underlies the terrace and generally overlies till.

The level to which this terrace was eroded by the melt waters appears to have been determined by the presence of a lake in Illinois Valley at an elevation of 600 feet. This lake, called Lake Illinois, was formed when Bloomington drift blocked Illinois Valley at Peoria, and it existed until near the end of Tazewell time.

Cary Substage

Cary Terrace Deposits. - The lower terrace, about 40 feet below the higher, rises from 560 feet in the southeast part of the quadrangle to 620 feet upstream, and is capped with fine gravel, sand, and silt. It was formed after the glaciers had waned, and the terrace deposits consist of material sorted from the drift during erosion to the terrace level.

Projected to Illinois Valley,the low terrace is at the same level as several large terrace areas, such as that at Hennepin opposite the mouth of Bureau Creek. This terrace surface is believed to be an erosional level formed during an early Cary interval of exceptionally large discharge of melt water, the Kankakee Flood (the Kankakee Torrent of previous reports). The erosion of Illinois Valley to this level permitted Bureau Creek to deepen its valley to the level of the low terrace. Later, waters discharged from Lake Chicago deepened the main valley further and Bureau Creek cut through the low terrace to its present level.

RECENT DEPOSITS

Peat and Muck

The numerous undrained depressions, both in the Bloomington Morainic System and the outwash plain, are characteristically floored with peat and muck (pl. 1). The peat is composed largely of partially decomposed and compressed vegetal material. The deposits are called muck where the organic material is mixed with a large amount of clay and silt. Many of the deposits mapped are 10 to 15 feet thick and,in some, borings $17\frac{1}{2}$ feet deep failed to reach bottom. In the south central part of the large marsh north of Manlius the peat is reported to be 50 to 70 feet thick. Because peat oxidizes and eventually disappears when the swamps are drained, the older observations of thickness may not be correct for some areas.

Stream Alluvium

The deposits underlying the floodplains of the present streams are mostly sandy clayey silt with lenses of sand and sandy gravel. The deposits are rarely more than 10 to 15 feet thick. They are present along all valleys but are mapped only where they generally are more than 200 feet wide.

GEOLOGIC STRUCTURE

The Buda quadrangle lies in the broad syncline west of the LaSalle Anticline. The deepest part of the syncline is close to the steep western flank of the anticline, about 20 miles east of the quadrangle. Westward from the axis of the syncline the strata rise gradually for many miles at an average rate of about 10 to 15 feet per mile. As the structures have a southeasterly plunge, the strata in the Buda quadrangle have an east by southeast dip. The pre-Pennsylvanian beds dip at a slightly steeper rate than the Pennsylvanian. The top of the Galena appears to decline 150-175 feet in the 12 miles between Sheffield and Tiskilwa, but the Colchester (No. 2) Coal declines only about 120 feet in that distance.

MINERAL RESOURCES

The mineral resources of the Buda quadrangle include coal, clay and shale, sand and gravel, molding sand, ground water, and drift gas. The area is predominantly agricultural and is dependent on the productivity of the soils. In most of the area the soils are developed on glacial materials rich in the minerals needed for plant growth.

Coal. - The commercial coals in the area (Cady, 1953) are the Colchester (No. 2) Coal, the Herrin (No. 6) Coal, and the Sparland (No. 7) Coal. In this region No. 7 Coal has been called "First Vein," No. 6 Coal "Second Vein," and No. 2 Coal "Third Vein." No. 6 Coal was incorrectly called No. 5 in some older reports.

From borings near Sheffield and Tiskilwa, No. 2 Coal is inferred to be up to 3 feet thick in this area. It is probably present throughout the southern part of the quadrangle in the area mapped as Carbondale and McLeansboro (fig. 3). No. 2 Coal has not been mined in this quadrangle but it is stripped west of the quadrangle near Annawan and it has been mined in shaft mines in the Hennepin quadrangle to the east. It is about 200 feet deep at Sheffield, at an elevation of about 470 feet above sea level, and it slopes eastward to an elevation of about 350 feet near Tiskilwa.

No. 6 Coal is mined by stripping along the quadrangle line southwest of Sheffield and formerly was worked in several shallow shafts. The coal is about $4\frac{1}{2}$ feet thick where mined. It occurs about 190 feet above No. 2 Coal. It underlies the area mapped as McLeansboro (fig. 3), but from relations in other areas it is probably not as uniform in thickness nor as consistently present as No. 2 Coal.

No. 7 Coal has been worked in a few small mines near Tiskilwa, where it is about 3 feet thick. It probably thins westward to about 2 feet in the west part of the quadrangle. As it occurs only 40 to 50 feet above No. 6 Coal it may generally be present in the area mapped as McLeansboro (fig. 3). However, it is close to the top of the bedrock, and it may be cut out along shallow bedrock valleys not shown by the available data.

Clay and Shale. - The Sheffield Shale, above No. 6 Coal, is used in the manufacture of structural clay products at Sheffield. This shale is exposed or present under shallow overburden only in the vicinity of Sheffield. Other Pennsylvanian shales are exposed along Rocky Run near Tiskilwa but have too thick an overburden of other Pennsylvanian rocks and glacial drift to be worked by stripping. The relatively thick underclay of No. 7 Coal is present in the area but is poorly exposed.

The leached upper part of the loess is a silty clay or clayey silt and has been used at Buda in the manufacture of drain tile.

Sand and Gravel. - The area contains extensive deposits of gravel and sand that from time to time have been worked on a moderately large scale. Local operations are active more or less continuously so that the area has ample supplies of sand and gravel for surfacing roads and building construction. The sand and gravel deposits have been the subject of a special report (Ekblaw, 1932).

Molding Sand. - Natural bonded molding sand has been extensively produced from several pits near Buda and Wyanet (Littlefield, 1925, p. 107-109). The material used for molding sand is the weathered zone on dune sand. As the content of clay is greatest near the surface, the amount of clay bond needed is controlled by the depth of digging and mixing. Additional clay is sometimes added by including weathered loess.

Drift Gas. - Natural gas, apparently derived from buried soil and peat beds, is encountered in sand and gravel beds underlying the Wisconsin or Illinoian till. Where encountered in the drilling of water wells it has been used for fuel. The nature and occurrence of drift gas in this region has been recently described (Meents, 1958).

Ground Water. - Ground water for domestic uses is in ample supply throughout most of the Buda quadrangle. Most farm wells find adequate supplies in the glacial drift. In the northern half of the quadrangle water is so abundant in the sands and gravels of the Princeton Bedrock Valley that few wells are drilled into the bedrock. The availability of ground water in this region has been discussed in other reports (Hackett and Bergstrom, 1956; Foster, 1956).

Limestone. - The Lonsdale Limestone may be thick enough to be quarried locally, but it has too thick an overburden to be extensively stripped at the outcrops noted in this study.

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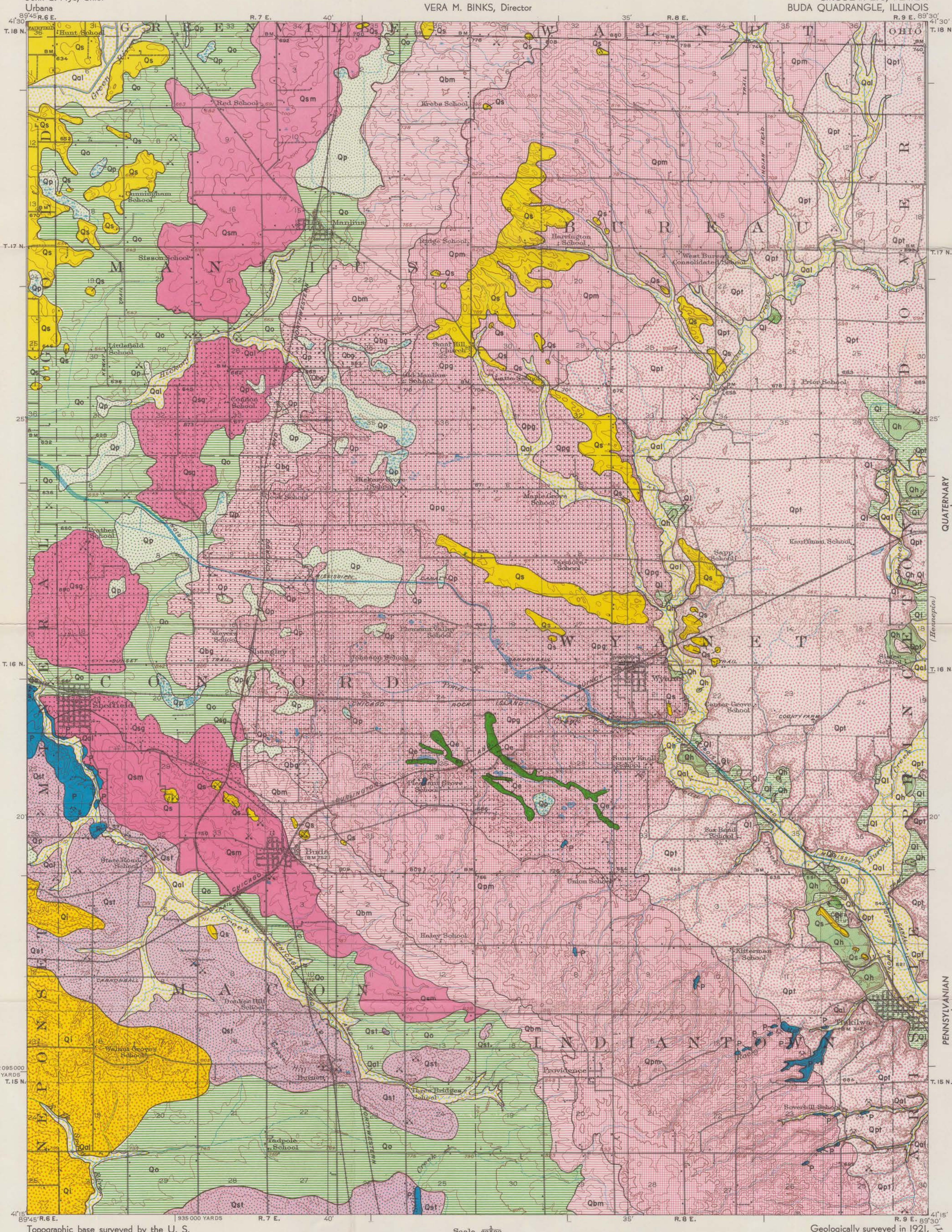
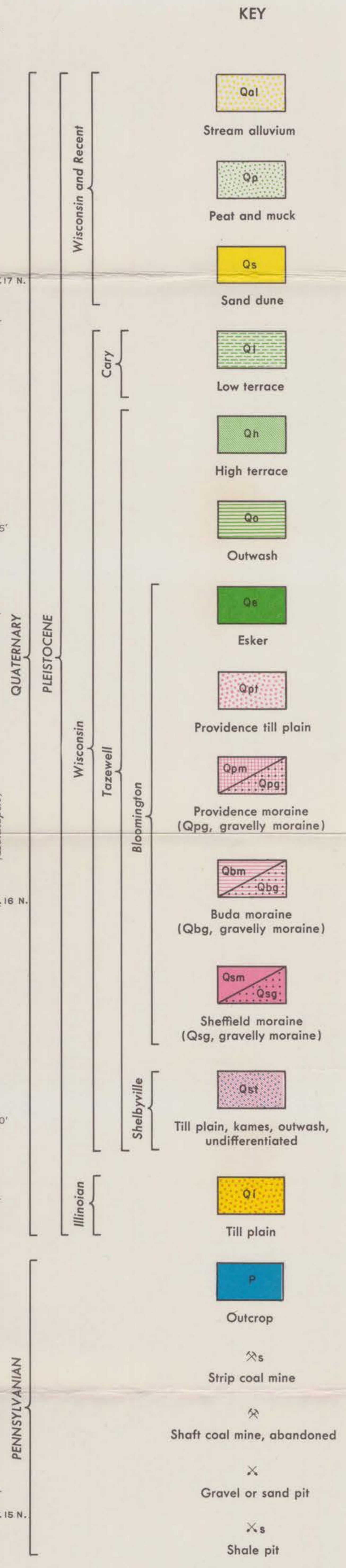
CIRCULAR 275, PLATE 1
BUDA QUADRANGLE, ILLINOIS





Topographic base surveyed by the U. S. Geological Survey in cooperation with the State Geological Survey in 1921.

Scale 1/62500

Geologically surveyed in 1921, 1935 by Paul MacClintock
Revised in 1958 by H. B. Willman

SURFICIAL GEOLOGY OF THE BUDA QUADRANGLE, ILLINOIS