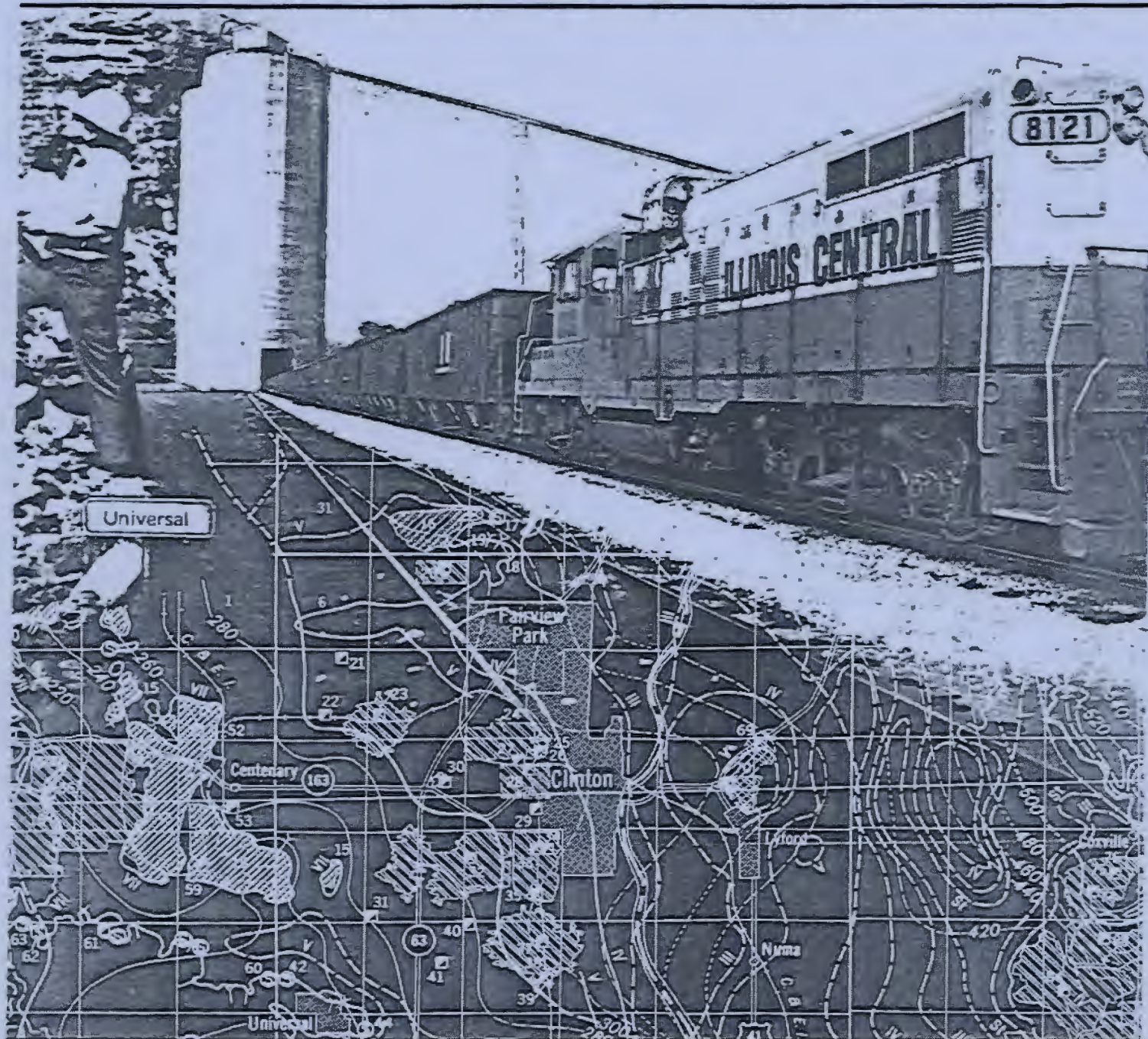


GEOLOGY AND COAL DEPOSITS OF THE CLINTON AREA, WEST-CENTRAL INDIANA

Special Report 42



State of Indiana
Department of Natural Resources
GEOLOGICAL SURVEY

AUTHOR OF THIS REPORT

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Geology and Coal Deposits of the Clinton Area, West-Central Indiana

By S. A. FRIEDMAN

DEPARTMENT OF NATURAL RESOURCES
GEOLOGICAL SURVEY SPECIAL REPORT 42



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DEDICATION

This publication is dedicated to the memory, work, and friendship of my late colleague, coal geologist Harold C. Hutchison. Hutch was a staff member of the Indiana Geological Survey, 1949-78.

—S. A. Friedman

GEOLOGY AND COAL DEPOSITS OF THE CLINTON AREA, WEST-CENTRAL INDIANA

By S. A. Friedman

ABSTRACT

The Clinton area, a 260-square-mile tract north of Terre Haute, Ind., has been one of the most productive coal-mining areas of the state, yet still contains 1.350 million tons of bituminous coal resources, or about 1/26 of the coal resources of Indiana. Resources and recoverable reserves were calculated for four major coals that are 4 to 6 feet thick in most places. Most of this coal, of high-volatile C bituminous rank, must be extracted by underground mining, but some of it can be mined by surface methods. About 700 million tons of these resources are recoverable reserves, assuming 50-percent recovery for underground mines and 80-percent recovery for surface mines. Nearly two-fifths of the recoverable resources are in the deepest commercial coalbed, the Seelyville Coal Member (III).

Eight hundred feet of sedimentary strata of Pennsylvanian age in the Clinton area contain 25 coalbeds. Only the middle 300 feet of these strata contain coal of commercial thickness and extent. Most of the other coalbeds are irregular in thickness and distribution. Rocks overlying the coal include principally shale and sandstone with thin beds of coal, limestone, and underclay. These rocks are overlain by glacial drift averaging about 50 feet in thickness, and the drift is overlain by alluvium in stream valleys and by windblown sand and silt on upland areas.

Where they crop out, strata appear as nearly horizontal beds; they dip less than one-third of a degree to the southwest. Gentle folds of the strata, however, cause hills and swales that hamper mining in the coalbeds.

Roof conditions for mining are variable. The best roof is formed by carbonaceous black shale that commonly overlies the

Springfield Coal Member (V). An intermediate roof is formed by gray shale that overlies the Survant Coal Member (IV). An intermediate to poor roof is formed by gray shale that commonly overlies the Seelyville Coal Member (III). And finally, a rather poor roof is formed by blue-gray mudstone that in some places overlies the Danville Coal Member (VII).

Coal has been mined underground from depths as great as 500 feet, and it is now (1986) being mined from open pits with as much as 150 feet of shale and glacial-drift overburden. One large mine remains open, the Universal Mine of the Peabody Coal Co. From 1970 to 1985 annual production from this strip mine ranged from 0.9 to 3.0 million tons.

INTRODUCTION

LOCATION AND GENERAL DESCRIPTION OF THE AREA

This report discusses in detail the stratigraphy of the strata of Pennsylvanian age and describes the location, distribution, and quantity of coal reserves in the Clinton area (fig. 1), which is in west-central Indiana, about 60 miles west of Indianapolis. The area consists of about 260 square miles in southwestern Parke County, southern Vermillion County, and northwestern Vigo County. The Saint Bernice, Clinton, Mecca, Sandford, New Goshen, and Rosedale 7.5-minute topographic quadrangle maps of the U.S. Geological Survey cover the area (fig. 1). Because Clinton is the largest and best known city in the study area, it is referred to as the Clinton area.

The rail center that serves the Clinton area is Terre Haute, whose north edge lies within

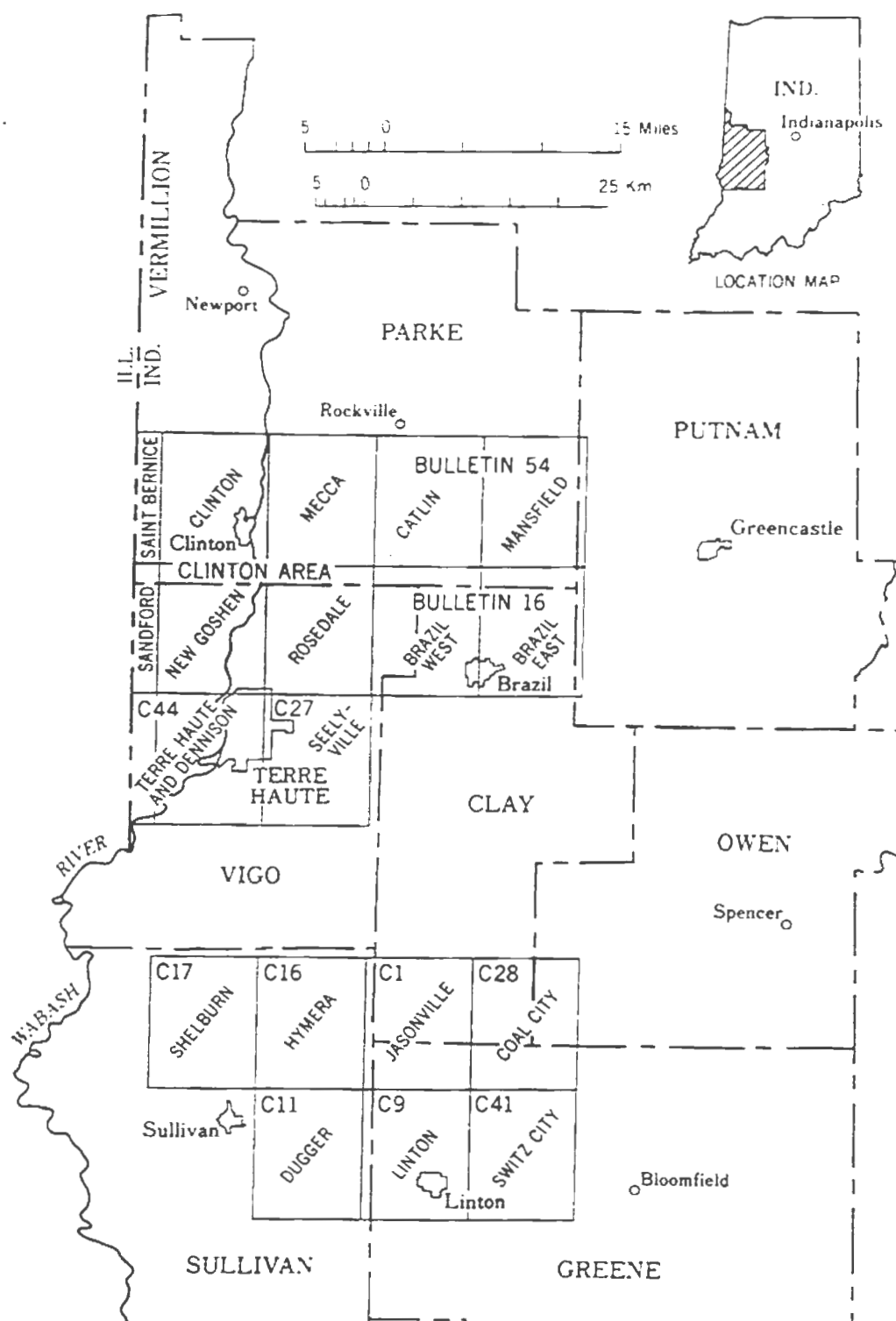


Figure 1. Index map showing location of the Clinton area and of adjacent areas mapped and published in the Coal Investigations series of the U.S. Geological Survey and the Bulletin series of the Indiana Geological Survey.

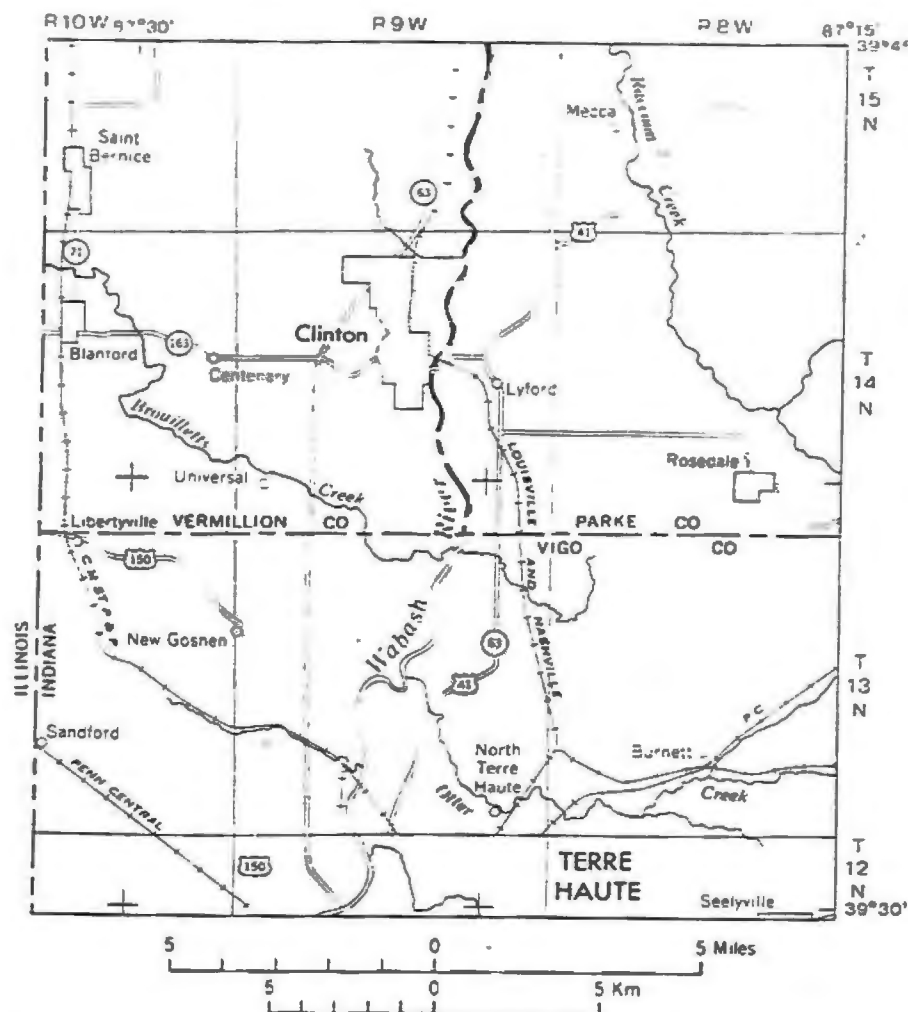


Figure 2. Map showing principal roads, railroads, and urban localities in the Clinton area.

the south-central part of the map area (fig. 2). Many of the small towns were once important mining centers, but they are now residential communities.

The Clinton area is divided by landforms into several distinct parts. West of the Wabash River is a till-covered upland that is relatively undissected except along the bluffs of the river and along the valleys of some of the large tributary streams, such as Brouillets Creek. East of the Wabash River and north of Rosedale, a higher and more thoroughly dissected upland area is cut through by the northward-flowing lower course of Raccoon Creek. In the southeastern part of the Clinton

area, a small area of low rolling hills is dissected by Otter Creek and its tributaries.

These upland areas are separated by the 2- to 4-mile-wide valley of the Wabash River and by another broad valley that enters the Wabash Valley from the northeast just north of Terre Haute. The latter valley carries no major stream but is thought to mark a former course of Raccoon Creek (Wayne, 1956). These flat-floored valleys are in sharp contrast to the surrounding rolling uplands.

The maximum relief in the area is about 250 feet near Mecca on the east bluffs of the Wabash River valley. The highest point, in sec. 6, T. 14 N., R. 8 W., has an altitude of 710

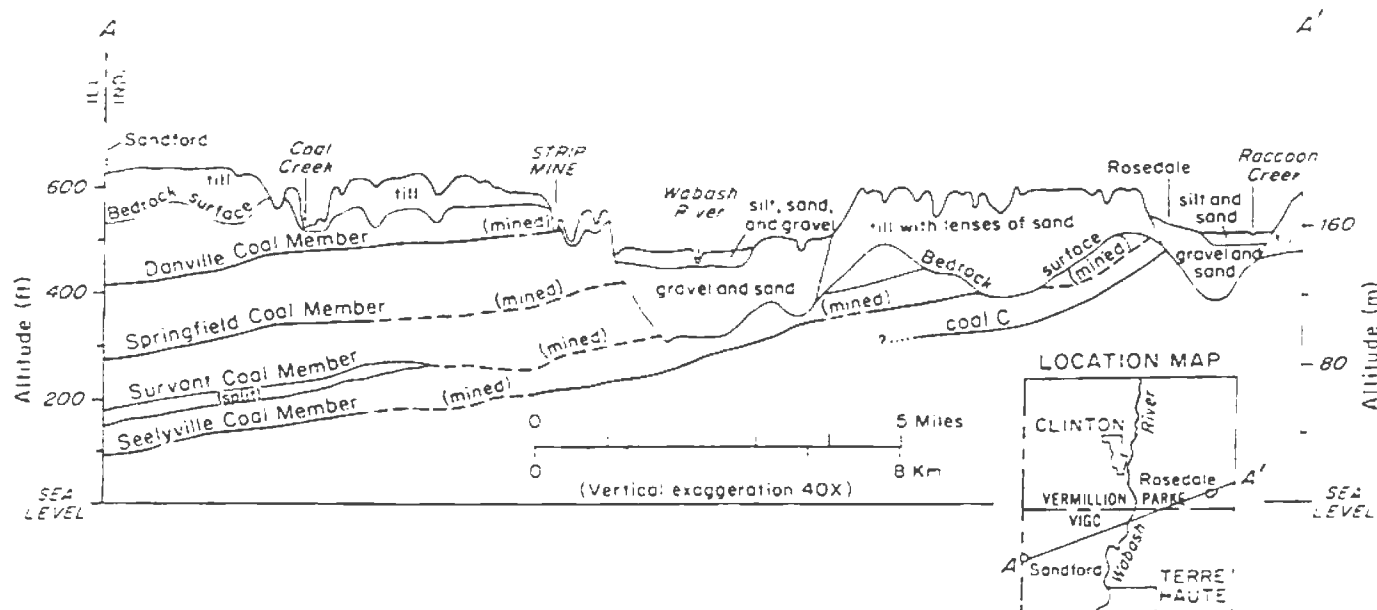


Figure 3. Generalized cross section of the Clinton area showing the southwesterly dip of major coals.

feet, and the lowest point is on alluvium along the banks of the Wabash River at an altitude of 460 feet. Bluffs on the west side of the Wabash River valley have as much as 150 feet of relief.

In the Clinton area the ground surface is almost everywhere underlain by unconsolidated deposits of various kinds: glacial till and outwash, windblown silt and sand, and alluvium. Lying beneath a varying thickness of these materials (fig. 3) and cropping out where the unconsolidated materials are absent is bedrock of Pennsylvanian age, including eight formations with an aggregate thickness of 800 feet (fig. 4). These formations contain no fewer than 25 coalbeds; four of these beds have been major producers of coal in this area.

The formations and coalbeds of Pennsylvanian age all dip southward at a rate that is imperceptible where they crop out but that may be determined to be generally about 25 feet per mile. Therefore the older and lower coalbeds that are near the surface in the eastern part of the Clinton area lie deep underground in the western part (fig. 3).

PREVIOUS GEOLOGIC WORK

Early reports that discussed the geology

and coal resources in the Clinton area were by D. D. Owen (1859), Richard Owen (1862), E. T. Cox (1869, 1875), and T. C. Hopkins (1896). G. H. Ashley (1899) made the most comprehensive single report on the coal deposits of Indiana, which he later revised (1909). More recently C. E. Wier (1952) mapped the distribution, structure, and mined areas of coals and tabulated coal-mine data, coal production, and coal reserves for Vigo County. Powell (1968) prepared a corresponding map of Parke County and southern Vermillion County. Friedman (1960), using examples from the Clinton area, made a study of channel-fill sandstones showing their stratigraphic positions and their effect on coal deposits. In a later paper he discussed the stratigraphy of the Staunton Formation (Friedman, 1967).

FIELDWORK AND ACKNOWLEDGMENTS

Fieldwork for this report was carried out in 1953-57 with assistance by Jack L. Nelson (1953), Richard L. Powell (1955), and Pete Garrison (1957). Part of the fieldwork in the Rose Dale Quadrangle was done in 1954 by Charles E. Wier, assisted by Richard L. Powell.

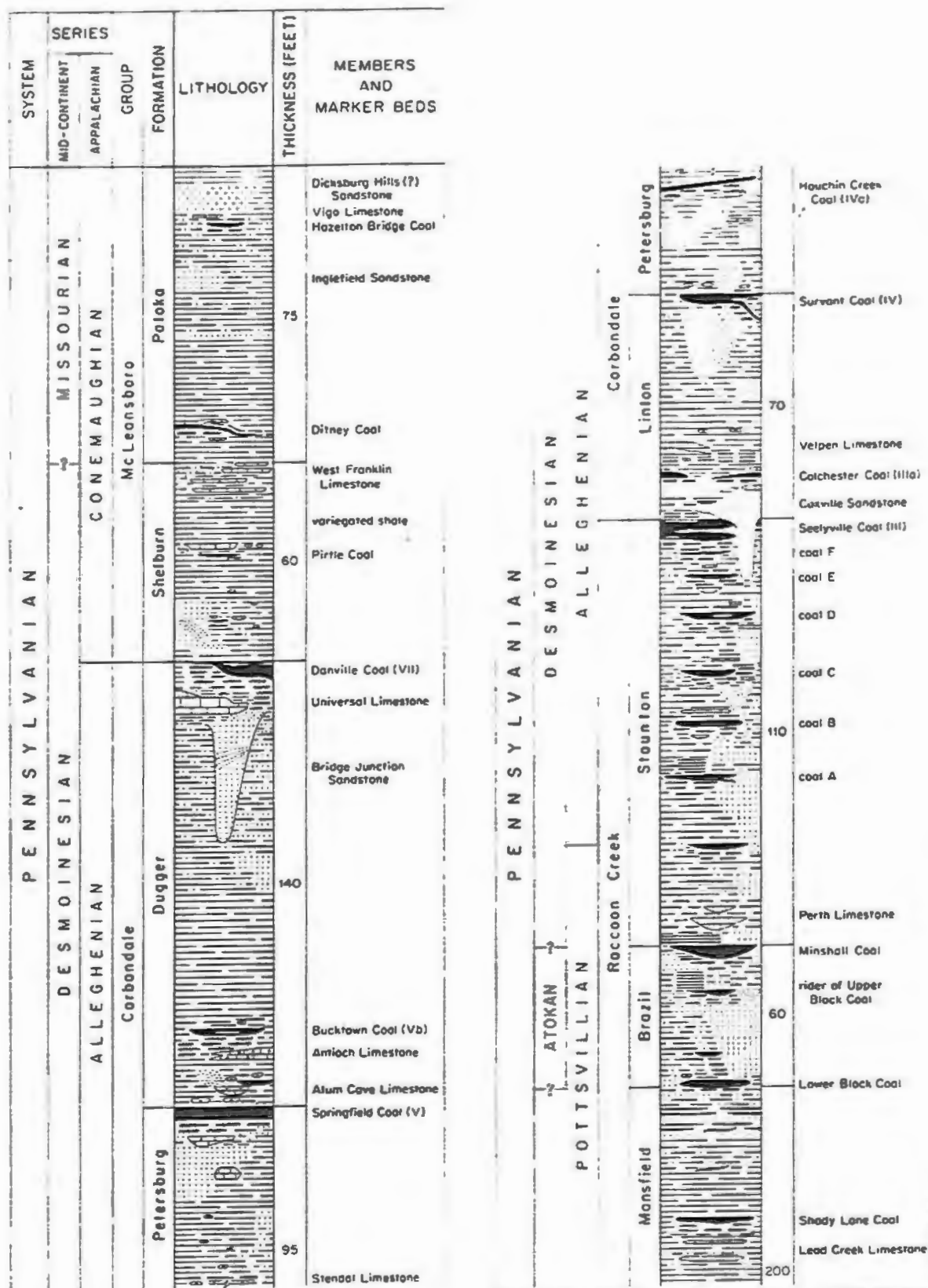


Figure 4. Generalized columnar section showing coal-bearing rocks of the Clinton area.

The manuscript was completed in 1967 and was extensively revised in 1979 and 1980. Further adjustments of production figures and mined areas updated the work to December 31, 1985. Henry H. Gray and Donald D. Carr guided and assisted in these revisions.

STRATIGRAPHY OF THE MISSISSIPPIAN SYSTEM

Two major erosional unconformities are recognized in the area: one is of Late Mississippian to Early Pennsylvanian age and is commonly identified as the pre-Pennsylvanian unconformity, and one is of pre-Pleistocene age. Strata of Middle and Late Mississippian age underlie the pre-Pennsylvanian unconformity, and strata of Middle and Late Pennsylvanian age underlie the pre-Pleistocene unconformity.

Strata of the Mississippian System do not crop out in the map area, nor do they lie directly beneath the blanket of glacial drift; they are recognized only beneath the Pennsylvanian rocks. The Salem Limestone (Middle Mississippian in age) is the oldest formation at the buried surface of the pre-Pennsylvanian unconformity in the Clinton area. In the northwestern part of the area, in a large pre-Pennsylvanian valley, this limestone is overlain by strata of Early Pennsylvanian age. At some localities the Salem Limestone is conformably overlain by the St. Louis Limestone, which is in turn overlain conformably by the Ste. Genevieve Limestone. The St. Louis and Ste. Genevieve Limestones are at the pre-Pennsylvanian unconformity in most of the Clinton area. Shale, sandstone, and limestone of early Chesterian age overlie the Ste. Genevieve but are recognized in only one small place in the southern part of the Clinton area (Dan M. Sullivan, oral communication, 1963).

STRATIGRAPHY OF THE PENNSYLVANIAN SYSTEM

Rocks of the Pennsylvanian System rest unconformably on strata of Mississippian age. The Pennsylvanian rocks are divided into series; in ascending order they are the

Pottsvilleian, the Alleghenian, and the Cone-maughian (fig. 4). The Pottsvilleian Series and the lower part of the Alleghenian Series do not crop out in the area, but they are known from subsurface data.

MANSFIELD FORMATION

The Mansfield Formation is composed mostly of shale and sandstone but also contains beds of coal, underclay, and limestone. The base of the Mansfield ranges from 275 feet below the surface in the northeastern part of the Clinton area to 970 feet in the southwestern part. Because rocks of the Mansfield Formation fill valleys eroded into the Mississippian strata, the formation shows a great range in thickness. It ranges from 106 to 314 feet and averages 204 feet. Cumulative measurements of 1,800 feet of Mansfield strata from data from 17 oil-test wells and Indiana Geological Survey drill hole (SDH) 34 (appendix) show an equal ratio of sandstone and sandy shale to gray and dark-gray shale. Available data indicate that gray shale dominates the upper part of the Mansfield; sandstone, the middle part; and medium- to dark-gray shale, the lower part.

A coal 0.7 foot thick in the upper part of the Mansfield Formation (fig. 4 and pl. 5, section 14) probably correlates with the Shady Lane Coal Member of Hutchison (1960, p. 12). This coal lies about 40 feet below the base of the Lower Block Coal Member of the Brazil Formation in SDH 34 (appendix). In this core the only key unit below this coal consists of two thin limestones separated by a thin bed of calcareous siltstone and shale. Possibly the limestones are correlative with the Lead Creek Limestone Member of the Mansfield Formation in Dubois County. The 40-foot interval between the Lower Block and Shady Lane coals is composed of shale, sandy shale, dark-gray to black shale interlaminated with yellow-brown fine-grained sandstone, and two coal films.

BRAZIL FORMATION

The Brazil Formation, like the Mansfield, lies entirely in the subsurface throughout the

Clinton area. The Brazil overlies the Mansfield (fig. 4), and its base is the bottom of the Lower Block Coal Member. If the Lower Block coal is absent, the contact between the Brazil and the Mansfield is difficult to find. The top of the Brazil is the top of the Minshall Coal Member (Hutchison, 1976, p. 20-21). The Brazil Formation is 51 to 66 feet thick and averages about 60 feet in the Clinton area. It is composed of gray shale, sandstone, sandy shale, dark-gray shale interbedded with yellow-brown fine-grained sandstone, high-volatile bituminous coal that contains bright and dull constituent layers, black carbonaceous shale, marine limestone, and underclay, in decreasing order of abundance.

BLOCK COALS

The Lower Block Coal Member was identified in well records, mainly by its stratigraphic position below the Perth Limestone Member and the rider of the Upper Block Coal Member. The coal averages 2.1 feet in thickness (table 1). Southeast of Rosedale this coal is split into two beds; the upper is 3.3 feet thick and the lower, 1.2 feet thick. As much as 10 feet of gray and blue-gray shale separates the two beds (pl. 5, section 9).

This coal is commonly underlain by underclay, averaging 2.8 feet in thickness, that is underlain by sandstone, sandy shale, or dark-gray shale interlaminated with yellow-brown fine-grained sandstone. Well data indicate that sandy shale, shale with small ironstone nodules, or sandstone commonly overlies the Lower Block coal (fig. 4). At Mecca and vicinity, where the Lower Block coal was produced from underground mines, the roof material consists of gray shale. In some parts of the Mecca No. 1 Mine (pl. 4, no. 161), limestone as much as 1.0 foot thick overlies the Lower Block coal. Ashley (1899, p. 370-371) stated that two veins of coal were worked at the Mecca No. 1 Mine. I believe that the upper vein either is a rider of the Lower Block coal or is the Upper Block coal. Plastic underclay, white sandy underclay, or claystone occupies the 1.5- to 16-foot interval between the coals. The coal was of good

quality in the Mecca No. 1 Mine and was 3.7 to 6.5 feet thick (Ashley, 1899, p. 370-371). In places within the mine the lower 0.5 foot of coal is shaly.

Because of insufficient information, correlation of this coalbed with the Lower Block Coal Member in Clay County is tentative.

The Upper Block Coal Member appears to be lacking in this area. A coal in the position of the rider of the Upper Block coal was recognized in a few drill records (pl. 5, *B-B'*), but its distribution is uncertain. Underclay, averaging 2 feet in thickness, lies beneath the coal. The interval between the rider of the Upper Block coal and the Lower Block coal consists of 28 feet of gray shale, sandy shale, and sandstone (fig. 4). In places where the rider of the Upper Block is absent, its position is occupied by dark-gray shale, dark-gray shale interlaminated with yellow-brown fine-grained sandstone, or sandstone. The rider of the Upper Block coal is underlain by about 1.7 feet of underclay and is overlain by dark-gray to black shale containing plant fossils, by gray shale, or by sandstone (pl. 5). This coal lies 10 feet below the Minshall Coal Member.

MINSHALL COAL MEMBER

The Minshall Coal Member, which marks the top of the Brazil Formation (fig. 4), has been called "semiblock" by mining operators in other areas. The Minshall coal and its underclay have greater continuity and thickness than other key beds in the Brazil Formation. The coal ranges from less than 0.1 to 5.2 feet in thickness and averages 3 feet (table 1). It is underlain by common but discontinuous underclay averaging 2.0 feet in thickness. In most places where the Minshall coal is absent, its stratigraphic position is occupied by gray shale interlaminated with yellow-brown fine-grained sandstone or siltstone. Gray shale that is sandy in some places most commonly overlies the Minshall coal.

STAUNTON FORMATION

The Staunton Formation, which overlies the Brazil Formation, includes rocks from the top of the Minshall Coal Member to the top

GEOLOGY AND COAL DEPOSITS OF THE CLINTON AREA, WEST-CENTRAL INDIANA

Table 1. Summary of coal-thickness data in the Clinton area

Formation	Coalbed	Number of observations	Thickness (ft)	
			Range	Average
Patoka	Hazelton Bridge	1	-----	1.3
	Ditney	4	0.4-1.3	0.7
Shelburn	Pirtle	2	<0.1-0.3	<0.2
Dugger	Danville	60	2.5-5.5 ^a	4.5 ^a
			2.5-7.5 ^b	6.1 ^b
	Bucktown	31	0.5-3.0	1.7
	Unnamed	15	<0.1-3.0	0.8
Petersburg	Springfield	86	1.5-5.5	4.5
	Houchin Creek	34	0.3-3.2	1.5
Linton	Survant	50	2.0-5.5	4.3
	Colchester	37	0.2-2.5	1.2
Staunton	Seelyville	104	0.4-7.1	5.6
	F	14	0.4-1.9	0.7
	E	14	0.3-2.0	1.3
	D	14	0.6-3.7	1.5
	C	9	1.0-4.0	1.8
	B	9	0.2-4.2	2.2
	A	9	0.5-4.0	1.7
	Unnamed	8	0.1-2.0	0.6
Brazil	Minshall	12	<0.1-5.2	3.0
	Rider of Upper Block	3	0.5-2.8	1.7
	Lower Block	5	0.5-4.9	2.1
Mansfield	Shady Lane	1	-----	0.7

^aNet coal without impure zone.^bTotal coalbed.

of the Seelyville Coal Member (III) (Hutchinson, 1976, p. 22). Evidence from numerous stratigraphic sections, from detailed logs of coal-test wells, and from stratigraphic-test wells indicates that the Staunton Formation is 85 to 135 feet thick, averages 110 feet, and contains at least eight coalbeds (fig. 4). Only the Seelyville Coal Member has a formal name. Six other coalbeds (fig. 4) have been informally lettered A through F in ascending order for a previous stratigraphic study (Friedman, 1967), and for convenience, I have used the same informal letter system for these coals in this report. These designations do not form a part of official stratigraphic nomenclature.

PERTH LIMESTONE MEMBER

The Perth Limestone Member lies near the base of the Staunton Formation (fig. 4). The limestone is medium dark gray, thick bedded, very fine grained to sublithographic, and fossiliferous. It is 0.1 to 18.4 feet thick and averages 8.0 feet, and it is the thickest limestone of Pennsylvanian age in the Clinton area. Available data from coal-test wells indicate that the Perth Limestone Member has an areal distribution of about one-half that of the Minshall coal, and therefore its usefulness as a key bed is not so great as that of the Minshall coal in this area. Despite this restriction, the Perth Limestone Member about 100 feet stratigraphically below the well marked Seelyville Coal Member (III) helps in many places to permit accurate identification of the Minshall Coal Member and the Staunton-Brazil formational contact.

Four to 19 feet above the Perth Limestone Member is an unnamed coal (fig. 4) that was formerly designated Coal II and that was included at the top of the Brazil Formation (for example, Friedman, 1967). This coal is less than 0.1 to 2 feet thick and averages 0.6 foot (table 1). Its continuity is much less than that of the Minshall coal, and it is difficult to identify at places where both the Minshall coal and the Perth limestone are absent.

COALS A THROUGH F

The coal informally designated coal A in

this report does not crop out in the Clinton area. Coal A averages 1.7 feet in thickness (table 1) and may be split into two beds, separated by as much as 6 feet of sandstone. Underclay, averaging 3.3 feet in thickness, underlies the coal. At half the places where coal A is found, black shale overlies it; in other places gray shale overlies it (pl. 5, *B-B'*).

Coal B of this report averages 15 feet above coal A and averages 2.2 feet in thickness. It is exposed in only one place in the Clinton area, in the north bank of the mouth of a tributary to Raccoon Creek in the SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 15 N., R. 8 W., Mecca Quadrangle, southwestern Parke County. Coal B is underlain commonly by 2.4 feet of underclay and is overlain commonly by 1.3 feet of black carbonaceous shale (pl. 5, *B-B'*).

The coal informally designated coal C is dull because of its high claro-durain content; it also contains thin vitrain laminae. It is semiblocky in some outcrops and in some places has pyritized plant-stem impressions at the base. This coal averages 1.8 feet in thickness in the Clinton area (table 1) and overlies underclay averaging 3.1 feet in thickness. The coal is overlain in most places by black shale averaging 2.0 feet in thickness.

Coal D of this report, the most common of the letter-designated coals in the Staunton Formation, averages 1.5 feet in thickness (table 1) and contains about 15 percent vitrain, 20 percent fusain (an abnormal amount), and 65 percent claro-durain. It is crumbly and contains calcite films in vertical cracks. In a valley in the NE $\frac{1}{4}$ sec. 20, T. 15 N., R. 8 W., this coal crops out and weathers to small rectangular fragments. Coal D is underlain by underclay in most places and overlain by the most widespread black carbonaceous shale in the Staunton Formation in the map area.

Coal E of this report is mostly dull, containing 5 percent vitrain in thin laminae, 95 percent claro-durain, and a small amount of pyrite and clay. The coal averages 1.3 feet in thickness (table 1). It is exposed in a ravine at the base of a massive bluff of the Coxville Sandstone Member in the NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 23, T. 14 N., R. 8 W., 1 mile due east of Coxville, Parke County. In slightly more than half the places where it is found, this coal is

underlain by underclay. Black carbonaceous shale overlies coal E in most places (pl. 5, *B-B'*). This coal is not well developed near the Illinois border of the Clinton area.

The coal informally designated coal F in this report averages only 0.7 foot in thickness (table 1). This is the uppermost of three coals described by Ashley (1899, p. 394) as lying below the Seelyville coal in the sump of the shaft of the Lyford No. 2 Mine (pl. 1, no. 5). It does not form a split of the Seelyville coal (Friedman, 1967), although that coal is split into two to three beds in parts of the Clinton area. Coal F is thin or absent from Seelyville northward to Mecca (pl. 5, *B-B'*), but it is about as widespread as coal E. Coal F is commonly overlain by gray shale or the underclay below the Seelyville coal.

SEELYVILLE COAL MEMBER (III)

The top of the Seelyville Coal Member is the top of the Staunton Formation (fig. 4). This coal is a principal marker bed in most of the Clinton area, where it is also a major commercial coal.

Table 2 shows thickness of principal coalbeds in the Clinton area by section, township, and range. Thicknesses were selected from borehole and shaft data interpreted as representative for each section. Information from 104 boreholes and mine shafts shows that the average thickness of the Seelyville Coal Member in the Clinton area is 5.6 feet. The coal has moderate sulfur and ash content but high Btu value (table 6).

East of the Wabash River the Seelyville Coal Member was mined extensively near Rosedale and Burnett (pl. 1). At both places areas of thick coal are surrounded and separated from each other by areas in which the coal is missing as a result of post-Pennsylvanian erosion. In some places the eroded areas are present valleys; other areas in which the coal is missing are filled with glacial deposits as much as 150 feet thick. East of Burnett the coal is 6 to 7 feet thick and contains a shale parting as much as 1.5 feet thick near its center. In the Rosedale area the coal is 6.6 feet thick and has a clay and shale parting as much as 0.3 foot thick in the lower part of the bed. The Seelyville coal was also

mined in several small mines on the north side of Raccoon Creek near the mouth of Rock Run (pl. 1), where the coal is 2.2 to 2.7 feet thick and contains a clay parting 0.3 to 0.7 foot thick near the base. The Coxville Sandstone Member (fig. 4) forms the roof here and was mined in an abandoned quarry nearby. In the SW $\frac{1}{4}$ sec. 15, T. 14 N., R. 8 W., the coal is represented only by a 0.3-foot-thick lens in the base of the sandstone.

North of the Rosedale area the Seelyville coal is thin and has not been extensively mined. It is exposed in many places, but commonly only as a smut streak, on both sides of Raccoon Creek near Mecca. Many exposures of coal in this area, however, are of the unnamed coals in the Staunton Formation.

On the west side of the Wabash River numerous boreholes provided stratigraphic data on the subsurface distribution and thickness of the Seelyville Coal Member. This coal is nearly everywhere, although it is absent in sec. 31, T. 15 N., R. 9 W., probably because of nondeposition. It is 2.0 to 6.3 feet thick in T. 15 N., R. 10 W., where in places it has a shale parting, as much as 1.8 feet thick, at the center (table 2). In T. 14 N., Rs. 9 and 10 W., the coal is 4.8 to 6.9 feet thick and contains one or two thin clay or shale partings. In most parts of T. 13 N., Rs. 9 and 10 W., this coal is 5 to 7 feet thick and contains a thin pyrite parting at the top and one or two thin shale partings, one at the center and the other 2 feet above the base. In some places the basal part of the Seelyville also contains a black shaly or "bone" coal.

The partings increase in thickness in the areas west and south of the Talleydale Mine (pl. 1, no. 32). Over an area of a few square miles, the Seelyville coal is split into two beds by shale and sandstone (pl. 5, *C-C'* and *D-D'*). The sandstone in the split of the coal is not the same as the Coxville Sandstone Member, which overlies the coal. At the south edge of the map area in T. 12 N., R. 9 W., the coal is also split into two beds. This split has been traced southward into the Terre Haute and Dennison Quadrangles (Friedman, 1961). In T. 12 N., R. 10 W., the Seelyville coal is a single bed about 6 feet thick and contains only a single thin shale parting.

Table 2. Thickness data on principal coalbeds in the Clinton area, arranged by congressional section¹

Location			Thickness (ft)				
T (N)	R (W)	Sec.	Danville (VII) (Coal) (Jack) ²		Springfield (V)	Survant (IV)	Seelyville (III)
15	10	12				4.5	
		13					3.7
		15			3.0	2.0	2.0
		26					5.4
		27			3.2		6.3
		34	4.3	1.5	3.9	3.3	6.1
		35			3.7		
15	9	30				4.5	
		32			5.3		
		33			5.5		
15	8	32					3.2
		34					2.5
14	10	1			4.6	3.7	6.3
		2	3.9		3.4	3.2	6.2
		3	4.3		4.0		
		9	4.3	1.0	4.6	3.7	5.3
		10	4.5		4.6	3.6	6.2
		11	4.2		4.5	2.7	6.1
		12	4.6	1.2	4.6		5.1
		13	5.1	1.0	4.6	3.9	
		14	5.1		4.9	3.3	4.8
		15	4.5	1.6	4.8	4.6	6.0
		16	4.5	1.8			
		21	4.2	1.9		5.5	
		22	3.6		4.5		
		23	4.1	2.3	4.5	3.2	5.8
		24	4.4	2.0	4.8	3.7	5.2
		25	4.5	1.5	4.8	3.9	6.1
		26	4.6	1.7	4.7	4.6	5.7
		27	4.3	2.7	4.6		6.0
		28			4.7		
		33	4.0	1.7			6.4
		34	4.0	1.3	4.7		5.0
		35	4.5	1.6	4.6		5.6
		36	4.6	2.0	4.5	4.0	5.9
14	9	5			5.0		6.0
		6			4.7	4.5	6.0
		7			4.6		
		8			4.8	4.3	5.6
		9			4.5		
		13			5.0		6.0
		14			4.8		6.8

Table 2. Thickness data on principal coalbeds in the Clinton area—Continued

Location			Thickness (ft)				
T (N)	R (W)	Sec.	Danville (VII) (Coal) (Jack)		Springfield (V)	Survant (IV)	Seelyville (III)
14	9	16			4.6		5.5
		17			5.0	3.8	6.2
		18					6.9
		19	4.0	1.2	4.5	2.8	6.0
		20			4.9		
		21			5.0	3.9	6.0
		28			4.8	4.5	5.5
		29			4.8	4.0	
		30	4.5	1.9	4.0	4.8	6.0
		31	4.5	1.9	4.5	4.3	5.3
		32				4.6	5.9
		33			4.7	5.0	5.5
		36					6.0
14	8	3					1.0
		5					2.6
		9					0.4
		15					2.5
		21					6.5
		22					5.0
		27					6.7
		28					6.0
		33					6.5
13	10	1	4.7	1.7	4.6		5.0
		2	3.9	2.2	4.7		5.8
		3	4.5	1.4	4.2		5.5
		4	5.0	1.0	1.5		6.3
		10	4.5		4.2		5.8
		11	3.8	1.6	4.2		5.8
		13			4.8		6.0
		14	5.0	1.2	4.6		5.8
		22	4.8	1.8	4.6		6.2
		23	4.8	1.3	4.3		
		24			4.3		5.8
		25	4.5	1.0	4.5		6.0
		26	4.6	2.0	4.5		4.0
		27	5.3		4.1		7.1
		28	4.7	1.0	4.1		6.0
		34	4.2		4.4		6.1
		35	5.2	1.7	4.4		
		36	5.5	2.0	4.3		6.2
13	9	1					6.0
		4	4.0	1.5	5.0	5.5	
		5			3.2		

Table 2. Thickness data on principal coalbeds in the Clinton area—Continued

Location			Thickness (ft)				
T (N)	R (W)	Sec.	Danville (VII) (Coal)	(Jack)	Springfield (V)	Survant (IV)	Seelyville (III)
13	9	6	5.0	1.8	5.0		
		7	5.0	2.5	4.6	4.3	5.9
		8	5.0	1.0	4.6	4.5	6.5
		9	2.5				
		10					5.7
		13					2.0
		15				5.2	6.2
		16			4.7	4.5	
		17	5.2		4.7	5.0	5.5
		18	4.7	1.8	4.7		5.8
		19	4.6		4.2	4.8	6.0
		20	4.8	1.2	4.8	4.7	6.0
		21			4.7	5.1	5.7
		22				4.5	7.0
		23				2.5	
		27				5.1	5.9
		28			4.3	5.2	5.8
		29	4.9		4.3	5.3	
		30	4.1	1.0	4.7	5.1	5.8
		31	5.0		4.6	4.0	
		32	5.2		4.4	4.6	
		33			4.2	4.8	
		34				5.0	
13	8	12					6.0
		16					6.5
		19					6.4
		20					6.7
		23					6.0
		24					5.5
		25					5.9
		26					6.0
		27					6.5
		28					6.2
		29					6.3
		30					6.5
		31					6.4
		32					5.8
12	10	34					6.2
		35					5.2
		36					5.6
12	10	1			4.0		5.5
		2	4.0	1.0	4.3		5.6
		3	4.5		4.5		5.8
		4	4.7		4.4		6.2

Table 2. Thickness data on principal coalbeds in the Clinton area—Continued

Location			Thickness (ft)				
T (N)	R (W)	Sec.	Danville (VII) (Coal) (Jack)		Springfield (V)	Survant (IV)	Seelyville (III)
12	10	11	5.3	1.5	4.5		6.2
12	9	4			4.0	5.3	
		5	3.1	1.5	4.3	4.5	
		6	5.5		4.5		
12	8	10					5.8
		12					5.0
Average thickness			4.5	1.5	4.5	4.3	5.6
			6.1				
Range in thickness			2.5-5.5	0-2.7	1.5-5.5	2.0-5.5	0.4-7.1
			2.5-7.5				

¹ One representative datum point was chosen per section from a borehole or shaft record.

² Impure coal, commonly not of commercial quality, which here is the uppermost part of the coalbed.

Nearly everywhere that the Seelyville Coal Member is present, it is underlain by underclay about 3 feet thick. No underclay-limestone (limestone that underlies an underclay) is associated with this coal in the Clinton area, although one is associated with the coal in other areas.

A channel sample of the Seelyville coal where it is 6 feet thick was collected from the Green Valley Mine (pl. 1, no. 52). Analysis of 200 plant spores from this sample by G. K. Guennel (oral communication, 1958) showed that 68.5 percent of the spores belonged to the genus *Lycospora*. This high percentage is diagnostic of the Seelyville coal.

LINTON FORMATION

The base of the Linton Formation is at the top of the Seelyville coal, and the top of the Linton is at the top of the Survant Coal Member (IV) (fig. 4). The Linton is 50 to 88 feet thick and averages 70 feet. It consists of gray shale, sandstone, black shale, underclay, coal, and limestone. Four named members are recognized: the Coxville Sandstone, the Colchester Coal, the Velpen Limestone, and the Survant Coal.

COXVILLE SANDSTONE MEMBER

The Coxville Sandstone Member overlies the Seelyville Coal Member in many small areas, but elsewhere the Coxville is underlain by dark-gray shale that is unevenly bedded and micaceous in most places but is soft and light brown in other places. This shale is as much as 21 feet thick. At the Briar Hill Mine (pl. 1, no. 14), the Seelyville coal is disconformably overlain by massive Coxville sandstone. "Faults" reported by miners in the Coxville No. 3 Mine and the Parke County No. 8 Mine (pl. 1, nos. 16 and 24) are probably narrow cutouts of channel-fill sandstone. Sandstone-filled channels are also common in the area west of the Wabash River, especially near the Talleydale and Green Valley Mines (pl. 1, nos. 32 and 52).

The Coxville Sandstone Member, informally but originally noted by Ashley (1899, p. 300-301, 385-386), was named formally as a member of the Linton Formation (Friedman, 1960, p. 24) because it is a widespread mappable lithologic unit and a useful key bed in local and regional stratigraphic correlation. Maximum known thickness of the sandstone in the map area is 60 feet in a quarry near the

type locality (Friedman, 1960, p. 27). Subsurface data show a maximum thickness of 44 feet and an average of 13 feet. Commonly the sandstone is a single bed, but it contains shale in some places.

Shale or sandy shale, 2 to 23 feet thick, overlies the Coxville in most places. Where the Coxville is absent, this shale overlies the brown shale directly above the Seelyville coal. An extensive underclay about 1 foot thick overlies the sandy shale or the Coxville sandstone directly where the shale is absent. This underclay is exposed along the west side of Raccoon Creek south of Mecca and is light gray, plastic, soft, and nonbedded. In some places the underclay contains at its base an underclay-limestone 1 to 3 feet thick or a calcareous sandstone.

COLCHESTER COAL MEMBER (IIIa)

The Colchester Coal Member (fig. 4) is a widespread marker bed that has been known to miners as the "rider" of the Seelyville coal. This coal lies from 3.5 to 43 feet above the Seelyville Coal Member. The Colchester coal is 0.2 to 2.5 feet thick and averages 1.2 feet (table 1), but in a few places where the Coxville Sandstone Member is thick, the coal is absent, probably because of nondeposition. In most places the coal contains a thin parting of light-gray clay in its lower third. *Lycospora* and *Laevigatosporites* are the dominant miospore genera (Guennel, 1952, p. 26).

In some places the Colchester coal is overlain by blue-gray shale or thin limestone, but in most places the coal is overlain by black carbonaceous shale (pl. 5, A-A'). The black shale crops out in many places at the foot of the upland and in tributary valleys along the west side of Raccoon Creek from Rosedale northward to Mecca and from there to the north edge of the map. Where the Colchester Coal Member is absent, this shale directly overlies underclay. The shale is 2 to 10 feet thick and averages 5.6 feet in the Clinton area.

Through extensive quarrying at a site in the Mecca area, Zangerl and Richardson (1963) collected and described an abundant and diversified vertebrate and invertebrate fauna from this black shale. The other two sites investigated by them are about 10 miles north

of Mecca and are in a black shale that appears to correlate with the black shale overlying coal C of this report.

VELPEN LIMESTONE MEMBER

Marine limestone believed to be equivalent to the Velpen Limestone Member (fig. 4) overlies the black shale in a few places and is represented by thin lenses or nodules in other places. Near Mecca the limestone consists of two thin beds with medium- or dark-gray shale between them. The lower limestone has an abundant marine invertebrate fauna. The limestone is 0.2 to 4.5 feet thick and averages 2.0 feet.

Widespread medium-gray shale, containing sideritic concretions at the base, overlies the Velpen Limestone Member. In places where the limestone is absent, the gray shale overlies the black shale. It is 4 to 34 feet thick and averages 12 feet. The gray shale is overlain by sandstone or sandy shale containing units of thinly laminated dark-gray shale and fine-grained sandstone. The sandstone and inter-laminated shale and sandstone are 2 to 38 feet thick. These sediments immediately underlie the Survant Coal Member in most places. Underclay is common beneath the Survant Coal Member and is found mostly in places where the coal is split.

SURVANT COAL MEMBER (IV)

The Survant Coal Member lies at the top of the Linton Formation (fig. 4). In places where the Survant coal is a single bed, its base lies 46 to 86 feet and averages 63 feet above the top of the Seelyville Coal Member; where the coal is split, the lower bed is 36 to 60 feet and averages 54 feet above the top of the Seelyville coal. The Survant coal is 0.4 to 5.7 feet thick and averages 3.8 feet where it is a single bed; where the coal is split, the lower bed is 0.4 to 2.0 feet thick and the upper bed is 0.3 to 2.7 feet thick. Fifty selected datum points show that this coalbed averages 4.3 feet in thickness (table 1). Chemical analyses indicate a low ash and sulfur content (table 6). The dominant miospores in the Survant Coal Member are *Laevigatosporites* and *Lycospora* (Guennel, 1952, p. 27).

The Survant Coal Member is split in a large

area in the western part of the map area. Sediments in the split are mostly gray shale but include some sandstone and black shale (pl. 5). The coal splits from a single bed, 5 feet thick, into two thin beds separated by as much as 28 feet of clastic sediments, within a belt one-fourth to one-half mile wide along the west edge of the large area of mining shown on the coal map (pl. 2). Northwest of Blanford the Survant Coal Member forms a single bed in eastern Illinois.

The Survant coal is absent from most areas east of the Wabash River, where gray shale commonly lies in the stratigraphic position of the coal. At the only outcrop found, 2 miles south of Mecca, in sec. 32, T. 15 N., R. 8 W., the coal consists of two thin beds separated by 7.5 feet of gray shale.

PETERSBURG FORMATION

The Petersburg Formation is composed of shale, sandstone, coal, limestone, and underclay and extends from the top of the Survant Coal Member (IV) to the top of the Springfield Coal Member (V). It is one of the most easily recognized and mappable formations in the Clinton area. Its full thickness is found only west of the Wabash River, where it averages 93 feet in thickness (pl. 5, A-A'). Readily recognizable key beds of wide distribution in this formation are the Houchin Creek Coal Member (IVa), black shale overlying the Houchin Creek coal, underclay-limestone and underclay beneath the Springfield Coal Member, and the Springfield Coal Member (fig. 4).

In most places where the Survant Coal Member is a single bed, it is overlain by gray or blue-gray shale that contains siderite nodules and is 2.0 to 32 feet thick and averages 14 feet. In a few places sandstone, sandy shale, or interlaminated sandstone and gray shale overlie the coal. In places where the coal is split, gray shale commonly overlies the upper bench of this coal and averages 15 feet in thickness.

In a few places carbonaceous black shale that contains widely scattered calcareous nodules overlies the upper bench of the Survant coal. The black shale is soft rather than hard and splittable; it is 0.6 to 2.7 feet

thick and averages 1.5 feet. It is everywhere overlain by gray shale, which in a few places contains a thin lens of limestone (fig. 4) about midway between the Survant coal and the Houchin Creek coal. Just beneath the Houchin Creek Coal Member is an underclay that is 0.2 to 5.0 feet thick and averages 2.4 feet. At the base of this underclay in a few places is an underclay-limestone about 2.6 feet thick.

HOUCHIN CREEK COAL MEMBER (IVa)

The Houchin Creek Coal Member is 15 to 50 feet and averages 33 feet above the Survant coal where the latter is a single bed. Where the Survant is split, the Houchin Creek coal is 24 to 69 feet and averages 43 feet above the upper bench of the Survant coal. The Houchin Creek coal is widespread and underlies most of the map area west of the Wabash River. It is 0.3 to 3.2 feet thick, averages 1.5 feet (table 1), and contains a clay parting at the center. It is an important stratigraphic marker but is not considered to be of commercial value.

Guennel (1952, p. 28) analyzed the miospores in this coal in adjacent areas. He found that *Laevigatosporites* was dominant and *Lycospora* second in the upper part of the coal and that *Lycospora* was dominant and *Laevigatosporites* second in the lower part. *Punctatisporites* and *Calamospora* were important accessory genera.

The Houchin Creek Coal Member lies 44 to 94 feet and averages 58 feet below the Springfield Coal Member (fig. 4). This is the second greatest interval between two successive coalbeds in the Clinton area; it includes primarily gray shale, but it also contains some sandstone, sandy shale, black shale, limestone, and underclay.

The Houchin Creek coal is most commonly overlain by widespread black carbonaceous shale that is 1.7 to 13 feet thick and averages 2.9 feet. Gray shale is found in a few places where the black shale is absent. At an abandoned mine in the Houchin Creek coal in sec. 5, T. 14 N., R. 8 W., and at an outcrop in the NW¼ sec. 25, T. 15 N., R. 9 W., Parke County, dark-gray limestone, which is 1 foot thick and silty and contains plant-stem fossils,

lies above the black carbonaceous shale. This may be the Stendal Limestone Member. Black shale overlies this limestone in one stratigraphic record (pl. 5, no. 3), where the black shale is split into two benches with the limestone between them.

Overlying the black shale is widespread gray shale that contains sideritic nodules, is 2 to 57 feet thick, and averages 32 feet. In most places sandstone overlies the gray shale and extends upward to a position close beneath or directly beneath the Springfield Coal Member (V). This sandstone is not exposed in the Clinton area, but it is known from records of coal-test boreholes. It is 5 to 43 feet thick and averages 18 feet. It is a mappable unit, and borehole records indicate that it includes a sheet phase as well as a channel-fill phase in the Clinton area. A body of sandstone, partly in a similar stratigraphic position, is found in the Terre Haute area, where it is well developed in a channel phase (Friedman, 1956, p. 165-168; 1960, p. 16-19).

The sandstone is overlain by an underclay-limestone or by sandy shale or gray shale. The limestone, which averages 5 feet in thickness, also overlies the gray shale in places where the sandstone is absent. The underclay beneath the Springfield Coal Member lies on the underclay-limestone, gray shale, and sandy shale that have just been discussed. This widespread underclay is 0.4 to 5.1 feet thick and averages 2.3 feet; it is well compacted and not plastic, and therefore it commonly forms a good floor in a coal mine. In a few places gray shale underlies the Springfield coal.

SPRINGFIELD COAL MEMBER (V)

The Springfield Coal Member is 1.5 to 5.5 feet thick and averages 4.5 feet in the Clinton area (table 1). Exceptionally uniform in thickness and widespread, it underlies most of the map area west of the Wabash River (pl. 3). Outliers of this coal at Lyford have been preserved in a shallow syncline. In the northwestern part of the map area, the coal is absent in buried valleys filled with glacial drift.

In number of mines, in area mined, and in tons of coal produced, the Springfield Coal Member leads all others in the Clinton area

(tables 3 and 4). This coal, like most other coals in this area, is of high-volatile C bituminous rank. Chemical analyses indicate that it contains a moderate amount of sulfur and ash and is consistently high in Btu value (table 6). Miospores in the Springfield coal were analyzed by Guennel (1952), whose samples included one from the abandoned Wabash Mine (pl. 3, no. 133). *Laevigatosporites* was dominant; *Lycospora* and *Punctatisporites* were less abundant.

DUGGER FORMATION

The Dugger Formation is about 140 feet thick, conformably overlies the Petersburg Formation, and consists of gray shale, sandstone, sandy shale, coal, underclay, black shale, limestone, and sandstone interlaminated with shale in the interval from the top of the Springfield Coal Member (V) to the top of the Danville Coal Member (VII) (fig. 4). The Dugger is therefore the second thickest formation in the Pennsylvanian System in the Clinton area. Of the six named members recognized—Alum Cave Limestone, Antioch Limestone, Bucktown Coal, Bridge Junction Sandstone, Universal Limestone, and Danville Coal—the Bridge Junction Sandstone Member is new.

ALUM CAVE LIMESTONE MEMBER

The Alum Cave Limestone Member is found in only 15 percent of the Clinton area west of the boundary of the Springfield coal. Although the limestone is thin and restricted in distribution, it is a good marker bed. The limestone does not crop out, and no cores showing this limestone are available for lithologic study, but gob piles at numerous mines that produced from the Springfield Coal Member contain fragments of dark-gray or black fine-grained limestone believed to be the Alum Cave. These fragments contain numerous white fossils, mostly brachiopods.

The Alum Cave commonly overlies a black carbonaceous shale that forms the roof of the Springfield coal, but in places it overlies a gray shale. The limestone is 1 to 3 feet thick and averages 2 feet; it is overlain in places by an unnamed coal formerly called Coal Va.

This unnamed coal is a good marker bed and is found in nearly half of the drill holes in that part of the Clinton area that is west of the boundary of the Springfield coal. The coal does not appear to occupy distinct basins, but it is more common in the southern part of T. 13 N. and the northern part of T. 12 N., Rs. 8 and 9 W., than elsewhere. Guennel (1952, p. 28-29) analyzed miospore genera from this coal at the Standard Materials strip mine (pl. 3, no. 79) northwest of Clinton. He found *Lycospora* was dominant, *Laevigatosporites* one-fourth as abundant, and *Calamospora* and *Punctatisporites* the only significant minor genera.

The unnamed coal is underlain in most places by black shale that lies above the Springfield coal or by the Alum Cave Limestone Member. The coal is a thin film to 3.0 feet thick and averages 0.8 foot in the Clinton area (table 1). It is overlain by carbonaceous black shale that also occurs where the coal is absent. The black shale is about 4 feet thick, contains calcareous nodules in some places, and is overlain by gray shale that in turn is overlain by the Antioch Limestone Member, the Bucktown Coal Member (Vb), or strata associated with the Bucktown coal (fig. 4).

ANTIOCH LIMESTONE MEMBER

An underclay-limestone, believed to be the Antioch Limestone Member, commonly overlies a gray shale. This limestone is a key bed in the Clinton area. It is 0.3 to 4.3 feet thick and averages 3.3 feet in places where it is a single bed; it is split by shale into two thin beds in a few places. The base of the limestone is 0.5 to 6 feet beneath the Bucktown coal. It is overlain either by underclay or by clayey shale. The limestone is exposed in a ditch on a hillside along the south side of a private driveway leading from U.S. Highway 41 in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 14, T. 14 N., R. 9 W., Parke County. Here it is 2 feet thick, blue gray, dense, silty, and weathered red orange to medium gray. It contains some poorly preserved brachiopods.

The underclay beneath the Bucktown Coal Member is widespread, is 0.5 to 9.5 feet thick, and averages 3.3 feet.

BUCKTOWN COAL MEMBER (Vb)

The Bucktown Coal Member (fig. 4) is widespread and is an excellent stratigraphic marker in the Clinton area. It is 0.5 to 3.0 feet thick and averages 1.7 feet (table 1). The Bucktown Coal Member is not confused with the unnamed coal beneath it in the Clinton area, because the Bucktown is associated with the Antioch limestone and because the unnamed coal is only half as common as the Bucktown coal. Besides, the base of the unnamed coal lies 2.2 to 9.0 feet above the top of the Springfield Coal Member, and the Bucktown coal is 15 to 27 feet above the top of the Springfield coal. Although the same spores are found in these two coals, the Bucktown has a lower percentage of *Lycospora* and a higher percentage of *Laevigatosporites*, *Punctatisporites*, *Calamospora*, and *Granulatisporites* than the unnamed coal (Guennel, 1952, p. 28-29).

The Bucktown Coal Member is commonly overlain by black shale or by gray shale in places where the black shale is absent. The black shale is 0.6 to 8.2 feet thick and averages 2.5 feet. The gray shale, which overlies the coal and the black shale, is a thick unit for this area; it is 10 to 90 feet thick and averages 39 feet (pl. 5).

The thick gray shale is overlain by sandy shale or by gray shale interlaminated with fine-grained sandstone that is informally known as "fake." The sandy shale is widespread and averages 35 feet in thickness. The interlaminated shale and sandstone unit includes some gray shale, is common, and averages 52 feet in thickness. These strata are exposed in many stream valleys west of the Wabash River, south of Coal Creek, and east of U.S. Highway 150.

BRIDGE JUNCTION SANDSTONE MEMBER

A previously unnamed sandstone occupies channels or valleys eroded into the sandy shale, interlaminated shale and sandstone, and thick gray shale that have just been described. The sandstone is here named the Bridge Junction Sandstone Member of the Dugger Formation. It is present in the New Goshen Channel and its tributaries in about 30



Figure 5. Type locality of the Bridge Junction Sandstone Member in the SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 29, T. 13 N., R. 9 W., Vigo County.

percent of the Vigo County area west of the Wabash River (Friedman, 1960).

This sandstone is well exposed at only one place, Bridge Junction, in Coal Creek valley, in the NE $\frac{1}{4}$ sec. 29, T. 13 N., R. 9 W., 3 $\frac{3}{4}$ miles southwest of New Goshen, Vigo County (fig. 5). It is light brown and weathers red brown and is massive, thick bedded to crossbedded, fine grained to medium grained, and about 30 feet thick. The brown color of fresh samples of the sandstone is typical of channel deposits. In places along the outcrop

at Bridge Junction the sandstone is slightly calcareous. The Bridge Junction outcrop is designated as the type section because it shows the thickest sandstone and typical bedding of the rock.

The Bridge Junction Sandstone Member is present in 75 percent of the selected drilling records used for the statistical data in this report. It averages 30 feet in thickness and is as much as 90 feet thick in sec. 26, T. 13 N., R. 9 W. It is overlain by calcareous to noncalcareous gray shale that is overlain in

turn by the Universal Limestone Member of the Dugger Formation (fig. 4). The calcareous gray shale averages 1.2 feet in thickness. In the absence of both the shale and the limestone, the sandstone is overlain by underclay.

The exposure at Bridge Junction, the type

locality, does not clearly display the vertical stratigraphic relations of the sandstone member. A subsurface record in the files of the Geological Survey does display these relations and is given below as a reference section.

Reference section for the Bridge Junction Sandstone Member. Part of a driller's log [stratigraphic interpretations added] of a coal-test borehole on the Hyler farm, 2 miles south-southeast of New Goshen and 1 mile west-northwest of Bridge Junction, in the NE¼NE¼ sec. 30, T. 13 N., R. 9 W., Vigo County, Ind. Altitude at top of hole, 585 feet.

	Thickness (ft)	Depth to base (ft)
[Shelburn Formation]		
Shale, blue	42.5	58.5
[Dugger Formation]		
Blackjack [Danville Coal Member (VII)]	1.0	59.5
Coal	5.0	64.5
Fireclay	3.5	68.0
Shale, blue	5.5	73.5
Limestone [Universal Limestone Member]	2.5	76.0
Sandstone [Bridge Junction Sandstone Member]	70.0	146.0
Sandshale	16.0	162.0
Shale, dark	19.0	181.0
Slate, black	6.0	187.0
Coal and slate [Bucktown Coal Member (Vb)]	2.0	189.0
Fireclay	2.0	191.0
Limestone	1.5	192.5
Shale, blue [Antioch Limestone Member]	3.0	195.5
Limestone	0.5	196.0
Shale, blue	4.0	200.0
Slate, black	2.0	202.0
Sandshale	2.0	204.0
Slate, black	5.0	209.0
[Total Dugger Formation — 150.5 ft]		
[Petersburg Formation]		
Coal [Springfield Coal Member (V)]	4.4	213.4
Fireclay	3.1	216.5
etc.		
Total depth		381.0

At this place the sandstone belongs to a channel-fill phase. The Danville coal retains its normal thickness over the channel sandstone, which suggests that the sand body did not stand up as a positive topographic feature during deposition of the coal.

UNIVERSAL LIMESTONE MEMBER

The Universal Limestone Member overlies the Bridge Junction Sandstone Member or

overlies gray shale in places where the Bridge Junction sandstone is absent. It is a widespread lithologic unit and is useful as a key bed in correlation. The limestone is exposed in tributaries of Gin Creek west of Universal in southern Vermillion County. Its type locality is an outcrop in the bed of Gin Creek in the NW¼SW¼ sec. 31, T. 14 N., R. 9 W., half a mile south of Universal (Wier, 1951).

The Universal Limestone Member is present

in 80 percent of an area delineated by the boundary of the overlying Danville Coal Member (pl. 4). It is 2 to 8 feet thick and averages 4 feet; in some places it contains a 0.5-foot gray-shale parting. The Universal limestone is an underclay-limestone but is not a freshwater limestone, because it contains marine invertebrates, such as fusilines and brachiopods, at the type locality and brachiopods at an outcrop on the north bank of Coal Creek in the SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 19, T. 13 N., R. 9 W., Vigo County.

The limestone is overlain by a widespread underclay or by clayey shale or gray shale (fig. 4). At all places where shale overlies the limestone, underclay overlies the shale. The shale unit is present in half the datum points studied; it is 0.3 to 9.3 feet thick and averages 3.7 feet. The underclay of the Danville Coal Member is soft and plastic when wet, is 3.1 to 11 feet thick, and averages 6.4 feet. It everywhere underlies the Danville coal.

DANVILLE COAL MEMBER (VII)

The Danville Coal Member (fig. 4) forms the top of the Dugger Formation and the Carbondale Group. The interval from the Bucktown Coal Member to the Danville is 99 to 122 feet and averages 110 feet, the greatest interval between any two successive principal coals in the Clinton area. Data from 60 well logs (table 1) indicate that the Danville is 2.5 to 7.5 feet thick and averages 6.1 feet, including the clayey upper part called "jack" or "bone" by persons in the coal-mining industry. Exclusive of this clayey zone, the coal averages 4.5 feet in thickness. Maximum thickness of the jack is 2.7 feet in sec. 27, T. 14 N., R. 10 W. (table 2).

Chemical analyses of this coal from samples not containing the jack indicate a moderate to low ash and sulfur content (table 6). Analyses of miospores from the Danville Coal Member indicate a dominance of *Lycospora*; *Laevigatosporites* and *Calamospira* are the accessory genera (Guennel, 1952, p. 31).

SHELBURN FORMATION

The Shelburn Formation extends upward from the top of the Danville Coal Member (VII) to the top of the West Franklin

Limestone Member. In the Clinton area the Shelburn is about 60 feet thick and contains mostly gray shale, which in places is black and carbonaceous, calcareous, sandy, variegated, or interlaminated with thin sandstone layers; it also contains thin limestone and coalbeds (fig. 4). Two named members, the Pirtle Coal Member and the West Franklin Limestone Member, are recognized in the Clinton area.

Although the Shelburn Formation is absent because of post-Pennsylvanian erosion in most of the Clinton area, it is present in much of Ts. 12 and 13 N., R. 10 W., Vigo County, and T. 14 N., R. 10 W., Vermillion County. In these townships the Danville Coal Member is commonly overlain conformably by blue-gray shale or mudstone containing in some places probable fossil worm burrows and in other places sideritic concretions containing crystals of calcite, barite, and pyrite. The shale is 11 to 55 feet thick and averages 34 feet. In a few places the coal is overlain by sandstone or by sandy shale, and at one location a coal, 0.2 foot thick, is present about 13 feet above an unusually thin Danville coal. This coal is either a split of the Danville or a "stray" unnamed coal. Limestone, 0.5 foot thick, or limestone nodules with unidentified invertebrate fossils lie at the approximate position of this unnamed coal in two other places. I therefore believe that the coal is not a split of the Danville coal but is a separate coalbed.

In the abandoned Sunspot Mine (pl. 4, no. 136) and in some of the other abandoned strip mines in the Danville coal, a crossbedded sandstone that has an undulatory base and that in places is conglomeratic and contains slightly rounded fragments of shale, limestone, and coal, lies about 25 feet above the Danville Coal Member. Possibly this represents the Busseron Sandstone Member of the Sullivan County area. Scattered driller's logs suggest that in a few places the erosional base of this sandstone descends to and possibly into the Danville coal.

PIRTLE COAL MEMBER

The Pirtle Coal Member (fig. 4), Coal VIIa of earlier usage (Wier, 1970a, p. 134), crops out at one place, in a small ravine on the south side of Coal Creek near U.S. Highway 150 in the SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 19, T. 13 N., R. 9

W., Vigo County. The Pirtle coal lies 32 feet above the top of the Danville coal, contains much black clay, and does not have a well-developed underclay. It is absent in most places and where present is a thin film to 0.3 foot thick (table 1).

An unnamed limestone 0.3 to 4.8 feet thick lies about 2 feet above the Pirtle coal. This limestone is blue gray, fine grained to sublithographic, dense, and tough and weathers yellow brown. At one place it is dolomitic. Gray shale, 6 feet thick and containing limestone nodules, is present at the position of this limestone in sec. 4, T. 13 N., R. 10 W. The limestone is present in about half the area west and within the boundary of the Danville coal (pl. 4), and it underlies about 15 feet of gray shale that in some places contains variegated pink, red, and green shale. This variegated shale is also present in places where the unnamed limestone is absent and is a useful stratigraphic marker.

WEST FRANKLIN LIMESTONE MEMBER

In most places studied the gray and variegated shale is overlain by one to four thin limestone beds representing the West Franklin Limestone Member (fig. 4). Earlier identified as the Maria Creek Limestone Member in part of the map area (Wier, 1952) and in adjacent areas (Friedman, 1961), these beds are now assigned to the West Franklin (Wier, 1970b, p. 190-191). Commonly, the West Franklin includes two, three, or even four beds of limestone separated by gray and variegated shale and occupying an interval as thick as 16 feet. The limestone beds themselves are generally about a foot thick, but at one place the lower bed is 2.8 feet thick.

The top of the West Franklin Limestone Member cannot everywhere be readily recognized, but this horizon or its equivalent stratigraphic position marks the top of the Shelburn Formation.

PATOKA FORMATION

The Shelburn Formation is overlain by the Patoka Formation, the youngest bedrock formation in the Clinton area (fig. 4). The Patoka extends from the top of the West

Franklin Limestone Member to the base of the Shoal Creek Limestone Member (Shaver and others, 1970, table 3), but only the lower three-fourths of the formation is present in the Clinton area, principally in Ts. 12 and 13 N., R. 10 W. The formation averages 75 feet in thickness and consists of gray shale, which in some places is sandy or interlaminated with thin sandstone layers. The Patoka also contains thin beds of sandstone, coal, underclay, and limestone.

Gray shale, 8 feet thick, overlies the upper beds of the West Franklin Limestone Member. This gray shale is overlain by the Ditney Coal Member or by the associated underclay, underclay-limestone, or calcareous sandstone. The underclay averages 3.7 feet in thickness and is present in more than 50 percent of the area underlain by the Patoka Formation.

DITNEY COAL MEMBER

The Ditney Coal Member (fig. 4) overlies this underclay or overlies gray shale where the underclay is missing. The Ditney coal is 0.4 to 1.3 feet thick and averages 0.7 foot (table 1). Boreholes indicate that it is present throughout much of the area underlain by the Patoka Formation. Spore analysis of a sample of the Ditney coal from an outcrop in sec. 24, T. 13 N., R. 10 W., Vigo County, indicated that *Triquitrites* and *Calamospora* were dominant and that *Punctatisporites*, *Endosporites*, and *Florinites* were accessory (Howard Lee, oral communication, 1965).

The Ditney coal is overlain by black shale, 0.2 to 2 feet thick, or limestone containing unidentified marine invertebrate fossils. This limestone is blue gray, dense, and tough and averages 0.8 foot in thickness. It is exposed in the heads of valleys of tributaries flowing northward into Gin Creek in sec. 1, T. 13 N., R. 10 W., Vigo County.

OTHER NAMED MEMBERS

Higher beds of the Patoka Formation are present in only a small part of the Clinton area, near the southwest corner. Data on these beds are few. The Ditney Coal Member, the black carbonaceous shale, and the unnamed limestone are overlain by gray shale, averaging

45 feet in thickness and containing some thin sandstone layers. The shale is overlain by 6 to 12 feet of sandstone, believed to be the Inglefield Sandstone Member (fig. 4). Sandy shale, 20 feet thick, overlies the sandstone, and similar sandy shale is present in place of the sandstone at one locality.

Overlying the sandy shale in secs. 27 and 34, T. 13 N., R. 10 W., are the stratigraphically highest key beds in the Clinton area: underclay, coal, black shale, and limestone (fig. 4). The coal is 1.3 feet thick and is believed to be the Hazelton Bridge Coal Member of southern Indiana. The limestone, probably the Vigo Limestone Member, is only 0.3 foot thick. It is overlain by 10 feet of sandstone that is possibly the Dicksburg Hills Sandstone Member, which also is better known in southern Indiana. Above the sandstone is as much as 6 feet of shale that is the stratigraphically highest bedrock in the Clinton area.

PLEISTOCENE DEPOSITS

The Clinton area is almost entirely covered by unconsolidated surficial deposits of Pleistocene age (fig. 6). These deposits include, principally, glacially deposited till; outwash sand and gravel deposited by glacial meltwater; wind-deposited dune sand and upland loess; and sandy to silty alluvial deposits associated with present streams. The till and outwash include deposits of three glacial stages: Wisconsinan, Illinoian, and pre-Illinoian. Uplands in the Clinton area are underlain by compact sandy gray calcareous till. Lenses of yellow and brown coarse-grained sand are present in some places within the till. Near the surface the till weathers brown, and carbonate minerals have been leached from the upper part. The Illinoian till, which is older, is more deeply leached than the Wisconsinan till.

The till contains pebbles and cobbles of limestone, dolomite, quartzite, quartz, red jasper, and metamorphic rocks, all of which have been transported southward to the Clinton area from the northern United States or from Canada. A few boulders of metamorphic rock that had been removed

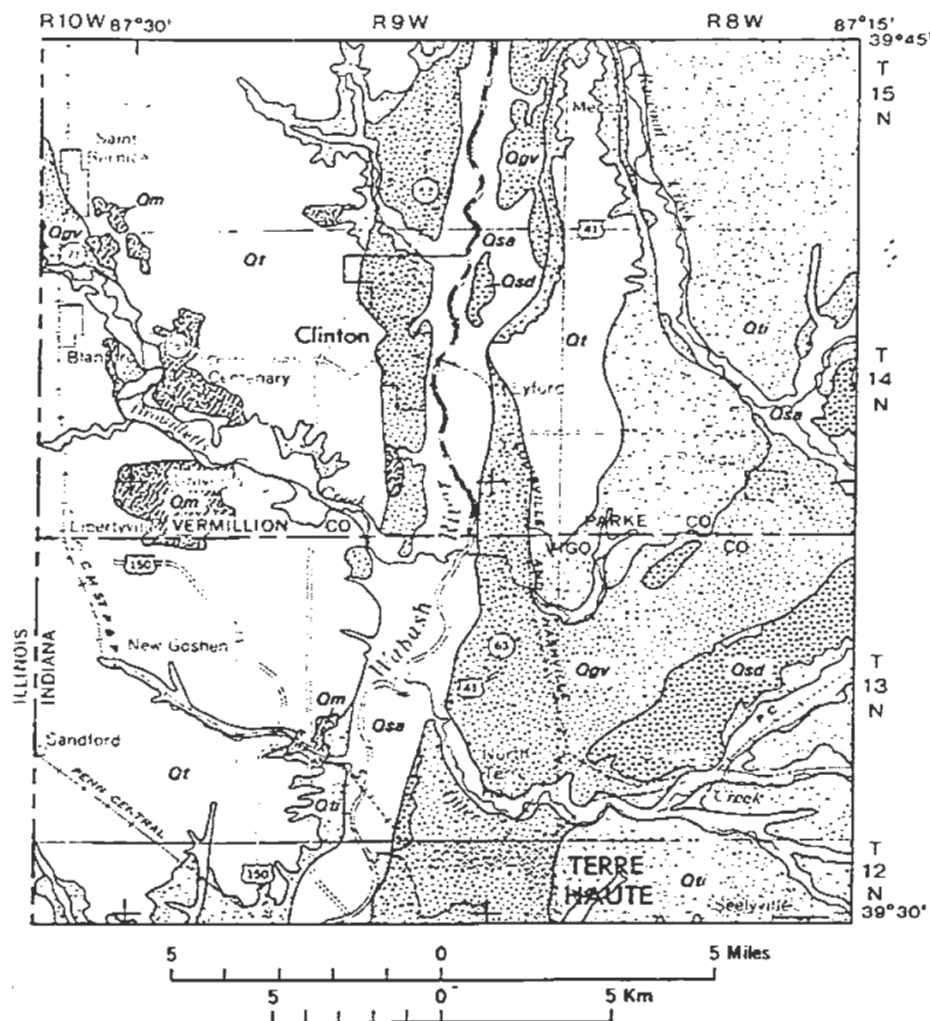
from plowed fields by local farmers were observed in the S½ sec. 24 and the N½ sec. 25, T. 13 N., R. 10 W., Vigo County, but by far the largest erratic boulder in the area is a gneissoid granite block 9.4 by 5.4 by 5.4 feet, which probably derived from till of the Wisconsinan Stage not far from its present site in the NE¼SE¼ sec. 19, T. 14 N., R. 9 W., Vermillion County, Ind.

An excellent exposure of Wisconsinan till was observed in 1956 in the south bank of a small stream valley in the NW¼NW¼ sec. 9, T. 12 N., R. 10 W., Vigo County. A fragment of a conifer branch or root about a foot long from the lower part of this till was dated by carbon-14 as 21,000± 650 years B.P. (Rubin and Alexander, 1960). This is a typical date for basal Wisconsinan till in western Indiana. The wood-bearing till at this outcrop is underlain by till of the Illinoian Stage. Dense pebbly calcareous gray Illinoian till was also exposed in a strip mine in the N½ sec. 29, T. 13 N., R. 9 W., Vigo County.

In places where till of the Wisconsinan Stage overlies till of the Illinoian Stage, a buried soil, or paleosol, has been observed. This paleosol is one line of evidence for stratigraphic separation of the two tills. Till of pre-Illinoian age has recently been identified within the Clinton area (N. K. Bleuer, oral communication, 1980).

Till on the upland in the Clinton area is commonly 80 to 120 feet thick. The greatest thickness, about 200 feet, is in the northwestern part of the map area, in Ts. 14 and 15 N., Rs. 9 and 10 W. Depth to bedrock is commonly greater on the upland than in valleys tributary to the Wabash River.

Windblown silt, known as loess, overlies the till on the uplands of the Clinton area. The loess is so extensive that most of the upland soils are formed in it rather than in the till. Because of its great extent, the loess would obscure the distribution of the till and therefore it is not shown on figure 6. Commonly, it is 5 to 10 feet thick on areas mapped as Illinoian and older till east of the Wabash River, and it is 3 to 5 feet thick on areas mapped as Wisconsinan till west of the Wabash River. A few patches of thin windblown dune sand are associated with the loess, especially east of the Wabash River.



EXPLANATION

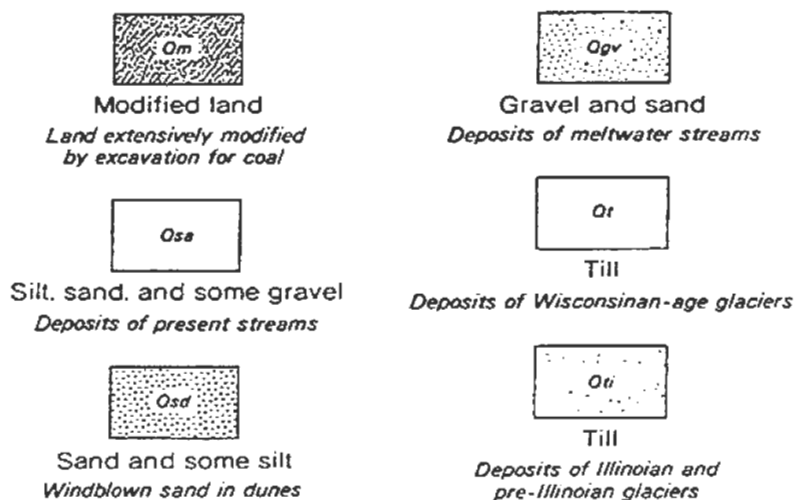


Figure 6. Map showing unconsolidated surficial deposits in the Clinton area.
Modified from Gray and others (1979).

Sand and gravel deposited by glacial meltwater occupy the Wabash Valley, another broad valley that enters the Wabash Valley from the northeast just north of Terre Haute (fig. 6), and to a lesser extent the valleys of Brouilletts Creek and Raccoon Creek. In most parts of the Wabash Valley the sand and gravel are more than 100 feet thick; elsewhere they are commonly about 25 to 50 feet thick. The sand and gravel are excellent sources of commercial aggregate and of ground water. Most of these deposits are Wisconsinan in age; some may be older.

Alluvial deposits of the present streams in the Clinton area are commonly not more than 10 feet thick except along the Wabash River, where they may reach 25 to 30 feet. Alluvium of the smaller streams is mostly silty to sandy in texture. Most of the alluvial deposits along the Wabash, however, are reworked from the outwash sand and gravel that underlie and adjoin the alluvium, and distinguishing the alluvium from the older deposits is difficult in most places.

STRUCTURAL GEOLOGY

REGIONAL STRUCTURE

The Clinton area is in the northeastern part of the Illinois Basin, an eroded structural remnant of an original depositional basin. Maximum thickness of Pennsylvanian rocks in the basin is more than 3,500 feet in western Kentucky, but it is only about 800 feet in the Clinton area. The great difference in thickness is due to greater post-Pennsylvanian erosion, depositional onlap, and probably a slower rate of deposition and subsidence in the Clinton area than in the western Kentucky area.

The coal-bearing strata of Pennsylvanian age in Indiana dip southwestward into the Illinois Basin at an average rate of 25 feet per mile, which is less than one-third degree from the horizontal. Along the east edge of the Illinois Basin the strata rise toward the Cincinnati Arch, a large positive structural feature that trends from north-central Indiana into north-central Kentucky and that forms the eastern boundary of the Illinois Basin.

STRIKE AND DIP OF THE STRATA

Strike and dip in the Clinton area, as determined from the structure contours (pls. 1-4), are consistent from the Danville Coal Member to the Seelyville Coal Member, at about N. 23° W. and 25 feet per mile southwestward. The amount of dip increases slightly with downward stratigraphic progression. Strike and dip on the oldest of the coals contoured, coal C of this report (pl. 4), are notably different: N. 34° W. and 37 feet per mile southwestward. The difference may be because the area of coal C available for contouring is restricted to only a small part of the map area and may therefore record a local variation.

MINOR STRUCTURES

Dendritic or branching anticlines and synclines are displayed by the structure contours drawn on each of the coalbeds (pls. 1-4). Some of these structures are persistent from the Seelyville coal (pl. 1) upward to the Danville coal (pl. 4). Most of these structures are of low relief and trend generally down the dip of the strata. A few are marked by small areas of structural closure.

A small high-angle thrust fault is exposed in the NE¼NE¼ sec. 26, T. 14 N., R. 10 W., Vermillion County, on the south side of Brouilletts Creek (fig. 7). Vertical displacement is about 6 feet. Another fault was observed in the south side of a valley in the SW¼NE¼ sec. 25, T. 15 N., R. 9 W., about 1¼ miles west-southwest of Mecca, Parke County (fig. 8). At this place the Colchester Coal Member has been downfaulted in a normal fault that strikes N. 12° E. and dips steeply westward. On the east side of the fault the Coxville Sandstone Member is opposite the coal, which suggests a 12-foot throw. Drag on the coal and black shale clearly indicates normal movement.

A fault was exposed in 1957 at a shale and coal strip mine operated by the Love brothers on Rock Run, in the SE¼SW¼ sec. 34, T. 15 N., R. 8 W., 3 miles southeast of Mecca, Parke County. The coal and its underclay have been

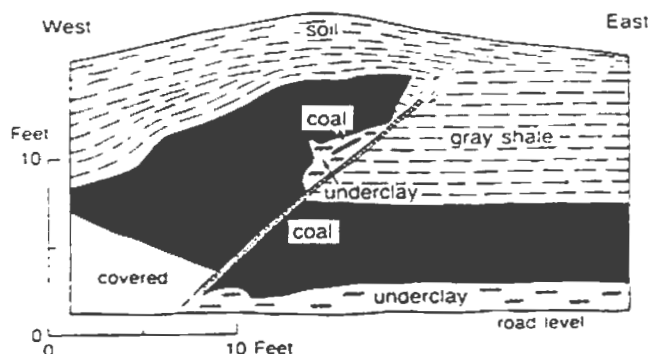


Figure 7. Sketch from a photograph showing a thrust fault in the Danville Coal Member in a road cut in the NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 26, T. 14 N., R. 10 W., Vermillion County.

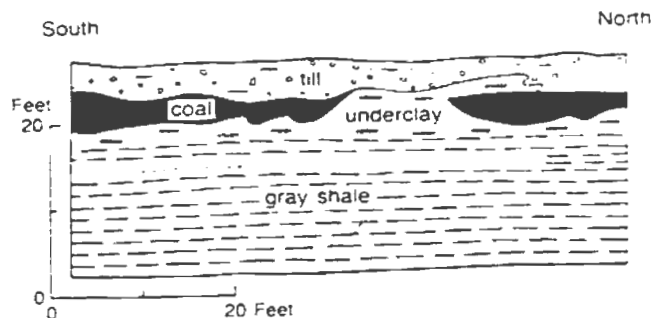


Figure 9. Cross section showing irregularities in the Seelyville Coal Member and its underclay in a strip mine in the SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 15 N., R. 8 W., Parke County.

to be associated with "slight faults" (Ashley, 1899, p. 389). Probably all of these features are of penecontemporaneous or diagenetic origin.

GEOLOGY AND COAL-MINE ENGINEERING

Many engineering problems in coal mining are related to geology. Among the aspects of geology that affect coal mining are structure of the coalbed, behavior of underground water, extent and stratigraphic position of channel-fill sandstones, nature of the strata that form the roof and the floor of the coal, and extent and position of preglacial bedrock valleys. A few examples are discussed below.

Serious drainage problems may arise in the Clinton area in mining unworked bodies of the coal beneath abandoned mines in higher coalbeds. I have observed unmeasured but rapid flows of water into numerous abandoned open shafts in parts of the area west of the Wabash River. Although the mine shafts never fill up with water, much water must be contained in the abandoned workings. If a mine is opened on a lower level, it may be subject to sudden flooding, depending on structural conditions and the lithology and the permeability of the strata beneath the abandoned mines.

Many of the channel-fill sandstones in the Clinton area have been mapped and described (Friedman, 1960). These sandstones are aquifers, and in some places they cut out coal deposits. The Coxville Sandstone Member of

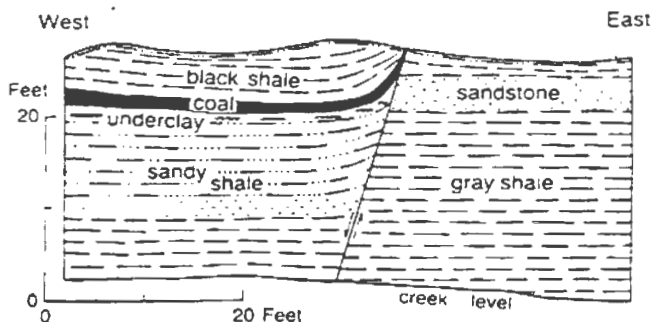


Figure 8. Diagrammatic cross section showing a normal fault in beds containing the Colchester Coal Member in a streambed in the SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 25, T. 15 N., R. 9 W., Parke County.

disturbed as in a clay squeeze, so that the light-gray or white plastic soft underclay has been forced upward through a joint in the coal and lies on top of the coal at one place at the bedrock surface (fig. 9).

Faulting in surface exposures in the Clinton area can be as convincingly argued to be the result of glacial disturbance as of tectonic or diagenetic origin. Faults in mines deep underground, however, are clearly not of glacial origin. Ashley (1899, p. 388-389) noted faults with a downthrow of 6 to 7 feet in the Parke County Coal Co. No. 6 Mine (pl. 1, no. 23). Though these cannot now be verified, Ashley did not confuse these features with clay veins or sandstone veins, which he also observed in the Clinton area (Ashley, 1899, pl. 3). He considered the latter features

the Staunton Formation cuts out or greatly thins the Seelyville Coal Member in places near Rosedale (pl. 1) and in the area between the Talleydale and Green Valley Mines (pl. 1, nos. 32 and 52). Where it forms the roof of a mine, this sandstone also yields much water, as it did in the Atherton Mine west of Rosedale and in the Parke County No. 10 Mine (pl. 1, nos. 30 and 36). Massive sandstone ordinarily forms a good roof, but thin-bedded sandstone or interbedded sandstone and shale may not. Most of the water from a sandstone roof can be pumped out of a mine if the volume is anticipated and large enough pumps are available. Water of high chloride content is likely to be corrosive to equipment.

Gray shale, sandy shale called "draw slate" by miners, clayey shale, and shale interlaminated with sandstone or siltstone commonly make poor roof materials in underground mines. Movement of ventilating air through the mine and seepage of water cause these already weak rocks to slake, and roof collapse may result. These shaly rocks form the roof strata over wide areas of the Seelyville and Survant coals; roof collapse has been common in mines in these coals.

The Springfield coal has the best roof of any coal in the Clinton area. This roof is impervious black carbonaceous sheety or fissile shale containing large concretions composed of calcite, quartz, pyrite, and siderite. In some places the concretions extend downward into the top of the coal. In about one-fourth of the area covered by this black shale, the Alum Cave Limestone Member or the thin unnamed coal just above it forms a solid cap rock above the black shale. Water penetrates these rocks in few places, although they are only about 1 to 2 feet thick. Water that enters the shafts of abandoned mines in the Springfield coal probably comes from permeable strata, such as the Bridge Junction Sandstone Member, in the middle and upper parts of the Dugger Formation or from the base of the glacial drift.

Little information on roof conditions in abandoned mines in the Danville Coal Member is available. In openings exposed by strip mining near Universal, roof supports

were not present, and the roof of clayey blue-gray shale has fallen and has formed an arch about 8 feet above the floor of the tunnel. This shale would be difficult to hold, and roof collapse would present a serious problem in mining this coal underground.

Soft plastic underclay that tends to creep when it is wet or when coal is removed by mining is common beneath the Seelyville and Danville coals. Clay squeezes were a problem in mines north of Seelyville. The Survant and Springfield coals are underlain in most places by shale, sandy shale, sandstone, or underclay that is tough and nonplastic and does not squeeze or creep.

Buried preglacial bedrock valleys filled with glacial drift have influenced coal mining in the area along the west side of the valley of the Wabash River. Between Barnhart Town and Coal Creek no mining has taken place where the Danville coal was removed by preglacial erosion. Another drift-filled bedrock valley in which the Danville coal is absent is on Coal Creek about 1 mile northwest of Bridge Junction. Two buried valleys at Shepardsville and along the valley of Gin Creek also have cut out the Danville Coal Member (pl. 4).

In the deep part of the buried bedrock valley at Shepardsville, the remaining bedrock over the Springfield Coal Member is so thin that it permitted water to enter the mines. These mines therefore do not cross the buried valley, and their borders curve parallel to the curve of this valley (pl. 3). The deep part of the bedrock channel of preglacial Brouillets Creek valley is delineated by a cutout in the Springfield coal that curves around Universal. To avoid areas of thin roof strata and water from the sand that fills Brouillets Creek bedrock valley, the operators of most mines in the Springfield coal guided development of the mines away from this valley.

Parts of the buried bedrock valleys northwest of Clinton are indicated by the boundary of the Springfield coal (pl. 3). Glacial drift here is as much as 200 feet deep. These valleys have reduced the roof-rock cover over the Survant and Seelyville Coal Members. Where the roof strata are thin, it will be difficult to keep ground water from the drift out of any possible future underground mines.

HISTORY OF COAL MINING IN THE CLINTON AREA

Coal mining in the Clinton area was reported more than a hundred years ago (Owen, 1862). By 1898 many small mines were active (Ashley, 1899). Coal supplied the local domestic and industrial demand for fuel for heating and for steampower. Steam locomotives also used much coal.

The number of tons of coal produced, the number of men employed in mining, and the number of injuries and fatalities in the mines follow, in a general way, the number of active mines. Before 1900, 34 known mines operated in the Clinton area; at one time or another from 1900 through 1914, 67 mines operated; from 1915 through 1929, 69; from 1930 through 1941, 37; from 1942 through 1955, 32; and from 1956 through 1967, 16. No known mines operated in 1968 or 1969. Since 1970 only one mine—the Universal Mine of the Peabody Coal Co.—has been operating in the Clinton area. All known mines are shown on plates 1-4; all mines whose operators are known are listed in table 3. This information was collected from many sources, principally reports of the State Mine Inspector of Indiana and early reports of the Indiana Geological Survey and its predecessors.

The Clinton area is extensive enough to include a wide stratigraphic range of coalbeds near the surface that were available to early shallow mining. The Seelyville Coal Member was mined at Seelyville, Burnett, and Coxville; the Springfield Coal Member was mined at Clinton and vicinity; and the Danville Coal Member was produced from numerous small operations along the valleys of Coal Creek, Gin Creek, and Brouilletts Creek, all before 1900. The stratigraphically lower coals, such as the Seelyville, were known to exist at depth west of the Wabash River, but they were not mined there until the shallower coals had been exhausted.

When large reserves of the Springfield Coal Member were exhausted along the west side of the Wabash River from Clinton south to Coal Creek, the mine operators went deeper to the Survant coal, and later they went even deeper to the Seelyville coal. But on the east side of the river, where the Seelyville coal was

shallow and the first to be mined, there were no deeper reserves of importance when the operators exhausted their leased area or for some other reason closed a mine. Therefore much of the area on the east side of the Wabash River ceased some time ago to produce coal in significant amounts.

Factors influencing mining include thickness, continuity, depth, and quality of coal. In underground mining, ground-water conditions and nature of roof and floor materials also are important. Obviously these factors differ from coalbed to coalbed, so that some coalbeds have been the object of more intensive mining interest than others. Fifty-six listed mines produced from the Springfield coal, 54 produced from the Seelyville coal, 24 produced from the Danville coal, 24 produced from the Survant coal, and six produced from the Lower Block coal (table 3). Besides, small unlisted mines produced from these and other coalbeds, including the Houchin Creek coal and coals C and D of this report.

Before 1900 none of the underground mines in the Survant and Danville coals individually produced as much as a million tons of coal during their operation. One early mine in the Springfield coal, the Prince No. 1 (table 3, no. 98), did produce over a million tons of coal before closing, as did the Lyford No. 1, the Brouilletts Creek No. 3, and the Parke County No. 10, all in the Seelyville coal (table 3, nos. 4, 11, and 36).

Six of the many mines that were started in the Seelyville coal between 1900 and 1914 ultimately produced more than a million tons each, but only one of the mines started in this coal in the 1915-29 period achieved this much production. Two mines begun since 1930 each produced more than a million tons of Seelyville coal. These were the Talleydale and the Green Valley Mines (table 3, nos. 32 and 52). The Talleydale was the largest underground mine in the Clinton map area; it produced more than 16 million tons of coal in 27 years. The Green Valley, the third largest underground mine in the area and the last of the mines in the Seelyville coal to go out of operation, produced more than 13 million tons of coal in 15 years.

Extensive mining of the Survant Coal Member did not begin until resources of the more accessible coals began to be exhausted.

Six of the shaft mines begun in this coal during 1907 through 1914 reached a final production of more than a million tons of coal each, and during 1915 through 1929, eight additional large mines were started. One of the latter, the Saxton No. 1 (table 3, no. 78), was the second largest underground mine in the area and produced nearly 14 million tons of coal in its 21 years of operation. Two mines started during 1930 through 1941 also produced more than a million tons each. One of these, the Snow Hill Mine (table 3, no. 74), was the last of the mines in the Survant coal to go out of operation, in 1946.

Fourteen of the shaft mines begun in the Springfield Coal Member from 1900 through 1914 reached a production of more than a million tons each, as did four of the mines begun during 1915 through 1929. Two mines begun since 1942 have also achieved this level of production. One of these, the Viking (table 3, no. 132), produced more than 7 million tons of coal and was both the largest of the mines in the Springfield coal and the last to go out of production, in 1964.

Underground mines in the Danville Coal Member were neither large nor long lived. The largest was the Pittsburgh No. 1 (table 3, no. 150); it produced about 900,000 tons of Danville coal.

Early strip mines in the Clinton area were small. The earliest known important stripping operation was the Sunspot Mine (table 3, no. 136), begun in 1927; during the following 32 years it produced more than 6 million tons of Danville coal. The most recent and the largest mine ever to produce coal from the map area is the Universal Mine of the Peabody Coal Co. (table 3, no. 135). More than 37 million tons of Danville coal was mined by stripping methods by this operation from its opening in 1970 through December 31, 1985.

COAL RESOURCES OF THE CLINTON AREA

Coal resources are classified for this report as measured, indicated, and inferred. Measured resources are those for which drill holes and other datum points that provide data on thickness of coal are spaced not more than half a mile apart. Indicated resources are those for which datum points are spaced more

than half a mile apart but not more than 1½ miles. Inferred resources are those for which datum points are more than 1½ miles apart.

Coal resources and recoverable reserves¹ in the Clinton area were calculated for the Seelyville, Survant, Springfield, and Danville Coal Members (table 4). Other coals, such as the Colchester, Houchin Creek, Bucktown, and Ditney Coal Members and some of the unnamed coalbeds, are thick enough for commercial development only in small areas and are not included in the resource compilations. Coal resources and reserves are listed separately for each major coal and for each township in Vermillion, Vigo, and Parke Counties in the Clinton area. A separate thickness category is included for each coal in areas where the coal was mined; the thickness used is that obtained from mine records and maps. In most places, however, data for all categories of resources were obtained from drilling records. These data by county are summarized in table 5.

Because the Danville Coal Member is accessible by stripping, it is classified as having less than 120 feet of overburden or more than 120 feet of overburden. Resources of Springfield coal, because of varying thickness and depth in different areas, are listed separately in categories that show different ranges in overburden thicknesses. Adjacent to areas where this coal was strip-mined west of the Wabash River, it is classified as having less than 100 feet of overburden or more than 100 feet of overburden because depths greater than 100 feet may be well below the water table in these areas. Most of the resources of the Survant Coal Member are listed in categories showing a range in overburden thickness from 100 to 400 feet. Resources of the Seelyville Coal Member are listed in separate categories according to thickness of overburden in small areas where strip mining can be used and in large areas where underground mining will be necessary. Most of the resources of the Seelyville coal are listed in categories indicating 150 to 550 feet of overburden.

¹ Coal resources are coals in such form that economic extraction is currently or may become feasible. Reserves are determined by applying a recovery factor to the resource estimate.

Table 5. Summary of coal resources and reserves in the Clinton area as of December 31, 1985, arranged by county
[in thousands of short tons]

County	Coal member	Original resources		Mined and lost in mining		Remaining resources		Recoverable reserves
		Acres	Tons	Acres	Tons	Acres	Tons	Tons
Parke	Seelyville (III)	3,990	40,120	1,610	18,036	2,380	22,084	11,044
Vermillion	Danville (VII)	8,218	62,758	6,257	47,710	1,961	15,047	10,093
	Springfield (V)	31,392	250,242	13,065	110,122	18,327	140,121	74,947
	Survant (IV)	21,353	156,360	4,574	36,380	16,779	119,980	60,490
	Seelyville (III)	34,531	356,374	3,626	38,147	30,905	318,226	159,114
	Vermillion County subtotal	95,494	825,734	27,522	232,359	67,972	593,374	304,644
Vigo	Danville (VII)	38,747	330,501	2,264	19,430	36,483	311,072	169,085
	Springfield (V)	30,007	235,601	12,414	98,839	17,593	136,762	69,903
	Survant (IV)	16,356	138,289	11,710	105,114	4,646	33,175	16,589
	Seelyville (III)	36,611	381,315	12,028	127,354	24,583	253,961	126,982
Vigo County subtotal		121,721	1,085,706	38,416	350,737	83,305	734,970	382,559
Total		221,205	1,951,560	67,548	601,132	153,657	1,350,428	698,247

Following the procedure established for Indiana coal-resource studies by Spencer (1953), the figure 1,800 tons per acre-foot, based on an average specific gravity of 1.32, is used for calculating the weight of coal in the ground. On this basis, original resources in the Clinton area before mining began were nearly 2 billion tons (table 4). Coal mined and lost in mining to December 31, 1985, was about 601 million tons, and remaining resources as of that date were about 1,350 million tons.

For that part of the resources that must be mined by underground methods, a 50-percent recovery factor was used to calculate recoverable reserves. A recovery factor of 80 percent was used for resources that are considered strippable. On this basis, recoverable reserves in the Clinton area as of December 31, 1985, were about 698 million tons (table 4). Recoverable reserves of the Seelyville Coal Member were about 297 million tons; of the Survant Coal Member, about 77 million tons; of the Springfield Coal Member, about 145 million tons; and of the Danville Coal Member, about 179 million tons.

Additional resources exist in some of the coals of the Staunton and Brazil Formations, but available data do not permit satisfactory estimates. Some of these coals are known to be as much as 4 feet thick in a few places (table 1), and further exploration, particularly in the area east of the Wabash River, seems worthwhile.

OTHER ECONOMIC MINERAL DEPOSITS

Shale and clay suitable for making brick, tile, and other heavy-clay ceramic products are widely distributed in the Clinton area. Especially thick deposits of shale are between the Bucktown Coal Member and the Danville Coal Member and above the Danville coal. Although these are easily accessible to stripping in many places, they have not been used in this area, but they were extensively used just south of the area at West Terre Haute. Clay and shale from the Staunton Formation were used for many years at Mecca for making draitile and sewer pipe. Even long after the plants at Mecca were closed, clay and shale from pits nearby were shipped

out of the area, mainly to Brazil, Ind., for tile manufacture there. Clay and shale from the Staunton were used at Montezuma, just north of the Clinton area, until 1980.

Thick deposits of sand and gravel extend the length of the Wabash Valley (fig. 5). Many of these deposits lie below the water table and can be removed only by dredging. In the Clinton area large gravel pits have operated for many years near Clinton. Other large pits just north of Terre Haute are no longer active. Ground water also is available in large quantity from the sand and gravel of the Wabash Valley. Wells in most other parts of the Clinton area will generally provide only enough water for domestic use (Clark, 1980, p. 283).

In the 1940's pyrite was produced as a byproduct of coal mining from the Talleydale Mine (pl. 1, no. 32) and was shipped out of the area for making sulfuric acid. Considerable quantities of pyrite are available from the upper part of the Danville Coal Member, and much pyrite is present in partings in the Seelyville coal. At present, however, the demand for sulfur and sulfuric acid is readily satisfied by deposits elsewhere, and in the Clinton area pyrite is regarded merely as a deleterious byproduct of coal mining.

Numerous wells have been drilled in the Clinton area in hopes of discovering oil or gas in commercial quantities, but all wells were dry and therefore were abandoned. Several potential reservoir rocks have been tested; the deepest formation tested so far is the Trenton Limestone of Ordovician age. The Clinton area is on a reef trend that has been productive elsewhere (Ault and others, 1976), but the closest known structures, just north of the area at Montezuma, have proved of value principally for gas storage.

Of historical significance was the Indiana Furnace, an iron-smelting establishment on the upland south of Brouillets Creek in the SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 14 N., R. 10 W., Vermillion County, which was in operation from 1840 to 1861 (Wayne, 1970). Although the Danville coal cropped out near the blast furnace, charcoal was used as fuel. The iron ore was in the form of concretions in the blue-gray shale that overlay the Danville coal. This shale cropped out in nearby creekbeds

and banks. A local limestone was used as flux (Owen, 1862, p. 169). This was the most successful of the Indiana furnaces that depended on native ores.

The site of the Indiana Furnace has been destroyed by stripping operations of the Universal Mine. According to former residents of the area, the furnace was dismantled for scrap about 1890, and the stone was removed and used for bridge abutments by the WPA in the 1930's (Henry H. Gray, oral communication, 1986).

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APPENDIX — INDIANA GEOLOGICAL SURVEY DRILL HOLES IN THE CLINTON AREA

Survey Drill Hole 33

Drilled June 6 to 29, 1956, on the Roy W. Tolin farm, SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 5, T. 14 N., R. 8 W., Mecca Quadrangle, Parke County, Ind. Surface altitude by altimeter, 560 ft. Location 13 on plates 1-4 and 5.

	Thickness	Depth
	(ft)	(ft)
Quaternary System undifferentiated:		
1. Loam, dark-brown, sandy	3.6	3.6
2. Clay, light-gray	3.6	7.2
3. Sandstone boulder	1.6	8.8
4. Sand, brown	1.6	10.4
5. Gravel; medium-size pebbles; angular; about 10 percent granite	1.6	12.0
Total Quaternary System	12.0	
Pennsylvanian System:		
Petersburg Formation:		
6. Sandstone, medium-gray, thick-bedded; silty at the top; very fine grained, micaceous, and somewhat carbonaceous; has numerous shale partings and alternating medium-gray and dark-gray laminae; slightly calcareous in the top 2 in.	3.49	15.49
Petersburg and Linton Formations undifferentiated:		
7. Shale, medium-gray, evenly medium to thick bedded, slightly micaceous; has moderate amount of carbonaceous films; has three silty calcareous zones, 1/8 to 1/4 in. thick at the center, each about 2 ft apart; has abundant brachiopods 1 in. wide and 1/4 in. high. (Contains place of Survant Coal Member (IV))	11.92	27.41
Linton Formation:		
8. Shale; medium light gray to medium gray progressively from top to base; medium to thick bedded, clayey, smooth; calcareous at the base; contains a moderate amount of thin (as much as 1/4 in.) sideritic concretions	11.45	38.86
9. Limestone, dark-gray, medium-bedded; in one layer; finely crystalline, dense, tough; has minute fragments of white bryozoans and a few calcite-filled vugs of long-winged small brachiopods; weathers tan	0.24	39.10
10. Shale, dark-gray, indistinctly medium to thick bedded, clayey, smooth; has two concretionary layers of siderite at the center, 0.06 and 0.2 ft thick; has a minute brachiopod cast, 0.02 ft long, and other brachiopod impressions with abundant pyritized fernlike carbonaceous films; unit is darker gray at base	2.46	41.56
11. Shale, gray-black, evenly and indistinctly thin or medium bedded, clayey, smooth; has abundant minute impressions and molds of fish remains; calcareous	1.54	43.10
12. Limestone, gray-black, thick-bedded, dense, carbonaceous; contains clastic white fossil material in a very fine grained calcite matrix; has a shale parting at the center	0.86	43.96

Pennsylvanian System—Continued

Linton Formation—Continued

	Thickness (ft)	Depth (ft)
13. Shale, black, evenly medium to thick bedded, carbonaceous; has calcite and pyrite films on bedding planes and crystalline pyrite in abundant minute fossil material; cohesive	2.40	46.36
14. Coal, black, banded, bituminous; has about 40 percent vitrain; contains calcite and pyrite films in vertical fractures. (Units 14-16, Colchester Coal Member (IIIa)) .	0.96	47.32
15. Shale, dark-gray, indistinctly bedded	0.07	47.39
16. Coal, black, banded, bituminous; has about 25 percent vitrain with dull coal at the base; has pyrite in vertical fractures	0.60	47.99
17. Underclay, medium-tan-gray, massive, noncalcareous; has irregularly scattered carbonaceous material with a few dark-gray calcareous siderite concretions; slightly harder in the basal 2 ft; calcareous in the lower 3 ft	5.56	53.55
18. Sandstone, light-brown-gray; probably medium to thick bedded; has a few 1/8-inch shale partings in the lower half; very fine grained and fine grained in the lower half; has angular grains of quartz; micaceous; has abundant grains of zircon or tourmaline at the center; has granular disseminated brassy-yellow pyrite 1 ft below the top; has a calcareous zone 1.5 ft from the top	3.38	56.93
19. Shale, light-brown-gray, thin- or medium-bedded; has silty and shaly wavy laminae; micaceous, noncalcareous, silty at the base; grades to medium blue gray downward . .	2.07	59.00
20. Shale, medium-blue-gray, evenly thin to medium bedded, micaceous, noncalcareous, somewhat silty, smooth; grades to dark gray at the base and has impressions and casts of fossil material (probably fish remains)	2.87	61.87
Total Linton and Petersburg Formations penetrated . .	49.87	

Staunton Formation:

21. Coal, black, banded, bituminous; has 5/8-inch gray granular pyrite at the top; has 0.16-foot pyrite about 1 ft from the top; is 20 percent vitrain; has 25 percent vitrain in lower two-thirds. (Units 21-23, Seelyville Coal Member (III))	3.56	65.43
22. Underclay, dark-gray, massive; bedding shown only by coal streaks; silty, smooth, tough; slickensides at various orientations; noncalcareous	0.73	66.16
23. Coal, black, banded, bituminous; has about 20 percent vitrain; cohesive	0.19	66.35
24. Mudstone, medium-dark-gray, massive, dense, silty; has carbonaceous fragments and streaks; splittable	2.50	68.85
25. Shale, medium-brown-gray, indistinctly and evenly medium to thick bedded, clayey, noncalcareous; silty at the base; smooth; uniform texture and color; weathers light gray tan	11.26	80.11
26. Siltstone, medium-brown-gray, thick-bedded; clayey at the top; has a 0.5-foot calcareous zone 1.1 ft from the top	2.22	82.33

Pennsylvanian System—Continued		Thickness	Depth
Staunton Formation—Continued		(ft)	(ft)
27. Shale, medium-dark-gray; probably medium bedded; silty, micaceous; has a small amount of minute carbonaceous films; somewhat tough at the base		14.15	96.48
28. Shale, medium-dark-blue-gray, thin- to medium-bedded, smooth, noncalcareous; has a 0.05-foot siderite band 0.4 ft from the top, is dark blue gray and carbonaceous at the base, and has ½- by 1-inch pyritiferous carbonaceous plant remains at the top		1.50	97.98
29. Shale; dark gray in the upper one-third and black in the lower two-thirds; thin to medium bedded, carbonaceous.		1.55	99.53
30. Coal, black, banded, bituminous; has about 15 percent vitrain, 20 percent fusain, and 65 percent claro-durain; has scarce calcite films in vertical cracks; crumbly. (Coal D of this report)		1.70	101.23
31. Underclaystone, dark-gray; medium dark tan gray at the center; massive, tough, cohesive, somewhat microbrecciated; has fragments of coalified material and a small (1-inch-long) siderite concretion at the center		2.55	103.78
32. Shale, dark-gray; gray black at the base; indistinctly thick bedded, tough, silty, slightly micaceous; has disseminated grains of brassy-yellow pyrite along a bedding plane at the top		3.00	106.78
33. Claystone, dark-gray to gray-black, massive and indistinctly thin to medium bedded, clayey, micaceous, crumbly, smooth		1.82	108.60
34. Limestone, black to dark-gray; in one bed; dense, tough, brecciated with abundant white or light-gray small fossils and fossil material		0.33	108.93
35. Shale, black to gray-black, medium-bedded, carbonaceous, smutty, soft, smooth; probably weathers to paper thin soft sheets and flakes; has an excellent pyritized brachiopod cast, .03 ft wide by .02 ft long, and abundant carbonaceous and calcareous films of brachiopods, a small oval pelecypod, and a coiled cephalopod at the base; has pyrite lenses at the base; calcareous in the upper 0.35 ft		2.73	111.66
36. Coal, black, banded, bituminous; has 10 percent vitrain and 10 percent fusain, is smutty, and has 80 percent claro-durain, so may be somewhat blocky in outcrop; has pyritized plant-stem impressions and films at the base. (Coal C of this report)		1.70	113.36
37. Shale, gray-black to black, thin- to medium-bedded, silty, micaceous, carbonaceous, smooth, tough, dense; has fossil-shell impressions		0.50	113.86
38. Underclay, medium-dark-gray; bedding absent in the upper two-thirds; micaceous; has indistinct shaly bedding in the lower one-third where unit is cohesive and silty; has a large amount of carbonaceous films and impressions		3.47	117.33
39. Shale, medium-dark-gray, evenly medium bedded, silty, micaceous; has calcareous sideritic zones and nodules .		6.16	123.49

Pennsylvanian System—Continued		Thickness	Depth
Staunton Formation—Continued		(ft)	(ft)
40. Claystone, medium-dark-gray; bedding absent or indistinct and irregular; massive, smooth, crumbly		2.05	125.54
41. Limestone, medium-gray-brown or brown; one medium-bedded unit; sublithographic, dense and tough; matrix loaded with white to gray fragments of fossil material .		0.29	125.83
42. Shale, black, thin- to medium-bedded, extremely carbonaceous; contains granular disseminated pyrite in the lower half and marcasite that weathers readily to light-gray melanterite; calcareous at the top and at the base; unit has moderately abundant impressions and pyritized remains of two or three species of brachiopods, is brittle, and has at least seven coal (vitrainlike) layers, ¼ to 1/16 in. thick, in the basal 0.85 ft		4.87	130.70
43. Underclay, medium-gray, massive, crumbly, smooth . . .		3.50	134.20
44. Limestone, light-gray, medium-bedded, sublithographic, dense, clayey		0.61	134.81
45. Shale, medium-dark-gray, irregularly thin bedded, smooth, clayey, calcareous		1.15	135.96
46. Shale, black, medium-bedded, smooth, clayey, carbonaceous; calcareous at the top		1.30	137.26
47. Shale, dark-gray or dark-tan-gray; medium gray in the lower one-third; thin bedded, clayey, slightly silty; contains two slightly calcareous siderite nodules, 0.09 and 0.15 ft thick, in the upper one-third and a dense ironstone layer in the middle one-third; the lower one-third is less silty and has a 0.05-foot calcareous zone 1.3 ft from the top and scarce carbonaceous films at the base		9.90	147.16
48. Shale, black, evenly thin bedded, smooth, clayey, carbonaceous		0.05	147.21
49. Coal, black, banded, bituminous; has 15 percent vitrain, 10 percent fusain, and 75 percent claro-durain; calcite and pyrite are in vertical cracks and joints; breaks in moderate-size fragments; slightly shaly at the base . . .		0.77	147.98
50. Shale, black, massive, carbonaceous, tough, cohesive; "bone coal"		0.03	148.01
51. Underclay, medium-dark-gray, massive, cohesive, slightly silty, smooth; grades to thin-bedded fissile shale at the base		5.45	153.46
52. Shale, medium-dark-gray, thin- to medium-bedded, clayey, smooth, slightly silty		1.22	154.68
53. Limestone, medium-dark-gray, thick-bedded, sublithographic, dense, tough, cohesive, clayey. (Units 53-55, Perth Limestone Member)		3.09	157.77
54. Shale, medium-gray, thin- to medium-bedded, highly calcareous; contains abundant small brachiopod molds of numerous species		2.19	159.96

Pennsylvanian System—Continued
Staunton Formation—Continued

	Thickness (ft)	Depth (ft)
55. Limestone, medium-dark-gray; dark gray in the basal 1.3 ft; thick bedded, massive, very fine grained to sublithographic, dense, tough, somewhat clayey, cohesive; shows rare bedding contortions and breccia zones in the middle one-third; contains abundant small brachiopod molds and casts of numerous genera; coquinalike in the basal 1 ft	13.05	173.01
56. Shale, black, indistinctly thin bedded, carbonaceous, very calcareous; contains light-gray fragments of fossil material	0.14	173.15
Total Staunton Formation	111.28	

Brazil Formation:

57. Coal, black, banded, bituminous; has 10 percent vitrain, 10 percent fusain, and 80 percent claro-durain; has calcite films in vertical cracks and thin lenses of pyrite parallel to bedding, breaks into moderate-size chunks, is shaly in the lower 0.6 ft, and has a 0.05-foot pyrite lens, weathered to melanterite at the base. (Minshall Coal Member)	4.21	177.36
58. Underclay, medium-dark-gray; has a trace of bedding; massive, slightly silty; has carbonaceous films irregularly scattered throughout the unit and a thin coal lens at the base	1.86	179.22
59. Sandstone, dark-gray; has irregular, uneven, and slightly contorted layers; thin bedded; highly impure; has numerous thin coal lenses and fine- to medium-grained subangular grains of quartz; has layers and lenses of dark-gray shale; has marcasite at the base weathered to melanterite needles and micaceous at the base where it is an impure shale with a small round brachiopod cast; the unit shows penecontemporaneous slump and differential compaction of coal and shale above the sand lenses	0.74	179.96
60. Shale, dark-gray, gray-black, and black; finely interbedded with layers and streaks of thin fine-grained light-gray sandstone; both shale and sandstone show contorted bedding and microfaults because of penecontemporaneous slump and faulting; shale is very carbonaceous in the upper one-third and is in sharp color and lithologic contrast with the sandstone, but the contrast fades in the lower two-thirds where the shale is less carbonaceous and the sandstone layers are medium gray and not common	47.09	227.05
61. Coal, black, banded, bituminous; has 10 to 15 percent vitrain, breaks into medium-size chunks, contains calcite films in vertical cracks, and has a 0.06-foot clay layer 0.6 ft from the top. (Lower Block Coal Member)	1.42	228.47
Total Brazil Formation	55.32	

Pennsylvanian System—Continued

Mansfield Formation:

	Thickness (ft)	Depth (ft)
62. Shale, dark-gray to gray-black, thin- to medium-bedded, silty, micaceous; has calcareous streaks and lenses . . .	0.46	228.93
63. Mudstone, medium-gray, thin- to medium-bedded; has only a trace of bedding at the base; dense, silty; has a sandstone nodule with a clay matrix at the center; has a white vein of chert at the center forming an angle of about 45° with the bedding; has abundant fossil material in the upper 1 ft	2.04	230.97
64. Sandstone, medium-light-gray, fine-grained; has a clay matrix; has a thin irregular layer of medium-dark-gray shale at the top	0.12	231.09
65. Shale, medium-dark-gray, indistinctly and irregularly thin bedded; has sandstone lenses; micaceous, silty, smooth .	0.50	231.59
66. Sandstone, medium-light-gray, medium-bedded, very fine to medium grained; contains layers of medium-gray shale as much as 0.05 ft at the center and subangular grains of quartz and a few rounded grains of zircon and (or) tourmaline	1.70	233.29
67. Shale, dark-gray to gray-black, evenly thin bedded; has a film of red iron oxide and pyrite at the top with the impressions of the sand grains from the overlying sandstone; unit is smooth and slightly micaceous and has layers of fine-grained clayey sandstone as much as 0.08 ft thick	3.53	236.82
68. Claystone, medium-light-gray, massive, soft and crumbly .	0.29	237.11
69. Shale, dark-gray to gray-black, thin- to medium-bedded, smooth; interbedded with clayey slightly calcareous fine-grained sandstone in medium-bedded layers as much as 0.3 ft thick; unit is somewhat pyritiferous at the base .	1.30	238.41
70. Sandstone, medium-light-gray; interbedded with medium-dark-gray shale; sandstone is thin to medium bedded and fine to medium grained, has subangular and subrounded grains, has a clayey matrix, and is noncalcareous; shale is in light-brown thin-bedded streaks and partings in the central one-third; sandstone is friable in the basal one-third	8.01	246.42
71. Claystone, medium-light-tan, massive; bedding absent . .	0.60	247.02
72. Sandstone, medium-light-brown-gray, thin- to medium-bedded; interbedded with dark-gray smooth thin-bedded shale or medium to irregularly thin bedded shale; micaceous; sandstone has subangular to subrounded grains of quartz with a calcareous clay matrix	3.63	250.65
73. Shale, dark-gray to medium-dark-gray, thin-bedded; contains abundant minute pyrite aggregate grains that fill minute molds left from dissolved fossil material; contains thin irregular lenses of noncalcareous sandstone and carbonaceous films at the base	4.23	254.88

Pennsylvanian System—Continued		Thickness	Depth
Mansfield Formation—Continued		(ft)	(ft)
74. Sandstone, medium-gray to medium-light-gray, medium-to thick-bedded, fine- to medium-grained; subangular to subrounded and clear to milky grains of quartz; friable; has small coal fragments and irregular thin lenses parallel to bedding; contains three layers of dark-gray micaceous shale as much as 0.06 ft thick in the upper 1 ft		10.96	265.84
Total Mansfield Formation penetrated		37.37	
Total Pennsylvanian System penetrated		253.84	
Total depth of hole			265.84

Survey Drill Hole 34

Drilled July 9 to August 8, 1956, on the Frank Armstrong farm, NW cor. SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 16, T. 15 N., R. 8 W., Mecca Quadrangle, Parke County, Ind. Surface altitude by altimeter, 647 ft. Location 14 on plates 1-4 and 5.

Quaternary System undifferentiated:		Thickness	Depth
		(ft)	(ft)
1. Clay, gray		2.0	2.0
2. Till, gray or yellow-brown, clayey		9.0	11.0
3. Sand, fine-grained; contains small fragments of coal . . .		18.0	29.0
4. Sand and gravel; fine-grained sand		12.7	41.7
Total Quaternary System		41.7	
Pennsylvanian System:			
Staunton Formation:			
5. Shale, medium-gray; medium dark gray in the lower two-thirds; indistinctly thick bedded, slightly micaceous, silty, noncalcareous; contains 0.1 ft of tan chert at the top and small ($\frac{1}{4}$ -inch) calcareous nodules unevenly distributed in the lower two-thirds; has 0.3 ft of light-gray sandstone 0.6 ft above the base		8.59	50.29
6. Shale, medium-gray; silty in the upper half; uniformly smooth, noncalcareous		5.31	55.60
7. Shale, medium-dark-gray, evenly thin bedded; carbonaceous at the base		3.31	58.91
8. Coal, black, bituminous, banded; contains about 30 percent vitrain and a film of brassy-yellow granular pyrite as a vertical filling. (Coal D of this report)		1.27	60.18
9. Underclay, light-gray; medium gray at the top; massive; noncalcareous in the upper 2.9 ft; calcareous in the lower 2.7 ft		5.58	65.76
10. Shale, medium-light-gray, indistinctly medium to thick bedded, sandy; silty at the base		4.42	70.18
11. Sandstone, light-gray; medium gray at the base; fine grained, medium to thick bedded; contains a few thin shale partings 0.5 to 0.9 ft apart; micaceous, silty, noncalcareous, dense		1.96	72.14

Pennsylvanian System—Continued		Thickness	Depth
Staunton Formation—Continued		(ft)	(ft)
12. Sandstone; contains alternating light-gray and medium-dark-gray laminae with shale partings as much as 0.04 ft thick at intervals of 0.3 to 1.0 ft		2.94	75.08
13. Shale, medium-dark-gray, silty, slightly micaceous, thick-bedded		4.01	79.09
14. Sandstone, medium-dark-gray; light tan gray at the top; fine grained, noncalcareous		0.33	79.42
15. Ironstone, medium-red-brown, massive, sideritic and siliceous, dense, tough; contains a cavity		0.46	79.88
16. Shale, medium-dark-gray; interlayered with layers of thin light-tan-gray fine-grained sandstone; noncalcareous . .		2.50	82.38
17. Shale, medium-dark-gray, silty, noncalcareous		0.45	82.83
18. Siltstone, medium-dark-gray; contains 0.03 ft of clayey sandstone, fine grained at the top; contains lenses of sandstone and wavy and contorted, very thin layers of siltstone and sandstone; contains a contorted patch of bituminous coal 0.49 ft down from the top; contains small carbonaceous fragments and is micaceous in the lower half; unit is noncalcareous		3.70	86.53
19. Sandstone, medium-dark-gray, fine-grained; contains subangular grains of quartz; medium bedded, noncalcareous; contains thin irregular contorted layers of dark-gray silty shale		3.30	89.83
20. Sandstone, medium-gray, very fine grained; contains subangular grains of quartz; micaceous; contains contorted thin-bedded dark-gray silty shale and sandstone, partly crossbedded		4.90	94.73
21. Sandstone, medium-gray, very fine to fine grained; contains very thin laminae of dark-gray silty shale; contains carbonaceous films and black plant material at the middle; noncalcareous; contains scarce aggregate grains of pyrite		3.66	98.39
22. Shale, medium-dark-gray, silty; contains contorted sandstone lenses and soft black-shale partings at the top . .		0.99	99.38
23. Sandstone, medium-gray, very fine to fine grained, carbonaceous, micaceous, silty		2.30	101.68
24. Shale, medium-dark-gray, silty, micaceous; contains carbonized black plant-stem films; noncalcareous . . .		1.30	102.98
25. Sandstone; medium gray with dark-gray laminae; fine grained, carbonaceous and micaceous, noncalcareous . .		3.27	106.25
26. Shale, medium-dark-gray, medium- to thick-bedded; silty at the top; micaceous, noncalcareous; contains sparse black carbonized films of plant material		3.00	109.25
27. Shale, medium-gray, splittable, slightly micaceous and silty		3.10	112.35
28. Shale, medium-gray, soft, clayey		1.77	114.12

Pennsylvanian System—Continued Staunton Formation—Continued		Thickness (ft)	Depth (ft)
29. Limestone, light-gray-brown, medium-bedded, very fine grained to sublithographic; contains abundant small light-gray fragments that may be fossil material and small unidentifiable brachiopods; contains sideritic nodules; shaly at the base		0.74	114.86
30. Shale, gray-black or black, carbonaceous; contains granular calcite that fills vertical cracks and granular brassy-yellow pyrite in bedding planes, contains a siderite nodule 0.75 ft above the base, and contains part of a medium-size plicated brachiopod		6.80	121.66
31. Underclay, medium-light-gray, massive, splittable; contains indistinct irregular bedding planes; tough; noncalcareous; grades downward to shale with distinct thin beds		4.28	125.94
32. Shale, medium-gray, thin-bedded, noncalcareous		1.43	127.37
33. Limestone, dark-gray, fine-grained, slightly crystalline; dense, tough, sideritic; contains small white fragments that may be fossil material and contains small brachiopod fragments filled with coarse-grained calcite .		0.41	127.78
34. Shale, black or dark-gray, thin-bedded, calcareous; contains 0.13 ft of medium-gray fine-grained sandstone at the base		0.35	128.13
35. Shale, medium-gray; contains a trace (0.02 ft) of bituminous coal, underlain by medium-gray massive underclay that contains fragments of coal		0.44	128.57
36. Shale, medium-gray or medium-dark-gray, indistinctly thin bedded; slightly silty and calcareous at the top; micaceous; contains eight dense ironstone or sideritic layers as much as 0.15 ft thick		5.04	133.61
37. Shale, medium-dark-gray; very dark gray at the middle; evenly thin bedded; dense and silty in the lower half; contains 0.41 ft of silty sideritic ironstone at the middle; contains fossil-plant material at the base and a carbonized film of a fern leaf		8.07	141.68
38. Shale, medium-light-gray, evenly thin bedded; a film of coal at the top		0.07	141.75
39. Ironstone, gray-brown, dense, tough, massive; contains sublithographic siderite; contains aggregate grains of brassy-yellow pyrite and grains of pyrite with radial structure		0.35	142.10
40. Shale, medium-dark-gray; gray black at the base; noncalcareous; contains a siderite nodule, 0.04 ft thick, at the base		2.48	144.58
Total Staunton Formation penetrated		<u>102.88</u>	

Pennsylvanian System—Continued

Brazil Formation:

	Thickness (ft)	Depth (ft)
41. Coal, black, bituminous; as thin as a film. (Minshall Coal Member)	0.01	144.59
42. Underclaystone, gray, massive; bedding absent; dense, noncalcareous, silty; a bituminous-coal lens, 0.04 ft thick, that contains granular pyrite is at the top	1.66	146.25
42a. Claystone, medium-light-gray, massive; bedding absent; contains patches of limonite stain	0.82	147.07
43. Claystone, medium-light-gray, massive; bedding absent; silty; contains medium to coarse orange or gray rounded grains of quartz that are about one-third of the volume of this unit; noncalcareous	1.70	148.77
44. Shale, medium-tan-gray, indistinctly thin bedded, clayey; contains two vertical clay dikes; noncalcareous	4.44	153.21
45. Shale, medium-gray, thin- to thick-bedded, silty, dense, cohesive, noncalcareous; contains alternating brown-gray and light-gray, fairly even layers in the lower half; contains six thin lenses of coarse rounded grains of quartz coated with red-brown iron oxide in a shale matrix; unit grades downward to very fine grained sandstone	5.41	158.62
46. Sandstone, medium-light-gray, thin-bedded, very fine grained; contains shale partings and thin medium-gray and light-gray alternating layers; grades downward to sandy shale with alternating light- and dark-gray layers; contains a gray-black layer at the base	2.10	160.72
47. Shale, dark-gray or black, thin-bedded; alternating with very thin layers of light-gray very fine grained sandstone showing differential compaction; carbonaceous; contains clayey soft black shale in the lower 0.53 ft; common name for unit is "fake"	4.42	165.14
48. Sandstone, light-gray or medium-gray, medium- to thick-bedded, fine- to coarse-grained; calcareous at the middle; slightly micaceous; contains coarse well-rounded grains of quartz with red-brown iron oxide coating; quartz grains are in lenses, in thin layers, or irregularly disseminated. Cementing agents are clay, iron oxide, calcite, and silica; contains alternating shale and sandstone layers at the base	10.45	175.59
49. Shale, medium-gray to medium-light-gray; contains alternating shale layers that are silty and micaceous; unit is noncalcareous; contains light-gray medium-grained thin sandstone lenses at the base	1.47	177.06
50. Sandstone, light-gray, medium-bedded, medium- to coarse-grained; contains subangular grains of quartz bonded by clay cement; friable	0.91	177.97
51. Shale, dark-gray or gray-black, medium-bedded; contains lenses of medium-grained sandstone as much as 0.09 ft thick; unit is silty and micaceous and contains small carbonaceous films of plants	2.21	180.18

Pennsylvanian System—Continued

Brazil Formation—Continued

	Thickness (ft)	Depth (ft)
52. Sandstone, light-gray, thin- to medium-bedded, fine- to medium-grained, friable; contains clay that cements the sand grains; micaceous especially along contacts between shale partings and sandstone. Shale layers are medium gray, reach 0.06 ft, and alternate with sandstone in the lower half of the unit; very shaly at the base	14.68	194.86
53. Shale, medium-gray, medium-bedded; interlayered with medium-light-gray shale, light-gray fine-grained sandstone, and thin black bituminous coal in 15 contorted lenses at the base; contains a dense siliceous zone and 0.05 ft of siderite at the base	2.22	197.08
54. Shale, dark-gray, clayey	0.36	197.44
55. Coal, black, bituminous, banded; contains about 50 percent vitrain and contains calcite films on a vertical face and pyrite on bedding planes and vertical faces. (Lower Block Coal Member)	0.48	197.92
Total Brazil Formation	53.34	

Mansfield Formation:

56. Shale, medium-dark-gray to medium-gray; contains thin coal lenses at the top and abundant black carbonized films parallel to the bedding; contains patches of coarse sand grains with iron oxide coating and nodular silty material	2.17	200.09
57. Sandstone, medium-gray, thick-bedded; contains a fine-grained clayey matrix; contains coarse-grained rounded grains of quartz coated in large part with red to brown iron oxide; grades downward to sandy shale at the base	2.50	202.59
58. Shale, medium-gray, thin-bedded, silty, micaceous; contains contorted bedding and shaly siltstone at the base	3.11	205.70
59. Shale, black, thin-bedded; interlayered with fine-grained clayey thin sandstone; bedding is highly contorted in places; contains 0.78 ft of silty shale about 1 ft below the top	4.45	210.15
60. Shale, medium-gray; medium dark gray at the middle; thin bedded; contains layers and lenses of fine-grained sandstone; silty, noncalcareous	4.57	214.72
61. Shale, black, carbonaceous, thin-bedded; wavy bedding; interlayered with tan-gray fine-grained noncalcareous sandstone that is irregularly bedded and contorted; differential compaction of the shale in places; contains dense sideritic nodules 1 to 2 ft above the base; contains a film of coal in the sandstone 0.9 ft above the base	3.39	218.11
62. Claystone, medium-gray; contains small irregular carbonaceous particles; noncalcareous	2.99	221.10
63. Shale, gray, indistinctly medium to thick bedded; contains medium to coarse rounded sand grains coated with brown iron stain; lower half of unit is silty and medium gray	2.08	223.18

Pennsylvanian System—Continued		Thickness	Depth
Mansfield Formation—Continued		(ft)	(ft)
64. Shale, medium-gray; contains lenses of tan-gray fine-grained sandstone that are contorted in places; the upper 0.2 ft is calcareous and very dark gray	2.41	225.59	
65. Shale, dark-gray, indistinctly thin bedded; grades into interlayered shale and sandstone at the base; contains coal, 0.35 ft thick, at the top; silty and micaceous . . .	2.21	227.80	
66. Shale, dark-gray; contains irregularly thin and contorted bedding, finely interlayered with lenses of tan fine-grained sand; micaceous at the top with black carbonaceous shale fragments; contains clayey layer, 0.32 ft thick, 0.66 ft above the base and a 0.34-foot siderite layer at the base	1.74	229.54	
67. Shale, dark-gray, evenly thin bedded, slightly micaceous and silty; contains brassy-yellow granular pyrite in patches at the middle on bedding planes and tan-gray dense siderite, 0.15 ft thick, 4.52 ft from the base . . .	12.14	241.68	
68. Coal, black, banded, bituminous; contains about 20 percent vitrain, 5 percent fusain, and 75 percent claro-durain; nonpyritiferous. (Shady Lane Coal Member)	0.74	242.42	
69. Claystone, light-gray; dark gray and coaly at the top; contains irregularly distributed coal fragments	0.17	242.59	
70. Underclay, light-gray, massive; dense at the base; slightly silty; contains numerous carbonaceous patches irregularly distributed; noncalcareous	4.17	246.76	
71. Shale, medium-gray, indistinctly and poorly bedded; silty at the top; contains two patches of dense clay-bonded sandy material, one of which is calcareous and at the base	2.10	248.86	
72. Shale, dark-gray to very dark gray, indistinctly thin bedded; contains 0.21 ft of dense limestone that is 0.16 ft from the top and is medium grained and crystalline. (Units 72-74, Lead Creek Limestone Member)	1.50	250.36	
73. Siltstone, dark-gray, massive, very fine grained, calcareous, and dense	0.97	251.33	
74. Limestone, dark-gray, with light-gray small fragmental fossil material	0.37	251.70	
75. Shale, dark-gray; shows medium- to dark-gray laminae; sandy at the top; silty; contains a 0.05-foot-thick siderite nodule at the middle	12.16	263.86	
76. Siderite, brown-gray, dense, massive	0.17	264.03	
77. Shale, dark-gray, evenly thin bedded, silty, micaceous . .	1.55	265.58	
78. Siderite, brown, dense	0.28	265.86	
79. Shale, dark-gray, indistinctly thin bedded	0.25	266.11	
80. Sandstone, medium-gray, fine- to medium-grained, dense, siliceous, noncalcareous; contains rounded brown-shale pebbles and fragments	0.48	266.59	
81. Shale, medium-gray, indistinctly bedded, silty, noncalcareous	6.45	273.04	

Pennsylvanian System—Continued		Thickness	Depth
Mansfield Formation—Continued		(ft)	(ft)
82. Sandstone, medium-gray; shaly and silty in the top 1 ft; very fine grained to fine grained; contains coarse rounded iron-stained grains at the middle; noncalcareous; contains numerous brown-shale partings		4.40	277.44
83. Sandstone, light-gray, thick-bedded, medium-grained; contains shale partings in the upper half; cross-laminated in places as shown by alternating light-gray and medium-gray laminae; basal part shows contorted bedding and microfaults; the lower half of the unit also contains layers of medium-gray shale as thick as 0.22 ft; unit is noncalcareous and contains a nodule of dark-gray pyrite 0.45 ft above the base		7.54	284.98
84. Shale, dark-gray; contains lenses of thin light-gray sandstone with contorted bedding		0.73	285.71
85. Sandstone, light-gray; contains partings of dark-gray shale that have contorted sandstone laminae; medium grained, shaly, dark gray, and very fine grained in the upper 1 ft. The basal 2 ft contains shale that is dark gray in contrast with the light-gray sandstone; contains nodules of green-gray pyrite 0.7 ft from the base and at the middle .		2.85	288.56
(Units 86 through 95 are described according to the driller's log and a study of 12 samples obtained from rock-bit drilling.)			
86. Sandstone, light-gray; contains lenses of dark-gray sandstone, angular grains of quartz that show secondary overgrowths, and partings of dark-gray silty shale . . .		16.90	305.46
87. Sandstone, dark-gray, fine-grained; interlayered with dark-gray micaceous sandy shale		87.00	392.46
88. Shale, dark-gray; sandy with lenses of light-gray sandstone; pyritiferous		28.00	420.46
89. Shale, medium-gray, silty, soft; contains thin sandstone lenses		11.00	431.46
90. Shale, medium-gray, silty, slightly micaceous		6.00	437.46
91. Shale, medium- and dark-gray, silty, slightly micaceous . .		5.00	442.46
92. Shale, medium-gray, silty; interbedded with light-gray siltstone; unit contains a flat fragment of black carbonaceous material		8.50	450.96
93. Shale, medium-gray, silty; contains sparse brown sandy grains of rounded quartz		4.50	455.46
94. Shale, siltstone, and fine-grained sandstone, medium-gray .		5.70	461.16
95. Shale, medium-gray; contains sandstone lenses		43.30	504.46
(Unit 96 is a core sample.)			
96. Sandstone, light-gray, fine- to medium-grained; contains subangular grains of quartz; unit is interbedded with black, carbonaceous, or dark-gray shale in fine laminae and in irregularly distributed masses in sandstone. This unit contains a black-shale conglomerate with a sandstone matrix		8.00	512.46
Total Mansfield Formation penetrated		314.54	
Total Pennsylvanian System penetrated		470.76	
Total depth of hole			512.46

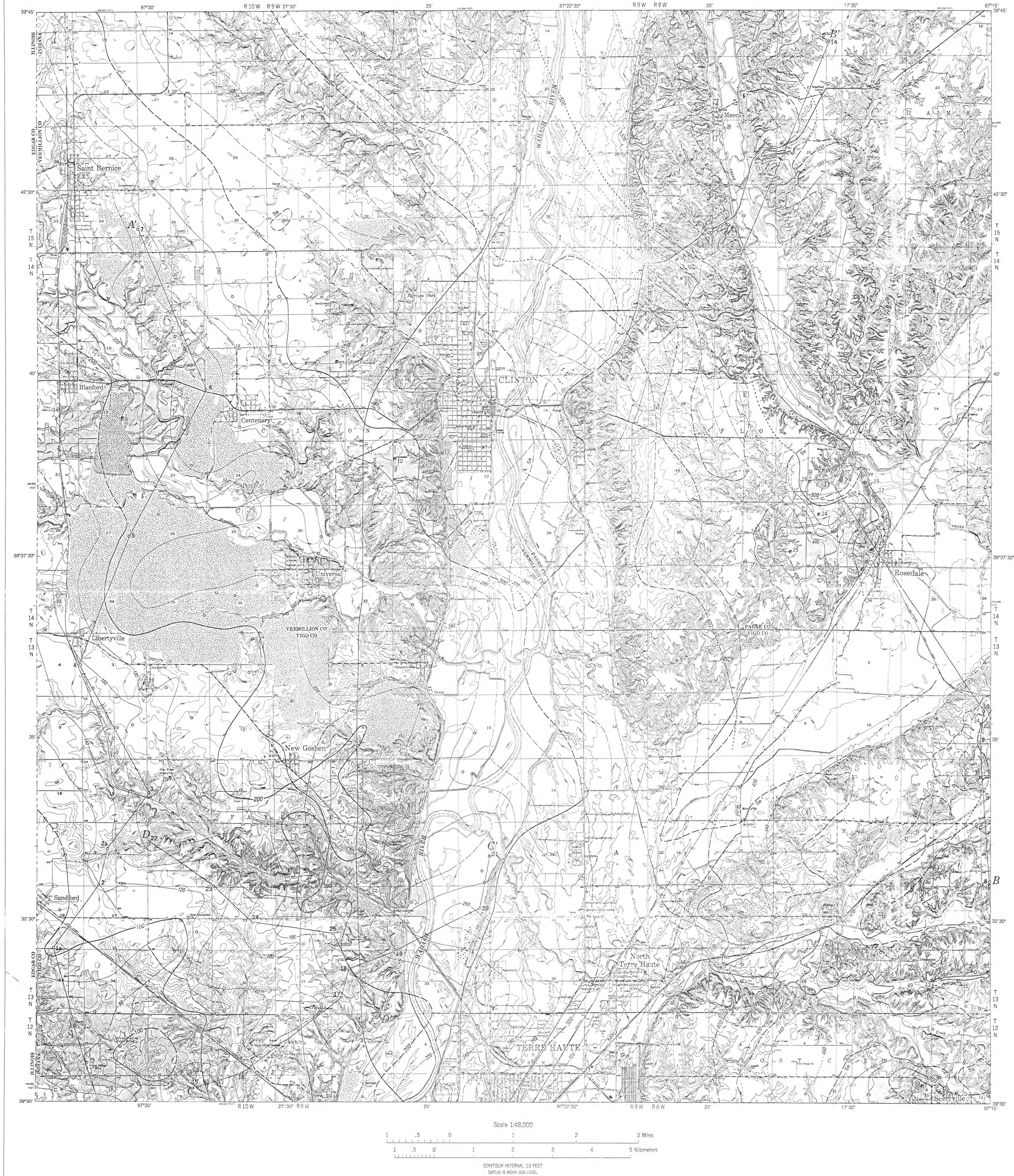
Survey Drill Hole 45

Drilled May 19 to 28, 1958, on the Tom Virostko farm, SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 15, T. 14 N., R. 8 W., Mecca Quadrangle, Parke County, Ind. Surface altitude estimated from topographic map, 622 ft. Location 12 on plates 1-4 and 5.

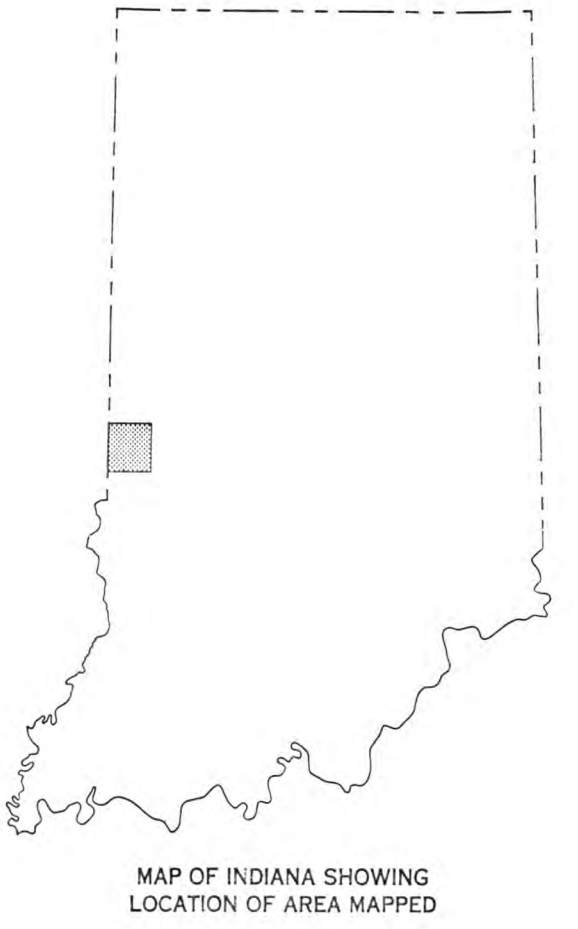
	Thickness (ft)	Depth (ft)
Quaternary System undifferentiated:		
1. Soil and weathered glacial till	35	35
2. Sand and gravel	44	79
Total Quaternary System	79	
Pennsylvanian System:		
Linton Formation:		
3. Sandstone. (Coxville Sandstone Member)	3.50	82.50
Total Linton Formation penetrated	3.50	
Staunton Formation:		
4. Coal, black, banded, bituminous; contains about 15 percent vitrain and small amounts of pyrite in vertical fillings. (Seelyville Coal Member (III))	0.15	82.65
5. Underclay, silty, calcareous	15.49	98.14
6. Shale, medium-blue-gray, medium-bedded, micaceous, silty, noncalcareous; contains 0.01 ft of coal and contorted bedding in the lower 0.1 ft	0.70	98.84
7. Coal, black, banded, bituminous; contains 20 percent vitrain and two thin pyrite lenses. (Coal F of this report)	0.33	99.17
8. Shale, blue-gray, slightly silty; noncalcareous except for a dense layer 0.12 ft from the top; unit is slightly micaceous and contains less than 0.01 ft of black carbonaceous shale at the base	4.20	103.37
9. Coal, black, banded, bituminous, mostly dull; contains about 5 percent vitrain in thin layers and a trace of clay and pyrite. (Coal E of this report)	0.26	103.63
10. Underclay, medium-gray and light-gray; bedding absent; noncalcareous; contains 0.57 ft of fine-grained sandstone 0.05 ft above the base	5.87	109.50
11. Shale, light-tan-gray, thick-bedded, micaceous, silty; calcareous in the basal 0.30 ft	1.67	111.17
12. Siltstone and very fine grained sandstone, light-tan-gray, thick-bedded; contains uneven layers of alternating medium- and tan-gray shale that is micaceous and sandy; unit is somewhat calcareous	9.57	120.74
13. Claystone, light-brown; bedding absent; contains fragments of carbonaceous material	0.90	121.64
14. Sandstone, medium-gray, thick-bedded, medium- to coarse-grained; contains 0.10 ft of dark-gray shale at the center and some siderite bands	1.53	123.17
15. Shale, dark-gray to black, evenly medium bedded, carbonaceous; contains small pyritized fossil debris and sparse brachiopod films and impressions; unit is noncalcareous	6.01	129.18
16. Limestone, medium-gray; in one dense fine-grained bed; contains abundant white fragments of fossil material . .	0.33	129.51

Pennsylvanian System—Continued		Thickness	Depth
Brazil Formation:		(ft)	(ft)
34. Coal, black, banded, bituminous; contains 15 percent vitrain and thin pyrite lenses in the upper half and calcite in vertical fissures in the lower half. (Minshall Coal Member)		0.94	204.10
35. Shale, dark-gray to very dark gray, evenly medium bedded; contains some bands and lenses of siderite and abundant lenses of coal that are paper thin throughout the unit and show plant-branch impressions		15.05	219.15
36. Coal, black, banded, bituminous; dull and bright attritus and vitrain are in thin bands in the upper 0.50 ft; unit contains a clay layer, 0.10 ft thick, 0.40 ft above the base and abundant pyrite on vertical faces. (Rider of the Upper Block Coal Member)		2.78	221.93
37. Shale, medium-gray, silty; interbedded with layers of thin brown-gray sandstone in the lower 7 ft; unit also contains carbonaceous fragments and a thin contorted lens of coal at the base; unit is micaceous and contains some siderite nodules and small light-gray patches of fine-grained limestone 1 ft below the top		8.38	230.31
Total Brazil Formation penetrated		<u>27.15</u>	
Total Pennsylvanian System penetrated		151.31	
Total depth of hole			230.31

Pennsylvanian System—Continued		Thickness	Depth
Staunton Formation—Continued		(ft)	(ft)
17. Shale, black, evenly medium bedded, carbonaceous; contains pyrite and brachiopod and pelecypod fragments at the base	2.63	132.14	
18. Coal, black, banded, bituminous; contains numerous thin vitrain bands and a 0.06-foot layer of fusain at the center; contains pyrite and calcite films. (Coal C of this report)	1.84	133.98	
19. Shale, dark-gray	0.15	134.13	
20. Siltstone, blue-gray, coarse-grained, noncalcareous	0.45	134.58	
21. Shale, blue-gray, thick-bedded; silty except in the basal 0.8 ft; slightly calcareous and micaceous at the center . .	6.53	141.11	
22. Limestone, brown-gray, dense, thick-bedded, very fine grained; contains fragments of light-gray fossil material .	0.60	141.71	
23. Shale, dark-gray or black, unevenly medium bedded; calcareous in the upper 0.10 ft	0.82	142.53	
24. Shale, blue-gray or medium-tan-gray; contains sandy layers at the top, middle, and base; noncalcareous, silty, and slightly micaceous	8.96	151.49	
25. Shale, dark-gray or black, medium-bedded, highly carbonaceous; very coaly in a 0.20-foot layer at the middle	1.66	153.15	
26. Shale, dark-gray, evenly medium to thick bedded, slightly silty, noncalcareous	4.13	157.28	
27. Coal, black, banded, bituminous; contains about 40 to 50 percent vitrain; calcite is in vertical fractures in the upper half; contains a 0.09-foot-thick pyrite band at the center and pyrite layers in the middle 0.12 ft. (Coal A of this report)	1.60	158.88	
28. Underclay, tan-gray, thin-bedded; shaly in the basal 0.3 ft; noncalcareous	1.65	160.53	
29. Shale, medium-gray; green gray at the center; evenly thin to medium bedded, noncalcareous	7.35	167.88	
30. Shale, black, evenly thin bedded, carbonaceous	0.20	168.08	
31. Coal, black, bituminous; has a bright luster; canneloid except in the lower 0.10 ft, which is banded and contains 15 percent vitrain; contains abundant calcite in vertical fractures and pyrite in the basal 0.10 ft	0.44	168.52	
32. Shale, blue-gray and green-gray, poorly bedded, noncalcareous; silty at the top; contains a dense sandy layer, 0.20 ft thick, at 177.4 ft; also contains a limestone lens, which is fine grained, brecciated, and 0.08 ft thick 5.5 ft down from the top; a thin dense calcareous layer of shale contains sparse impressions of a small brachiopod about 8 ft down from the top	17.86	186.38	
33. Shale, dark-gray and black, evenly thin to medium bedded; contains some large mica flakes and some shapes and impressions that may be fossil material of marine origin; unit also contains light-gray thin siderite bands . .	16.78	203.16	
Total Staunton Formation penetrated	120.66		



- EXPLANATION**
- Mined area of Seelyville Coal Member
Solid line indicates accurately located boundary; dashed line indicates approximately located boundary of reported mining
 - Boundary of Seelyville Coal Member
Solid line indicates boundary accurately located from borehole, mine, and outcrop data; dashed line indicates approximately located boundary. Identifying symbol is within area that contains coal
 - Structure contours on top of Seelyville Coal Member
Dashed where approximately located; short dash where coal is absent and altitude is inferred. Contour interval 20 feet. Datum is 1916 sea level
 - Outcrop of Seelyville Coal Member
 - Shaft mine in Seelyville Coal Member
Numbers refer to table 3
 - Slope or drift mine in Seelyville Coal Member
Numbers refer to table 3
 - Strip mine in Seelyville Coal Member
Numbers refer to table 3
 - Shallow borehole that penetrates coal
Numbers refer to plate 5
 - Dry and abandoned oil-test well
 - Cross sections A-A', B-B', C-C' and D-D' are shown on plate 5

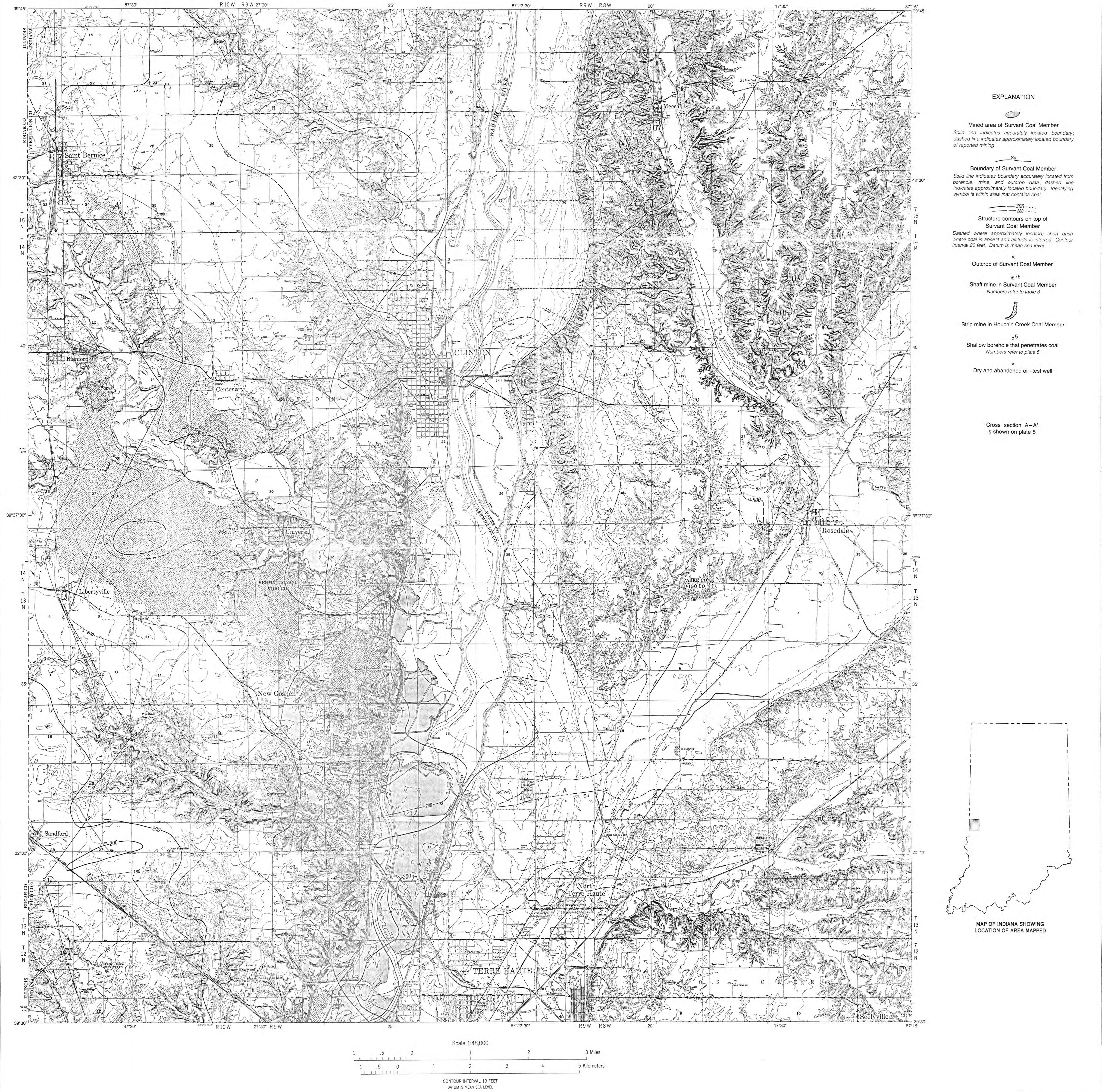


Base modified from U.S. Geological Survey topographic quadrangle maps, 7.5-minute series, 1950-51 editions

MAP OF CLINTON AREA SHOWING DISTRIBUTION, STRUCTURE, AND MINED AREAS OF SEELYVILLE COAL MEMBER

By S. A. Friedman
1988

Compilation complete through 1987; partial revision to December 31, 1985. Drafted by James R. Tolen



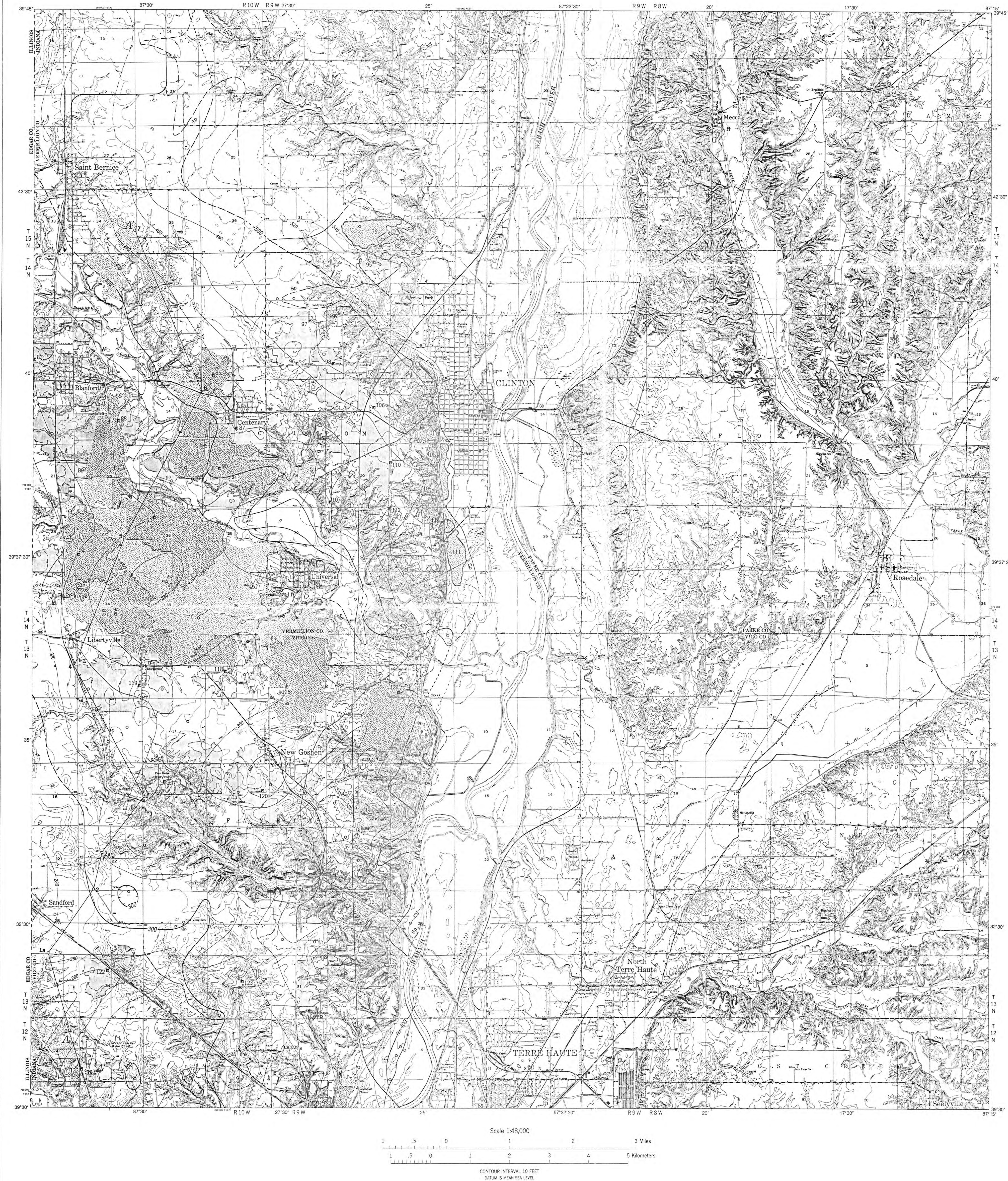
Base modified from U.S. Geological Survey topographic quadrangle maps, 7.5-minute series, 1950-51 editions

MAP OF CLINTON AREA SHOWING DISTRIBUTION, STRUCTURE, AND MINED AREAS OF SURVANT AND HOUCHIN CREEK COAL MEMBERS

Compilation complete through 1967; partial revision to December 31, 1985. Drafted by James R. Tolén

By S. A. Friedman
 1988

SURVANT STRUCTURE (Plate 2)



EXPLANATION

Mined area of Springfield Coal Member
Solid line indicates accurately located boundary;
dashed line indicates approximately located boundary
of reported mining

Boundary of Springfield Coal Member
Solid line indicates boundary accurately located from
borehole and mine data; dashed line indicates ap-
proximately located boundary. Identifying symbol is
within area that contains coal

Structure contours on top of
Springfield Coal Member
Dashed where approximately located; short dash
where coal is absent, and contour is inferred; contour
interval 20 feet. Datum: mean sea level

Shaft mine in Springfield Coal Member
Numbers refer to table 3

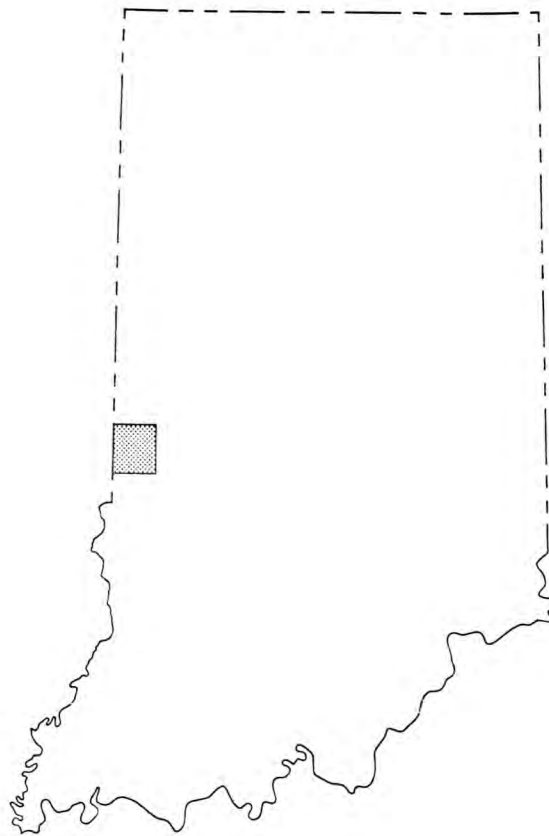
Slope or drift mine in Springfield Coal Member
Numbers refer to table 3

Strip mine in Springfield Coal Member
Small mines shown by letter symbol only.
Numbers refer to table 3

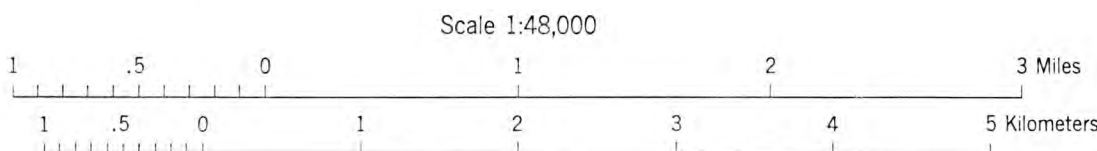
Shallow borehole that penetrates coal
Numbers refer to plate 5

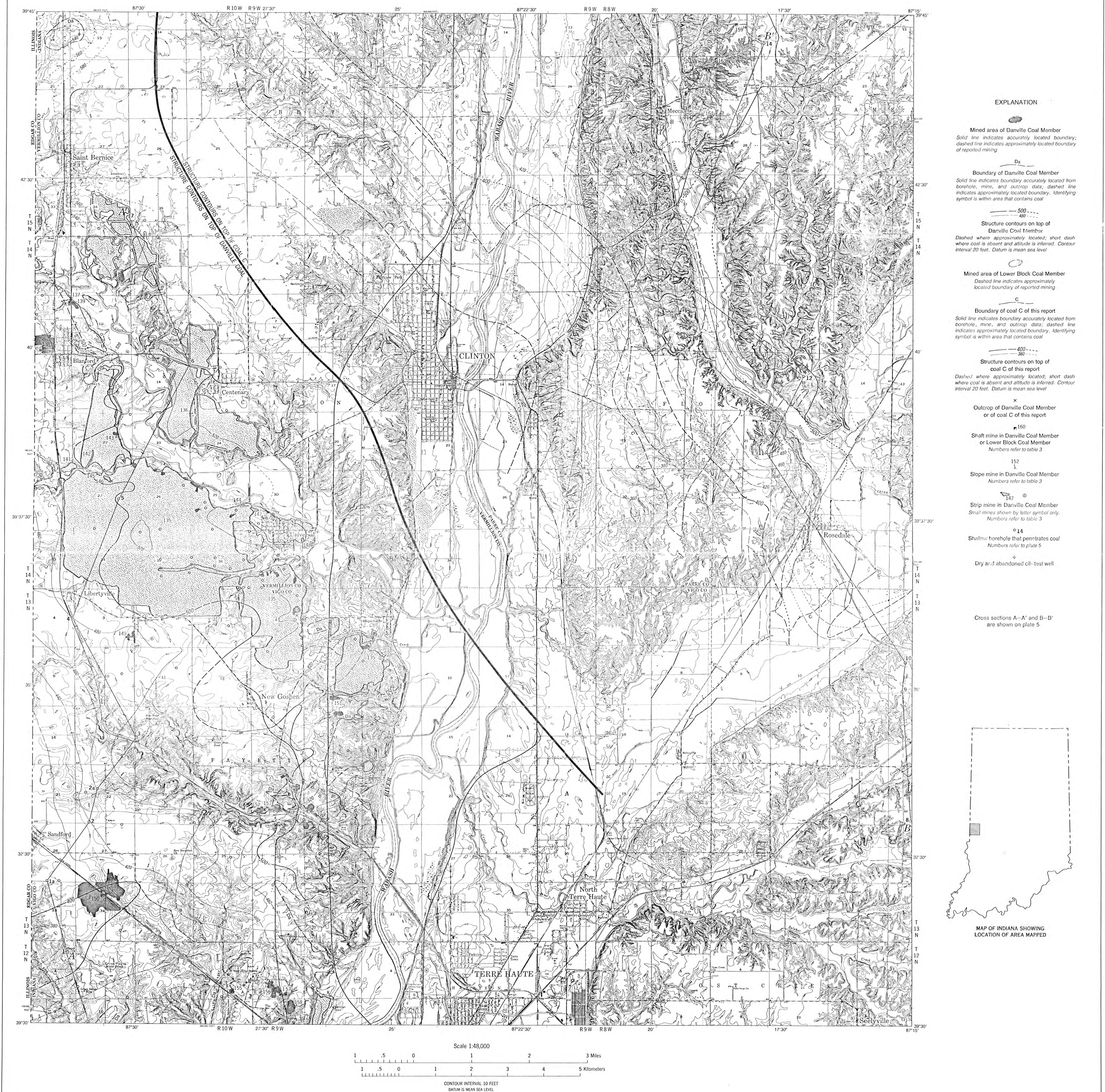
Dry and abandoned oil--test well

Cross section A-A'
is shown on plate 5



MAP OF INDIANA SHOWING
LOCATION OF AREA MAPPED



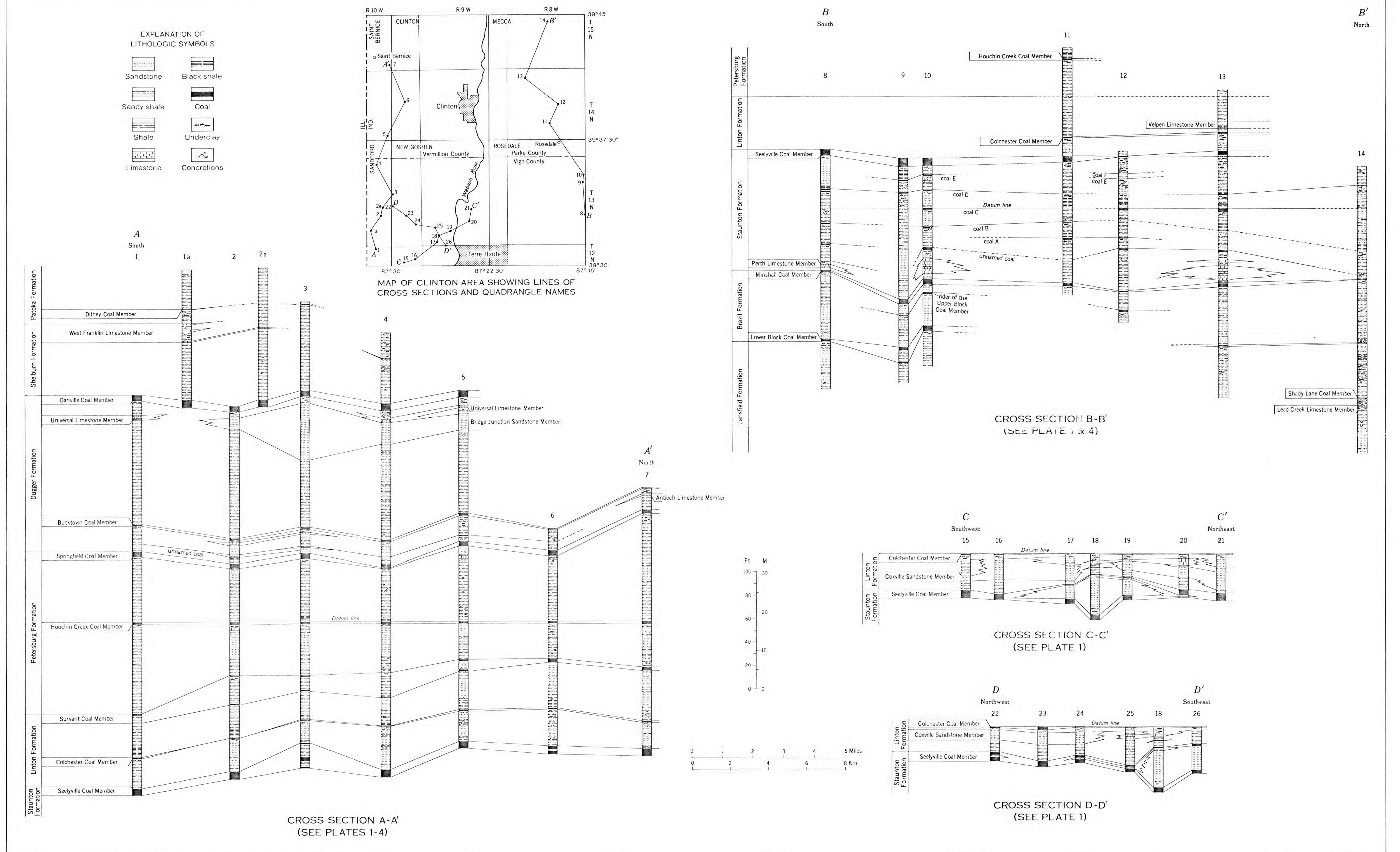


Base modified from U.S. Geological Survey topographic
quadrangle maps, 7.5-minute series, 1950-51 editions

MAP OF CLINTON AREA SHOWING DISTRIBUTION, STRUCTURE, AND MINED AREAS OF DANVILLE COAL MEMBER, DISTRIBUTION
AND STRUCTURE OF COAL C OF THIS REPORT, AND MINED AREAS OF LOWER BLOCK COAL MEMBER

By S. A. Friedman
1988

Compilation complete through 1967; partial revision
to December 31, 1985. Drafted by James R. Tolen



CROSS SECTIONS SHOWING CORRELATIONS OF COALBEDS IN CLINTON AREA

By S.A. Friedman
1988

Drafted by James R. Tolen

LOCATION AND PRODUCTION DATA ON COAL MINES IN THE CLINTON AREA

No. on map	Name of mine ¹	Operator ¹	Location			Type of mine	Lithology of roof	Thickness of coal (ft)	Depth to coal (ft)	Altitude of coal (ft)	Years operated	Tons of coal shipped as of December 31, 1985 ²
			Sec.	T (N)	R (W)							
A. Mines in the Seelyville Coal Member (III) (See pl. 1 for location of mines)												
1	Binkley No. 8 Essanber No. 3	Binkley Coal Co. W. S. Bogle & Co.	15	14	10	Shaft		6.0	341	209	1919-35	5,428,678
2	Torrey No. 4	Torrey Coal Co.	5	14	9	Shaft	Gray shale	6.0	285		1899-1904	330,766
3	Keller No. 3 Oak Hill No. 3 Klondyke No. 2 Prince No. 2	Indiana & Illinois Coal Corp. Keller Coal Co. Dering Coal Co. Oak Hill Coal Co.	8	14	9	Shaft	Gray shale	5.7	304	311	1907-21	829,605 ^{3, 4}
4	Wabash Valley No. 1 Hudnut No. 1 Lyford No. 1	Wabash Valley Coal Co. New Kentucky Coal Co. Calumet Coal Co. Wabash Valley Coal Co. Lincoln Coal & Mining Co. Vivian Collieries Co. Middle States Coal Corp.	13	14	9	Shaft	Gray shale	6.5	139	356	1891-1913	1,053,579 ³
5	Hudnut No. 2 Lyford No. 2	New Kentucky Coal Co. Calumet Coal Co. Scott Mines Coal Co. Wabash Coal Co. Torrey Coal Co. Wabash Valley Coal Co.	14	14	9	Shaft	Gray shale	6.5	147	343	1892-1902	434,543 ³
6	Buckeye No. 1	McClellan, Sons & Co. McClellan, Eastman & Co.	16	14	9	Shaft		5.8	165		1895-1905	492,140 ³
7	Dering No. 15 Willow Grove	Dering Coal Co. Willow Grove Coal Co.	16	14	9	Shaft	Brown shale	6.0	176	334	1900-07	483,169 ^{3, 4}
8	Maple Valley No. 2	Oak Hill Coal Co. Shirkie Bros. Maple Valley Coal Co.	16	14	9	Shaft		5.5	225	312	1904-13	585,955 ⁵
9	Crown Hill No. 2	Clinton Coal Co.	17	14	9	Shaft					1919-22	179,000 ⁶
10	Crown Hill No. 3	Clinton Coal Co.	21	14	9	Shaft		6.0	345	285	1907-21	1,121,000 ⁶
11	Dering No. 7 Brouillets Creek No. 3	Dering Coal Co. Brouillets Creek Coal Co.	21	14	9	Shaft	Gray shale	5.5	265		1899-1909	1,217,653
12	Keller No. 1 Dering No. 1	Keller Coal Co. Dering Coal Co.	28	14	9	Shaft		6.5	201	329	1911-23 ⁷	547,594 ³
13	Dering No. 8	Dering Coal Co.	33	14	9	Shaft	Sandy shale	6.2	246	244	1921-23	35,757
14	Briar Hill	Raccoon Valley Coal Co.	15	14	8	Drift	Sandstone and sandy shale	5.0	515 ⁺		1903-5	30,559 ³
15	Coxville No. 1	Parke County Coal Co.	21	14	8	Shaft	Shaly sandstone	6.5	80	495	Before 1891	
16	Coxville No. 3	Brazil Block Coal Co. Brouillets Creek Coal Co.	21	14	8	Shaft	Brown shale and sandstone	6.0	94	520	1891-1905	888,673 ³
17	Beckleheimer	Beckleheimer	22	14	8	Slope	Sandy shale			530	-1955 ⁷	
18	Coxville No. 2	Parke County Coal Co.	22	14	8	Shaft	Sandy shale	6.5	10 ⁺	530	-1891	
19	Parke County No. 9	Parke County Coal Co.	22	14	8	Slope	Shale	4.5	20 ⁺		1892-98	74,626 ³
20	Wabash Valley Elec. No. 1	Wabash Valley Elec. Co.	22	14	8	Shaft	Shale and sandstone					
21	Parke County No. 1	Parke County Coal Co.	27	14	8	Slope						
22	Parke County No. 2	Parke County Coal Co.	27	14	8	Shaft			35	520		
23	Parke County No. 6	Parke County Coal Co.	27	14	8	Shaft	Gray shale	6.5	92		Before 1892-97	144,177 ³
24	Parke County No. 8	Parke County Coal Co.	28	14	8	Shaft	Gray shale	6.5	118		Before 1891-1902	485,323 ³
25	Parke County No. 12	Parke County Coal Co.	28	14	8	Shaft	Sandy shale	6.6	176		1910-19	1,193,798 ³
26	Parke County No. 11	Parke County Coal Co.	33	14	8	Shaft		6.5	125	435	1903-12	1,367,316
27	Parke County No. 5	Parke County Coal Co.	34	14	8	Shaft						
28	Glenjean No. 1	Glenjean Coal Co.	3	13	10	Shaft		5.5			1919-22	87,749
29	Pine Ridge No. 1	Binkley Coal Co.	14	13	10	Shaft					1922-	
30	Atherton Retlaw Mines	Retlaw Mining Co. Atherton Splint Coal Co. Keeler Coal Co.	1	13	9	Shaft	Brown shale	6.0	158	352	1903-14	1,167,392
31	Miami No. 10	Miami Coal Co.	4	13	9	Shaft			250		1919-27	530,491 ^{3, 7}
32	Talleydale	Snow Hill Coal Corp.	20	13	9	Shaft	Gray shale and sandstone	6.0	350		1932-59	16,486,028
33	North Terre Haute	North Terre Haute	36	13	9	Shaft		5.7	150	340	1931-	
34	Union	Union Mining Co. Coal Bluff Mining Co.	12	13	8	Shaft	Shale, sandstone, and glacial drift	6.5	103	500	1895-1904	966,832 ^{3, 4}
35	Hercules	Coal Bluff Mining Co.	13	13	8	Shaft					Before 1892-95	136,760 ^{3, 4}
36	Parke County No. 10	Parke County Coal Co.	16	13	8	Shaft	Shale and sandstone	6.5	100	445	1893-1908	1,377,450 ³
37	Diamond No. 1	Coal Bluff Mining Co.	23	13	8	Shaft					1892-95	84,003 ³
38	Diamond No. 2	Fontenot Coal Co.	24	13	8	Slope	Brown shale	6.0	54		1895-1906	929,206 ³
39	Lawton	Coal Bluff Mining Co.	24	13	8	Shaft	Brown shale	6.7	116	476	1900-09	1,174,864 ³
40	Dering No. 10 Klondyke	Dering Coal Co. Brouillets Creek Coal Co. Neivins Coal Co.	26	13	8	Slope		6.5			1897-1906	454,967
41	Grant No. 3 "Big Muddy"	Grant Coal & Mining Co.	26	13	8	Shaft		6.5	40		1908-12	624,569
42	Grant No. 2	Grant Coal & Mining Co.	26	13	8	Shaft	Brown shale	6.6	120		1900-08	968,190 ³
43	Grant No. 1	Grant Coal & Mining Co.	27	13	8	Slope		6.5	80		1889-1901	385,233 ³
44	Forrest Park No. 1	Monon Coal Co. Forrest Park Coal Co. Indiana Southern Coal Co.	31	13	8	Shaft	Blue sandy shale	6.4	150	370	1904-11	790,060
45	Glen Oak No. 1 Dering No. 9	Glen Oak Coal Co. Dering Coal Co. Torrey Coal Co.	34	13	8	Shaft	Brown shale	6.5	50		1900-05	501,762
46	Burnett No. 1	Burnett Coal Mining Co.	35	13	8	Slope	Shale	6.0	180	357	1919-24	286,338 ³
47	Burnett No. 2	Little Otter Creek Coal Co. Burnett Coal Winner Co. Wood Coal Co. Ehrmandale Coal Co.	35	13	8	Shaft		5.4			1928-33	43,595
48	Dry Fork No. 1	Dry Fork Coal Co.	35	13	8	Slope		6.5			1917-21	85,365 ³
49	Little Fork No. 1 Schrepferman No. 1	Little Fork Coal Mining Co. Schrepferman Coal Co.	35	13	8	Shaft		6.0	47	493	-1927	16,740 ³
50	Lone Star	Leo Girton	35, 36	13	8	Strip	Gray shale and sandstone	6.0 ⁸	25		1954-56	
51	Miami No. 4	Miami Coal Co.	36	13	8	Shaft		6.5	55	515	1908-17	1,005,044 ^{3, 4}
52	Green Valley	Snow Hill Coal Corp.	3	12	10	Shaft	Gray shale and sandstone	6.0	503		1948-63	13,221,200 ⁷
53	LaCleave No. 1	John LaCleave & Sons	11	12	8	Shaft		6.0	60	502	1928-35	89,504
54	Shady Lane No. 1	Shady Lane Coal Co.	11	12	8	Shaft		6.0	72	503	1936-41	52,222

B. Mines in the Survant Coal Member (IV)

(See pl. 2 for location of mines)

55	West Clinton No. 2	West Clinton Coal Co.	10	14	10	Shaft					1923-24	158,141 ³
56	Esanbee No. 2	W. S. Bogle & Co.	15	14	10	Shaft		4.8	272		1914-19	82,530 ³
57	Waukeo No. 2	Waukeo Coal Corp.	24	14	10	Shaft		4.0	277		1931-42	618,000 ³
58	Keller No. 3	Indiana & Illinois Coal Corp.	8	14	9	Shaft		4.3	236		1919-21	
59	Crown Hill No. 2	Ferguson Coal Co.	17	14	9	Shaft		3.8	249	371	1923-28	721,000
60	Crown Hill No. 3	Clinton Coal Co.	21	14	9	Shaft		3.9	256	364	1919-24	67,000 ³
61	Dering No. 7	Dering Coal Co.	21	14	9	Shaft					After 1899-1903	
62	Keller No. 5	Indiana & Illinois Coal Corp.	28	14	9	Shaft		4.5	178	367	1911-24	1,122,152 ³
63	Oak Hill No. 50	Oak Hill Coal Co.	28	14	9	Shaft					-1911 ⁷	
64	Crown Hill No. 4	Clinton Coal Co.	29	14	9	Shaft		4.0	249	336	1909-24	1,193,342 ³
65	Universal No. 4	U.S. Fuel Co.	31	14	9	Shaft	Shale	4.9	238	262	1911-39	5,284,788 ³
66	Dering No. 8	Dering Coal Co.	33	14	9	Shaft	Shale	5.2	200	318	1907-22	2,897,624
67	Miami No. 10	Miami Coal Co.	4	13	9	Shaft		5.5	250	260	1919-27 ⁷	2,152,800
68	Miami No. 8	Miami Coal Co.	4	13	9	Shaft		5.5	265	230	1911-30 ⁷	2,881,836
69	Binkley No. 10	Community Coal Co.	8	13	9	Shaft		4.7	260	360 ⁷	1923-42	2,212,345 ³
70	Dering No. 6	Glenham Coal Co.	16	13	9	Shaft		4.5	234 ⁹	280	1923-34	2,355,900
71	Jackson Hill No. 5	Jackson Hill Coal & Coke Co.	16	13	9	Shaft		5.2	180	290	1910-27	3,519,878
72	Black Betty	Oak Hill Coal Co.	17	13	9	Shaft		3.0	346 ⁷	240 ⁷	1919-26	1,840,400
73	Bardyke No. 1	Zimmerman Coal Co.	19	13	9	Shaft		5.5	338		1921-31	1,804,000
74	Fayette No. 4	Fort Harrison Mining Co.	20	13	9	Subslope and shaft ⁸		4.7			1940-46	1,760,000
75	Talleydale No. 1	Snow Hill Coal Corp.	20	13	9	Shaft		5.7	268		1921-31	4,766,339
76	Submarine	Ferguson-Spaw Coal Co.	21	13	9	Shaft		5.4	225	255	1917-30	3,129,200
77	Fayette No. 1	Fayette Realty & Development Co.	29	13	9	Shaft		5.3	200	280	1917-27	1,923,400
78	Saxton No. 1	Viking Coal Corp.	34	13	9	Shaft		5.0	220	320	1923-54	13,790,155

C. Mines in the Springfield Coal Member (V)

(See pl. 3 for location of mines)

79	Standard No. 1	Standard Materials Corp.	32, 33	15	9	Strip	Black shale or glacial drift	5.3 ⁹	20-50	550 ⁺	1943-49	727,070 ^{3, 7}
80	Kanizer	Love Bros. Coal Co.	33	15	9	Strip	Black shale or glacial drift	4.6 ⁹	30	555 ⁺	Before 1953-62	
81	Norton Creek No. 1	Norton Creek Coal Co.	33	15	9	Shaft and slope				550 ⁺	1884-97	15,000 ¹
82	Norton Creek No. 2	Norton Creek Coal Co.	33	15	9	Slope and shaft				550 ⁺	1884-97	57,000 ¹
83	Interstate No. 1	West Clinton Coal Co.	9	14	10	Shaft	Black shale	4.6	275	345	1919-31	3,026,339 ¹⁰
84	Black Diamond	Black Diamond Mining Corp.	10	14	10	Shaft	Black shale	4.5	170	355	1938-67	438,787
85	West Clinton No. 1	West Clinton Coal Co.	10	14	10	Shaft	Black shale	4.5	185	350	1913-22	686,365 ³
86	Keller No. 2	Keller Coal Co.	12	14	10	Shaft	Black shale	4.7	164	430	1919-33	452,000 ³
87	Crown Hill No. 6	Indiana & Illinois Coal Corp.	13	14	10	Shaft	Black shale	4.6	188	420	1911-42	2,567,839 ³
88	Binkley No. 6	Binkley Coal Co.	15	14	10	Shaft	Black shale	4.7	183	367	1912-29	2,964,724 ³
89	Big Oak	Big Oak Coal Co.	22	14	10	Slope	Black shale	5.0	244	348	1944-62	392,501
90	Crown Hill No. 5	Ferguson Coal Co.	24	14	10	Shaft	Black shale	5.0	182	408 ⁷	1910-30	3,453,170 ³

LOCATION AND PRODUCTION DATA ON COAL MINES IN THE CLINTON AREA—Continued

No. on map	Name of mine ¹	Operator ¹	Location			Type of mine	Lithology of roof	Thickness of coal (ft)	Depth to coal (ft)	Altitude of coal (ft)	Years operated	Tons of coal shipped as of December 31, 1985 ²
			Sec.	T (N)	R (W)							
C. Mines in the Springfield Coal Member (V)—Continued (See pl. 3 for location of mines)												
91	Jackson Hill No. 6	Jackson Hill Coal & Coke Co.	26	14	10	Shaft	Black shale	4.8	210	360	1915-39	3,788,500
92	Interstate No. 2 Tighe No. 2 (No. 1) Stark No. 2 Bickett & Shirkie No. 2	West Clinton Coal Co. Tighe Coal Co. Stark Coal Co. Bickett & Shirkie Coal Co.	27	14	10	Shaft	Black shale	4.6	249	341	1917-38	1,874,144 ³
93	Bluebird Big Four	Bluebird Coal Co. K. M. & F. Coal Co.	28	14	10	Slope	Black shale	4.7	200	330	1960-62 1950-56	65,840 ³
94	Bickett & Shirkie No. 1	Bickett & Shirkie Coal Co.	34	14	10	Shaft	Black shale	4.6	228	372	1917-23	754,147 ³
95	Torrey No. 4	Torrey Coal Co.	5	14	9	Shaft	Black shale	5.0	76		1893-98	335,000 ³
96	Oak Hill No. 4 (No. 20) Buckeye No. 2	Dering Coal Co. Oak Hill Coal Co. Shirkie Bros. McClellan, Sons & Co.	7	14	9	Shaft	Black shale	4.5	142	460	1904-12	1,395,092 ³
97	Whitcomb Monkey	Whitcomb Coal Co. Vermillion Coal Co.	7	14	9	Shaft	Black shale	5.0	130		1919-23	296,000
98	Prince (No. 1)	Oak Hill Coal Co. Keller Coal Co.	8	14	9	Shaft	Black shale	4.8	130	485	1898-1907	1,383,608
99	Sallie Malone		9	14	9	Slope	Glacial drift	4.5		510±	1898-?	
100	Hazel Creek No. 1	Hamilton, Vannest & Co. Hazel Creek Coal Co. Hazel-Dart Coal Co.	16	14	9	Slope					Before 1891-96	110,621 ³
101	Hazel Creek No. 2 Fern Hill	Hazel Creek Coal Co.	16	14	9	Shaft	Black shale with concretions	4.6	60	480	1892-98	251,514 ³
102	Maple Valley No. 1	Oak Hill Coal Co. Shirkie Bros. Maple Valley Coal Co.	16	14	9	Shaft	Black shale	4.7				
103	Merry-Go-Round	Cohous & Co.	16	14	9	Shaft	Black shale	5.0	35	495±	Before 1898-99	
104	Silotto	Joe Silotto	16	14	9	Slope	Black shale and coal	4.0		510±	Before 1900-Idle	
105	Thompson Hill	Thompson Hill Coal Co. M. V. Brown Coal Co.	16	14	9	Slope	Black shale	4.5		505±	1892-96	54,000 ³
106	Crown Hill No. 2	Clinton Coal Co.	17	14	9	Shaft	Black shale	5.0	151	474	1903-18	1,443,217 ³
107	Crown Hill No. 7	Ferguson Coal Co. Clinton Coal Co.	20	14	9	Shaft	Black shale	4.9	170	440	1917-31	751,000 ³
108	Brouillets Creek No. 1 Indiana Bituminous No. 1	Indiana Bituminous Coal Co.	21	14	9	Shaft	Black shale	5.0	50	485	Before 1895-98	168,236 ³
109	Brouillets Creek No. 4	Brouillets Creek Coal Co.	21	14	9	Shaft	Black shale	4.8	60	490	1898-1903	679,119
110	Crown Hill No. 1	Clinton Coal Co.	21	14	9	Shaft	Black shale	5.0	164	456	1901-15	1,729,040
111	Standard No. 2	Standard Collieries Corp.	27, 28 33, 34	14	9	Strip	Black shale	4.5	20	470	1948-49	210,438 ³
112	Crown Hill No. 8 Oak Hill No. 2	Clinton Coal Co. Keller Coal Co. Dering Coal Co. Oak Hill Coal Co.	28	14	9	Shaft	Black shale	4.6	164	436	1919-21	885,012 ³
113	Dering No. 5 Brouillets Creek No. 5	Dering Coal Co. Brouillets Creek Coal Co.	28	14	9	Shaft	Black shale	4.8	85	460	1900-10	1,303,747
114	Oak Hill No. 1	Oak Hill Coal Co.	28	14	9	Shaft	Black shale	4.8	40	490	1900-10	931,627
115	Reeder Hill	Reeder Hill Coal Co.	28	14	9	Drift	Black shale	5.0			Before 1953-57	
116	Universal No. 5	U. S. Fuel Co. Burns Coal Co.	31	14	9	Shaft	Black shale	5.0	143	357	1912-23	921,167 ³
117	Dering No. 8 Rhodes	Dering Coal Co. Brazil Block Coal Co.	33	14	9	Shaft	Black shale	4.5	100		1903-7	486,330
118	Vermilion Ferndale No. 1 Vermilion No. 1	Kirk Coal Co. Ferndale Coal Co. Vermillion Coal Co.	1	13	10	Shaft	Black shale	5.0	270	310?	1918-43	1,994,783 ³
119	Shirkie No. 1	Hugh Shirkie Coal Co.	3	13	10	Shaft	Black shale	4.7	272	343	1913-36	3,576,100 ³
120	Maple Grove No. 4	Grant Coal & Mining Co.	13	13	10	Shaft	Black shale	4.7	270?		1913-28	1,882,698 ³
121	Pine Ridge No. 1	Binkley Coal Co. Pine Ridge Mining Co. W. S. Bogie & Co. Higgins-Martin Coal Co.	14	13	10	Shaft	Black shale	4.7	281	354	1913-29	1,698,357 ³
122	Pittsburgh No. 2	Sanford Mining Co. Pittsburgh Mining Co.	34	13	10	Shaft	Black shale	4.7	170	255	1912-27	584,081 ³
123	Mary No. 3 Majestic	Mary Coal Corp. Lower Vein Coal Co.	36	13	10	Shaft	Black shale	4.2	250	303	1925-31	364,336 ³
124	Miami No. 6	Miami Coal Co.	4	13	9	Shaft	Black shale with concretions	5.0	156	349	1910-28	3,009,700 ³
125	Western Miami No. 5	Bert Conner & Son Miami Coal Co.	4	13	9	Shaft	Black shale	5.0	125	375	1941-44 1919-24	701,900 ³
126	Miami No. 9	Miami Coal Co.	6	13	9	Shaft	Black shale	5.0	260	360	1914-29	2,104,200 ³
127	Dering No. 6 Riverside	Dering Coal Co. Brazil Block Coal Co. Indiana Fuel Co.	16	13	9	Shaft	Black shale	4.5	110	403	1904-23	3,621,893 ³
128	Eagle No. 1	Oak Hill Coal Co. Eagle Coal Co.	16	13	9	Shaft	Black shale	4.7	102	388	1922-33	742,013
129	Black Betty No. 1 Locust Grove Black Betty	Black Betty Mining Co. Locust Grove Coal Co. Oak Hill Coal Co. Zimmerman Coal Co.	17	13	9	Shaft	Black shale	4.8	225	365	1933-49	710,000 ³
130	Clovelly No. 1	Fort Harrison Mining Co. Clovelly Coal Co.	20	13	9	Shaft	Black shale	4.7	140	399	1913-25	1,208,600 ³
131	Fayette No. 5	Fayette Realty & Development Co.	29	13	9	Shaft	Black shale	5.0	110	370	1928-36	949,300
132	Viking	Viking Coal Corp.	33	13	9	Slope	Black shale with concretions	4.2	114	398	1949-64	7,624,148 ⁷
139	Wabash	Snow Hill Coal Corp.	3	12	10	Shaft	Black shale with concretions	4.2	312	478	1948-52	1,016,080 ⁷
134	St. Mary	Sisters of Providence Coal Co.	6	12	9	Shaft	Black shale	4.5	340	310	1921-54	484,700 ³

COAL RESOURCES AND RESERVES IN THE CLINTON AREA AS OF DECEMBER 31, 1985
[in thousands of short tons]

Coal member	County T (N) and R (W)	Thickness of overburden (ft)	Average weighted thickness of coal (ft)	Original resources (before mining)		Mined and lost in mining						Remaining resources								Recoverable reserves Tons															
						Strip		Underground		Total		Measured		Indicated		Inferred		Total																	
				Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons	Acres	Tons																
Danville (VII)	Vigo, 12-9	<120	5.5	740	7,326	54	535	43	426	97	961	547	5,415	96	950			643	6,365	5,093															
		>120	5.5	234	2,316							78	772	156	1,544			234	2,316	1,158															
	Vigo, 12-10	<120	4.7	394	3,334			8	68	8	68	88	745	298	2,521	49	415	386	3,266	2,612															
		>120	4.7	2,726	23,063							636	5,381	2,041	17,267			2,726	23,063	11,531															
	Vigo, 13-9	>120	4.9	787	6,941	633	5,583	48	423	681	6,006	42	370	709	6,253	36	318	787	6,941	3,471															
		<120	4.9	3,137	27,668							1,927	16,996	529	4,666			2,456	21,662	17,330															
		<120	4.6	565	4,678							554	4,587	11	91			565	4,678	21	174			21	174	87									
		>120	4.6	64	530							43	356	43	356																				
	Vigo, 13-10	<120	4.7	2,174	18,392	535	4,526	323	2,733	535	4,526	683	5,778	933	7,893	23	195	1,639	13,866	11,093															
		>120	4.7	27,926	236,254	12	102			335	2,835	3,896	32,966	22,790	192,803	905	7,656	27,591	233,419	116,710															
	Vermillion, 14-10	<120	4.2	5,086	38,450	4,603	34,799	20	151	4,623	34,950	463	3,500	444	3,436	87	673	463	3,500	2,800															
		<120	4.3	1,600	12,383	1,069	8,274			1,069	8,274	531	4,109					3,288																	
		>120	4.3	737	5,704	22	170	55	426	77	596	558	4,319					102	789	660	5,108	2,544													
		>120	4.1	182	1,343					182	1,343	182	1,343					182	1,343	182	1,343	672													
	Vermillion, 14-9	<120	4.7	111	939	111	939			111	939							109	864	690															
		<120	4.4	292	2,313	183	1,449			183	1,449										109	864													
	Vermillion, 15-10	<120	4.3	210	1,625	194	1,502			194	1,502	16	123					16	123	99															
Total, Danville Coal Member				46,965	393,259	8,613	62,822	508	4,318	8,521	67,140	8,688	74,421	28,554	241,652	1,202	10,046	38,444	326,119	179,178															
Springfield (V)	Vigo, 12-9	<100	3.2	222	1,279							222	1,279					222	1,279	1,023															
		>100	4.2	1,599	12,088							1,172	8,860					1,172	8,860	4,430															
	Vigo, 12-10	200-350	4.4	3,308	26,200			466	3,691	466	3,691	1,481	11,730	1,361	10,779			2,842	22,509	11,254															
	Vigo, 13-9	100-350	4.5	9,192	74,455			7,634	61,835	7,634	61,835	1,558	12,629					1,558	12,620	6,310															
		<100	4.5	469	3,799							469	3,799					469	3,799	469	3,799	3,039													
	Vigo, 13-10	250-450	4.3	15,217	117,780			3,887	30,085	3,887	30,085	5,659	43,801	5,671	43,894			11,330	87,695	43,847															
	Vermillion, 14-9	<100	4.8	2,460	21,254							430	3,715	313	2,704			743	6,419	1,658	14,325	59	510	1,717	14,835	11,867									
		100-170	4.8	7,161	61,871									5,327	46,025	5,327	46,025	1,451	12,557	383	3,309	1,834	15,846	7,923											
	Vermillion, 14-10	100-275	4.6	14,138	117,063			6,727	55,700	6,727	55,700	5,555	45,395	1,820	15,070	36	298	7,411	61,363	30,682															
Vermillion, 15-9	<100	4.1	465	3,432	7	52	261	1,926	268	1,978	138	1,018	59	435			197	1,453	1,163																
	>100	4.5	107	867							5	41	75	608			27	219	107	868	434														
Vermillion, 15-10	120-190	3.6	7,061	57,755							614	3,919	1,950	12,636	4,497	29,141	7,061	45,756	22,878																
Total, Springfield Coal Member				61,399	485,843	437	3,767	25,042	205,194	25,479	208,961	19,982	159,984	11,378	87,241	4,560	29,658	35,920	276,883	144,850															
Survant (IV)	Vigo, 12-9	140-350	2.4	797	3,443							374	1,616	423	1,827			797	3,443	1,722															
			4.9	1,531	13,503																														
	Vigo, 13-9	130-350	5.0	13,018	117,162			10,179	91,611	10,179	91,611	2,380	21,420	459	4,131			2,839	25,551	12,776															
			2.3	1,010	4,181													1,010	4,181	1,010	4,181	2,091													
	Vermillion, 14-9	100-260	4.9	2,729	24,070			2,221	19,589	2,221	19,589	263	2,320	245	2,161			508	4,481	2,241															
			4.0	6,637	47,786							1,760	12,672	1,760	12,672			2,521	18,151	2,356	16,963	4,877	35,114	17,557											
	Vermillion, 14-10	200-400	3.9	7,532	52,874			566	3,973	566	3,973	3,972	27,833	2,926	20,541	68	477	6,966	48,901	24,451															
	Vermillion, 15-9	100-240	4.5	1,654	13,397											117	948	709	5,743	828	6,706	1,654	13,397	6,699											
<100		3.0	335	1,809	27	146			27	146	46	248	114	616	148	799	308	1,663	1,330																
Vermillion, 15-10	200-280	3.7	2,466	16,424							356	2,371	1,462	9,737	648	4,316	2,466	16,424	8,212																
Total, Survant Coal Member				37,709	294,649	27	146	16,257	141,348	16,284	141,494	10,029	74,957	9,704	65,900	1,692	12,298	21,425	153,155	77,079															
Seelyville (III)	Vigo, 12-8	60- 90	5.7	354	3,632			354	3,632	354	3,632							641	4,038	2,019															
		150-190	3.5	641	4,038																														
	Vigo, 12-10	450-550	6.0	2,271	24,527			2,271	24,527	2,271	24,527	618	6,229					618	6,229	3,115															
		380-540	5.6	618	6,229																														
	Vigo, 13-8	20-190	5.7	8,798	90,267	39	400	2,682	27,517	2,721	27,917	3,378	34,658	2,435	24,983	264	2,709	6,077	62,350	31,175															
	Vigo, 13-9	180-240	5.8	1,884	19,669			290	3,028	290	3,028	318	3,320	651	6,796	625	6,525	1,594	16,641	8,321															
		200-400	5.9	10,943	116,214							4,352	46,218	4,352	46,218	1,560	16,567	4,883	51,857	148	1,572	6,591	69,996	34,998											
		220-260	2.8	549	2,767											128	645	421	2,122			549	2,767	1,384											
	Vigo, 13-10	380-540	6.0	10,553	113,972			2,040	22,032	2,040	22,032	3,005	32,454	5,075	54,810	433	4,676	8,513	91,940	45,970															
	Parke, 14-8	180	5.0	662	5,958							42	227	42	227			339	1,831			339	1,831	916											
		<100	3.0	42	227																														
		20-190	6.3	1,412	16,012																				1,412	16,012	1,412	16,012							
		20-190	3.0	339	1,831																														
	60-200	3.0	169	913																															
	Parke, 14-9	150-200	6.0	774	8,359			156	1,797	156	1,797	162	1,750	612	6,609			774	8,359	4,180															
		130-300	6.4	592	6,820							436	5,023	436	5,023			436	5,023	2,512															
	Vermillion, 14-9	160-370	5.8	14,865	155,191			2,006	20,943	2,006	20,943	4,442	46,374	8,144	85,023	273	2,850	12,859	134,247	67,124															
	Vermillion, 14-10	260-450	5.9	11,145	118,360							1,620	17,204	1,620	17,204	2,816	29,906	6,264	66,524	445	4,726	9,525	101,156	50,578											
Vermillion, 15-9	200-300	5.4	1,445	14,045							132	1,283	896	8,709	417	4,053	1,445	14,045	7,023																
Vermillion, 15-10	200-380	5.4	7,076	68,778							603	5,861	2,639	25,651	3,834	37,266	7,076	68,778	34,389																
Total, Seelyville Coal Member				75,132	777,809	39	400	17,225	183,137	17,264	183,537	17,937	185,901	32,880	339,584	7,051	68,786	57,868	594,271	297,140															
Total, Clinton area				1,951,560		67,135		533,997		601,132		495,263		734,377		120,788		1,350,428		698,247															

CHEMICAL ANALYSES OF SAMPLES FROM COALBEDS IN THE CLINTON AREA

[As received basis]

Collection No.	Coalbed and thickness (ft)	Source of sample	Location			Moisture	Ash	Volatile matter	Fixed carbon	Sulfur	Btu/lb	Kind of sample	Collector	
			Sec.	T (N)	R (W)									
	Danville (VII)													
58X6	1.9 U ¹	Sunspot Mine	SW¼NE¼	15	14	10	9.2	23.0	33.3	34.5	2.4	9,610	Channel	Hutchison
58X7	4.0 L	Sunspot Mine	SW¼NE¼	15	14	10	12.1	9.6	39.9	38.4	2.7	11,180	Channel	Hutchison
55X130	5.0	Reed & Brown Mine	SE¼SW¼	22	14	10	12.4	9.0	38.5	40.1	3.5	11,365	Channel	Friedman
54X22	5.0	Sunspot Mine	SE¼NE¼	24	14	10	11.4	8.3	27.9	52.4	4.3	11,681	Channel	Friedman
54X23	5.0	Frazier Mine	SW¼NE¼	29	13	9	14.3	9.0	34.9	41.9	4.0	10,819	Channel	Friedman
	Springfield (V)													
54X21	5.0	Kanizer Mine	NW¼SW¼	33	15	9	13.7	9.2	44.6	38.1	4.2	10,977	Channel	Friedman
56X100	4.4	Blanford Mine	NE¼NE¼	9	14	10	11.7	10.2	40.9	37.2	2.9	11,392	Channel	Powell
57X11	4.4	Big Oak Mine	NE¼NE¼	28	14	10	8.7	10.8	41.5	39.0	3.0	11,640	Channel	Powell
58X8	4.7	Reeder Hill Mine	NW¼SW¼	27	14	9	6.2	10.1	43.3	40.3	3.3	12,010	Channel	Hutchison
54X48	5.1	Viking Mine	NW¼SW¼	29	13	9	10.0	11.0	38.8	40.2	4.5	11,377	Channel	Friedman
55X45	4.8	Wabash Mine	SW¼SW¼	3	12	10	8.4	12.2	36.6	42.8	3.6	11,381	Channel	Friedman
	Houchin Creek (IVa)													
56X45	1.3 U	Outcrop	NE¼NE¼	25	15	9	37.1	13.1	36.6	13.2	0.8	5,932	Channel	Powell
56X46	0.35 L	Outcrop	NE¼NE¼	25	15	9	35.7	17.8	27.4	19.1	0.7	5,440	Channel	Powell
55X18	1.5	Saxton-Viking subslope	NW¼NW¼	33	13	9	10.2	7.4	41.0	41.4	2.4	11,903	Channel	Friedman
	Survant (IV)													
56X66	1.3	Outcrop (N. of U.S. 41)	NE¼SE¼	31	15	8	12.8	21.1	36.5	29.6	5.5	8,497	Channel	Powell
55X16	3.09 U	Saxton Mine subslope	NW¼NW¼	33	13	9	11.5	7.2	35.6	45.7	0.6	11,793	Channel	Friedman
55X17	1.7 L	Saxton Mine subslope	NW¼NW¼	33	13	9	11.5	7.4	41.0	41.4	2.4	11,903	Channel	Friedman
	Colchester (IIIa)													
55X56	1.7	Outcrop near fault	SW¼NE¼	25	15	9	26.9	9.4	27.0	36.7	1.0	7,208	Channel	Friedman
56X56	1.15 U	Outcrop near U.S. 41	SW¼NE¼	29	15	8	13.5	6.7	40.5	39.3	3.4	11,337	Channel	Powell
56X55	0.7 L	Outcrop near U.S. 41	SW¼NE¼	29	15	8	15.4	8.0	37.1	39.5	2.7	12,293	Channel	Powell
56X48	1.1 U	Outcrop (Tolin)	NW¼SE¼	5	14	8	26.3	11.9	32.9	28.9	1.0	7,774	Channel	Powell
56X49	0.8 L	Outcrop (Tolin)	NW¼SE¼	5	14	8	25.0	13.4	28.9	32.7	1.8	9,847	Channel	Powell
56X76	1.56	SDH 33 (Tolin)	NW¼SW¼	5	14	8	9.1	18.7	35.7	36.5	3.9	10,383	Core	Robinson
56X62	0.8 U	Slope, Parke County No. 9 Mine	NE¼SW¼	22	14	8	14.4	6.3	35.5	43.8	1.8	10,980	Channel	Powell
56X63	0.65 L	Slope, Parké County No. 9 Mine	NE¼SW¼	22	14	8	14.7	6.3	36.3	42.7	2.0	10,993	Channel	Powell
	Seelyville (III)													
56X50	0.85	Outcrop N. Br. Okla. Hollow	SE¼NE¼	17	15	8	16.7	11.2	35.1	37.0	1.8	9,847	Channel	Powell
56X54	1.5	Outcrop (U.S. 41)	SW¼NE¼	29	15	8	16.2	11.9	32.4	39.5	3.3	10,039	Channel	Powell
56X47	2.2	Outcrop (Tolin)	NW¼SE¼	5	14	8	28.8	11.1	41.8	18.3	0.7	7,375	Channel	Powell
57X77	3.75	SDH 33 (Tolin)	NW¼SW¼	5	14	8	11.6	12.5	32.8	42.1	6.4	10,727	Core	Robinson
58X42	0.15	SDH 45 (Virostko)	SE¼NW¼	15	14	8	7.7	13.2	40.4	38.7	6.8	11,020	Core	Friedman
56X64	1.7 U	Briar Hill Mine	NW¼SW¼	15	14	8	14.6	11.0	38.0	41.3	6.0	11,163	Channel	Powell
56X65	0.6 L	Briar Hill Mine	NW¼SW¼	15	14	8	9.7	21.1	36.5	29.6	5.5	8,497	Channel	Powell
54X45	1.7 U	Talleydale Mine	SE¼NE¼	13	13	10	10.1	10.4	37.4	42.1	5.0	11,573	Channel	Friedman
54X46	2.45 M	Talleydale Mine	SE¼NE¼	13	13	10	11.8	7.3	37.7	43.2	3.3	11,720	Channel	Friedman
54X47	2.37 L	Talleydale Mine	SE¼NE¼	13	13	10	10.1	12.7	37.6	39.6	3.9	11,466	Channel	Friedman
54X42	2.3 U	Talleydale Mine	SW¼NW¼	17	13	9	9.3	9.7	38.3	42.7	4.1	11,811	Channel	Friedman
54X43	1.5 M	Talleydale Mine	SW¼NW¼	17	13	9	10.0	6.7	38.8	44.6	3.5	12,253	Channel	Friedman
54X44	3.2 L	Talleydale Mine	SW¼NW¼	17	13	9	8.6	12.3	39.0	40.1	4.0	11,417	Channel	Friedman
55X40	1.45 U	Green Valley Mine	SE¼NW¼	2	12	10	11.2	8.5	37.6	42.7	2.8	11,753	Channel	Friedman
55X39	2.45 M	Green Valley Mine	SE¼NW¼	2	12	10	10.9	8.6	36.6	43.9	4.1	11,635	Channel	Friedman
55X38	2.2 L	Green Valley Mine	SE¼NW¼	2	12	10	10.5	10.0	37.6	41.9	2.6	11,097	Channel	Friedman
56X136	3.9 U	Green Valley Mine	SE¼SW¼	10	12	10	11.5	8.6	39.2	40.7	3.9	11,348	Channel	Powell
56X137	1.9 L	Green Valley Mine	SE¼SW¼	10	12	10	10.0	11.2	39.5	39.3	3.9	11,349	Channel	Powell
	E													
58X43	0.3	SDH 45 (Virostko)	SE¼NW¼	15	14	8	7.7	13.2	40.4	38.7	6.8	11,020	Core	Friedman
	D													
56X122	1.27	SDH 34 (Armstrong)	SE¼SE¼	16	15	8	11.0	10.0	38.2	40.8	3.2	11,256	Core	Robinson
56X51	1.3	Outcrop (roadside)	SE¼SW¼	17	15	8	19.1	18.7	28.7	33.5	3.9	7,987	Channel	Powell
56X53	1.3	Outcrop (shale pit)	SW¼SE¼	20	15	8	13.8	10.4	40.5	35.3	3.2	10,846	Channel	Powell
56X78	1.7	SDH 33 (Tolin)	NW¼SW¼	15	14	8	12.2	10.1	36.2	41.5	3.1	11,531	Core	Robinson
	C													
56X52	1.2	Outcrop (Okla. Hollow)	SW¼NE¼	20	15	8	10.0	20.2	24.5	45.3	4.3	11,012	Channel	Powell
56X57	0.45	Outcrop (U.S. 41)	NW¼SE¼	29	15	8	8.3	21.1	36.2	34.4	5.5	9,981	Channel	Powell
56X79	1.7	SDH 33 (Tolin)	NW¼SW¼	5	14	8	8.3	18.8	35.4	37.5	4.5	10,416	Core	Robinson
58X45	1.84	SDH 45 (Virostko)	SE¼NW¼	15	14	8	7.2	15.3	43.7	33.7	4.4	10,900	Core	Friedman
	A													
58X46	1.6	SDH 45 (Virostko)	SE¼NW¼	15	14	8	9.8	10.9	40.5	38.8	5.7	11,160	Core	Friedman
	Unnamed													
56X80	0.77	SDH 33 (Tolin)	NW¼SW¼	5	14	8	10.3	31.8	36.6	21.3	2.6	8,009	Core	Robinson
58X47	0.44	SDH 45 (Virostko)	SE¼NW¼	15	14	8	9.2	16.8	35.9	38.1	5.3	10,390	Core	Friedman
	Minshall													
56X81	4.21	SDH 33 (Tolin)	NW¼SW¼	5	14	8	10.1	17.6	34.3	38.0	5.3	10,248	Core	Robinson
58X48	0.94	SDH 45 (Virostko)	SE¼NW¼	15	14	8	9.0	27.0	33.4	30.5	5.5	8,740	Core	Friedman
	Lower Block													
56X123	0.48	SDH 34 (Armstrong)	SE¼SE¼	16	15	8	10.4	13.9	35.0	40.7	4.7	10,767	Core	Robinson
56X82	1.36	SDH 33 (Tolin)	NW¼SW¼	5	14	8	10.8	12.9	38.2	38.1	3.3	10,984	Core	Robinson
	Shady Lane													
56X124	0.74	SDH 34 (Armstrong)	SE¼SE¼	16	15	8	13.1	11.4	33.2	42.3	1.4	10,832	Core	Robinson

¹ U = upper; M = middle; L = lower.