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URBANA

REPORT OF INVESTIGATIONS—NO. 45

STRATIGRAPHIC STUDIES OF PENNSYLVANIAN OUTCROPS IN PART OF SOUTHEASTERN ILLINOIS

BY

WILLIAM A. NEWTON and J. MARVIN WELLER

PRINTED BY AUTHORITY OF STATE OF ILLINOIS

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Topographic Mapping in cooperation with the United States Geological Survey

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STRATIGRAPHIC STUDIES OF PENNSYLVANIAN OUTCROPS IN PART OF SOUTHEASTERN ILLINOIS

WILLIAM A. NEWTON AND J. MARVIN WELLER

INTRODUCTION

Location and extent.—The area included in this report comprises seven counties in the southeastern part of Illinois, namely: Coles, Cumberland, Jasper, Richland, Lawrence, Crawford, and Clark counties, the eastern border of the latter three counties being the Wabash River (see index map, fig. 1). The area is bounded on the east and west approximately by the meridians 88° 30′ and 87° 32′ W. respectively, and on the north and south respectively by the parallels 39° 40′ and 38° 38′ N. It is about 75 miles long and 50 miles wide, the total area of these seven counties comprising about 3,047 square miles.

The eastern part of this area includes the Southeastern Illinois oil field which has produced 97 per cent of the State's total oil production to date. The western part includes part of the Illinois basin.

Purpose of the report.—The recent discoveries of new oil fields in the central part of the Illinois basin have led to new interest in the geology of the area. At present there is no published information adequately describing and correlating the rock formations of Pennsylvanian age that are exposed at the surface in the seven counties mentioned above. The purpose of this report is to describe and correlate those formations that crop out at the surface, thus providing a basis for structural studies which may assist in the exploration for oil and gas. It does not include a discussion of geologic history nor of structure, detailed studies of which have not as yet been made in this area.

Acknowledgements.—The field studies for this report were made principally in 1934, 1935, and 1936 by Dr. J. Marvin Weller and Mr. W. A. Newton, and are a part of a larger project covering the Pennsylvanian Stratigraphy of Illinois. Most of the material here included was prepared by Mr. W. A. Newton as a master's thesis at the University of Illinois. Professor Harold R. Wanless, of the Department of Geology and Geography, University of Illinois, was adviser in the preparation of the thesis.

Geologic field notes used in preparing this report include, in addition to those of the authors, some by Mr. Rex McGehee and Mr. Melville W. Fuller, formerly of the State Geological Survey staff.

Fig. 1.—INDEX MAP SHOWING AREA COVERED IN THIS REPORT.

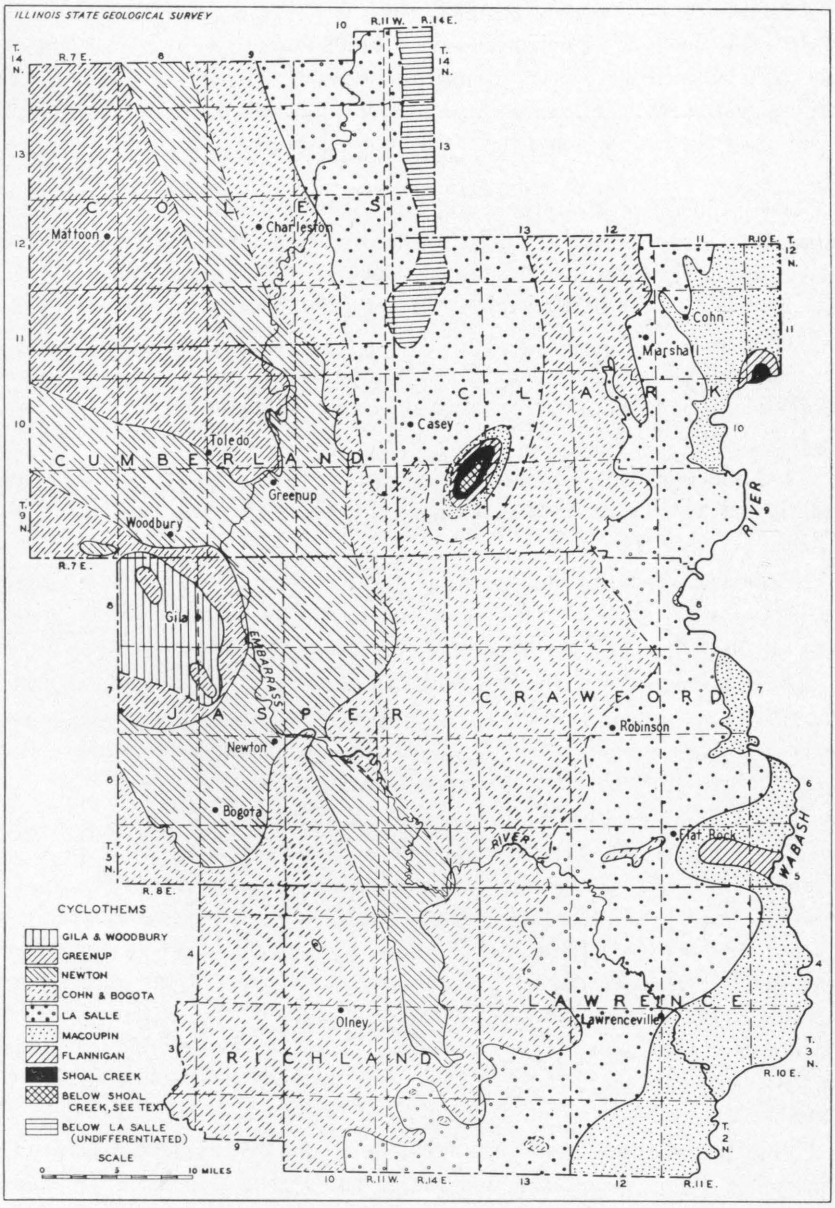

Fig. 2.—MAP SHOWING AREAL GEOLOGY OF PART OF SOUTHEASTERN ILLINOIS, BY CYCLOTHEMS.

GENERAL GEOLOGY

Discussion.—The area included in this report is largely covered by glacial deposits of Wisconsin, Illinoian, and pre-Illinoian age. Detailed glacial geology is not included in this report. For such information the reader is referred to the citation given below.[1] The surface rocks exposed are all of upper Pennsylvanian age and crop out mainly along the walls of small valleys and gullies and in road cuts.

The youngest rock stratum, which blankets a large part of this area, is tentatively correlated with the Merom sandstone. It may not be of the same geologic age at all localities. In many places it lies disconformably on older strata, and locally the base of this sandstone fills old stream channels (fig. 12, p. 29).

The areal geology map (fig. 2) is based primarily on the outcrops. Because considerable parts of the area are without outcrops the position of the cyclothem boundaries is tentative.

The Survey's files provided subsurface data on the top of the Lower Mississippian which were used particularly for the vicinity of the Clark County oil fields.

In the area shown as undifferentiated Pennsylvanian there are no outcrops. The logs of wells show only about 200 feet of Pennsylvanian strata, most of which is sandstone, and no definite cyclothems can be recognized.

The distribution of cyclothems as shown in this map depends on two factors, structure and topography. Some occurrences of older beds surrounded by younger beds represent an anticline or dome; others are due to the partial removal of a younger formation which has an irregular basal contact.

Plate 1 shows geologic sections of various exposures throughout these seven counties, excluding the Merom sandstone. The numbers at the top of each column refer to the locations shown on the accompanying map. The geologic sections are arranged according to correlations of persistent strata in the cyclothems, such as coal, limestone, or black slaty shale, with no reference to elevation. The great variations in lithology and thickness of the same strata in different outcrops may be noted. The changes in dip of the strata are numerous in this area making correlations difficult. Pennsylvanian correlations in this area have been possible only through detailed geologic field studies and a cognizance of the peculiarities of Pennsylvanian deposition.

Cyclothems exposed in this area.—A group of successive strata, usually exemplifying conditions of both non-marine and marine deposition, is included under the term "cyclothem". The name given to each cyclothem is derived from the locality in which the particular group of beds is known to be best exposed.

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1 MacClintock, Paul, Physiographic divisions of the area covered by the Illinoian drift-sheet in Southern Illinois: Recent discoveries of Pre-Illinoian drift in southern Illinois: Illinois State Geol. Survey Rept. Inv. No. 19, 1929.

A complete cyclothem may have the following members, in order from bottom to top: sandstone, sandy and micaceous shale, "fresh-water" limestone,[2] underclay, coal, "middle" marine limestone, black sheety to slaty shale, calcareous shale ,"upper" marine limestone, and non-silty shale, the latter commonly containing ferruginous concretions. The portion of the cyclothem from the sandstone to the coal is regarded as of continental origin, and that portion from the "middle" marine limestone to the non-silty shale is thought to be of marine origin. This sequence represents the ideal cyclothem, but actually one or more of the members is generally absent. However, the complexities of the stratigraphic section may be understood better by grouping the strata into cyclothems.

The following cyclothems have been recognized in these seven counties, listed with the youngest at the top:

Woodbury.—The type locality is near the town of Woodbury, Cumberland County

Gila.—This is a rudimentary cyclothem locally developed near the town of Gila, Jasper County

*Greenup**.—The type locality is just north of the town of Greenup, Cumberland County

Newton.—The type locality is near the town of Newton, Jasper County

Bogota.—The type locality is a few miles southwest of the town of Bogota, Jasper County

Cohn.—The type locality is about 2 miles northwest of Cohn, Clark County

LaSalle.—This cyclothem is known as "upper" and "lower" where two massive limestones are present in the positions of "upper" limestones

The type locality is near the town of LaSalle, LaSalle County

Macoupin.—Named from exposures along Macoupin Creek, south-east of Carlinville, Macoupin County

Flannigan.—Named from exposures in Flannigan Township, Hamilton County

Shoal Creek.—Named from exposures along Shoal Creek, Clinton County

Collinsville.—Named from exposures along Canteen Creek, near Collinsville, Madison County

Trivoli.—Named from exposures in Trivoli Township, Peoria County

Gimlet.—Named from exposures along Gimlet Creek, near Sparland, Marshall County

The cyclothems below the Macoupin are below drainage in practically all parts of the area except in the vicinity of the Martinsville dome. In the SE. ¼ of the NE. ¼ of Clark County there are a few exposures of members belonging to the Flannigan and Shoal Creek cyclothems. Members of the Flannigan cyclothem also outcrop in the extreme southeastern part of Crawford County. The exposures of those cyclothems older than the Macoupin and outcropping near the Martinsville dome are discussed first.

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2 The characteristics of a "fresh-water" limestone are discussed on page 13 under the description of the LaSalle cyclothem.

* Work done since this report was prepared indicates that the Greenup limestone correlates with the Omega limestone as described in Report of Investigations No. 40. This will be more fully discussed in another publication.

DESCRIPTIVE GEOLOGY

Exposures in the vicinity of the Martinsville dome, Clark County.—Two ravines on the flanks of a structural uplift known as the Martinsville dome expose practically the same geologic section from the base of the LaSalle cyclothem down to the upper part of the Gimlet cyclothem. These ravines are in the southwest portion of Clark County, in T. 9 N., R. 14 W., secs. 2, 3, and 10, south-southeast of Casey, Illinois. One of the two creeks flows eastward from the E. ½ sec. 3 into the SE. ¼ sec. 2 where it enters North Fork Creek. The other ravine is about a mile south of sec. 3 in the E. ½ sec. 10. This creek also flows eastward into North Fork Creek.

The following geologic section may be seen in these two creek valleys (8)[3]:

	Thickness	
	Feet	*Inches*
LaSalle cyclothem		
Sandstone, thin-bedded, basal member of this cyclothem	6	
Macoupin cyclothem		
Shale, brownish-gray, very slightly silty, laminated, closely jointed, small ironstone concretions	10–15	
Limestone, nodular in part with abundant shell fragments, expecially *Ambocoelia*		8
Shale, medium dark gray, very fossiliferous with *Ambocoelia*, *Phanerotrema grayvillensis*, and *Chonetes*	2	6
Shale, black, thinly laminated, rather brittle, with a few fossils	2	
Coal		9–10
Underclay, medium dark gray to olive gray, with some calcareous nodules in lower 18 inches	7–9	
Shale, yellowish-brown to bluish-gray, nonsilty to slightly sandy	5	6
Coaly streak, not persistent		⅛
Underclay, medium gray, sandy		6–18
Shale, gray, sandy, soft	3	
Sandstone, shaly and thin-bedded, and sandy shale	10±	
Flannigan cyclothem		
Shale, gray, soft, silty to slightly sandy, with large flattened ironstone concretions in lower part	20±	
Coal	1	
Underclay, olive green to greenish-gray, with some slickenside surfaces and calcareous nodules	6	
Limestone, impure, nodular, "fresh-water" type	1	
Shale, light bluish-gray, very sandy with irregular bedding		6
Sandstone, fine grained, micaceous, and sandy shale, grading into underlying shale	4–5	
Shoal Creek cyclothem		
Shale, greenish-gray to medium-gray weathering a rusty brown color, lower 6 feet containing medium to large calcareous ironstone nodules	15	
Limestone, weathering a rusty brown color, massive, dense to crystalline, conglomeratic in upper 1 foot, very fossiliferous with crinoid stems in abundance (fig. 3)	2⅓–3	

[3] Numbers in parentheses refer to locations of outcrops as shown on Plate I and described in the Appendix, p. 31.

	Thickness	
	Feet	*Inches*
Shale, greenish-gray, fossiliferous with black pebbles at base		4–8
Shale, black, with gray clay streaks, hard, somewhat slaty, fossiliferous, with gypsum crystals		4
Coal, rather shaly		1
Underclay, gray to greenish-gray with slickensides in upper part and secondary calcite crystals in lower part	4–7½	
Limestone, very impure, nodular "fresh-water" type	1	
Sandstone, buff to medium gray, fine grained and micaceous, with some sandy shale	4–5	
Shale, drab to greenish-gray, very sandy	15	
Sandstone, thin-bedded to shaly	10	
Collinsville cyclothem		
Limestone, weathering reddish brown, crystalline, sandy in places, with irregular upper surface, fossiliferous with *Composita* and *productids* most abundant	1	10
Shale, greenish-gray to drab	2	
Sandstone, thin-bedded	6	
Shale, sandy, light bluish-gray, with concretions	20–25	
Sandstone, thin-bedded to shaly, with much carbonaceous material	8	
Trivoli cyclothem		
Limestone, impure, nodular, very fossiliferous, with *Ambocoelia*	1	
Shale, black, slaty, fossiliferous with *Composita*, *Ambocoelia*, etc	1	
Shale, black, slaty to flaky with *Rhombopora* and crinoid stems	1	
Coal		8–10
Underclay	2±	
Shale, gray, sandy	4	
Sandstone, hard, calcareous, thin-bedded, shaly, and sandy shale	15–20	
Gimlet cyclothem		
Shale, gray, silty, with spheroidal weathering and flat ironstones	30	

Fig. 3.—Shoal Creek limestone, NW. ¼ SE. ¼ sec. 3, T. 9 N., R. 14 W., Clark County.

Macoupin Cyclothem.—The exposures of the Macoupin cyclothem are confined to the eastern portions of this area. Outcrops may be seen in Clark, Crawford, and Lawrence counties, and also in Sullivan County, Indiana, which borders the Wabash River just east of Crawford County (fig. 2).

The Macoupin cyclothem varies considerably in thickness and lithology in this area, some of the members being absent in places. This cyclothem lies above the Flannigan and below the LaSalle cyclothems.

Probably the most diagnostic member of the Macoupin cyclothem in this area is a black sheety to slaty shale, a few inches to 2 feet thick, with a very fossiliferous white to buff colored limestone above it and coal below. Although the black sheety shale is present in most places it is locally absent where one would normally expect to find it well developed.

The basal member of the Macoupin cyclothem in eastern Clark County is sandstone, the upper few feet of which is calcareous. The lower part of the sandstone is thin-bedded and cross-bedded and in places is shaly and grades into sandy, micaceous shale. In western Clark County and in Lawrence County this basal member is gray, sandy, soft shale. At locality (22) in Lawrence County (Pl. I and Appendix) the underclay is absent and the shale below the coal is nonsilty at the top and contains poorly preserved plant remains. This shale grades downward into a greenish-gray, fine grained, irregularly bedded sandstone, the top of which is about 17 feet below the base of the coal.

Above the Macoupin basal sandy shale and sandstone and below the underclay in Clark County at locality (8) (Pl. I) there has been recognized locally a clayey to slightly sandy shale about 6 feet thick with an underlying coaly streak and sandy underclay, as described above in the discussion of the Martinsville dome area. The probable equivalent of this bed may be seen below the Macoupin underclay at the Merom bluff locality (14) in Sullivan County, Indiana, where ironstone concretions are present in a dark clayey shale. About 7 feet below the underclay there is a light blue clayey shale with calcareous nodules. These local occurrences are above the basal sandstone of the Macoupin cyclothem and probably represent local irregularities of deposition, the beds having some characteristics of the marine portion of a normal cyclothem.

The Macoupin underclay, where present, is medium gray to dark gray, and carries a few limestone nodules in the lower part at locality (8) and root traces at locality (17). In Lawrence County the underclay is thin or absent, as shown on Plate I, columnar sections (20), (21), (22), and (23).

The Macoupin coal in Clark County is about 6 inches thick at localities (8) and (9), although at (10) it is only one inch thick (Pl. I). At locality (13) in Crawford County the coal, if present, is below water level. At (16) the top of the coal may be seen in an old surface mine where the coal is said to be 20 inches thick. Across the Wabash River to the east it is 1½ feet thick at locality (14). In the extreme east-central part of Crawford County at (17) the coal

is one foot thick. It thins southward, and is absent or ranges from a trace to 8 inches thick in Lawrence County, as shown in sections (20), (21), (22), and (23) on Plate I. At locality (23) the coal is slaty and canneloid.

As has been mentioned, a persistent black sheety to slaty shale is characteristic in the Macoupin cyclothem in this area. In certain localities this black shale has a marine limestone both above and below it (Pl. I, columnar sections 17, 20, 21, 22, and 23). At each of these horizons the limestone is very earthy and nodular or is represented by limestone nodules in a clay matrix. It is also very fossiliferous. At locality (16) in the old surface mine exposure the black sheety shale occurs directly below a 4-foot bed of massive limestone and rests upon the coal. About 20 feet away, in the same exposure, the black shale is absent and a dark bluish-gray shale containing small gray, hard, elongate limestone concretions occurs in its place between the limestone and the coal. The black sheety shale is also absent in locality (15) in creek bed exposures both north and south of the road. At this locality the dark gray shale between the limestone and the coal contains the same small elongate limestone concretions, but also contains oval septarian concretions as large as 1½ feet in diameter. The hard concretions were also found at locality (22). Conodonts and fish scales are present in the lower part of the black shale at locality (17) and a few poorly preserved fossils at locality (8). In Lawrence County (23) on the south side of Raccoon Creek two slaty shales were noted, one directly above the coal and one directly above the intervening limestone. An 8-inch black silty shale between the lower slaty shale and the limestone contains a species of *Aviculopecten* at this locality.

The limestone found above the black sheety to slaty shale varies from a massive bed to one composed mainly of calcareous fossiliferous nodules. It is a very fossiliferous limestone, usually containing numerous crinoid stems and *Ambocoelia. Dictyoclostus, Linoproductus, Lophophyllum,* and fenestellid bryozoans are present at locality (15) and at some other localities. The limestone commonly weathers a rusty brown to buff color.

The shale directly above the limestone is usually nonsilty, gray to dark gray in color, and is commonly calcareous, containing fossils similar to the underlying limestone. Small ironstone concretions or spalls are found in this upper shale.

LaSalle cyclothem.—Exposures of strata belonging to the LaSalle cyclothem may be seen in Coles, Clark, Crawford, Lawrence, and Richland counties, Illinois, and in Sullivan county, Indiana (fig. 2 and Pl. I). In the geologic section the LaSalle lies above the Macoupin and below the Cohn cyclothems.

The type locality of the cyclothem here known as the LaSalle is in LaSalle County in the northern part of the State. At the type locality there is only one

marine limestone in this cyclothem, but in Coles and Clark counties, in the northern part of the area under discussion, there are two marine limestones, recognized in the field as "upper" and "lower" LaSalle, whose presence constitutes a problem (figs. 4 and 5).

These two limestones have been recognized in well logs in several counties to the west of Coles County. South of Clark County only one of these limestones, which is thought to be the "lower" LaSalle, is present on the surface.

The two LaSalle limestones outcropping in Coles and Clark counties are much alike in appearance. Where both are present neither one of the limestones is included in a series of strata which constitute a complete cyclothem. The "upper" limestone has no underlying sandstone and the "lower" limestone does not have much shale above it. Columnar sections (6) and (7) (Pl. I) show these characteristics. In Clark County the thin coal locally present between the two limestones suggests that the "upper" limestone should be included in a separate cyclothem, inasmuch as the strata below the limestone may be well developed in localities outside of this area. The "lower" limestone, where outcropping in those counties south of Clark County, generally overlies a thick and persistent coal, and is overlain by a well developed upper shale.

The problem of the LaSalle cyclothem resolves itself into the following points: (1) the absence of the "upper" limestone south of Clark County should be explained; (2) subsurface studies in adjoining counties may reveal that these two limestones should be included in separate cyclothems; (3) one of these two limestones should, if possible, be definitely correlated with that at the type locality in LaSalle county; and (4) if this correlation is possible it may be advisable to include one of the two limestones in a differently named cyclothem, or if this correlation is not possible both limestones should probably be renamed, other than LaSalle, into two separate cyclothems for this area. The fact that these two limestones crop out together only in two counties in this area has caused the writer to include them, where present, in one cyclothem, tentatively known as the LaSalle cyclothem.

The LaSalle cyclothem is characterized by a generally persistent coal below the lower limestone throughout this area (Pl. I). The limestone is massive in character in the northern part of the area, and where two limestones occur they are usually subcrystalline to brecciated in appearance. In the southern part of Crawford, Lawrence, and Richland counties the limestone, where exposed, is bluish-gray and in places is quite nodular. It is somewhat fossiliferous in the northern part of this area and very fossiliferous in the southern part. In contrast to the Macoupin cyclothem no black slaty shale has been found associated with the LaSalle in this area.

The basal sandy shale and sandstone of the LaSalle cyclothem in this area has no characteristics peculiar to it alone, although it is usually quite calcareous where overlain by a "fresh-water" limestone.

"Fresh-water" limestones have been found below the LaSalle underclay at localities (17) and (19) in Crawford County (Pl. I). "Fresh-water" limestones have been designated as such because where present they occur in the lower or continental portion of the cyclothem, and because they are often nonfossiliferous or contain nonmarine fossils, such as *Spirorbis* and certain species of nonmarine fish. The "fresh-water" limestone of the LaSalle cyclothem is apparently nonfossiliferous, hard, impure, and nodular, and is about 1½ feet thick. This horizon is often recognized by nodules the size of the fist in a clay or shale matrix. Where massive and sandy it often grades laterally into a very calcareous sandstone with a knobby or uneven upper surface, as is commonly found in the vicinity of locality (19).

The LaSalle underclay is usually silty and contains small limestone pellets and nodules. Where it is nonsilty, as at localities (17) and (24), it usually contains abundant plant stem impressions.

The LaSalle coal below the lower limestone is generally of good quality, hard and blocky in structure. In Crawford, Lawrence, and Richland counties it contains much clarain and vitrain which gives it a characteristic bright luster. It breaks into rectangular blocks. Its thickness averages about 1½ feet.

The shale below the lower LaSalle limestone and above the coal varies in thickness and is not present throughout the area (Pl. I, columnar sections 6, 7, 12, 13, 14, 17, 19, 24, and 25). In the northern part of Crawford County at localities (12) and (13), where the limestone is massive, the underlying shale is light to medium gray, weathering brownish gray, and is usually very sandy at the top becoming nonsilty towards the base. At locality (13) plant stem impressions are present about 4 feet from the top of the shale and are very abundant at the base just above the coal. At locality (13) this shale between the limestone and the coal is 17 feet thick. It thins to 2 feet within a distance of 9 miles to the Merom bluff locality (14). In southern Crawford, Lawrence, and Richland counties the shale is generally absent where the limestone is massive. At those localities where the limestone is more earthy to nodular in appearance the underlying shale is light to dark gray, very fossiliferous, and contains abundant limestone nodules similar to the limestone found above it. In many places the limestone grades laterally into this type of bed.

The LaSalle limestone is well exposed east of Charleston along the Embarrass River in Coles County, in several places in the east half of Clark County, along tributaries to North Fork Creek in the west part of Clark County, and at the following locations near Casey: (1) in the east-central part of sec. 28, T. 10 N., R. 14 W. (fig. 4); (2) along the south line of this same section; and (3) in the N. ½ sec. 8, T. 9 N., R. 14 W.

Good exposures of the "lower" LaSalle limestone may be seen in the east half of Crawford County, Illinois (fig. 5), and at the Merom bluff locality (8) in Sullivan County, Indiana. West of the town of Flat Rock, in the southern

part of Crawford County, there are several outcrops along the small streams.

In southwestern Lawrence County along the west county-line there are a few exposures of the LaSalle. There are also several excellent exposures in small coal stripping pits in the extreme southeastern part of Richland County.

In Coles County (6) and in Clark County (7) the two "upper" LaSalle limestones may be seen (Pl. I). In this area it is only in these two counties that the two limestones have been recognized. In Coles County (6) there is a medium gray, finely silty shale 3½ feet thick separating the two limestones. The upper one foot of this shale locally contains ironstone concretions; the lower part contains small limestone nodules. The uppermost limestone is 8 feet

Fig. 4.—LaSalle limestone at quarry in middle of section along south line sec. 28, T. 10 N., R. 14 W., Clark County.

thick, being light gray, hard, and dense, with thin irregular limestone beds at the top and more massive beds below. In places this limestone is subcrystalline and brecciated. It is fossiliferous, and at some places the crinoid stems are large and very abundant. It also contains *Linoproductus, Spirifer,* and other brachiopods. The lower limestone is about 3 feet thick with a very irregular base. It is quite nodular in the lower part and large limestone nodules extend down into the underlying shale.

The two limestones are present in several exposures in Clark County, although the lower limestone is considerably thicker and coal lenses occur between the two limestones. In the west portion of Clark County in the S. ½ sec. 28, T. 10 N., R. 14 W., the two limestones attain a total thickness of 23 feet, and are separated by one foot of light gray, poorly bedded, plastic clay or shale bearing gypsum crystals. This clay or shale zone is about 4 feet from the top of the limestone in the quarry face. North of this exposure in the east center of

the same section about 14 feet of what is thought to be the lower limestone is exposed in an old quarry face along the stream cut. Below this limestone is a greenish to brownish-gray, calcareous shale 1 foot 8 inches thick, below which is 1 inch of coal, 2 inches of underclay, and 4 feet of very sandy shale to shaly sandstone with abundant plant material and some well preserved leaves in the upper part.

In the eastern portion of Clark County in the northeast part of sec. 1, T. 11 N., R. 12 W., the shale and clay interval between the two limestones is about 5 feet, which includes a 3-inch layer of coal. This section is shown in (7) (Pl. I) which includes also the exposure further south in the west-

Fig. 5.—LOWER LASALLE LIMESTONE SHOWING SOLUTION JOINTS, IN BED OF CREEK IN THE NE. ¼ SEC 9, T. 8 N., R. 12 W., CRAWFORD COUNTY.

central part of sec. 12, T. 9 N., R. 12 W. At this locality the interval between the two limestones has increased to more than 10 feet, the included coal bed having likewise thickened to about 8 inches. At these localities the upper limestone is medium gray to grayish-white, hard, subcrystalline with a brecciated appearance, thin-bedded in the upper one foot and massive below. Crinoid stems are very abundant in the upper portion, and *Composita* is common in the lower part. The lower limestone is grayish-white, very hard, massive, and breaks with a splintery fracture. Crinoid stems are present but not abundant.

Southeast of these Clark County exposures in the extreme northeast part of Crawford County, localities (12) and (13) (Pl. I), the lower limestone of the LaSalle cyclothem has thinned to 5 feet. It is light bluish-gray, weathering brownish-gray on the interior and white on the exterior. It is hard, somewhat brittle and splintery, and weathers into large rectangular blocks. Crinoid stems

and small corals are present although not abundant. This limestone contains productids at the Merom bluff locality in Sullivan County, Indiana (14) where it is directly overlain by 20 feet of Merom sandstone. At locality (17) east of Palestine, Crawford County, the limestone is about 3 feet 8 inches thick and is dark gray to bluish-gray. At this locality it is earthy and nodular with abundant crinoid stems and worm casts. At localities (18) and (19) (Pl. I) west of Flat Rock, Crawford County, the limestone is 2½ feet to 3½ feet thick, dark gray to bluish-gray in color. Although it is massive in many exposures it is earthy and very nodular in others, much in contrast to those exposures in northern Crawford and Clark counties. Exposures of the LaSalle limestone in southwestern Lawrence County and in Richland County to the west show the limestone generally to be from 2½ feet to 3 feet thick. The limestone in some exposures is a dark gray to bluish-gray bed, while some outcrops of the limestone are earthy and nodular to shaly. One may observe the complete disappearance of a massive bed within a distance of 75 feet at the same locality.

The upper shale of the LaSalle cyclothem is generally medium gray to olive gray, slightly silty to sandy, well bedded, and commonly contains large flat ironstone concretions near the base.

Cohn Cyclothem.—The Cohn cyclothem is a small cyclothem occurring above the LaSalle and below the Bogota cyclothems in this area. It has been recognized at two localities in Clark County and at one in Richland County (fig. 2).

The type locality is about two miles northwest of Cohn in northeastern Clark County, in the NE. ¼ sec. 1, T. 11 N., R. 12 W. A small showing of the upper part of this cyclothem may also be seen at the base of a bluff along a small stream in the N. ½ sec. 21, T. 10 N., R. 12 W., in the southeast portion of the same county. These two geologic sections are included in Clark County (7) (Pl. I).

The total thickness of the Cohn cyclothem exposed in southeastern Richland County at locality (24) is only 7½ inches. This exposure is along a small stream in the central part of the E. ½ sec. 11, T. 2 N., R. 14 W.

No basal sandy shale or sandstone member of the Cohn cyclothem is present at any of the three localities described above.

The Cohn underclay at the type locality in Clark County is 5 feet 8 inches thick. It is gray in color becoming greenish-gray in the lower 1 foot, and contains small, round, calcareous concretions in the lower part. At locality (24) in southeastern Richland County the underclay is only 1½ inches thick.

The Cohn coal is very thin where present in this area, being 2 inches thick at the type locality and only 1 inch to 1½ inches thick at the locality in Richland County. The coal is very shaly and grades into a shale with thin coaly lenses.

At the type locality in Clark County the shale above the coal is black, flaky, and contains *Ostracodes* in the lower part. This shale is 1 foot thick. Above

it is 1 foot 3 inches of light to medium olive-gray, soft shale, which contains small, weathered, ferruginous concretions. *Ostracodes* and coprolites as much as an inch in length, are present in sec. 21, T. 10 N., R. 12 W., Clark County. In Richland County the shale above the coal is dark gray at the base and grades upward into the basal sandy shale and sandstone of the Bogota cyclothem.

Bogota cyclothem.—Exposures of strata belonging to the Bogota cyclothem may be seen in Coles, Clark, Crawford, Richland, and Jasper counties (fig. 2).

The Bogota lies above the Cohn and below the Newton cyclothems. It actually includes two separate cyclothems, which are here referred to as upper and lower Bogota. Strata probably equivalent to the upper and lower Bogota also crop out in counties to the south and west of this area. The type locality of the upper Bogota is along Muddy Creek in the extreme southwestern part of Jasper County, about five miles southwest of Bogota. Although there are several exposures of the lower Bogota in this area, the writer has not given this group of strata a separate name because he believes that exposures outside of this area will later serve better as type localities.

The lower Bogota is characterized by a thin coal in Coles and Crawford counties (Pl. I). This coal thickens southward and is as thick as 2 feet in Jasper and Richland counties. There is no overlying marine limestone although the shale above the coal is somewhat fossiliferous. Where the Cohn cyclothem is present below the lower Bogota in Clark County there is an intervening "fresh-water" limestone.

The upper Bogota is characterized by its thick black sheety to slaty shale in which are found large, hard, oval or flat, calcareous concretions. There is a marine limestone above and often below the black sheety shale. The underlying coal, if present, is usually only 1 inch to 2 inches thick. The underclay is quite persistent and thick. There are commonly one or two "fresh-water" limestones in the lower part of the upper Bogota cyclothem.

The basal member of the lower Bogota is thin-bedded and shaly sandstone in the lower part, grading upward into sandy shale near the top.

In Clark County (7) there is no basal sandstone. At this locality the medium gray, hard, massive to nodular "fresh-water" limestone contains *Spirorbis* and probably represents the base of the lower Bogota. Between this limestone and the underclay above is 2½ feet of shale which contains *Ostracodes* and small calcareous pebbles.

The lower Bogota underclay is thin in Coles County (6) (Pl. I), and is dark gray to black containing root traces and carbonaceous material. It also contains root traces in Richland County (26) and (27), being 2 feet thick at locality (27). In Clark and Crawford counties, (7) and (11), the underclay is more than 4 feet thick, is finely silty, and contains gray, argillaceous, and calcareous pebbles. A thin limestone conglomerate zone which contains *Spirorbis* and *Ostracodes* occurs at the top of the underclay in Clark County (7).

The lower Bogota coal is thin in Coles and Clark counties and was not found at all in Crawford County at locality (11). The coal is as thick as 2 feet in Jasper and Richland counties. At localities (25), (26), and (27) it is shaly and badly weathered. The coal mined southeast of Newton, Jasper County, is probably the lower Bogota.

The shale above the lower Bogota coal is commonly silty to sandy. At locality (7) in Clark County the shale is medium gray and contains ironstone concretions and plant impressions in the upper part. In the lower one foot the shale is gray to black, poorly bedded, and contains *Estheria* and *Ostracodes*. In the NE. ¼ sec. 1, T. 11 N., R. 12 W., Clark County, near water level in

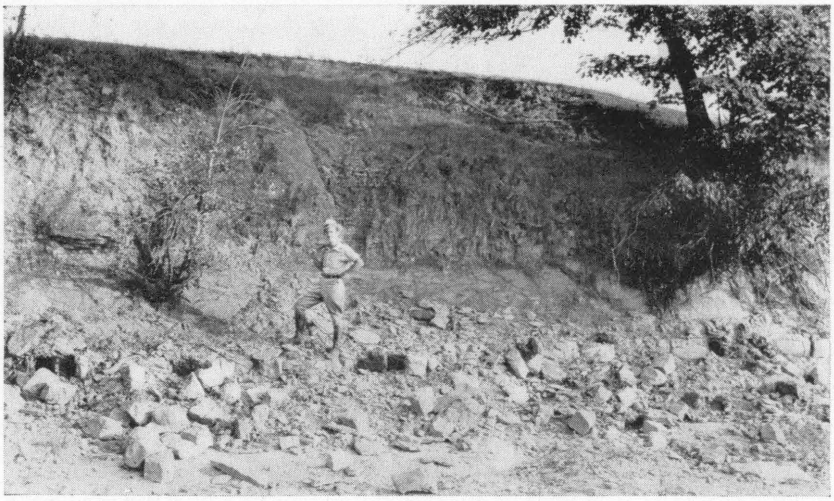


Fig. 6.—Bogota "fresh-water" limestone showing conchoidal fracture, along Muddy Creek, NE. ¼ NE. ¼ sec. 17, T. 5 N., R. 8 E., Jasper County.

a small gully there is a local mud-crack zone in the shale about 6 inches above the coal. The cracks are filled with iron carbonate and the shale between the cracks contains *Estheria*. At locality (26) in Richland County the shale is sandy to silty and contains ferruginous layers in the upper part. The lower 2 feet is nonsilty and soft and flaky. In this lower part one species of *Aviculopecten* was found.

The basal member of the upper Bogota is thin-bedded sandstone which in part is calcareous. Above this sandstone is sandy shale which becomes silty at the top. In places it is iron-stained and contains irregular ferruginous nodules in discontinuous layers, notably along Crooked Creek in the west half of sec. 27, T. 7 N., R. 10 E., in Jasper County.

The "fresh-water" limestones of the upper Bogota are found in the shale just described. Their relative position below the underclay varies considerably, as does the thickness of shale separating the two limestones where both are present.

At the type locality of the upper Bogota, Jasper County (3), one "fresh-water" limestone occurs immediately below the underclay (fig. 6). Here the limestone is only a few inches thick, dark gray, and contains shark teeth. *Spirorbis* may also be present. Three feet below this limestone is the lower "fresh-water" limestone. It is medium light gray splotched with green, hard, and breaks into irregular nodules with a conchoidal fracture. *Spirorbis* are present in the limestone. At locality (30) in Richland County the upper "fresh-water" zone is composed of abundant calcareous nodules, some being quite large. The lower "fresh-water" limestone is separated from the one above by 3 feet of greenish clay. This limestone is more of a limestone conglomerate which locally becomes very sandy (fig. 7).

Fig. 7.—BOGOTA (?) "FRESH-WATER" LIMESTONE SHOWING CONGLOMERATIC CHARACTER IN THE SE. ¼ NW. ¼ SEC. 22, T. 3 N., R. 10 E., RICHLAND COUNTY.

The upper Bogota underclay is medium to greenish-gray, sometimes weathering buff, is silty, and contains small, irregular shaped limestone nodules. It is usually massive and in some places is hard and nonplastic. It is usually 3 or more feet thick wherever exposed in this area.

The upper Bogota coal is thin and not very persistent in this area.

Where a shale occurs above the coal or underclay and below the lower marine, or "middle" limestone it is usually finely silty to sandy. At the type locality in Jasper County (3), this shale is about 2½ feet thick. It contains a sandstone lens from 4 inches to 5 inches thick which is fossiliferous in the upper part. At some localities this shale contains limestone nodules, especially where the "middle" limestone can not be definitely recognized as a persistent bed. At locality (7) in Clark County this shale is above a thin coal and contains plant leaves and stems and *Estheria.* At locality (27) in Richland County the shale

above the upper Bogota underclay is dark gray, weathers brown, is finely silty, and is flaky when dry. The black sheety shale is not developed at this locality.

The "middle" marine limestone where present above the coal or underclay and below the black sheety shale, as shown in sections (3), (6), and (7) (Pl. I), is very dark gray, weathers brownish, is argillaceous, somewhat ferruginous, and in some places is very nodular. It is also fossiliferous and contains *Hustedia* and *Aviculopecten* at locality (7) in Clark County.

At locality (30) in Richland County this limestone crops out one-quarter of a mile east of the highway bridge along a tributary to Fox River. At this location it is medium dark gray, very impure and argillaceous, but hard and platy. It contains carbonaceous plant stems and *Ostracodes*. It is 1 foot to 2½

Fig. 8.—BOGOTA PLATY LIMESTONE CONTAINING OSTRACODES AND CARBONIZED PLANT STEMS AND LEAVES, IN THE SE. ¼ SEC. 15, T. 3 N., R. 10 E., RICHLAND COUNTY. This limestone grades into a platy shale containing *Aviculopecten* and *Solenomya* half a mile to the west.

feet thick and weathers gray. The horizon of this limestone crops out one-quarter of a mile west of the highway bridge along the same stream-cut but here the bed is a black, calcareous, rather platy shale that contains *Aviculopecten, Solenomya,* and some carbonaceous material.

About one-quarter of a mile south of the above described exposure in the NW. ¼ sec. 22 a platy limestone 2½ feet thick is quarried in a small gully. It contains carbonaceous plant stems and *Ostracodes* and is very similar to the platy limestone east of the highway bridge in sec. 15, T. 3 N., R. 10 E. as shown in (30) (Pl. I). About 75 yards east up the gully from the platy limestone is a very nodular, ocherous, and conglomeratic "fresh-water" limestone containing *Spirorbis* (fig. 8). No evidence of a black sheety shale can be found along the gully between these two limestones. The platy limestone dips to the north and

west. It is suggested that this platy limestone is the same as the limestone or its equivalent platy shale below the black sheety shale and that the ocherous, nodular "fresh-water" limestone is the same as the nodular "fresh-water" limestone below the underclay that crops out at locality (30).

The shale above the "middle" limestone horizon and below the black sheety shale of the upper Bogota is commonly dark gray to black becoming lighter towards the base; it is well bedded, flaky in part, and contains small, irregular, rounded and flattened limestone or ironstone concretions. It is fossiliferous, containing *Estheria,* fish scales, *Ambocoelia,* and small productids.

The characteristic black sheety to slaty shale of the upper Bogota is commonly 4 feet or more thick in this area. At some places the large oval or flat, hard, calcareous concretions are more numerous than at other places. The

Fig. 9.—BOGOTA SLATY SHALE CONTAINING LARGE CALCAREOUS CONCRETIONS, WEST OF HIGHWAY BRIDGE, SOUTH LINE OF SEC. 15, T. 3 N., R. 10 E., RICHLAND COUNTY.

best exposure of the sheety shale and large concretions is in Richland County (30) just west of the bridge on Illinois Highway 130. One concretionary mass in the creek is about 1 foot wide and 15 feet long. The well exposed sheety shale at this locality is as much as 7 feet thick with abundant calcareous concretions (fig. 9).

The shale above the black sheety shale and below the upper marine limestone is gray to buff, poorly bedded, and contains marine fossils at the top. At the base of this shale it is black and silty where it overlies the black sheety shale.

The upper marine limestone of the Bogota is medium gray, weathers brownish, is dense, silty, and contains marine fossils, including crinoid stems, *Ambocoelia, Lophophyllum, Chonetes,* and *Aviculopecten.* In Richland County

this bed may grade laterally from massive limestone into shale with abundant calcareous, fossiliferous nodules.

The upper shale of the upper Bogota is usually medium to dark gray to drab, silty to sandy, and contains beds of nodular ironstone concretions. In Jasper County the shale is quite sandy and at locality (4) it contains sandstone beds which carry marine fossils, including crinoid stems, bryozoa, and brachiopids. The shale often contains marine fossils near the base where it occurs above the upper limestone. At locality (30) in Richland County, *Ambocoelia, Chonetes,* corals, gastropods, and other marine fossils are present in the lower part of the shale.

Newton cyclothem.—Strata belonging to the Newton cyclothem may be seen in Cumberland, Jasper, and Richland counties (fig. 2). It occurs above the Bogota and below the Greenup cyclothems in the geologic section.

The type locality of the Newton is along Crooked Creek, about 4 miles east and a little north of Newton, Jasper County. Exposures can be seen along Crooked Creek and in gullies leading down to the creek in secs. 15, 16, 22, and 27, T. 7 N., R. 10 E. The geologic section is shown in (4), Plate I. These are the best exposures of the Newton cyclothem in this area.

The Newton is characterized by a black sheety to flaky shale which overlies a gray, earthy, fossiliferous limestone. Two "fresh-water" limestones occur in the lower part of the cyclothem at the type locality. In the lower one *Spirorbis* is very abundant. Both limestones are not always seen at less extensive outcrops. No marine limestone has been found above the black shale in this cyclothem. Although there is an underclay there is no coal above it.

The basal member of the Newton cyclothem is mainly sandy shale with some thin-bedded sandstone which is calcareous in part. At the type locality this sandy shale rests upon a gray, hard, calcareous siltstone about 3 inches thick at the top of the upper member of the Bogota.

The "fresh-water" limestones occur in the sandy shale or lower portion of the Newton. They may be within a few feet of each other or may be separated by as much as 20 feet of shale and sandstone. The lower "fresh-water" limestone is gray, weathers gray to buff color, and usually contains abundant *Spirorbis*. It is fine-grained to dense, hard, with calcite streaks. It sometimes weathers into slabs or is nodular. The upper "fresh-water" limestone is a yellowish-brown color, generally nonfossiliferous, although *Spirorbis* is occasionally present. It is hard, conglomeratic, contains calcite flecks, and weathers into angular fragments.

The Newton underclay is drab to light bluish-gray. At the type locality it contains calcareous nodules with *Spirorbis* where it overlies the "fresh-water" limestone. At locality (31) in Richland County the underclay contains a few root traces in the upper part.

At the type locality, Jasper County (4), there is 2 feet of medium dark gray silty shale above the underclay and below the "middle" limestones. It is poorly bedded above and flaky below. At locality (31) in Richland County this shale

is about 1 foot thick (Pl. I). In the upper part just below the limestone crinoid stems are present; in the lower part it contains carbonaceous material where it overlies the underclay.

The Newton "middle" limestone is a dark gray, very argillaceous limestone varying from 7 inches to 1 foot in thickness. It is very fossiliferous containing mostly brachiopods, many of which are crushed and broken. *Chonetes* and crinoid stems are abundant. This horizon may locally be a shale with abundant limestone nodules and fossils. At locality (31) in Richland County the limestone is very ferruginous and contains tiny calcite veinlets.

The black sheety shale above the Newton limestone varies in thickness from 1½ to 4 feet at the type locality along Crooked Creek in Jasper County. The

Fig. 10.—GREENUP LIMESTONE, EAST BANK OF EMBARRASS RIVER WITHIN SIGHT OF BRIDGE, NW. ¼ SEC. 2, T. 10 N., R. 9 E., CUMBERLAND COUNTY.

black shale is not always sheety throughout the entire thickness. It may in part be flaky, rather soft to very hard, and slightly silty. It may also be in part well laminated and contain poorly preserved carbonaceous plant impressions. The black shale is not present above the limestone at locality (31) in Richland County.

The Newton upper shale is gray to dark gray, silty, becoming sandy at the top, thin-bedded, and contains flat oval ironstone concretions. In the NE. ¼ sec. 1, T. 9 N., R. 9 E., just northeast of Greenup in Cumberland County the first 5 feet of the shale above the black sheety shale has a distinct blocky structure and contains *Aviculopecten* and other fossils. The upper shale of the Newton cyclothem is more than 40 feet thick in places.

Greenup cyclothem.—The Greenup cyclothem lies above the Newton and below the Gila cyclothems in the geologic section. The principal exposures of strata belonging to the Greenup occur in the central western part of this area, in Cumberland and Jasper counties, and the basal sandy shale member extends southward into Richland County.

The Greenup cyclothem is characterized by a light gray, nodular to shaly, fossiliferous limestone with *Fusulina* often present in the upper part. It is underlain by massive to thin-bedded sandstone or sandy shale, and is overlain by massive, calcareous sandstone or poorly bedded shale. No beds of "fresh-water" limestone, underclay, coal, or black sheety shale have been recognized in this cyclothem in this area.

The basal member of the Greenup cyclothem is composed of thin-bedded sandstone and sandy shale which may be calcareous and massive in the upper part. It varies in thickness from a few feet to more than 25 feet in this area.

The Greenup marine limestone varies considerably in lithology but can usually be distinguished from the marine limestones of associated cyclothems by its occurrence between two shales or sandstones and by the fossils which it contains, notably *Fusulina* (see columnar sections 1, 2, 5, and 31, Pl. I.).

The Greenup limestone is exposed at several places along the Embarrass River just north of Greenup, Cumberland County, especially in secs. 2 and 3, T. 9 N., R. 9 E. A very accessible outcrop of the limestone is along the Illinois Highway 130 road-cut just south of the Embarrass River in sec. 2 where it overlies sandstone and is about 15 feet above the flood-plain of the Embarrass River (fig. 10). Four miles north of this locality the Greenup limestone outcrops on the east side of the Embarrass in the NW. ¼ sec. 2. The limestone may be seen from the bridge an eighth of a mile south of the outcrop. The limestone is light gray, weathers somewhat brownish, is quite fossiliferous, and some upper surfaces of the limestone are covered with small worm-tube casts. The shale below the limestone is silty at the top and sandy below.

The Greenup limestone is exposed at several places in T. 10 N., R. 8 E., along the northwest-southeast tributary to the Embarrass in sec. 15 and in the northeast part of sec. 16. The limestone is 2½ feet to 3 feet thick where the total thickness is seen. The upper 10 inches of the limestone is gray, weathers to a buff color, and is very fossiliferous with many *Fusulina*. This part of the limestone is well exposed along the creek just north of the road in the SE. ¼ sec. 15. The lower part of the limestone is gray, argillaceous, and fossils are not conspicuous. The upper fusulinid portion of the limestone is not everywhere present. Where it is absent the lower part weathers with a very uneven surface. Shale is found both above and below the limestone.

In southwestern Cumberland County in the road on the half-section line in the W. ½ sec. 30, T. 9 N., R. 8 E., is an outcrop of nodular Greenup limestone. Just north of this road a cross-bedded channel sandstone cuts out the limestone, and has limestone pebbles in its conglomeratic base.

In northwestern Jasper County, just south of the Cumberland County line, the limestone crops out in an east-west gully which crosses a north-south road in the northeast part of sec. 3, T. 8 N., R. 8 E. At this locality the Greenup limestone is gray, weathers gray to buff, is rather pure to somewhat earthy, and grades laterally into greenish-gray clay with limestone nodules. It also grades into the underlying calcareous sandstone. The limestone contains *Fusulina* and crinoid stems. It is also present in discontinuous outcrops up a hollow which crosses secs. 10, 16, and 21 in a southwest-northeast direction. The limestone has an uneven surface and is underlain and overlain by sandstone.

At locality (1) in Jasper County, outcrops of the Greenup limestone occur along Mint Creek in secs. 7 and 17, T. 7 N., R. 9 E., northwest of Newton. The limestone is hard, nodular, weathers gray to buff color, and is fossiliferous. Crinoid stems, echinoid spines, *Rhombopora*, and other marine fossils are present. In secs. 28 and 29, T. 8 N., R. 9 W., Jasper County, in a gully that drains eastward into the Embarrass, the limestone rests upon a calcareous, irregularly bedded, brownish weathering siltstone.

The stratum above the Greenup limestone may be a thin-bedded to a massive sandstone (columnar sections 1 and 5, Pl. I), or it may be a poorly bedded, slightly greenish shale which grades into the basal member of the cyclothem above.

Gila cyclothem.—The Gila cyclothem is a small cyclothem locally developed in the northwestern Jasper County (fig. 2). It occurs between the Greenup and the Woodbury cyclothems in the geologic section.

The Gila cyclothem outcrops in T. 8 N., R. 9 E., 1½ miles southeast of Gila, in the upper part of a hollow in the southeast part of sec. 29, as shown in (2) (Pl. I). The type locality is along Mint Creek in sec. 31, to the southwest in this same township, as shown in (1) (Pl. I). Outcrops in sec. 31 continue downstream into sec. 6 of the adjoining township to the south. The Gila cyclothem at the type locality is about 20 feet thick. It thins northeastward and is only about 4 feet thick at locality (2) in sec. 29, within about one mile.

The Gila cyclothem is characterized by a medium gray, dense and hard, thin limestone containing carbonaceous material, and an underlying coal horizon, below which is an underclay that is silty and weathers buff in the lower part. The basal member is a massive to thin-bedded sandstone which may in part be calcareous.

At the type locality (1), the Gila underclay is bluish-gray to greenish-gray and weathers buff in the lower part with a texture similar to that of loess. It is very silty, rather hard, and in some places may be described as a buff, argillaceous siltstone. It has a maximum thickness of 7 feet.

At the top of the underclay at (1) there is a locally developed 3-inch cone-in-cone structure. Above this and below a coal horizon there is 6 inches of medium gray to black flaky shale.

The Gila limestone is 1 to 4 inches thick at locality (1) and is not persistent at (2). It is medium gray, weathers nearly white, is dense, fine-grained, brittle, and contains small fragments of carbonaceous material. No fossils have been found in this limestone.

The upper shale of the Gila is medium light gray, nonsilty to silty, poorly bedded, contains a few irregular ironstone concretions and at locality (1) grades laterally into hard, calcareous siltstone slabs and grades vertically into the sandy shale of the overlying Woodbury cyclothem.

Woodbury cyclothem.—The Woodbury cyclothem is the uppermost cyclothem exposed in this area. It occurs above the Greenup cyclothem in Cumberland County and above the Gila cyclothem in Jasper County.

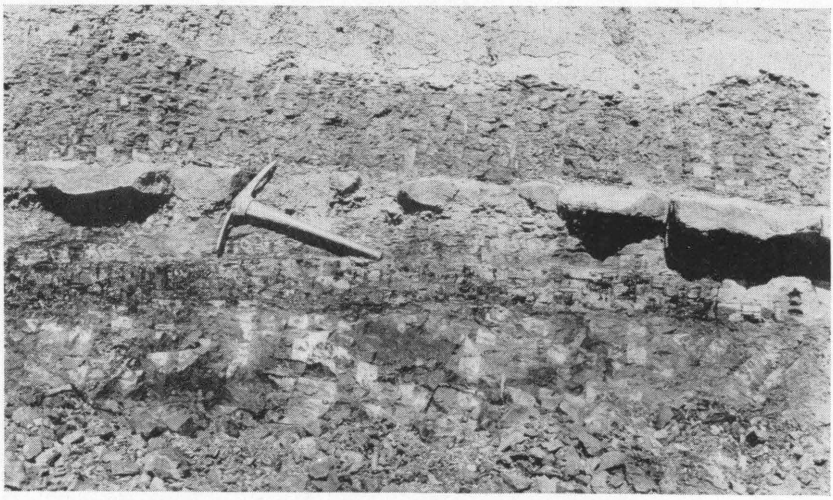


Fig. 11.—TYPE LOCALITY OF THE WOODBURY CYCLOTHEM SHOWING FOSSILIFEROUS IRONSTONE (AT TOP OF PICK), 5-INCH BED OF COAL (AT BASE OF PICK), AND UNDERCLAY. MIDDLE OF S. ½ SE. ¼ SEC. 32, T. 9 N., R. 8 E., CUMBERLAND COUNTY.

The type locality of the Woodbury is about two miles southwest of Woodbury, Cumberland County, along Webster Creek just north of the Jasper County line (fig. 2). The best outcrop (fig. 11) is on the north side of the creek in the SE. ¼ sec. 32, T. 9 N., R. 8 E., about one-quarter of a mile west of the east section line. This geologic section is shown in (5) (Pl. I).

The Woodbury cyclothem is characterized by a fairly persistent thin coal with a silty underclay that thickens southward. The lower part of the upper shale contains marine fossils. At the type locality there is an easily recognized very fossiliferous and calcareous ironstone band about 6 inches above the coal. Southward into Jasper County the shale is black, calcareous, and slaty.

At the type locality in Cumberland County (5), the basal member of the

Woodbury cyclothem is a calcareous, thin-bedded, locally massive sandstone which rests upon the Greenup limestone. Southward in Jasper County at locality (2) in sec. 29, T. 8 N., R. 9 E., there is no sandstone and the Woodbury underclay rests upon the upper shale of the Gila cyclothem. At locality (1) in sec. 31 of this same township the basal member of the Woodbury consists of sandy shale with thin beds of sandstone.

At locality (5) in Cumberland County the underclay is bluish-gray and sandy. It thickens southward and in Jasper County at localities (1) and (2) it is bluish-gray, quite silty, rather hard, and may be iron stained locally.

Fig. 12.—MEROM SANDSTONE CHANNEL IN NEWTON SHALE, SOUTH BANK OF WEBSTER CREEK, NE. ¼ SEC. 33, T. 9 N., R. 8 E., CUMBERLAND COUNTY.

The Woodbury coal in southern Cumberland County at the type locality is hard, blocky, and 5 inches thick. In Jasper County it is shaly and 1 to 4 inches thick.

At the type locality there is a 6-inch shale above the coal which is dark gray to bluish-gray and fossiliferous. At some localities this shale is soft and red. It contains small calcareous nodules in the upper part and gypsum crystals in the lower part.

Southward in Jasper County at locality (2) this shale is 8 inches thick, dark gray to black, is flaky below and contains *Estheria, Ostracodes,* pelecypods, and carbonaceous plant stems. At locality (1) this shale is black, flaky to slaty, very calcareous, and contains poorly preserved fossils. It has the appearance in places of an impure slaty limestone.

Above this shale at locality (5) in Cumberland County is a 3-inch to 4-inch fossiliferous ironstone bed. It is medium gray and weathers a reddish, rusty brown color, and is quite hard. It contains *Schizostoma catilloides, Pharkidonotus*

pericarinatus, Meekospira peracuta, Phanerotrema grayvillenses, Lophophyllum profundum, Ambocoelia planoconvexa, Marginifera, crinoid stems, and a species of nautiloid.

This fossiliferous ironstone bed was not found in Jasper County but the lower part of the upper shale contains similar fossils and locally contains small limestone nodules at the base.

The upper shale of the Woodbury cyclothem is gray to drab becoming darker gray below, is silty, fossiliferous in the lower part, and contains some knotty appearing ironstones.

Merom sandstone.—As stated at the beginning of this report, the sandstone which blankets a large part of this area is tentatively correlated as the Merom. In many places it lies disconformably on older formations and locally the base of this sandstone fills old stream channels (fig. 12). This sandstone is commonly brown, medium to coarse grained, friable or loose grained, cross-bedded, and it often contains irregular lenses or pockets of coal and limestone near its base.

APPENDIX

GEOGRAPHIC LOCATIONS OF COLUMNAR SECTIONS SHOWN ON PLATE I

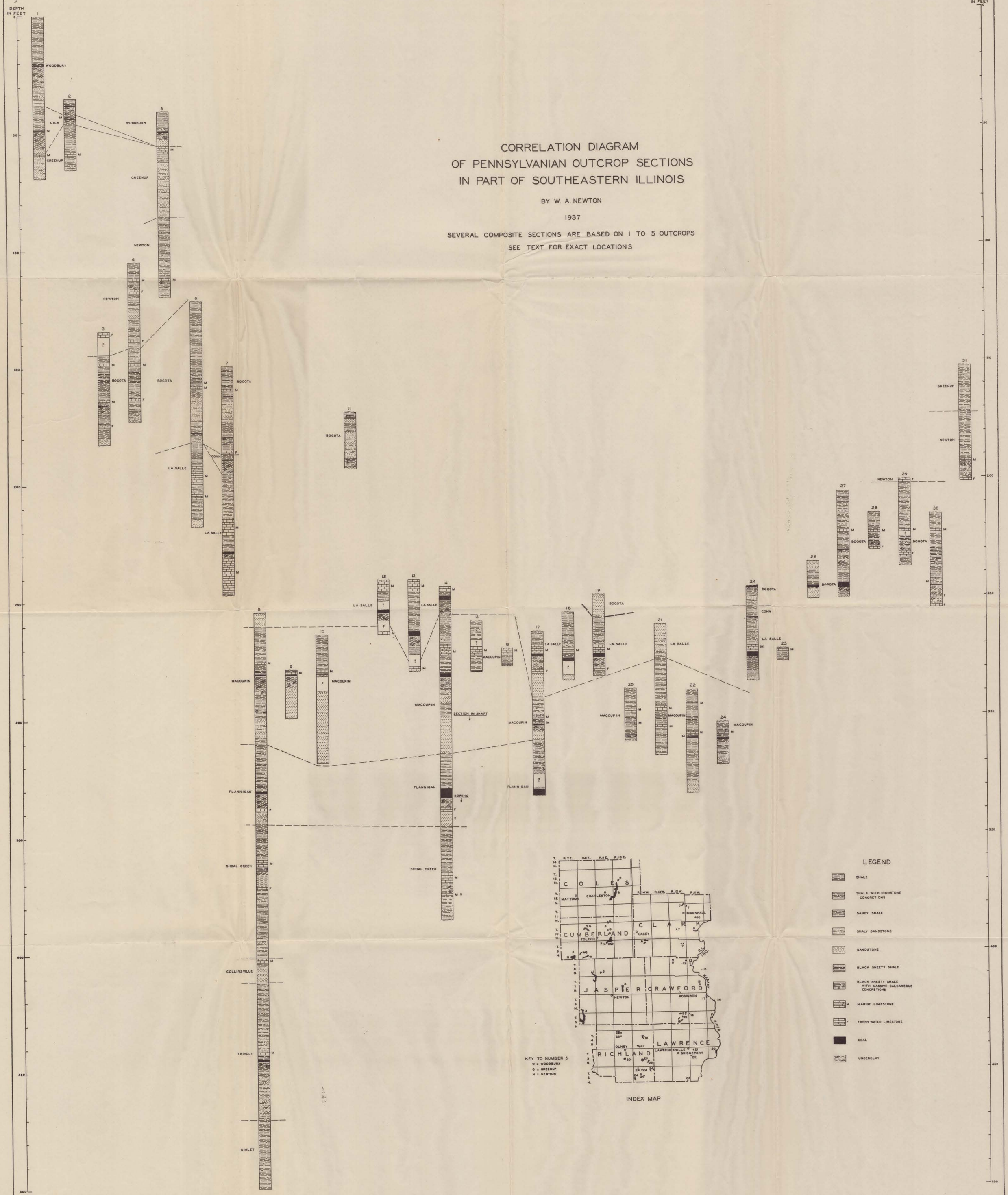
Locality Number	County	Township	Range	Sections
(1)	Jasper	8 N.	8 E.	25, 36
		8 N.	9 E.	31, along NW.–SE. tributary
		7 N.	9 E.	6, 7
		7 N.	8 E.	12, 13
(2)	Jasper	8 N.	9 E.	28, 29
(3)	Jasper	6 N.	8 E.	29, 32, 33
		5 N.	8 E.	4, 5, 8, 9, 16, 17, 18, 20
(4)	Jasper	7 N.	10 E.	15, 16, 21, 22, 27, 28
(5)W	Cumberland	9 N.	8 E.	32, 33
		9 N.	9 E.	10, center W. ½ NW. ¼
(5)G	Cumberland	9 N.	8 E.	30
		9 N.	9 E.	3, SE. ¼
		10 N.	8 E.	15, 16
		10 N.	9 E.	2, 14, 26
(5)N	Cumberland	9 N.	9 E.	1, 2, 3
		10 N.	9 E.	36, SW. ¼
		9 N.	7 E.	35, 36
(6)	Coles	13 N.,R.	10 E.	21, 32
		12 N.,R.	10 E.	5, 6, 17, 18, 20
		12 N.,R.	9 E.	25
(7)	Clark	11 N.	12 W.	1, 2
		10 N.	12 W.	21, north central
		9 N.	12 W.	11, 12
(8)	Clark	9 N.	14 W.	2, 3, 10
(9)	Clark	10 N.	11 W.	15, 16, S. ½
(10)	Clark	11 N.	11 W.	27, W. ½
(11)	Crawford	8 N.	12 W.	5, 8, S. ½, sec. 5
(12)	Crawford	8 N.	12 W.	1, SE. ¼
(13)	Crawford	8 N.	11 W.	7, 17, NW. ¼ and west bank Wabash River
(14)	Sullivan, Ind.	6 N.	10 W.	18, river bluff at Merom
(15)	Sullivan, Ind.	8 N.	11 W.	24, east center
(16)	Crawford	7 N.	11 W.	23, east center
(17)	Crawford	6 N.	10 W.	7, NW. ¼
(18)	Crawford	5 N.	11 W.	6, SW. ¼
(19)	Crawford	5 N.	12 W.	1, 2, 3, 14, 15
(20)	Lawrence	3 N.	10 W.	9, west bank Wabash River
(21)	Lawrence	3 N.	11 W.	5, east bank Embarrass River
(22)	Lawrence	3 N.	11 W.	18, middle
(23)	Lawrence	2 N.	12 W.	26, SE. ¼
(24)	Richland	2 N.	14 W.	2, 6, 8, 11, 16, 17, 19
(25)	Richland	4 N.	10 E.	16, road-cuts in NW. ¼
(26)	Richland	4 N.	10 E.	4, road-cuts in NW. ¼
(27)	Richland	4 N.	14 W.	30
		4 N.	11 E.	30, E. ½
(28)	Richland	3 N.	14 W.	26, N. ½
(29	Richland	3 N.	14 W.	20, 21, road-cut and W. ½, sec. 21
(30)	Richland	3 N.	10 E.	15, 22, S. ¼ sec. 15, NW. ¼ sec. 22
(31)	Richland	4 N.	14 W.	8, 17

CORRELATION DIAGRAM OF PENNSYLVANIAN OUTCROP SECTIONS IN PART OF SOUTHEASTERN ILLINOIS

BY W. A. NEWTON

1937

SEVERAL COMPOSITE SECTIONS ARE BASED ON 1 TO 5 OUTCROPS
SEE TEXT FOR EXACT LOCATIONS



KEY TO NUMBER 5
W = WOODBURY
G = GREENUP
N = NEWTON

INDEX MAP

LEGEND

- SHALE
- SHALE WITH IRONSTONE CONCRETIONS
- SANDY SHALE
- SHALY SANDSTONE
- SANDSTONE
- BLACK SHEETY SHALE
- BLACK SHEETY SHALE WITH MASSIVE CALCAREOUS CONCRETIONS
- M — MARINE LIMESTONE
- F — FRESH WATER LIMESTONE
- COAL
- UNDERCLAY

ERRATUM: On the above index map the township line between R. 11 E. and R. 14 W. through Jasper and Richland counties is omitted. R. 11 E. is only one section wide. See figure 2 for correct township lines.