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ILLINOIS

COAL MINING INVESTIGATIONS

COOPERATIVE AGREEMENT

State Geological Survey
Department of Mining Engineering, University of Illinois
U. S. Bureau of Mines

BULLETIN 10

Coal Resources or District I (Longwall)



B

GILBERT H. CADY

Field Work by G. H. Cady, K. D. White, and others

In cooperation with U. S. Geological Survey

STATE GEOLOGICAL SURVEY UNIVERSITY OF ILLINOIS URBANA 1915

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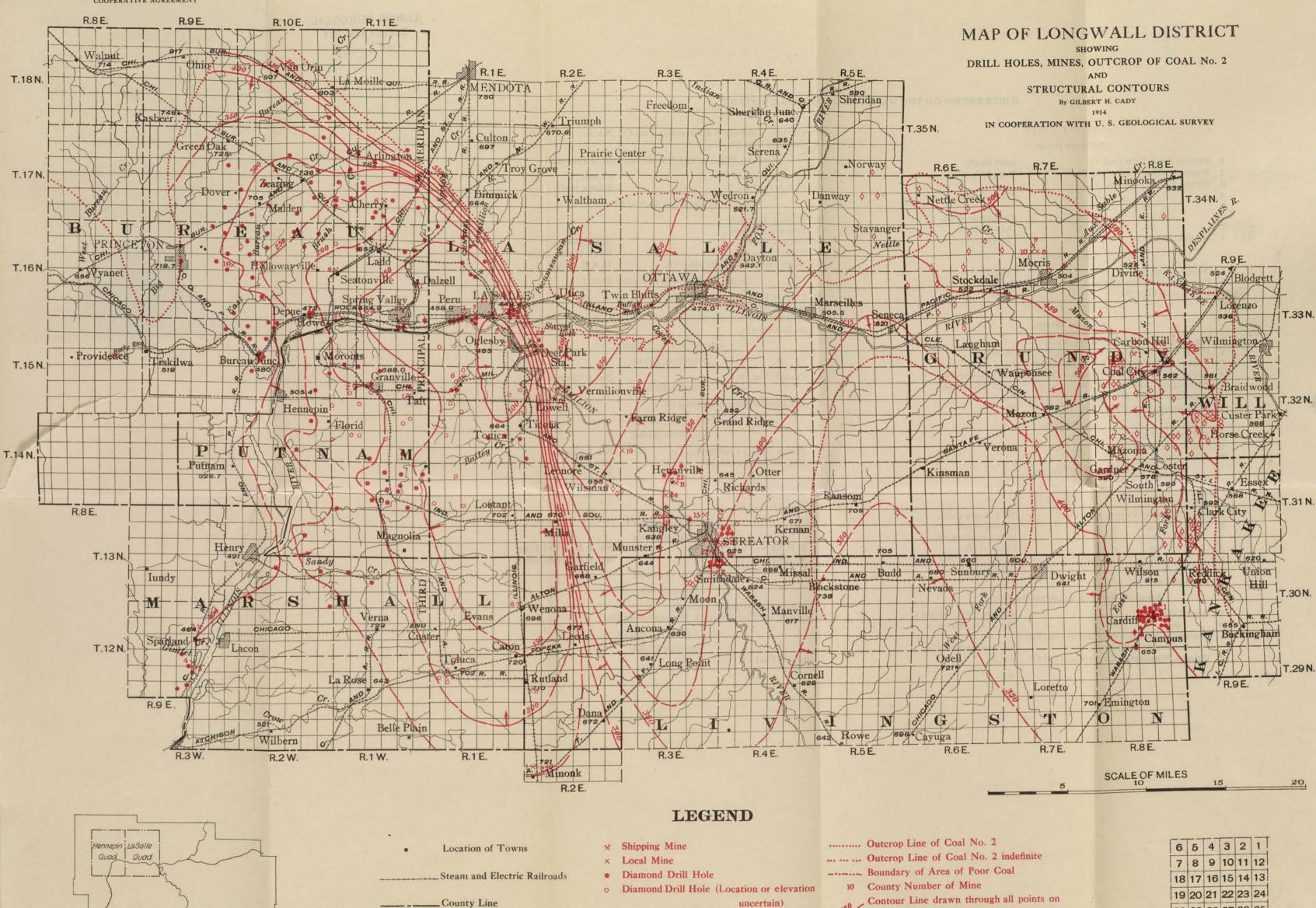
JAN 29 1959

The Forty-seventh General Assembly of the State of Illinois, with a view of conserving the lives of the mine workers and the mineral resources of the State, authorized an investigation of the coal resources and mining practices of Illinois by the Department of Mining Engineering of the University of Illinois and the State Geological Survey in cooperation with the United States Bureau of Mines. A cooperative agreement was approved by the Secretary of the Interior and by representatives of the State of Illinois.

The direction of this investigation is vested in the Director of the United States Bureau of Mines, the Director of the State Geological Survey, and the Head of the Department of Mining Engineering, University of Illinois, who jointly determine the methods to be employed in the conduct of the work and exercise general editorial supervision over the publication of the results, but each party to the agreement directs the work of its agents in carrying on the investigation thus mutually agreed on.

The reports of the investigation are issued in the form of bulletins, either by the State Geological Survey, the Department of Mining Engineering, University of Illinois, or the United States Bureau of Mines, For copies of the bulletins issued by the State and for information about the work, address Coal Mining Investigations, University of Illinois, Urbana, Ill. For bulletins issued by the United States Bureau of Mines, address Director, United States Bureau of Mines, Washington, D. C.

SKETCH MAP SHOWING LOCATION OF QUADRANGLES



Churn Drill Hole

County Line

Township Line

Surface Elevation for Towns

as Indicated

- Arrow indicating direction of dip

the figures

Coal No.2 having the altitude indicated by

uncertain)

uncertain)

Churn Drill Hole (Location or elevation

TOWNSHIP PLAT

30 29 28 27 26 25

31 32 33 34 35 36

ILLINOIS COAL MINING INVESTIGATIONS

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Department of Mining Engineering, University of Illinois
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OF

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> State Geological Survey University of Illinois Urbana 1915



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Fig. 1. Map showing the area of District 1 as covered in this report. (Shaded portion)

COAL RESOURCES OF THE LONGWALL DISTRICT OF NORTHERN ILLINOIS (DISTRICT 1)

By Gilbert H. Cady

CHAPTER I—INTRODUCTION

IMPORTANCE OF THE AREA

The amount of fuel originally available in the 1700 square miles of the Longwall District (Fig. 1 and Plate I) is enormous, being approximately 5,977,000,000 tons. Of this amount only about 3 per cent has been mined or placed beyond recovery by past mining. At the present rate of production (1913) this available coal would supply the State for about 90 years. The additional value of the millions of yards of shale and clay and cement-making limestone associated with the coal, and the location of the area near the Chicago market gives this district an economic importance second to none of the districts of the State. The mineral products obtained from the coalbearing rocks of the area had a total value in 1912 of about eight and one-half million dollars, or about 7 per cent of the total value of the mineral products of the State for that year, although the district comprises only 3 per cent of the total area of the State. The estimate does not include the output of several zinc smelters and rolling mills and glass factories attracted to the region by the accessibility of the fuel, the value of whose manufactured products is several million dollars annually. It seems improbable that another area of the State of similar size outside of the oil fields produces from its own natural resources products having a greater value.

ACKNOWLEDGMENTS

This description of the coal resources of the Longwall District is one of a series of reports on the Illinois coal districts being prepared under the cooperative agreement of the State Geological Survey with the Department of Mining Engineering of the University of Illinois and the U. S. Bureau of Mines. The reports on coal resources cover approximately the same areas as corresponding bulletins on Coal Mining Practice, as defined in Bulletin 1: "A Preliminary Report on Organization and Method of Investigations."

In the study of this region little special field work has been undertaken by the writer, but use has been made of the excellent notes taken in 1912 by Mr. K. D. White in the mines selected for field observation under the cooperative agreement. If has been the purpose to assemble also the information previously collected by other members of the Survey since its organization. Field notes by the following men have been reviewed: Measrs, Jon A. Udden, Frank F. Grout, E. W. Shaw (U. S. Geological Survey), L. W. Swett, Edwin F. Lines, E. H. Pool, and O. F. Brooks. Much of the information collected in cooperation with the U. S. Geological Survey by Professor U. S. Grant and the present writer in the study of the La Salle and Hennein quadrangles has been incorporated in this report. The results of drilling operations conducted under the direction of Mr. G. S. Rice, now Chief Mining Engineer of the Bureau of Mines, have contributed much to our knowledge of the stratigraphy and structure of the district.

To the kindly cooperation of the various mining companies in this field, the Survey is indebted for the large amount of information. There has been a generous response to requests for drilling records and other information of a geological nature, even though much was of a confidential character. Individual mention would hardly stop short of a complete list of the companies. From the superintendents of the various mines, from the pit bosses, and not infrequently from the miners, have come many of the details of our information.

In the preparation of the report the writer is especially indebted to the Director, Mr. Frank W. DeWolf, and to Mr. F. H. Kay for kindly and helpful suggestions, and to Miss Helen Skewes, Messrs, M. L. Nebel, and L. S. Baldwin for aid in the preparation of the various diagrams and sketches.

DEFINITION AND EXTENT OF THE LONGWALL DISTRICT

The Longwall District is so called from the prevailing method of mining. The western part of the field is commonly spoken of as the "third-veln" field, because the principal coal mined at La Salle is the third bed below the surface. In the eastern part of the field this bed is known as the Wilmington coal. This "third vein" or "Wilmington" bed is coal Nô, 2 of the Illinois section, and is recognized by the State and U. S. Geological Surveys as approximately equivalent in age to the Murphysboro coal of southwestern Illinois. By definition it marks the base of the Carbondale formation of the Pennsylvanian system in this State. The Longwall District includes the area underlain by coal No. 2 in commercial thickness. The area is limited on the north and east by the outcrop of the coal. On the south and west the coal probably continues beyond the limits of the area but in most places is not mined because of either its decrease in thickness or its greater depth in contrast to higher coals. To the south and west, therefore, the Longwall District merges with indefinite boundaries into the adjacent coal districts.

The accompanying map (fig. 1) shows the boundaries of the Longwall District as assumed in this report. Parts or all of the following counties are included in the area: Bureau, La Salle, Grundy, Will, Potnam, Marshall, Livingston, and Kankakee.

DEVELOPMENT OF MINERAL INDUSTRIES

This area lies near Chicago and is therefore crossed by many trunk lines, the more important of which are the Chicago, Burlington and Quincy Railway; the Chicago, Rock Island and Pacific Railway; the Atchison, Topeka and Santa Fe Railway; the Chicago, Indiana and Southern Railroad; and the Walsash Railroad. The transportation actilities are apparently ideal, but the present depression in the mining business of the district is thought by coal operators to be due to an artificial discrimination in freight rates between this and other districts of the State.

There are a number of important small cities in the district, the chief of these being Streator, La Salle, Peru, and Ottawa. These, and several of the smaller towns, Spring Valley, Granville, Oglesby, Coal City, South Wilmington, and Morris, owe much of their importance to the development of the mineral resources of the vicinity. The district contains rich and largely undeveloped resources of shale, clay, coal, glass sand, and limestone for cement making and for other uses. With slightly more favorable mining and transportation rates, and with useful canals traversing the district, the field might hold its own with any in the State. The coal output of the State has gradually advanced from north to south. In 1881 La Salle County led in output with 624,900 tons; in the next year it still held first place with over 2,000,000, after which the center of production moved south until the county leading in 1907 and 1908 is at the extreme southern end of the coal field. The center of production has steadily receded from Chicago markets because of (1) development of north-south railroads; (2) proportionately cheaper ton-mile rates; (3) thick coal and other conditions favoring easy mining; (4) low tonnage price paid to miners; (5) better quality of coal in the southern counties. It is thought by

some that the eventual revival of coal mining in the area will depend on the use of coal at the mine to develop power, coal-gas products, and coke, so as to free the producer from much of the burden of transportation.

No oil or important gas fields have been discovered in the district, but the possibilities do not seem to have been exhausted, especially along the line of the La Salle anticline.

CHAPTER II-GENERAL GEOLOGY

INTERPRETATION BY MEANS OF BLOCK DRAWING

In order to understand the position of the coal beds in the general logical formations present in the district, a knowledge of the general goological relations is necessary. In the following description of the general geology the rocks older than the "Coal Measures" or coal-bearing rocks are discussed very briefly, whereas the "Coal Measures" are considered in great detail. Operators or engineers in charge of development work will, it is hoped, find this a valuable reference chapter. The reader may, however, prefer to turn to other chapters directly and may refer to the Contents for topics of greater interest. The general relationship of the coal to the other strata is shown by the accompanying block diagrammatic and does not conform closely to horizontal scale ore geographic boundaries.

The diagram represents a block of the earth's crust about as it is in the Longwall District. The block is divided into three sections along east-west lines. From the south section nearest the reader, all the strata have been removed to the base of the "Coal Measures" or The resulting surface represents that upon Pennsylvanian series which the Pennsylvanian rocks were laid down, and is seen to be underlain by various kinds of rocks dipping eastward away from the fold, which trends approximately northwest-southwest. The fold is known as the La Salle anticline. It is shown to vary both in closeness and in height. To the south it is more gentle than to the north. Increasingly younger rocks next underlie the "Coal Measures" toward the east and toward the west from the axis of the fold as is shown in the diagram, and because of the unsymmetrical character of the anticline, which is much steeper to the west than to the east, the formations succeed one another much more rapidly to the west than to the east. In addition to the eastward and westward dip of the older strata there is also a dip toward the south, so that younger rocks are more likely to lie under the Pennsylvanian system to the south than to the north,

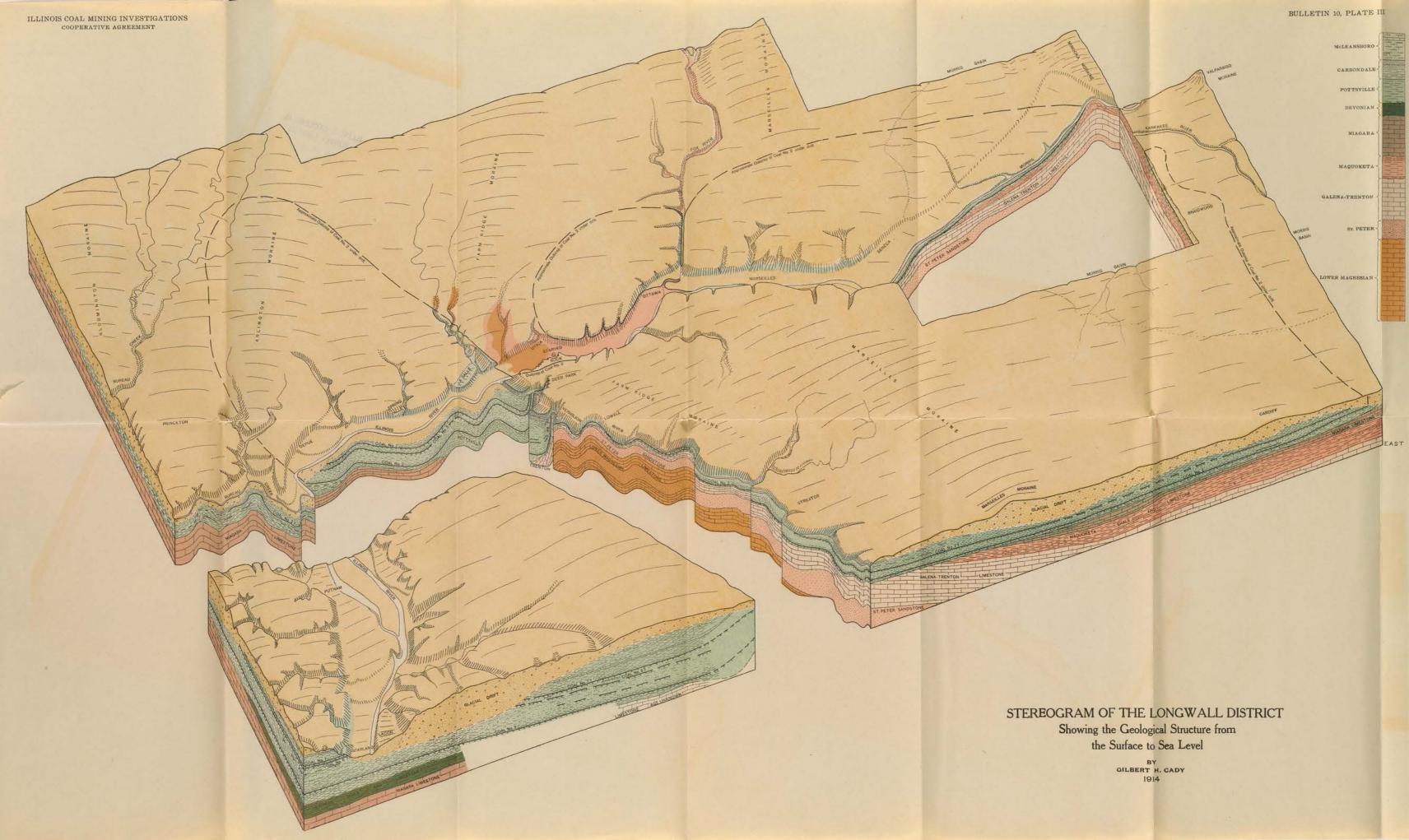
The middle section of the diagram (Pl. II) shows the surface of coal No. 2 as it would appear if all the overlying rocks were removed. It differs from the original surface of the coal in being folded along the axis of the anticline and in being limited on the east by an erosional, rather than a depositional, edge. The coal bed as originally formed probably had a very level surface and a gradually diminishing thickness toward the edges.

After the accumulation of the coaly material the deposition of other Pennsylvanian strata continued to a thickness of at least 500 feet above coal No. 2 in the center of the district. That this thickness persisted over all the area seems improbable. The succession evidently was thinner east of the anticline and toward the old shore line, which probably lay several miles beyond the present line of outcrop of the "Coal Measures".

At some time after the deposition of coal No. 2, and possibly after the close of Pennsylvanian deposition in this area, further movement along the line of the anticline occurred so as to fold the coal and other rocks as shown in the diagram. An earlier period of movement is described under "Structures".

The long period or 'périods of erosion that followed the deposition of Pennsylvanian strata removed the "Coal Measures" entirely from some areas and greatly thinned them in others. Just before the glacial period valleys had been cut so as to expsee the coal, and the outcross on the north and east were eroded back irregularly toward the center of the coal field. The boundaries of the coal could be readily traced if the covering of glacial drift were removed. The glacial material left by the ice is of general occurrence except where it has been removed by subsequent erosion, and is of irregular thickness, reaching a maximum of 340 feet. It is represented in the north section of the diagram in Plate II. The surface is in general a plain, but is cut here and there by steep-sided valleys which may or may not penetrate the underlying rook. The drift surface evidently bears no relation to the underlying rooks. The drift surface evidently bears no relation to the underlying rooks urface, and therefore the limits of the coal beds can be determined only by extensive drilling.

This brief explanation of the stereogram (Pl. II) presents the three main groups of strata within the Longwall District and shows the general relationship existing among them. These strata in ascending order are (1) the pre-Pennsylvanian rocks ranging in age up through the Devonian and separated from the overfying rocks by an erosion unconformity that is conspicuous in parts of the district; (2) the Pennsylvanian rocks, consisting of sandstone, shales, limestones, and the thin beds of coal which are the special objects of our attention; and (3) the glacial drift. The main structural feature is a general southward dip interrupted by the pitching fold of the La Salle anticline which trends about northwest-southeast. Each of the groups of strata receives more detailed description in the pages that follow, and the structural features will be discussed at some length. There is also presented in Plate III a stereogram of the Longwall Dis-



trict showing the main geographic and geological features, to accompany the description of the geology.

STRATA BELOW THE "COAL MEASURES"

(PRE-PENNSYLVANIAN ROCKS)

The strata next underlying and forming the floor for the "Coal Measures" of the Longwall District as shown by Plate III range in age from the St. Peter sandstone to Devonian limestone and shale. The age of the underlying rock at Wenona, however, is unknown; it may possibly be as young as Mississippian. The Lower Magnesian limestone is the oldest rock exposed at the surface within the State. Possibly in a few places in the vicinity of La Salle it originally lay next below the Pennsylvanian or, at any rate, was separated from the Pennsylvanian by only a few feet of the St. Peter sandstone. The Lower Magnesian limestone is exposed along the Illinois River bluff between Utica and La Salle, along Pecumsangan Creek, and along Tomahawk Creek and Little Vermilion River three and four miles north of La Salle. Where it outcrops along the streams, it forms perpendicular cliffs which reach a height of 50 to 75 feet. Figure 2



Fig. 2. The Lower Magnesian limestone outcropping along the north bluff of Illinois River between Split Rock and Utica (photo by T. E. Savage).



Ftg. 3. Lower Falls in Deer Creek Glen; a canyon in St. Peter sandstone (photo by Rhodes).

shows the character of the Lower Magnesian limestone between La Salle and Utica.

The St. Peter sandstone underlies the Pennsylvanian system extensively, particularly along the anticline on the two Vermilion rivers and along, and north of, Illinois River east of the anticline as far as a



Fig. 4. The contact of St. Peter sandstone and Lower Magnesian limestone near Split Rock. (Vertical scale about 16 ft, to 1 inch)

point halfway between Marseilles and Seneca. The bluffs of Illinois Valley are largely St. Peter sandstone from Utica to Twin Bluffs on the north side of the river, and from the anticline to the mouth of Covel Creek on the south side of the river. In this rock the beautiful gorges of Starved Rock and Deer Park have been carved (see figure 3). The St. Peter sandstone is variable in thickness, largely because of the irregular surface of the Lower Magnesian limestone upon which it was deposited. Figure 4 is a photograph taken near Split Rock and shows the St. Peter sandstone resting on the uneven surface of the Lower Magnesian limestone. The sandstone varies from about 120 to 200 feet in thickness in this district. It is an important source of glass sand and also supplies some of the artesian water.

The formation overlying the St. Peter sandstone is the Platteville limestone commonly known as the Trenton limestone. This formation passes upward without conspicuous interruption into the Galena dolomite. These two formations are practically inseparable as found in this district, especially on the basis of information obtained from drill records, hence they will be described collectively as the Galena-Platteville or Galena-Trenton formation. This extends from Deer Park northward as a narrow belt along the west side of the fold under

the Pennsylvanian strata. Southward from Deer Park the limestone seems to be present over the fold and to extend eastward for 12 or 15 miles.

The stereogram on Plate III shows in a generalized way the relation of the Galena-Terento to the anticline and to the overlying Maquoketa shale. The east boundary between the limestone and the shale passes southeastward from about midway between Seneca and Morris toward Ransom in southeastern La Salle County. The Galena-Trenton is exposed along the west side of the anticline at various points on Vermilion River as far south as Lowell, at Split Rock, and along Little Vermilion River about four miles north of La Salle. East of the fold the limestone is found as a thin layer above the St. Peter sandstone and below the Pennsylvanian fire clay at various places as far as Ottawa. The Galena-Trenton averages 250 to 300 feet thick within this district.

The Maquoketa shale is present to the west of the Galena formation as a narrow belt on the west side of the anticline. On the east side of the fold it underlies the "Coal Measures" throughout most of Grundy County. In the southeastern part of Grundy, and in the neighboring parts of Livingston, Kankakee, and Will counties, the Niagaran limestone lies between the Maquoketa shale and the Pennsylvanian system. The Maquoketa is exposed along the east border of the Longwall District on the Kankakee, Dupage, and Desplaines rivers; within the district, however, it is known only from drill samples obtained from artesian wells. It has a variable thickness within the district up to about 200 feet.

The Niagaran limestone, which outcrops extensively in the vicinity of Joliet, is known within the borders of this area only from drill samples. There is evidently a considerable area in the southeast corner of the district east and south from Dwight, where the Pennsylvanian overlies Niagaran dolomite. West of the anticline, and apparently beyond the zone affected by the folding, the Niagaran is present and increases in thickness to about 400 feet in the vicinity of Depue. (See record in Chapter IV.)

The Devonian formation underlies the Pennsylvanian rocks in a small area in the Longwall District, but is not known to outcrop nearer than in the vicinity of Rock Island, Illinois. Within this area reddish Devonian shales containing Sporangites have been identified by Professor J. A. Udden in samples from the well at Henry, but the extent of this area of Devonian is uncertain. Devonian formations are not known below the Pennsylvanian system on the east side of the anticline.

The stereogram of the Longwall District (Plate III) shows

the rocks from the surface down to sea level. This diagram and that shown in Plate II explain graphically the various relations that exist between the Pennsylvanian system and the underlying rocks in this district. The larger stereogram is drawn to scale, and the geology is represented as accurately as is consistent.

PENNSYLVANIAN SERIES OR "COAL MEASURES"

GENERAL DESCRIPTION

The general succession of the Pennsylvanian series in the central part of the Longwall District where conditions are most typical is excellently recorded in the detailed section by H. C. Freeman. This section, with some modifications suggested by recent investigations, is reproduced in Chapter IV. Most of the drilling shown on the map, Plate I, has been done since Mr. Freeman's work, so that a more accurate knowledge of the geological conditions is now possible, and it is necessary to modify the original section in some particulars and to suggest correlations not evident to the earlier investigator.

The Illinois "Coal Measures" are divided into three formations, all of which are represented in the Longwall District. In ascending order these are the Pottsville formation, the Carbondale formation, and the McLeansboro formation. In southern Illinois, where the section is more complete and thicker, these formations are more characteristically developed, and the horizons of separation are definite. The Pottsville includes that part of the Pennsylvanian series which lies below coal No. 2, the Carbondale is represented by the portion between the base of coal No. 2 and the top of coal No. 6, and the McLeansboro formation includes all the "Coal Measures" lying above coal No. 6.

In this district the Pottsville is distinct as elsewhere and lies below coal No. 2. The boundary between the Carbondale and the McLeansboro is not so clear. Coal No. 6 is apparently not represented in the district, unless it be in the vicinity of Sparland, and it seems that the division between the two formations is at a probable unconformity between coal No. 5 and coal No. 7. The formation above this possible unconformity comprises the thickest part of the Pennsylvanian series in the northern district, and it can probably be subdivided on good stratigraphic grounds.

The Longwall District is divisible into a number of subdistricts or fields, in each of which the details of stratigraphy are fairly constant. The correlation of the sections of the various fields, however,

^{&#}x27;Freeman, H. C., La Salle County: Geology of Illinois, Ill. Geol. Sur. 1867, pp. 264 to 266.

seems possible only in a general way, although certain major parts of the local sections seem to agree with certain parts of other local sections, yet the attempt to correlate smaller units, such as local beds of sand, clay, limestone, coal, or shale seems inadvisable. There are, however, some exceptional strata, including some coal beds, which are widespread and are readily identifiable from place to place.



Fig. 5. Sketch map showing location of subdistricts.

The fields (see figure 5) into which the Longwall District is divisible are as follows:

- (1) The La Salle, Bureau, and Putnam counties field west of the anticline and east of the bend in the Illinois: the La Salle-Minonk field.
- (2)- A small area in the vicinity of Bureau, Bureau County, running south possibly 10 to 12 miles and extending indefinitely westward: the Western field.
 - (3) The Streator field east of the anticline.
 - (4) The Kangley-Henanville field, a small area lying north and northwest of Streator field along Vermilion River.
 - (5) The Coal City-South Wilmington field.
 - (6) The Cardiff field.
- (7) The Illinois River field from the anticline to Morris: the Ottawa-Morris field.
 - (8) The Sparland field.
- (9) The axis of the anticline along Little and Big Vermilion rivers: the Anticline field.

POTTSVILLE FORMATION

LA SALLE-MINONK FIELD

The variations in the character of the Pottsville formation among the different fields of the Longwall District are considerable. In the La Salle-Minonk field for three or four miles west of the anticline the Pottsville is unusually thick, some drillings in the vicinity of La Salle showing 200 to 275 feet of siliceous shales and sandstone. The record of the well of the Chicago Portland Cement Co. at Oglesby given in Chapter IV and reproduced on Plate IV (No. 6) is representative of this thick phase of the Pottsville. The position of this unusual thickness of Pottsville is shown in the stereogram. Plate III, in the vicinity of La Salle and Peru. The formation is shown to be thinner westward from Spring Valley to Depue. At this latter place the Devonian (?) limestone lies relatively close to the base of coal No. 2 as is shown in the record of well No. 2 of the Mineral Point Zinc Co., given in Chapter IV. Westward from Depue the underlying rock surface declines. coal No. 2 rises somewhat, and the intervening Pottsville accordingly becomes thicker

WESTERN FIELD

The Pottsville in the small western field near Bureau is about 80 feet thick. Coal No. 2, if correctly identified in this small area, varies from about 2 feet to about 3 feet in thickness. A coal 2 feet or less in thickness is recorded in several of the logs 30 to 40 feet below coal No. 2. Some of the records also note another 1-foot bed of coal 25 to 30 feet lower in the section, and still another of about the same thickness 10 to 15 feet below. The intervening strata are blue or gray shales which in places are siliceous. One log shows a thin limestone about midway in the section. The Pottsville in the vicinity of Bureau rests on limestone, probably of Niagaran age. A record of drilling in this field is given in Chapter IV. No. 11).

Southward towards Putnam and Marshall counties along the Illinois Valley the Pottsville continues thick. Observations of drill records show at least 100 to 110 feet of sediment below coal No. 2. The formation contains one thin bed of coal near the bottom, and as andistone about 25 feet thick near the middle of the section. In this region, at least in the vicinity of Henry, the Pottsville seems to rest upon Devonian shale. The record of strata below coal No. 2 encountered in a drill hole in T. 30 N., R. 2 W., located opposite Henry, is given in Chapter IV and is log No. 12, Plate IV.

OTTAWA-MORRIS FIELD

East of the anticline along Illinois River from the anticline to

Morris the Pottsville is in very few places over 25 feet thick. North of the river toward the outcrop it becomes still thinner and to the south, thicker. From the anticline eastward to Morris the formation is practically all fire clay, which varies in character accordingly as the underlying rock is sandstone, limestone, or shale.

ANTICLINE FIELD

In that part of the district lying along the anticline and Vermilion rivers (Anticline field), the clay is in many places separated into two



 ${\rm Fig.}$ 6. Boulder of pisolitic limestone from the Pottsville formation of southwestern Illinois.

beds by a sandstone varying from 1 to 5 feet in thickness. Along Little Vermilion River the sandstone is thicker than the underlying clay except locally, whereas along Vermilion River this lower clay is of greater thickness and the sandstone plays out to the south. Above the sandstone in clay pits in the vicinity of Deer Park are found round builders of limestone of a peculiar pisolitic structure, which upon weathering break up into small, round fragments about one-fourth inch in diameter. Most of the broken surfaces display a cross-section of

each nodule and show a radiating structure. The rock therefore is easily identified. Figure 6 shows a boulder of pisolitic limestone from the same horizon in the southwestern part of the State, but similar to those found in this district. This limestone is thought to correspond to a similar bed above the Cheltenham clay at St. Louis.

In the Longwall District the pisolitic limestone has been seen in the clay mine of the Illinois Clay Products Co. at Deer Park, in the exposures on the north side of Vermilion River at Loweli, and along one of the gullies running through the west side of Starved Rock Park from the south. Although the limestone or the sandstone is not everywhere present in this clay, it nevertheless seems probable that over much of the arac east of the anticline the Pottsville is represented by two clays, the lower one of which is not in every place easily distinguishable from the upper, but which probably represents an earlier period of deposition.

STREATOR AND SOUTHEASTERN FIELDS

In the Streator field the Pottsville has the same general characteristics as it has along the Illinois to Vermilion River. The formation is at least 20 to 30 feet thick and is composed of gray clays and sandstone. The details of the succession are not known. In the Wilmington and Coal City and the Cardiff fields the Pottsville is thicker than elsewhere east of the anticline. At Cardiff 40 feet of Pottsville are present The formation is composed of one or two thin coal beds, shales, and thin limestone and sandstones. The details of stratigraphy are known from only one or two records so that generalization is impossible,

THE CARBONDALE FORMATION

The Carbondale formation lying next above the Pottsville can be described best by considering separately the stratigraphy of certain subdistricts

THE WESTERN FIELD

As has been pointed out in the discussions of the Pottsville certain irregularities in the "Coal Measures" in the area lying west of Depue and Granville and south of T. 16 N., make difficult the definite correlations of the coal. In the first place, throughout this area the two upper coals have been eroded and the outcrops are deeply covered by glacial drift, so they are of no aid in correlation. Secondly, the structure is uncertain, although there seems to be a rather sharp rise of the strata to the west, as is indicated on the structure contour map, Plate I. Again, several thin coal beds in the section have about the same thickness, so that the identification of No. 2 is uncertain. Finally, all our information is based upon about 10 drill records, there being no surface data whatever.

The strata of the Carbondale in this field are known only for about 100 feet above the base of the formation, the upper part having been removed by pre-glacial erosion. Of this 100 feet of strata, all but a small proportion is shale, blue, gray, and black. In several of the records a thin limestone is noted 50 to 60 feet above coal No. 2. In the lower 20 feet of the formation is a black shale which probably corresponds to the fissile shale in most places present at this horizon over large areas of the Longwall District.

LA SALLE-MINONK FIELD

Lying west of the anticline and stretching from the northern to the southern limits of the district is an area where the succession as presented by Freeman* in his discussion of the Geology of La Salle County seems to hold. Toward the south there are probably some changes involving the introduction of coal No. 6 and the possible elimination of coal No. 7, which have not yet been determined.

Coal No. 2 is persistent and is everywhere apparently of workable thickness, averaging 42 inches. It can be readily correlated in the different drill records. The coal will be described in detail on a later page (see Chapter IV). As a rule coal No. 2 is overlain by a gray shale or "soapstone", 12 to 18 feet thick. In places this shale is absent entirely, and the next overlying stratum rests upon the coal, Above the "soapstone" there follows a 3-foot bed of black, fissile shale, which contains in many places large nodules of black ironstone. Concretions of a somewhat different character are found for a distance of about 4 feet in an overlying gray shale. The latter nodules possess a peculiar structure due to planes of calcite passing through them, have a weathered surface that resembles the shell of a turtle, and break in a very characteristic manner. So far as known, this is the only horizon in the Carbondale of this district where such septarian concretions are found, and they afford a rough, but apparently reliable, means of identification of the underlying black shale. Above the sentarian bed is 8 to 10 feet of gravish-blue, rather plastic shale or clay capped by a calcareous sandstone, 2 to 5 feet thick. Above the sandstone follows another black shale which in places is almost a cannel coal. This black shale differs from the black, fissile shale below in the fact that it is not so sheety, but tends to break into rectangular fragments. These are readily identifiable along the streams where they have been washed out, as along Vermilion River near Lowell. This carbonaceous bed is about 4 feet thick and is locally overlain by a thin, impure limestone. Commonly overlying the limestone is gray shale becoming more or less siliceous toward the top. This shale varies in

²Op. cit.

thickness to a maximum of possibly 75 feet. Along Vermilion River it does not exceed 20 feet. There follows a heavy sandstone also of variable thickness. In some places it occupies the entire horizon of the underlying siliceous shale and attains a thickness of 60 to 75 feet or more, but in other places is entirely replaced by the shale. Where the sandstone is thickest the middle bed of coal, thought to be No. 5, is absent. The sandstone is evidently in all places younger than the shale, since it seems to lie in troughs cut into the shale, and there is an abrupt change from one rock to the other. Although this is prob-



Fig. 7. The heavy sandstone below coal No. 5 (Vermilionville sandstone) outcropping along the big bend in Vermilion River between Deer Park and Lowell.

ably not sufficient evidence for believing that an erosion plane existsbetween these two terranes, their relationships are certainly suggestive of rapid changes in conditions of deposition. This sandstone will be called the Vermilionville sandstone in this report. Figure 7 shows this sandstone outcropping along Vermilion River between Deer Park and Lowell.

The accumulation of the peat which represents coal No. 5 seems to have taken place during an interruption in the deposition of the sandstone and sandy shale in more or less restricted areas, for of all the important coal beds in the district this is the most irregular in distribution. Coal No. 5, its underday, and its overlying black and gray shale roof together comprise possibly 25 feet of the Carbondale section in this field. It is followed above by sandy shale and sandstone, which continues to the underclay of coal No. 7, a distance of 35 to possibly 75 feet.

The exact position of the top of the Carbondale formation in this section is not known. Where coal No. 5 is present it is certainly above that coal. Where the coal is not present the top of the formation must be regarded as indefinite. It seems probable that there were oscillations in sea level in this district during the time of the deposition of the siliceous strata associated with coal No. 5 which were about contemporaneous with similar changes in level noted by Savage3 as existing in southern Illinois after the deposition of coal No. 6. In this region these changes were of such a nature as to give rise to several local planes of erosion. The coarse sandstones tended to be localized along the channels, to assume a lenticular cross-section as a result, and in place to cut down through and displace the coal. A continuous section of sandstone and sandy shale aeross the horizon of coal No. 5. such as occurs in a broad belt running north and south through the east side of Putnam County and the western edge of La Salle County. probably exists along one of these erosion lines. In such sections the ton of the Carbondale may be as far below coal No. 7 as the usual interval between that and the No. 5 seam.

THE STREATOR FIELD

The Streator field lies east of the anticline in the vicinity of Streator. The Carbondale section is exposed in part down Vernilion River from Streator to see. 32, T. 32 N., R. 3 E., and is known from mines and from shaft and drill records. The section of the Carbondale in this field differs from that of the La Salle-Minonk field, in that it is considerably thinner, and has a number of thin local beds of coal in the lower part of the section which possibly correspond to some of the black shales noted in the La Salle section.

There is sufficient evidence that the "Coal Measures" section as it rises over the anticline and extends eastward becomes notably thinner. West of the fold about 150 feet of strata lie between coals No. 2 and No. 5. In the exposures showing the succession between these two strata along Vermilion River near Deer Park, the interval between the two coals is about 100 feet. In the vicinity of Streator coal No. 5 is not present, but the interval between coals No. 2 and No. 7 is only about 150 feet, or 50 feet less than it is in the La Salle field.

It is impossible to present the lower part of the Carbondale section of this field with as great detail as for the La Salle-Minonk area because our information on this part of the section depends upon a few, rather unsatisfactorily drill records. In sinking the shaft of mine No.

Shaw and Savage, U. S. Geol. Survey Geol. Atlas Murphysboro-Herrin folio (No. 185) p. 11, 1912.

2 of the Chicago, Wilmington, and Vermilion Coal Co., from coal No. 7 to coal No. 2 the following strata were penetrated:

Partial Log of Shaft No. 2, Chicago, Wilmington and Vermilion Coal Co., Streator

	Description of Strata	Thickness		Depth	
		Ft.	In.	Ft.	In.
26	Coal No. 7				
25	"Slate"	2		2	
24	Fire clay	2	6	4	6
23	Sandstone	6		10	6
22	Slate	1	. 6	12	
21	"Soapstone"	6		18	
20	Sandstone	2	6	20	6
19	Coal		3	20	9
18	"Slate"	12		32	. 9
17	Sandstone	25		57	9
16	Blue granite (?) Niggerhead	2	9	60	6
15	"Soapstone"	3		63	6
14	Flinty "soapstone"	5	6	69	
13	"Slate"	4		73	
12	Sandstone	3		76	
11	"Slate"	1	6	77	(
10	Coal	2	6	80	
0	Fire clay	3		83	
8	Sandstone	3		86	
7	Blue limestone	3		89	
6	"Soapstone" and boulders	15	6	104	1
5	Coal	2	4	106	10
4	Blue shale	14		125	10
3	"Slate"	5		125	10
2	"Soapstone"	21		146	10
1	Coal No. 2	4		150	10

In this record it seems probable that the lower four members are essentially the same as the strata in the La Salle region below the septarian shale. Coal No. 5 of the above section is possibly the equivalent of the cannel coal which lies a few feet above the septarian bed. Other parts of the section, however, cannot be identified until the heavy sand-stone No. 17 of the section is reached. No. 10 does not seem to be the equivalent of any persistent bed in the La Salle field. The sand-stone, No. 17, is thought to belong to the series of sandstones and shales which is associated with coal No. 5 horizon, and which outcrops in cliffs 50 to 75 feet high along Vermilion River between Lowell and Streator. As elsewhere in the Longwall District, this sandstone is of variable thickness in the Streator field. In places it lies next below coal No. 7 in great thickness, and elsewhere it is separated from coal No. 7.

by a succession of shales which may contain beds of coal. The stratigraphic succession in the Kangley-Henanville field is of this latter character, which serves to separate it somewhat from the Streator field as a whole.

The correlation of formations of the Streator and the La Salle fields is based largely upon the possibility of tracing coal No. 2 with little interruption from one field to the other by the way of Vermilion River. The coal horizon goes under the river not far above Lowell. It has been found about 30 feet below the river 4 miles above the Lowell bridge in sec. 24, T. 32 N., R. 2 E., and two miles farther up stream at about the same depth. At Streator the coal is about 400 feet above sea level, or about the same devation as at Marseilles.

The section exposed along Vermilion River south of Lowell is unfortunately not continuous, so that the upper strata cannot be traced from one field to another. In secs. 24 and 25, T. 32 N., R. 2 E., and sec. 30, T. 32. N., R. 3 E., the bluffs above Vermilion River are composed entirely of glacial drift. The essentially horizontal position of coal No. 2 through the area, as described in the preceding paragraph, makes it reasonable to suppose that the overlying rocks were horizontal before they were eroded, and that correlations across the break are fairly safe. In sec. 32, T. 32 N., R. 3 E., and secs. 5, 8, and 9, T. 31 N., R. 3 E., the river is lined on one side or the other by a practically con-



Fig. 8. Coal No. 7 and the underlying sandstone near the Kangley Bridge on Vermilion River.

Coal -

timuous cliff of sandstone. Below the sandstone is a blocky, black, fissile shale and cannel coal, which is possibly equivalent to the black, fissile shale lying 35 to 40 feet above coal No. 2 north of Lowell and along Vermilion River.

About one-fourth mile west of the Kangley Bridge over Vermilion River the surface of the heavy sandstone declines, and the Streator, or No. 7, coal, is found a few feet above the river at the level of the middle of the sandstone if it were continuous. Upstream, east of the bridge, this coal bed rises to an elevation of possibly 35 to 40 feet above the water. Below the coal for about 20 feet are clays and shales, the latter containing a black, carbonaceous stratum and streaks of coal. Below this lies the sandstone about 5 feet thick. Figure 8 shows the coal and sandstone east of the Kangley bridge. The sandstone thickens considerably again upstream, so that from where the river bends south along the north line of sec. 15, T. 31 N., R. 4 E. to the Chicago, Indiana and Southern Railroad bridge the coal is apparently absent. South from the railroad bridge the coal is apparently thickness and in normal relationships, so far as has been determined.

KANGLEY-HENANVILLE FIELD

The small area underlain by coal No. 7 in the vicinity of the Kangley bridge apparently is bounded on the west by the heavy sandstone which is exposed along Vermilion River, and is limited similarly by a sandstone to the east. The basin extends northeast beyond Henanville and south to the old Acme mine at Kangley. This is the Kangley-Henanville field of the Longwall District.

Mention has already been made of the existence of a local bed of coal between coal No. 7 and the heavy (Vermilionville) sandatone. In the Henanville District this lower coal is in places thick, but varies in its distance from the upper coal. At places in the old Henanville mine the two coals were in contact, the two beds having a combined thickness of about 9 feet. To the south near Kangley there is a bed of shale between the two coals and they can be worked separately.

COAL CITY-SOUTH WILMINGTON FIELD

This field is part of the eastern end of the Longwall District. It lies between the Ottawa-Morris field to the north and the Cardiff field to the south, into both of which it merges with indefinite boundaries. The relationships with the Morris area are possibly closest, and the correlations are made most accurately in that direction. Coal No. 2 is widespread in this field. Above it is a bed of shale or "soapstone" about 00 feet thick, which in places is quite sandy and elsewhere contains many fossil-bearing, ironstone concretions—the famous Mazon Creek fossil horizon. This shale is overlain by carbonaceous beds, in places a thin coal seam, and then sandstone and sandy shale to the upper coal, which is apparently No. 7. As in the case of the fields already described the boundary between the Carbondale and McLeansboro formations is indeterminable, but not improbably it lies in the sand-stone below coal No. 7, as in the Streator field.

OTTAWA-MORRIS FIELD

The transition from the stratigraphic sequence of the La Salle field to that of the Coal City field can be traced with but slight interruptions from the anticline to Morris. At Ottawa the "Coal Measures" are thin, only the lower 50 feet or so being left in the valley bluffs. The soapstone roof, characteristic of coal No. 2 in the La Salle region and also the black, fissile shale and the septarian zone above. can be traced at least as far east as Buffalo Rock. The soapstone is however about twice as thick, approximately 35 feet being measured at the clay mine of the Herrick Clay and Manufacturing Co. near Twin Bluffs. East from this location the strata lose more and more of their characteristic appearance near La Salle, and the "soanstone" continues to increase in thickness. Above the horizon of the fissile shale and septarian zone, which become less conspicuous, is another carbonaceous, sheety shale which is possibly about the same age as the blocky, carbonaceous shale found a short distance below the heavy sandstone hed at Lowell.

Between Ottawa and Marseilles the coal goes under Illinois River. At Marseilles it is about 60 feet below the surface, and the upper black, fissile shale is near the surface of the Illinois River flat. In the valley bluffs above the town a heavy sandstone, 60 feet or more in thickness, makes up the rest of the Carbondale section. The sandstone is thought to be the equivalent of the Vermilionville in the La Salle and Streator fields. A coal, possibly No. 7, is reported above this sandstone. The Marseilles section resembles both the Streator and Coal City sections, in thickness and in the disposition of the various strata.

Towards Seneca the heavy sandstone appears in the north bluff of the river, but because of the erosion of the upper part it becomes thinner eastward. About 30 feet of "Coal-Measures" sandstone underlies the town of Seneca directly below the surface deposit. It can be seen outcropping along the Illinois at the Big Four Railroad bridge. From Seneca to Morris much the same succession continues except that older and older rocks are brought to the surface in that direction, due to the slight dip to the west. At Morris the Carbondale is represented by so to so feet of shale which possibly represents the thickened

gray shale or "soapstone" normally above coal No. 2 in the La Salle field. The black, fissile shale and the septarian zone above are not known to exist in the section at Morris. Southeast of Morris toward Mazon Creek this shale horizon contains the fossil-bearing nodules for which that region is famous

CARDIFF FIELD

The Cardiff field is made a separate division of the district because of the occurrence in the Carbondale section of a thick, lenticular bed of coal which seems to have been deposited in a small channel-like basin running in a quarter circle for about two miles, with a breadth of 1000 to 1200 feet (see Plate V). At the bottom of the trough this coal (the "big vein") lies a few feet, as a rule not over 10, above coal No. 2: at a few points the beds are in contact. The bottom of the coal rises to a height of 15 to over 30 feet above coal No. 2 at the sides of the trough. Twelve feet of coal has been encountered, but the average thickness in the trough is about 9 feet. Stratigraphically the coal seems to occupy about the same position relative to coal No. 2 as the fossiliferous, nodular horizon along Mazon Creek. Its correlation with any other coal in the State is not possible at present, and it is improbable that there is a coal bed of exactly the same age. A similar channel deposit is reported near Clark City at the Old Clark City mine, 6 or 7 miles north of Cardiff. These are relatively unimportant areas in the Longwall District as a whole.

A detailed description of this field, accompanied by maps and sections is given in Chapter III.

McLeansboro Formation

GENERAL DISTRIBUTION

Within the Longwall District the McLeansboro formation has been orded from large areas. The map showing the area underlain by coal No. 7 (Pl. VIII) is practically a map of the McLeansboro formation. Over the entire district the boundary between the McLeansboro and Carbondale is indefinite, but apparently it is not far below coal No. 7.

The McLeansboro formation is found west of the anticline to about the location of Depue, the western edge running about north and south along the east side of the pre-glacial Illinois-Rock River Valley. Southward the formation has been removed over the fold, at least as far south as Lowell and probably nearly to Leonore on the Illinois Central Railroad west of Kangley. East of the fold there is possibly a V-shaped area of McLeansboro, one side of the V, running from a point near Leonore toward Marseilles, the other side extending from Marseilles toward South Wilmington. This area, however, is much more irregular than is indicated by this description, as several lines of pre-glacial drainage cross this triangle and apparently center in a deep, broad, valley which passes out of the district between Dwight and Streator. (See stereogram for position of this drainage line. Plate III). The formation is found in only three of the subdistricts into which the Longwall District has been divided.

LA SALLE-MINONK FIELD

The McLeansboro formation extends from about midway between the middle and upper coal beds (coal No. 5 and coal No. 7) to the top of the Pennsylvanian system in this field. It includes therefore coal No. 7 and the La Salle limestone, which is used extensively in the La Salle region for the manufacture of Portland cement. The formation is thicker in this field than elsewhere in the district, extending from about 300 to 600 feet above sea level in the vicinity of La Salle and Peru. The formation seems to be divisible into at least two parts and possibly into three. The lower part of the formation is predominately siliceous and is essentially a continuation of the upper part of the Carbondale formation. About 50 to 75 feet above coal No. 7 the character of the rocks changes from siliceous to predominately calcareous, and thin limestones and limy shales comprise most of the rest of the section. Because of a marked change in the character of the fauna in one of the upper limestones exposed in the bluff of Illinois River opposite La Salle, there is possibly some basis for the division of the formation. The fauna above is composed essentially of pelecypods and that below, of brachiopods,

Within the lower siliceous section of the McLeansboro formation the coal known locally as the "first" or "upper vein," No. 7 of the Illinois section, is the most constant member and is found practically everywhere in this field, except where it has been eroded. Erosion however has been extensive. It is in most places associated with a thick underclay which has been demonstrated to be of commercial importance in some places. Locally this clay exceeds ten feet in thickness. The coal is overfain by dark shale, which grades into a sliceous shale, and that into sandstone in places. This sandstone is locally known to cut down through the coal and to unite with the sandy strata below the coal. A description of the coal is to be found in Chapter III.

Near the base of the upper section of the McLeansboro formation and 50 to 75 feet above coal No. 7, is a rather definite limestone horizon thinner and less readily identified than the La Salle limestone, but apparently more widespread. This horizon is thought to be the same as that of the Lonsdale* limestone in the Peoria area. This limestone has been found outcropping in the vicinity of Coal Hollow, Bureau County (sec. 17, T. 16 N., R. 10 E.), in Rocky Run east of Tiskilwa, at Sparland, and thence south toward Peoria, and possibly in the Streator field. In all places the relation to coal No. 7 is about the



Fig. 9. The La Salle limestone along Vermilion River showing the middle part of the formation (photo by Rhodes).

same. A similar relationship is reported by T. E. Savage to exist throughout Fulton County, though the coal and limestone are somewhat nearer together than at Sparland. The identification of this horizon in the drill holes is very impracticable. The limestone contains a large amount of argillaceous material, and it is apparently only under the influence of weathering that it hardens and appears as a definite ledge of rock, whereas a few feet back it is very fragmentary. Be-

⁴Udden, J. A., Geology of the Peoria Quadrangle, Illinois: U. S. Geol. Survey Bull 506, p. 39, 1912.

cause of this characteristic, the rock is likely to be interpreted by the driller as shale, or limy shale.

The upper section of the formation which contains the limestones and limy shales has one, and possibly two, economically important limestone horizons. The most important of these commercially is the La Salle limestone, which borders both Little and Big Vermilion rivers for several miles above their mouths, and which is used in the manufacture of Portland cement by three large cement mills located at Oglesby and La Salle. The limestone reached a thickness of 25 to 30 feet. This bed lies about 400 feet above coal No. 2 or 175 feet above coal No. 7. It has a very local distribution, being confined to a belt about two miles broad and extending parallel to its outcrop along the anticline from Bailey Falls on the south to the NE. ½ sec. 28, T. 34 N., R. 1. E., three miles north of La Salle. The belt is much wider in the



Fig. 10. Strata at the horizon of the La Salle limestone in a gulley in Peru, showing the more siliceous phase.

middle than at either end.⁶ In this area much of the rock has been removed by erosion along Illinois and Vermilion rivers and their tributaries. The same horizon extends farther westward, but the lithological change is considerable, so that the stratum loses its value as Portland cement rock within two miles of the outcrop. Along the Illinois bluff to the west the bed appears as either a very siliceous, dirty limestone, or as a more or less calcareous shale. Figure 9 shows the La Salle limestone along Vermilion River, and figure 10 the siliceous limestone.

Intermediate strata between these rather characteristic limestone beds are largely limy shales and thin limestones. The strata are so variable that a generalized section is misleading. The Freeman section (Plate IV, No. 7) is as representative as is consistent. Certain of the coal beds will be considered in greater detail in the discussion of the economic geology.

About 25 feet above the La Salle limestone and near the top of the McLeansboro formation there is 24 feet of shale divided into three beds which are reddish, bluish, and yellowish in color. This shale has been used to some extent in the vicinity of La Salle for the manufacture of brick. So far as known it exists only in a small area within the city limits of La Salle and Peru, and across the river opposite these towns in another limited tract. The same stratum probably extends along Bailey Creek above the Falls, but whether the shale is of the same character is not known.

STREATOR FIELD

The McLeansboro formation in the Streator field is exposed in murrous outcrops along Vermilion River. A probable part of this formation has been already described in the discussion of the Carbondale formation of the Streator field. As it is not practicable to separate the formations at a definite horizon, the base of coal No, 7 is used as a convenient plane of separation and one which is thought to be near the stratigraphic division plane. The description of the McLeansboro formation in this field will accordingly be limited to the strata above the base of coal No. 7.

As has been previously shown coal No. 7 does not underlie this field continuously, but is interrupted in places because of the increased thickness of the underlying sandstone, as for instance to the east and west of the Kangley-Henanville area. Freeman described the coal outcropping above Kangley bridge (see figure 8) and named it the Kirkpatrick coal, not believing that this bed was the exact equivalent

⁸Cady, G. H., Cement Making Materials in the Vicinity of La Salle, Illinois: State Geol. Survey, Bull., 8, p. 127, 1907.

of the Streator coal, or coal No. 7. It is not known definitely whether the sandstone barrier to the east entirely separates the coal of the Kangley-Henanville field from both the Streator field and the La Salle field, but there are indications that such is the case. At least, it is certain that the coal is different in appearance and is associated with different strata than in the Streator and Kangley fields. Although Freeman's distinction of the Kirkpatrick coal from the Streator or No. 7 coal may not be found justified, it seems probable that the Kangley-Henanville basin was largely isolated during the deposition of coal No. 7 so that conditions there differed from those in the adjacent parts of the district. Coal No. 7 is described in detail in Chapter III.

Above the coal is a light, bluish-gray shale 35 to 40 feet thick, used by several of the brick and tile companies in the vicinity of Streator. Above the shale is a shaly sandstone about 10 feet thick. The succession above this horizon is not accurately known as exposures are poor. Within 25 feet of the sandstone there lies locally a nodular, concretionary shale, which at one place at least hardens into a heavy nodular limestone 4 to 5 feet thick. This is possibly the equivalent of the Lonsdale limestone of the La Salle and Sparland districts. This nodular shale is noted at the north end of the road bridge over the Vermilion just below the Santa Fe Railroad bridge. At this place it is 50 to 60 feet above No. 7 coal. In sec. 18, T. 30 N., R. 4 E. large blocks of nodular limestone lie on the banks of Vermilion River for a distance of about one-fourth of a mile. Although these blocks are not in place, they could not have been moved a great distance and they represent the approximate position of the Lonsdale limestone. A limestone, probably the Lonsdale, outcrops in a very similar way in Rocky Run near Tiskilwa, large isolated blocks lying in the bed of the stream or along the sides of the valley.

Between \S and 10 feet above the sandstone noted in the preceding paragraph there is present a seam of coal about 30 inches thick in a small area in the N, \S see, 18, T, 30 N., R, 4 E. The coal is underlain by fire clay and overlain by gray shale. The distribution of this coal has not been determined, but it seems to be very limited.

The strata overlying the limestone are not known. Within this district east of the anticline they have a very limited distribution, and are confined to Livingston County.

SOUTH WILMINGTON AND CARDIFF FIELDS

The distribution of the McLeansboro formation in this part of the Longwall District is indicated approximately by the distribution of coal No. 7 as shown in the map in figure 27. It is a small, narrow, arrow-shaped area running from a broader base in the Cardiff region to a point near Mazonia. The strata have been removed to the east and west by pre-glacial erosion. The thickness remaining above the coal is in few places more than 50 feet and is as a rule much less, so that the formation is relatively unimportant. The formation in this field is composed almost entirely of shales, although one or two records show a thin limeston 3 to 5 feet thick, 15 or 20 feet above the coal.

SUMMARY

A section of the Pennsylvanian series of the Longwall District applicable to the different parts of the area would need to be of general character, presenting merely the salient features of the succession. It is thought that after the preceding review of the general geology of the different parts of the district the following statement will not be misleading:

- (1) Coal No. 2 is of uniform character and widespread distribution so that it is rather easily identifiable in any of the fields.
- (2) There is a similar persistance of coal No. 7, although there is a greater variation in thickness and in the character of the associated strata than is true of the lower coal.
- (3) The Lonsdale limestone is probably traceable from one point to another that is widely separated from it, but the identification is not readily made in drill records,
- (4) So far as known no other single stratum is identifiable over the entire district.
- (5) The Pennsylvanian system as a whole is lithologically divisible into three parts: the lower part is dominately shale, and contains one persistent bed of coal (No. 2) and several black "slates"; the middle part is dominately either sandstone or sandy shale, and includes two horizons where coal is likely to be found; the upper part is dominately calcareous shale and thin limestone and is barren of coal of any economic importance. This latter division contains a persistent nodular bed of limestone near its base.
- (6) It is thought that any attempt to map the stratigraphic divisions, McLeansboro and Carbondale, in this district will be attended by uncertainty and inaccuracy because of the indefiniteness of the position of the contact of the two formations.

STRUCTURE

DEFINITION

The term structure as used in geology commonly refers to the attitude or "lay" of the rock layers, that is, whether they are flat lying, inclined, folded, or broken by faults. Structure of this kind can be



Fig. 11, a. Sketch of ideal landscape.



Fig. 11, b. Model of ideal landscape.



Fig. 11, c. Topographic map of ideal landscape.

represented by photographs and sketches, by diagrammatic crosssections and block drawings, but most clearly and accurately by means of structural contours. As the use of contours to show differences in elevation or relief may not be familiar, the attention of the reader is called to the following explanation:

USE OF CONTOURS

The use of contours to exhibit geologic structure can best be explained to the reader by inviting attention to the similar use of contours to show relief or configuration of land forms.

The explanation can be based on the accompanying representations (Fig. 11a, b, and c) of an ideal landscape from the geological folios issued by the U. S. Geological Survey. Figure 11a represents a river valley between two hills. In the foreground is the sea, with a bay that is partly closed by a hooked such bar. On each side of the valley is a terrace. The terrace on the right merges into a gentle hill slope; that on the left is backed by a steep ascent to a clift, or scarp, which contrasts with the gradual slope away from its crest. In the model and map each of these features is indicated, directly beneath its position in the sketch, by contour lines.

Figure 11, b shows a model of the same landscape viewed from above. On this model lines have been drawn connecting points of equal elevation above sea level.

Figure 11, c shows only the level lines or contour lines. It is a contour map. The following notes may help to explain the use of contour lines.

1. A contour line represents a certain height above sea level. In this illustration the contour interval is 50 feet; therefore the contour lines are drawn at 50, 100, 150, and 200 feet, and so on, above mean sea level. Along the contour at 250 feet lie all points of the surface that are 250 feet above the sea, that is, this contour would be the shore line if the sea were to rise 250 feet; along the contour at 200 feet are all points that are 200 feet above the sea; and so on. In the space between any two contours are all points whose elevations are above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, and that at 200 feet lies above the terrace: therefore all points on the terrace are shown to be more than 150 feet but less than 200 feet above the sea. The summit of the higher hill is marked 670 (feet above sea level); accordingly the contour at 650 feet surrounds it. In this illustration all the contour lines are numbered, and those for 250 and 500 feet are accentuated by being made heavier. Usually it is not desirable to number all the contour lines. The accentuating and numbering of certain of them-say every fifth one—suffices, and the heights of the others may be ascertained by counting up or down from these.

- 2. Contour lines show or express the forms of slopes. As contours are continuous horizontal lines, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing around spurs or prominences. These relations of contour curves and angles to forms of the landscape can be seen from the map and sketch.
- 3. Contour lines show the approximate grade of any slope. The vertical interval between two contours is the same, whether they lie along a cliff or on a gentle slope; but to attain a given height on a gentle slope one must go farther horizontally than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

SIGNIFICANCE OF STRUCTURAL CONTOURS

A structure contour map is similar to the surface contour map already explained. It differs from the surface contour map in showing the elevation of the top of a selected stratum rather than the elevation of the surface of the ground. The detail of the structure contour map is much less than that of the surface contour map, because in the latter case the elevations of all points on the surface can be readily determined, whereas in the case of the structure contour map the elevation of the stratum mapped is known only at outcrops and where it has been reached by the drill or by mine shafts and the map must be constructed from more or less seattered data.

THE ACCURACY OF STRUCTURAL CONTOURS

In the Longwall District the structure contours shown on the material Plate 1) are based upon the top of coal No. 2. The quality of the contouring is determined first, by the number and distribution of observations; second, by the reliability of geological data, which involves the accuracy of statement by those from whom the information is sought, the accuracy of the location of the drill holes, and the correctness of correlation of strata at outcrops and in drill holes; and third, by the method of determining the elevation of the bed to be contoured. Three methods are used by the Survey to determine elevations. (1) Instrumental leveling, by which method the limit of error lies within one-tenth of a foot. Where the position of the drill hole is known only in a general way more or less inaccuracy results, but the observer attempts to eliminate errors greater than two or three feet. (2) Elevations obtained by hand-level from adjacent bench marks. The error in extreme cases amounts to 5 feet, but most elevations are correror in extreme cases amounts to 5 feet, but most elevations are correctness.

rect within 2 or 3 feet. (3) Elevations estimated from topographic maps. Elevations estimated from accurate contour maps may possibly be in error as great as the contour interval which varies from 10 to 20 feet in the different types of maps. These maps are of two grades of accuracy. The new La Salle, Hennepin, Ottawa, and Marseilles topographic sheets (1910-1914) are considerably more accurate than the old Morris and Wilmington sheets made twenty years ago. These latter are of about the same degree of accuracy as a series of county contour maps prepared by Professor C. W. Rolfe for the Board of World's Fair Commissioners in 1893 and based upon railroad elevations and barometer readings. In rough country they are unsatisfactory. Unfortunately many of the errors in the contours of the older maps are more than the contour interval, hence it is possible that elevations estimated from these maps are inaccurate to an extent of 25 feet. In a few cases rough estimates of elevation are based upon railroad elevations of the neighboring stations. This is not done when any marked surface irregularity is known to be present.

The surface of the coal is somewhat more irregular than the contours indicate. There are local variations as great as 10 or 15 feet in the elevation of the coal that camot be shown because of the large contour interval. The interval is sufficiently large, also, to minimize the effect of slight errors in elevation to which the map is liable, at the same time it is sufficiently adequate to show the main structural features of the district. If a knowledge of the detailed structure of a small area is desired, more careful leveling, more numerous observations, and a map having a smaller contour interval is necessary.

The most accurately mapped area within the field is that of the La Salle and Hennepin quadrangles (see Plate I) where the contours on coal No. 2 are thought to be accurate everywhere within 10 feet. South of these quadrangles the companies who drilled the holes obtained accurate elevations for the prospects in T. 31 N., R. 1 W., and for a number of holes in the various townships in R. 2 W. In the vicinity of Streator the State Survey has obtained instrumental elevations of all the mines of coal No. 7 at the various brick and tile pits. and of a few drill holes. The flatness of the upland around Streator reduces the chance for great error in this area, however. All elevations within the Coal City-South Wilmington field are determined by estimate from topographic maps. This area is a plain, sloping gently toward Illinois River, and the changes in elevation are slight in any direction, so that the chances for error are not great. The same conditions hold in the Morris area. In the Cardiff field accurate elevation on a company datum had been determined for the various drill holes and shafts. These elevations were approximately adjusted to sea level and were incorporated in the map. The accuracy of the elevations of the various drill holes shown on the map (Pl. I) is indicated by the different patterns, as explained in the legend of the map.

Having determined at numerous points the elevation of the top of the coal, contour lines are drawn on the assumption that slopes between adjoining points of different elevations are uniform. An element of error enters here, which increases with the distance between points, for it is obvious that between two points of observation one-fourth of a mile apart, there is less chance for irregularities in the elevation of the coal than between points a mile apart. For this reason, the structure map as constructed, has been slightly modified to eliminate unnatural angles that would appear if the data employed were strictly followed.

Uses of the Structure Map

The primary purpose of the structure map (Plate I) is to show the structural features. The coal stratum slopes away or dips as shown by arrows from contour lines of higher elevation to those of lower. Remembering that the strata slope away from the anticline or upward fold, toward the east and west (see stereogram), and from the west side of the district toward the syncline or downward fold, the local relationship of structure can be readily determined.

In addition to the usefulness of the structure contour map in showing the lay of the coal, it can be used to determine the approximate depth of the coal bed. In case the depth of the coal is desired at some point crossed by a structure contour line, it can be readily calculated by subtracting the elevation shown on the contour line from the surface altitude. If the point lies between two contour lines, its relative distance from them is observed, and the elevation of the coal approximated accordingly, after which process the regular calculation can be made.

One of the special services of the coal structure map in Illinois has been to determine the possible areas of oil and gas accumulation. It has been found as a rule that structural features affecting the "Coal Measures" affect also the underlying rock to a considerable depth in the same way, though possibly to a greater or less degree. A relationship of areas of accumulation to anticlinal folds and domes is known to exist, and the fact that, at least in some places, domes in the coal strata indicate conditions favorable for oil and gas has given added value to structure contours on the coal beds.

There has been no adequate testing of this area for petroleum except indirectly by the deep water wells. These wells are located in many places in the Longwall District, many penetrating to the

Galena-Trenton limestone, several to the Lower Magnesian limestone, and three or four to the Potsdam or Cambrian sandstone. If oil or gas was discovered in these wells it was not in sufficient quantity to stimulate further drilling. The few oil prospects are not any deeper than many of the artesian wells and no more advantageously located. None are known to have been successful. It is reasonably certain that where these artesian wells are located oil or gas is not slikely to be found. Various apparently unsuccessful "wild-cat" explorations have been made within the area. These wells were located near the following places: southeast of Streator, and at Odell in Livingston County, at Minooka in Grundy County, at Lowell and Tonica in La Salle County, and at Tiskilwa in Bureau County. Others may have escaped notice. (For discussion of drift gas wells see page 57.)

LA SALLE ANTICLINE

DESCRIPTION

The La Salle anticline is the most conspicuous structural feature of northern Illinois. Its continuation into southeastern Illinois is marked by the oil and gas fields of Clark, Crawford, and Lawrence counties which are situated along its crest. The anticline crosses Illinois in a northwest-southeast direction, forming a broad arch along the Illinois-Wisconsin line. The fold is steeper and narrower, but well developed, between Oregon and Dixon in Ogle and Lee counties. Between Dixon and the La Salle region the fold is again broader, and the crest lower. Near La Salle and for a distance of about 10 miles the fold is sharp, and the west limb very short, being less than a mile in length. The crest of the arch, from which strata slope in all directions at various angles, seems to be about where it is crossed by Illinois Valley; thence to the south, as to the north, the fold pitches downward, and the crest becomes less and less sharp. Through Livingston County it seems to continue as a broad arch. Its character farther south is not well known until it reaches the main oil fields as a sharp anticlinal fold.

Within the area of the Longwall District, the anticline is best exposed along the Illinois and the two Vermilion rivers. The Illinois valley crosses the fold at a right angle, so that the entire thickness of the "Coal Measures", 125 feet of Galena-Trenton limestone, the entire thickness of St. Peter sandstone, and about 100 feet of the Lower Magnesian limestone is exposed within a distance of less than a mile along the north bluff of the river in the vicinity of Split Rock (NW. ¼ sec. 13, T. 33 N., R. 1. E.). Along Little Vermilion River similar sections passing from the Pennsylvanian through Galena-Trenton the Pennsylvanian through Galena-Trenton and the state of the pennsylvanian through Galena-Trenton the Pennsylvanian th

ton limestone, St. Peter sandstone, and into the Lower Magnesian limestone, can be found. Since the anticline pitches southward the sections exposed along Big Vermilion River do not include formations older than St. Peter sandstone, as at Deer Park. That the Lower Magnesian limestone is relatively close to the surface, however, is shown by drilling.

Our information in regard to the details of the structure has been considerably enhanced by the development in the Black Hollow mine of the Illinois Zinc Company, near Deer Park. The workings of this mine have been carried down the west limb of the fold practically from the top of the arch to the bottom of the trough. Observations on the dip have been taken constantly under the direction of Mr. J. A. Ede, Mining Engineer in charge, so that the structure of the coal bed at this place is very well known. The coal at the entrance of the slope has a dip of about 10 per cent (6°): for the first 1150 feet in the direction of slope the dip increases to 15 per cent (9°); in the next 200 feet it increases to 34 per cent (20°); in the next 100 feet to 71 per cent (37°); and in the next 250 feet to 100 per cent (45°). The physical changes in the coal resulting from the folding have been studied in considerable detail by Mr. Ede, and he reports a harder, more brittle, and a somewhat shattered coal on the flank of the fold than is found near the trough. The roof shale in the mine is much broken and difficult to control, and the floor is exceptionally liable to heave

Of special interest is a comparison of the structure of the surface rocks with that of the strata in the mine. The La Salle limestone is exposed along Vermilion River practically directly over the observations in the mine at the foot of the slope. It is apparent that the high dips which characterize the coal do not continue upward and affect all the overlying strata. It is not clear whether this is because there were two periods of folding, one during the Pennsylvanian period and one later, or whether it is because of the softer and incompetent character of the lower rock which would accordingly yield to minor folds that would not have a very great horizontal distribution. The fact that small faults cut the coal in the vicinity of the anticline, but apparently are not distributed throughout the measures as a whole, seems to indicate that the weaker strata were more severely affected by the folding than the more resistant layers, rather than that there were two periods of folding since the deposition of the coal.

The problems involved in mining coal in the Black Hollow mine where there are constantly changing conditions of dip, broken roof, and soft floor, are such as are not encountered elsewhere in the State. Exceedingly interesting mining methods have been put into practice in order to reach the bottom of the incline. These methods have been described to some extent by Mr. S. O. Andros in Bulletin 6, Mining Practice in District I.

The difficulties encountered in this mine are so well known that it is improbable that other mines will undertake the development of the coal under similar conditions, at least not until the value of the fuel has considerably increased. It is to be remembered, however, that the closeness of the fold probably decreases to the south, so that mines opened along the anticline in southern La Salle County would probably not encounter conditions so difficult as are found in the vicinity of La Salle.

HISTORY OF THE LA SALLE ANTICLINE

The anticline affects all exposed strata in the region older than the Pleistocene. Two periods of folding are evident, one pre-Pennsylvanian and the other post-Pennsylvanian. The pre-Pennsylvanian folding certainly took place after the deposition of the Galena-Trenton limestone, and probably before the deposition of the Maquoketa shale



Fig. 12. The unconformity between the Pennsylvanian series and the St. Peter sandstone at Split Rock. The dip of the Pennsylvanian (12 to 15 degrees) is shown by the ledge of sandstone outcropping under the stairs. The dip of the St. Peter sandstone (20 to 30 degrees) is shown in the strata in the foreground.

It seems to have been about contemporaneous with the arching of the Cincinnati anticline in Ohio, Indiana, and Kentucky.

The age of the post-Pennsylvanian and pre-Pleistocene folding is not known exactly. There is some doubtful evidence that there was movement during the Pennsylvanian. The greater angle of dip of the strata associated with coal No. 2 as compared with the strata of the upper part of the McLeansboro formation has been described. This, as has been said, may be due to another cause. There is also the



Fig. 13. Split Rock from the east showing the dipping St. Peter sandstone. The picture shown in Fig. 8 was taken at the west end of the tunnel shown in this picture.

difference in thickness of the Pennsylvanian series on the two sides of the anticline that is suggestive of movement after the deposition of coal No. 2 and before the deposition of coal No. 2. If the relative thinness of the "Coal Measures" to the east is due to elevation on that side of the anticline, the movement apparently occurred at about the time of the break or change in deposition which inaugurated the McLeansboro epoch.

Because of the pre-Pennsylvanian period of folding along the antiline, the "Coal Measures" overlie strata varying in age from the Niagaran limestone and possibly Devonian shale to Lower Magnesian limestone (see pages 19 to 23). As the older strata have been affected

^{*}Savage, T. E., Unpublished paper on the Maquoketa of Illinois, presented before Ill. Acad. Sciences, 1912. For a discussion of the age of the fold see also Cady, G. H. Geological sequence in the vicinity of La Salle as revealed by recent drilling: Trans. Ill. Acad. Sci., Vol. V. p. 87, 1912.

by two movements these strata show higher angles of dip along the fold. The "Coal Measures" at Split Rock dip 12 to 15 degrees, whereas the adjacent St. Peter sandstone slopes with twice that angle. Figure 12 shows the relationship of the "Coal Measures" to the older rocks. Figure 13 shows the character of the dip in the St. Peter sandstone.

TROUGH WEST OF THE ANTICLINE

Just as the crest of the anticline pitches to the north and south from the region of Oglesby and La Salle, the trough west of the fold becomes shallower in the same directions. The elevation of coal No. 2 in the various mines from La Salle south to Minonk reveals the character of the slope of the trough parallel to the anticline. At La Salle the coal has an altitude of 109 feet, at Oglesby 100 feet, at Wenona 123 feet, at Rutland 197 feet, and at Minonk 219 feet. Apparently the rise is slight as far south as Wenona, and from that point increases rapidly. Northward from La Salle the trough rises rapidly and practically loses its character about where the anticline crosses the La Salle-Bureau county line. Although there may be no causal relationship between the facts, it seems that the best coal No. 2 in the La Salle-Minonk field lies in the trough.

MINOR STRUCTURAL FEATURES

All the structural features not associated with the anticline are of minor importance as compared with the main fold. The greatest irregularities are found in the Coal City-South Wilmington region. Differences of 50 feet in the elevation of coal No. 2 within distances less than a mile have been encountered near Coal City (see page 73). The larger features of the structure include a domelike elevation on the west side, and a depression through the center of the field. The combined features resemble a wave in the general castward rise of the coal from an axis of low elevation that runs southward from Marseilles.

The beds near the western margin of the district like those near the eastern rise toward the outcrop. The rise between Depue and Bureau, if the correlations are correct, amounts to about 100 feet in 1½ miles. This area of steeper dip on the west edge of the district continues northward, but to the south the dip becomes gentler. It may be worth noting that the 300-foot contour line follows closely the Illinois Valley below the bend.

FAULTS

So far as the field in general is concerned no faults of importance are known. Displacements affecting the thickness of the coal have

been encountered in some of the mines, but fracturing of great thicknesses of strata does not seem to have taken place even along the La Salle anticline. Several small faults will be considered in the descriptions of the coal (see page 73).

GLACIATION IN THE LONGWALL DISTRICT

THE PRE-GLACIAL SURFACE AND THE THICKNESS OF THE DRIFT

Glaciation had a widespread effect upon this district. From the stereogram (Plate III) some idea of the thickness of the glacial deposits in different parts can be gained. Sufficient drift is present everywhere away from the streams to give the country a distinctly glacial topography. Hard rodes control the topography as a rule only where erosion has removed the glacial material along Illinois Valley and some of its tributaries.

Mine shafts except in the new, rock-bordered valleys, have usually been sunk through a considerable thickness of drift, some of which is very likely to be water-bearing gravel. In general it is true that where the surface elevation exceeds an altitude of 600 feet, drift is probably present. Where the La Salle limestone outcrops along the anticline, it reaches an altitude of 625 feet, as does the St. Peter sandstone and the Lower Magnesian limestone near the anticline; but these are unusual altitudes for the rock surface.

The pre-glacial surface has a relief of 250 to 300 feet and varies in altitude from about 650 feet near the anticline to about 350 feet



Fig. 14. Sketch map of Longwall District showing approximate position at pre-glacial valleys.

along the Illinois-Rock or Illinois-Mississippi valley. Leverett' has described the pre-glacial valley which ran north and south on the west side of this district. The center of the valley passes about under Princeton and Bureau in Bureau County, under Hennepin, Putnam County, and a little east of Lacon, Marshall County. The older valley then, although it ran in the same direction as the present Illinois below the bend, lay slightly to the east. Lateral valleys drained toward this pre-glacial stream on either side (see figure 14). One valley apparently extended east along a line running from Hennepin to north of Granville and Cedar Point, where two branches entered, one from the direction of Oglesby and another from the direction of Lowell. South of Cedar Point in sec. 8 the surface of the rock has an altitude of about 460 feet, and the drift has a thickness of 170 feet. This valley seems to lie about in the position of Allforks Creek as it runs from the east. There was a similar valley north of the present Illinois. running from the east between the present positions of Cherry and Ladd. It apparently started east of Little Vermilion River, since the Vermilion crosses it about two miles south of Troy Grove in secs. 10 and 11. Valleys tributary to these secondary valleys extended to the north and south, and some of them are now crossed by the present valleys. For instance, the Illinois crosses an old valley which drained to the south from the area just east of Spring Valley. The older valley is now filled with gravel and sand and till, but its cross-section is clearly shown, especially on the south bluff, by the shape of the glacial deposit. There are several interruptions in the continuity of the "Coal Measures" between La Salle and Marquette, where Illinois River crosses drift-filled valleys.

Eastward from the anticline these interruptions in the rock bluff above the river are rare. At Utica there is evidence of a pre-glacial valley along Clark Run north of town. This possibly is a continuation of the valley intersected by the Illinois north of Oglesby. Between Utica and Ottwa the rock seems to be continuous along the Illinois bluff. The drift at the end of Fox River Valley is thick, but does not extend below the river. The rock surface rises toward Marseilles and falls again to the east. At Seneca there is no rock in the river bluffs, but the "Coal Measures" are only a few feet below the surface upon which the town is located. Eastward toward Morris the topography is subdued but the rock surface rises somewhat in that direction. From Seneca southeast toward Mazon in Grundy County and southwest toward Kernan in La Salle County, the drift is thick, and the rock surface has a correspondingly low altitude. The direction and the position of the pre-glacial drainage lines have not been determined

Leverett, F., Illinois Glacial Lobe: U. S. Geol. Survey Mon. 38, p. 483, 1899.

for this area, but apparently the drainage was to the south into Livingston County. The elevation of the rock floor in the vicinity of Ransom is about 350 feet above sea level, as determined by a well on the farm of Ernest Pancake 2½ miles east of town. About 2 miles south of Mazon where the surface elevation is about 600 feet, 160 feet of glacial drift was encountered. In the intermediate area the drift is everywhere reported thick and the altitude of the rock very inconstant. Because of this fact the coal underlies the drift only in patches and has a very uncertain and irregular distribution. This strip of thick drift extends southward into Livingston County between Dwight and Streator.

In the Coal City field the coal outcrops to the north along the side of a pre-glacial valley that runs east and west, north of Carbon Hill. Some of the mines at the north end of the field have been made dangerous by beds of sand and gravel that reach the coal and are a source of quantities of water.

At Cardiff the drift is from 80 to 100 feet thick and obscures the very irregular distribution of the upper coal (No. 7). This bed is near the top of the "Coal Measures," however, and is apparently of no economic importance.

Mention has already been made of the pre-glacial valley that runs from near Lowelt loward the west. Upstream about three miles above Lowell a wide, drift-filled valley, the bottom of which has not been reached by the present stream, is crossed by the Vermillion (see stereogram, Plate III, and fig. 14). The bearing of this valley is not known, but if it follows a southwesterly course toward the Illinois, some of the coal beds must have been removed along its course. Where it crosses the Vermiliön, strata at the horizon of coal No. 7 have been removed, and possibly to a limited extent coal No. 2, though this is not certain. If the pre-glacial valley continues in a westerly direction the lower coal is almost certainly removed over the fold along the line of erossion.

Upstream from this locality through La Salle County the river bluffs are lined on one side or the other with rock. In the SE, cor. sc. 1, T. 30 N., R. 3 E., Livingston County, at the dam above the pumping station of the Streator Aqueduct Co., a thick filling of drift was noted in the valley.

In the vicinity of Sparland the Pennsylvanian rocks outcrop in the bluff above town, and the modern Illinois Valley apparently occupies the west side of the pre-glacial Rock-Illinois valley. Below Lacon and for several miles to the east, thick deposits of drift are the rule. In the explorations that have been carried on east of the Illinois in R. 2 W., the lowest altitude at which the surface of the rock has been encountered is 350 feet above sea level about two miles west of Granville. Several holes to the south indicate elevations varying from 367 to 400 feet for the surface of the rock. The east slope of the old valley seems to lie through the west side of R. I W., where elevations of the rock surface vary from about 450 on the west to about 525 and 550 on the east. At Toluca and Wenona the drift is about 100 feet thick, and the surface of the rock has an altitude of about 600 feet.

North of Illinois River in Grundy County the thickness of the drift varies considerably and increases for the most part toward the northwest.

For more detailed discussion of the drift in the various counties.

For more detailed discussion of the drift in the various counties, the reader is referred to Monograph XXXVIII, U. S. Geol. Survey.

GLACIAL TOPOGRAPHY OF THE LONGWALL DISTRICT

There are four conspicuous topographic features that are controlled by the drift or the modified drift: till plains, moraines, lake plains, and terraces. These have been described by Leverett in part, and in more detail, locally, in a folio on the La Salle-Hennepin quadrangles which is in preparation.

The upland surfaces are in general relatively flat or only gently rolling till plains. It is not unusual to hear the term "plateau" applied to the upland above the Illinois. A surface of conspicuous flatness surrounds the city of Streator, another borders the Chicago and Northwestern Railroad which runs north from Spring Valley. The surface is nearly level west of Fox River for six or eight miles.

Interrupting the continuity of these level tracts are several rather conspicuous, more or less concentric morainic ridges (see stereogram, Plate III). Along these ridges the drift is commonly thicker than elsewhere, and the surface material more largely clay than gravel and sand. The drift ridges or moraimes seem to have no relation in their distribution to the underlying rock surface.

The third type of glacial topography is that arising from combined lade and glacial action—the lake plains. The most conspicuous of these is the Morris Basin, surrounding the town of Morris and merging toward the southeast into a similar plain bordering Kankakee River and known as Lake Kankakee. Sand hills formed by blown sand are not uncommon on the east side of the Morris Basin and on the Kankakee Plain.

Along Illinois River below the bend at Bureau there are large gravel terraces of about uniform altitude, which represent valley filling at the time of one of the glacial advances. As these terraces lie above the preglacial valley, most of the surface deposits underlying them are thick, and extend down to an altitude of about 400 feet above sea level. Similar terraces, though on a much smaller scale, are found along practically all the streams of the district, at least as far east as the mouth of Fox River, and still farther up that stream. East of the bend on the Illinois the gravel is confined almost entirely to streams tributary to the major stream. These gravel deposits, especially below Bureau, are a very important source of road metal and ballast.

These four topographic features resulting from glacial action are the most conspicuous of the district. Since glacial time streams have cut more or less deep valleys into the plains and through the morainic ridges. The Illinois has been especially effective because of the large amount of water it received for a long time while it served as an outlet to the Great Lakes. The depth to which the Illinois has cut its valley increases greatly west of the La Salle anticline in the Pennsylvanian rocks. Recent exploration near La Salle by the Matthiessen and Hegeler Zinc Co. shows an extreme thickness of about 90 feet of alluvium in the flood plain south of the city. The depth seems to increase somewhat toward the anticline, as a thickness of about 130 feet has been reported about on the line of the fold. The rock floor of the valley from here rises very rapidly to a point about a mile east of Little Rock, where the channel of the present Illinois is cut into rock. We have no data on the depth of the alluvium in the flood plain of the Illinois between Peru and the bend at Bureau. Below that point it is impossible to distinguish between Illinois Valley alluvium and the material filling the pre-glacial valley.

CHARACTER OF THE DRIFT

There are two kinds of glacial deposits, till and stratified drift. The greater part of the area is covered with till, which is in most places a rather stiff clay containing stones scattered throughout, and commonly called "hardpan" by drillers. In this district there are tills of several glacial advances, the lower clays being as a rule somewhat harder than those above. A sudden increase in hardness of the "hardpan" in drilling operations is due commonly to the penetration of an older till. In many places the different tills are separated from one another by layers of gravel (see record p. 113). It must not be supposed that all the tills are present in each section of the drift, for the occurrence of each is very irregular.

Most of the stratified drift is concentrated along drainage lines. Old valleys are likely to contain considerable amounts of porous gravel interbedded with the till, as the area seems to have been affected by several advances of the ice each of which deposited its layer of gravel and till. Where the drift is thickest it is not uncommon to find several layers of till separated by beds of water-bearing gravel, and in places

even beds of black muck representing buried soils. In the vicinity of Princeton, Bureau County, a great many water wells that penetrate 100 to 300 feet of drift encounter beds of gravel that yield gas. The source of the gas is apparently the buried soils or mucks associated with the gravel. Drift wells that yield more or less gas are located also in the southern part of Grundy County near Kinsman, near Tonica in La Salle County, near Granville in Putnam County, and probably elsewhere.

From the preceding discussion it is obvious that the distribution of the glacial deposits has economic significance. Glaciation has concealed the outcrops of the important horizons so that their area is not readily ascertained; it has imposed a covering of till and stratified drift over the surface, the thickness of which depends somewhat on the type of the deposit; it has effectively concealed the position and direction of lines of pre-glacial drainage which have a marked control on the areas of the coal beds; and it has brought to the region great quantities of sand and gravel that are easy of access.

CHAPTER III—ECONOMIC GEOLOGY of COALS AND ACCOMPANYING STRATA

NAMES OF COAL BEDS

As designations for the Illinois coal beds, the State and Federal Surveys have in general preferred place names to numerals. Hence we have introduced for No. 7 coal, Danville coal; for No. 6 or the "blue-band" coal the local names, Herrin or Belleville coal; for coal No. 5, Springfield or Harrisburg coal; and for No. 2 coal, Murphysboro or La Salle coal. The place names have been selected because of the characteristic development of the coal bed in the locality indicated. Since the numerical system of nomenclature is more established, it has not been rejected by the State Survey in the various reports, and it will be used wherever greater clearness will result. It is the feeling that since most of the place names for Illinois coal beds are taken from towns not within the Longwall District, a consistent adherence to the numerical nomenclature throughout, with proper reference and correlations, should be the rule in this report.

DISTRIBUTION OF COALS

The coal beds of the Longwall District are at least 6 in number. These are No. 2, No. 5, No. 6, No. 7, the thick bed at Cardiff, and a local bed present in a small area in Livingston County southeast of Streator. In addition there are a few thin beds of little or no economic importance.

The bed most extensively mined is coal No. 2 which is everywhere worked by the longwall method. This coal is known at La
Salle as the "third-vein" and in the Coal City-South Wilmington field
as the Wilmington coal. This is the bed worked at La Salle, Spring
Valley, Ladd, Cherry, Seatonville, Marquette, Oglesby, Deer Park,
Granville, Cedar Point, Standard, Wenona, Rutland, Minonk, Toluca,
Eureka, Sparland (one mine), Streator (two mines), Morris, Coal
City, South Wilmington, and Cardiff. Coal No. 2 is thickest in the
trough west of the La Salle anticline and in the Coal City-South Wilmington field; elsewhere it becomes thinner toward the outcrop, especially in the vicinity of Bureau in Bureau County, and east of the
anticline and north of Illinois River. In this last-named area, besides
being thinner than elsewhere, the coal has a very thin roof so that it

is probably of no value commercially. Also south of Marseilles and Seneca, there is an area where the commercial recovery of the coal is rendered doubtful by its irregular distribution resulting from preglacial erosion. Over the rest of the Longwall District coal No. 2 is exceedingly regular and constant. It underlies about 1800 square milee

Coal No. 5 is confined to the La Salle-Minonk field but is not continuous. It has been worked somewhat in the La Salle region and is known locally as the "middle" or "second yein." The Matthiessen and Hegeler Zinc Co, is operating the only mine in this bed at present, though it is only since the Cherry disaster that the No. 5 coal bed was abandoned at the Cherry mine. Formerly it was worked at several of the shafts in the vicinity of La Salle among which are the shafts of Cahill Coal Co. and Oglesby Coal Co. This coal bed has an irregular distribution, and it is impossible to determine its total area with accuracy. Although the horizon of coal No. 5 is more widespread than that of coal No. 7, the lower coal itself is not present over considerable areas, so that it underlies an area less in extent than that underlain by coal No. 7, or about 500 square miles,

Coal No. 6 is present in the vicinity of Sparland. South from Sparland it becomes more important and reaches a workable thickness at Chillicothe. A thin coal bed, which in places combines with coal No. 7, is found at Streator, especially in the Kangley-Henanville field. This coal is known locally as No. 6, but it is very doubtful whether the correlation is correct. Coal No. 6 consequently is relatively unimportant in this district, and can practically be neglected in a consideration of the coal resources of the region.

Next to coal No. 2, coal No. 7 is the most widespread coal bed in the district. It is mined at Streator and Sparland, and was formerly worked in the La Salle field. This coal bed is known as the "Streator coal" at Streator, and as the "upper" or "first vein" at La Salle and Sparland. The area underlain by this coal is equal to about one-third that underlain by the lower coal, or 550 square miles.

In the vicinity of Cardiff there is an important bed of coal a few feet above coal No. 2, and it is known locally as the "thick vein". So far as known, the area underlain by this coal does not exceed 3 or 4 square miles.

Southeast of Streator in sec. 18, along Vermilion River a coal about 30 inches thick has been worked at local banks. This coal seems to lie 40 to 50 feet above coal No. 7 and below a bed which is possibly at the horizon of the Lonsdale limestone. The area underlain by this coal is not known, but it probably is small.

CORRELATION OF COALS

METHODS OF COPPELATION

The correlation of strata from place to place where the outcrops are discontinuous is accomplished by two methods. Of these two the paleontological method is the most convincing. The discovery that a certain fossil or association of fossils is characteristic of a certain hed makes it possible to identify the same bed elsewhere. The presence of a certain species of Fusuling in the limestone over coal No. 6, but not found in limestones associated with other coal beds, definitely identifies No. 6. The shale overlying coal No. 2 carries certain fossil plants which identify this horizon from Murphysboro to the La Salle region.1 Unfortunately our present knowledge of the "Coal Measures" does not warrant many such definite correlations, so that for the most part we are limited to the second method of correlation, or the comparison of the physical characteristics of the coal and associated strata, to identify the coals in the different fields. Similarity of interval between coal beds is an aid to correlation. Because of the relative uniformity in dip of the Illinois "Coal Measures" over large areas, identification of strata can commonly be made with reasonable correctness on the basis of similarity in elevation and thickness when points of observation are not separated by more than two or three miles. The greater the number of drillings the greater the safety in this method

Correlation of Coals of the Longwall District

COAL NO. 2

Coal No. 2 of the Longwall District is correlated with No. 2 of western counties and of the Jackson County area on the basis of plant fossils in the roof shale. The same bed is recognized under a different number in western Indiana. Within the district the coal and associated strata have fairly constant physical characters which are described in a later part of the chapter.

COAL NO. 5

So far as known coal No. 5 cannot be correlated over the State by means of fossils. In some areas but not in the northern district it has a rather constant interval below coal No. 6. In the western part of the Longwall District the coal lies from 150 to 206 feet above coal No. 2, and variations are shown in Table 2. "Horsebacks" or

³White, David (U. S. Geol. Survey), Paleontological Work in Illinois in 1908; Ill. State Geol. Survey, Bull. 14, p. 293, 1909.

clay veins in the coal resemble those in No. 5 of the Springfield area; the roof materials are also similar. The characters of the coal bed and accompanying roof and floor strata are described on later pages of this chapter.

COAL NO. 6

Coal No. 6 is the most readily correlated of all the coal beds in the State where it exists under normal conditions. It is called also the "blue-band" coal because of a thin bed of shale or clay 1/2 inch to 6 inches in thickness which lies in most places 12 to 18 inches from the base of the bed. Commonly also a limestone cap rock is found above the coal at intervals varying to a possible maximum of 15 to 20 feet. This limestone contains a species of Fusulina which in size and shape resembles a slender grain of wheat. The coal where typically developed averages 7 to 9 feet thick, has a top bench 12 to 36 inches thick, an intermediate bench, and a bench below the blue band. Coal No. 6 is not typically developed in the Longwall District. The coal described as No. 6 near Sparland has a limestone cap rock resembling that above coal No. 6 in the Peoria region and elsewhere in the State, but no Fusuling was found even after considerable search. The coal where observed was only about 2 feet thick, and there seemed to be no blue band. The only adequate reason for correlating this bed with No. 6 is its apparent continuity with the No. 6 coal at Chillicothe. The coal developed in small areas in the vicinity of Streator and in some places combined with the overlying coal No. 7. is thought to be local. Descriptions of No. 6 coal and accompanying strata are presented later.

COAL NO. 7

The correlation of coal No. 7 (Streator coal) in the Longwall District with coals similarly numbered in the Danville area and the Peoria region, is doubtful. It is the only thick bed in the McLeansboro formation as now defined. The usual means of identification of this coal in the Longwall District is not by physical characteristics, nor by fossils, but by its position 25 to 70 feet below the Lonsdale limestone. The interval is about 50 feet at Streator and in the La Salle-Minonk field. Apparently this limestone outcrops in Rocky Run near Tiskilwa and along Bureau Creek cast of Princeton.

The coal seems to vary so much even locally, that physical characteristics are of no service in identification. There is reason for believing that coal No. 7 represents, not a single widespread bed, but a number of beds distributed locally and lying at about the same horizon.

PHYSICAL CHARACTERISTICS AND DISTRIBUTION OF COALS AND ASSOCIATED STRATA

COAL No. 2

DISTRIBUTION AND THICKNESS

Coal No. 2 underlies approximately 1800 square miles of the Longwall District, and is or has been minable under 1200 to 1400 square miles. The coal varies in thickness from less than 1 foot to 54 inches, but in general is very regular. The average thickness in the La Salle region is 42 inches, and in the Coal City region about 37 inches. Between Deer Park and Ottawa the thickness ranges from 24 to 36 inches and northward along Fox River it dimnishes to less than a foot near the northern limit of the district. Thin coal also underlies areas in southern Bureau and in Puttame counties.

The thickest observed section is in the Oglesby mine, where the thickness is between 4 and 5 feet, but is due to overthrust faulting. In the adjacent Black, Hollow mine of the Illinois Zinc Co., unusual thicknesses have been encountered near the foot of the anticline.

PHYSICAL CHARACTERISTICS

Coal No. 2 is a long-grain coal, splitting most readily parallel to the bedding and having cleat everywhere poorly developed. The coal is relatively hard but brittle, the top coal being harder than that below, where there is any difference.

The coal bed is interrupted by thin layers, lenses, or balls of sulphur (pyrite or marcasite), mother coal, and dirt, and in places by bone coal. The bedded impurities do not make up a large percentage of the coal. In the La Salle region, at least, this is the cleanest of the three coal beds.

There follow a number of detailed observations made on the coal bed in the mines by K. D. White, of the Cooperative Mining Investigations, and other members of the Geological Survey.

OGLESBY COAL COMPANY

Section t, face, oth left off convict entry.—Thickness, 46 inches. Bed is about same in quality throughout except near bottom where it is softer and breaks into finer coal; the bed is only slightly banded. Coal is bright, medium hard, and the fracture sub-concloidal; texture is uniform. The few mother coal partings are compact and soil the fingers but slightly; coal contains considerable subplur mostly in bands, although balls are present irregularly; near the top of the bed the sulphur is mixed with calroin cours also mixed with calcule in veins roughly perpendicular to the bedding.

Section 2, 10th right, off convict entry.—Thickness 39 inches. Coal much purer than in section 1; very little sulphur; calcite in thin plates, with only a little sulphur. banded; makes large blocks. Coal hard and bright. There is sulphur mixed with the mother coal and carbonaceous dirt in lenses and bands throughout: calcite in veins exists in small amounts, and little or no sulphur is associated with it: mother coal partings are fairly sooty.

Two graphic sections of the coal in this mine are shown in figure 15 (Nos. 1 and 13).

LA SALLE COUNTY CARRON COAL CO. LA SALLE SHAFT

Section 1, 15th northeast, Rockwell.-Coal hard, bright, having hackley fracture and smooth texture. Contains some sulphur that is separated from the coal with difficulty.

Section 2, 14th east, 1st left north,-Thickness 41 inches. A portion of the bed has a banded appearance but the remainder presents a solid face: there is no regularity in the position of the handed portion. Coal very bright hard brittle, clean, save for sulphur bands and balls; sheets of calcite and sulphur along the cleavage planes give the coal a whitish appearance; the occurrence of the calcite is irregular; a band of sulphur balls which is persistent at this place, lies 21 inches from the top of the coal.

Graphic sections 10, 11 and 12, figure 15, are drawn from detailed measurements of the coal in this mine.

ILLINOIS ZINC COMPANY, BLACK HOLLOW MINE

Section 1, face, main slope,-Thickness 44 inches. The coal is solid, is not banded, and has about the same character from top to bottom. Coal strikes N. 17° W. and dips 30° southwest. Coal hard, bright, and brittle. Large amount of calcite and sulphur along faces; veins of calcite and sulphur traverse the bed at right angles to the din: bands of sulphur balls lie 16 and 18 inches from the bottom of the bed, but are in many places absent; bottom of coal is very clean.

General description,-Maximum thickness 48 inches; minimum 28 inches; average 39 inches. The coal occurs in two benches, the division being 13 inches from the top of the seam. The coal is harder at the top, is bright, blocky, with smooth texture. A clay 1/2 to 4 inches thick containing bands of pyrite, lies between the draw slate and the coal; this is absent when the coal is overlain by black slate; it is "frozen" to the coal and brings the draw slate with the coal. Veinlets of calcite and sulphur occur irregularly.

Section 1, main east entry.-Thickness 37 inches. Top 13 inches bright. clean, solid, blocky, and not banded; lower coal slightly banded. Top 13 inches contains very little mother coal and small amount of calcite: mother coal parting 13 inches from top; bands of mother coal are numerous in lower part of bed and in places are filled with sulphur; sulphur band 6 inches from bottom is fairly persistent. Cleat is poorly developed.

Section 2, 2d left, off main east entry.-Thickness 41 inches. Coal generally similar to that observed at section 1. Partings 13 inches from the top and 6 inches from the bottom; middle of the bed has several bands of sulphur and mother coal; a few vertical streaks of sulphur are present,

For a graphic section of the coal in this mine see figure 15. No. 15.

ST. PAUL COAL CO., CHERRY MINE, CHERRY,

Coal varies from 52 inches to 24 inches, with an average thickness of 42 inches.

Section 1, main west entry.—Thickness 43 inches. Upper foot of the coal solid, not banded. Parting lies 13 inches from the top; 16 inches from the top occurs a mixture of 4 inches of sulphur and coal, which is discarded in mining; the lower 2 feet of the bed contains calcite plates, though not in large amount. For a rearbite section of the coal in the mine, see figure 15. No. 14.

MARQUETTE THIRD VEIN COAL CO., MARQUETTE MINE, MARQUETTE

Maximum thickness 48 inches; minimum, 38 inches; average 40 inches.

Section 1, face, 7th west, south entry—The coal is hard and britte, and cleat is poorly developed. There are a few layers of bone and mother coal; the sulphur occurs in balls, few in number, easily separated from the coal; calcite is found in vertical veins about 1 inch thick and in small amounts along the faces.

WENONA COAL CO., WENONA

Maximum thickness 48 inches; minimum, 38 inches; average 40 inches. Section 1, face, straight west outry—Thickness 45 inches. Coal is hard, solid toward the top, slightly banded near the bottom; the edges of the fractures are sharp. Cleat north 47° west is strongly developed. There is considerable mother coal near the bottom, making that part of the bed rather soft; sulphur exists in small balls and calcite lies along cleavage planes.

Section 2, 27th north, 3d east entry.—Thickness 38 inches. The coal is solid, hard, and brittle; the fracture is slightly conchoidal; cleat is poorly developed. Calcite occurs in veins throughout the bed.

WILMINGTON STAR COAL CO., MINE NO. 7, COAL CITY

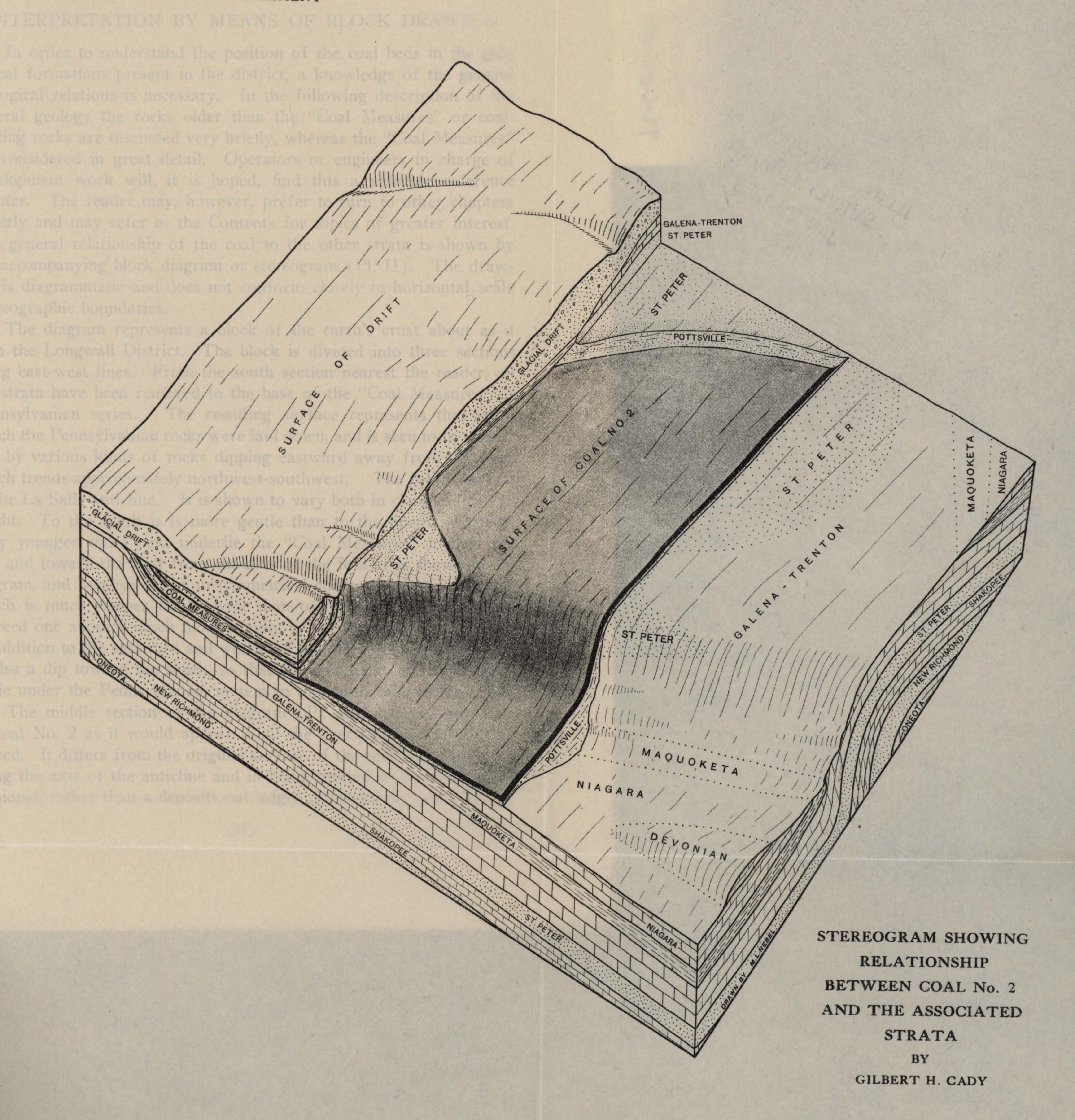
Section 1, face, 7th weat, routh entry—The coal is hard and brittle, and cleat the tection process is harder than the bottom and in most places is brighter. The cleat is poorly and irregularly developed. The coal shoots into good-sized blocks. There is very little calcite present; near the middle of the bed there is a band of mother coal and sulphur in parts of the mine.

CHICAGO, WILMINGTON, AND VERMILION COAL CO., MINE NO. I, SOUTH WILMINGTON


Maximum thickness 39 inches; minimum 36 inches; average 37 inches. Section 1, face, main southeast heading—Thickness 38 inches. Coal hard and brittle, fracture slightly concloids]; the bed is solid and not laminated; the coal is in general similar from top to bottom. Impurities are mother coal in streaks and bands, sulphur in balls and lenses; the sulphur "freezes" to the coal but is separated in mining. The middle 8 inches of the bed 13 inches from the top contains the most of the impurities and seems to be a little softer than the remainder.

TOLUCA COAL CO., TOLUCA

Maximum thickness 40 inches; minimum 26 inches; average 34 inches. Section 1, face, main west entry.—Thickness 35 inches. Coal brittle, cleavage irregular; the coal is slightly banded near the bottom. The top 6 inches of coal is especially bright. Calcite occurs in small amount in wertical veins about 12 inches apart, and in thin plates throughout the bed; sulphur occurs

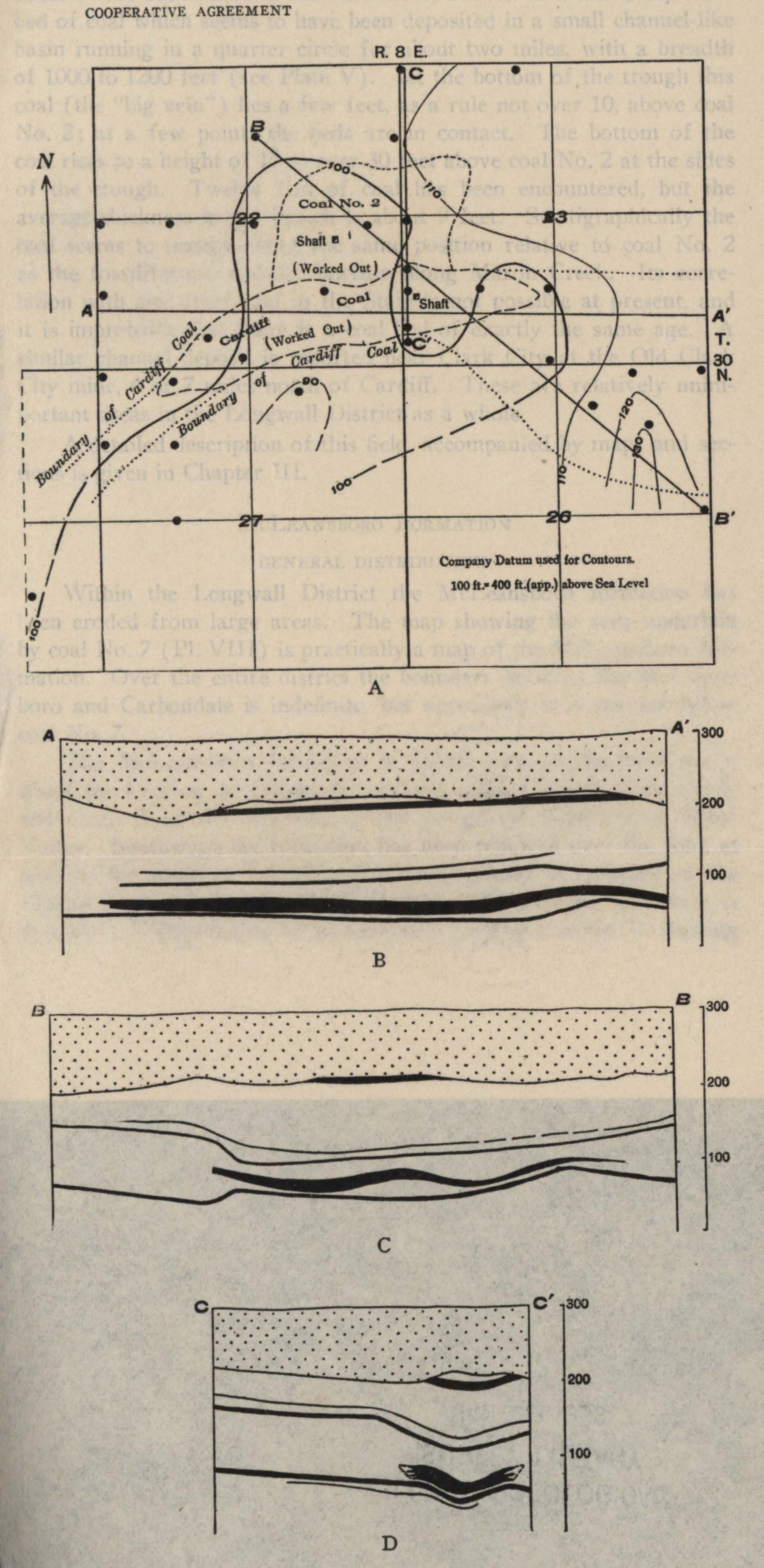


CHEST SHAND COUNTY

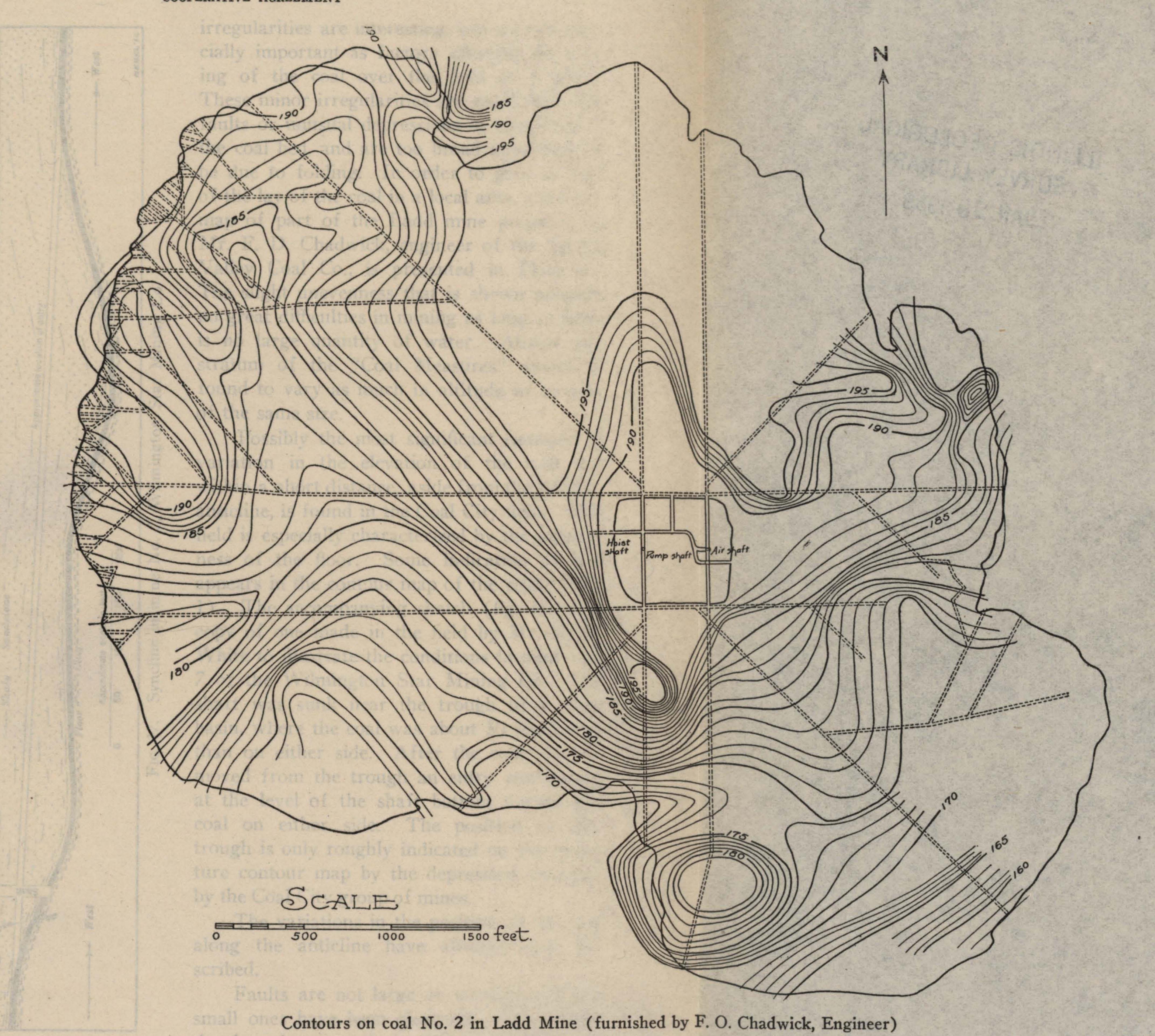


ILLINOIS COAL MINING INVESTIGATIONS BULL. NO. 10, PLATE V

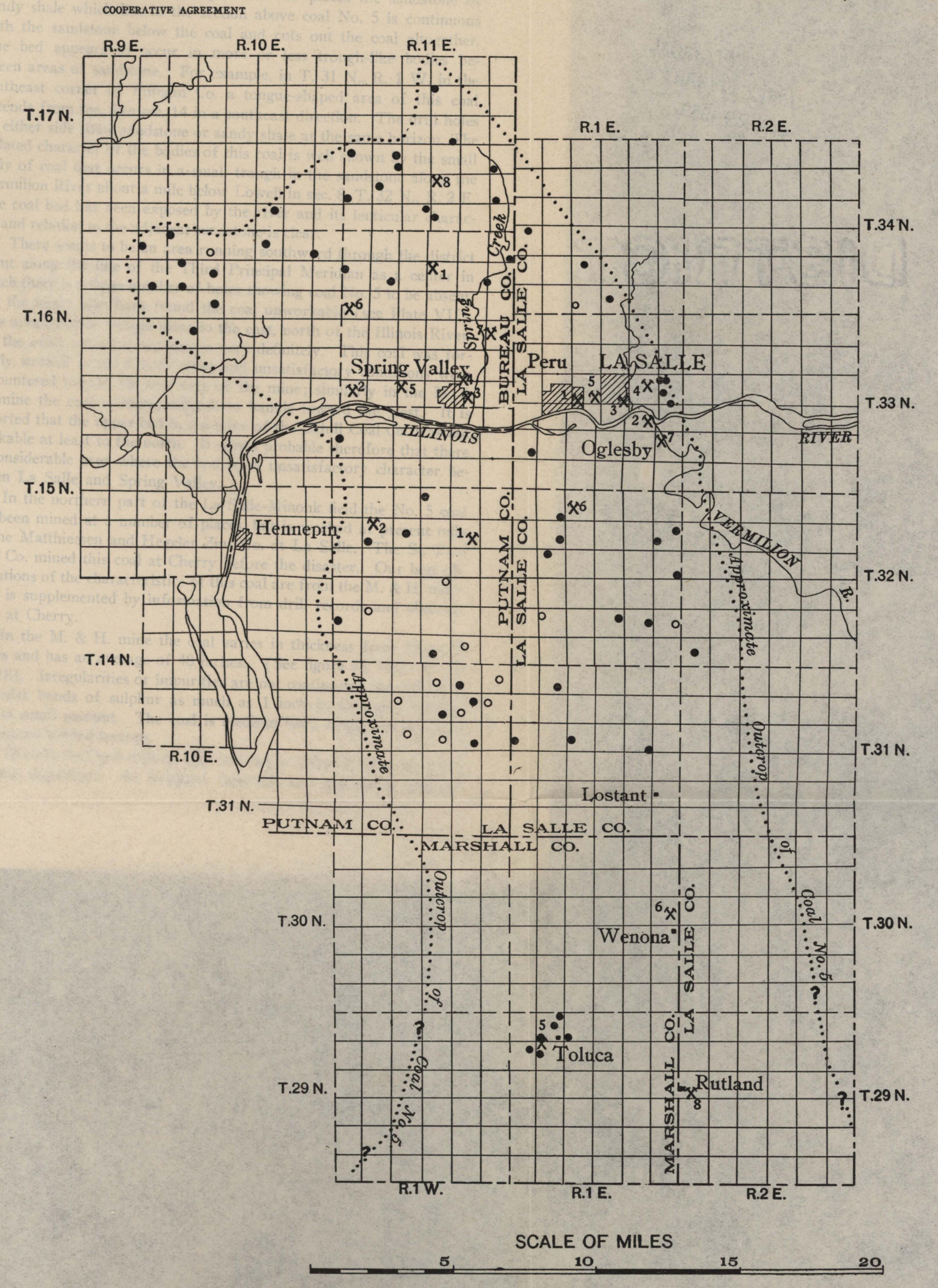
which that region is famous.

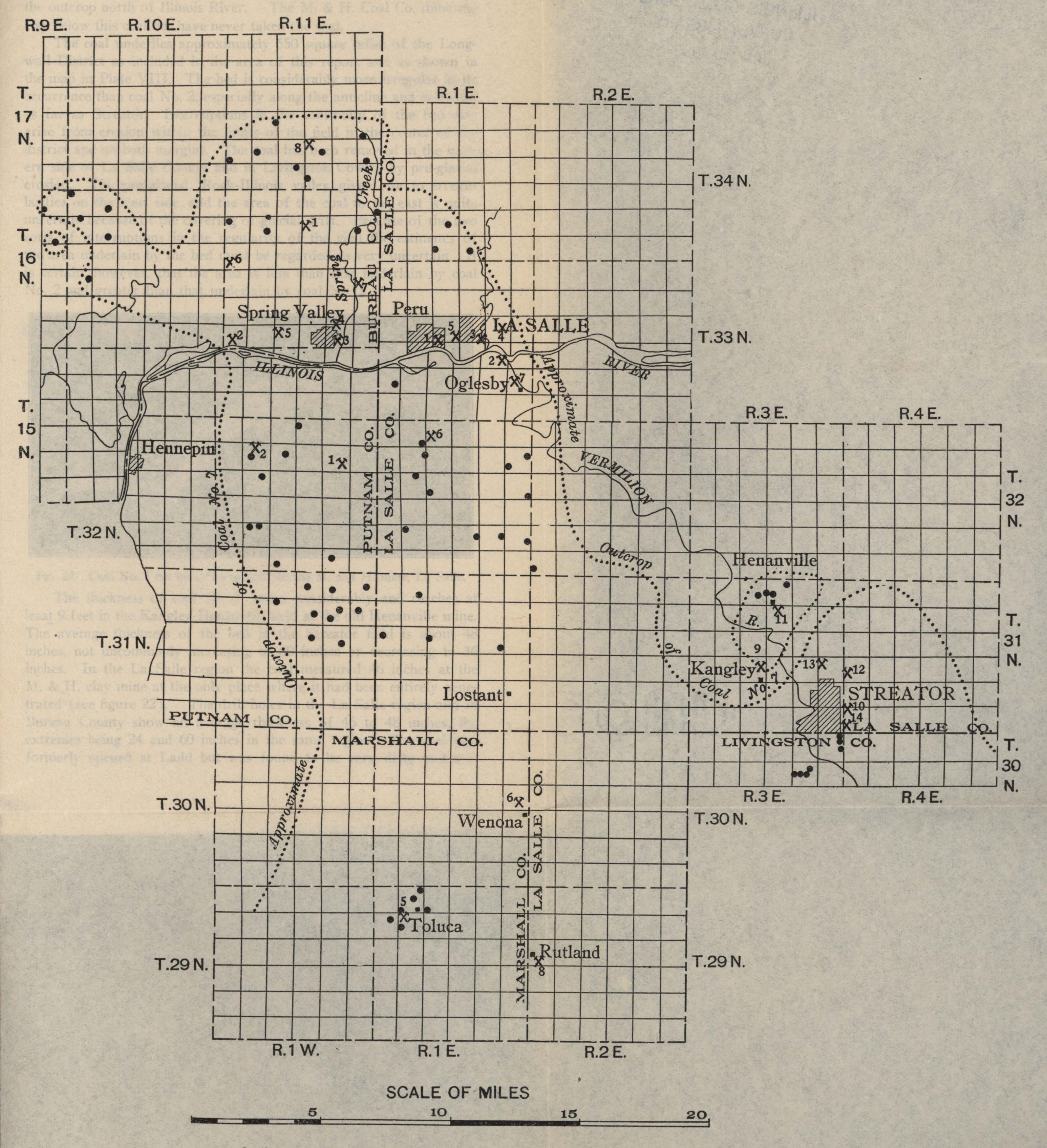


Map and cross-sections of the Cardiff field. Contours in A are on Coal No. 2



cause the coal is stat everywhere present west of the anticline.





Outline map showing area underlain by coal No. 7 in the western part of the Longwall District

