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GEOLOGY AND MINERAL RESOURCES

OF THE

PEORIA QUADRANGLE, ILLINOIS

BY

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GEOLOGY AND MINERAL RESOURCES OF THE PEORIA QUADRANGLE, ILLINOIS.

By J. A. UDDEN.

INTRODUCTION.

The Peoria quadrangle, an area of about 225 square miles, is included between parallels 40° 30′ and 40° 45′ north latitude, and meridians 89° 30′ and 89° 45′ west longitude. Peoria is in the north half of the quadrangle and Pekin in the south half. Illinois River traverses the area diagonally from northeast to southwest.

Near the edge of the uplands, on both sides of the river, there are several coal mines, whose product is partly consumed by industries in Peoria and Pekin and partly by the general coal market. Two workable coal beds outcrop in several places in the quadrangle, and coal has been mined in the region ever since the first arrival of settlers. The comparative cheapness of fuel was one of the features which gave an early impetus to the growth of Peoria.

Plates I and II (in pocket) show respectively the areal and economic geology of the quadrangle.

TOPOGRAPHY.

The surface of most of the Peoria quadrangle consists of plains, which form the uplands on both sides of Illinois River.

WEST UPLAND.

The upland on the west side of the river is divided by the valley of Kickapoo Creek into two parts. The northeast part consists in the main of a morainic belt, which, along the valley of Illinois River north of the city of Peoria, terminates in abrupt bluffs nearly 300 feet high. For a mile west of this bluff the upland is dissected by a number of deep ravines, and back of these it attains an elevation of 740 feet above the level of the sea, or about 300 feet above Illinois River. The descent of the surface of the morainic upland is comparatively rapid from the north border of the quadrangle southward for a distance of nearly 2 miles, nearly to the southern boundary

of Richwoods Township. Southward from that line to the bluff which terminates the upland the plain is very smooth and flat. The south slope of the moraine is drained chiefly by the creeks known as Dry Run and Big Hollow.

The southern border of this upland is a long, straight bluff, which runs through Peoria as far as Kickapoo Creek and which has an average height near the north end of 100 feet, but is about half this height west of Peoria.

The bluffs on the east side of Kickapoo Creek are very much dissected and present several turns, which are evidently due to meanders of the stream. The bluffs rise abruptly in height from south to north, measuring about 100 feet opposite the south end of Peoria and 160 feet at the east end of Kickapoo Township, Peoria County. It is worthy of note that the long bluff which borders Peoria on the west is only slightly affected by erosion. In this respect it differs greatly from the bluffs on the north side of Kickapoo Creek and west of Big Hollow. These bluffs consist of cusps which extend southward from an upland that seems to have been eroded more by the tributaries than by the stream itself. Most of this bluff line lies outside of the area of the Wisconsin drift.

The upland southwest of Kickapoo Creek and west of Illinois River presents, in the main, a level surface, which rises to a maximum elevation of 720 feet in the S. ½ sec. 32, Kickapoo Township, and in the N. ½ sec. 5, Limestone Township. From these points it gradually decreases in elevation toward the south. The average height of the upland prairie in Hollis Township north of Mapleton is 610 feet, making an average gradient southward of 11 feet per mile.

The north end of this upland, which borders the valley of Kickapoo Creek, terminates in a low bluff that is less than 80 feet high, except at a point south of Edwards, where it rises to 120 feet. South of this bluff, for a distance of 2 miles, the general level of the surface rises nearly 100 feet to the mile. Just west of Pottstown a low swale in the upland extends westward across the center of the W. ½ sec. 35, Kickapoo Township, and the northeast part of sec. 34, and to the center of the S. ½ sec. 26 in the same township. Remnants of a slight ridge bordering this swale on the north appear in the N. ½ sec. 35, in the S. ½ sec. 27, and in the central part of sec. 26. This suggests the presence, at some earlier time, of a temporary drainage line which is now partly buried.

The southern slope of the upland west of Illinois River and south of Kickapoo Creek is dissected by the east and the west branches of Lamarsh Creek. Both of these streams have flood plains which average 100 yards in width in the northern part of their course, but in places measure a quarter of a mile from bluff to bluff, as in Hollis Township. In sec. 15 of this township the upland presents a well-

matured stage of topography, which indicates that the drift is thin and does not wholly conceal the preglacial land forms. The west bluff of Illinois River below Bartonville is not so steep nor so high as the bluff north of Peoria, and the belt of upland immediately beyond it is not so much dissected. Evidence of settling by slow creep and by landslides appears at many places in these bluffs.

EAST UPLAND.

The upland east of Illinois River is nearly 100 feet higher at the north end than it is at the south end of the quadrangle. The line that separates the upper from the lower plain extends southward from the bluffs of Illinois River at a point near the south line of sec. 17, Groveland Township, through secs. 18, 20, 29, and 32, Groveland Township, and secs. 5, 8, 17, 20, and 29, Elm Grove Township. East of this line the upland rises for a mile and a half at a rate of 100 to 200 feet per mile. The line of bluffs on the east side of Illinois River valley in Fondulac Township, Tazewell County, has an average height of 200 feet, and this height holds as far as a mile south of Wesley. South of this point the bluff recedes from the river and decreases in height to less than 100 feet near the south line of the quadrangle. All the ravines and gullies in the higher upland on the east side of the river have steep slopes, which indicate their recent origin. The flat upland terminates abruptly at the edges of the ravines, and this feature may be regarded as the chief difference in the appearance of the topography in the two areas, for on the lower plain the slopes which lead down into the streams in many places merge imperceptibly with the sloping margin of the upland itself. Another distinction between the topography of the two plains is the presence in the higher plain of gentle undulations that form either shallow depressions or slight elevations. Few of the elevations measure more than 20 feet in height. These undulations are especially noticeable on the principal divide of this upland, in an area extending from a point 2 miles north of Groveland to a point a mile southeast of Hawley.

ALLUVIAL PLAINS.

The average width of the valley of Illinois River is about 3 miles, but it varies from 1½ miles north of Peoria to 6 miles below Mapleton and Hawley. This apparent difference in the effectiveness of the erosive work of the river is clearly due to variations in the height of the upland and to difference in the resistance of the eroded material. North of Peoria, where the width of the valley is least, the upland is highest, and hence sapping of the bluffs has been slow, owing to the great amount of material which the stream has been obliged to move. The valley at this point crosses the crest of the terminal moraine of the Wisconsin drift. As no bedrock appears on either side of the valley

at this place, it is reasonably certain that the work has not been so much impeded by the greater resistance of the rock material as by its greater depth.

From this point down to the mouth of Farm Creek the height of the uplands gradually decreases and the width of the valley increases to nearly 3 miles, at the mouth of Kickapoo Creek. A little more than a mile south of this point the valley is only 2 miles wide. This contraction is clearly due to the presence of the less readily yielding indurated rocks of the coal measures, which appear here in the base of the bluffs on both sides of the river. South of this place the work of the river appears to have been favored both by the absence of indurated strata and by a decrease in the height of the land. The result is a gradual expansion in the width of the valley to about 7 miles at the south line of the quadrangle.

The effect of difference in resistance of eroded rock material is strikingly illustrated in the development of the bottoms of Kickapoo Creek. For 2 miles above Bartonville the valley of the creek varies in width from 200 to 400 yards. Throughout this distance the stream has cut into the coal measures, which rise in bluffs 50 to 100 feet on both sides of the creek. Above this point the valley has an average width of fully half a mile, except at Pottstown, where the indurated rocks again appear. The west bluff of the creek coincides with what must have been the east border of a preglacial upland, and this bluff line presents few flexures. The east bluff, on the other hand, runs in curves, which apparently correspond to earlier meanders of the stream. One of these curves includes the Horseshoe Bottom. The materials which have been carried away from this side of the stream consist largely of loose gravel and sand. At Pottstown bedrock appears on both sides of the present channel of the creek. For most of the distance from the mouth of Big Hollow to Edwards station the drift extends below the present level of the bottom and consequently very little cutting in bedrock has been done by the present stream.

The bottoms of the two Lamarsh creeks also exhibit features due to differences in resistance to erosion, for in places where they cross resistant strata of sandstone their valleys are slightly more contracted than where the bedrock is soft shale or where it consists of drift. The bottoms vary in width from 200 yards to a quarter of a mile. The valley of Farm Creek likewise shows results due to such differences. It has been cut across a low bench of bedrock at the line of the river bluffs in East Peoria, but east of this place bedrock does not appear in the valley, and from Farmdale to within half a mile of the river bluffs the valley has an average width of half a mile, and for the distance between this point and the river valley it approximates in width one-third of a mile.

TERRACES.

The present flood plain of Illinois River is bordered by several terraces, which are the remnants of older flood plains. The highest of these terraces has a general elevation of about 530 feet above sea level in the northern part of the quadrangle, and about 520 feet in the southern part. This is about 90 feet above the level of the river. The original surfaces of these terraces have to some extent suffered erosion by small streams and in some places have been modified by the action of the wind, but evidently they were uneven when first made. The largest tract of this terrace extends from Lick Creek to the southern border of the quadrangle, with a width of 4 miles. This terrace contains several undrained basins, the largest being Meyers Lake, a mile south of Pekin. It also shows some low swells or ridges. Peoria is built on a terrace at the same level, which follows the west side of the river for nearly 5 miles, with a width of about 1 mile at the south end of the city and less than half a mile at the north end. Smaller terrace remnants at the same level occur below the bluffs north of Tenmile Creek, in the northeast part of the quadrangle; also east of Grove station, and between Grove station and Lick Creek, in Tazewell County. There are also some built terraces in the lower parts of the valleys of the two Lamarsh creeks, in the upper part of the valley of Kickapoo Creek, and in the valley of Farm Creek, which probably represent the same age. Another terrace, which is about 30 feet lower than the one just described, occurs in the Illinois River valley from Pekin southward, and also in the southern part of Peoria. In Spring Lake Township its surface is marked by numerous hills, the highest points of which extend up nearly to the elevation of the higher terrace, and it is probable that these hills represent unreduced parts of the old terrace.

ALLUVIAL FANS.

The gradient of Illinois River is very low and its power of transporting rock waste is correspondingly small. It is perhaps a question whether the river is not at the present time building up its alluvial plain rather than deepening its valley. At any rate, it is evident that the débris which is being delivered by the tributaries entering the river in this region is more than the river is able to carry away. Accordingly, at the mouth of each of the creeks there are accumulations which rise in the form of alluvial fans. The highest point of each of these fans is near the place where the tributary stream leaves the upland. The most conspicuous and symmetrical fan is the one which is formed by Farm Creek and on which the town of East Peoria is built. The fan has been built so rapidly that it has partly dammed the channel of the river, pushing it over to the west and causing the water to accumulate on the north side of the fan in a wide expanse

known as Peoria Lake. The building of this fan is no doubt due to the fact that Farm Creek is eroding a region covered by soft material, which lies high and is very easily eroded. The fan of Tenmile Creek is likewise nearly symmetrical and clearly encroaches on the channel of the river, for this has a width of nearly a mile at the north edge of the quadrangle and rapidly narrows to less than a quarter of a mile opposite the mouth of this creek. It appears that the river has somewhat modified the shape of the fan by carrying the débris downstream and thus lengthening it in that direction. This modifying influence of the main stream also appears in the fans south of Bartonville and west of the mouth of the Lamarsh creeks. Its effectiveness is enhanced in the last-mentioned locality by the fact that the streams from the Illinoian upland carry a relatively small load. Although Kickapoo Creek is much larger than Farm Creek the only trace of a fan in its course occurs south of the point where it leaves the bluffs. In the same way material carried by the Lamarsh creeks has merely been sufficient to leave a trail down the valley under the bluffs. The deposits on both of these creeks are evidently mingled with talus from the bluffs.

STRATIGRAPHY.

DEEP-WELL RECORDS.

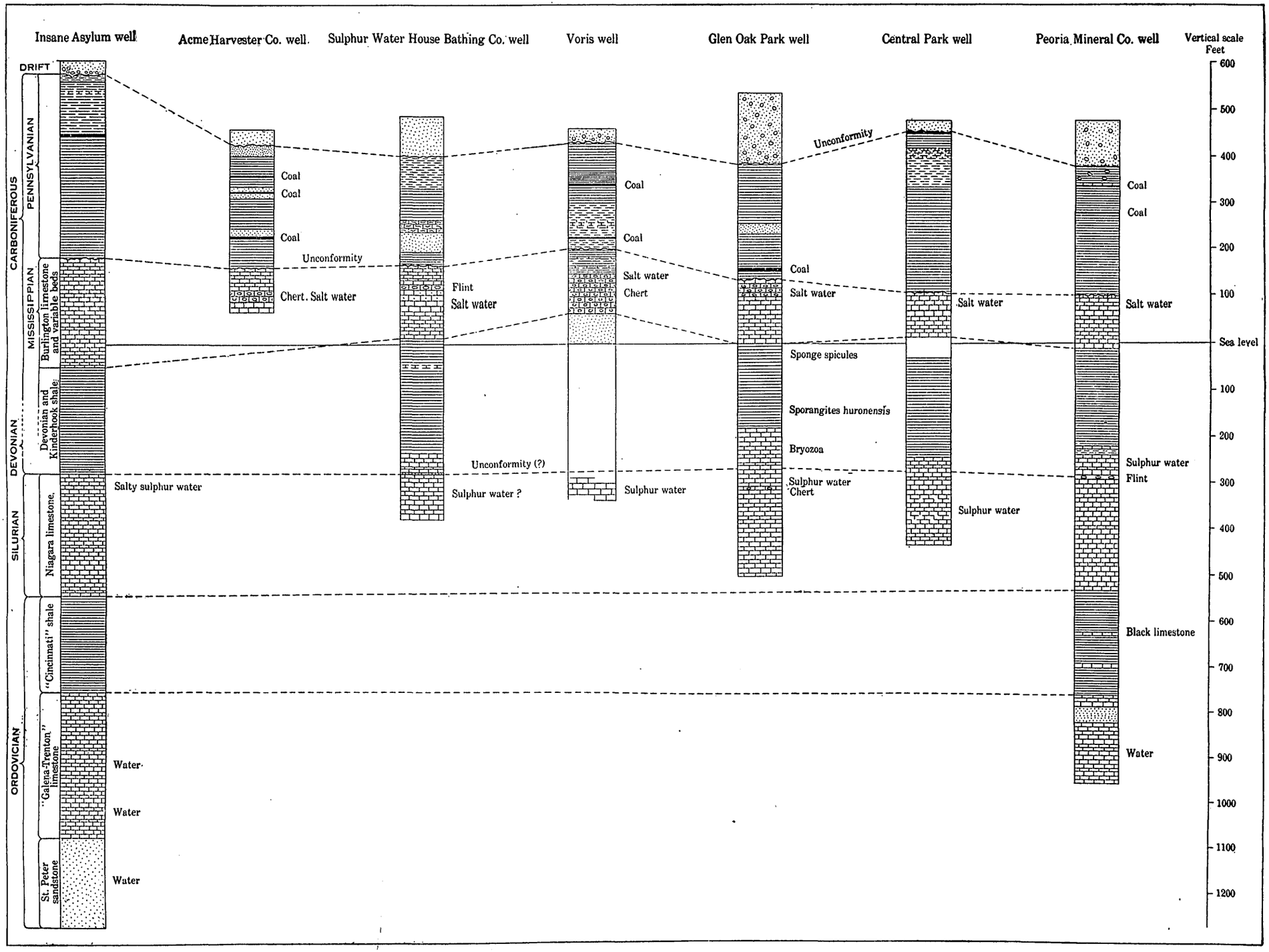
The lowest strata exposed in this quadrangle are some layers of sandstone which lie about 20 feet below the bottom of the main coal bed of the region. Knowledge of the formations below this comes exclusively from the records of coal-mine shafts and drill holes. All available records of this kind have been collected. Examination of the logs that have been kept most accurately shows a close correspondence among them, although they have been made by different drillers and at different times. The formations known only from underground explorations will be described before the surface strata are considered, the data obtained at first hand from drillers and well owners being presented first. (See Pl. III.)

Logs of deep wells in the Peoria quadrangle.

1. Illinois Asylum for Incurable Insane.[1]

Location: About 500 feet north of southeast corner of sec. 26, T. 8 N., R. 7 E. Elevation of curb (aneroid): 605 feet above sea level. Made by J. P. Miller & Co., 1903. Casing: 12-inch pipe, 60 feet 9 inches; 10⅝-inch pipe, 421 feet 6 inches; galvanized pipe, 1,350 feet 6 inches. Original hole from 885 feet to 1,350 feet, was $8\frac{1}{15}$ inches. This was afterwards reamed to 10½ inches.

[1] Log furnished by the superintendent of the asylum.



SECTIONS OF DEEP WELLS IN OR NEAR PEORIA AND PEKIN.

	Ft.	in.
Pleistocene:		
Loam, drift	40	
Pennsylvanian (382 feet):		
Coal	3	7
Shale	17	3
Rock	3	7
Shale	90	11
Coal	4	7
Shale	262	
Mississippian (not including Kinderhook):		
Lime rock [1]	228	7
Devonian and lower Carboniferous (including Kinderhook):		
Shale	235	
Silurian (Niagara):		
Lime rock	265	
Ordovician:		
"Cincinnati"—		
Shale	200	
"Galena-Trenton"	315	
St. Peter—		
Sandstone	199	1
Total	1,864	7

2. Acme Harvester Co. well.[2]

Location: Bartonville, south of Peoria. Elevation: 460 feet above sea level (estimate from topographic map).

	Ft.	in.
Pleistocene (36 feet):		
Drift	30	
Sand	6	
Pennsylvanian (281 feet 4 inches):		
Sandstone	3	
Sandstone, argillaceous, with hard bands	20	
Soapstone	20	
Iron band		5
Shale, dark		11
Iron band		11
Shale, dark	10	
Slate	3	
Soapstone	12	
Coal	2	8
Fire clay	14	9
Soapstone	14	
Sandstone, hard, gray ("grit")	10	4
Coal.[3]		
Fire clay	1	8
Sandstone, hard, gray	8	
Soapstone, dirty	12	

[1] The meager descriptions and the lack of correspondence of this section, and especially of this bed, with the other records, suggests that this log is perhaps in part given from memory. The greater thickness of this limestone, which certainly is in part the Burlington, may otherwise be partly due to individual interpretation by the drillers. The logs of two of the other wells indicate that the Kinderhook is a harder rock than the shale below, and it may perhaps be included in the "lime rock" measuring 228 feet 7 inches.

[2] From C. W. Hicks, well driller.

[3] This hole was drilled for prospecting and the thickness of the coal beds was not obtainable, being regarded as information of a confidential nature.

Pennsylvanian—Continued.	Ft.	in.
Sandstone	7	
Shale, almost black	11	
Fire clay		4
Shale, dark, with sulphur or spar bands	15	
Sandstone with soft bands	8	
Coal.[1]		
Fire clay	1	4
Argillaceous rock, changing from black to white	14	
Sandstone with soft partings	21	
Coal.[1]		
Argillaceous rock (?)	69(?)	
Coal (?)		
Clay (?)	1	
Mississippian (not including Kinderhook) 73 feet:		
Limestone (easy drilling)	47	
Chert	2	
Limestone	4	
Chert	5	
Limestone	2	
Chert	7	
Porous yellowish rock	6	
Total	390	4

3. Well of Sulphur Water House Bathing Co.[2]

Pleistocene (87 feet):	Feet.
Soil	2
Sand, yellow	10
Gravel with bowlders	75
Pennsylvanian (240 feet):	
Clay, blue	66
Shale, dark	25
Shale, blue	48
Limestone	3
Limestone, light colored, soft	19
Sandstone, gray	46
Soapstone, hard	8
Shale	25
Mississippian (not including Kinderhook) 150 feet:	
Limestone	25
Limestone, blue, porous	13
Limestone, "flint"	3
Limestone, honeycombed	1
Limestone, "flint"	7
Limestone, porous	15
Limestone, sandy	20
Limestone, blue	65
Devonian and lower Carboniferous (including Kinderhook) 297 feet:	
Shale, blue	55
Limestone, blue	2
Shale, blue	194
Limestone, blue (Devonian ?)	46

[1] This hole was drilled for prospecting, and the thickness of the coal beds was not obtainable, being regarded as information of a confidential nature.

[2] Log furnished by the proprietors.

	Feet.
Silurian (Niagara), 103 feet:	
Sandstone, white	3
Limestone, blue, interstratified by streaks of shale	100
Total	877

4. Voris well (also called Bailey's well).[1]

Location: East Peoria, on bottom land east of the Toledo, Peoria & Western Railway, and north of the river bluff, about one-tenth mile east of the center of the west line of sec. 32, T. 26 N., R. 4 W., Tazewell County. Drilled in 1860. Elevation of curb: 455 feet above sea level (estimate from topographic map).

	Feet.
Pleistocene (28 feet):	
Alluvial soil of river bottom	4
Sand	4
Gravel (bowlder drift)	20
Pennsylvanian (289 feet):	
Clay, shale	59
Slate, bituminous	3
Fire clay	15
Clay shale	15
Coal	4
Clay shale	34
Shale, sandy and argillaceous (very hard)	34
Sandstone	4
Limestone, nodular, argillaceous	6
Sandstone, compact, fine grained	5
Shale, hard, dark blue, sandy	25
Coal	3
Shale, sandy, argillaceous	25
Shale, bituminous, with bands of limestone	57
Mississippian (not including Kinderhook) 77 feet:	
Cherty rock	44
Hard siliceous rock, mainly chert (possibly chert and limestone mixed)	33
Sandstone, fine grained	65
Total	459
Silurian (Niagara):	
Limestone, gray, porous at 774 feet.	

5. Well in Glen Oak Park, Peoria.[2]

Location: Glen Oak Park. Elevation (aneroid): 534 feet above sea level.

	Feet.
Pleistocene:	
Drift, gravel and clay	150
Pennsylvanian (250 feet):	
Shale, mostly	130
Sandstone	20
Shale, mostly	80
Shale, with coal	10
Shale, black, micaceous	10

[1] Log from Worthen's Geol. Survey, Illinois, vol. 4, p. 180. Notes from Peoria Transcript for Apr. 25, 1864, on this well: (*a*) At 120 feet below surface, a 4-foot bed of coal. (*b*) At 235 feet, 3-foot bed of coal.

[2] Log from samples kept in a glass tube in the office of the secretary of the City Park Commissioners. The borings were examined by the author.

	Feet.
Mississippian (not including Kinderhook), 125 feet:	
Limestone, with chert and green shale	30
Limestone, with some chert	50
Limestone, crystalline, with crinoid stems	45
Devonian and lower Carboniferous (including Kinderhook), 280 feet:	
Shale, greenish, with sponge spicules and chert	65
Shale, gray	60
Shale, gray, pyritiferous and with *Sporangites huronensis*	70
Limestone	85
Silurian (Niagara), 235 feet:	
Limestone, dolomitic, with some chert	100
Limestone, dolomitic, porous in lower part	135
Total	1,040

6. Central Park well.[1]

Location: Corner Madison Street and Abingdon Avenue. Depth: 925 feet. Elevation: 476 feet above sea level (estimate from topographic map). Drilled in 1875.

	Feet.
Pleistocene (29 feet):	
Loam	6
Clay	3
Gravel	12
Quicksand	8
Pennsylvanian (341 feet):	
Coal	4
Shale ("Blue clay")	26
Rock ("Coral rock") (sandstone?)	30
Soapstone, soft	6
Rock ("Coral rock") (sandstone?)	45
Soapstone, soft gray	19
Shale, blue	17
Soapstone	194
Mississippian (not including Kinderhook), 94 feet:	
Slate	5
Limestone, blue	18
Sandstone, brown	6
Limestone, hard, blue	65
Devonian and lower Carboniferous (including Kinderhook), 287 feet:	
Hard (?) (record illegible, possibly Burlington limestone)	45
Slate, blue	14
Shale, soft	200
Slate	6
Limestone (Devonian?)	22
Silurian (Niagara), 164 feet:	
Limestone, blue	52
Sandstone, brown	76
Limestone, porous	36
Total	915

[1] Log from an old record in possession of present owner of the ground. The record is in part illegible.

7. Peoria Mineral Co. well. [1]

Location: Hart Lee farm, under the bluff in the NW. ¼ sec. 22, T. 26 N., R 4 W. Elevation of curb: 475 feet above sea level (estimate from topographic map).

	Feet.
Pleistocene (101 feet):	
Loam	4
Sand and gravel	97
Pennsylvanian (289 feet):	
Clay, blue	40
Limestone, black	6
Coal and slate	4
Clay, blue (shale)	50
Coal and slate	20
Soapstone	55
Slate	104
Sandstone, gray	10
Mississippian (not including Kinderhook), 96 feet:	
Slate (Pennsylvanian?)	5
Limestone, white	10
Limestone, porous	81
Devonian and lower Carboniferous (including Kinderhook), 351 feet:	
Slate	213
Limestone, gray, with zinc	85
Shale, white, with zinc	10
Limestone, white, porous	43
Silurian (Niagara), 263 feet):	
Limestone, flinty	43
Limestone, white	21
Limestone, porous	39
Limestone, white, porous, and quartz	80
Limestone, gray	80
Ordovician:	
"Cincinnati" (198 feet):	
Slate	85
Limestone, black	6
Slate	59
Limestone, black	10
Slate	38
"Galena-Trenton" (199 feet):	
Limestone	20
Sandstone	23
Sandstone, coarse	26
Trenton	130
Total	1,497

8. Carter's well.

Location: At foot of bluff in Carter's brickyard in East Peoria, Tazewell County. Elevation of curb, 465 feet above sea level (map estimate). Depth, about 370 feet. Coal (4 inches) at 302 feet, and another coal about 50 feet above this one. Section much like that of the Acme Harvester Co. well.

[1] Log from record furnished by the company drilling the well.

9. Colean factory well.

Location: On bottom land, near northeast corner of sec. 31, T. 26 N., R. 4 W., Tazewell County. Elevation of curb, 453 feet above sea level. Depth, 320 feet.

The drift is 90 feet deep. The Pennsylvanian shale is noted as having more "spar" and calcareous concretions than at other points, and the coal is less pure, as if somewhat broken up. At about 310 feet there is considerable white chert (Burlington limestone). Coal observed at 190 feet below surface.

10. O'Brian well.

Location: One-third mile west of the northeast corner of sec. 14, T. 25 N., R 4 W., Tazewell County. Elevation of curb, 738 feet above sea level (map estimate). Depth, 1,442 feet. Drilled in the summer of 1876. Water obtained from a porous rock called "Trenton rock" by the drillers, in the lowest 50 feet of the boring. Flint was reported by the drillers at 1,200 feet below the surface.

11. Pekin City well.[1]

Location: One-fourth mile south of the crossing of the Chicago & Alton Railroad and the Atchison, Topeka & Santa Fe Railway in the east part of Pekin, Tazewell County. Elevation of curb, 630 feet above sea level (map estimate). Depth, 900 feet.

	Feet.	
Pleistocene:		
Sand and gravel	120	
Pennsylvanian:		
Soapstone and slate	180	
Coal	?	
Mississippian, Devonian, and Silurian (690 feet):		
Limestone, white	500	(?)
Stone, porous (very porous at 950 feet below surface)	190	
Total	990	

UNEXPOSED STRATA.

INTRODUCTION.

From the preceding notes and from what is known of the geology of the northern part of the State the formations underlying Peoria are readily identified down to the bottom of the deepest well. The author had an opportunity to examine the drillings of the Glen Oak Park well and found *Sporangites huronensis* in the lower part of the shale, the part intervening between the Burlington and Devonian limestones, and this shale can now with greater assurance than before be referred to the Upper Devonian. The evidence on which such reference has heretofore been made for the wells on Illinois River is that of stratigraphic position only. On similar evidence the upper part of this bed of shale has been regarded as equivalent to the clay underlying the Burlington limestone on Mississippi River. This conclusion has also been verified by finding, in drillings from the Glen Oak Park well, sponge spicules which are known also from this clay on the Mississippi. Except this shale and the Burlington limestone above it the entire section for the Peoria wells can be traced to the respective outcrops farther north as shown in the records of other borings. Much of the Devonian and all of the Mississippian were cut away by erosion before the Pennsylvanian was laid down over the northern territory.

[1] Log from memory, by Thomas Cooper.

In the account which follows, the different formations are given in the order of their stratigraphic succession, beginning with the oldest. (See fig. 1.)

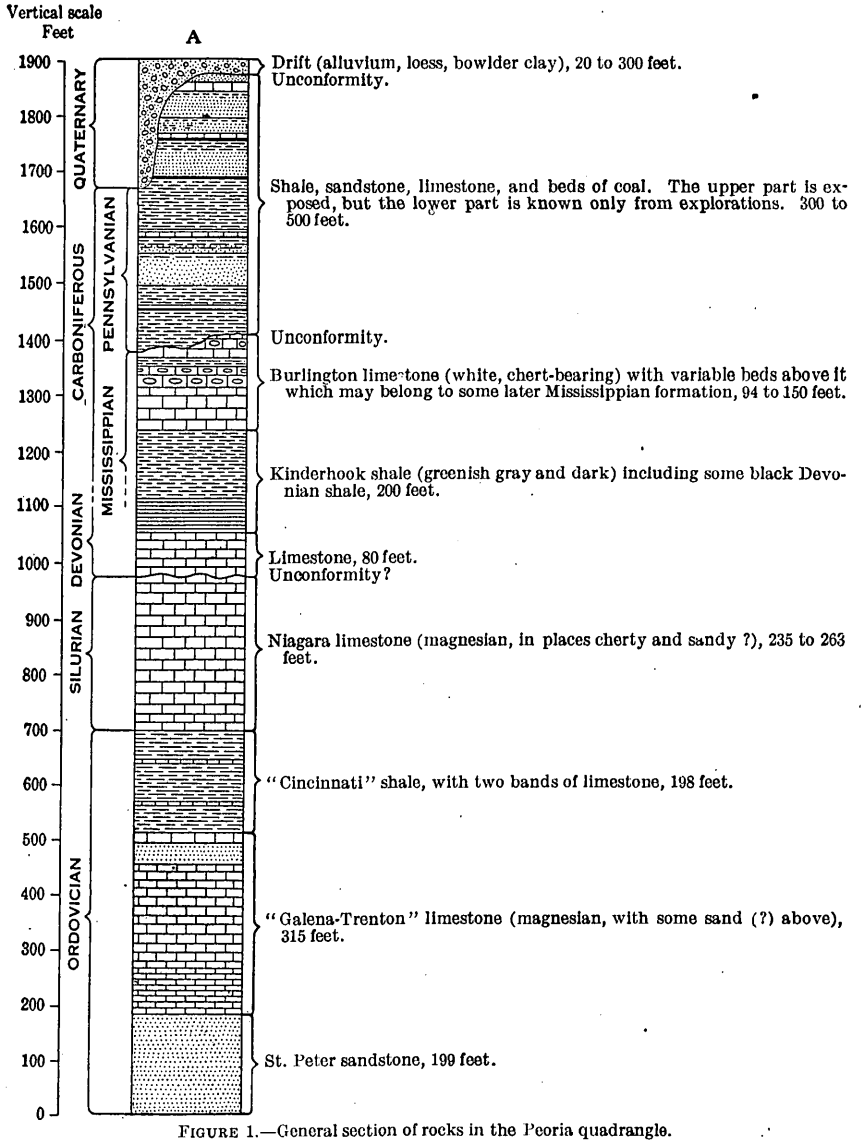


FIGURE 1.—General section of rocks in the Peoria quadrangle.

ORDOVICIAN SYSTEM.

St. Peter sandstone.—The lowest formation explored in deep well drilling is the St. Peter sandstone. This was penetrated for 199 feet in a well at the Illinois Asylum for Incurable Insane at Bartonville. The drillers report the rock merely as St. Peter sandstone. This identification is doubtless correct, for the St. Peter sandstone underlies the "Galena-Trenton" limestone, which has been explored by two other wells.

"Galena-Trenton" limestone.—The log of the Insane Asylum well reports 315 feet of "Trenton rock" immediately above the St. Peter sandstone. The log of the well of the Peoria Mineral Co. gives a more descriptive account of this part of the section and shows something unusual in the strata. Under the uppermost 20 feet, which is limestone, there are 23 feet of sandstone and below this 26 feet of a "coarse sandstone." The lowest 130 feet are reported as "Trenton limestone." This boring no doubt penetrated the Galena limestone, which in the northern part of the State is free from sandstone, the "sand" and "coarse sand" reported in this place being probably cavern fillings. This is all the more likely as other evidence [1] indicates an unconformity between the "Galena-Trenton" limestone and the overlying "Cincinnati" shale in the region west of the Cincinnati anticline. The combined thickness of the strata which it seems correct to refer to as the "Galena-Trenton" limestone in this log measures 199 feet. The O'Brian well, on the east side of the river, is reported to have penetrated about 50 feet of this rock. The limestone is said to be porous and water bearing in this well also.

"Cincinnati" shale.—Three wells have penetrated this formation. The record of the Asylum well shows 200 feet of shale. The Peoria Mineral Co. recorded five different kinds of rock which may be referred to this formation. There were three beds of "slate," separated from one another by two beds of "black limestone," one 6 and the other 10 feet thick. It is probable that the black color is due to the presence of pyrite, which in many places impregnates these limestones. The total thickness of the five members of the formation reported from this boring is 198 feet, only 2 feet less than the thickness reported from the Asylum well.

SILURIAN SYSTEM.

Niagara limestone.—This limestone furnishes most of the artesian water now flowing in the region. It has been entered by not less than 14 wells, but only 2 are known to have passed through it. In the log of the Peoria Mineral Co. well the strata which are referred to this formation measure 263 feet. The equivalent "lime rock" reported from the Asylum well measures 265 feet. The samples from the Glen Oak Park well show that a highly dolomitic limestone, no doubt of this age, was penetrated for 235 feet. Drusy quartz covered the surface of one fragment from the upper part of the formation. In the drillings from the upper 100 feet of the limestone several minute and flat grains of quartz were observed, which contained a tangle of straight microscopic needles of some transparent mineral. The lower part of the limestone is coarse grained in places, and the drillings contained lumps of green clay, such as is common in fissures produced

[1] Weller, Stuart, The geological map of Illinois: Bull. Illinois Geol. Survey No. 1, p. 16.

by solution. Most of the records of the other wells describe the formation as "limestone" and "lime rock," and parts of it are called "porous limestone." "White chert," "quartz," and "flint" are reported as present in three wells, in the upper part of the formation in one well and near the base in the other two. In one well 76 feet of brown sandstone near the middle of the formation are reported as the source of the water. This is probably a porous and cherty limestone. If it is not, the sand is perhaps a cavern filling.

Three feet of white sandstone and pockets of clay are reported near the top of the Niagara in the Sulphur Water House Bathing Co. well. This sandstone may mark the division between this and the overlying Devonian, as the 46 feet of rock overlying is described as blue limestone, and this is usually not the color of the upper part of the Niagara. In all of the wells the water which flows from the Niagara has a strong odor of hydrogen sulphide.

DEVONIAN SYSTEM.

Devonian limestone.—Five records show the presence of beds above the Silurian which average 283 feet thick, and which are overlain by a limestone that is undoubtedly Burlington. The main and upper part of these beds is a shale, which has been variously reported by the drillers as "slate," "slate rock," "white shale," "blue slate," and "soft shale." The lower part, about 80 feet thick, is limestone, described variously as "blue limestone," "white limestone," or merely as "limestone." This limestone is without doubt of Devonian age. In the Glen Oak Park well it measures 85 feet thick and is a very pure carbonate of lime, which effervesces briskly with acid. The drillings contain numerous particles of crytalline calcite. Several minute fragments of Bryozoa and some other organic forms were noted. In the log of the Peoria Mineral Co. well mention is made of the occurrence of "zinc" (blende?) near the top of this limestone.

All of the features noted above are characteristic of the Wapsipinicon and Cedar Valley limestones as described by the Iowa geologists. These formations overlie the Silurian limestone on Mississippi River in Rock Island County.

DEVONIAN AND CARBONIFEROUS ROCKS.

Kinderhook shale (lower Mississippian) including some Devonian shale.—The overlying shale measures about 200 feet. The upper part has a greenish color. A microscopic examination of the samples from the Glen Oak Park well shows numerous siliceous sponge spicules and some other organic fragments. Granules of pyrite are common. The middle part of the shale is gray, slightly calcareous, and contains a few minute flakes of mica, small clusters of cubic crystals of pyrite, and spores of acrogens. The lowermost 70 feet of the shale is of an

olive color and contains here and there minute flakes of mica and aggregations of minute crystals of pyrite. In this part of the shale *Sporangites huronensis* is abundant.

The record of the Central Park well indicates some alternations in hardness in the upper part of this clay member, and in the Sulphur Water House Bathing Co. well a 2-foot blue limestone was penetrated which appears to have yielded some water. An indurated stratum at about the same level is reported in the log of the Peoria Mineral Co. well as "slate rock."

It is believed that the lowermost part of this shale is identical with the Sweetland Creek shale (Devonian) overlying the Cedar Valley limestone in Muscatine County, Iowa. *Sporangites huronensis* is abundant in these localities. This lower shale is regarded as a western formation of the Chemung epoch. The upper part of the shale in the Peoria wells is probably equivalent to the Kinderhook, underlying the Burlington limestone farther to the west, for there the Kinderhook is known to contain fossil sponges, and it has the same stratigraphic position.

CARBONIFEROUS SYSTEM.

MISSISSIPPIAN SERIES (NOT INCLUDING KINDERHOOK).

Burlington limestone and overlying beds.—Between the Pennsylvanian and the Kinderhook shale just described, all of the well logs record a limestone which no doubt is the equivalent of the Burlington limestone. All of the flowing wells entered this formation and 10 passed through it. Six logs give fairly complete records and 4 give partial records of the materials which this formation contains. The samples of drillings from the Glen Oak Park well consist of a light-colored calcareous limestone mixed with much white chert. The uppermost 30 feet contain also a considerable amount of green shale. The lowest 40 feet had less chert and no shale but considerable calcite and some fragments of crinoid stems. Chert from the bottom of the Carter well and from the well of the Acme Harvester Co. was seen by the author, and it is reported at this horizon from seven of the well logs. The chert is white or light gray and closely resembles the chert in the Burlington limestone. The upper part of the limestone has yielded salt water in all of the wells, and the water-bearing rock is close to the cherty strata.

Above the chert alternations of shale and limestone are mentioned in the log of the Voris well. Some "slate" is reported above the limestone in the logs of the Central Park well and the Peoria Mineral Co. well. It seems likely that the variable beds may represent some later formations of the Mississippian series, but in the absence of fossils it is not possible to locate definitely the boundary between this

series and the Pennsylvanian. Considerable latitude as to noting details is taken by drillers in their reports of thin layers of various kinds of rock, and this no doubt partly accounts for the differences in the records.

Without taking into account the log of the Insane Asylum well, the thickness of the strata, which appears to be referable to the Burlington limestone and overlying Mississippian, varies from 94 feet in the Central Park well to 150 feet in the well of the Sulphur Water House Bathing Co. The average is 120 feet. There is hardly any doubt that this variation is partly due to an unconformity between the Mississippian and Pennsylvanian series. This unconformity is general in the Mississippi Valley, and in the northern part of this region it is indicated by the disappearance of the Mississippian limestone from the well records.

PENNSYLVANIAN SERIES.

The thickness of the coal-bearing strata is about 520 feet. The lower part, including about 300 feet, is known only from underground explorations, whereas about 220 feet of the upper part appear in exposures. This exposed part extends downward 20 feet below the chief productive coal bed of the region, and it will be described later. Knowledge of the coal-bearing rocks below the principal productive coal bed is based on the logs of wells already presented and on records of two shafts sunk to the lower coals. One of these shafts has a depth of 240 feet and reaches a bed believed to be identical with Worthen's coal No. 1 on Mississippi River. This is the shaft of the now abandoned mine at Pottstown.

Section of rocks penetrated by shaft of the Wantling coal mine at Pottstown, west side of SW. ¼ sec. 36, Kickapoo Township, Peoria County.

	Ft.	In.
Alluvium	10	
Sand, dry	6	
Gravel	3	
Hardpan	2	
Soapstone, white	10	
Iron band		2
Soapstone	8	
Iron band		3
Shale, black	20	
Iron band		3
Soapstone, white	20	
Iron band		2
Shale, white	4	
Iron band		4
Shale, white	3	
Iron band		2
Shale, dark	6	
Cap rock	2	
Slate, black	2	8

	Ft.	in.
Shale, white	9	
Coal (Worthen's coal No. 2?)	2	8
Fire clay	4	
Sandstone	17	
Soapstone	6	
Sandstone, white	56	6
Clod, black	3	6
Fire clay	1	6
Coal	2	4
Sandstone, dark	4	6
Rock, hard	3	6
Clod, dark	8	
Sandstone, hard	7	6
Slate, black	3	
Shale	2	
Rock, white	3	
Coal (upper part of Worthen's No. 1?)	1	4
Clod, black	3	6
Coal (lower part of Worthen's No. 1?)	3	
Fire clay	1	
	240	10

The other shaft was sunk at Orchard, about 4 miles south of Bartonville, and extends down to a coal bed equivalent to the upper coal bed of Wantling's mine at Pottstown. This bed lies about 140 feet below Worthen's coal No. 5. The record of this shaft is given below:

Section of Orchard shaft.

	Ft.	in.
Surface	3	
Fire clay	2	
Hardpan	1	8
Loam, black	3	6
Shale, black		9
Soapstone, soft	2	
Shale, sandy	7	6
Limestone	2	
Sandstone	17	
Soapstone	4	
Iron band		8
Soapstone	18	
Sandstone, blue	4	
Soapstone	36	
Slate, gray, and iron band mixed	16	
Slate, black	4	8
Hardpan	1	8
Slate, black		10
Soapstone	12	
Coal (Worthen's No. 2?)	2	6
Fire clay	1	10
	141	7

From comparison of these data it will be seen that the lower part of the section of the Pennsylvanian, not seen in exposures, is essentially as described below.

It is not possible to locate definitely the contact between the Pennsylvanian and Mississippian series in the logs of the borings which penetrate the older formations. In the Glen Oak Park well the preserved drillings show coal about 20 feet above the chert-bearing limestone of the Mississippian. In the Carter well, in East Peoria, a coal bed is reported at nearly the same level, but in the Voris boring, only half a mile north, no such coal was noted, nor is it reported from the wells drilled by the Peoria Mineral Co. or by the Acme Harvester Co. Apparently this coal bed is not continuous for any great distance, and it probably represents a local accumulation in some limited depression on the underlying eroded Mississippian formations.

Above this lowermost coal there is 80 feet of shale in the Glen Oak Park well. This is recorded in the Voris well, and also in the Acme Harvester Co. well, in which it measures 104 feet and is underlain by 10 feet of gray sand.

At the top of this shale is the horizon of the coal which was mined at Pottstown and which is known locally as coal No. 1. The same coal also appears in the Acme Harvester Co. well and in the Carter well. This coal is in two benches, the lower one varying from 2 feet 2 inches to 3 feet in the Pottstown mine, and the upper measuring about 1 foot 3 inches. The two benches are separated by nearly 3 feet of shale. The average thickness of the coal and the included shale is 6 feet.

For 40 feet above this, the shaft of the Pottstown mine went through many different strata containing coal about 30 feet above the lower bed. A coal at this horizon is noted also in the records of the Acme Harvester Co. well and in the Carter well. In the Voris well there is a thin limestone at the horizon of this coal in the other wells.

Above these two coal beds all of the explorations show considerable sandstone or sandy shale, measuring from 70 to 87 feet. In the Acme Harvester Co. boring and also in the Voris well the upper part of this arenaceous member shows some alternations with finer material. In the Peoria Mineral Co. well it is all reported as blue clay, shale, and "soapstone." In the Glen Oak Park well the material from this depth is partly shale and partly limestone.

In the Pottstown mine a coal bed locally known as the Blue Fly coal bed was worked. It varies in thickness from 2 feet to 2 feet 5 inches. In the shaft there are 4 feet of fire clay below it, and it is overlain by 9 feet of white shale, which serves for a roof. This coal bed is worked also in the Orchard mine, where its average thickness

is 2 feet 4 inches. In the light bluish gray shale which overlies the coal in this mine there are some plant remains which Dr. David White regards as suggestive of the flora in the shale over Worthen's coal bed No. 2, in the northern part of the State. This coal bed is noted also in the record of the Voris well and in the record of the Acme Harvester well, and it appears to have been identified in the Colean factory well and in the Carter well.

Before reaching the Blue Fly coal bed the Orchard shaft was sunk through 120 feet of shale with only 2 feet of limestone. In the Pottstown shaft there was 86 feet of shale with several bands of clay ironstone. In the Acme Harvester factory boring a coal bed was noted in the lower part of this shale, and there are some small coal beds in it in the Carter well and also in the Colean factory well. The upper part of this shale is known from exposures and contains some small beds of sandstone.

EXPOSED STRATA.

That part of the section of the Pennsylvanian which overlies the beds just described and which appears in outcrop is now to be considered.

CARBONIFEROUS SYSTEM.

PENNSYLVANIAN SERIES.

VARIABLE BEDS UNDER COAL BED NO. 5.

Some variable beds (designated "a" in fig. 2) under coal bed No. 5 consist of fire clay, shale, black shale, clay ironstone, thin coal beds, local streaks of a thin calcareous conglomerate, and thin layers of sandstone, amounting in all to about 18 feet. The lowest strata exposed immediately underlie coal bed No. 5. In the north bank of Kickapoo Creek and west of the wagon bridge east of Edwards station a gray ripple-marked sandstone was noted, lying about 25 feet below the bottom of the coal bed. The same sandstone appears in the south bank of Lamarsh Creek, about one-fourth mile south of the junction of its two main branches in sec. 16, Hollis Township. At this place there is a small remnant of the coal and a continuous section of about 19 feet of strata below it. The section is as follows:

Section in the south bank of Lamarsh Creek, in sec. 16, Hollis Township.

	Ft.	in.
Shale, black	9	
Coal	3	6
Fireclay	2	
Clay shale, dark, with two layers of concretionary ironstone	3	
Clay, shaly, with some calcareous concretions in basal layer	5	
Sandstone, shaly, micaceous	6	
Clay ironstone, concretionary		3
Sandstone, thin bedded, shaly	3	
	31	9

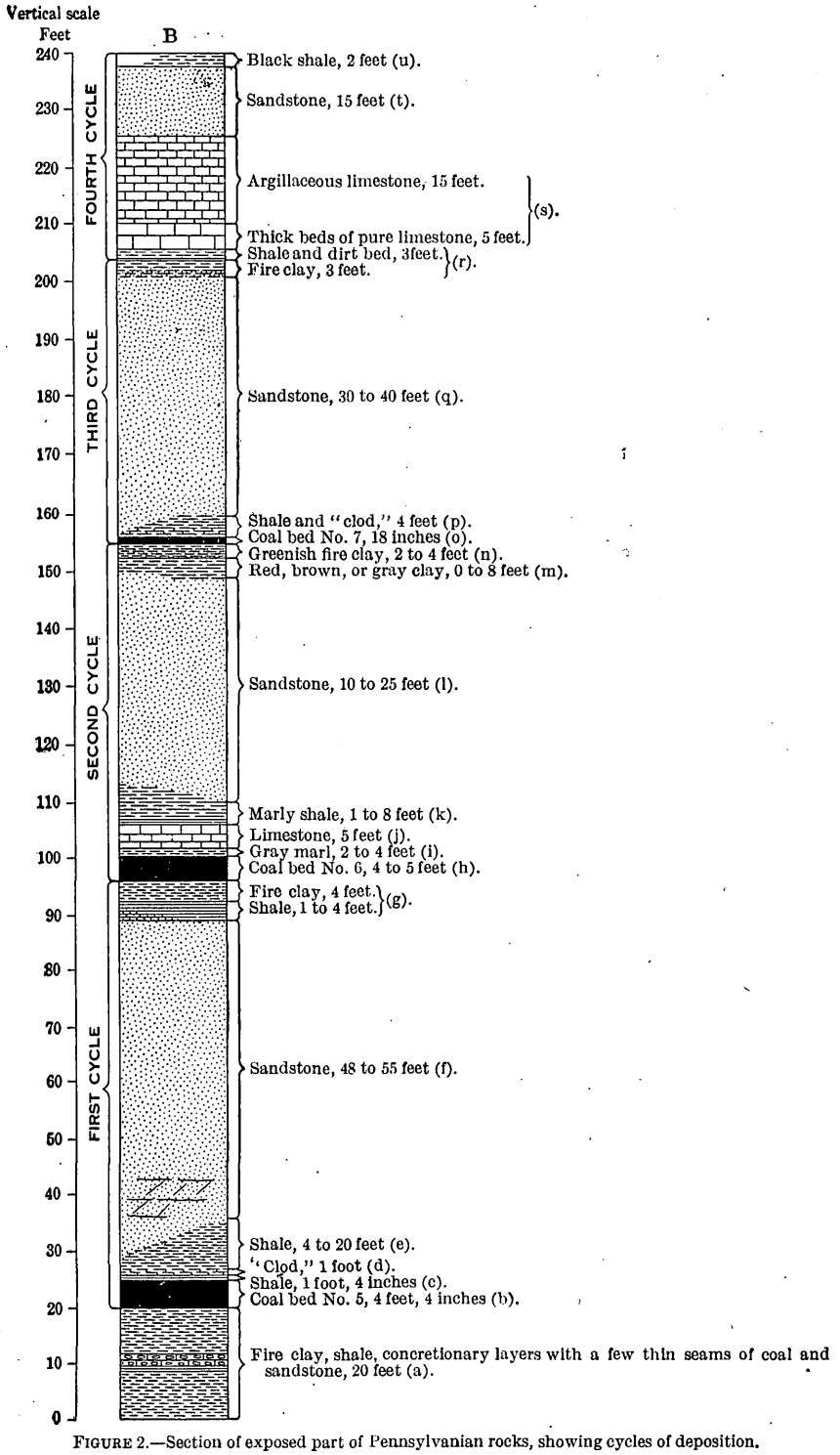


FIGURE 2.—Section of exposed part of Pennsylvanian rocks, showing cycles of deposition.

In the base of the south bluff of the West Branch of Lamarsh Creek in sec. 17, Hollis Township, this coal is conspicuously exposed for 100 yards, and the underlying beds consist of 3 feet of fire clay above, underlain by 2 feet of clay, containing two bands of concretionary ironstone 4 inches apart. Under this there are 7 feet of clay shale, in the lower part of which are some thin calcareous bands with a Productus and some other brachiopods. In the east bank of Kickapoo Creek, just north of Pottstown, the same beds appear and contain similar concretionary bands, as shown by the following section:

Section in the east bank of Kickapoo Creek north of Pottstown.

	Ft.	in.
Coal No. 5 (mostly removed)		3
Fire clay	5	
Shale, black, coaly	1	
Clay ironstone		6
Fire clay	4	6
Clay ironstone, with clay parting	2	
	13	3

The dark carbonaceous band which underlies the fire clay in this section in places develops into a thin bed of coal. Such a coal was noted in the bank of a tributary to the East Branch of Lamarsh Creek, near the center of the NW. ¼ sec. 10, Hollis Township, and also in the bank of another tributary, which traverses sec. 3 from northeast to southwest in the same township. The latter exposure is near the center of the section. In both of these places the strata have been disturbed, but in each the presence of coal No. 5 above the small coal beds can be made out satisfactorily. In sec. 10 there are two small coal beds, a lower one 3 inches thick, and an upper one of half that size, separated by a foot of "slaty" shale. Many impressions of stems of Calamites occur in this shale at both localities. A similar small bed of coal was observed on Kickapoo Creek, where a section shows the following beds under the main coal:

Section in the south bank of Kickapoo Creek in the northwest corner of sec. 29, Kickapoo Township.

	Ft.	in.
Coal No. 5	4	
Fire clay and shale, mostly concealed	8	
Shale, gray, clayey, with concretions	2	
Shale, dark, with fucoid markings		7
Shale, almost black		7
Shale, black, fissile		1
Coal, somewhat impure		4
Fire clay	3	6
Shale	5	
	24	1

Near the horizon of the small coal beds, which in these sections lie from 5 to 11 feet under coal bed No. 5, there is in places a thin bed of conglomerate or sandstone, consisting of rounded pebbles of indurated calcareous material or of clay ironstone. This was noted in the south bluff of Kickapoo Creek, near the center of the SW. ¼ sec. 27, Kickapoo Township, in the creek below the exposure of the two small beds of coal in sec. 10, Hollis Township, and in the bed of the tributary to Little Lamarsh Creek coming from the northeast at Reed City. In places this conglomerate has infiltrations of zinc blende.

COAL BED NO. 5.

The principal coal bed of the region is No. 5 (b, fig. 2). Where it has not been affected by any disturbance it varies from 4 feet to 4 feet 8 inches thick, the average being 4 feet 4 inches. It is a single bed without clay partings or sulphur bands and breaks into large blocks with a dull black luster and a faintly brownish, almost black streak. A detailed account of it will be given later. It is seen in natural exposures in the base of the south bluffs of Kickapoo Creek south and east of Edwards and west and south of Pottstown, at several places on the tributaries of this creek west of Peoria, and on the Lamarsh creeks south of the north tier of sections in Hollis Township.

STRATA BETWEEN COAL BEDS NOS. 5 AND 6.

Over this coal there is a black shale ("miner's slate") (c, fig. 2) varying from 10 inches to 3 feet thick. This shale is finely laminated and stiff. Many layers are not more than one-fiftieth of an inch thick and the shale splits into thin laminæ which, when dry, are notably elastic, springing back when flexed. The middle and upper parts of the shale are everywhere characterized by some peculiar and apparently to some extent concretionary structures. These are flat laminæ or traversions of irregular "fucoid" shape, running with the bedding, mostly of gray or almost white aspect in the black matrix as shown in Plate IV, *B*. In places they are wide and appear like alternations of light layers. In most places, however, they are one-eighth to one-fourth of an inch thick, and one-half to 2 inches broad. Many of them are slightly and some are largely calcareous. Associated with them are some small lenticular or spheroidal calcareous nodules that have bent the original laminæ into flat mammillary convexities on either side. In a few localities large septaria, locally known as "niggerheads," have developed. These are more abundant in the shale above.

Fossils are not abundant in the shale over the coal. A single Lingula was noted in one of the mines east of Pekin. *Orbiculoidea nitida* Phillips, *Productus costatus* Sowerby, and Aviculopecten are more common, especially in the mines north and west of Bartonville. So far as known this shale is seldom, if ever, absent where the ground has

remained undisturbed, and it immediately overlies the coal, from which it is sharply marked off.

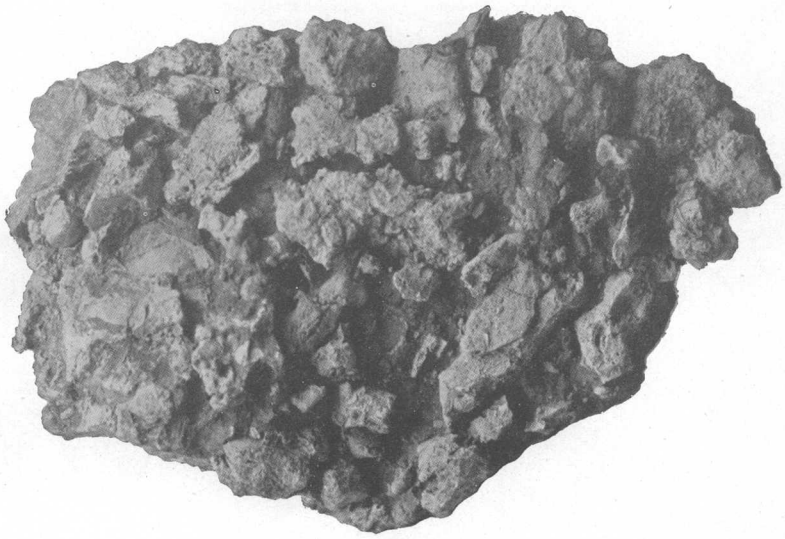
Over the roof shale just described there is in many places a layer of marly shale, which merges into a concretionary gray limestone. This almost always contains carbonate of iron, as well as of lime, and may occur either in well-defined concretions or septaria of varying sizes and forms. Where the lime is disseminated and mingled with the clay the mass is soft and yields more or less readily to weathering, owing, perhaps, to the presence of marcasite. It is then generally known as "clod" (d, fig. 2). Above this there is in many places a continuous bed of marcasite 2 to 6 inches thick, the lower surface of which is generally studded with mammillary protuberances 1 to 3 inches in height and width. In the parlance of the mines, this is "cat" or "catclaw." In places it is carbonate of iron, clay ironstone. It is then more often called the "iron band." The thickness of this marly and ferruginous deposit varies from 1 to 2 feet. In many places it is absent or represented by a calcareous phase of the shale.

This calcareous bed carries a copious fauna, mostly brachiopods, as may be seen from the following list:

List of fossils from the "clod" over coal bed No. 5.[1]

	Number of localities.	Number of specimens observed.
Ammodiscus sp	3	10
Lophophyllum proliferum McChesney	3	28
Hydrionocrinus sp	5	5
Crinoid plates undet	5	Several.
Crinoid stems	Everywhere.	Many.
Bryozoa	1	25
Amboccelia planoconvexa Shumard	1	1
Chonetes mesolobus Norwood and Pratten	3	59
Chonetes sp	2	5
Derbya crassa Meek and Hayden	2	3
Lingula sp	1	1
Orbiculoidea nitida Phillips	1	1
Productus cora D'Orb	1	2
Productus costatus Sowerby	3	3
Productus longispinus Sowerby	4	24
Productus nebraskensis Owen	1	1
Productus sp	1	1
Seminula argentea Shepard	5	17
Spirifer cameratus Morton	4	17
Aviculopecten sp	1	1
Nuculana bellistriata Stevenson	2	2
Solenomya sp	3	4
Pelecypods sp	3	4
Bellerophon carbonarius Cox	1	1
Bellerophon percarinatus Conrad	2	7
Bellerophon sp	2	6
Macrospira peracuta Meek and Worthen	1	1
Macrospira sp	1	2
Pleurotomaria tenuicincta Meek and Worthen	1	8
Pleurotomaria speciosa Meek and Worthen	1	3
Pleurotomaria sp	3	24
Soleniscus paludinæformis Hall (?)	1	4
Soleniscus brevis White	2	9
Trepospira convexa	1	1
Gastropod undet	1	1
Orthoceras rushenis McChesney	3	14
Orthoceras sp	1	1
Cephalopod undet	1	1

[1] The fossils named in this list and the following lists were examined and identified by Mr. Jon A. Udden.



A. BRECCIATED PHASE OF LIMESTONE EXPOSED AT THE LONSDALE QUARRY.

The specimen has been etched on the surface by the solvent action of water.

B. BLOCK OF ROOF SHALE OF COAL BED NO. 5.

Showing laminated structure.

Generally there is a shale (e, fig. 2) overlying the "clod." The transition fron one to the other is gradual, and the shale partakes somewhat of the character of the "clod." The shale always contains some concretionary bands of carbonate of iron or of calcareous material. These are commonly 1 to 3 inches thick and lie several inches apart. Fossils do not occur at many places in this shale, but the few noted also are present in the "clod." In different parts of a mine the thickness of this shale may vary from a thin film to 20 feet. In most places it measures 4 to 8 feet. Its upper limit is generally marked by an abrupt change to sandstone or to notably coarser material. Among some miners all of this shale is known as "clod."

The surface separating this shale from the overlying sandstone is not always a straight or even plane. There are many broad low combs in the lower surface of the sandstone which extend down into the shale. On close inspection of the bared bottom of overhanging parts of the sandstone, especially in places where it has a coarse texture, these combs are seen to have the forms of molds made in small channels, which were cut by rills into the mud bottom of the underlying shale. The largest of these channels noted on the old mud flats is 3 feet wide and about 9 inches deep, evidently a cut such as might have been made by a receding tide. To what extent the differences already mentioned in the thickness of the shale may be due to more extensive erosion at this level it is not possible to say, but it appears probable that some erosion had taken place.

The sandstone (f, fig. 2) overlying the shale of coal bed No. 5 is the most conspicuous unit in the exposed section of this region. It is present almost everywhere in the west bluffs of Kickapoo Creek from Bartonville to Pottstown, and in the bluffs of the same stream south of Edwards. It appears along almost every stream which drains the upland on the west side of Illinois River and Kickapoo Creek, and also in some creeks near East Peoria in Tazewell County.

An entire section of the sandstone appears in the west bluff of Kickapoo Creek just north of the main entry of the Schmidt mine, near the south line of sec. 13, Limestone Township. This section includes both coal beds Nos. 5 and 6 and is as given below, where f represents the different parts of this sandstone:

Section of the rocks in the west bluff of Kickapoo Creek near the Schmidt mine.

	Ft.	in.
Drift	40	
Sandstone, thin-bedded (1)	10	
Shale, black (h)		6
Coal, impure, weathered (h)		7
Coal (h)	1	8
Clay, red (h)		3
Coal (h)	1	1
Fire clay (g)	1	6

	Ft.	in.
Sandstone, thin bedded and fine grained, almost shaly (f)	19	
Sandstone, moderately coarse, homogeneous (f)	2	
Sandstone, thin bedded, soft, fine grained, with thin clay seams (f)	13	
Sandstone, thick bedded (f)	23	
Shale (near mine) (e)	9	
Shale, "slate" (c)	1	
Coal No. 5 (b)	4	4
	126	11

Differences in texture like those in the sandstone in this exposure occur everywhere. The coarser beds are generally in the lower part of the formation. Cross-bedding is common. Single beds measure 3 feet thick. In many places the upper part contains seams of silt and clay. The sandstone varies in color from almost snowy white to dark brown, but it is most commonly gray. It consists of angular grains of quartz, with which there is some mica. The sizes of most of the quartz grains range from 0.05 to 0.2 millimeter. Pebbles are absent, and so is coarse sand. Though the texture of the sandstone is fairly constant horizontally, there are places where the lower and coarser part is replaced by sandy shale. Such a section was noted near the Standard mine, in the east bluff of Coal Creek south of East Peoria, as follows:

Section of sandstone (f) in the east bluff of Coal Creek, south of East Peoria.

	Feet.
Shale	15
Sandstone, fine, regular bedding, but with some rippled surfaces	8
Sandstone, shaly above, changing gradually into sandy shale below	15
Shale, black, only partly exposed	1+
	39+

No identifiable fossils were found in this sandstone. In the channel-filling "combs" of its base, described above, there are many imprints of small fragments of stems and twigs, and these are mingled with rolled lumps of the underlying clay, all evidently heaped together by the currents which excavated the channels. In places there are also streaks of comminuted carbonaceous material in some of the beds. This sandstone averages 55 feet thick.

The sandstone just described changes somewhat abruptly into shale and fire clay above (g, fig. 2). There is generally 3 to 4 feet of dark or gray, slightly sandy, shale above the sandstone, and this is overlain by 2 to 3 feet of fire clay of greenish-gray color, in all about 7 feet. At the plane of change from sand below to fine and impervious rocks above there are in many places calcareous impregnations, which weather as irregular chunks of a light blue or oxidized and rusty color and exhibit a peculiar reticulation of intersecting joint planes. These are particularly well shown in the creek valleys east and north-

east of Grove. They appear also in places in the upper parts of the sandstones underlying the fire clays of coal beds Nos. 5 and 7. Apparently they are the result of some influence limiting the circulation of the ground water, imposed by the impervious beds above.

COAL BED NO. 6.

Coal bed No. 6 (h, fig. 2) consists of two benches, separated by a layer of clay, locally known as the "blue band." The lower bench varies from 1 foot 3 inches to 1 foot 8 inches thick. The "clay band," as the "blue band" is also called by the miners, is uniform and persistent, being absent in very few places, and is 2 to 3 inches thick. The upper bench of the coal bed is in many places partly destroyed, as will be shown later. Where intact it measures 2 feet 1 inch to 2 feet 6 inches thick. In addition to this there is in places about 6 inches of bony coal, which probably was only locally deposited. This bony coal has a satiny luster, due to very fine lamination—about 300 laminæ to the inch. It is tough and exceedingly stiff, so that a thin dry block will give a dull ring when struck with a hammer. Fine splinters, which may be broken from a block, appear translucent and brown under the microscope. When split parallel to the lamination many blocks exhibit dull olive-green blotches of clayey material which is impregnated with marcasite and lies in thin interbedded leaves. The luster of coal No. 6 is brighter than that of coal No. 5 and its fracture is more frequently conchoidal. Its streak is more brownish. The main body of the coal also shows lamination, which is even finer than that of the bony coal, but also less distinct. In places the lower part of the coal has two interrupted bands of marcasite, one about 5 inches from the bottom and the other about 9 inches higher up. These measure one-fourth to one-half inch thick.

STRATA BETWEEN COAL BEDS NOS. 6 AND 7.

As will be shown later, the shale (i, fig. 2) overlying coal bed No. 6 has been extensively leached, and this leaching has also affected the coal underneath and the limestone above. It is evident that originally there were places where this limestone was separated from the coal bed by only a few inches of gray marl and bone. Such conditions were noted in the southeast corner of sec. 11, Limestone Township, on the west side of Illinois River. Near the center of the SE. ¼ sec. 33, Kickapoo Township, the two are separated by about 18 inches of gray shale, and this seems to represent the original amount of deposition. There are other places on the Lamarsh creeks and in the creeks in Tazewell County where the shale measures nearly 2 feet. It is different from the shale over the other two coal beds. Its lamination is somewhat obscure and it has a dark-bluish color. It weathers into small chips which show conchoidal fracture on the edges.

It is notably free from concretions of marcasite or of clay ironstone. In one place only, in the west bank of Lick Creek, in the northwest corner of sec. 31, Groveland Township, were found such flat, light, gray traversions as characterize the shale above coal bed No. 5, but they were not so well marked. A microscopic examination of the material composing these structures revealed some minute denticles, probably remains of annelids. These are the only fossils noted in the shale.

The shale just described, together with a part of the coal bed below it and a part or even all of the limestone above, are sometimes replaced by a variable sandy deposit known among the miners as "white top." In the opinion of the writer this is a deposit of much later age than the strata it replaces or between which it is inclosed. Its full description will be given in connection with the discussion of the economic features of the coals in this region.

The shale is overlain by a limestone (j, fig. 2) that appears originally to have had a uniform thickness of 4 to 5 feet. In sixteen places where it was measured it ranges from 3 inches to 4 feet thick and averages a little more than 2 feet. In at least three places it is absent from the section. These places are (1) in the bluff near the Schmidt mine, a mile north of Bartonville; (2) in the west bank of West Branch of Lamarsh Creek, near the north line of sec. 31, Limestone Township; and (3) in the west bank of East Branch of Lamarsh Creek, on the north line of sec. 23 in the same township. Clay seams separate it into four or five beds of unequal thickness. In places the middle beds weather into blocks a foot and a half thick. The thin top layer is in places separated from the other beds by a seam of clay measuring several inches.

The rock is light gray in color. In places it exhibits an indistinct nodular or concretionary structure, the nodules measuring one-half to 1 inch in diameter, but this is not general. With the aid of a lens nearly one-third of the mass of the upper beds is seen to consist of organic fragments, representing mostly brachiopods, crinoids, and Fusulinas. These lie embedded in an apparently structureless calcareous matrix. Many of the shell fragments are appreciably rounded. Fragments of Fusulina can be found in every piece of the rock. Another constant characteristic is the presence, especially in the upper beds, of black nodular lumps impregnated with bituminous material. These are sharply deliminated from the matrix and exhibit a rough exterior surface. In many places they contain fragments of shells and appear to conform to the structure of the limestone itself. In size they vary from a mere speck to masses 2 inches in diameter. Generally they are three-fourths of an inch in diameter and slightly flattened. In the upper beds there are in places rounded pieces of calamarian stems, which also are black from impregnating bituminous material and which exhibit a coarse cellular tissue.

The fauna of the limestone is, as may be seen from the appended list, not very rich in species. The profusion of Fusulina is unique. Numerous specimens of Endothyra were noted in the middle beds at one place. Crinoid stems also are numerous and a few plates were found. Brachiopods are predominant, and numerous individuals were found of most of the few species present. Pelecypods and gastropods are absent or rare. The assemblage indicates open seas.

Fossils observed in the limestone over coal bed No. 6.

	Number of localities where collected.	Number of specimens.
Worn pieces of fossil wood of Calamariæ	3	7
Endothyra sp	1	Many.
Fusulina secalica Say	9	Many.
Lophophyllum proliferum McChesney	6	21
Crinoid stems	8	Many.
Crinoid plates	1	2
Chonetes vernuiliana Norwood and Pratten	3	8
Derbya crassa Meek and Hayden	4	14
Productus costatus Sowerby	3	3
Productus punctatus Martin	1	1
Pugnax uta Marcou	5	8
Reticularia perplexa McChesney	1	1
Seminula argentea Shepard	3	6
Spirifer cameratus Morton	9	20
Tomnocheilus sp	1	1
Dermal tubercle of fish	1	1

On top of the limestone just described there is in most places a light-gray or greenish shale (k, fig. 2), a "soapstone," of which the lowermost few inches are marly. It ranges in thickness from 1 to 8 feet, and its upper limit is mostly marked by a change to coarser arenaceous material.

The sandstone which rests on this shale (l, fig. 2) is about 20 feet thick. It is generally fine-grained, micaceous, and thin bedded, and resembles a shale. The upper part is nearly everywhere of this character, but in places it may be overlain by 3 or 4 feet of coarser beds. The thin-bedded shaly character is well shown along the creeks back of the bluffs between East Peoria and Pekin. The coarsest phase appears in the lowest beds on the two Lamarsh creeks, in secs. 18, 20, 21, 29, and 30, Limestone Township. Some beds are 2 feet thick, and cross-bedding is common. On weathering these coarse beds become stained with numerous brown rusty spots, as was noted in a ravine north of the German Coal Co.'s mine in sec. 11, Hollis Township. In places where these basal beds are coarse, the transition from the underlying shale is abrupt, and the upper surface of the shale here and there shows rill-cut channels which have been filled with sand. The shaly phase was noted in only one place across the road from the Mohn Coal Co.'s shaft near the center of sec. 11, Limestone Township. Here the sandstone is fine and shaly, but in other localities it is also

calcareous, and some beds in its lower half are almost a limestone of bluish-white color. The calcareous matter in the rock is evidently an original constituent of the sediment. This phase is not to be confounded with some calcareous infiltrations that mark the top beds. These have filled the open spaces between the sand grains with crystalline lime that tends to form large and poorly defined concretionary masses. They show a network of thin, filled, joint cracks that weather out as narrow ridges of a rusty color.

The total thickness of this sandstone ranges from 10 to 25 feet, and no fossils were noted in it. In well records it is often reported as shale, on account of its fine texture.

Between the sandstone just described and the fire clay of coal No. 7, there is generally a clay shale (m, fig. 2), which varies in thickness from 1 to 8 feet. In some places this is dark-greenish gray, and in others dark red or brown. In some places there is a blotched mixture of these two colors. This red clay, where present, is an infallible guiding stratum for the coal beds of this region. It lies from 8 to 16 feet under coal bed No. 7, and there is no other red clay in the exposed Pennsylvanian series in this area. It is, however, not continuous, for the color may change to dark bluish gray or the clay may be absent altogether.[1] Its distribution and color suggest that it was deposited in pools of water under conditions which were favorable to the oxidation of the sediments.

The fire clay (n, fig. 2) above the clay just described and under coal No. 7, is characterized by a greenish tinge, which is deeper than that of the fire clays of the other beds. It varies from 1 to 4 feet thick.

COAL BED No. 7.

Coal bed No. 7 (o, fig. 2), like No. 6 below it, probably was laid down as a continuous deposit over this entire area. It is present in every place where the part of the rock section in which it belongs can be seen. The uniformity of its thickness is remarkable. In 10 measurements, made where the bed is unaffected by leaching or weathering, the variation amounts to only 4½ inches. The coal averages 1 foot 5 inches thick. It is distinctly but unevenly laminated. Some laminæ are thin, some thick; some are very bright, and others dull. A characteristic feature in many places is the great development of layers of mineral charcoal, generally near the top of the bed. In a ravine a little west of the center of sec. 35, Limestone Township,

[1] The red clay was noted in many places, some of which are as follows: (1) About 100 yards northwest of Shoal Bros.' mine south of Bartonville; (2) on the west side of West Branch of Lamarsh Creek, in the NE. ¼ NE. ¼ sec. 31, Limestone Township; (3) in the south bank of a creek near the center of the north line of sec. 7, Groveland Township, Tazewell County; (4) in the south bank of a branch of Lick Creek, in the SE. ¼ SE. ¼ sec. 18 in the same township; (5) on the east slope of a ravine about one-third of a mile northwest from the southeast corner of sec. 33, Kickapoo Township; (6) in the south bank of a creek a little west of the center of sec. 27, Limestone Township, Peoria County.

such a layer is 2 inches thick and has the appearance of a charcoal breccia, consisting of flattened fragments from one-half to 2 inches in diameter. At the northwest corner of sec. 22 in the same township, there is a layer of this material 1½ inches thick and 6 inches below the top of the coal bed. In places the mineral charcoal layers are impregnated with sulphide of iron and appear as "sulphur cakes." The streak of this coal is almost black, being darker than that of coal No. 6.

STRATA ABOVE COAL BED No. 7.

The rocks overlying coal No. 7 differ from those over the two coal beds below it in that they are less uniform and that in many places a few inches of soft shale lies between the coal and the black roof shale. This shale is generally marly and resembles the "clod" over coal No. 5. In places it is a mixture of shell fragments and clay, and it also contains calcareous material in the form of concretions. Only two places were seen where the black roof shale rests directly on the coal. In two exposures repetition of the clay shale and the black roof shale was noted, so that there are two clay shales and two black roof shales, each only a few inches thick. The black roof shale varies in thickness from 6 inches to 2 feet. It is never so stiff or so thinly laminated as the black roof shales over the lower coals. Over the black roof shale and the calcareous "clod" there are in most places a few feet of shale (p, fig. 2), slightly arenaceous and micaceous. Where this is thin or absent, the overlying sandstone is coarse and generally cross bedded. The erosive action of currents during deposition is also manifest in the marly layers and in the black roof shale, for the upper laminæ of the marl are in places cut away to the depth of 3 or 4 inches, and the base of the black roof shale then rests on the gently beveled edges of the laminæ of the clay shale. These small contemporaneous unconformities were evidently produced by currents in the first water that inundated the marsh after the vegetation producing the coal had flourished. One of the trees killed by this inundation left its stump in the "clod" over the coal. It stands in a vertical position as a hollow hulk, filled with sandy clay, and with its spreading base resting directly on the coal. It occurs in an exposure of the coal bed in a creek west of the center of sec. 15, Limestone Township. In many places the currents which brought the overlying sand tore up some of the clay and black laminated shale, leaving them as small blocks embedded in the basal beds of the overlying sandstone. Phenomena of this kind were noted a short distance south of the locality just mentioned. Where the contact between the sandstone and the clay is sharply marked, channels also occur in the lower beds, being filled by the sand above them.

The calcareous deposits in the clay and shale over this coal bed carry the following fossils:

Fossils from calcareous concretions and lentils, "clod," over coal bed No. 7.

	Number of localities.	Number of specimens.
Sigillaria, fragment	1	1
Crinoid stems	3	7
Lophophyllum proliferum McChesney	2	3
Productus costatus Sowerby	3	11
Chonetes mesolobus Norwood and Pratten	3	4
Productus longispinus Sowerby	4	26
Seminula argentea Shepard	3	12
Seminula subquadrata Hall	1	12
Bellerophon percarinatus Conrad	1	2
Bellerophon sp.	1	2
Gasteropod undet.	1	1
Soleniscus brevis White	2	2
Pelecypod undet.	2	3
Orthoceras rushensis McChesney	1	5

Like the other sandstones, the arenaceous sediments deposited after coal bed No. 7 vary in texture from sandy shale to sandstone (q, fig. 2). Generally but not invariably the lower beds are coarser. Ripple marks occur in places, but they are no more abundant than in the two lower sandstones. Mica is slightly more abundant than in the sandstone over coal No. 5. About a mile west of Bartonville this bed is nearly 40 feet thick. At this place the highest bed contains lumps of shale, such as are common in association with small contemporaneous unconformities.

Secondary structures characterizing the fine-grained layers of this sandstone are some flat septaria of carbonate of iron, which measure a foot or more in diameter and from 1 to 3 inches thick. They are most abundant in the middle and upper part of the bed. The basal layers are characterized by a profusion of impressions of the stems of coal-making plants, such as Sigillaria and Lepidodendron. Large pieces of silicified trunks of trees were noted near the outcrops of this sandstone in sec. 11, Limestone Township, but these may have come from the "dirt bed" presently to be described. This sandstone is the highest part of the Pennsylvanian section in the country east of Illinois River and southwest of Bartonville.

In the south bank of a ravine which runs west through the N. ½ sec. 6, Limestone Township, some dark clay beds (r, fig. 2) overlie this sandstone. The section is given below:

Section of rocks exposed in N. ½ sec. 6, Limestone Township.

	Ft.	in.
Limestone, nodular, weathering into thin layers (exposed at the Lonsdale quarry) (s)	15	
Limestone, gray, thick beds containing entire fossils and organic fragments in considerable numbers, and projecting with combs or ridges into the shale below (exposed at the Lonsdale quarry) (s)	6±	
Shale, black, laminated (r)	5	

	Ft.	in.
Old soil, indurated, dark, micaceous, with fragments of vegetation, impressions of stems, and rarely fragments of vertebrate bones and teeth (r)		3
Shale, black (r)		6
Shale, gray, arenaceous (q)	1	
	27	9

In sec. 11, Limestone Township, the black material corresponding to the third bed from the base in the above section has the appearance of a structureless indurated mud without lamination. Pieces of a silicified tree trunk were seen in a position that suggested that they had come from this bed. The thickness of the beds included between the arenaceous gray shale below and the gray limestone above is about 6 feet.

The limestone (s, fig. 2) described by Worthen from the old Lonsdale quarries was seen in many places. In sec. 10, Limestone Township, it shows at intervals along a ravine for nearly half a mile, and several other outcrops appear in sec. 11 in the broken upland adjacent. Several old quarry faces and natural outcrops occur near the forks of the wagon road at the southeast corner of sec. 3. It crops out in the ravines and in the hills in the central part of sec. 9, both north and south of the railroad west of Maxwell. It has been found in a well on the upland half a mile northwest of this station, on a farm belonging to J. C. Cameron. It was noted in a creek a little north of the center of sec. 30, west of West Branch of Lamarsh Creek. Part of this rock is a crinoidal limestone. It outcrops in several places in the ravines in the E. ½ sec. 7, where it comes within 30 feet of the general level of the upland. One of the best exposures is the one already given in the section on page 38, not quite 3 miles south of Edwards. A very similar section appears in the next creek valley half a mile north. It was also seen at the heads of each of the three principal ravines in secs. 31 and 32, Kickapoo Township, and in the creek valley crossing the northwest corner of sec. 4, Limestone Township. Evidently this rock underlies most of the triangular area included within the line joining the above-mentioned outcrops. In the southernmost outcrop in sec. 31, Kickapoo Township, it disappears to the west in a manner suggesting that it has undergone preglacial erosion. This may have removed it also in other places in this area, where it might otherwise occur under the drift.

The lower 5 feet of this rock consists of a firmly cemented, largely organic limestone in beds varying in thickness from 6 inches to 1 foot 6 inches. On one of the beds a large Campophyllum, from 1 to 2 inches in diameter, is locally profuse in the outcrop near the west line of sec. 3, Limestone Township. A little east of the center of sec. 32, Kickapoo Township, one of the beds is a typical crinoidal limestone. In some of the outcrops in sec. 7, Limestone Township,

there is still another phase of this rock. A part of it consists of a calcareous mud-lump breccia, in which angular lumps of dark compact structureless carbonate of lime are embedded in a less pure greenish-gray matrix. In this matrix fragments of fossils also occur. In some places, as shown in Plate IV, *A* (p. 30), the brecciated structure is made strikingly evident by the etching away of the matrix, so as to leave the lumps in relief. Above these firm beds there are 15 feet of a slightly argillaceous and more flaggy rock, in which concretionary structures can nearly always be detected. Near the boundary between secs. 3 and 4, Limestone Township, the calcareous material in these beds has been gathered into irregularly shaped nodules about an inch in diameter, and generally confluent. These constitute perhaps one-fourth of the mass and weather out more or less distinctly from the more argillaceous residuary matrix in which they are embedded. In the upper beds fossils are scarce and are chiefly brachiopods. A long, slender Fusulina occurs in the marl adhering to the under side of the lowest bed of the formation.

Fossils from the limestone exposed at the Lonsdale quarry.

	Number of localities.	Number of specimens.
Ammodiscus sp	1	6
Fusulina secalica Say (a slender form)	1	8
Campophyllum torquium Owen (?)	4	22
Chætetes milleporaceus Edwards and Haine	1	2
Lophophyllum proliferum McChesney	1	8
Crinoid stems	3	8
Chonetes sp	1	2
Houstedia mormoni Marcou	2	3
Productus cora D'Orbigny	1	1
Productus costatus Sowerby	2	2
Productus punctatus Martin	1	3
Reticularia perplexa McChesney	1	7
Seminula argentea Shepard	2	17
Spirifer cameratus Morton	2	3
Bellerophon sp	1	1
Naticopsis altonensis McChesney	1	1
Soleniscus anguliferus White	1	1
Strophostylus peoriensis McChesney	1	4
Gasteropod undet	1	1

A sandstone (t, fig. 2) about 15 feet thick, overlies this limestone in the northwest corner of sec. 4, Limestone Township. Where weathered it is brownish in color and of medium coarse texture. It appears on the south side of a ravine some hundred yards north of the Episcopal Church. Above it, in one place, is 2 feet of dark carbonaceous shale (u, fig. 2), evidently slightly disturbed and partly worked into the drift. The locality is mentioned by Worthen in his report on Peoria County. The dark shale is the uppermost part of the Pennsylvanian seen in this area, and neither this nor the sandstone under it was noted in any other place.

LOCAL SECTIONS.

There is here added for reference a detailed account of sections of outcrops and explorations of the exposed Pennsylvanian rocks not

fully given in the preceding pages. The letters within parentheses refer to the divisions in the exposed section just described. (See fig. 2, p. 27.) Some records of wells entering the Pennsylvanian are are also given.

WEST OF ILLINOIS RIVER.

Section in ravine on east side of wagon road in Kickapoo bluffs, in north part of sec. 30, Kickapoo Township.

	Ft.	in.
Drift	35	
Limestone (j)	2	
Marl, gray (i)		6
Coal, with a 3-inch clay seam (h)	3	6
Fire clay (g) seen	1	
Concealed	15	
Shale, sandy, and sandstone (f)	10	
	67	

Section near wagon road in ravine about one-third mile north of south line of sec. 31, Kickapoo Township.

	Feet.
Limestone, nodular, impure, in thin layers (s)	8
Limestone, in thick beds (s)	4
Shale, black (r)	4
	16

Section in wagon road near a ravine, one-fourth mile northwest of southeast corner of sec. 33, Kickapoo Township.

	Ft.	in.
Drift.		
Coal, blossom (o)	1	
Fire clay, weathered (n)	4	
Shale, red (m)	4	
Shale, sandy, micaceous, not all exposed (l)	25	
Limestone (j)	3	6
Shale (i)	1	6
Coal, only partly seen (h)	1	
	40	

Section on north side of wagon road opposite Mohn Coal Co.'s shaft, near center of sec. 11, Limestone Township.

	Ft.	in.
Limestone, in thick beds (s)	6	
Concealed (q and r)	23	
Shale, arenaceous, with large septaria containing fissures filled with columnar calcite (q)	6	
Shale, arenaceous, with five bands of clay ironstone, about three-fourths of an inch thick (p)	6	
Coal (o)	1	6
Fire clay (n)	3±	
Shale, arenaceous, or sandstone, bluish, with much calcareous material in the lower half, in which indistinct ripple marks occur (l)	33	
Limestone, in places (j)	2	
Coal (h)	2	
	82	6

Section in south bank of creek along Iowa Central Railway on line of longitude 89° 40′ W.

	Ft.	in.
Sandstone, thick-bedded (f), seen	10	
Sandstone, thin-bedded, the base filling excavations in the shale 3 feet wide and 8 to 10 inches deep. In these fillings are fragments of plant stems and rolled lumps of clay one-eighth to 1½ inches in diameter (f)	6	
Shale, dark above and gray below, with eight bands of clay ironstone 1 to 2 inches thick (e)	6	
Clay ironstone 1 to 5 inches thick, miners' "cat," changing horizontally into a gray stony or soft marl with fossils (d)		6
Shale, black (d)	1	6
Shale, black, with large concretions of clay ironstone (c)	1	
Coal (b)	4	3
Fire clay (a)		6
Shale, dark (a)	3	
Clay ironstone, calcareous (a)	1	
	33	9

Section in creek along Iowa Central Railway, in southeast corner of sec. 10, Limestone Township.

	Ft.	in.
Sandstone, thinly laminated (q)	25	
Shale (p)	2	
Coal (o)	1	6
Fire clay (n)	2	
	30	6

Section in bluff about one-fourth mile north of Hollis.

	Ft.	in.
Sandstone, coarse, brownish, micaceous (l)	5	
Concealed	2	
Shale, micaceous (l)	2	
Limestone, with an indistinct concretionary structure above (j)	3	
Shale (i)	1	6
Coal, decayed (h)	1	
Clay (h)		3
Coal (h)	1	6
Fire clay, changing downward to sandy shale (g)	5	
	21	3

Section in bluff along wagon road, north of Mapleton.

	Ft.	in.
Loess	27	
Bowlder clay	8	
Sandstone, coarse, micaceous (l)	5	
Sandstone, shaly, micaceous (l)	10	
Limestone (j)	3	
Marl, shaly (i)	1	6
Coal (h)	2	
Sandstone, shaly (f and g)	22	
Sandstone, coarse, micaceous (f)	23	
	101	6

Section in ravine one-fourth mile west and a little south of northeast corner of sec. 7, Hollis Township.

	Feet.
Sandstone, coarse (l)	2
Sandstone, shaly (l)	14
Limestone (absent in places) (j)	2
Shale, greenish (k)	2
Coal (h)	2 (?)
	22 (?)

Section in bank of West Branch of Lamarsh Creek, one-fourth mile north of southeast corner of sec. 30, Limestone Township.

	Ft.	in.
Limestone (j)		6
Marl, nodular (j)		6
Limestone (j)		4
Sand, shale, and coal, marly ("white top")	1	
Coal (h)	2	10
Clay (h)		2
Coal with two interrupted bands of iron pyrites one-fourth to two-thirds inch thick and 10 inches apart, the lower one lying 5 inches above the base of the coal (h)	1	6
Fire clay (g)	3	
	9	10

Section in east bank of West Branch of Lamarsh Creek, one-fourth mile south of northeast corner of sec. 19, Limestone Township.

	Ft.	in.
Shale, gray (q)	5	
Shale, dark, slaty (p)	4	
Shale, black, with indistinct bedding (p)		6
Shale, soft, black (p)		9
Clay shale, dark (p)		6
Coal (o)	1	6
Fire clay and shale (m and n)	9	
Sandstone, coarse and micaceous (l)	5	
	26	3

Section in road excavation in bluff of West Branch of Lamarsh Creek, on south line of sec. 18, Limestone Township.

	Feet.
Drift, including weathered bowlders of limestone (s)	2
Sandstone, shaly, in thin layers containing, above, symmetrical septaria a foot in diameter and 1 to 2 inches thick and large weathered concretions of clay ironstone of irregular shape below. Zinc blende was noted in one of the septaria (typical appearance of q)	15
	17

Section near center post of east line of sec. 7, Limestone Township.

	Feet.
Loess and till	20
Limestone, thick beds (s)	5
Shale, sandy (q and r)	10
	35

Section in ravine one-sixth mile west of center of sec. 15, Limestone Township.

	Ft.	in.
Sandstone, thick bedded (q)	4	
Sandstone, cross bedded (q)	3	6
Shale, gray, arenaceous (p)	1	6
"Miner's slate" (p)	2	
Shale, gray, with a hollow tree stump (p)		6
Coal, with layer of mineral charcoal 6 inches below the top (o)	1	6
Fire clay (n)	3	
	16	

Section in ravine one-half mile north of Illinois Hospital for Incurable Insane, near Shoal Bros.' mine.

Drift.	Ft.	in.
Sandstone, micaceous (q)	10	
Shale, sandy (q)	15	
Shale, black, fissile (seen near Collier Cooperative Coal Co.'s mine (p)	2	
Clay, shaly (p)	1	
Coal (o)	1	4
Fire clay, greenish, with a few small layers of coal (n)	4	
Shale, gray, arenaceous (m)	8	
Shale, gray and in places red (m)	7	
Sandstone, cross bedded (l)	5	
Shale, light gray (l?)	3	
Limestone (j)	3	
Shale, marly, "white top"		6
Coal (h)	3	
Fire clay (g)	4	
	66	10

Section in south bank of ravine a little west of center of SE. ¼ sec. 23, Limestone Township.

	Feet.
Loess and bowlder clay	25
Sandstone, weathered, containing rolled mud lumps in uppermost stratum (q)	40
Shale (p)	3
Shale, slaty (p)	2
Coal, partly seen (o)	?
	70+

EAST OF ILLINOIS RIVER.

Section in south buff of a creek, near the center post of the north line of sec. 7, Groveland Township.

	Ft.	in.
Sandstone in 3-inch beds, with numerous impressions of Sigillaria in base (q)	15	
Shale, stiff, sandy (q)	9	
"Miner's slate," black, soft (p)	1	
Clay, bluish, shaly (p)		8
Marl, black, carbonaceous, sandy, with fossils (p)	1	
Coal (o)	1	6

	Ft.	in.
Fire clay, dark bluish gray (n)	5	
Clay, bluish, in places has red or brown blotches (m)	4	
Sandstone (?) micaceous and calcareous (1), seen	1	
	38	2

Section in south bank of creek one-fourth mile east of northwest corner of sec. 18, Groveland Township.

	Ft.	in.
Sandstone, shaly (q)	10	
Shale, black, fissile (p)		9
Clay, shale, soft (p)	2	
Coal (o)	1	2
Fire clay and arenaceous shale (m, n)	14	
Concealed	6	
Sandstone, bluish gray, micaceous, with network of fine brown joint seams (1)	3	
	36	11

Section in main creek a little north of center of NW. ¼ sec. 18, Groveland Township.

	Feet.
Clay, red (m)	3
Sandstone, cross bedded (1)	7
Shale, gray, arenaceous (1)	8
	18

Section in north bank of creek, one-fourth mile south-southwest of northeast corner of sec. 24, Pekin Township.

	Ft.	in.
Shale, light gray (1)	1	
Limestone, thinning rapidly to east (j)	2	
Shale, "white top" (i in part)		6
Coal, thinning rapidly to east (h)	1	6
Fire clay (g)	3	
Shale, arenaceous (f and g)	15	
	23	

Section in west bank of Lick Creek, near junction of its two forks, sec. 25, Pekin Township.

	Ft.	in.
Sandstone (1)	4	
Sandstone, shaly (1)	6	
Limestone, discontinuous (j)	1	
Shale, "white top" (in part i)	1	6
Coal (h)	2	6
Fire clay, with a dark ferruginous band near middle (g)	3	6
Shale, gray (g)	2	6
Sandstone in somewhat shattered beds (f)	3	
Shale, light bluish gray, arenaceous (f)	23	
	47	

Section in west bank of Lick Creek, near wagon bridge in northwest corner of sec. 31, Groveland Township.

	Ft.	in.
Shale, light gray (1)	6	
Clay, structureless, residuum from (j)	1	2
Shale, dark, fissile, with gray discontinuous laminations (i)	1	
Coal (h)	2	9
Clay (h)		2
Coal, with lenses of pyrites near the middle (h)	1	6
Fire clay, greenish gray (g)	4	
	16	7

Section in south bank of Lick Creek, near center of sec. 31, Groveland Township.

	Ft.	in.
Sandstone, shaly (q)	25	
Shale, black, fissile, with small dumb-bell shaped concretions (p)		8
Clay, bluish gray, in places calcareous and fossiliferous, thickness variable (p)	1	
Coal (o)	1	6
	28	2

NOTES ON WELLS AND MINE SHAFTS ENTERING PENNSYLVANIAN ROCKS.

ELM GROVE TOWNSHIP.

1. The depth to the base of coal bed No. 5 in the old shaft of the Tazewell Coal Co.'s mine in sec. 6 is 160 feet. The base of coal bed No. 6 in the same shaft is 96 feet 6 inches below the surface. Elevation of landing above sea level, about 580 feet. The thickness of the drift could not be ascertained, as the shaft is timbered.

2. A memory record of the strata penetrated by the shaft of the Champion Coal Co. in sec. 6, given by the foreman of the sinking gang, is as follows: The first coal (No. 7) is 1 foot 6 inches thick and lies 90 feet below the surface; the second coal (No. 6) lies at a depth of 125 feet, and varies from 3 feet to 4 feet 6 inches thick; the third coal lies 190 feet below the surface and is 4 feet 8 inches thick. The lower 70 feet is described as soapstone, apparently a shaly fine-textured sandstone. Elevation of landing about 600 feet.

3. At the Poor Farm in sec. 11 a well 180 feet deep goes through 118 feet of drift, and below this there is "gray rock." Elevation about 650 feet above sea level.

FONDULAC TOWNSHIP.

4. The Eastern Coal Co.'s shaft in East Peoria is 65 feet deep. Its landing has an elevation of about 525 feet above sea level.

5. A well on the bottom land in sec. 34, near the mouth of Kerfoot Hollow, entered coal bed No. 5 at a depth of 20 feet. Elevation of the ground is about 480 feet above sea level.

GROVELAND TOWNSHIP.

6. In the shaft of the Giebelhausen mine in Coal Hollow, about one-half mile north of the south line of sec. 5, the bottom of coal bed No. 5 is 90 feet. Elevation of landing is 525 feet above sea level.

7. Manhattan Fuel Co.'s shaft in Coal Hollow, one-half mile south of the north line of sec. 5, is 80 feet deep down to coal bed No. 5. The elevation of the landing is about 510 feet above sea level.

8. The shaft of the Phœnix Coal Co. is in a ravine near the southwest corner of sec. 6 and is about 75 feet deep. Elevation of landing is 520 feet above sea level.

LIMESTONE TOWNSHIP.

9. Record of the strata in shaft B of the Empire Coal Co. in sec. 10, about three-fourths of a mile east of Maxwell: Coal bed No. 7, 1 foot 6 inches thick, lies 70 feet below the surface; coal bed No. 6 is 40 feet below this; and coal bed No. 5 is at the bottom of the shaft, which is 182 feet deep. Elevation of landing is about 652 feet above sea level.

10. The shaft of the Hanover Coal Co. in sec. 11 is 74 feet deep. The elevation of the landing is about 505 feet above sea level.

11. The depth of the shaft of the Mohn mine, south of the center of sec. 11, is 93 feet. This extends some 3 or 4 feet below coal bed No. 5. Elevation of landing, not known.

12. On the Barnewoldt farm in sec. 12 a well entered sand and gravel after going through a 4-foot bed (No. 5?) of coal.

13. The depth to the base of coal bed No. 5 in the lower Empire mine, A, near the northeast corner of sec. 15, is 85 feet. Elevation, about 565 feet above sea level.

14. In Winter Cooperative Coal Co.'s mine in sec. 23, coal bed No. 5 lies 102 feet below the level of the landing, and coal bed No. 6 lies 18 feet below the landing, which has an elevation of about 570 feet above sea level.

15. The depth of the bottom of coal bed No. 5 in the shaft of the Treasure Coal Co. in sec. 24 is 80 feet. Elevation, about 518 feet above sea level.

16. The section of the main shaft of Shoal Bros.' mine, near the west line of sec. 25, is as follows: Filling, 10 feet; shale, 21 feet; sand rock, 35 feet; "cloddy" shale, 9 feet; shale, 12 inches; coal, 4 feet 4 inches. Elevation of landing (estimated), 505 feet above sea level.

17. The air shaft of Shoal Bros.' mine, on the upland in sec. 26, went through the following strata: Loess, 20 feet; bowlder clay, 20 feet; shale, 30 feet; coal bed No. 6, 3 feet thick on one side of the shaft and 1 foot on the other. Below this there were some 70 feet of sandstone and shale. Elevation of top unknown.

PEKIN TOWNSHIP.

18. The shaft of Grant Bros.' mine, on the east side of Lake Meyers, in sec. 1, T. 24 N., R. 5 W., is 98 feet deep. Coal bed No. 5 is at the bottom and coal bed No. 6 lies 62 feet above No. 5. The top of the shaft is 540 feet above sea level.

OUTSIDE THE QUADRANGLE.

19. In a well in Tremont, just outside of the quadrangle to the southeast, a little coal was noticed by A. J. Davis at a depth of about 80 feet, and a coal bed 1 foot 6 inches thick (No. 7) at 120 feet. Under this coal there is a sand which produced a flow of gas that for some time was used for fuel under a 20-horsepower boiler in the city power house. The supply lasted six months, but at last it fluctuated with barometric changes and ceased. There was wood in the drift at a depth of about 70 feet. Elevation, about 640 feet above sea level.

PHYSICAL CONDITIONS OF SEDIMENTATION.

The exposed sections of the coal-bearing rocks present an unusual persistence of the 21 recognizable divisions that have been described, and these may be grouped into an almost perfect quadruple repetition of a sedimentary cycle. Each cycle may be said to present four successive stages, namely: (1) accumulation of vegetation; (2) deposition of calcareous material; (3) sand importation; and (4) aggradation to sea level and soil making. (See fig. 2, p. 27.)

In the four cycles the several stages show difference in time values or, at any rate, in material development. The first stage, that of accumulation of vegetation, presents on the whole a serial diminution throughout the four cycles. Coal bed No. 5, which represents the first cycle, is slightly thinner than coal bed No. 6, which represents the next cycle. Coal bed No. 7, in the third cycle, is about one-third the thickness of either No. 5 or No. 6, and the vegetation represented by the carbonaceous shale under the limestone of the fourth cycle, exposed at the Lonsdale quarry, is about one-tenth of the volume of that represented by coal bed No. 7. Dimensionally, the comparative development of the vegetable accumulation or of the time values of this stage in the four cycles would be as the thickness of the carbonaceous material expressed in inches from below upward, or 50, 53, 17, and 2 (estimated roughly). From this stage to the next there is in each cycle a transition, represented by a finely laminated deposit of vegetable material and mud, "bone coal," "miner's slate," and dark laminated shale. This was formed during the beginning of the inundation of the swamp while the water was not deep enough to prevent vegetable accumulation but allowed a gentle influx of slightly muddy water.

The stage of calcareous sedimentation was more variable in its duration, and was alternately much prolonged and shortened. In the first and third cycles it was of brief duration, scarcely allowing the accumulation of a stratum of lime as much as 6 inches thick, but in the second and fourth cycles it apparently lasted several times as long. The calcareous material was laid down in quite open waters, which were more or less free from silt. The surface of the sea was inhabited by Foraminifera, such as Ammodiscus, Endothyra, and Fusulina, and on the bottom lived corals, crinoids, brachiopods, and mollusks. Gastropods and pelecypods, having the best locomotive equipment, are most numerously represented in the cycles where this stage had the shortest duration. The thickness of the sediments of this stage in the four cycles without doubt represents time values quite correctly; the beds are 3, 60, 6, and 240 inches thick. This stage also ended each time with a deposit of fine silt that evidently represents a turbidity caused by the currents bringing the sand of the next stage. It seems very probable that the currents which transported and deposited this sand were chiefly tidal. In many places they were strong enough to scour and disturb the silt laid down before their coming. The uniformity in the thickness of the sandstones in each cycle suggests that they were built up to some definite limit, and this limit was probably the surface of the sea. Transporation was chiefly by bottom currents, which now and then built low cross-bedded bars of sand, and at times fashioned the surface of the accumulating sand in small wavy ripples. No wave marks, prints of raindrops, or mud

cracks, indicating the shores, were noted, although such marks are found in the lowest sandstones of the Pennsylvanian at their line of outcrop farther north in the State. The sands alternate with slightly finer sediments that were, no doubt, actually suspended in the same currents. This stage of sand importation also shows some variation in duration in the different cycles, and it is a suggestive circumstance that the importations of sandy material, measured in the thickness of each of the sandstones, maintain a rough inverse ratio to the several calcareous deposits in the same cycles. In the cycles with the briefest duration of deep and open water occurs the thickest overlying sand deposit, and in the cycle with the heaviest limestone the least sandstone and sandy shale were deposited, as will be apparent from the tabular statement below.

Thickness in inches of sediments laid down during the three first stages in each of four sedimentary cycles, numbered from below upward.

Number of cycle.	Carbonaceous deposition.	Calcareous deposition.	Sand importation.
4	2	240	180
3	17	6	420
2	53	60	240
1	50	3	804

On the theory that the cycles represent recurrent submergences, alternating with periods during which the sunken areas were filled to the level of the surface of the sea, this relation between the thickness of the calcareous and the sandy deposits might be accounted for as due to the difference in the promptness with which the transporting current brought the sand. In the deeper seas the currents might be stronger because less interrupted, and might more rapidly bring forward the continental deposits from their evidently somewhat distant source and so terminate earlier the quiet conditions prevailing in the lime-depositing waters. This reasoning lends support to the view that the four cycles represent recurrent interruptions in a progressive submergence.

The last stage is represented by shale and fire clay, and by the even surface upon which the coal bed was deposited. As soon as the sand was built up to the surface of the sea at any place, the work of the sand-transporting currents ceased. Local deposition of clay and silt, resulting from decay and weathering of the upper surface of the last sand deposit, helped to bring the surface of this low land to a most surprisingly perfect flatness over wide areas, at least in the first and second cycles. Meanwhile a swampy soil was produced, and on this new swamp vegetation began the next cycle.

Everything considered, the most remarkable feature bearing on the physical conditions prevailing at the time of the deposition of the coal measures of this quadrangle is the horizontal extent and uniformity in thickness of each deposit. The regularity in thickness is pronounced even in the sandstones, which are also quite uniform in texture, all of the grains being of a smaller size than a pinhead. The limestone over coal bed No. 6, though now generally reduced by leaching, no doubt originally had a thickness varying, as will be shown, from 4 to 5 feet. The lower bench of coal bed No. 6 is commonly 1 foot 6 inches thick, and it varies from this in few places as much as 2 inches. The persistency of the clay which separates the lower from the upper bench of this coal bed is a feature that seems to have required physical conditions which are unknown at the present day. The accumulation of a layer of fine mechanical sediment 2 to 3 inches thick in the middle of an epoch of swamp vegetation over an area of at least 200 square miles, in such a manner that the thin deposit remains entirely unmingled with the vegetation both above and below, could hardly take place in any known swamp of to-day.

The record of the progress of sedimentation in this region during the Carboniferous period ends with the top of the section just described. Sediments of this age continued no doubt to be laid down for some time after this, the strata so made having an unknown thickness. At some later time the region was elevated above the sea. The erosion of the resulting land before the deposition of the drift was so great that all evidence of any strata of later age than the Pennsylvanian, if any such were formed, was destroyed. The conditions during the Mesozoic era no doubt varied, but it is generally supposed that during most of this time the region was a land area undergoing denudation.

TERTIARY PERIOD.

GRAVEL DEPOSITS.

During the greater part of the Tertiary period the Peoria quadrangle was also very probably a land area. Some gravel which overlies bedrock under the glacial drift in the N. ½ sec. 30, Limestone Township, may represent a residuum of surficial deposits of early Pleistocene or late Tertiary time, preceding the glacial epoch. Glacial corrasion in the surrounding upland was evidently not very great, and gravel may have been left in protected situations, or have been imperfectly worked into the base of the glacial drift. This gravel consists largely of yellow chert, which elsewhere in this part of the State is not known to be abundant in the glacial drift.

SURFACE OF BEDROCK.

Erosion in preglacial time had produced a land surface which differed considerably from the present topography. Since that time the land has been rebuilt by glaciation, the general effect of which has been to reduce the relief. The old land surface has undergone some changes by postglacial agencies, but these are small. The present surface of bedrock is known mainly from wells and other excavations that have penetrated the drift. These data are not very numerous, but an attempt has been made to present the general features of the rock surface in the quadrangle by contour lines on a separate map (Pl. V). Where data are wanting the probable course of these contours is indicated by interrupted lines.

In the area west of Kickapoo Creek and Illinois River, the old rock surface closely parallels that of the land to-day. In Limestone Township it reaches an elevation of 675 feet in secs. 5 and 6. From here it descends southward to an average height of 550 feet in the uplands of Hollis Township. The two Lamarsh creeks and Kickapoo Creek above Pottstown occupy valleys which were eroded before the deposition of the drift. Below Pottstown the last-named stream evidently has been lately crowded up on the east slope of the old upland to the west, and from Horseshoe Bottom to Bartonville it has cut a new and comparatively narrow valley on this slope.

Under Peoria, and also under the upland for a distance of 3 miles north from the city, and on the east side of the river north of Farm Creek, the rock surface has an average altitude of about 400 feet above sea level. This is 200 feet lower than the same surface in Limestone and Hollis townships. It rises, however, north from Pottstown, so as to bring the coal measures again into view in some of the creeks immediately north of the north boundary of the quadrangle. South from Farm Creek, on the east side of Illinois River, bedrock rises and reaches its highest altitude of 600 feet above the sea in sec. 7, Groveland Township. Under the upland to the south it gradually sinks to an average height, as far as known, of about 525 feet in the south part of Elm Grove Township. Two wells on the lowland south of Pekin reached altitudes of 430 and 420 feet above sea level without entering bedrock. In and near the present valley of the river the surface of bedrock is lower than in other localities, as shown by an altitude of 355 feet above sea level at the Colean factory well, 345 feet near Iowa Junction, and 340 feet in the Pekin water-works wells.

INTERPRETATION OF TOPOGRAPHIC CHANGES.

The deep drift north and east of Peoria consists of the moraine of the Wisconsin glacial epoch described later. The excavation of the valley of Illinois River in the indurated rocks between Peoria and Pekin was perhaps in the main accomplished during the glacial epoch.

It will be noticed that the old upland in Kickapoo, Limestone, and Hollis townships terminates abruptly opposite this trench between Bartonville and Mapleton, and that likewise the rocks on the east side of the river, which appear in the creeks between East Peoria and Hawley, present a sudden and abrupt slope facing westward. The bedrock on that side of the river is highest in the tract which lies opposite the highest bedrock on the west side of the river. In the belt of land which extends from East Peoria southeastward to about 2 miles north of Groveland there is a general declivity of the old land surface to the northeast, and this appears like a continuation of the old land slope under the drift west of Peoria and the country northward to Pottstown. The bedrock also slopes under the drift southward from Lick Creek, and from Groveland into Elm Grove Township. The general slopes of the old preglacial land surface suggests that the old upland in Limestone and Groveland townships was continuous in preglacial time, and upon it were developed drainage systems with a divide that extended in a northwest-southeast direction, crossing the present river valley about 2 miles south of Bartonville. Another hypothesis also may be tenable. If the Illinois River valley antedates the glacial epoch, its narrow course between Iowa Junction and Pekin may be due to the comparatively more resistant sandstone above coal bed No. 5, which prevented as rapid a recession of the bluffs on both sides of the valley as has taken place elsewhere.

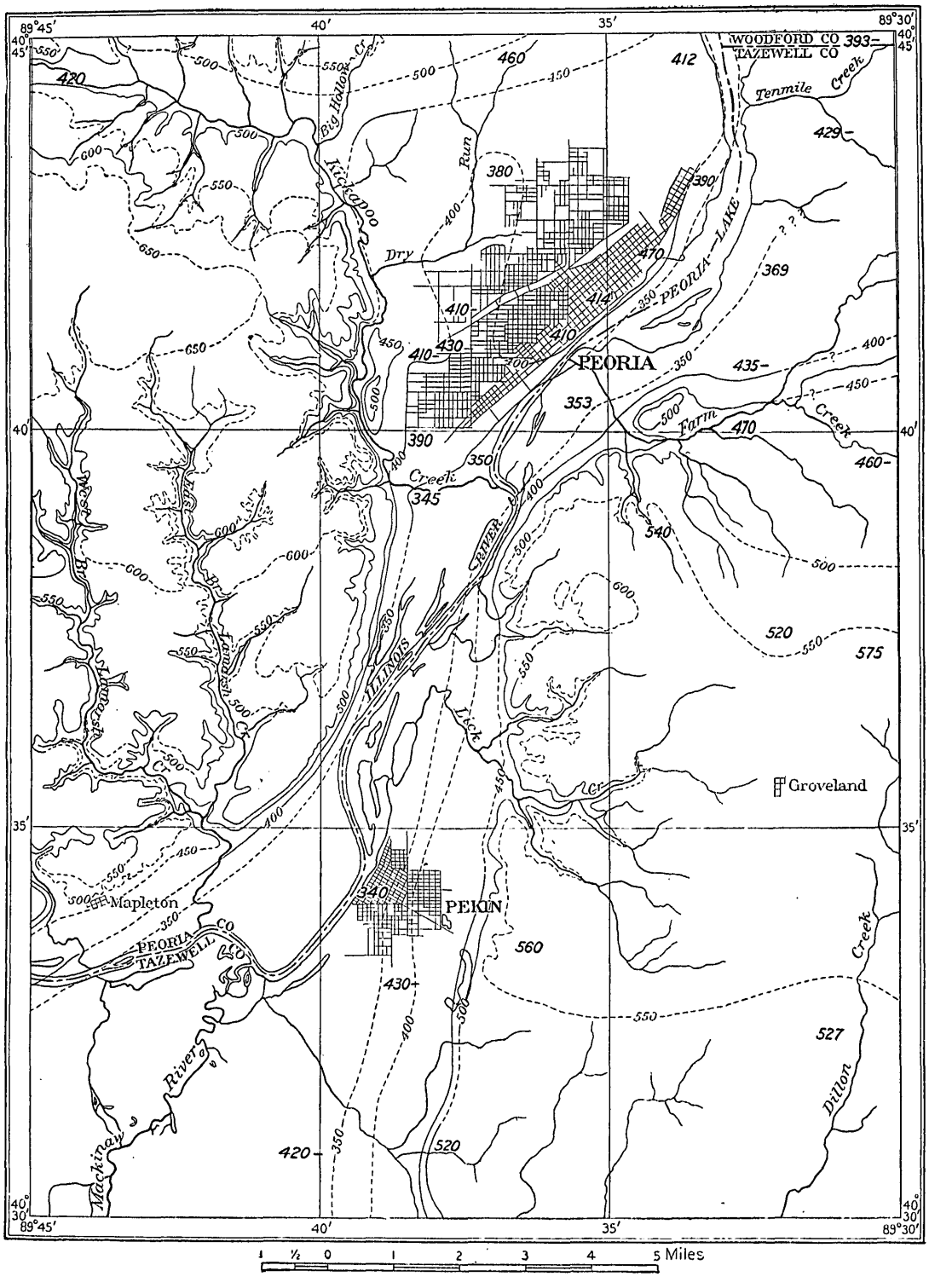
QUATERNARY PERIOD.

PLEISTOCENE DEPOSITS.

The Pleistocene deposits consist of remnants of a probable early drift of unknown age, Illinoian drift, Wisconsin drift, loess, and postglacial alluvium.

PROBABLE EARLY DRIFT.

In the bank of a small tributary joining East Branch of Lamarsh Creek from the west, in the NE. ¼ sec. 10, Hollis Township, dark bowlder clay was noted, which resembles in some respects an old till occurring under the Illinoian and the Kansan drift sheets in Iowa. This bowlder clay contains a smaller percentage of dolomitic limestone pebbles among the smaller sizes than is normally present



MAP OF PEORIA QUADRANGLE SHOWING THE APPROXIMATE ELEVATION, IN FEET, OF SURFACE OF BEDROCK.

Figures followed by a minus sign indicate that the ground has been penetrated to the elevation mentioned without encountering bedrock.

in the Illinoian drift, and it is associated with silt that commonly occurs in association with the older drift in Iowa. A similar drift was noted near the northeast corner of sec. 3 in the same township, in the bed of another tributary to the same creek. At this place it contains wood of a coniferous tree, and seems to overlie at one point a cemented sandy gravel containing much quartz, yellow chert, and some greenstone. A similar bed of gravel is known under an old till in Rock Island County. The till itself contains large pockets of yellow sand such as are common in the old tills west of the Mississippi. The till in these places is of uncertain age, but it differs considerably from the local Illinoian till in its general appearance and probably represents an earlier invasion of the ice.

ILLINOIAN DRIFT.

The till resulting from the Illinoian ice invasion was no doubt originally laid down over the entire area of this quadrangle. At present it is overlain in the eastern part of the area by drift of Wisconsin age where it has not been removed by interglacial erosion or worked into the later till. It is the principal till sheet, if not the only one, in the upland west of Kickapoo Creek and Illinois River and on a narrow strip of land back from the bluffs east of Illinois River from Wesley to the south border of the quadrangle. In the latter place it forms a belt of upland 1 to 2 miles wide, which has a considerably lower elevation than the upland farther east, covered by the Wisconsin drift. The average elevation of the Illinoian plain on this strip is about 620 feet above sea level. On the west upland the surface of the Illinoian till plain is more variable in its general elevation, averaging, as has been stated, about 610 feet above sea level in the southern part of Hollis Township, and 720 in the southwest corner of Kickapoo Township.

All of the Illinoian till plain is covered by loess, but it does not appear that this cover has modified the original surface of the plain to any great extent. The thickness of the Illinoian till is somewhat variable. In the highest upland in the northwest corner of Limestone Township, under the loess, it probably does not exceed 20 feet and in some exposures on the highest land south of Edwards it seems to be very thin. In the greater part of Limestone Township its average thickness is about 30 feet and in Hollis Township 40 feet. Its greatest thickness occurs in the vicinity of the lowlands. In places in the river bluffs north of Mapleton it measures 60 feet, and in the bluffs of East Branch of Lamarsh Creek, in secs. 3 and 10, Hollis Township, it measures nearly 80 feet. On the east side of the river the thickness of the Illinoian till where it forms the surface probably averages 40 feet for the entire tract.

In its physical characteristics the Illinoian till does not differ much from later bowlder clays. Where it has been subjected to weathering and leaching, it is yellow in color, and the deeper unweathered exposures are dark gray in different shades. Like other bowlder clays it has a matrix of fine clay in which there are fragments grading from fine sand to bowlders. The largest bowlder seen was 25 feet long and consists of limestone from local beds in the coal-bearing rocks. Generally the bowlders are scarce, but in places they occur in large numbers. A nest of bowlders was noted on Lick Creek, near the southeast corner of sec. 25, Pekin Township. At this place the limestone blocks lie in a belt which runs northeast and southwest across the creek, and they can be readily identified as belonging to the lower thick beds of the limestone exposed at the Lonsdale quarry. A nest of bowlders was also noted near the center of sec. 16, Hollis Township, another in the northwest quarter of the same section, and yet another on the west bluff of West Branch of Lamarsh Creek, near the center of sec. 10 of the same township. The bowlders of crystalline rock in this till are never large. In the country overlain by this till not more than half a dozen bowlders of crystalline rock measuring more than 4 feet in diameter were noted. Bowlders more than 3 feet in diameter consist for the most part of diabase and gabbro. In a count of a hundred bowlders measuring more than 2 feet in diameter, 38 consisted of diabase and gabbro, 27 of granite and gneiss, 15 of quartzite, 12 of limestone, 2 of dolomite, 2 of schist, and 3 of greenstone. In a similar count of bowlders measuring about 9 inches in diameter, 48 were of granite and gneiss, 16 of diabase and gabbro, 18 of quartzite, 7 of limestone, 2 of syenite, 2 of chert, and 1 of schist. Of the pebbles which measured about one-third of an inch in diameter, 36 per cent consisted of dolomite, 31 of limestone, 11 of chert, 5 of quartz, 4 of sandstone, 3 of shale, 3 of diabase, 2 of granite, 2 of greenstone, and 1 of clay ironstone. There are also a few fragments of coal in this till. In places it contains small beds of gravel poorly assorted. Such a deposit was noted in the north part of sec. 9, Hollis Township.

Gravel occurs under the Illinoian till in the upland along Farm Creek. This is associated with glacial silt and sand. In Glendale Hollow, about one-fourth of a mile west of the east line of sec. 3, Groveland Township, this water-bedded drift is 11 feet thick in the south bank of the creek. It consists in part of sand and silt, with bedding planes slanting as much as 30°, apparently due to the settling of the ice near where the gravel was deposited. The dip flattens out in less than 100 yards, and the direction of tilt is reversed. At this point the gravel is overlain by 25 feet of till, which evidently is continuous with another exposure where it is overlain by loess, that in

turn underlies the Wisconsin till. An extensive bed of gravel occupies apparently the same position in the drift complex on both sides of the Illinois River north and east of Peoria. In many places in the high bluffs north of the city it appears as gravel more or less consolidated by the infiltration of calcareous material, which in places is present in such quantity as to make some strata appear almost sufficiently firm for quarry rock. East of Peoria Lake this gravel extends for 2 miles along the road and gives rise to a number of springs from the base of the bluffs. An approximate classification of the bowlders measuring 3 inches in diameter in the gravel under this bluff shows that about 50 per cent consist of dolomitic limestone, 10 of calcareous limestone, 10 of granite, 10 of quartzite, 6 of greenstone, 4 of yellow chert, 3 of diabase, 3 of local sandstone and shale, 2 of quartz, 1 of gneiss, and 1 of a rock resembling the conglomerate of Port Huron.

Laminated silt and sand, which underlie the bowlder clay in the south bluff of Farm Creek below the mouth of Glendale Hollow, are probably also to be referred to the Illinoian. All of this drift was no doubt laid down in water coming from the Illinoian ice sheet, either directly in front of it or in channels under the ice. In either event it indicates a lowland where accumulations of unconsolidated materials remained almost undisturbed under an overriding sheet of ice.

INTERGLACIAL EPOCH.

The valleys in the area of the Illinoian till are more open than in the region of the later drift, and their ramifications have made farther inroads on the upland. This is especially apparent in the country southeast of Pekin and in Hollis Township, west of the river. This drift sheet has suffered superficial leaching and oxidation, and in few places contains any calcareous matter in its uppermost 3 or 4 feet. In some places there is a rusty ferruginous tinge near the surface of the till under the loess, as was noted in several exposures in the Lick Creek basin. In some of the ravines in the west part of sec. 32, Groveland Township, a reddish clay overlies the till. This is also leached. It is tough and contains a few pebbles, resembling in this respect the "gumbo" overlying older tills west of Mississippi River. All of these features are due to weathering, erosion, and superficial rearrangement of material, which occurred mostly before the advent of the Wisconsin ice sheet.

There is also in places a slight development of soil at this horizon, consisting of a dark and mucky base of the overlying loess. This is shown in some exposures near Farm Creek, where this drift underlies the Wisconsin till. In a cut recently made for the Peoria, Bloomington & Champaign trolley road the following section of the drift appears.

Section of drift on north side of Glendale Hollow near the east line of sec. 3, Groveland Township.

	Feet.
Bowlder clay (Wisconsin), calcareous to grass roots	8
Loess of rusty color and apparently slightly indurated, dark below, not effervescing with acid	12
Till, leached, giving no response to acid (Illinoian)	6
Till, calcareous, yellow above, blue below (Illinoian)	18
	44

In this section the lower part of the loess does not differ much from the upper, but about 150 yards to the east 9 feet of loess appears again under the till and here the lower 2 feet are dark from vegetation and humus.

The greater erosion which the Illinoian till has suffered, in comparison with the Wisconsin, the greater leaching of its upper surface, and the development of the ancient soil was effected during the time interval that elapsed from the disappearance of the Illinoian ice to the advent of the Wisconsin ice. This soil has been called the Sangamon soil by Frank Leverett, who first recognized its significance in the Pleistocene history of this State. It has a greater development in the Farm Creek valley just east of this quadrangle than in any place in this quadrangle.

WISCONSIN DRIFT.

The west limit of this drift in Peoria County coincides with the valley of Kickapoo Creek from its mouth up to Big Hollow north of Pottstown and from there northwest beyond the boundary of the quadrangle. In Tazewell County the limit of the same drift sheet is marked by a rise of the upland from 620 feet above the sea to 700 feet or more. This rise takes place in a belt from a half mile to a mile wide, which extends from Wesley south to a point about 2½ miles east of Hawley, presenting a gentle bend to the east. Leverett[1] has shown that this belt is the outer border of the terminal Shelbyville moraine, the earliest drift of Wisconsin age. He has traced the moraine southeast past Shelbyville and then east across the State into Indiana. In the Peoria quadrangle the morainic features of this belt of drift are somewhat subdued. Low knolls or undulations in the upland occur about the head gullies of Lick Creek and to the northwest. On the drainage divide near Groveland there are some small and shallow undrained depressions in the surface, generally less than an acre in extent. One of these was noted near the wagon road close to the west boundary of sec. 21, Elm Grove Township. A low but characteristic morainic ridge runs north-northeast to south-southwest through sec. 22 in the same township and continues into secs. 27 and 28. Near sec. 22 this ridge rises nearly 50 feet

[1] The Illinois glacial lobe: Mon. U. S. Geol. Survey, vol. 38.

above the general level of the land to the east and bowlders appear in places on its surface. A shallow well on the east slope entered gravel a few feet below the surface. A thin deposit of loess, which elsewhere covers the surface of the Wisconsin till, is absent on the crest of the ridge at this point.

A subdued morainic topography of this kind also characterizes the upland in the western part of Richwoods Township and in the adjoining part of Kickapoo Township, and this tract is likewise shown by Leverett to be a part of the Shelbyville moraine. Low swells occur in sec. 31, Richwoods Township, and were noted in an undrained shallow basin covering an area of several acres in the forks of Dry Run.

The highest land in the Peoria quadrangle lies east of the Shelbyville moraine. This is a small part of another morainic system traced by Leverett for nearly 300 miles through the northeast part of the State and called by him the Bloomington morainic system. Prospect Heights is situated on the crest of this moraine at an elevation of 780 feet above sea level. The land immediately to the southwest of this point has a rolling surface with unmistakable morainic topography, though the relief is comparatively gentle. The same is true of the upland in the north half of Fondulac Township on the east side of the river, where the general level is 50 or 60 feet below that of Prospect Heights.

The great bulk of the till in these morainic belts consists of bowlder clay, to all appearances like the typical bowlder clay of till plains. In view of the present lack of knowledge of the distinctive characteristics of the till of different stages of the glacial epoch, the author hesitates to assign depths to the different till sheets in this locality. The total depth of the drift explored in a well at the clubhouse near Prospect Heights is 268 feet. In a well at the old sugar factory half a mile to the southwest the drift is reported to be 300 feet deep. In the clubhouse well about 50 feet of sand lies below an apparently continuous mass of till. In the high bluff east of Grand View Park yellow sand appears between two till sheets at a height of about 50 feet above the river. It may be that the lower till in this exposure is the Illinoian, but at a point like this, where a great drainage valley left the ice sheet, it is evidently risky to correlate drifts by altitude or even by superposition. In such places there may have been irregular local movements and disturbances in the ice, giving rise to almost hopelessly involved entanglements in small local problems of correlation. The great features of the history of the drift, which have been outlined by Leverett, are based largely on physiographic distinctions, relative surface leaching, and interbedded soils, and these features are well established on a large scale. For example, there can be no doubt that Illinoian till underlies a large part of the margin

of the Wisconsin drift in this vicinity. This is evident from the exposures of interglacial deposits already described in Glendale Hollow and known at other places on Farm Creek, just beyond the limits of this quadrangle. But it seems probable that a more particular knowledge of the drift sheets may make it possible to recognize each by its composition wherever it may be seen. For this purpose extensive and minute examinations must be made of the erratics contained in each sheet in different regions.

With this as yet distant end in view, collections of erratics from exposures of undoubted Wisconsin till were made as opportunities offered in this survey. Lots of a hundred fragments of various uniform sizes were examined and percentages were obtained of the different kinds of recognizable rocks in each. The results are given in the following table, some of the percentages being averages of several lots taken in different localities:

Percentages of rocks present in various sizes of erratics in the Wisconsin drift near Peoria.

	Diameter of erratics in inches.				
	27	9	3	1	⅓
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
White quartz					2
Granite (including a few of gneiss)	25	27	15	5	5
Greenstone					1
Schist		1	3	1	
Syenite (?)	5				
Red granite porphyry	3	8			
Diabase and gabbro (mostly Keweenawan)	58	53	14	4	4
Quartzite	3	5	7	4	1
Dolomitic limestone	4	3	35	53	58
Chert			4	10	10
Limestone, calcareous, mostly from the Pennsylvanian	2	1	12	17	13
Shale			1	2	1
Sandstone, mostly from the Pennsylvanian		2	6	4	3
Clay ironstone from the Pennsylvanian			2		2

On comparing this table with the data given for the erratics of the Illinoian drift, it will be seen that granite, greenstone, quartzite, and calcareous limestone are more abundant in the Illinoian drift, whereas diabase, gabbro, and dolomitic limestone are decidedly more numerous in the Wisconsin drift. Another difference in the nature of these two drift sheets is the greater abundance in the later drift of bowlders 6 inches or more in diameter. It is not known if this difference is due to the morainic nature of the later drift in this locality, but this seems likely. Large bowlders are numerous. An interesting large erratic was noted in Glen Oak Park, where several blocks of the Niagara limestone, one of which measures 7 feet in diameter, lie on the crest of one of the upland spurs. Evidently these rocks were once a single block which was brought from one of the Niagara outcrops in Cook, Kankakee, or adjoining counties but which has broken into pieces under the action of the weather. All of them lie close together.

A bed of gravel which the author believes was deposited at the time the Wisconsin ice lay in this immediate vicinity, probably while it was disappearing, underlies most of the upland plain between Dry Run and Illinois River. Like the Wisconsin till it is overlain by several feet of yellow loess. South of the Pottstown road, near the southeast corner of sec. 6, Peoria Township, an outcrop shows that this gravel is interbedded with bowlder clay, or at any rate that it contains some layers which are more like bowlder clay than gravel. It is believed that such a stratum could not be formed in a stream except near the margin of the ice. The section referred to is as follows:

Section south of Pottstown road, near southeast corner of sec. 6, Peoria Township.

	Ft.	in.
Loess, yellow	6	
Gravel, in streaks		6
Bowlder clay, somewhat silty	8	
Gravel	12	
	26	6

On the strip of upland projecting westward from north of Horseshoe Bottom, a bed of sand occupies the same relative position. Gravel was noted at the point where Western Avenue comes up on the bluff in Peoria, and for half a mile west of this place it has been encountered in shallow excavations. A similar gravel is obtained in two pits in the bluffs south af East Peoria at about the same level, near each of the wagon roads which ascend the bluffs just south of the city. In a pit on the road east of Coal Creek this gravel contains a very irregularly developed layer of fine calcareous silt in the middle of a bank 20 feet high. Other exposures of gravel were seen on the bluffs of Farm Creek and Tenmile Creek. In each place the gravel is covered by loess of about the same thickness as that overlying the Wisconsin till, and it lies at elevations ranging from 580 to 620 feet above sea level. Leverett regards all of these gravel deposits as parts of a terrace, which he refers to the stage of the Bloomington moraine.[1] Along Kickapoo and Big Hollow creeks occur gravel, sand, and silt, which are evidently water-laid marginal deposits of Wisconsin age. In its first advance, represented by the Shelbyville moraine, the Wisconsin ice evidently crowded the drainage of Kickapoo Creek against the upland in Limestone Township and the southern part of Kickapoo Township, as already noted. This resulted in the deposition of some gravel on the west bluffs of Kickapoo Creek west of Horseshoe Bottom and near the Farmington road, a mile south of Pottstown. From this place north along Big Hollow Creek much gravel and sand is associated with the drift and is apparently an outwash from the Shelbyville moraine. This farthest westward extension of the Wis-

[1] Mon. U. S. Geol. Survey, vol. 38, pp. 270-280.

consin ice seems to have held back the water in the Kickapoo Valley, producing a temporary lake in which glacial silt and sand are deposited and on which, probably by the aid of ice blocks, a few bowlders were transported to the land on the south side of the flooded valley, where they now lie exposed on the surface. Deposits of silt occur at several points on both sides of this stream.

GLACIAL TERRACES.

In places remnants of two former flood plains border the present bottom lands of the streams. Both of these date from late stages of the Wisconsin ice invasion. The older terrace has an average elevation of 520 feet above sea level. Four tracts of this terrace occur in the valley of Illinois River in this quadrangle. A half section of land belonging to it projects into the northeast corner of the area along the bluffs north of Tenmile Creek. This is a part of a large tract reaching northward beyond the limit of the quadrangle. Another tract is the site of the main part of Peoria and forms a wedge-shaped flat on the west side of the river, reaching from Iowa Junction to the wagon bridge across the river north of Peoria Lake and covering about 5 square miles. The largest remnant extends as a triangular tract west of the upland in Tazewell County, from Grove to a point beyond the south boundary of the quadrangle, covering an area of about 14 square miles within the quadrangle. The fourth tract lies south of the bluffs below the junction of the two Lamarsh creeks and covers scarcely 160 acres of land.

The surface of this terrace shows considerable relief. Some of the relief is evidently the result of recent erosion, such as the valley of Lick Creek and apparently in part that of Lost Creek and the gullies of several small ravines in the outer margin of the terrace. Along the bluff in the western part of Peoria there is a channel 2½ miles long and about a third of a mile wide, the bottom of which is nearly 30 feet lower than the highest part of the terrace. This appears to be a nearly filled lagoon on the old flood plain. Meyers Lake, southeast of Pekin, and the valley of Lost Creek, farther south, may mark locations of similar lagoons. But most of the relief which characterizes the surface of this terrace east of the river must be attributed to other causes. A few of the ridges are evidently ancient sand dunes. North of Tenmile Creek this is clearly indicated, and also near South Park in Peoria. South of Pekin some hills are probably also dunes, such as the hills in the SW. ¼ sec. 2 and in secs. 16 and 17, Cincinnati Township. But it is believed by the writer that much of the relief of the terrace dates from its origin and is a direct result of the high gradient of the stream by which it was built.

The later Wisconsin terrace has an average elevation of 476 feet above sea level. It forms a narrow strip bordering the older terrace

and extends 2 miles northeast from Iowa Junction on the west side of the river. On the east side it borders the western margin of the older terrace with a strip half a mile wide from Pekin to the Mackinaw bottoms, and it appears again on the west side of this valley in the southwest corner of the quadrangle. Some hills which stud this terrace in sec. 23, Spring Lake Township, are apparently remnants of the older and higher flood plains.

The material in these terraces consists for the most part of sand and gravel. The higher terrace has in many places a capping of finer material, which here and there resembles loess. A well dug on the highest ground north of South Park in Peoria went through 10 feet of sandy soil and then 30 feet of gravel. In many places there is gravel in the upper part of this terrace. It consists largely of pebbles of dolomitic limestone with less than 30 per cent of calcareous limestone and less than 10 per cent of pebbles of crystalline rocks. Most of the large bowlders are composed of crystalline rocks.

In Adam Saal's gravel pit between Dead Lake and the river channel, a mile south of Pekin, a part of the skeleton of a mastodon or other proboscidean was found in an excavation 18 feet below the surface. There were two tusks, two teeth, a part of a jaw, a rib, and some other bones. The tusks are said to have been 6 feet long, 5 inches in diameter at the butt, intact to the point and bent outward, lying with their tips 4 feet apart. One of the teeth is reported to have weighed 18 and the other 8 pounds. The bones were in sand under the gravel in the north end of the pit. This gravel probably belongs to the latest Wisconsin terrace.

Along the two branches of the Lamarsh creeks in Hollis Township there are some silt terraces having about the same elevation as the older Wisconsin terrace in the river valley. The largest remnant of this silt deposit follows the west side of East Branch, south from the center of sec. 10. Near the south line of the section there is an exposure 20 feet high, which discloses some 16 feet of red and partly sandy silt, capped by loess. A mile and a half west of this place a creek from the north joining West Branch exposes the same silt resting on gravel. There it is also covered by loess. Some of the red silt seen along the Kickapoo above Pottstown, and particularly the terrace on the east side of this creek in sec. 36, Kickapoo Township, is probably to be correlated with the terraces on the Lamarsh creeks. All appear to have been made from the silt brought down by the streams along which they lie, at the time when the Illinois Valley was being filled with the material of the earlier Wisconsin terrace. What part of the silt along the Kickapoo belongs to this age and what part belongs to the age of the earlier outwash gravel from the Bloomington moraine the author is not prepared to say.

LOESS.

The loess is a dusty yellow material which covers all of the upland. Its upper part is dark from decayed vegetation, forming the upland soil. Directly under the soil the loess in many places is impregnated with ferruginous material, which gives it a reddish-brown color in various shades. In other places, especially where the ground has been poorly drained, the iron stain immediately under the black soil has been leached away and the deposit has an ashen-gray, almost white, appearance. The main deposit, as it appears in natural exposure, is commonly yellow. In wells it is generally yellow above and bluish gray below what appears to have been the old ground-water level. This varies considerably, so that the change may take place 5, 10, or 15 feet from the surface. The base of the loess is sometimes darkened by an ancient vegetation constituting an old soil. Pieces of decayed wood have been found at this horizon in some wells on the upland of the Illinoian drift, but the old soil is nowhere well developed in this quadrangle. The contact of the loess with the Illinoian till more commonly shows oxidation, and the base of the loess, as well as the upper surface of the till, have generally a ferruginous stain.

A characteristic feature of the loess is its uniform texture. It consists mostly of fine grains of quartz, more than 80 per cent of which measure one-sixteenth to one sixty-fourth of a millimeter in diameter, and coarser particles exceeding one-half a millimeter or finer particles less than two-thousandths of a millimeter are practically absent. In this area the loess is generally not calcareous, only a few places having been noted where it effervesces on the application of acid.

The thickness of the loess is fairly constant for each drift sheet on which it rests. On the upland of the Illinoian till it ranges from 20 to 30 feet and averages 24 feet. In places it is eroded, the thickness decreasing to where the deposit has been entirely removed. In two localities this older and thicker loess was seen to contain fossil land snails: Near the mine of the Champion Coal Co., in sec. 6, Elm Grove Township, and in the hills near a creek in the northwest corner of sec. 30, Elm Grove Township. In each of these places the loess is slightly calcareous.

The greater part of this heavy blanket of loess on the Illinoian till evidently must be older than the Wisconsin till, for it underlies this till in the basin of Farm Creek, as previously described. It is a suggestive fact that the buried loess is nowhere known to reach a thickness which, when added to the average depth of the loess on the Wisconsin till, would exceed the average depth of the deposit on the Illinoian till.

On the Wisconsin drift the loess averages 7 feet thick, but it varies considerably. At a point about a mile north of Prospect Heights, outside of the quadrangle, it has twice this depth, but on the crest of the morainic ridge in secs. 15, 23, and 28, it becomes thinner until it disappears and the bowlder clay enters the soil. The plane of contact between the loess and the Wisconsin till is generally sharply marked. In many places it exhibits abrupt changes in level of a few inches to as much as 2 feet, as if the loess were deposited on a rough hummocky surface, or as if there had been a modification of the plane of separation of the two formations due to unequal settling of small parts of the underlying bowlder clay. This suggests that the loess may in part have accumulated on the vanishing ice sheet or while the ground was still in a frozen condition, as on a tundra.

On the older Wisconsin terrace much of the surface is covered 3 or 4 feet deep by material which in every way resembles the loess, except that in places it contains a small percentage of fine sand. If the loess is a wind deposit, as many geologists now are inclined to believe, its lesser development on a terrace which is considerably younger than the Wisconsin till plain, where it measures 7 feet, might be explained as due to the shorter time during which the accumulation on the terrace has been going on. In the same way the much greater thickness of loess on the Illinoian till would find its explanation in the greater age of this drift sheet.

RECENT DEPOSITS.

ALLUVIUM.

Alluvial deposits of more recent age fill the present flood plain of Illinois River to considerable depths. The Illinois Hospital for Incurable Insane several years ago made some 60 prospect holes for water on the river bottom in the southern part of Peoria Township, southeast of the Acme Harvester Works. The deepest of these holes are said to have been about 80 feet below the surface and several reached a depth of 60 feet below low water. No good water sand was found, and most of the material is described as "slushy clay." At Woolner's distillery about one-third mile south of the northeast corner of sec. 19, Peoria Township, a well went through 40 feet of "slushy sand." This indicates that the valley in which the present flood plain has been deposited was excavated to a considerable depth in the filling of the glacial terraces. Snail and other shells were found in the alluvium in the Colean factory well.

Tenmile Creek and Farm Creek both have a gradient of about 23 feet per mile and are making active inroads on the upland of the Bloomington till. The silt and sand which they carry is copious, and has resulted in the building of alluvial fans which are encroaching on

the river bottoms and have pushed the channel over against the west side of the alluvial plain opposite their mouths. Farm Creek seems to have been the more active. In both places the alluvium from these creeks seems to have been sufficient to dam the channel, so that the water is held back in lakelike expansions above each of the fans. The expansion between the two fans is known as Lake Peoria. The low gradient and slow current of the river combine to make this damming possible.

RECORDS OF WELLS IN THE DRIFT.

For ready reference in studying the local character of drifts likely to be encountered in wells in the different parts of the quadrangle, a descriptive list is given below of such wells and other explorations as have not been previously introduced.

CINCINNATI TOWNSHIP.

1. On the Cumming farm, in sec. 11, a well has been dug 100 feet deep in sand and gravel. Elevation about 535 feet above sea level. On the Cumming farm, near the southwest corner of sec. 21, there is a well 90 feet deep in sand and gravel. Elevation about 540 feet above sea level.

2. On the M. Hatch farm, in sec. 14, a well is 70 feet deep, all in sand. The water tastes oily. Elevation 515 feet above sea level.

ELM GROVE TOWNSHIP.

3. On the highest uplands in this township C. W. Hicks reports a well 230 feet through drift, reaching a depth of some 480 feet above sea level.

4. At a point about 4 miles east of Pekin, near the Cleveland, Cincinnati, Chicago & St. Louis Railway, the drift is reported to be 100 feet deep. Elevation of the land is from 620 to 650 feet above the sea level.

SPRING BAY TOWNSHIP (WOODFORD COUNTY).

5. At a farmhouse just north of the north boundary of the quadrangle, and three-fourths of a mile west of its northeast corner, in Woodford County, wells have been dug 100 feet deep, all in sand.

FONDULAC TOWNSHIP.

6. On the alluvial slope under the bluff in the northwest corner of sec. 12 a well 56 feet deep passed through alluvial clay into quicksand, which continued to the bottom.

7. On the highest ground on the Dan R. Sheen farm, in sec. 34, C. W. Hicks reports a well 235 feet deep, all in drift. Elevation about 660 feet above sea level.

8. On the creek bottom in secs. 24, 25, and 35, wells go down 40 feet through drift. Elevation is from 510 to 550 feet above sea level.

9. At the foot of the bluffs on Farm Creek, in the Mowberry farm, in sec. 36, a well dug by C. W. Hicks went down 80 feet through bowlder clay and sand. Elevation about 540 feet above sea level.

10. In sec. 13, on the Amos Roth farm, a well has been sunk more than 200 feet through drift, on land having an elevation of 740 feet above sea level.

11. In the northwest corner of sec. 14, at the residence of Mr. O'Brian, a well stopped in gravel at 235 feet below the surface. Elevation 745 feet above sea level.

12. A well located about 3½ miles south of Farmdale, near Joseph Mozeman's place, entered bedrock at 165 feet below the surface. Elevation about 720 feet.

KICKAPOO TOWNSHIP.

13. On the highest land, about 1 mile north-northeast of Pottstown, a well 230 feet deep is reported by C. W. Hicks as going through clay (loess?), 12 feet; dirty silty clay of various colors, 120 feet; gravel, 30 feet. The bottom was in "soapstone." Elevation of curb of well, 665 feet above sea level.

LIMESTONE TOWNSHIP.

14. Near the southeast corner of sec. 6 a well 40 feet deep went through 16 feet of loess, the middle part grayish-white and the lower 4 feet containing old twigs. Below this is 25 feet of bowlder clay. Water was obtained from sandstone in the bottom.

15. On the Poor Farm at Maxwell a well was bored to a depth of more than 200 feet. Henry Newsam, of Peoria, reports that no coal was found in this boring.

16. About one-third mile west of the northwest corner of sec. 13, Mr. Baer has a well some 150 feet deep. Its upper 25 feet is through bowlder clay, and below this there is sand and gravel to the bottom of the well. Elevation about 590 feet above sea level.

17. Section of a well on the upland near the south line of sec. 22: Loess, 15 feet; "brown ground," 15 feet; blue clay with bowlders, 6 feet; quicksand, 8 feet. In the upper part of the quicksand was mucky material with fragments of "leaves and trees."

PEKIN TOWNSHIP.

18. The deepest well at the city waterworks in Pekin goes down 128 feet through sand, silt, and gravel. Elevation of the curb, 470 feet above sea level.

PEORIA TOWNSHIP AND CITY.

19. At the Peoria Steam Marble Works, on Adams Street, 30 feet of gravel and sand rest on the bedrock. Elevation of surface, about 485 feet above sea level.

20. J. Hagerman has a well at the foot of the bluff, on the road between secs. 7 and 18, 110 feet deep in sand and gravel. Elevation about 510 feet above sea level.

21. Near the crossing of Mullman and Bush streets, at Burr's residence, a well encountered shale at a depth of 90 feet. Elevation of ground about 505 feet above sea level.

22. On the upland in sec. 7 a well dug by Mr. Heneberry passed through yellow clay 10 feet; hardpan with bowlders, 40 feet; shale, 8 feet; sandstone, 25 feet; then sand and quicksand down to 180 feet. Elevation about 600 feet above sea level.

23. A well on the upland adjoining the cemetery east of Horseshoe Bottom went through yellow clay loess, 10 feet; bowlder clay, 40 feet; shale, 8 feet; sandstone, 25 feet; quicksand down to 180 feet below the surface. Elevation of curb, about 600 feet above sea level.

24. Near the corner of Chestnut and Adams streets shale lies 70 feet below the surface. Elevation about 490 feet above sea level.

25. At the Woolner Building, near the crossing of Adams and Fulton streets, 72 feet of sand and gravel rest on "hardpan" (bedrock). Elevation about 500 feet above sea level.

26. At the crossing of Knoxville Street and Hamilton Avenue a well was made for the Central Railway Co. 120 feet deep. The upper 40 feet are silt, the rest is sand and gravel. Elevation about 500 feet above sea level.

27. At the building of the Young Men's Christian Association a well 84 feet deep encountered shale at the bottom, under gravel and sand. Elevation about 510 feet above sea level.

28. At the Woolner distillery, about one-third mile south of the northeast corner of sec. 19, a well 105 feet passed through slushy dark sand, 40 feet; black clay with

bowlders and rotten wood, 30 feet; sand and gravel, 25 feet; "hardpan" (bedrock?), 10 feet. Elevation about 450 feet above sea level.

29. On the property of Chr. Wiegman, near the crossing of South Park Avenue and Idaho Street, a well passed through 90 feet of sand and under this 40 feet of gravel. Elevation 520 feet above sea level.

30. About 100 feet south of Kickapoo Creek and 100 feet east of the Toledo, Peoria & Western Railway a prospect boring made for the Illinois Hospital for Incurable Insane passed through 100 feet of sand and gravel before encountering bedrock at the bottom. Some 500 feet south of this another well found bedrock 60 feet below the surface. Another well 400 feet farther south found the rock 40 feet from the surface. Elevation of land is near 450 feet.

31. On the bottoms of secs. 29, 30, and 31, southeast of Bartonville, 60 prospect borings for water for the Illinois Hospital for Incurable Insane were made to an average depth of 50 feet. The deepest holes were about 80 feet. Some extended to 65 feet below low water in the river. No rock was noted in any of these borings, and no good water was found. Most of the material noted was "slushy clay."

RICHWOODS TOWNSHIP.

32. At the Giles old brickyard, in sec. 20, a well went through 130 feet of blue clay, under which there were 100 feet of dry sand and then shale. The elevation of the curb of this well is estimated to be about 670 feet above sea level.

33. At the old sugar factory near the Rock Island-Peoria line of the Chicago, Rock Island & Pacific Railway, south of Prospect Heights, a well has been sunk through 300 feet of drift, below which there is shale. The elevation of the curb of this well is about 730 feet above sea level.

34. J. D. Mounds, who bored a well at the clubhouse east of Prospect Heights in the summer of 1907, furnished the following notes on the strata penetrated: Yellow clay (bowlder clay), 24 feet; blue clay, 184 feet; yellow sandstone, 9 feet; dry sand, 49 feet; blue sandstone, 2 feet; soapstone, 65 feet. Elevation about 710 feet above sea level.

35. The Aeriton stock farm, located one-eighth mile southwest of the center of the north line of sec. 31, has a well 250 feet deep. It does not enter bedrock. The water is drawn from a sand about 50 feet thick. Elevation about 620 feet above sea level.

STRUCTURE.

GENERAL DIP OF THE ROCKS.

Owing to the thick cover of drift in the southern and eastern parts of the quadrangle knowledge of the geologic structure of these areas is imperfect. In a well dug some years ago in Tremont an 18-inch bed of coal was found 20 feet below the surface. This is no doubt coal bed No. 7. As the elevation of the land in Tremont is about 630 feet and the distance from coal bed No. 5 to coal bed No. 7 is about 110 feet, coal bed No. 5 should be about 400 feet above sea level. Near Edwards, in the extreme northwest corner of the quadrangle, the same coal bed has an elevation of about 512 feet above sea level. The distance between these places is about 21 miles and hence these measurements show a dip of 5.3 feet to the mile in the direction from Edwards to Tremont.

In the west part of Kickapoo and the northwest part of Limestone townships the same coal bed has a general elevation of 500 feet above

the sea. In the country southeast of Pekin it has a general elevation of 430 feet. The distance between these two areas may be taken as 14 miles, and the dip along a line running from north-northwest to south-southeast, through Pekin, is thus about 5 feet per mile.

In order to determine the geologic structure in greater detail, the elevation of coal bed No. 5 has been ascertained in 98 localities. These have been averaged for each quarter township, and the results are given in the following table:

Average elevations above sea level of coal bed No. 5.

Tracts averaged.	Number of observations.	Extreme difference of elevations.	Average elevation in feet above sea level.
		Feet.	*Feet.*
Kickapoo, west end	6	3	497
Kickapoo, east end	6	15	480
Limestone, northeast quarter	15	65	480
Limestone, northwest quarter	7	35	500
Limestone, southeast quarter	12	32	455
Limestone, southwest quarter	8	30	478
Hollis, northeast quarter	6	52	464
Hollis, northwest quarter	8	30	476
Hollis, southwest quarter	3	30	453
Richwoods	1	.....	470
Fondulac	3	5	461
Groveland, northwest quarter	8	80	457
Groveland, southwest quarter	7	45	434
Elm Grove, northwest quarter	2	10	415
Elm Grove, southeast quarter	.....	.....	.....
Outside quadrangle, near Tremont	1	.....	400
Pekin	3	33	431
Cincinnati	2	5	443
	98	112	459

If the averages for each quarter township in belts running north and south be averaged the results are as follows, beginning on the west side of the quadrangle: 481, 470, 437, 474, and 400 feet. Similar averages for east-west belts about 3 miles wide, beginning on the north side of the quadrangle, give 482, 480, 463, 439, 435, 420 feet. For seven belts running from northeast to southwest the averages are, beginning at the northwest: 497, 490, 479, 467, 458, 432, 427, 400 feet. For belts extending from northwest to southeast the averages vary by only 28 feet, showing that the northeast-southwest direction is nearly parallel to the general strike of the formations.

Again, if the elevations be averaged in each quarter township for one common geographic center west of the river, and for another geographic center east of the river, the most generalized comparison is obtained that can be made for the entire quadrangle. The average elevation of all observations on the west side of the river is 475 feet above sea level, and the common geographic center of these localities lies north of sec. 22, Limestone Township. The average elevation similarly obtained on the east side of the river is 434 feet above the level of the sea, and the common geographic center of these localities

is near the southeast corner of sec. 30, Groveland Township. The distance between these two centers is a trifle more than 7 miles, and as the difference of the general average elevation is 41 feet the dip along the line joining the two points is 5.5 feet per mile. The course of this line is northwest-southeast, and it approximately represents the direction of the general dip of the rocks in the quadrangle. The result of both methods of calculation is the same.

An inspection of the elevations shows several localities where local dips are much greater than the dips indicated in these averages Thus, in sec. 5, Groveland Township, the strata lie 80 feet higher in the southwest part of the section than in the northeast. On Lick Creek in Groveland Township there are differences in elevation of 45 feet, between places less than 2 miles apart; and at a point about 2 miles west of Mapleton there is a difference of 40 feet in less than half a mile. Southwest of Pottstown there are local dips of 60 feet to the mile. Some of these abrupt changes in elevation seemingly are due to structures which do not affect the whole of the bedrock, but which have been induced by superficial dislocations, due probably; to glaciation.

LOCAL FRACTURES IN COAL BED NO. 5.

GENERAL STATEMENT.

There are some peculiar fractures [1] in coal bed No. 5 in the vicinity of Peoria which have occasioned a large amount of unprofitable work in coal mining. These fractures have been encountered in several mines that are no longer in operation. A list of locations of some of these fractures is given below, based on information furnished by Isaac Wantling, Richard Newsam,[2] and some other operators of long experience.

List of localities in Peoria quadrangle where fractures have been encountered, affecting coal bed No. 5.

1. In Shoal's old mine in sec. 1, T. 7 N., R. 7 E., about 1,500 feet west of the river bluff.
2. In the SE. ¼ sec. 2, T. 7 N., R. 7 E.
3. In the E. ½ SW. ¼ sec. 11, T. 7 N., R. 7 E.
4. In the W. ½ NW. ¼ sec. 14, T. 7 N., R. 7 E.
5. In the W. ½ NW. ¼ sec. 19, T. 7 N., R. 7 E.
6. In the E. ½ NW. ¼ sec. 19, T. 7 N., R. 7 E., about 600 feet north of the tracks of the Toledo, Peoria & Western Railway.

[1] The author adopts the new term "fractures" for the dislocations here described, as these are believed to be the result of physical processes altogether different from those causing faults, and it is therefore desirable to use a different term for them. In many places they have a close resemblance to true faults, but the direction of the dislocation is normally horizontal instead of normally vertical. Among the miners in the Peoria region the term "fault" has been applied to these structures, but in a sense wholly different from the usual one, it having been used to designate any part of the ground where the coal is absent or where it is out of its proper place.

[2] Newsam, Richard, A fault in Peoria County: Jour. Illinois Min. Inst., vol. 1, No. 8, pp. 271-273.

7. In the NE. ¼ sec. 21, T. 7 N., R. 7 E., about 600 feet north of the face of the river bluff.
8. In the NE. ¼ sec. 2, T. 8 N., R. 7 E.
9. Near the north line of sec. 12, T. 8 N., R. 7 E., about 400 feet west from the west bluff of Kickapoo Creek.
10. In the SW. ¼ sec. 6, T. 25 N., R. 4 W. (Tazewell County).
11. About one-sixth mile west of the center of sec. 19, T. 25 N., R. 4 W. (Tazewell County).

In exploratory borings which have been made by churn drills the absence of the coal at its usual level has been noted at a few places, and it is believed that similar irregularities in the structure of the coal-bearing rocks is indicated in some of these places. No coal was encountered in a boring in the W. ½ SW. ¼ sec. 10, T. 7 N., R. 7 E. The same was the case in two holes bored in the east half of the same quarter of the same section, and in two holes in the NE. ¼ sec. 15 in the same township and range.

EXPOSURES IN MINES.

GERMAN COAL CO.'S MINE.

The only place where these disturbances have been explored recently in mining operations is in the workings of the German Coal Co. The main entry of this mine is in the base of the bluff near the southeast corner of sec. 2, Hollis Township. It bears at first about 23° west of north, but farther in it turns more to the northwest. About 200 yards from the gate in the main entry of the mine the country rock dips 15° to the northwest in the walls of the entry. About 30 yards farther in, a fault-like fracture, bearing north and south, brings the coal up to the full height of the entry (fig. 3, *a*). The coal lies at this level for about 60 yards and then dips to the north again below the main entry (fig. 3, *b*), which for the next 60 yards is cut through sandstone. Then the coal is brought up by a fracture slanting 24° to the southeast (fig. 3, *c*). This block of the coal bed is 10 feet thick. In less than 8 yards the coal and the strata in which it lies are cut by another fracture having the same trend, but slanting to the northwest (fig. 3, *d*, and Pl. VI, *A*). The coal here abuts against a wall of shaly sandstone and a partly crushed flange of the upper part of the bed has been pushed in above the shale, disappearing above the roof. This shaly sandstone first lies in a nearly horizontal position, forming both walls of the entry, but some 60 yards farther in it is affected by a flexure which has broken in the manner of a thrust fault (fig. 3, *e*). This dips with a low angle to the northwest. About 8 yards beyond this another fracture, also clearly a thrust fracture, brings the coal to the full height of the entry (fig. 3, *f*). This fracture trends about 15° east of north and dips with a high angle to the east (Pl. VI, *B*). The coal bed at this point is double and has been crumpled in a small sharp fold against the fracture. One bed lies above

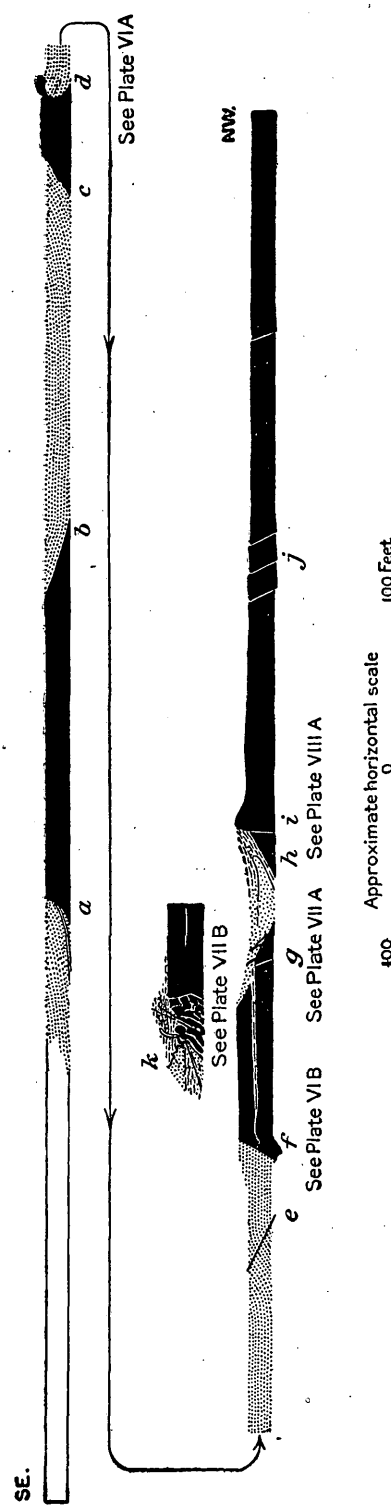


FIGURE 3.—Sections of main entry of the German Coal Co. mine in SE. ¼ sec. 2, T. 7 N., R. 7 E. See text for explanation.

the other, and the two are separated by clay ranging in thickness from a few inches to 2 feet. Most of the coal taken out was so brecciated and broken that it was readily worked with pick and shovel. The miners speak of it as "soft coal." Both beds otherwise resemble the main coal (No. 5) in this region, and one is forced to the conclusion that the upper bed is the same as the lower and that one part of this coal bed has been pushed over another part. The overthrust extends about 30 yards along the entry. The west side of the double bed terminates abruptly with a nearly vertical fracture that is followed by a fissured and brecciated zone (fig. 3, *g*). In the southwest wall of the entry the principal plane of motion follows a sigmoid course in the vertical plane, secondary fissures joining it near its sinuosities at various angles (Pl. VII, *A*, *a*, *b*, *c*). The northeast face shows several nearly parallel and flexuous fissures associated with the main fracture plane, which terminates the coal. This fracture plane exhibits indistinct scorings and gougings which run horizontally in both walls (Pl. VII, *A*, *a*, and *B*, *b*). In fact, the flexuosities of nearly all of the fissures in the vertical plane represent horizontal flutings on the blocks separated by these fissures (Pl. VII, *A*, *b*). It is clear that no vertical movement could have produced such fluting, but that the movement producing the dislocation must have been prin-

A. ROOF AND SOUTHWEST WALL OF MAIN ENTRY OF THE GERMAN COAL CO.'S MINE IN SE. ¼ SEC. 2, T. 7. N., R. 7 E.

Looking southeast. (See fig. 3, *d*.) A projecting flange of the coal is seen in the center rising in the roof over the timbers. Several of the shearing joints show indistinct horizontal striæ or flutings.

B. LEFT (SOUTHWEST) WALL OF THE MINE ENTRY SHOWN IN *A*.

Looking southwest. (See fig. 3, *f*.) A fracture runs diagonally across the center of the field, separating the sandstone on the left from the coal on the right. Near the sandstone the coal is shattered and mixed with fragments of shale and sandstone.

A. ANOTHER VIEW OF MINE WALL SHOWN IN PLATE VI, *B*.

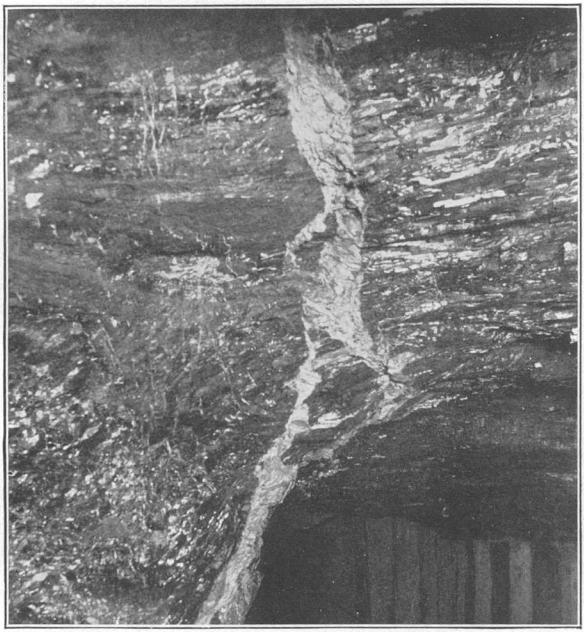
(See fig. 3, *g*.) An S-shaped sheared fracture is indicated by the letters *a*, *b*, *c*. Somewhat irregular indistinct horizontal flutings appear to the right of a line joining *a* and *b*.

B. RIGHT (NORTHEAST) WALL OF SAME MINE ENTRY.

Looking northeast. (See fig. 3, *k*, opposite *g*.) The fractured face of the coal appears above and to the left of the receding entry in the lower right-hand corner of the view. Horizontal flutings appear on the face of the coal at *a*. An S-shaped belt of fissured coal and shale separates the coal from the sandstone on the left, and other fissures, roughly parallel to this belt, appear indistinctly at *b*.

A. ANOTHER VIEW OF MINE WALL SHOWN IN PLATE VI, *B*.

(See fig. 3, opposite *h*.) Bed *a* is dark shale with some streaks of coal, somewhat shattered, possibly the same as *b*; *b* is the roof shale of coal bed No. 5; *c* is coal bed No. 5; *d* is sandstone.



B. ANOTHER VIEW OF THE MINE ENTRY SHOWN IN PLATE VI, *A*.

Showing clay vein in the coal roof.

cipally in a horizontal direction. The accompanying brecciation is clearly a result of these movements.

The block on the west side of this plane of displacement consists of strata that overlie the coal in the undisturbed section. The block continues about 30 feet along the entry, its bottom first dipping and then rising, troughlike. The lower part is a strong sandstone which terminates on the west in a rounded edge. The lower side of this sandstone appears to have been ground away so as to thin out in both directions (fig. 3, *h*, and Pl. VIII, *A*). Such wear could have resulted only from movement in a horizontal direction. From under this wedge of sandstone the coal again rises. The edge of the wedge has divided the roof shale, part of which continues under the sandstone and part above (Pl. VIII, *A*, *a*, *b*). Or it may be that the shale is repeated and that there is a nearly horizontal thrust fissure following the upper surface of the sandstone. The evidence is not quite clear.

A few feet beyond this point the coal for a short distance measures 12 feet thick, and it shows vertical flexous fissures which trend in a general north-south direction (fig. 3, *i*). All this coal appears to belong to one bed which has been thickened by lateral pressure. In a short distance the bed thins out to the usual dimensions of 4 feet 6 inches to 5 feet. As far as explored in this direction it has been found to be undisturbed, barring some small faults or "slips," involving displacements of 1 to 3 feet (fig. 3, *j*). Two other displacements of considerable magnitude have also been encountered recently, but exploration stopped short of exposing them sufficiently for accurate description.

The general observation is pertinent that the trend of the fractures, as here exposed, varies from north-south to N. 15° E.

POTTSTOWN MINE.

The most extensive underground explorations of these fractures were made in the old Pottstown mine in the NE. ¼ sec. 2, Limestone Township. This mine has been abandoned for some time and is now filled with water.

From the descriptions given by the operators it is evident that the disturbances are genetically related to those seen in the German Coal Co.'s workings. A memory sketch of the entries and the "faults," which was furnished by one of the miners (fig. 4), indicates that a straight and narrow strip of sandstone lay between the edges of two blocks containing the coal (fig. 4, *a*). The trend of this "fault" is northwest-southeast. Another straight fracture trending in the same direction cut out the coal on the southwest (fig. 4, *b*). Other fractures with more or less vertical displacement run transversely to these. In the sketch some of these show gentle curves near their intersections with other fractures, but are otherwise represented by

straight lines (fig. 4, *c*, *d*, *e*, *f*). Nearly every one was located in several successive entries, and there is no reason to doubt that they are essentially as represented in the sketch.

In at least one place, in the vicinity of one of these fractures, the coal in this mine has a greater thickness than the normal (fig. 4, *e*), as if the bed had thickened by yielding to lateral pressure. In places the coal was crushed and brecciated. In a part of the mine there

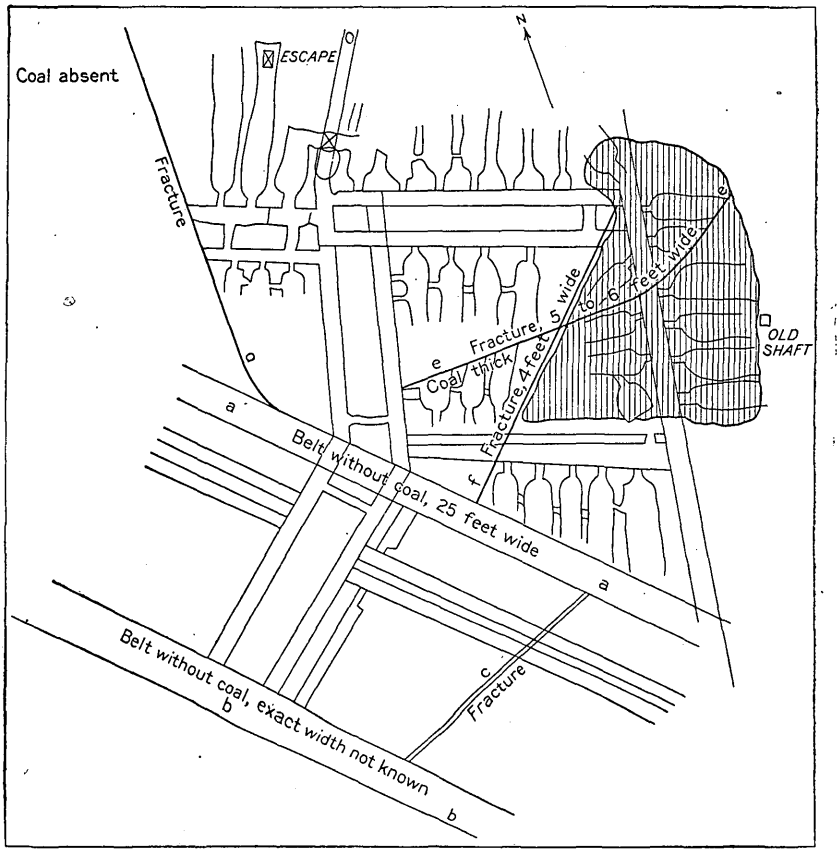


FIGURE 4.—Plan of Pottstown mine, showing irregularities and fractures in the coal bed. This drawing is reproduced exactly as furnished. Several slight imperfections will be noted in the details, but these will be readily recognized and it is believed that the reader will have no difficulty in making out the essential points presented in the sketch—the courses of the glacial fractures.

were two coal beds, both of which were mined. They were separated by shale and sandstone having a thickness of 1 to 15 feet. The west limit of the upper bed agrees with one of the lines of fracture (fig. 4, *b*). This upper bed was known to the miners as the "top coal." It lacked the middle clay seam, which everywhere characterizes the overlying coal bed, No. 6, in this region. In one place near a principal fracture the coal is reported to have been repeated twice, so that

there were three beds separated by several feet of fissured and brecciated material. The middle bed was tilted at a high angle and soon ran out.

VICKERY MINE.

In the Vickery mine, in the SW. ¼ sec. 1, T. 8 N., R. 7 E., southeast of the old Pottstown mine, a fractured belt about 300 feet wide has been encountered. The coal terminates more or less abruptly on the sides of this belt, and the opinion of the miners, who believe that this is a continuation of one of the dislocations in the Pottstown mine, is no doubt correct. The fractures trend northwest to southeast, diagonally across the quarter section.

SURFACE EXPOSURES.

MINOR DISTURBANCES.

Some disturbances showing at the surface were no doubt produced by the same cause as the fractures just described. The most com-

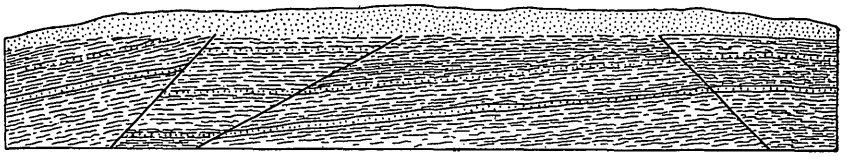


FIGURE 5.—Thrust fractures in Pennsylvanian shales in bank of creek in NE. ¼ sec. 2, T. 8 N., R. 7 E., near fractured tracts in Pottstown mine.

mon of these consist in a crushed or slightly crumpled appearance of the shale and sandstone which overlie the coal. The stratification of the rocks is shattered, so that it is difficult or impossible to follow any particular parting or seam on the surface of the exposure. This condition is commonly associated with faults, involving dislocations of small extent, from a fraction of an inch to a foot or two (fig. 5). Perhaps as many of these faults are reversed as are normal, and they

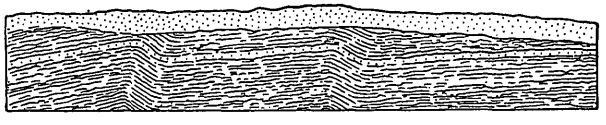


FIGURE 6.—Folds in shale in west bank of creek in E. ½ SE. ¼ sec. 2, T. 7 N., R. 7 E.

hade at angles varying from 90° to vertical. In many places they have opened slightly and are filled with concretionary calcareous material. They may divide and branch in various directions. Generally some flexing of the beds is apparent in such places. This may be gentle and run on for 100 or 200 feet, or it may present small and abrupt folds, only a foot or two in horizontal extent (fig. 6). In

sandstone there may be a coarse brecciation, where blocks 5 to 50 feet in diameter have been turned and tilted in irregular fashion (fig. 7).

PLICATIONS.

At four points severe crumples and faults were observed, clearly due to lateral pressure. Two of these occur in the banks of a creek

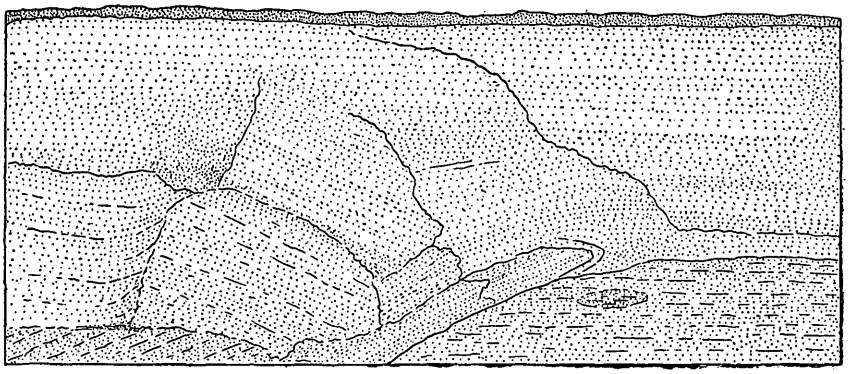


FIGURE 7.—Fractured sandstone in left bank of creek about one-third mile south of center of north line of sec. 4, T. 25 N., R. 4 W.

which runs from northeast to southwest through sec. 27, Limestone Township. Near the mouth of a tributary coming from the south plications appear in dark shale in the left bank (fig. 8). The trend of the folds is north-northwest to south-southeast. The largest

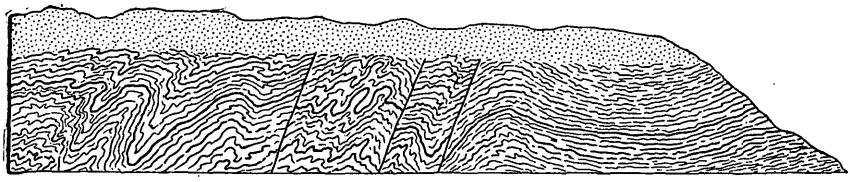


FIGURE 8.—Plications in Pennsylvanian shales in left bank and near mouth of a southern tributary to main creek in center of sec. 27, T. 8 N., R. 7 E.

fold measures 2 feet vertically and the clear exposure extends only about 15 feet in the bank. Three faulted fissures also cut the folded shale, paralleling the axes of the folds. About 300 yards farther up in the main creek more folds and faulted fissures were noted in the

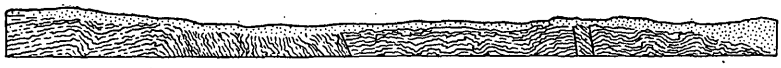


FIGURE 9.—Plications and fractures in Pennsylvanian shales in right bank of main creek about 300 yards northeast of plications shown in figure 7.

low right bank of the stream, extending at least 30 feet (fig. 9). The shale involved probably lies above coal bed No. 6 in the general section of the region, and the limestone over this coal bed appears to the west of the lowermost exposure, apparently undisturbed.

Folds also show in the banks of the creek coming into Little Lamarsh Creek from the northeast at Reed City in the N. ½ sec. 19, Hollis Township. The exposures cover only a few square yards, and no details could be made out. The disturbances affect the shale capping coal bed No. 5.

A plain fold was noted in the south bank of Lick Creek near the center of the NE. ¼ sec. 29, Groveland Township, Tazewell County (fig. 10). This affects coal bed No. 7 and the beds which

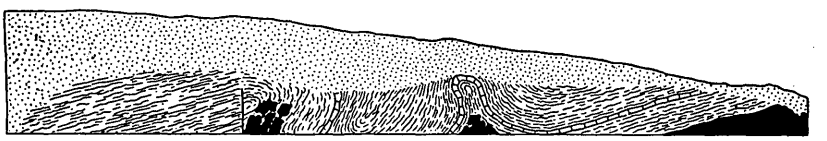


FIGURE 10.—Crumpling of bedrock affecting coal bed No. 7 in left bank of north fork of creek near center of NE. ¼ sec. 29, T. 25 N., R. 4 W.

occur above this coal, including a thin seam of dark, impure limestone. The coal and limestone are broken in places, but the shale is crumpled into smooth folds which trend in a north-south direction.

A ROTATED BLOCK.

Near the Pottstown mine an exposure shows a block of the Pennsylvanian rocks, which now lies in an inverted position. The base of coal bed No. 5 and the underlying fire clay and shale are exposed in the left bank of Kickapoo Creek about one-fourth of a mile north of the town. The usual succession of beds appears undisturbed in the

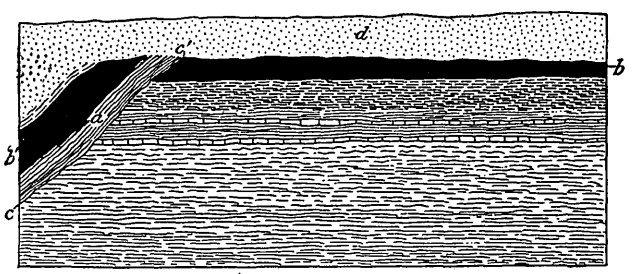


FIGURE 11.—An inverted block of coal measures strata seen in left bank of Kickapoo Creek a short distance north of Pottstown. *a*, Roof shale and slate of coal No. 5; *b*, coal No. 5 undisturbed; *b'*, coal No. 5 in the inverted block; *c–c'*, shearing plane; *d*, drift.

bank below the coal for 14 or 15 feet, but the north end of this bank is beveled off and covered by some strata that dip at a high angle (fig. 11). On close examination it appears that the beveling is slightly concave and that the overlying stratum consists of coal bed No. 5, inverted and resting on its capping black laminated shale. This block is too large and soft to have been placed in its present position by water or by the ice of the stream. It was closely pressed

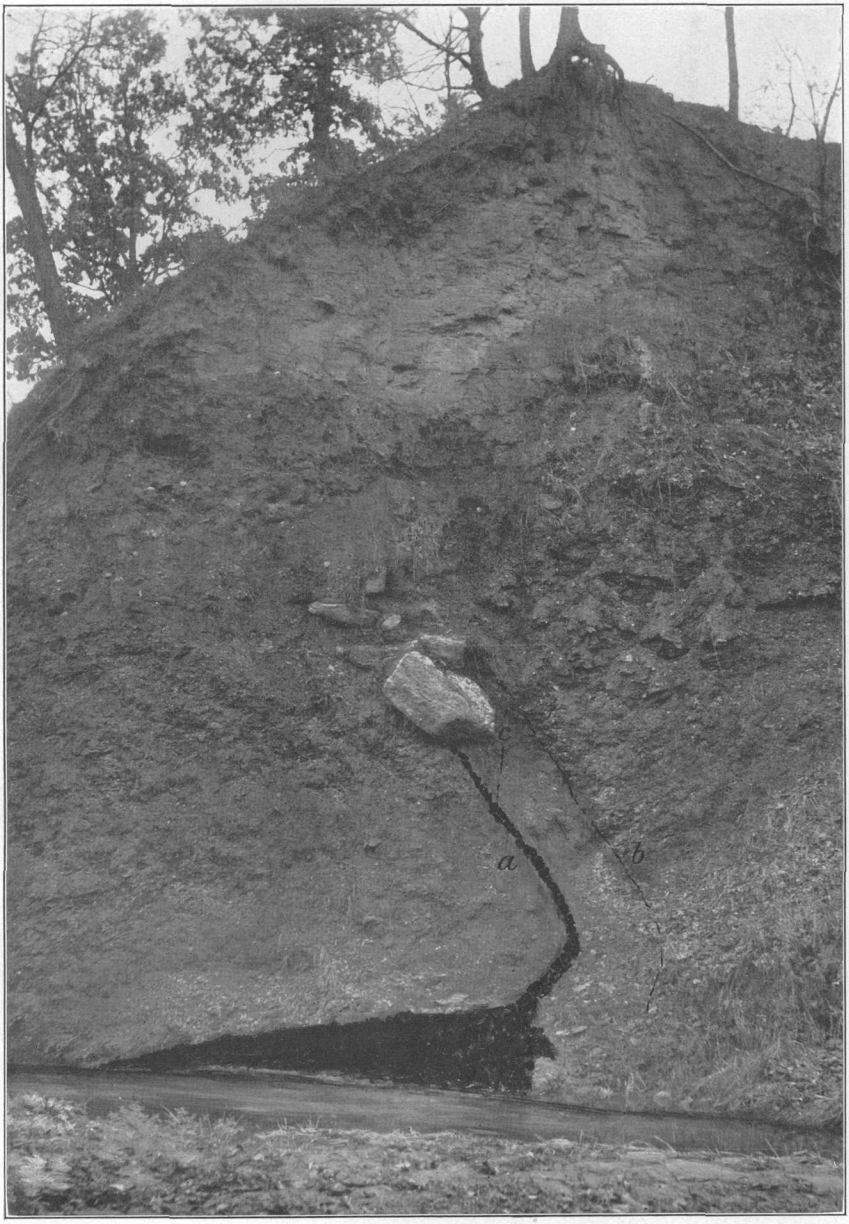
with great force against the horizontal beds and it appeared as a part of the bedrock. It is believed that this is a dislocation like those found in the Pottstown mine.

LAMARSH CREEK FRACTURES.

The most instructive surface exposure of these disturbances occurs in the right bank of East Branch of Lamarsh Creek near the center of sec. 10, Hollis Township. It is at a point where the stream has exposed the north side of a projecting spur of the upland, about 100 yards below the mouth of a small tributary which joins the creek from the west. About 20 feet of Pennsylvanian rocks are overlain by assorted drift, consisting of clayey gravel and silt (Pl. IX). The east end of the exposure shows the sandy shale overlying coal bed No. 5, dipping 5° to 20° to the southeast. The rocks present a slightly shattered appearance. To the northwest the coal rises about 2 feet above the water in the creek. It then terminates abruptly against a faultlike fracture which trends N. 15° W. This fracture extends up through bedrock to the drift (Pl. IX, *a*). A stringer of broken coal follows it from the top of the coal bed to the lower side of a limestone bowlder which projects downward from the drift into the shale. This fracture is paralleled by another fracture, 3 feet to the west (Pl. IX, *b*). This is so sharply cut that in places it may be traced with the edge of a knife. Both fractures bend in a vertical plane so as to present convexities to the west. The westernmost fracture cuts the shale about 6 inches away from the limestone bowlder and can be traced about as far up as the upper edge of this bowlder. The contact between bedrock and the drift in the whole exposure is just above this bowlder. Another small and sharply marked shearing plane runs diagonally across the block between the two main fractures in such a way as to inclose a triangular area on the surface of the exposure under the limestone bowlder, between itself and the easternmost fracture (Pl. IX, *c*). In the lower apex of this triangle some scored pebbles of crystalline rock were noted. Some such pebbles and also some rounded lumps of bowlder clay were found in the lower part of the westernmost fracture. From this it is evident that the fracturing occurred contemporaneous with or subsequent to the deposition of the till from which these pebbles were derived. The large limestone bowlder was evidently placed in its present position at the time the shearing occurred, and its position appears to have been determined by the movements which caused the fractures.

CAUSE OF THE FRACTURES.

The nature and the cause of these fractures has long been a subject of inquiry and discussion locally. The disturbances have rendered unprofitable several ventures in mining which otherwise would have proved successful. Before much of the field had been examined by



FRACTURES IN BEDROCK ON LAMARSH CREEK NEAR CENTER OF SEC. 10, T. 7 N., R. 7 E.

Looking south. *a*, *b*, and *c* are shearing planes in the Pennsylvanian shale; *a* is partly filled with fragments of coal. Drift pebbles are found at several places in these shearing planes, as at the junction of *a* and *c* and at the gentle bend in the lower part of *b*. Note the shattered condition of the shale and coal.

the author, working hypotheses that suggested themselves for the interpretation of these unique phenomena were either (1) contemporaneous erosion during sedimentation, or (2) collapse of extensive caverns in the underlying Silurian or Mississippian limestones. The latter theory has been used to account for some irregular faults noted in the zinc region in Missouri,[1] and irregularities due to contemporaneous erosion are known from other places in the Illinois coal fields.

But some features were noted which indicated that neither of these hypotheses is tenable. The breccias and the fractures show that the sediments were essentially in their present state of induration when the fracturing occurred, and contemporaneous filling in erosional excavations was not observed anywhere in connection with them. Such a structure as that seen in the west bank of East Branch of Lamarsh Creek, where the shattered and broken coal has been worked into a fault plane which cuts off the bed abruptly, and the further fact that the fractures and the associated phenomena show that they are the result of thrust movements in almost every instance, renders it improbable that they are the result of collapsing caverns. Another feature for which it is equally difficult to account on this hypothesis is that some of the best defined fractures run on straight courses for long distances. This is best shown in the sketch of the fractures in the Pottstown mine, but it has also been observed in the Vickery mine. Faults due to collapsed caverns would be more irregular in their horizontal outlines. The theory that these are true structural faults is believed to be altogether untenable, for the reason that the horizontal dislocations outnumber as well as outmeasure the vertical.

The author believes that the fractures are disturbances in the upper part of the soft bedrock, caused by the pressure and the motion of a continental ice sheet in Pleistocene time; that they are planes marking the outlines of immense blocks of the uppermost rock strata, tens or possibly hundreds of acres in extent, which have been dislodged from their original position, displaced, fractured, rotated horizontally and in places vertically, and partly ground into the till. He regards the region as having been a locus of incipient glacial abrasion. Instead of thoroughly triturating the grist the glacial mill here merely blocked it out of the old land on which it spent its force. The evidence which seems to support this theory is briefly as follows:

1. Flutings on the walls of some of the most clearly cut faults show that the movements which produced them were horizontal. Two such walls are shown in Plate VI, *A*, and Plate VII, *A* and *B*, from photographs taken in the German Coal Co.'s mine. The flexures in

[1] Siebenthal, C. E., Structural features of the Joplin district: Econ. Geology, vol. 1, p. 119.

the fractured surfaces on East Branch of Lamarsh Creek must be regarded as flutings of this kind. No vertical movement between the two blocks could have left such projections across the line of motion. Of course there is also some vertical displacement here, the uplift being on the left side; but this must be accounted for as incidental to a much more extensive horizontal displacement.

2. The fractures, so far as known, are confined to a belt following the principal drainage channels, where the preglacial topography must have been more deeply dissected than farther back in the upland. Glacial abrasion involving the more or less intact transference of entire hilltops would naturally be most effective on a line of bluffs and on uneven topography.

3. That the locality was subject to active glacial abrasion, arrested before trituration of the till was far advanced, is shown by the occurrence of what may be called nests of erratics, which are clearly not far removed from their original place. These consist of large blocks and bowlders of the limestone exposed at Lonsdale quarry, where it lies about 120 feet above coal bed No. 5. In preglacial time this limestone probably formed capping remnants on many buttes and small mesas in the region. It is not a conspicuous ingredient of the till, but it occurs in nests, where some blocks measure 30 feet in length and where dozens of smaller bowlders of the same limestone lie together in small isolated tracts an acre or less in extent.

4. In the absence of great vertical dislocations no other hypothesis will explain the extensiveness of the lateral displacements, which are known to exceed 100 feet. The almost horizontal overthrusts by which one part of the principal coal bed has been pushed over another part, measure in the German mine at least 30 feet. In the Pottstown mine (fig. 4, p. 72) the coal is double over an area about 100 feet wide and about 200 feet long. It is reported from this mine that at one point in the broken ground the coal bed is inverted and rests on its roof shale. This repeats the condition noted in the left bank of Kickapoo Creek just above Pottstown. It is evident that the horizontal motion effecting a complete rotation of even a small block of bedrock must have been considerable. But there is no evidence that the vertical movement anywhere exceeded 20 or 30 feet. Where the coal is absent in the mines, the entries generally encounter the sandstone and shale which lie immediately above or immediately below the coal. A downthrow of 60 feet would bring the overlying coal bed No. 6 down far enough to appear, and it could not fail to be in evidence. With its overlying limestone and its characteristic middle clay seam it is a bed readily recognized.

5. At one point in the Pottstown mine the main coal was "twisted out," the operators report, while coal bed No. 6 lay in a horizontal position near or at its usual level above. Such a condition can not

readily be accounted for as resulting from either collapsed caverns or from common orogenic faulting, but it would be the natural and expected consequence of infraglacial disturbances involving transportation of large subjacent slabs of the bedrock.

6. Pronounced vertical shearing planes were noted in the drift close above the bedrock and a short distance from the fractures on Lamarsh Creek. Associated with this shearing plane or zone are vertical laminæ of silt and sand, such as might have been formed in vertical fissures in frozen moving till or in ice. The direction of shearing is roughly parallel to the direction of the fractures in the bedrock on the main creek. The structure is unique, so far as the author's observations on drift extend (fig. 12). It is regarded as indicating shearing in till due to differential horizontal motion in the lowest part of the mass containing the till while this till was in process of deposition.

7. In the fractures on Lamarsh Creek there are drift pebbles and lumps of bowlder clay at least 10 feet below the top of bedrock. This is regarded as proof that the fractures are not older than the till they inclose, and as presumptive evidence that the fractures are themselves

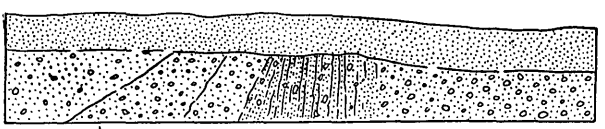


FIGURE 12.—Vertical fissures and lamination in till in left bank of a tributary of East Branch of Lamarsh Creek about 400 yards northwest of center of sec. 10 T. 7 N., R. 7 E. Two feet of alluvium caps the fissured bowlder clay.

of glacial origin. Drift pebbles were also noted in one of the shearing planes in the German Coal Co. mines.

8. On the east side of Kickapoo Creek in the SE. ¼ sec. 12, T. 8 N., R. 7 E., two wells have been drilled on the upland which, as stated on page 65, have gone through drift, then sandstone and shale and in one well coal, in the upper 100 feet, and below this have been sunk more than 50 feet through sand and gravel clearly belonging to the drift. One such occurrence might be due to fortuitous location on an overhanging buried cliff of bedrock, but that two can be so explained seems improbable. Evidently a piece of rock strata, about 100 yards wide and 30 or 40 feet thick, has been caught by the ice sheet and slid from the near-by hills and is now lodged in the drift. This appears to be direct evidence that glaciers have been the cause of the disturbances in the rock strata.

LOCALITIES AFFECTED BY THE FRACTURES.

If these fractures are of glacial origin, as the author believes, there is no doubt that they are limited to places near preglacial drainage channels where the capping—excluding the drift—is scant, say less

than 100 feet, and where the preglacial topography had a comparatively high relief. In the uplands where the drift is thin, where the old land surface is more even, and where the coal has a rock cover of 100 feet or more, there is little if any probability of such disturbance.

Some guidance in avoiding bad tracts in the fractured belt can be obtained by examining closely all outcrops of the bedrock for such small folds, fractures, faults, joints, and zones of crushing as have here been described and figured. The presence of concretionary filling in joint planes, especially where frequent and profuse, must also be regarded as an indication that disturbances have taken place, though these are known to occur in places where the coal is intact.

Unlike true structural faults, which generally run parallel, these fractures may have almost any course. The greater number vary from a northwest-southeast to a northeast-southwest trend, which is in harmony with the fact that the general glacial motion in this region was from north to south.

On land where glacial disturbances affected the bedrock, explorations by the drill can not always be trusted, unless a number of borings are made. Some such explorations in this vicinity have proved misleading.

ECONOMIC GEOLOGY.

COAL BEDS.

OCCURRENCE.

No less than seven coal beds occur in the Pennsylvanian rocks of the Peoria quardangle. Four of these are not exposed in this vicinity, however, and they are known only from wells and shafts which extend through them.

The lowermost coal bed occurs at a depth of 302 feet in the Carter well in East Peoria. It is reported to have a thickness of only 4 inches. The log of the Glen Oak Park well shows a coal bed 380 feet below the curb, and this probably is the same as the lowest coal in the Carter well. In both wells this bed lies at about 90 feet below the lowest coal bed which has been mined at Pottstown, and in the Carter well it is separated by only a foot of clay from the Burlington limestone, being thus close to the contact between the two formations. It is a thin bed, and apparently of little extent. It is overlain by rocks described in the well records as "argillaceous rock" and as "slate." Small beds of coal are of common occurrence elsewhere in the basal part of the Pennsylvanian series, and they change in thickness and run out in short distances.

LOWER POTTSTOWN COAL BED.

In the Wantling coal mine in Pottstown two coal beds are worked, one at a depth of 106 feet and another at a depth of 240 feet. The lower bed consists of a lower bench varying in thickness from 2 feet

2 inches to 3 feet, a parting of shale a little less than 3 feet thick, and an upper bench of coal 1 foot 2 inches to 1 foot 4 inches thick. Where the parting between the two benches was not too heavy both were mined. The coal is of fairly good quality, but mining was too expensive for the market at the time, and operations ceased a few years ago.

This coal bed has been recognized in no less than six of the artesian borings in this vicinity, and the bed appears to be continuous within the quadrangle. The record of the old Voris well shows a coal bed 3 feet thick at a depth of 225 feet. The drill hole of the Acme Harvester Co. passed through this coal bed at a depth of 197 feet and that of the Colean factory at a depth of 190 feet. It is also believed that this bed was encountered in the well of the Peoria Mineral Co. at a depth of 201 feet and in the Pekin well at 200 feet. The following table shows the height above sea level of this coal bed at each of the places where it has been noted:

Height above sea level of the lower Pottstown, or coal bed No. 1.

	Feet.
Voris well	230
Acme Harvester Co. well	263
Wantling mine shaft	244
Peoria Mineral Co. well	266
Colean factory well	260
Pekin well	230

Thirty feet above the lower Pottstown coal bed the Wantling shaft passed through a coal measuring a little more than 2 feet thick. In the Acme Harvester Co. well a coal was noted 36 feet above the bed that has here been referred to the lower Pottstown coal. In the Voris record a calcareous stratum was noted at the same horizon. This is apparently the horizon of a discontinuous coal bed represented in places by coal, in other places by calcareous "clod," and in still other places by dark shale. The coal encountered in the well of the Peoria Mineral Co. at a depth of about 210 feet appears to be at this horizon. It is at any rate a coal which is too variable in thickness to have any economic importance in this region. It may be regarded as the equivalent to one of the two or three beds which occur close to the principal coal, Pottstown coal, Worthen's No. 1, in the base of the Pennsylvanian series on the northern border of the Illinois coal field.

BLUE FLY COAL BED.

The uppermost coal bed in the old Wantling mine at Pottstown is now worked in the Orchard mine. Locally it has come to be known as the Blue Fly bed. It is comparable, according to David White, to Worthen's coal No. 2, both from its position in the general

section and from plant remains in the overlying roof shale. In the Pottstown mine, where it was worked for several years, it lies 133 feet above the lower bed. The coal from the Blue Fly bed, both in the Orchard and in the Pottstown mine, is of good quality, especially adapted, it is reported, to steaming purposes. The roof is a stiff white shale 10 feet thick. The bed is about 2 feet 6 inches thick, varying from 2 feet 4 inches to 2 feet 8 inches.

There is little doubt that this bed is continuous under most, if not all, of the land in the vicinity of Peoria, although it can be identified with certainty only in two of the well records. It is evident that the well drillers have frequently taken but little notice of the coal beds. In the Voris boring in East Peoria the distance from the Pottstown lower bed to the Blue Fly bed is 102 feet and in the Acme Harvester Co. well it is 124 feet, and the Blue Fly bed lies at a depth of 120 feet in the former well and 107 feet in the latter. The coal noted at a depth of 147 feet in the Peoria Mineral Co.'s boring appears to belong to this bed. In the Acme Harvester Co. well a small bed of coal was noted 24 feet below this bed.

The height above sea level of the Blue Fly coal bed is given below:

Height above sea level of the Blue Fly coal bed.

	Feet.
Pottstown shaft	375
Acme Harvester Co. well	353
Voris well	335
Orchard mine shaft	320
Peoria Mineral Co. well	328

COAL BED NO. 5.

No direct measurement was obtained of the distance from the Blue Fly bed to coal No. 5. At the Orchard mine the depth to the Blue Fly bed is 134 feet, and as the top of the shaft is about 5 feet below coal No. 5, which has been mined in the bluff close by, the distance between the two coal beds is about 140 feet. From the Voris boring another close estimate can be made of this distance. The lower coal in the well lies at a depth of 120 feet. The curb of the well is 10 or 15 feet below the upper coal, which has been worked a hundred yards away from the well in the bluff to the south. At Pottstown the distance appears to be less than at these two places. In the Wantling shaft the Blue Fly coal is 107 feet below the top of the shaft, which is about 10 feet below coal bed No. 5 in the bluffs to the west. This makes the distance between the two coal beds 117 feet. These measurements indicate that there is a slight increase to the south in the thickness of the intervening beds.

The thickness of coal bed No. 5 averages 4 feet 4 inches. Measurements in different mines and exposures vary from 4 feet to 4 feet 8

inches. This does not take into account some extreme variations which are associated with structures that are due to recent changes in the indurated rocks near the surface.

Not taking into account the Orchard mine, all of the coal now mined in the Peoria quadrangle comes from this bed. It has been mined in the bluffs of Kickapoo Creek and Illinois River, all the way from Pottstown to Mapleton. On the east side of Illinois River the mines at East Peoria, Wesley, and east of Pekin are all in this coal bed. For the last 30 years it has furnished more than nine-tenths of all the coal produced in this vicinity.

The coal bed underlies nearly all of the upland west of the river and south of Kickapoo Creek. In a few small tracts near the junction of the two Lamarsh creeks, near Hollis and Pottstown, it has been broken by fractures, but these are of slight extent and mostly confined to a belt along the bluffs of the upland. In the Kickapoo bluffs in secs. 27, 28, and 29 erosion has in places extended below the level of this bed. In the valleys of Kickapoo Creek, Farm Creek, and of Illinois River the coal has thus been entirely removed. Such is no doubt largely the condition also under the drift in the upland east of Big Hollow and Kickapoo creeks and north of Farm Creek, within this quadrangle, and perhaps partly in the east half of Groveland and Elm Grove townships in Tazewell County. North of Kickapoo Creek outliers of the coal remain and have in places been mined. One such outlier near Central Park, in the north part of Peoria, was mined for a season by stripping. Following the east bluffs of the Illinois from the north, no evidence of this coal bed was noted until within a mile of the south boundary of Fondulac Township, where more or less extensive outliers occur under the drift in the spur of upland which separates the valley of Farm Creek from Illinois River. In the mines near East Peoria and at Edwards the coal runs out against the drift in several of the entries. Miners recognize that these defects in the coal are due to erosion and they speak of the drift as "wash." The drift generally consists of sand and silt, which in some places has been found to contain embedded trunks of trees and other vegetation. Experience has shown that the surface of the bedrock does not always conform to the present topography of the land and operators are careful to avoid unprofitable explorations of places where "wash" has been encountered. In the southwest part of Groveland Township and in the northwest part of Elm Grove Township the coal bed lies at a greater depth and is in a better state of preservation. East of Pekin there is an area of several sections where this bed has proved to be intact. It has been mined near the upland bluffs as far south as a point within half a mile of the south line of the quadrangle.

COAL BED NO. 6.

This coal lies about 70 feet above coal bed No. 5. Its greatest thickness in the outcrops in this quadrangle is 4 feet 3 inches. It consists of a lower bench about 1 foot 2 inches thick and an upper bench about 2 feet 9 inches thick. These benches are separated by a clay seam 2 to 3 inches thick. The lower bench has generally more or less continuous bands of pyrites or "sulphur." In places the upper bench has a few inches of bony coal, an impure, tough, stiff, slaty coal.

This coal bed is almost coextensive with coal bed No. 5. It underlies the same areas, except that it has been invaded more on the margins of the tracts by erosion, so that more frequently it is wanting under the drift in the uplands. It has been mined at several places, but its defective condition has led to the abandonment of all work at the present time. Most of the old mines were in Limestone and Kickapoo townships and in the upland east of Pekin.

THE "WHITE TOP" ABOVE COAL BED NO. 6.

In describing the exposed strata mention was made of a bed known as the "white top," occurring between coal No. 6 and its roof limestone. In mining this coal the "white top" has proven most troublesome. It is an irregularly developed deposit above the coal and is liable to fall in the rooms and entries in large and small masses. Where the "white top" is thickest, the coal is apt to be thinnest and most broken by faults. The thinning of the coal is due to the absence of more or less of the upper part of the bed. Those who have worked the coal in this region claim that the lower bench is always intact. There is a good foundation for this belief, for where there is enough coal left to allow mining the destruction has seldom gone so far as to reach below the clay seam. As a matter of fact, however, several places are known where no coal is left, not even the lower bench.

The "white top" is a mixed detritus of shale, sand, limestone, and coal, which the author believes has been brought together by underground rivulets and at times by small streams, which were opened in the lower part of the limestone, primarily by the solvent action of the water on this rock, but also by its mechanical action on the marl and coal which formed the floors of the cavernous openings. In other words, the lower part of the limestone above coal bed No. 6 appears to have been removed quite generally in this area by underground solution, and the upper part of the underlying coal has incidentally suffered corrasion. The cavernous openings thus produced have been partly refilled by foreign material and partly closed by creeping of the ground. This has been accompanied by small faulting in both the limestone and the coal (fig. 13).

It is believed that the evidence of such action by underground water is conclusive. It appears, first, that the destruction of the coal is usually partial and is greater in some places than in others. Although this coal bed is now mined in only a small way in the Peoria quadrangle, in the early days it furnished more fuel than the lower bed. The greater part of the limestone, as well as of the coal, is still left. It is also to be remembered that miners who speak of the "white top" as overlying much of the coal do not always distinguish between the introduced sediment and a light marly shale, which in many places

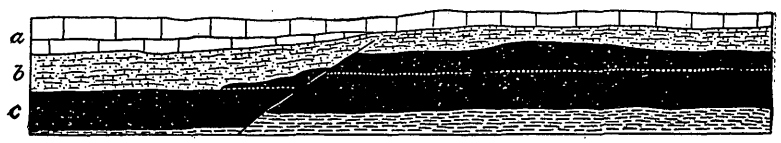


FIGURE 13.—Exposure in east bank of West Branch of Lamarsh Creek one-fourth mile north of southwest corner of sec. 29, Limestone Township. *a*, Limestone above coal bed No. 6 etched on lower surface. Lowermost bed is partly removed at a point close to the exposure. *b*, "White top" and shale containing bituminous nodules and fossils etched out from overlying limestone. Lowermost part of this bed is sandy. *c*, Coal bed No. 6, partly eroded in upper part and faulted.

comes in between the coal and the limestone as a part of the original sediments.

The development of underground caverns in the limestone is known from the occurrence, in places, of such etched surfaces as characterize caverns. It is also indicated by the eroded lower surface of the limestone, the lower beds of which exhibit in places an abrupt beveling and in other places gradual thinning out below. Clearly they have been dissolved and in some places entirely removed from under the uppermost beds, which are nearly always intact. (See fig. 13). The

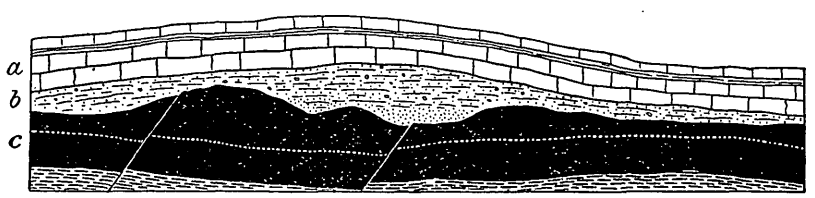


FIGURE 14.—Exposure of coal bed No. 6 in north bank of creek about a mile east of Grove station, near northeast corner of sec. 13, T. 25 N., R. 5 W. The conditions are similar to those shown in figure 12, except that lowest bed of limestone has been entirely removed. *a*, Limestone; *b*, "white top"; *c*, coal bed No. 6.

destruction of the coal, on the other hand, is always from the top downward. The coal bed may measure from 4 feet 6 inches down to a fraction of an inch, but the missing part is always at the top. It is to be expected that where the cavernous etching was greatest in the limestone the trenching in the top of the coal was deepest also. And this condition is evident both from appearances in single outcrops and from comparisons of many localities. In an exposure in the north bank of a creek coming from the east into the NW. ¼ sec. 19, Grove-

land Township, the lower half of the coal alone is intact at the west end, but even this remnant is beveled off so as to run out entirely at the east end of the outcrop (fig. 15). The limestone thins in the same direction by the disappearance of its lower beds, and these have the lower surface etched in a manner which is characteristic of cavern walls. This more or less coextensive destruction of the coal and limestone is apparent also from the comparison of sixteen measurements, made at as many exposures in different parts of the quadrangle. It appears that in six exposures where the limestone ranges from 2 feet 10 inches to 4 feet 3 inches thick the coal averages 2 feet 11 inches; in five places where the limestone measures from 2 feet 2 inches to 2 feet 7 inches the coal averages 1 foot 10 inches; and in five places where the thickness of the limestone runs from 1 to 2 feet the average thickness of the coal is 1 foot 7 inches.

In the same manner it was ascertained that the quantity of the "white top" increases with the reduction of the strata by the excavation of the caverns. That is to say, there was as a rule the least filling in the smallest caverns. In five exposures where the combined

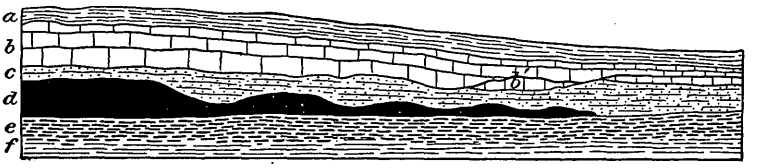


FIGURE 15.—Exposure of coal in north bank of creek one-fourth mile south of northwest corner of sec. 19, T. 25 N., R. 4 W. *a*, Shale; *b*, limestone, removed at eastern end of exposure and showing some slabs etched by water and fallen from roof of cavity; *c*, shale and "white top"; *d*, coal bed No. 6, entirely removed at east end of exposure; *e*, fire clay; *f*, shale.

thickness of the limestone and the coal ranges from 5 feet 6 inches to 8 feet 1 inch the filling between them averages only 10 inches; in six places where the limestone and the coal together measure 4 feet 4 inches to 5 feet 4 inches the "white top" averages 1 foot 5 inches; and in seven localities where the limestone and the coal range from 1 foot 6 inches to 3 feet 11 inches in combined thickness the "white top" averages 1 foot 9 inches. It will be noticed that the decrease of the coal and limestone is greater than the increase of the introduced sediments. This circumstance shows that the general effect of the cavern water has been to reduce the thickness of the rocks.

That cavernous openings have once existed at this level is also shown by the manner of creeping and faulting of the coal. In many places small faults appear in the coal, but do not reach the limestone. In some places it appears that the elevated block is pushed up into a space from which the limestone had been partly removed, and thus the cavern has been closed by the same process of creep that takes place in mines to-day where the cover is deep and the lower ground soft.

An exposure which very clearly illustrates the whole process, with resulting structures, may be seen in the bed of a creek about 200 yards above the Phœnix mine in the northwest corner of sec. 7, Groveland Township. This exposure is shown in figure 16. The limestone at one point has been almost entirely removed, and in its place lies a sandstone which goes under the limestone in both directions. Embedded in this sandstone is a large block of the limestone (fig. 16). This no doubt fell from the roof of the cavern while it was yet open. Below this block and the sandstone is some typical "white top," which consists of sand and clay with minute flakes of coal. In this also occur fossils that have come from the limestone. These show the effects of etching and oxidation. There are also a number of those bituminous concretions which characterize this limestone and which frequently weather out on the surface of the rock. It is clear that these are present in the "white top" as a residue from the decayed rock. At one point this residual cave filling extends up into a crevice formed along a vertical joint in the limestone. The

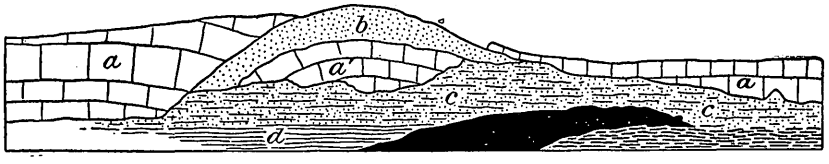


FIGURE 16.—Exposure of coal bed No. 6 in bed of creek about 200 yards north of Phœnix coal mine, near northwest corner of sec. 7, Groveland Township. *a*, Limestone; *a'*, a block of limestone fallen from roof of a cavern and embedded in "white top"; *b*, sand filling the cavern; *c*, "white top"; *d*, shale ("white top"?). The black is coal.

destruction of the coal has been complete on the south side of the creek.

The prevalence of collapsed cavernous passages is evidently due to the fact that the limestone has given ready entrance to the ground water, which has dissolved and etched away the rock. Even at the present day springs issue at its outcrops in many places. The proximity of the coal, from which acids are naturally evolved, would render the solvent action of the water most effective in the base of the limestone. This may account for the widespread destruction of the lower beds. The water circulating through passages in the lower beds would in many places actually run on the upper surface of the coal bed, so that any detritus carried by the currents would immediately mechanically attack the coal and produce those excavations in its upper surface which mark the plane of contact between the coal and the "white top."

If this explanation of the origin of the irregularities in the coal is correct, and if the making of the caverns was not too far back in geologic time, the least destruction would naturally occur where the cover is greatest and where the general dip of the limestone is the

least. Both of these conditions prevail in the northwest part of Limestone and in the southwest part of Kickapoo townships. It does not seem at all unlikely that this coal may yet be profitably mined on some of the land west and northwest of Maxwell station.

COAL BED NO. 7.

This coal bed lies 40 feet above coal bed No. 6, and its outcrops in the creek valleys are generally from a fourth of a mile to a mile above the outcrop of the latter. It is evident that this bed underlies most of the upland where the two lower coal beds are found. The bed no doubt formerly extended over the entire area, but as it lies higher in the section it has been more extensively removed by erosion. In a few places where it has been laid bare by creeks and ravines it is stripped for fuel, and it is said to be a fairly good coal, although it is too thin for mining.

COAL MINES.

The mining of coal has long been an important industry in the vicinity of Peoria. In 1906 the total product of the mines in the quadrangle amounted to 844,484 short tons. This goes largely to supply the local market, but some of the mines on the Iowa Central Railway ship much of their coal to the Northwest. The mine at Orchard ships most of its output to St. Louis. But the principal market is at home, and the cheapnesss of fuel has been one of the factors in insuring the industrial prosperity of the two cities of Peoria and Pekin.

In the early days mining was almost exclusively done by drifting on the outcrops of either the upper (No. 6) or the lower (No. 5) coal bed. At the present time two-thirds of the mines, not counting the smallest producers, hoist through shafts, most of which are less than 100 feet deep. The deepest shaft, that of the Champion Coal Co., is only 190 feet in depth.

The method of mining is the room and pillar. Electric haulage has been installed in several of the largest mines. Steam is used for hoisting in all the shafts.

The clay veins, known among the miners in this locality as "horse-backs," are fissures in the coal, generally from an inch to a foot wide and filled with a light-gray indurated clay. They do not offer any serious obstacle to mining and are probably no more common in this locality than elsewhere. They generally cut the coal vertically. Some of them are accompanied by slight faults, and these faults may affect the fire clay as well as the roof. A typical clay vein of this kind is shown in Plate VIII, *B* (p. 70), from a photograph taken in the main entry of the German Coal Co.'s mine.

List of principal coal mines.

No. on map.		Kind of mine.	Product in 1906.	Thickness of coal bed.
			Tons.	*Inches.*
1	Clark Coal & Coke Co., A	Shaft	146,620	48–54
2	Clark Coal & Coke Co., B	do	70,238	50
3	Wolfschlag Cooperative Coal Co	Slope	88,208	52
4	Shoal Bros	Shaft	65,524	52
5	Howard & Taylor	Slope	54,546	54
6	Collier Cooperative Coal Co	Shaft	53,788	54
7	Vickery Bros	do	35,840	54
8	Third Vein Coal Co	do	12,945	28–30
9	German Coal Co	Slope	11,481	48–60
10	Cram mine (Isaac Wantling)	do	18,000	54
11	Winter Cooperative Coal Co	Shaft	21,600	56
12	Treasure Coal Co	do	20,340	51
13	Hanover Coal Co	do	6,423	50–52
14	Tazewell Coal Co	do	61,748	48
15	Phœnix Coal Co	do	44,652	48
16	Erie Star Coal Co	Slope	22,192	48–60
17	Carter Coal & Mining Co	do	14,532	48–54
18	Eastern Coal Co	Shaft	23,533	48–54
19	Grant Bros.' mine	do	14,100	54–60
20	W. J. Burdette	Slope	1,458	50
21	Hibbard & Sneddon	Shaft	14,520	50
22	F. P. Schmidt & Sons	Drift	3,560	52
23	Fair Oaks CoalCo	Shaft	2,400	48–52
24	Mohn Coal Co	do	3,500	50
25	Frank Richiger	Slope	500	48
26	Champion Coal Co	Shaft	4,962	56
27	Giebelhausen & Son	do	4,620	52–54
28	Manhattan Fuel Co	do	7,000	54
29	A. B. Cummings	Slope	5,710	48
30	Doering Coal Mining Co	Shaft	5,400	50

BRICK AND TILE.

The principal clay works which supply the local market in Peoria are the F. R. Carter plant, located half a mile southwest of East Peoria, Kanne Bros.' brickyard, a fourth of a mile farther to the southwest, and the brickyard belonging to Albert Randall, located on the upland half a mile southwest of Bartonville. The Kanne Bros.' and the Carter works are both situated at the base of the bluff along the Lake Erie & Western Railroad, and were formerly operated in connection with the Erie Star and the Carter coal mines, which yet furnish fuel for these yards. The clay used in both of these plants is taken from pits in small ravines that lead down from the upland to the east. In both pits the sandy shale under coal bed No. 6 furnishes the largest part of the clay. This shale shows evidence of leaching and weathering, which no doubt has improved its quality. In the pit of Carter's yard the fire clay under coal bed No. 6 is used. Bedrock is overlain by drift, which consists of leached bowlder clay and loess. This is mixed in the proportion of about 1 part of the loess to 3 parts of the shale. Stiff-mud machines mold the brick in both plants, and it is burnt in down-draft kilns. The total annual product of the two plants is 15,000,000 bricks. About a million semivitrified paving bricks are included in this figure. The greater part of the common product, which is a grayish-yellow hard brick, goes to supply the local market.

The Albert Randall yard uses the uppermost 15 feet of loess on the Illinoian drift. This makes a common red brick. It is dried in sheds and burnt in down-draft kilns. About 2,500,000 bricks are made each year, and these are sold in the local market.

Jansen & Zoeller have a brick and tile works a mile east of Pekin. It is located at the forks of the wagon road near the center of the SE. ¼ sec. 1, T. 25 N., R. 5 W. About 2,000,000 bricks are made yearly and 100,000 draintile. Some are burned in up-draft and some in down-draft kilns. The clay used is loess which is partly of a unique character. A section at the north end of the pit exposes 5 feet of typical yellow loess. This rests on 6 feet of a brownish-gray loess, which is an ancient soil containing humus and here and there fragments of wood. Under this the pit exposes about 10 feet of a greenish clay, which evidently is water-bedded. This is slightly calcareous and more plastic than the loess. Different mixtures of these are used for tile and for brick.

The thin loess which covers the Wisconsin drift on the upland north of Peoria has also been used at various times for brickmaking. It produces a good common red brick.

WATER RESOURCES.

ARTESIAN WELLS IN PEORIA AND VICINITY.

DEVELOPMENT.

The first artesian well near Peoria was sunk on the east side of Illinois River in 1860, and a flow of salt water was obtained at a depth of 317 feet. Some years later this boring was carried to a depth of 734 feet, and a stronger flow of "sulphur water" was obtained. In 1875 two more wells were drilled on the west side of the river—the Spring Hill well and the Central Park well. In the following year Sidney Pulsifer sunk a well at the foot of the bluff between Main and Hamilton streets. The next year McNeil tapped the "sulphur water" on the low bottom land at the stockyards, and a deeper well extending down into the "Galena-Trenton" limestone was located on the O'Brian farm, 5 miles southeast of Peoria. This boring was on high ground, and the water did not flow. In 1902 the Peoria Mineral Co. finished a boring at the base of the bluff on the east side of the river. This extended still deeper into the Ordovician limestone, and a strong flow of water was obtained. The following year the Illinois Asylum for the Incurable Insane at Bartonville drilled a well to a greater depth than any other well in this vicinity. It is 1,864 feet deep and extends into the St. Peter sandstone. The lowest water rose within a short distance of the curb, but did not flow.

WATER-BEARING HORIZONS.

Three water-bearing horizons have been tapped by the Peoria wells—the Burlington limestone, the Niagara limestone, and the Ordovician, including the "Galena-Trenton" limestone and the St. Peter sandstone.

ORDOVICIAN ROCKS.

The St. Peter sandstone is the lowest formation penetrated. In the Insane Asylum well the greater part of the deepest water is said to have come from the upper part of the "Galena-Trenton" limestone, but the supply is said to have increased when the boring entered the St. Peter sandstone. The latter formation is the principal water-bearing rock in the upper Mississippi Valley. As the sandstone is not separated from the overlying limestone by any impervious stratum, it is very likely that the waters in the two formations are in hydrostatic communication through joints and fissures in the overlying limestone. In Davenport and Rock Island, only 90 miles northwest of Peoria, the same condition is indicated by the absence of any notable difference in the head of the waters coming from these two formations. In the Peoria Mineral Co.'s well, water was obtained in the "Galena-Trenton" limestone at a depth of 1,400 feet. Whether the water reported from the same depth (but from a higher level, referred to the sea) in the O'Brian well was from the St. Peter sandstone can not be definitely settled, owing to the absence of a log of the well.

Compared with the other artesian waters of this locality the water from the St. Peter sandstone contains the smallest amount of solids in solution—only about 1,600 parts in a million. Most of this is sulphates of sodium and calcium, which are present in about twice the quantity of the chlorine compounds of the same elements.

The intake area of the St. Peter is in the northern part of the State and in the southern part of Wisconsin.

NIAGARA LIMESTONE.

Water from this formation has been tapped at depths ranging from 700 to 1,000 feet. In most of the wells it has come from a horizon nearly 100 feet below the upper surface of the formation, where this is reported to have a porous texture, and in some wells where cherty seams are reported. In the Peoria Mineral Co.'s well water was drawn from the uppermost surface of the Niagara, or perhaps from the base of the overlying Devonian strata, owing probably to upward extension of the porous rock. It is well known that the upper part of the Niagara is characterized by pronounced local variations in texture and bedding. In all of the outcrops nearest Peoria it exhibits oblique bedding.

The water from the Niagara limestone is the principal artesian water in Peoria. It now flows from nine wells. It contains about

twice the amount of mineral solids in solution that is present in water from the Ordovician limestone. Analyses from three Peoria wells show a notable constancy in the mineral character of this water. Chlorine varies from 1,395 to 1,562 parts in a million, and sodium oxide only from 1,452 to 1,486 parts in a million. Sulphuric acid is present in less than half the quantity in which it is present in water from the Ordovician, ranging from 199 to 246 parts in a million. Common salt is the chief mineral in solution, making more than two-thirds of all the solids. The presence of hydrogen sulphide is a no less constant characteristic, readily detected by its odor, though not appearing in the analyses.

The Niagara outcrops over a tract of several thousand square miles around Lake Michigan in this State and in Indiana, and over another large area on both sides of Mississippi River in this State and in Iowa. These tracts are the intake areas of the Niagara water, especially the region near Mississippi River.

BURLINGTON LIMESTONE.

The uppermost formation which has yielded flowing water is the main limestone of the Mississippian. This formation is separated from the Niagara by the Devonian limestone and shale and the Kinderhook shale, which effectually shut off its waters from those of the lower formations. To the north and east this limestone thins out and terminates under the impervious argillaceous rocks of Pennsylvanian age, but to the west it outcrops in a belt along Mississippi River. This belt is the intake area of this formation. Of course it is possible that some water may also enter from the basal sandstones of the Pennsylvanian into the buried unconformable north margin of the Burlington.

The water from the Burlington limestone has been noted in all the Peoria wells except at the Illinois Asylum for the Incurable Insane. In six wells it comes from beds which contain seams of chert, and which occur mostly in the upper part of the formation. In one well the water is noted as coming from the middle part of the limestone and in another one from the lowermost bed. In the region of the outcrop of the formation on Mississippi River these same strata commonly give issue to large springs.

ANALYSES OF ARTESIAN WATER.

The water of the Burlington limestone carries more minerals than either of the other two waters. Analyses have been made of samples from the wells of the Acme Harvester Works, of Carter's brickyard, and of the Peoria Mineral Co., and these show a close correspondence. They vary from 7,191.8 to 8,859.8 parts per million of mineral matter and average 8,284.9. More than nine-tenths of this is common salt. Sulphuric acid averages 10.2 parts per million, which is only one-twentieth of the amount in the water from the Niagara and less than one-fiftieth of the amount in water from the Ordovician.

Analyses of artesian waters in the Peoria wells (in parts per million).

	Ordovician.		Niagara.			Burlington.		
	Peoria Mineral Co. well, depth 1,450 feet.[a]	Asylum well, depth 1,864 feet.[b]	Unknown well, depth 980 feet.[c]	Peoria Mineral Co. well, depth 1,000 feet.[d]	Central Park well, depth 875 feet.[e]	Acme Harvester Co. well, depth 366 feet.[f]	Peoria Mineral Co. well, depth 500 feet.[g]	Carter's well, depth 370 feet.[h]
Potassium (K_2O)	25.0	17.6	30.1	36.8	.....	.....	38.4	.....
Sodium (Na_2O_3)	544.2	592.8	1,463.1	1,452.4	1,486.6	4,071.8	3,358.2	4,036.0
Ammonium (NH_4)	1.5	.....	1.9	.....	2.1	3.2	.....	3.1
Magnesium (MgO)	32.6	44.8	34.4	48.6	42.3	59.4	39.4	65.8
Calcium (CaO)	71.8	96.4	59.6	79.8	68.9	78.8	70.8	74.5
Iron (FeO)	.4	.....	.....	.8	2.6	.....	3.4	2.0
Aluminum (Al_2O_3)$_2$	2.4	.....	.....	2.2	4.0	.....	5.4	20.2
Nitrate (N_2O_5)	.4	1.7	0.6	0.6	0.6	0.7	0.7	1.3
Chloride (Cl_2)	212.3	297.0	1,562.5	1,395.0	1,425.0	4,637.5	3,637.0	4,579.1
Sulphate (SO_3)	486.8	537.2	198.8	246.0	226.1	1.0	14.4	15.2
Silica (SiO_2)	26.6	10.4	16.8	11.4	11.2	7.8	24.4	6.0
Total	1,404.1	1,597.9	3,367.7	3,273.6	3,269.4	8,859.8	7,191.7	8,803.2
Average	1,501.0		3,303.6			8,284.9		

[a] Analysis made by University of Illinois. Laboratory number, 10380.
[b] Analysis made by University of Illinois (Edgar and Carr). Laboratory number, 12164.
[c] Analysis made by University of Illinois (Robt. W. Stark), Feb. 20, 1902. Laboratory number, 10280.
[d] Analysis made by University of Illinois, Sept. 8, 1904. Laboratory number, 12415.
[e] Analysis made by University of Illinois, Jan. 24, 1907 (J. M. Lindgren). Laboratory number, 15250. Recalculated for comparison by Prof. J. P. Magnuson. Potassium calculated as sodium.
[f] Analysis made by University of Illinois, June 18, 1902. Laboratory number, 10464. Potassium calculated as sodium.
[g] Analysis made by University of Illinois (Robt. W. Stark), Feb. 20, 1902. Laboratory number, 10230.
[h] Analysis made by University of Illinois (J. M. Lindgren), Jan. 24, 1907. Laboratory number, 15241. Recalculated for comparison by Prof. J. P. Magnuson. Potassium calculated as sodium.

QUANTITY OF FLOW.

Data on the original quantity of water supplied by some of these wells is given below:

Niagara.

	Gallons per minute.
Voris well	546
Central Park well	416
Pekin well	277
Sulphur Water House Bathing Co.'s well	250
Glen Oak Park well	200
Spring Hill well	150
Pulsifer well	105
Peoria Mineral Co. well	Shut off.
Insane asylum well	Shut off.
Stockyards well (estimate)	400
	2,344

Burlington.

	Gallons per minute.
Acme Harvester Co. well (estimate)	100
Carter brickyard well	100
Colean factory well (estimate)	100
	300

The Ordovician water is not now used.

The difference in the quantity of water yielded by the wells tapping the Niagara limestone is due to some extent to difference in the size of the boring, but it is evidently mostly due to differences in elevation of the curb, causing variation in pressure. The largest flows are from the wells on the lowest ground. This is clearly shown in the following table:

Relation of flow to elevation above sea level in wells in the Niagara limestone.

	Elevation of curb above sea level.	Flow, in gallons, per minute.
	Feet.	
Spring Hill well	550	150
Pulsifer well	540	105
Pekin well	530	277
Sulphur Water House Bathing Co. well	485	250
Central Park well	476	416
Voris well	455	546

HEAD OF FLOWS.

Specific data on the original artesian heads can not be obtained for most of the wells. The water of the Burlington limestone has a pressure considerably lower than the others. This is indicated by notes on the Voris well, which mention merely the fact that the water tapped at 317 feet overflowed, but records 65 feet as a minimum measure for the rise of the lower water. The height to which the upper flow rose in the Carter well is given as 65 feet above the curb, which would make the head about 530 feet above sea level. In the Glen Oak Park well the same water rose within 6 feet of the curb, which would make the head 528 feet above sea level. From the appearance of the flows at the wells it is quite evident that the pressure of this water is not equal to that of the water of the Niagara limestone. At the present time the Carter well has a head of only 20 feet.

The head of the Niagara and Ordovician waters is nearly 600 feet above the sea. In the Insane Asylum well the lowest water rose within 13 feet of the curb, or to a height of 592 feet above sea level. The elevation of the curb of the Pekin well is 530 feet and the water originally rose 60 feet above this. In the Peoria Mineral Co. well the water is reported to have had a pressure of 120 pounds at an elevation of 475 feet above the sea. If the figure represents the height in feet (instead of pounds of pressure) to which the water rose above the curb, it corresponds exactly with the Pekin and the Asylum wells, and this is probably correct. In most of the wells the original pressure has diminished in the course of years, owing, no doubt, to

leakage in the upper part of the well. In some wells it has been found necessary to repair the casing in order to maintain a sufficient flow. The flow of the Peoria Mineral Co. well is said to have noticeably affected the flow from the Glen Oak Park well, and it has for that reason been shut off.

As the Niagara and Ordovician limestones are separated by a thick bed of shale, it would be natural to find a difference in the heads of the waters in each. If there is such a difference, it is probably not very great, for local observations fail to indicate its existence.

The head of the Silurian and Ordovician waters is high enough to make them flow on all of the lowlands along Illinois River, including the extensive terrace south of Pekin, and also on the bottom lands of Farm Creek, Kickapoo Creek, and of the two Lamarsh creeks in Hollis Township north at least 2 miles into Limestone Township. The water from the Burlington limestone will hardly furnish a reliable flow on Illinois River terraces, at least not where these are highest, but it can be expected to flow everywhere on the lowest bottoms of Illinois River and of Kickapoo and Farm creeks, and also for a mile or two up from the river bluff on the bottom of the Lamarsh creeks.

USE OF WATERS.

The artesian waters are now used principally for drinking water and for baths and swimming tanks. The Pekin well, the Central Park well, and the Sulphur Water House Bathing Co. well each supply water for swimming tanks. The hydrogen sulphide gas which the water from the Niagara limestone contains is believed by some to make this water particularly suitable for baths. The Voris well and the Stockyards well are used to furnish water for drinking purposes and for stock. The Glen Oak Park well, the Spring Hill well, and the Pulsifer well furnish drinking water only, and the waters of the well of the Peoria Mineral Co. are not now used for any purpose. Carter's brickyard well is used for boiler water. Water from the St. Peter sandstone in the Insane Asylum well was for several years pumped and used for all purposes in the institution, but the supply began to be insufficient two years ago and it is now entirely discarded.

TEMPERATURES OF WATERS.

The temperatures of the flowing waters are known only in four wells. These show an average increase with depth of 1.58° Fahrenheit for each hundred feet, if 50° Fahrenheit be taken as the temperature of the surface.

Rate of increase of temperature, with depth.

	Depth of main flow.	Observed temperature.	Rate of increase of temperature per 100 feet from surface.
	Feet.	°*F.*	°*F.*
Asylum well	1,600	78	1.75
Pulsifer well	900	65	1.66
Stockyards well	850	65	1.41
Sulphur Water House Bathing Co. well	800	62	1.50
Average			1.58

SHALLOW WELLS.

On the bottom lands of Illinois River the alluvial filling consists for the most part of loose silt, sand, and gravel, in which water is obtained at the level of the water in the river. The waterworks in Peoria and Pekin take their supplies from these beds. The Peoria waterworks have three wells, each about 60 feet deep, one with a diameter of 34 feet, another of 13 feet, and another of 9 feet. These wells are located in the channel of the river above the city. The material penetrated by one of these wells consists of fine sand with some clay in the upper part and of sand and gravel in the bottom. In Pekin 20 wells have been driven to depths varying from 100 to 128 feet below the surface. Similar wells furnish water for the distilleries, which are located on the bottom land, and many other wells have also been driven for buildings and private residences in the two cities. In the north half of Peoria it has sometimes been found impracticable to drive wells on account of the rise of the bedrock, which here is above the level of the permanent water table. The supply of water is limitless, as it is practically drawn from the river, and the sandy strata from which the water is drawn furnish a natural sand filter.

On the Wisconsin terrace north and south of Pekin, water is also usually obtained in sand which lies below the water of the river, in some places from driven wells and in others from open wells.

In many places on the uplands in Kickapoo, Limestone, and Hollis townships water is obtained in open wells, extending into bowlder clay under the loess. In the early days a sufficient quantity of water was usually obtained in the base of the loess on the surface of the bowlder clay, but from the cultivation of the soil and incident draining of the land the water table has been lowered so much that such wells can not in general be depended on in dry seasons. Some of the wells on this land extend through the bowlder clay and draw the supply from sandstones and limestones of the underlying coal measures. This is common in the country underlain by the upper heavy limestone in the southern part of Kickapoo Township and

the northern part of Limestone Township. At the Poor Farm at Maxwell station, it was found necessary to drill to the depth of 200 feet, thus penetrating the heavy sandstone lying on top of coal bed No. 5.

On the upland in Richwoods Township, where the drift is 200 to 400 feet thick, the best wells take their supply from a thick deposit of sand which appears to be continuous under the till of this region. It has been found that this sand is dry in some places, which no doubt is due to the fact that it lies above the level of the river, and the water escapes in that direction by underground seepage. This bed is no doubt the continuation of a sand which occurs under the drift in the bluff north of Peoria.

Similar conditions prevail in the upland on the east side of the river in Fondulac Township. The line of outcrop of the sand and gravel, under and below the bluffs on the east side of the river, is marked by a number of copious springs. In the region of Farm Creek several wells on the upland extend down into the gravel, and such wells invariably furnish a reliable supply. Many shallow wells are also in use which do not go below the Wisconsin drift. In the southern part of Groveland Township and in Elm Grove Township the deep drift gravel is not always to be found and there is a greater number of shallow wells in the drift. At the Tazewell County Poor Farm a good supply of water was secured by boring through the drift and into the underlying rock. For more detailed information the reader is referred to the list of wells given above.

GRAVEL AND SAND.

Between the Wisconsin till and its overlying thin sheet of loess some beds of glacial gravel occur, which were produced by marginal drainage on the Wisconsin ice. Some of these beds of gravel are imperfectly sorted and contain admixtures of sand and clay and even seams of bowlder clay. They have been worked at several points in the bluffs in Peoria and in East Peoria. Some sand and gravel obtained in the west bluff of Kickapoo Creek opposite the mouth of Dry Run probably belong here, as do also some found in the bluffs on the upper tributaries of Dry Run and at a point about a mile northwest of Farmdale. None of those deposits of gravel lies far back from the bluffs.

Gravel and sand have also been taken from the Wisconsin terrace in Peoria. The most extensively worked pit, which is owned by A. A. Bushel, lies at the foot of the bluff, south of the Springdale Cemetery road in the north part of the city. Some of this gravel is screened and used for roofing. The terrace remnant which lies in the NE. ¼ sec. 28, Hollis Township, contains some gravel which

is covered by a few feet of sand and silt, and gravel was also noticed in the bottom of the excavations along the roadbed of the Toledo, Peoria & Western Railway, about a quarter of a mile southeast. About a mile southwest of Pekin, Adam Saal has taken out considerable quantities of clean calcareous gravel, which lies between Dead Lake and Illinois River. At several other places, the lowest terrace of the river contains coarse sand which is mixed with more or less gravel, as on the east side of Worley Lake north of Pekin, near Grove station, along the lower course of Lick Creek, and in the terrace west of Mackinaw River in Spring Lake Township. All of the gravel in this region consists largely of limestone pebbles, granitic and volcanic rocks in few places constituting as much as 10 per cent of the material. The gravel of the terraces is more free from clay material and better sorted than the gravel from the overwash from the Wisconsin drift. In the foot of the bluffs east of Peoria Lake in secs. 23, 24, and 27 in Fondulac Township, and also near the mouth of Glendale Hollow, there are a few small exposures of gravel which underlie till, but the thick cover over these deposits will prevent them from being extensively worked. In comparison with the drift to the south and west in the State, gravel may be said to be common in the vicinity of Peoria and Pekin, but it is limited to the bluffs and the terraces of the river and of the larger creeks.

BUILDING STONE.

Very little building stone is at the present time obtained in this region. The only rock which can be quarried for such purposes is the limestone which overlies the shale in Limestone and Kickapoo townships, the thin limestone overlying coal bed No. 6, and various sandstones.

The softness of the sandstones has prevented them from being extensively used. There are only a few places where such rock is quarried, but it is believed that it could be made more generally serviceable than has been done in the past. Beds are in places several feet thick. Even in places where the face of a natural exposure is split up into thin and irregular ledges there may be good quarry rock inside. Suitable locations for quarries can be found in the west bluffs of Kickapoo Creek between Pottstown and Bartonville, and also in the bluffs south of East Peoria and at some points back of the bluffs in the upland between East Peoria and Pekin. In the bluffs and along the tributaries of the two Lamarsh creeks the sandstone commonly lies in beds thick enough for building stone.

Some of the limestone overlying coal bed No. 6 is in beds thick enough for dimension stone, but in most places it breaks into slabs from 4 to 8 inches thick. Almost the only localities where it is

exposed are in the bottoms of ravines of the upland, and much of the material in these situations has already been quarried. The available quantity remaining is insignificant.

The outcrops of the limestone which overlies the shale in Kickapoo and Limestone townships have already been enumerated in connection with the description of the country rocks. The most extensive working in this rock has been in the Lonsdale quarries in secs. 10 and 11, Limestone Township. The beds have been worked in the hills for a distance of half a mile, and there is very little of the rock left which is not covered by a considerable thickness of drift. The lower 5 feet of the rock is the only part which is suitable for building stone, but the 11 feet of limestone which overlies this has been worked for road metal. This upper part is inferior in strength and purity and is in places almost shaly. The outcrops of this formation lie along the border of the upland in the north tier of sections in Limestone Township and in secs. 31, 32, and 33, Kickapoo Township, and can be easily worked in several places by small quarries. Other localities where the rock can be obtained in smaller quantities are in secs. 6, 7, 18, and 9, Limestone Township.

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