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DIVISION OF THE
STATE GEOLOGICAL SURVEY
JOHN C. FRYE, *Chief*
URBANA

REPORT OF INVESTIGATIONS 181

SUBSURFACE GEOLOGY AND COAL RESOURCES OF THE PENNSYLVANIAN SYSTEM IN JASPER COUNTY, ILLINOIS

BY

F. E. WILLIAMS and M. B. ROLLEY

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SUBSURFACE GEOLOGY AND COAL RESOURCES OF THE PENNSYLVANIAN SYSTEM IN JASPER COUNTY, ILLINOIS

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ABSTRACT

Jasper County, in southeastern Illinois, lies in the deeper part of the Illinois Basin. Pennsylvanian strata underlie unconsolidated surficial deposits. Four Pennsylvanian limestones and six coal beds are discussed with special reference to their use as key structural marker beds. Structure maps based on electric logs and detailed rotary-well sample studies were made for the Shoal Creek limestone (McLeansboro) and Herrin (No. 6) coal bed (Carbondale). The relationships of the LaSalle anticline, east of the county, the Bogota-Rinard syncline in the western part of the county, and an unnamed syncline in the southeastern part of the county are considered.

Coal-reserve estimates totaling 3,276,861,000 tons have been made for No. 6 and No. 5 coal beds in *indicated* classes of reserves. No reserves have been estimated in *proved* and *probable* classes.

INTRODUCTION

Jasper County lies in the southeastern part of Illinois, in the deeper part of the Illinois Basin (fig. 1). This report presents the results of a subsurface study of strata of Pennsylvanian age in Jasper County, based on records of selected electric logs of 467 rotary drill holes, driller's logs of 2 churn drill holes, and records of 13 control drill holes. Control drill holes are those rotary drill holes for which one-foot drilling time and five-foot samples of drill cuttings were collected in the field and studied by members of the Coal Division of the Survey. Locations of the 13 control drill holes are shown in figure 2.

Drill-hole data used in compiling the maps in this report have been recorded on International Business Machine punched cards. The data include location, type drill hole, map number (county number), company and farm names and numbers, surface elevation, and depth and elevation of the principal key beds. The tabulated lists are on open file at the Survey and are available for public inspection.

The structure maps prepared by the authors as of 1951 have been revised to 1954 by John A. Harrison and Paul E. Potter. The manuscript has been revised by several members of the Survey staff. Margaret A. Parker prepared tabulations of the drill-hole data on IBM punched cards.

DESCRIPTION OF PENNSYLVANIAN KEY BEDS

In Jasper County, electric logs are the principal basis for stratigraphic control. Strata considered as key beds are recog-

FIG. 1.—Index map of Jasper County and the Illinois Basin.

nizable both in drill cuttings and time logs of control wells and produce distinctive patterns in one or more curves on electric logs. Useful key beds occur over a relatively large part of the county.

Eight Pennsylvanian key beds were recognized in this study. From highest to lowest they are: (1) Millersville limestone, (2) Shoal Creek limestone, (3) West Franklin limestone, (4) No. 7 coal bed, (5) "Jamestown" limestone and coal bed, (6) Herrin (No. 6) coal bed, (7) Harrisburg (No. 5) coal bed, and (8) No. 4 coal bed. They were not equally useful as key beds; the most satisfactory key strata were the Shoal Creek limestone and the No. 7, 6, and 5 coal beds.

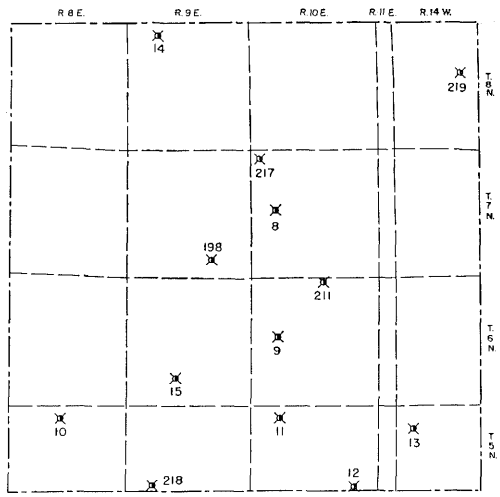

FIG. 2.—Distribution of control drill holes in Jasper County.

MILLERSVILLE LIMESTONE

The Millersville limestone is thought to be present in most of Jasper County and is best developed in the northern half. The limestone here does not have the massive character that it has in the northern part of the Illinois Basin (Taylor and Cady, 1944). In the northern part of Jasper County, limestone benches 2 to 8 feet thick are separated by one or more prominent shale beds which range from 2 to 6 feet thick. In the southern part of the county one limestone bench is commonly observed, and the limestone is apparently absent locally. This limestone normally lies 500 to 600 feet above No. 6 coal bed.

The Millersville is described from drill cuttings as a light-gray, buff to light-brown fossiliferous limestone with a fine to slightly granular texture. The associated shale is generally light to medium gray, but in control well 217 (sec. 6, T. 7 N., R. 10 E.), green as well as gray shale occurs, and in control well 14 (sec. 5, T. 8 N., R. 9 E.) variegated green, red, and gray shale is reported between the benches.

SHOAL CREEK LIMESTONE

The Shoal Creek limestone is one of the most widespread and conspicuous Pennsylvanian members in Jasper County. It is encountered at depths varying from 151 feet in a drill hole on the flank of the LaSalle anticline (No. 219, sec. 15, T. 8 N., R. 14 W.) to 846 feet in a drill hole (No. 15, sec. 28, T. 6 N., R. 9 E.) in the Bogota-Rinard syncline (Lowenstam, 1951).

The Shoal Creek is absent in two areas: (1) the northeastern corner of the county, high on the flank of the LaSalle anticline, and (2) in the southern and southeastern part of the county. Its absence in the latter area does not appear to be related to structure (plate 1).

Drill cuttings of the Shoal Creek limestone are commonly buff, grayish white to white, fine to slightly granular, and fossiliferous. Drilling time indicates a thickness of 4 to 6 feet. The limestone is generally underlain by 1 to 2 feet of black shale and a thin underclay. In a few wells a thin coal occurs below the black shale. The interval between the Shoal Creek limestone and the No. 6 coal bed normally ranges from 350 to 400 feet. This interval thins to about 300 feet on the flank of the LaSalle anticline.

About 50 to 60 feet below the Shoal Creek limestone is a 25-foot zone composed of black shale, coal, calcareous shale, and limestone (plate 3). It is difficult to trace any one component of the zone, but the zone generally can be identified throughout the county.

West Franklin Limestone

The West Franklin limestone, although widespread in Jasper County, is quite variable in lithology and thickness. In the area of the type outcrop in Posey County, Ind. (Collett, 1884; Shrock and Malott, 1929), this unit consists of three limestone benches separated by shale. In Jasper County, three limestone benches were observed in only two control wells—No. 14 (sec. 5, T. 8 N., R. 9 E.) and No. 218 (sec. 20, T. 5 N., R. 9 E.). In hole 218 the upper limestone bench is six feet thick and found at a depth of 918 feet. The rock cuttings are white to light-gray to buff limestone with a slightly granular to sublithographic texture, sandy in part, and containing fossil fragments. The upper limestone is separated from the middle bench by four feet of light-gray to greenish-gray clay shale. The middle limestone is seven feet thick. It is separated from the lower limestone bench by ten feet of light-gray to greenish-gray clay shale and dark-gray shale. The lower limestone is six feet thick. The limestone benches are all lithologically similar.

Although red and gray variegated shale is commonly associated with the West Franklin zone, no red shale was found associated with any of the three limestones benches in this drill hole.

In drill hole 219,* in section 15, T. 8 N., R. 14 W., on the flank of the LaSalle anticline, the West Franklin zone contains two limestone benches. The upper limestone is a nine-foot bed of light-gray to tan limestone with a fine to coarsely crystalline texture; the cuttings contain fossil fragments. Two feet of light-gray shale separate this limestone bench from a lower four-foot limestone bed of similar lithology. A red shale was encountered twenty-two feet below the base of the lower limestone bench. Fifteen feet above the upper bench is seven feet of highly calcareous and fossiliferous shale which may represent the third or uppermost limestone bench.

*The logs of drill holes 9, 10, 211, and 219 are shown on plate 3.

Four control drill holes, nos. 9,* 11, 13, and 198 penetrated two limestone benches in the West Franklin zone. In four others, nos. 8, 10,* 211,* and 217, only one limestone is present in this zone. Red shale was found under the lower limestone bench in one drill hole (No. 9, sec. 17, T. 6 N., R. 10 E.) and below the single bench of limestone in two drill holes (nos. 211, sec. 3, T. 6 N., R. 10 E., and 217, sec. 6, T. 7 N., R. 10 E.). In drill holes 211 and 217, the red shale is separated from the limestone by about 10 feet of light-gray to grayish-white and grayish-green shale.

The West Franklin zone can be recognized on most electric logs from Jasper County. However, it is usually not practical to identify individual limestones when less than three benches are present as no bench has distinctive characteristics. In a number of wells, the red shale unit underlies one or two benches of limestone, but red shales are known to occur between benches in other areas so they cannot be used with certainty to determine which benches may be present.

The variation in interval between the West Franklin zone and the No. 6 coal bed is shown in figure 3 and plate 3. In drill hole 218, in which three limestone benches are present, the interval from the top of the highest limestone bench to the top of No. 6 coal bed is 213 feet.

No. 7 Coal Bed

The No. 7 coal bed is a thin persistent stratum commonly occurring 25 to 75 feet above No. 6 coal bed. Its position on electric logs is marked by a characteristic and relatively sharp break in the resistivity curve below a long low-resistivity pattern of shale under the West Franklin zone.

In most control drill holes, drilling time did not provide sufficient basis for differentiating the coal in the combined black shale and coal thickness (one to five feet). In several control drill holes, where such a differentiation seemed valid, the coal bed had an estimated thickness of one to four feet.

"Jamestown" Limestone and Coal Beds

In eleven control drill holes, one to three feet of black shale and coal are present one to seven feet above the Herrin limestone. In eight of these drill holes a limestone is present a few feet above the coal bed. Drill cuttings show it to be a buff to brown fossiliferous limestone with a fine-grained to crystalline texture. In drill hole 10 (sec. 4, T. 5 N., R. 8 E.), two thin limestone benches separated by a shale parting occur seven feet above the coal; in drill holes 8 and 11 (sec. 17, T. 7 N., R. 10 E., and sec. 5, T. 5 N., R. 10 E.), a four-foot limestone was penetrated one foot above the coal; in drill holes 13, 14, and 211 (sec. 7, T. 5 N., R. 14 W., sec. 5, T. 8 N., R. 9 E., and sec. 3, T. 6 N., R. 10 E.), the overlying limestone is three feet thick; in drill hole 12 (sec. 23, T. 5 N., R. 10 E.) the limestone is two feet thick; and in drill hole 198 (sec. 35, T. 7 N., R. 9 E.) the limestone is one foot thick. This coal bed and the associated limestone occupy the same relative position as the Jamestown coal and limestone of Perry County (Bell et al., 1931, p. 3).

Herrin (No. 6) Coal Bed

The Herrin (No. 6) coal bed is one of the most widespread and readily recognizable strata in the Illinois Basin. Although it is not completely coextensive with the area underlain by the McLeansboro group in the Illinois coal field, its continuity over large areas, particularly in the southern part of the State, is remarkable. Its limestone cap rock is known in southern Illinois as the Herrin limestone.

The Herrin limestone is three-to-eight feet thick and widely distributed throughout the county. Study of cuttings indicates that it is generally medium to dark gray or tan to dark brown, fossiliferous, and somewhat granular. The fossils, most of which are fragmentary, consist of crinoid skeletal elements, brachiopod fragments, and fusulinids.

The No. 6 coal bed has been traced by means of subsurface studies from the southern Illinois mining districts into Hamilton County (Rolley, 1951), Wayne County (Sims, Payne, and Cady, 1944), Clay County (Lowenstam, 1951), and Richland County (Siever and Cady, 1951). Spore examinations of coal samples from

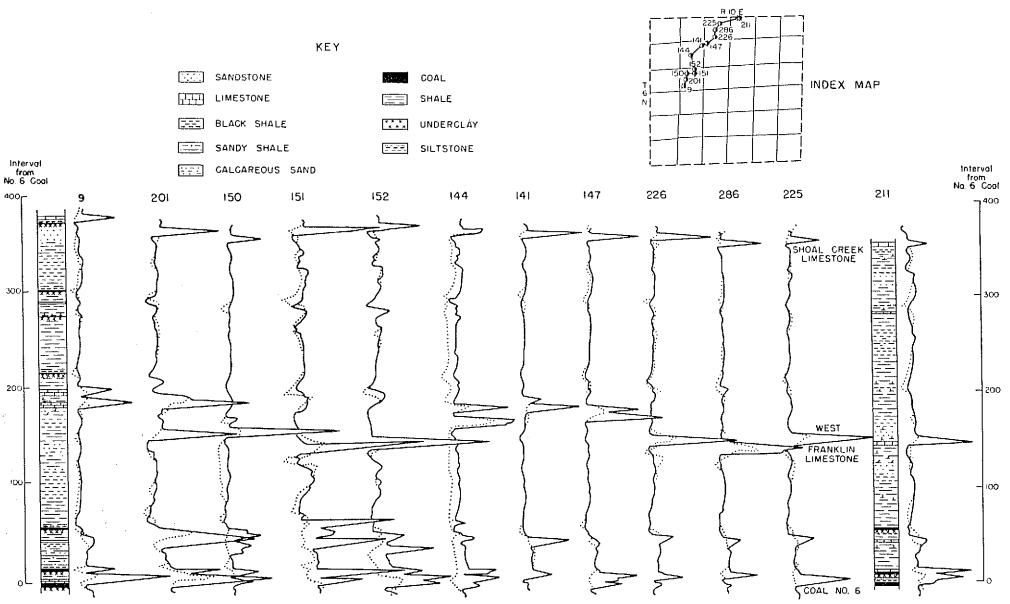

Fig. 3.—Local variations in the West Franklin limestone as shown by resistivity curves.

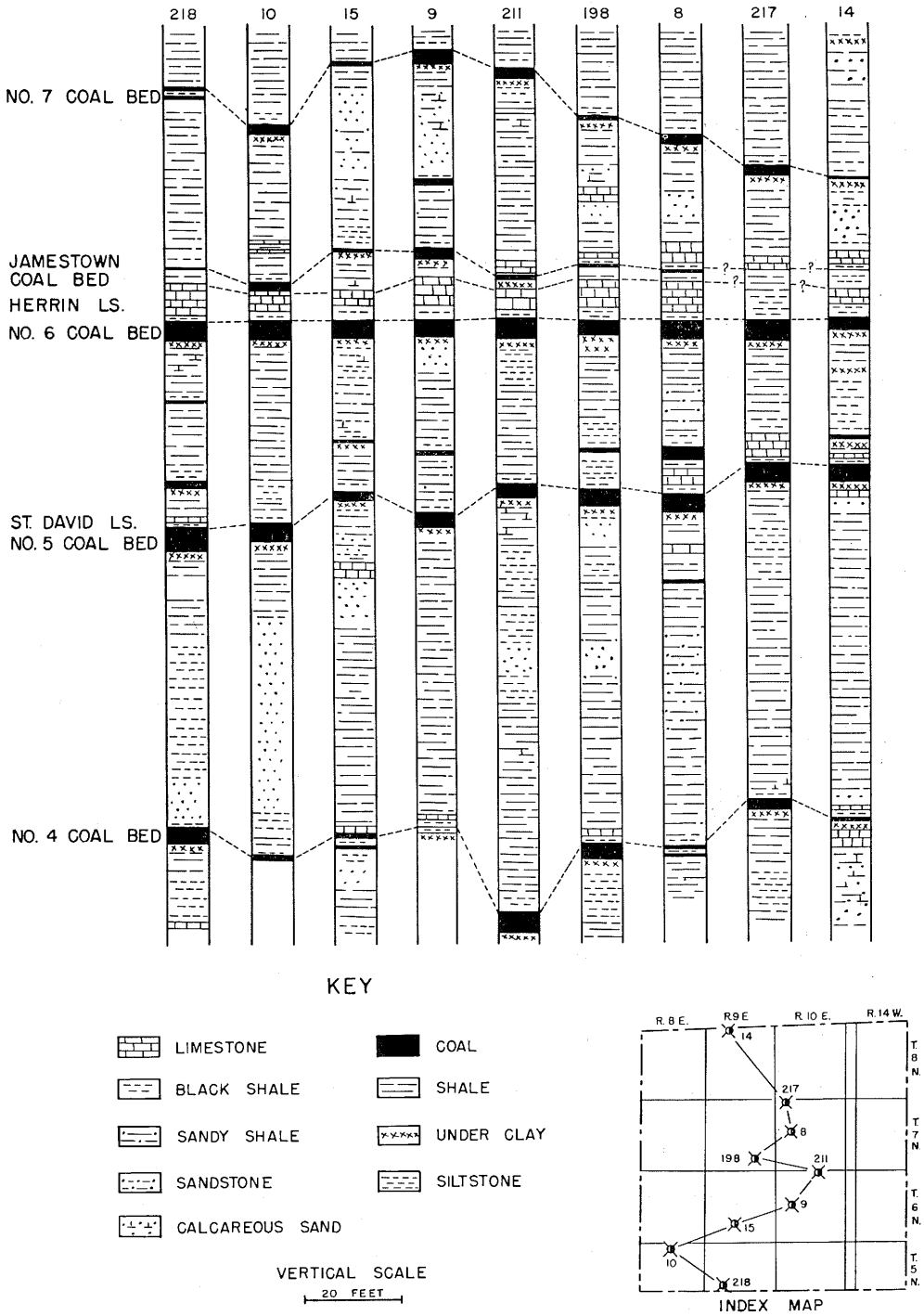

FIG. 4.—Interval from No. 7 coal bed through No. 4 coal bed for nine control drill holes.

drill holes in Wayne and Richland counties substantiate the correlation of the No. 6 coal bed made by other means (Kosanke, personal communication).

The No. 6 coal bed is a very satisfactory key bed in Jasper County. It is widespread, and with its limestone cap rock produces a characteristic pattern in electric-log curves (plate 3). For these reasons and because it is commercially important in large areas of the Illinois coal field and is easy to identify, No. 6 coal bed has been chosen as the principal datum for delineating the structure of the Pennsylvanian beds in Jasper County (plate 2).

The No. 6 coal bed is reached at depths ranging from 390 to 1250 feet. As there has been no core drill exploration in Jasper County, rotary and a few cable-tool drill holes provide the only information concerning its thickness. This information is derived from drilling-time records of control drill holes and electric logs and should be regarded as approximate. In control drill holes in which drilling time makes possible a differentiation between the black shale and the coal, the coal is estimated to have a thickness of from two to five feet. Underclay is generally present; its thickness ranges from one to four feet. Several feet of black shale generally separates the No. 6 coal bed from the Herrin limestone or cap rock.

The electric-log pattern of the normal resistivity curves produced by No. 6 coal and its cap rock is commonly the most prominent part of the curve for an interval of 200 to 300 feet. The coal bed and limestone usually produce a more-or-less combined high-resistivity peak in the normal curve, but in many logs there are separate peaks for the limestone and the coal bed (plate 3).

Between No. 6 and No. 5 coal beds there is commonly a thin black shale and coal in the position of the No. 5A coal bed.

Harrisburg (No. 5) Coal Bed

The No. 5 coal bed lies 30 to 45 feet below the No. 6 coal bed. It is commonly overlain by black shale which varies in thickness. The combined thickness of the shale and coal ranges from three to five feet. In control drill holes in which it was possible to differentiate the black shale and coal, the coal is estimated to be three-to-four feet thick. The position of the coal bed is generally indicated on electric logs by a fairly prominent peak in the normal resistivity curve.

The limestone cap rock of the No. 5 coal bed, the Saint David limestone (Savage, 1927), is locally developed in Jasper County. In four control drill holes it was found to be one-to-five feet thick (fig. 4). Drill cuttings consist of fragments of buff to brown or dark-gray fossiliferous fine- to medium-grained limestone.

No. 4 Coal Bed

The No. 4 coal bed occurs about 90 to 140 feet below the No. 6 coal bed. This unit is the IV-A coal bed of Indiana (Weller and Wanless, 1939). The combined thickness of the coal and the immediately overlying black shale is from one to five feet. There is thin limestone above the black shale in four control drill holes, nos. 9, 14, 15, and 198 (fig. 5 and plate 3). Drill cuttings of the limestone are light gray to buff and fine grained. This contrasts with the dark-gray to black limestone associated with the No. 4 horizon in other areas.

Strata Below No. 4 Coal Bed

There are numerous coal zones between the No. 4 coal bed and the base of the Pennsylvanian. It is generally difficult to trace these strata laterally because of great variability in this part of the section. In control hole 218 (sec. 20, T. 5 N., R. 9 E.), fourteen coal zones were recorded below No. 4 coal bed (fig. 5).

A thin coal that occurs 125 to 140 feet below No. 4 coal is probably the No. 2 coal. This thin bed is not as prominent on electric logs as many of the key beds but may be identifiable in most of Jasper County.

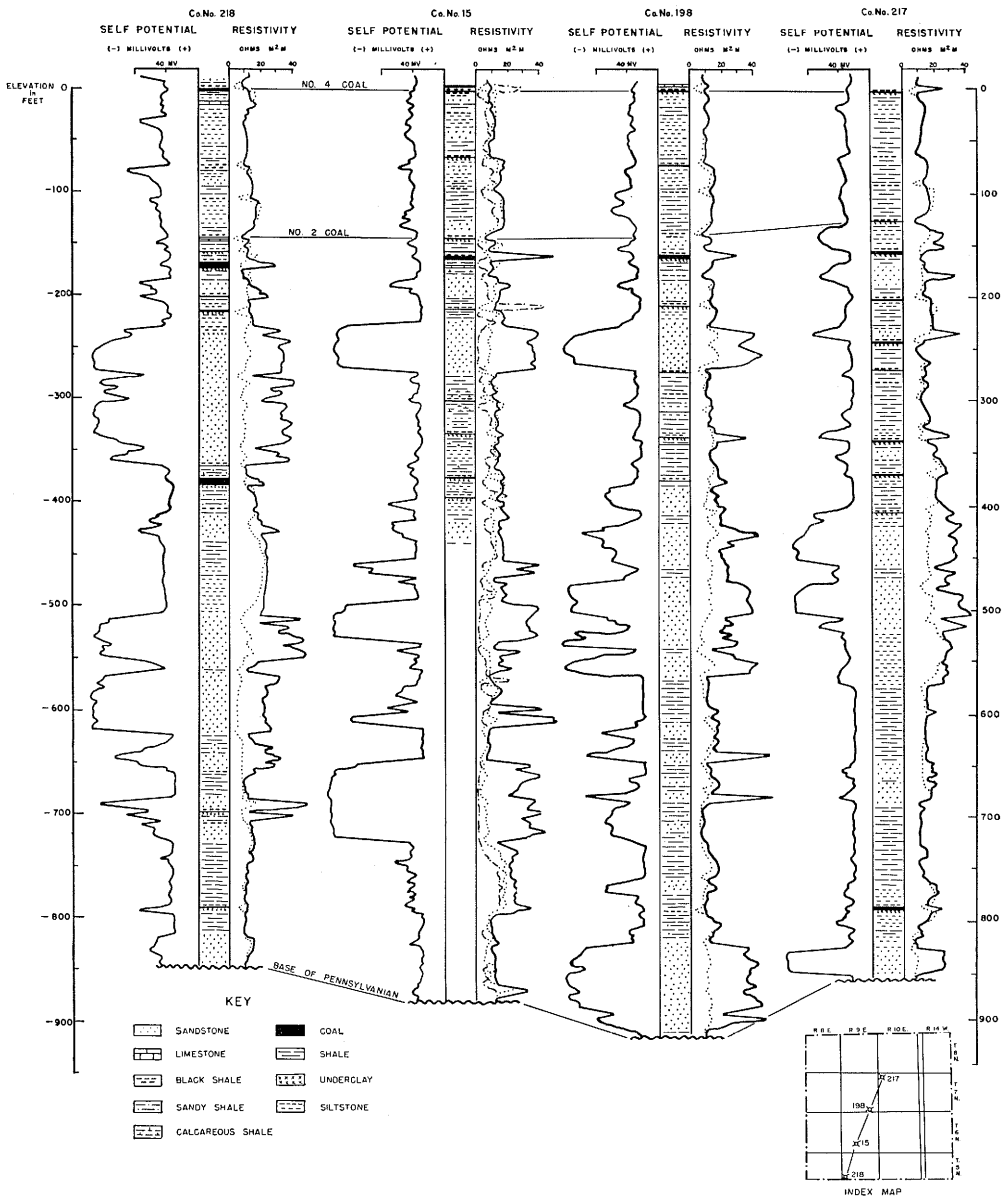

FIG. 5.—Lithology and electric logs of four control drill holes from No. 4 coal bed to the base of the Pennsylvanian.

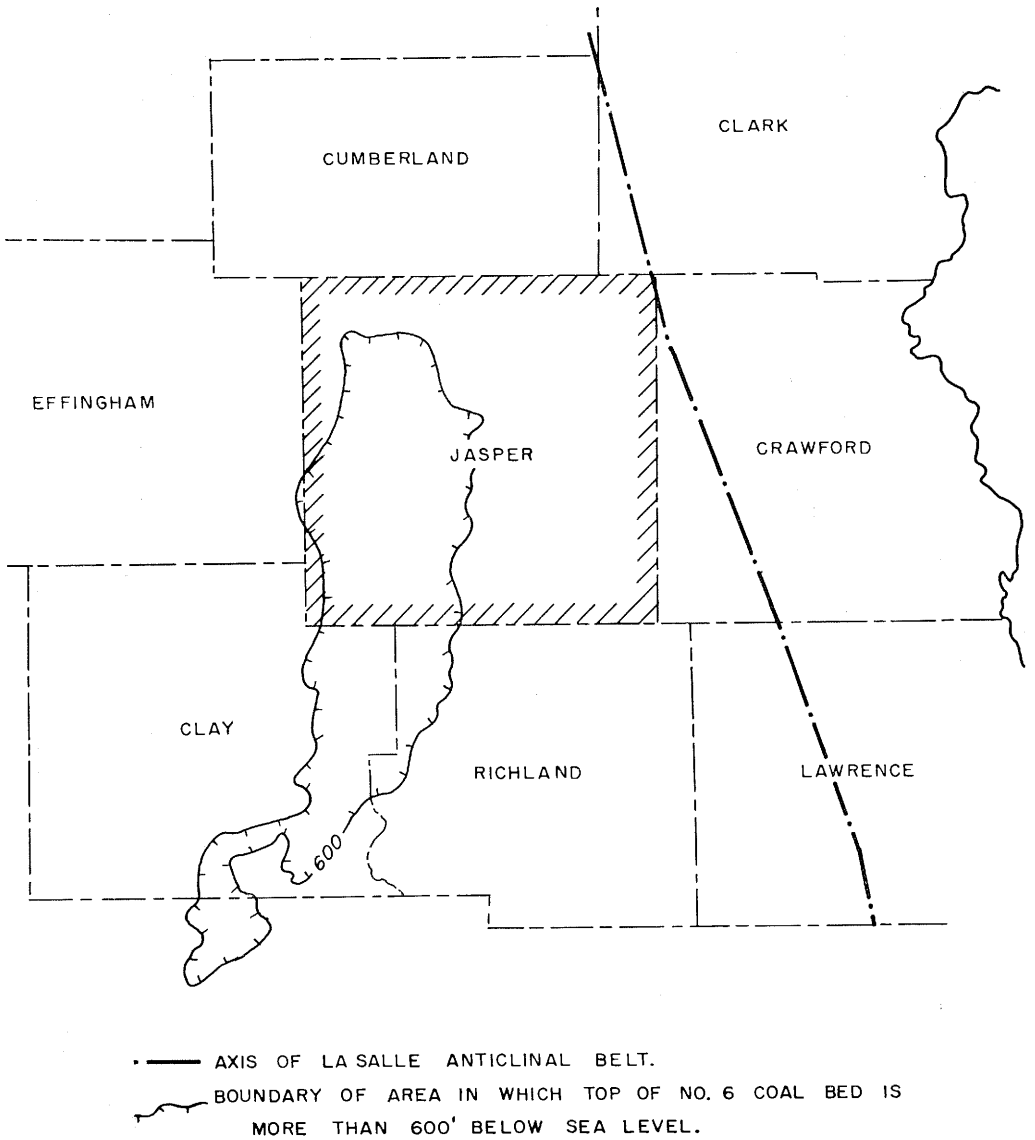

FIG. 6.—Relation of Jasper County to the LaSalle anticline and the Bogota-Rinard syncline.

STRUCTURE OF NO. 6 COAL BED

The eastern part of Jasper County is located on the southwestern flank of the LaSalle anticlinal belt, the axis of which lies to the east in Crawford County (fig. 6). The influence of the anticlinal belt on the structure of No. 6 coal bed is apparent from the structure contour map (plate 2), particularly in the northeastern corner of the county where the coal rises rapidly toward the northeast, toward the axis of the anticlinal belt. The highest datum point of the No. 6 coal bed in Jasper County is 168 feet above sea level, 402 feet below the surface, in drill hole 190 on the flank of the LaSalle anticline (sec. 4, T 8 N., R. 14 W.). From this hole the coal dips southwestward at a rate of about 100 feet per mile to hole 6 (sec. 14, T. 8 N., R. 10 E.). Between hole 6 and hole 290 (sec. 16, T. 7 N., R. 9 E.), the dip decreases to approximately 25 feet per mile.

In the western and southwestern part of the county, the dominant structural feature is a synclinal trough, the Bogota-Rinard syncline (Lowenstam, 1951). This syncline extends from north-central Wayne County, across eastern Clay and the bordering part of Richland County, and northward into western Jasper County. The lowest elevation of the No. 6 coal bed in the Illinois Basin is within this syncline in Jasper County. In drill hole 354 (sec. 19, T. 6 N., R. 9 E.), it is 713 feet below sea level at a depth of 1244 feet. The Bogota-Rinard syncline is roughly bounded by the minus-600-foot contour. The area in which the top of the No. 6 coal bed is more than 600 feet below sea level is shown in figure 6.

A small synclinal area in the southeastern part of the county is separated from the Bogota-Rinard syncline by a low divide. This synclinal area continues southward into Richland County (Siever and Cady, 1951).

STRUCTURE OF SHOAL CREEK LIMESTONE

The structure of the Pennsylvanian rocks in Jasper County, as reflected by the Shoal Creek limestone (plate 3), is similar to that of the No. 6 coal bed. The southwestern flank of the LaSalle anticlinal belt, the Bogota-Rinard syncline across the western half of the county, and the small synclinal area in the southeastern part of the county are reflected on the structure map of the Shoal Creek limestone.

COAL RESOURCES

Estimates of the minable coal reserves of Jasper County were included in a recent Survey publication by Cady and others (1952). Minable coal was defined in this publication as coal over 28-inches thick. No limit was placed on depth to coal as no coal in Illinois is at sufficient depth to render it technically unminable. Coals underlying oil fields were not classed as reserves.

TABLE 1.—MINABLE COAL RESERVES OF JASPER COUNTY*
(in thousands of tons)

Coal bed Average thickness, inches	I-A Proved	I-B Probable	II-A Strongly indicated	II-B Weakly indicated	Total
JASPER COUNTY					
Herrin (No. 6)					
28	—	—	117,908	184,421	302,330
35	—	—	250,209	—	250,209
42	—	—	202,717	—	202,717
48	—	—	1,073,730	—	1,073,730
60	—	—	32,676	—	32,676
Total, coal bed	—	—	1,677,239	184,421	1,861,661
Harrisburg (No. 5)					
28	—	—	182,826	184,421	367,247
35	—	—	583,232	—	583,232
42	—	—	220,176	—	220,176
48	—	—	244,545	—	244,545
Total, coal bed	—	—	1,230,779	184,421	1,415,200
Total, county	—	—	2,908,018	368,843	3,276,861

*After Cady and others, 1952, p. 112.

No coals in the county were considered in the *proved* or *probable* classes; these classes are based on mines or coal-test drill holes, of which there are none in Jasper County.

Although it is probable that there are several seams over 28-inches thick in the county, reserves have been estimated only for the No. 6 and No. 5 coal beds. Reserves for these two coal beds have been estimated entirely on the basis of data from control drill holes. All coal reserves in the weakly indicated class were calculated on an assumed thickness of 28 inches. The estimates of reserves for Jasper County are given in table 1.

Although the deep coals in Jasper County must be considered as ultimate reserves, it is probable that thicker and shallower seams in other areas of the State will be exploited before those in this county.

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