THE FAYETTE GAS FIELD, ALABAMA.

By M. J. MUNN.

INTRODUCTION.

LOCATION AND HISTORY OF THE FIELD.

A diamond-drill hole was put down about 2 miles east of the town of Fayette, Fayette County, Ala., in the early part of 1909, in search of coal. This hole, which is located at the present site of Gas Wells station on the Southern Railway, reached a depth of about 475 feet and encountered two or more sands that furnished small quantities of oil. This led to the drilling of two deep test wells, for oil and gas, adjacent to the diamond-drill hole. On December 20, 1909, one of these wells encountered a gas-bearing sand at a depth of 1,400 to 1,420 feet and began producing gas at an estimated rate of 1,600,000 cubic feet a day, the gas having a closed pressure of about 630 pounds to the square inch. This well was drilled by the Eureka Co., which was afterward merged with the Providence Oil & Gas Co., and the well is now known as Providence well No. 1. The other test well, located about 30 yards from the diamond-drill hole, was sunk by the Providence Oil & Gas Co. to a depth of about 1,685 feet. It is reported to have encountered oil and gas in small quantities at several horizons, but the well was a failure.

Shortly after the completion of Providence well No. 1 several other wells were started. One of these, known as Providence well No. 8, reached the sand March 1, 1910, and began producing gas at a rate estimated to be 4,500,000 cubic feet a day. This is said to be the best well in the Fayette gas field. Providence well No. 6 was completed about April 15, 1910, finding gas in paying quantities. The initial capacity and the closed pressure of this well are not known to the writer. Its daily capacity has been estimated at between two and three million cubic feet, and at present (December, 1910) the closed pressure is said to be about 580 pounds to the square inch. Providence well No. 3, located about half a mile from the railway station at Fayette, was completed in April, 1910, to a depth of about 2,200 feet. Aside from several "shows" of oil and gas this well is reported to have furnished an initial flow of about 150,000 cubic feet of gas from a depth of about 1,400 feet. The well was abandoned. Providence well No. 9 was completed about June 1, 1910, with a

reported daily capacity of about 800,000 cubic feet. This well is said to have furnished salt water from the gas-bearing sand, as does Providence well No. 10, which was drilled later. The latter is said to have furnished a strong flow of gas until shot with 80 quarts of nitroglycerine, after which the salt water increased so much in quantity and head that it greatly reduced the capacity of the well. Four wells within a few thousand feet of the center of the gas field and six others at distances of 1 to 20 miles from it had been drilled to various depths, or were being drilled at the time of the writer's last visit, December 8, 1910. At that time none of these wells were producing oil or gas in commercial quantities.

SCOPE AND PURPOSE OF THE WORK.

In this paper are discussed very briefly the general geologic conditions in and around the Fayette gas field, so far as they are known, the material contained herein being a summary of a more detailed report prepared by the writer under a cooperative agreement between the United States Geological Survey and the Alabama Geological Survey, by which each organization contributed funds for the field work and the Alabama Survey published the results as a State report.

As this area had not been topographically mapped, one of the chief objects of this work was to prepare a good base map suitable for the use of both the geologist and the oil producer. It was also desired to make a preliminary study of the geologic structure of the rocks of the gas field and vicinity for the purpose of determining the nature and extent of the folds in the strata and of ascertaining if geologic work of value to the oil and gas producers could be done in advance of the drill.

Field work for the topographic map was done between October 1, 1910, and February, 1911, by R. H. Reineck, assisted by J. M. Rawls, both of the United States Geological Survey.

Geologic work was carried on by the writer from October 9 to December 9, 1910. The lack of a suitable base map at the beginning of the work made it necessary for him to run stadia traverse and level lines over much of the eastern quarter of the area. These lines were carried over most of the roads and to all points in the interior where rock outcrops were to be found. The dip of exposed beds was determined principally by level lines along their outcrops.

ACKNOWLEDGMENTS.

The field work on which this report was based was done under the general direction of Dr. Eugene A. Smith, State geologist of Alabama, and Mr. David White, of the United States Geological Survey, to whom the writer is indebted for many suggestions. To Mr. Charles Butts, of the United States Geological Survey, and Dr. William F. Prouty, of the University of Alabama, he is also indebted for data

used in the tentative correlation of the rocks of this region. Maps and field notes made by Dr. Prouty in this district were consulted during the progress of the work, especially in the interpretation of geologic structure. The writer is also indebted to Mr. S. A. Hobson, geologist, for the detailed logs of the wells of the Providence Oil & Gas Co.; to Mr. F. Harley Davis, president of the Davis Drill Co., for a core-drill record of Cosmos well No. 1 and for courtesies shown to the writer and his assistants in the field; to Prof. W. O. Crosby, of the Massachusetts Institute of Technology, for his classification of the rocks in the core of the Cosmos well; to Mr. H. G. May, superintendent of the Alabama Central Oil & Gas Co.; to Mr. W. W. Silk, fiscal agent of the Five Rivers Oil & Gas Co., Mr. J. F. Moore, the Minge Mortage & Realty Co., of Birmingham, and others for records of wells, and to many citizens of the town of Fayette and the surrounding country for their uniformly courteous and considerate assistance.

GEOLOGY.

GENERAL CONDITIONS.

The Fayette gas field is situated in the western part of the Warrior coal field. The country is one of relatively low relief and the larger streams are sluggish, meandering across broad alluvium-covered valleys. The hills, which rise from 100 to 200 feet above the principal streams, are deeply dissected

The outcropping rocks in the northeastern part of the Warrior coal field belong to the Pennsylvanian series ("Coal Measures") and are of Pottsville age. In the western and southwestern parts, adjacent to the Fayette gas field, these beds are mantled by unconsolidated sand, gravel, and clay of Cretaceous and younger age which rest unconformably upon the coal-bearing rocks. The northeastern extent of the Cretaceous beds marks approximately the shore line of a great arm of the sea which during this period covered a large part of what is now the Atlantic and Gulf Coastal Plain. Over the Warrior coal field the unconsolidated beds are thinnest along their northeastern border. The plane of contact between the Carboniferous and the overlying Cretaceous beds dips to the southwest at a low angle and consequently the Cretaceous rocks are thicker in that direction. The southwestward extent of the coal-bearing rocks in the Warrior field is unknown, for in that part of the field the plane of contact between them and the Cretaceous lies far below the deepest valleys and very few deep wells have been drilled to it, but inasmuch as most of the coal-bearing series is present at the Cretaceous margin in the vicinity of Fayette, it is highly probable that the Carboniferous rocks extend far to the southwest under the Cretaceous and Tertiary formations of the Coastal Plain. The general areal distribution of the formations is shown on figure 1.

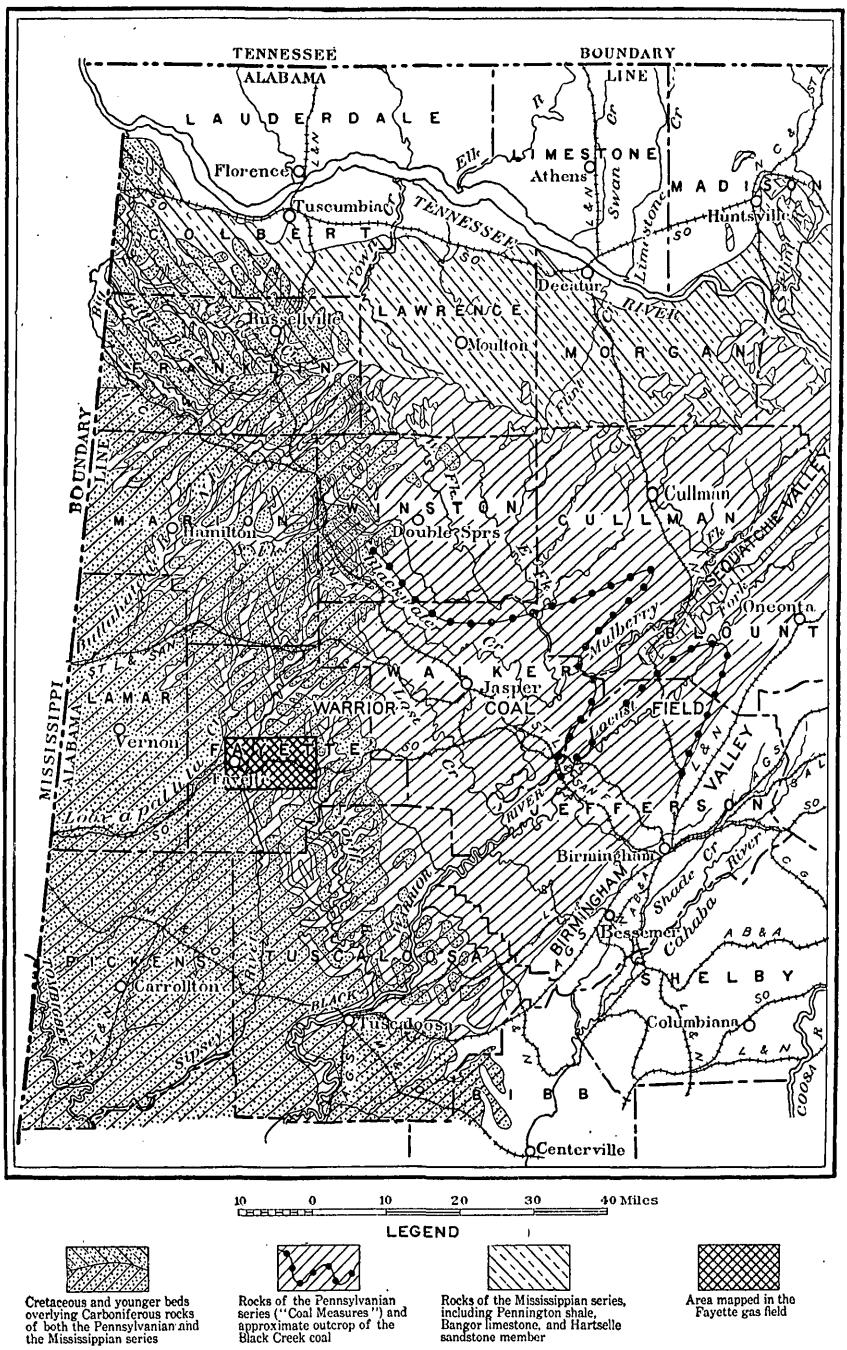

FIGURE 1.—Sketch map of northwestern Alabama, showing location of area mapped in the Fayette gas field, the general structure of the region, and the northern and eastern extent of the Pennsylvanian series, in which the gas is found.

The Fayette gas field is located at a point where the plane of contact between the Carboniferous and Cretaceous rocks is at or just below the valleys of the streams, the Carboniferous beds being exposed at rare intervals in narrow strips along the base of valley walls, and the unconsolidated Cretaceous rocks covering the hills to a maximum depth of about 300 feet. As no oil or gas has yet been found in the Cretaceous beds of the Warrior field, little attention was given to them in this examination. The sandstone furnishing the large flows of gas belongs to the lower part of the Pennsylvanian series, and the study was therefore more immediately concerned with the general distribution of this and the underlying formations which may contain valuable accumulations of oil and gas in the Warrior field

STRATIGRAPHY.

WARRIOR COAL FIELD.

Our knowledge of the stratigraphy and structure of the greater part of the Warrior coal field in Alabama rests on the work of Henry McCalley, whose last paper is a report on the Warrior coal basin, published by the Geological Survey of Alabama in 1900.[1] Although McCalley's field examinations were made without the aid of topographic base maps and with meager facilities for precise work, his large map, which extends to the Fayette district, has, so far as tested by later and more detailed observations, revealed a high degree of accuracy and value and is the best and most reliable source of information regarding the greater part of the region. The subdivisions of the coal measures given in McCalley's text and map have been adopted by Butts in the Birmingham folio [2] and are employed in the present report.

The rocks not exposed at the surface in the Fayette gas field have been studied to a small extent in well sections to a maximum depth of about 2,350 feet, below which no well has yet penetrated. The possibility that there may be lower strata favorable in composition for the accumulation of oil and gas is of importance to those interested in the development of the field.

The nearest exposures of formations underlying the Pennsylvanian series are along Birmingham and Sequatchie valleys, to the east and northeast. On the west side of Birmingham Valley the rocks have been upturned and faulted in such a manner as to expose thousands of feet of strata which extend westward under the Warrior coal field to an unknown depth. The nature of these rocks is shown by the

[1] See also a report on the geology of the Warrior coal field published by the Geological Survey of Alabama in 1886.

[2] No. 175, Geol. Atlas U. S., U. S. Geol. Survey, 1911.

generalized sections on Plate V, and they have been described by Charles Butts,[1] as well as by the writer in the more detailed report on the Fayette gas field, published by the Alabama Geological Survey. They require no further treatment herein than that given on the following pages.

UNEXPOSED ROCKS IN THE FAYETTE DISTRICT.

GENERAL STATEMENT.

The character and thickness of the rocks underlying the surface of the Fayette district are not well known. A few facts relative to them have been obtained by a study of some of the upper beds at places where they outcrop in this district and adjacent to it, but by far the larger part of the present knowledge of them has been obtained from the logs of deep wells drilled in search of oil, gas, or coal. The logs of wells that have been obtained have been platted to scale and arranged on Plate V with reference to their geographic position and the height of the mouth of each well above sea level.

A careful study of Plate V will make evident the fact that logs of churn drills can not be relied on for detailed correlations for the reason that in drilling by this method only the well-marked changes in the beds can be detected with certainty even by trained observers, and therefore only the general character and sequence of the beds can be used as guides in correlation, the valuable paleontologic evidence furnished by the fossils contained in the beds being destroyed. Unfortunately, core drills have not yet penetrated the rocks of this district to a sufficient depth to furnish the paleontologic data so much needed. The greatest single source of error in making correlations from churn-drill logs lies in the fact that drillers have no uniform system of identifying and naming the rocks which they encounter. Each driller names the pulverized material brought up by the bailer according to his own standards. Errors in making and in noting measurements to the strata encountered and failure to detect the presence of thin coal beds, especially if they are encountered in soft black shale, also tend to render less valuable the use of well logs in correlating rocks of widely separated districts.

PENNSYLVANIAN SERIES.

POTTSVILLE FORMATION.

With the exception of a comparatively thin covering of sand, clay, and gravel, of Cretaceous and later age, the rocks penetrated by the drill in the Fayette district appear to belong entirely to the Pottsville

[1] Bull. U. S. Geol. Survey No. 400, 1910; Birmingham folio (No. 175), Geol. Atlas U. S., U. S. Geol. Survey, 1911.

formation. This conclusion is based largely on a comparison of the coal beds and prominent beds of sandstone of the well sections with the Pottsville formation where it is exposed on the eastern edge of the Warrior field. (See Pl. V.)

Correlation of coal beds of the well sections.—In well section F, Plate V, 10 coal beds have been reported which appear to fall into groups similar to those of the generalized section of the Pottsville formation, shown on the same plate. By assuming that there is a general decrease in thickness of the Pottsville westward from Birmingham Valley, which is generally thought to be probable, the most prominent group of coal beds in well section F, composed of beds Nos. 28, 30, 32, and 34, appear to correspond somewhat closely with the Mary Lee coal group of the generalized section. On this basis of comparison the lowest of this group, No. 34, may be equivalent to the Ream bed, either No. 32 or No. 30 may be the Jaggar bed, and No. 28 may be either the Blue Creek or the Mary Lee bed. The fact that a fairly persistent sandstone separates the Blue Creek and Mary Lee beds in the generalized section, together with the distance between the beds, suggests that No. 28 is more nearly equivalent to the Blue Creek bed. If this is true, coal No. 19 in well section H, which overlies a sandstone, may be the Mary Lee bed, in which case the Newcastle coal, if present, has not been recorded in the well sections.

Below this coal group in well section F occur two coal beds, Nos. 38 and 42, which are comparable, respectively, to the Lick Creek and Black Creek beds of the Black Creek coal group. The distance between these two beds in well section F and in the generalized section are practically the same. The interval from the Black Creek coal to the Sapp coal in the eastern part of the Warrior field averages about 230 feet, in comparison with that of 160 feet between what is assumed to be the Black Creek coal and the next one below (No. 49) in well section F, thus leaving the identification of the latter in considerable doubt.

In the generalized section the Pratt group of five coal beds occupies an interval of about 130 feet and lies 300 to 430 feet above the top of the Mary Lee coal group. In well section F two coal beds, Nos. 13 and 20, occupy an interval of 130 feet at a distance of 300 to 430 feet above the four coal beds of this section, and appear to be comparable in part at least to the Mary Lee group. These also appear to be the same as coal beds Nos. 12 and 17, respectively, of well section C, and possibly beds Nos. 7 and 11 of section A. Unfortunately the record of the upper 475 feet of section F is not available, nor is the section of the Brennen core-drill hole, located a few feet distant from Providence well No. 5. The few scattered coal beds reported in the upper parts of the wells are doubtfully correlated as stated below.

SECTIONS OF DEEP WELLS IN THE FAYETTE DISTRICT, ALABAMA

SCALE 160 FEET=1 INCH

A
ALABAMA CENTRAL OIL AND GAS CO.
FREEMAN WELL NO. 1
Above sea level 466 feet.

Driller's record
1. Cretaceous sand
2. Black slate
3. "Broken lime"
4. Black slate
5. Coal
6. "Slate and shale"
7. Coal
8. Fire clay
9. Sand
10. Slate
11. Coal
12. Fire clay
13. Sand, dark
14. Broken lime
15. Black slate
16. Lime, shale
17. Sand, show of oil 10 feet from top
18. "Black shale"
19. Sand, show of oil 5 feet from top
20. Broken lime
21. Black slate
22. Sand, gas and show of oil 10 feet from top
23. "Slate and shale"
24. Black slate
25. Sand, good show of gas 90 feet from top
26. Black slate
27. Sand, show of gas in bottom
28. Black slate
29. Sand
30. Black slate
31. Sand, large amount of salt water about 145 feet from top
32. Shale 3 feet
33. Coal 4 feet
34. Sandstone
(Well not completed)

SEA LEVEL

B
ALABAMA CENTRAL OIL AND GAS CO.
WOODS WELL NO. 1
Above sea level 406 feet

Driller's record
1. Soil
2. Sand and shale
3. Black shale
4. Soft black shale
5. Fire clay and "slate"
6. Sandstone "conglomerate"
7. Sandy grayish shale
8. Sand
9. Shales
10. Argillaceous sandy shales
11. Saturated chocolate sandstone with streaks of gray; gas; sandstone and argillaceous shale
12. Coal (no fire clay)
13. Gray sandstone gradually developing gas
14. White sand, strong flow of salt water completely drowning out the gas
15. Argillaceous shale full of shell fragments
16. Dark saturated sandstone
17. Coal and fire clay
18. Slightly saturated sandstone
19. Argillaceous shale
20. Argillaceous shale with several thick ledges of extremely hard, slightly saturated sandstone
21. Record not kept for next 90 or 100 feet, owing to presence of driller, but supposed to be irregular alternations of shales and sandstones. Drilling discontinued about 1265 feet

SEA LEVEL

C
PROVIDENCE WELL NO. 4
Above sea level 396 feet.

Driller's record
1. Massive sandstone; weathered soft, loaded, pulverulent, grown hard and gray at 40 feet and shaly at 50 feet showing fresh water about 60 feet
2. Fire clay
3. Irregular alternations of argillaceous and semi-argillaceous shale with extraordinary amount of unlocated fire clay (whether separate seams or slough-off from above undetermined)
4. Coal and much fire clay
5. Argillaceous and sandy shales
6. Massive gray sandstone; some coal
7. Argillaceous shale
8. Light-colored, slightly saturated sandstone
9. Shales
10. Argillaceous sandy shales
11. Saturated chocolate sandstone with streaks of gray; gas; sandstone and argillaceous shale
12. Coal (no fire clay)
13. Gray sandstone gradually developing gas
14. White sand, strong flow of salt water completely drowning out the gas
15. Argillaceous shale full of shell fragments
16. Dark saturated sandstone
17. Coal and fire clay
18. Slightly saturated sandstone
19. Argillaceous shale
20. Argillaceous shale with several thick ledges of extremely hard, slightly saturated sandstone

D
PROVIDENCE WELL NO. 2
Above sea level 393 feet.

Drillers record
1. Soil
2. Sandstone
3. Bluish argillaceous shale with irregularly sandy, friable, or semi-pulverulent strata
4. Dark argillaceous shale with many aquatic shell fragments
5. Coal and fire clay
6. Rather coarse sandstone growing gradually massive and finer-grained
7. Argillaceous and semi-argillaceous shale with occasional ledges of fine-grained, light gray to whitish sandstone
8. Sandstone slightly saturated (with oil)
9. Irregular alternations of argillaceous and semi-argillaceous shale and shaly sandstone
10. Semi-cannel coal (greased at)
11. Shaly sandstone and fire clay
12. Argillaceous and semi-argillaceous shale with unlocated fire clay
13. Irregular alternations of argillaceous and sandy shales and shaly sandstones
14. Argillaceous shale
15. Light-colored saturated sandstone
16. Argillaceous and semi-argillaceous shale
17. Fine-grained grayish sandstone
18. Argillaceous and gritty shale
19. Gray sandstone
20. Argillaceous and semi-argillaceous shale
21. Tight-grained sandstone
22. Irregular alternations of sandstone and shale (mainly shale)
23. Sand
24. Shale
25. Sand
26. Shale
27. Sand
28. Shale
29. Sand
30. Argillaceous shales with several thick ledges of sandstone
31. Sandstone growing whiter and developing strong flow of slightly salt water. (Tools lost in well and abandoned.) Last item guessed at as to thickness

E
COSMOS WELL NO. 1
(CORE DRILL)
Above sea level 223 feet.

Driller's record
1. Sand, Cretaceous
2. Clay, Cretaceous
3. Alternating gray micaceous sandstone and shale
Mainly finely banded, and both sandstone and shale very uniform
4. Light-colored micaceous shale, with many thin bands of the gray micaceous sandstone
5. Dark-gray shale; no sandstone; very soft and shaly
6. Massive green shale. Brown at top, grades down into fine, greenish-gray micaceous sandstone. Only 2 feet of true shale and that contains much mica
7. Fine gray micaceous sandstone
8. Massive brown sandstone. Saturated with oil in part; highly micaceous. Near bottom is a small vein of coal
9. Alternating gray micaceous sandstone and shale. Finely banded and highly micaceous
10. Light and dark gray shale. Becomes darker downward. A few clay ironstone nodules in lower part. Abundant fossil plants
11. Massive greenish shale. Brown (by oxidation) at top. Grades downward into sandstone. Some fossil plants
12. Massive gray micaceous sandstone
13. Massive, very coarse micaceous brown sandstone. Impregnated with oil
14. Gray micaceous sandstone. Some shaly layers
15. Alternating sandstone and shale. Shale increases downward
16. Dark-gray to black shale. Very soft and free from grit. Slickensided throughout, with many minute faults. Some sandstone streaks and at bottom very dense and hard sandstone
Dark argillaceous shale 13.
Fine-grained gray sandstone 13.
Coal 15.
Same sandstone 14.
Fire clay, some argillaceous 16.
shale, and much fine-grained dark-to-gray micaceous sandstone
Same sandstone, grown massive, with small darkish, carbonaceous-looking inclusions 17.
Gritty, semi-argillaceous shale 19.
Coal and fire clay 20.

F
PROVIDENCE WELL NO. 5
Above sea level 283 feet.

Driller's record

NOTES: Located about 30 yards northeast of Brennan's diamond-drill hole, which reached a depth of 472 feet. The record of this well was not kept above 475 feet

From 35 to 75 feet strong stream fresh water occurring in thin interstrata of porous, soft, pulverulent, shaly sandstone

First oil sand probably struck about 225 feet, continuing to about 270 feet, seemingly saturated but giving no flow into the hole

Second oil sand struck about 400 feet; saturation seemed promising but no flow into hole; saturation continued to about 420 feet

Dip from diamond-drill hole about 20 feet; height of mouth of hole about 12 feet above mouth of diamond-drill hole

1. Argillaceous and semi-argillaceous shale
2. Sandstone
3. Argillaceous shale, sometimes gritty, sometimes very hard, sometimes micaceous, and sometimes pyritiferous. (In above shale one or two seams of fire clay at unlocated intervals)
4. Same shale and shell fragments; also much fire clay
5. Fire clay and many coal particles; also much coal dust on water
NOTE: At 455 feet half-pound block of coal thrown into hole; not enough, however, seemingly, to account for amount of coal disclosed in cuttings
6. Fire clay and some shale
7. Sandstone
8. Argillaceous shale
9. Coarse-grained shaly sandstone with small, very white, quartzitic or feldspathic-looking crystalline inclusions
10. First gas. Gas and salt water; rather fine grained, very micaceous shaly sandstone, with occasional smoothly rounded, irregular, pebble-like, brownish, very fine grained particles
15. Dark argillaceous shale with irregular alternations of more compact, hard, fine-grained brownish semi-sandstone, many shell fragments
19. Dark micaceous fine-grained shaly sandstone with thin calcitic-looking inclusions and minute carbonaceous-looking inclusions
21. Argillaceous shale with occasional unlocated streaks of fire clay
22. Third oil: Chocolate colored, fine-grained, pulverulent, shaly, sometimes micaceous sandstone, interstratified with numerous laminæ of argillaceous shale, the sandstone seemingly very strongly saturated with oil
23. Argillaceous shale and fire clay
24. Fourth oil: Same saturated chocolate laminations as above; also seam of unlocated fire clay
25. Fine-grained sandstone, white; en masse, but mottled with numerous, dark carbonaceous-looking particles; also many coal chips
26. Argillaceous shale, coal, and fire clay
27. Argillaceous shale, fire clay, some pyrite and brown to gray sandstone; whether thin sandstone is interstratified with the argillaceous shale or concretionary is undetermined (probably interstratified)
30. Argillaceous shale with a few chips of sandstone
34. Coal
35. Sandstone
36. Fire clay and argillaceous shale
37. Argillaceous shale
38. Argillaceous shale
60. Gray sandstone
41. Argillaceous shale and some sand
42. Coal
46. Argillaceous shale and fire clay
47. Fine-grained shaly sandstone
48. Argillaceous shale, much fire clay, large skulse of bituminous or carbonaceous soils in each bailer, probably from matter in the fire clay
49. Argillaceous shale, fire clay, coal
50. Argillaceous shale, very soft three feet screws
51. Second gas: Gray sand with slight gas
Argillaceous shale, fire clay, and same sandstone as last above, though much harder and whiter 26.
Fifth oil: Same sandstone showing saturation of very thin oiseless petroleum; with water of a rich super-creamy yellow color 27.
Coal, fire clay, argillaceous shale 30.
Sixth oil: Argillaceous shale with some dark-colored shaly sandstone slightly saturated with thin oiseless petroleum 31.
Coal, fire clay, and argillaceous shale 32.
Argillaceous shale and coal with some gray to white sandstone 38.
Seventh oil: Dark to light sandstone with distinct odor of petroleum; also some fire clay and many shell fragments 42.
Argillaceous shale; also fire clay and shell fragments at unlocated intervals 44.
Sandstone, very hard, fine grained, and shaly 45.
Eighth oil: Sand and some argillaceous shale laminations; the sand containing a thick, dark paraffine or asphaltic substance, which cements the sand and squeezed into a solid mass with clear indentations of the finger without discoloring hands 52.
Sand grown white, clogging bailer and showing some salt water 53.

G
PROVIDENCE WELL NO. 1
Above sea level 317 feet.

Driller's record
1. Soil
2. Hard, medium-grained gray micaceous sandstone
3. Same sandstone with inclusions that colored water in bailing almost an ochreous red
4. Same as 2 (first water, fresh, rising to 5 feet of surface)
5. Alternations of sandstone ledges and thin streaks of grayish semi-argillaceous shale
6. Semi-argillaceous gray shale (6¾-inch casing set)
7. Bluish argillaceous shale
8. Gray fine-grained sandstone; slight show of oil and gas
9. Bluish argillaceous shale
10. Fine-grained gray sandstone with streaks of argillaceous shale
11. Sandstone saturated with petroleum (best showing at 415 to 430 feet)
12. Bluish argillaceous shale
13. Irregular alternating light fine-grained sandstone, semi-argillaceous and argillaceous shale, and darkish fine-grained sandstone
14. Coal and fire clay
15. Fire clay, semi-argillaceous shale, shaly sandstone, and thick-ledged sandstone
16. Whitish to dark-gray sandstone with knife-blade layers of argillaceous shale seemingly well saturated at unlocated intervals
17. Argillaceous shale
18. Saturated shaly sandstone
19. Argillaceous shale
20. Dark coarse sandstone with showing of gas (3 ft. flame)
21. Argillaceous shale
22. Irregular alternations argillaceous shale and shoudats to gray sandstone with coal and fire clay at about 1150 feet
23. Argillaceous and semi-argillaceous shale
24. Coarse gray sandstone (some gas first screw), growing finer and whiter each screw
25. Argillaceous shale
26. Coal and fire clay
27. Argillaceous shale
28. Argillaceous shale with oil in thin layers of gray micaceous sandstone
29. Argillaceous shale with some streaks of semi-argillaceous shale (NOTE: Packer set about 1320 feet)
30. Brownish-gray shaly sandstone growing massive and white; gas
5th screw gas increased

H
PROVIDENCE WELL NO. 8
Above sea level 316 feet.

Driller's record
1. Soil
2. Argillaceous shale
3. Coal and fire clay
4. Argillaceous shale
5. Sandstone alternations; massive, coarse-grained, fine, and shaly. In places very micaceous
6. Shale, with unlocated fire clay
7. Fire clay
8. Argillaceous shale
9. Gray micaceous sandstone with show of oil
10. Gray micaceous sandstone
11. Shaly sandstone
12. Argillaceous shale
13. Coal and sandstone
14. Irregular alternations of argillaceous shales with several thick layers of sandstone
15. Thin coal and fire clay
16. Irregular alternations of argillaceous shale and layers of thick sandstone
17. Sandstone, with show of oil and gas
18. Argillaceous shale and thin shaly sandstone
19. Coal
20. Sandstone, shaly at top
21. Shale
22. Shaly sandstone
23. Fine-grained streaceous shale at top graduating into argillaceous shale below
24. Sandstone with gas; shaly at top, growing white and soft at 20 feet, largest flow of gas near bottom

I
PROVIDENCE WELL NO. 6
Above sea level 322 feet.

Driller's record
1. Red sandy soil. (Surface soil)
2. Yellow sand
3. Blue clay
4. Soft gray micaceous sandstone and bastard conglomerate of chert pebbles. (Probably Tuscaloosa)
5. Gray sandstone and sandy shales with thin strata of semi-argillaceous shale toward bottom (fresh water)
6. Argillaceous shales (top 135 feet)
7. Shale
8. Sand
9. Small seam of coal
10. Sand
11. Clay 1 foot
12. Sand 40 feet
13. Sand 21 feet, 6-inch pipe set at 288 feet
14. Shale 27 feet
15. Gray sand
16. Shale
17. Gray sand
18. Clay
19. Shale
20. Irregular alternations (presumably of sandstone and shale)
726-750 feet sand
21. Shale 750-788 feet
22. Sand (gray), slightly saturated
23. Gas in sand about 910 feet
24. Shale
25. Sand
26. Shale
27. Sand
28. Coal
28. Irregular alternations, mainly argillaceous shale
30. Shaly sandstone graduating into the regular gas sand. Well brought in about 1460 feet
31. Sand

J
PROVIDENCE WELL NO. 10
Above sea level 216 feet.

Driller's record
1. Clay
2. Gravel
3. Sand
4. Shale
5. Argillaceous shale, clay, and thin sandstone
6. Sand
7. Sandy shale
8. Sand
9. Shales
10. Sand
11. Shale
12. Sand
13. Shale
14. Sand
15. Shale
16. Sand
17. Shale
18. Sand
19. Shale
20. Sand
21. Shale
22. Sand
23. Shale
24. Sandstone with showing of oil
Lower part of record and total depth not given
Probable position of gas-bearing sand
This well is said to have found gas and salt water in the same sand as No. 8 and at about the same depth

K
FAYETTE GAS CO. WELL NO. 1
Above sea level 319 feet.

Driller's record
1. Soil
2. Shale
3. Hard sand (water at 150 feet)
4. Shale 35 feet
5. Hard sand
SEA LEVEL
6. Slate
7. Sandstone
8. Hard slate
9. Slate
10. Sand
11. "Slate"
12. Sand
13. Black slate
14. Sand, salt water at bottom

L
PROVIDENCE WELL NO. 3
Above sea level 284 feet.

Driller's record
1. Soil
2. Pink coher shading into yellow streaked dark gritless clay. Tuscaloosa
3. Grayish unconsolidated silt shale
4. Dark fine-grained micaceous sandstone; hard; about 50 feet of sand; some water (at first five feet); then growing more impervious until the last 10 feet, which became shaly and coarse-grained, showing very strong stream of fresh water
5. Very fine-grained shaly sandstone
6. No. 5 shading into irregular alternations of shaly sandstone and argillaceous shale
7. Fine-grained sandstone slightly saturated with petroleum
8. Gas, coal, and slight saturation; same sandstone
9. For next 40 feet show of oil increased and much flowed down ditch with bailings
10. Semi-argillaceous and argillaceous shale and shaly sandstone
11. Light shaly sandstone
12. Coal and fire clay
13. Irregular alternations of argillaceous and semi-argillaceous shale and shaly and also ledgy sandstone
14. Shaly sandstone
15. Massive fine-grained dark sandstone
16. Semi-argillaceous shale and shaly sandstone
17. Purplish-chocolate sandstone, seemingly very strongly saturated with petroleum
18. Irregular alternations of shaly sandstone with some argillaceous shale
19. Light-gray sandstone, seemingly considerably saturated with petroleum
20. Shaly sandstone with occasional streaks of argillaceous shale
21. Argillaceous shale
22. Light-colored massive sandstone; about 50 feet of sand making strongest show of oil yet seen in the field
23. Whitish fine-grained shaly sandstone with occasional streaks of argillaceous and semi-argillaceous shale
24. Dark sand growing lighter and giving very strong odor of oil
25. Irregular alternations of argillaceous shale, semi-argillaceous shale, shaly sandstone, and ledgy sandstone
28. Sandstone with a good showing of oil
27. Argillaceous shale
28. White very fine-grained extremely hard sandstone
29. This sandstone grew darker for about 200 feet, then became white, though coarser grained, showing salt water at about 2150 feet April 1. Still in this amazingly thick sandstone April 1916. Drilling discontinued in same sand at about 2200 feet

M
FAYETTE OIL AND GAS CO. WELL
3 miles southwest of Kennedy
No altitude obtained

1. Drive pipe through sand, clay, and gravel
2. Sandstone
3. Shale
4. Hard sand shells
5. Sandstone
6. Hard "shells and slate"
7. Slate
8. Slate
9. Sand
10. Shale
11. Sandstone with show of oil and gas and salt water
12. Sandstone
13. Hard "shells and slate"
14. Sandstone
15. Slate
16. Hard shells and slate
17. Slate
18. Sandstone
19. Drilling in slate

GENERALIZED SECTION OF THE POTTSVILLE FORMATION ON THE EASTERN SIDE OF THE WARRIOR COAL FIELD
From U. S. G. S. Folio 175 and Bull. 400, by Charles Butts
Scale 160 feet=1 inch

Brookwood coal
Milldale coal
Carter or Johnson coal
Gwinn coal
Cobb upper coal
Cobb lower coal
Pratt coal
Nickel Plate or Candiff coal
American coal
Pratt coal group
Curry coal
Gillespie coal
Newcastle coal
Mary Lee coal
Blue Creek coal
Jagger coal.
Mary Lee coal group
Black Creek sandstone member
Ream coal
Lick Creek coal
Jefferson coal
Black Creek coal group
Black Creek coal
Sapp coal
Rora coal
Thin coal
Tidmore coal
Boyles sandstone member possibly equivalent to Pine sandstone member
UNCONFORMITY

GENERALIZED SECTION OF ROCKS EXPOSED ALONG THE EASTERN SIDE OF BIRMINGHAM VALLEY
From U. S. Folio 175 by Charles Butts
Scale 1000 feet=1 inch

SYSTEM	SERIES	FORMATION	THICKNESS	COLUMNAR SECTION	GENERAL CHARACTER
PENNSYLVANIAN	Pennsylvanian	Pottsville formation	5500'		Predominantly shale with beds of sandstone, conglomerate, and coal; also some fire clay, conglomerate, "Millstone grit," at base
		Pine sandstone member			Pine sandstone member
		Shades sandstone member			Shades sandstone member
MISSISSIPPIAN	Carboniferous	Parkwood formation	300' to 350'		Predominantly gray shale and sandstone. Finely, very rare
		Pennington shale	30' to 200'		Green, green, and black shale with a few thin beds of limestone
		Bangor limestone	700'		Dark-gray, fine-grained, cherty limestone. Heads in part of Shades Mountain. Weathers into characteristic "honeycomb" rock
		Fort Payne chert	250'		Gray and yellow cherty limestone, with some thin beds of sandstone
		Floyd shale	1200'		Black and gray shale and a little sandstone and limestone
		Chickamauga limestone	1000'		Thick-bedded crystalline dolomite with some argillaceous beds in upper part. Heads in part of Red Mountain, Shades Mountain, and Double Springs
ORDOVICIAN	Lower Chickamauga	Knox dolomite	2500'		Thick-bedded crystalline dolomite with some argillaceous beds in upper part. Heads in part of Red Mountain, Shades Mountain, and Double Springs. Thin-bedded limestone with gray or yellow shale in upper 600 feet.
CAMBRIAN	Middle Cambrian	Conasauga ("Coosa") limestone	1000' to 2000'		Predominantly thin-bedded blue limestone interbedded with gray or yellow shale

GENERALIZED SECTION OF THE ROCKS EXPOSED IN CAHABA VALLEY
EAST OF BIRMINGHAM
From U. S. Folio 175 by Charles Butts
Scale 1000 feet=1 inch

SYSTEM	SERIES	FORMATION	THICKNESS	COLUMNAR SECTION	GENERAL CHARACTER
PENNSYLVANIAN	Pennsylvanian	Pottsville formation	5500'		Predominantly shale with beds of sandstone, conglomerate, and coal; also some fire clay, conglomerate, "Millstone grit," at base
		Pine sandstone member			Pine sandstone member
		Shades sandstone member			Shades sandstone member
MISSISSIPPIAN	Carboniferous	Parkwood formation	1000'		Sandstone and shaly shale
		Floyd shale	1200'		Black and gray shale and a little sandstone and limestone, Pennington?
		Fort Payne chert	250'		Same thin-bedded cherty limestone and shale as at Shades Mountain. Limestone weathers into characteristic "honeycomb" rock
		Chickamauga ("Birmingham") limestone	1000'		Very thick-bedded dove, blue, and dove-gray limestone
ORDOVICIAN	Lower Chickamauga	Knox dolomite	3500'		Thick-bedded crystalline dolomite with some argillaceous beds in upper part. Heads in part of Red Mountain, Shades Mountain, and Double Springs. Thin-bedded limestone with gray or yellow shale in upper 600 feet.
CAMBRIAN	Middle Cambrian	Conasauga ("Mendenhall") formation	1000'		Variegated red, green, and yellow shale, calcareous sandstone, and thin limestone

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If it is assumed that the tentative identification of the Mary Lee group of coal beds in the Providence well No. 5 (section F) is correct, coal No. 5 of this well section and coal No. 14 of well section G (Providence well No. 1) seem to occupy a position about 550 feet above the Mary Lee coal group, or about 125 feet above the Pratt coal group of the generalized section. The thin coal (No. 15) of the Providence well No. 5 (section H) may belong to the same horizon but appears to be somewhat higher. These coal beds seem to be too low to belong to the Cobb coal group and to be somewhat too high for the Pratt group, though the presence of the thick sandstone (No. 7) below this coal in section F suggests that an increase in interval between the Pratt coal and the Nickel Plate coal may, in the Fayette district, bring the former up to this horizon. The Cobb coal group appears to be represented by coal beds Nos. 5, section A; 6, section C; 11, section D; 13, section H; and 12, section L.

The Gwinn coal bed, which in the generalized section is shown about 140 feet above the Cobb upper coal, appears, from the above correlation, to be represented by coal No. 4 of section C and the small lens of coal near the base of sandstone No. 8, section E. The Carter or Johnson coal appears to be present in section D as coal No. 5, in section I as coal No. 9, and in section L as coal No. 8. If this correlation of the Carter or Johnson coal bed is correct, the Milldale coal above it is not represented in the well sections, the Brookwood coal being shown only as No. 3 of section H. In section H sandstone No. 5 is equivalent to sandstones Nos. 2, 3, and 4 of section G; No. 3 of section E; No. 2 and the upper part of No. 3 of section D; No. 1 of section C; and No. 2 of section B. It probably lies above the top of section A. In sections I and J the top of this sandstone is in contact with the basal conglomerate of the Cretaceous, and in section J the lower portion of the sandstone is shaly. This sandstone appears to be No. 3 of section K, where it is overlain by shale; and No. 4 of section L, the first three numbers of which are Cretaceous beds. This sandstone is partly exposed in the railroad cut just east of Gas Wells station, in the road near Cosmos well No. 1 (section D), and in the river bluff at Providence well No. 4 (section C). A correlation of the outcropping beds based on the identification of this sandstone in areas where it is exposed is given on page 43.

These tentative correlations are, of course, offered suggestively only. They might have been made more conclusive if the positions of more coal beds in the well sections had been known. At best they will very likely be subjected to considerable revision when a sufficient fund of paleontologic evidence has been accumulated, or when the records of suitably distributed wells are available.

Correlation of the other strata of the well sections.—In this report no attempt will be made to correlate in detail the strata reported in the

deep wells. However, in all attempts to trace beds from place to place by well records alone, it is best to remember that the tendency of drillers is to report greater thicknesses of sandstone than actually occur. Many hard, compact beds of sandy shale are mistaken for sandstone, because the appearance of the pulverized material from such beds generally shows a large percentage of sand grains, the beds offer relatively great resistance to drilling, and the wear on the bits is similar to that produced by sandstone. In well section K, Plate V, the relatively great thickness of sands Nos. 10 and 12, as compared with sands shown in the other well logs, strongly suggests that those beds are made up principally of sandy shale in which occur numerous thin beds of sandstone. Also in well section A, beds Nos. 3, 14, 16, and 20, characterized by the driller as "limes," "broken lime," etc., are most probably not limestone at all, but somewhat calcareous shale and sandstone. No. 3 of this section is very probably a calcareous sandstone. Nos. 17, 22, and 23 of well section B, though probably containing a noticeable amount of lime carbonate, most likely would not be classed by the drillers themselves as limestone if the beds were exposed at the surface.

The sandstone found to contain gas in paying quantities in Providence well No. 1 is known as the Fayette gas sand. This sand is shown at the base of sections G, H, I, and K and is sandstone 26 of section L. There is doubt as to the position of this sand in the well near Kennedy, as shown by section M. The elevation of this well was not obtained and the tentative correlation based on stratigraphic sequence alone suggests sandstone No. 18 as being equivalent to the Fayette gas sand, but it is possible that sandstone No. 18 of section M is the same as either No. 22 or No. 24 of section L.

Nos. 40 to 43, inclusive, of section F are very probably equivalent to the Fayette gas sand, as are also Nos. 18 to 20, inclusive, of section B and No. 22 of section A. Sandstone No. 31 of section D appears to overlie the Fayette gas sand, but the nature of the log leaves this in much doubt.

The very thick sandstones, Nos. 28 and 29, of well section L appear to be equivalent to Nos. 25 to 31, inclusive, of well section A, and the shale beds Nos. 26, 28, and 30 of section A seem to be absent in section L. The exact position in the Fayette district of the sandstones shown in the generalized section of the Pottsville formation on the eastern edge of the Warrior coal field is somewhat in doubt. If the Fayette gas sand is one of the sandstones of the Black Creek coal group, as correlated above, the very thick sandstones shown at the base of well sections A and L may be correlated with the shale, sandstone, and coal of the generalized section from a short distance below the Black Creek coal to and possibly including some of the Boyles sandstone member. A very massive sandstone is locally found below the Black

Creek coal at places along its outcrop on the north side of the Warrior coal, and this sandstone may increase in thickness southwest across the coal field, becoming several hundred feet thick in the western part of the Fayette district and possibly uniting at its base with the Boyles sandstone member. The absence in well section L of the three beds of shale (Nos. 26, 28, and 30), of well section A, suggests thickening of the sandstones of this horizon from east to west.

As already stated, the Boyles sandstone member of the east side of the Warrior coal field is tentatively correlated with the Pine sandstone member of Birmingham and Cahaba Valleys, east and northeast of Birmingham. The stratigraphic position of this sandstone is shown in the generalized sections of the rocks of these valleys on Plate V.

PROBABLE CHARACTER OF THE ROCKS BELOW THE WELLS OF THE FAYETTE DISTRICT.

A very important factor which must not be overlooked in attempting to determine the nature of the beds lying below the bottom of the deepest well in the Fayette district is the unconformity[1] known to occur at the base of the Boyles sandstone member on the east side of the Warrior coal field. This unconformity represents a long period of time during which the Mississippian rocks constituted a land surface and were being removed by streams. Along the northeastern edge of the Warrior coal field this hiatus includes all of the Pottsville formation below the Boyles sandstone member, say 500 feet; all of the Parkwood formation, say 2,000 feet; and all but about 60 feet of the Pennington shale, say 200 feet—a total of 2,700 feet. The Boyles sandstone member thus rests directly upon the eroded surface of the Pennington shale. If similar conditions prevailed in the Fayette district, the drill may penetrate only a few feet of red, gray, green, and black shale below the Boyles sandstone member before entering the Bangor limestone or possibly its equivalent, the Floyd shale. This unconformity may be either greater or smaller in the Fayette district than on the eastern border of the basin. If it is greater, all of the Pennington shale and even the Bangor limestone and the Floyd shale may have been removed from the old land surface before the sea again covered this region and the deposition of the Pottsville began.

If the unconformity decreases in magnitude from the northeastern edge of the Warrior coal field toward the Fayette district, all of the Pennington shale (shown in the generalized section on Pl. V) may be present, and under this formation the Bangor limestone or possibly its equivalent part of the Floyd shale in its full thickness. If geologic conditions were similar in the Cahaba and Fayette districts during the deposition of the rocks below the Pine sandstone member, then the beds should be prevailingly shaly for 500 feet below the Boyles

[1] Butts, Charles, Birmingham folio (No. 175), Geol. Atlas U. S., U. S. Geol. Survey, 1911.

sandstone member, and the next 500 to 700 feet of strata should be made up principally of the massive, siliceous, conglomeratic Shades sandstone, which forms the basal member of the Pottsville formation in Cahaba Valley, east of Birmingham. It seems very doubtful if the Parkwood formation is present in the Fayette district, for it thins rapidly westward from the Cahaba Valley and is absent along the east side of the Warrior coal field. If the Parkwood is present, it probably is very much thinner than it is in Cahaba Valley and consists largely of sandy shale.

The Pennington shale and Bangor limestone are very likely present in the Fayette district and similar in character there to the same formations in the eastern part of Birmingham Valley as shown on Plate V, but it is possible that these formations assume the characteristics of the equivalent Floyd shale in this area. If all these formations are present, they probably have a combined thickness of 1,000 to 1,200 feet. The Fort Payne chert and the underlying formations, as shown in the generalized sections of Plate V, are widespread and are most probably present in the Fayette district.

It seems probable that the section below the Pennsylvanian series of the Fayette district is the same as that part of the generalized section for Birmingham Valley, beginning 100 feet above the base of the Pennington. The depth to the Hartselle sandstone or Chickamauga limestone or any other desired horizon can very probably be computed from the generalized section of the Warrior coal field and the section in Birmingham Valley by assuming that the bottom of the Boyles sandstone member lies 50 to 100 feet above the bottom of the Pennington.

EXPOSED ROCKS IN THE FAYETTE DISTRICT.

AGE AND CONDITIONS OF DEPOSITION.

As stated above, the rocks exposed at the surface of the Fayette district are separable into two great systems, the Carboniferous and the Cretaceous.

At the close of Carboniferous deposition this region was elevated above sea level, forming a land area throughout Triassic and Jurassic time. Near the beginning of the Cretaceous period the land sank and in the water which covered it, sand, gravel, and clay from the adjacent land areas were deposited. Thus the surface of unconformity represents the time during which this was a land area and no material was being deposited upon it.

Because of folding in the Carboniferous beds previous to the deposition of the Cretaceous the bedding planes of the latter are not parallel to those of the former but lie across or uncomformably upon their eroded edges. Owing to this unconformity, the folds in the Cretaceous beds give no clue to the character and amount of disturbance in the

Carboniferous rocks lying below. In this district gas is found only in the Carboniferous rocks, and in order to determine accurately the positions of the anticlines and synclines in them not only uniformly good exposures of the rocks are required, but also some of the beds must have such characteristics as will afford a means of identifying them at all places where they are exposed.

POTTSVILLE FORMATION

Although Carboniferous rocks of Pottsville age are present within a maximum distance of about 400 feet of the surface at all points in the area represented by figure 1 the beds actually come to light in relatively small portions of it, where streams have cut through the Cretaceous and Tertiary blanket of sand, gravel, and clay which once covered the entire surface into the Carboniferous strata below. In places the Pottsville beds are laid bare over considerable stretches of the valleys. At many of these places the older rocks have since been covered by thin deposits of alluvium and wash from adjoining hill slopes, being thus effectively concealed from view.

In the reconnaissance field work in advance of topographic mapping, where all lines of traverse were run out and plotted in the field, time did not permit the tracing of outcrops through their entire length.

The change in character of the sandstone and shale which largely make up the exposed section of the Carboniferous strata is very noticeable from point to point along the line of outcrop. This is due not only to the varying conditions under which the beds were deposited, but also to the fact that portions of them were later exposed at the surface of the pre-Cretaceous land and greatly altered by weathering before the region was again submerged and the younger beds deposited.

The Carboniferous rocks, exposed only over a relatively small part of the area mapped, are best shown along the sides of the valleys of Clear Creek, Deadwater Creek, Baker Creek, Little Pinney Creek, Rock Creek, North River, and that portion of Boxes Creek northeast of sec. 11, T. 16 S., R. 12 W. Small exposures also occur at Fortenberry's and White's mills on Davis Creek and on the south bank of Boxes Creek, in secs. 9 and 10, T. 16 S., R. 12 W., at the cut near Gas Wells station, and on the wagon road near well E, sec. 9. A few feet of sandstone and shale may be seen in the bluff of Sipsey River for half a mile south of Newton's mill and at a few other places near the foot of the river hills in the NE. ¼ sec. 33, T. 15 S., R. 12 W. The surface of the remainder of the area is covered by Cretaceous and younger beds.

The following sections are exposed at the places indicated:

Section of outcropping rocks on Clear Creek a short distance below the road crossing in sec. 2, T. 16 S., R. 11 W.

	Ft.	in.
Concealed at top of bluff.		
1. Sandstone, very thin bedded, greenish and shaly	6	
2. Shale, brownish, compact, sandy	8	
3. Sandstone or sandy shale, very compact, greenish	12	
4. Concealed with shale and sandstone débris	18	
5. Sandstone or sandy shale, thin bedded, greenish to brown	5	
6. Sandstone, massive, medium grained, cliff making, greenish to brownish	10	
7. Concealed	15	
8. Sandstone, reddish brown (5-foot massive, cliff-making ledge in the middle)	12	
9. Concealed (brown shale and some thin-bedded sandstone débris)	21	
10. Shale, bluish to brown, blocky, sandy	10	
11. Coal	1	2
12. Clay, yellowish brown, sandy	4	
13. Shale, black to dark blue, coarse, to water	5	
14. Sandstone in bed of creek.		
	127	2

The following section of the same beds as those described above was measured on the east side of Deadwater Valley, in the northeastern part of the NE. ¼ SE. ¼ sec. 35, T. 15 S., R. 11 W. It is typical of the exposed rocks in the northern part of the area mapped:

Section of outcropping rocks on Deadwater Creek.

	Feet.
Cretaceous sand at top of hill.	
1. Sandstone, thin bedded, shaly, greenish, or sandy shale, containing a few thin, resistant beds of sandstone	42
2. Sandstone, massive, gray to brownish, cliff-making, weathers to coarse light-yellow sand	9
3. Concealed by sandstone débris from massive bed above	11
4. Sandstone, massive, gray, cliff making	4
5. Concealed by bowlders of sandstone from above	10
6. Sandstone in massive, cliff-making layers	3
7. Concealed by sandstone bowlders from above	10
8. Sandstone, massive, cliff-making bed in two or three layers	5
9. Concealed by sandstone bowlders from above	27
10. Shale, blocky, sandy, bluish brown at top to dark brown at bottom	6
11. Coal, about	1
12. Clay, yellowish, sandy, fossiliferous	2
13. Shale, dark brown, blocky	2
14. Concealed below level of tributary valley	7
	139

In attempting to correlate the outcropping rocks in the eastern part of the mapped area with those of the well sections it seems that sand-

stone No. 2 of the Deadwater Creek section is probably equivalent to the massive sandstone exposed in the cut at Gas Wells station, and also the same as No. 5 of well section H, Plate V. If this is a correct correlation, the coal of the Deadwater Creek section is the Carter or Johnson bed. This correlation, it should be observed, does not agree with the conclusions reached by McCalley,[1] who considers the coal exposed along Deadwater and Clear creeks to belong to the Cobb coal group.

It is to be regretted that sufficient paleontologic material is not available to make a positive identification of this coal bed. An examination by David White of a few small collections of fossil plants obtained a short distance below the coal bed on Deadwater Creek, which he considers to be younger than the Pratt coal group, and probably not later than the Brookwood coal, still leaves unsettled the question of whether or not the coal on Deadwater Creek belongs to the Cobb group or is the Carter or Johnson bed. The writer's correlation of this coal bed is by no means satisfactory to himself, and is presented merely as a suggestion.

Portions of sandstones Nos. 2 to 6 of the Deadwater Creek section are exposed along the "Byler Road" from Little Pinney Creek southward to Rock Creek above Dardon's mill. About a quarter of a mile west of this mill a fine outcrop of the sandstones of the Deadwater Creek section occurs on an abandoned road just above the place where the "Byler Road" crosses Rock Creek. The following section was measured at this place:

Section on abandoned road on west side of the "Byler Road," one-fourth mile west of Dardon's mill.

	Feet.
1. Shale, reddish, sandy, deeply weathered, at top of hill	5
2. Sandstone, coarse, reddish, deeply weathered	5
3. Shale, sandy, whitish, deeply weathered, with pronounced vertical joints producing long rectangular blocks; thin streaks of whitish clay	6
4. Sandstone and shale, massive, greenish beds at top, 3 feet thick, very deeply weathered, with 2 feet of light-colored shale, then 2 feet of thin-bedded greenish standstone, then 4 feet of massive cliff-making greenish sandstone at base	11
5. Sandstone, greenish, thin bedded, shaly	5
6. Sandstone, very massive, cliff making, irregular bedded	5
7. Clay, shale, and sandstone; 3 feet of bluish, sandy, very fossiliferous clay and shale, with 1 foot of thin-bedded greenish shaly sandstone below	4
8. Sandstone, thin bedded, compact, cliff making, ripple marked, greenish	6
9. Shale, coarse, sandy, bluish brown, blocky to creek level	3
	50

[1] McCalley, Henry, Report on the Warrior coal basin, Geol. Survey Alabama, 1900, pp. 169 et seq.

The numbers in the preceding section conform to those of the Deadwater section.

The Carboniferous beds exposed in the area mapped appear to include a vertical range of not more than 150 feet. At many places the prominent sandstones mentioned in the sections given above formed the surface of the pre-Cretaceous land and here and there they seem to have been cut away by streams, thus developing more or less relief on this surface.

EXPOSURES OF CRETACEOUS AND YOUNGER BEDS IN THE FAYETTE DISTRICT.

As the object of this examination was to determine the conditions under which gas has accumulated in the Carboniferous rocks, little attention was given to the Cretaceous and younger beds, which unconformably overlie the gas-bearing formation and which are of no value in attempts to determine the dip of the gas-bearing beds. These rocks are composed largely of unconsolidated sand and clay, with some beds of dark-red conglomerate and coarse red sandstone cemented by iron. The valleys are covered by surficial beds of wash and alluvium of Recent age, deposited by the present streams.

STRUCTURE.

GENERAL STRUCTURE OF THE REGION SURROUNDING THE FAYETTE GAS FIELD.

The general structure of the Warrior coal basin, in which the Fayette gas field lies, is that of a broad, flat basin, gently tipped to the southwest, with the strata steeply upturned and faulted at the eastern edge along Birmingham and Sequatchie valleys and the western limb hidden beneath the unconformable Cretaceous beds. The most prominent structural feature in this basin is the Sequatchie anticline (fig. 1). This fold is highest at the northeast border in Blount County, and pitches southwestward to the northern part of Tuscaloosa County, where it flattens out and loses its prominence. Between this anticline and Birmingham Valley the rocks, though generally synclinal in structure, are wrinkled into many minor folds and in places are cut by many faults.

West of the Sequatchie anticline the rocks are less disturbed and no large, well-defined folds have been discovered, though the area seems to have been subjected to enough deformation to wrinkle the strata into many low irregular folds and in some places to produce local faults of slight displacement, but the positions of all the minor folds have not been traced out and mapped.

On figure 1 the general structure of the basin is suggested by the lines marking the limits of the formations. The direction of the line of contact between the Pennsylvanian and Mississippian rocks is almost

due east from the western border of the State to the southeastern part of Morgan County, and northeast from this place to Tennessee River. This line is roughly parallel to the outcrop of the Bangor limestone. The change in direction of the line of outcrop seems to be due to a broad arching of the strata north of Tennessee River along a line passing near Athens and Decatur. From this locality a broad anticline trends southward through the western part of Morgan County and the eastern part of Winston County. The effect of this fold is noted in the curve in the outcrop of the Black Creek coal bed in northern Walker County, as shown by the dotted line on figure 1. There is evidently a well-defined synclinal area a short distance west of and parallel to the Sequatchie anticline through its entire length, but the details of the structure in and west of this area are not known, except in a portion of the Fayette district which is described below.

The folds in the Warrior field which have a general northeast-southwest trend were formed by crustal movements that produced great folds and thrust faults along the Appalachian region from Middle Alabama to New York. The impulse which produced this deformation probably came from the southeast and most of its energy was expended before reaching the Warrior field. The Sequatchie anticline is the northwesternmost fold of prominence that was developed by this movement. West of it strata originally horizontal were more or less wrinkled into a series of broad, open, irregular folds, having a general northeast-southwest trend.

Another period of deformation of the Warrior coal field was marked by the depression of the region to the west along an axis parallel to the present course of Mississippi River below its juncture with the Ohio. This sinking was followed by an encroachment of the sea in which the Cretaceous and Tertiary sediments were laid down in a great V-shaped embayment extending from the Gulf of Mexico northward into southern Illinois. This regional depression may have produced more or less deformation in the Warrior field, the folds having a general northwest-southeast trend roughly at right angles to the direction of maximum depression. These two great crustal movements have produced the structural features in the Fayette district.

STRUCTURE OF THE CARBONIFEROUS ROCKS OF THE FAYETTE DISTRICT.

CONTOUR MAP.

On Plate VI an attempt has been made to show the dip of the Carboniferous strata in portions of the Fayette district by the use of contour lines. These are lines of equal altitude with a vertical interval of 10 feet and are numbered according to their height in feet above sea level. They are drawn upon the horizon of the coal bed described in the Clear Creek and Deadwater Creek sections. For example, the heavy contour line marked 350 is drawn through all

points on the horizon of this coal bed that are 350 feet above sea level; the next brown line on one side of it marks all points on this coal that are 340 feet above the sea, and the one on the opposite side marks the points at which the coal is 360 feet above the sea.

The accuracy with which structural contours may be drawn upon any deformed surface depends, of course, on the number and position of the points whose elevation above sea level has been determined by instrumental work in the field; and this in turn depends on the position and extent of the outcrop of the bed upon which the measurements are taken. Unfortunately, in the Fayette district the coal bed on which the structural contours are based is exposed at not more than four places, so far as the writer is aware. In order partly to avoid the difficulties of contouring a bed which is so rarely exposed, the writer has used the approximate vertical distance between this bed and the tops of the cliff-making sandstone beds described above to calculate the height of the horizon of the coal at places where it is not exposed or could not be found. In this way all the measurements made on recognized beds were reduced to approximate elevations of the coal bed and from these elevations and the known dip of the exposed beds, the contours were drawn. From these facts it can be readily seen that though the contours on the map in the main show the structure with fair accuracy, they may locally be considerably in error because of the lack of accurate measurements on the key surface.

The portions of the map where no contours are drawn represent areas where the surface is covered by Cretaceous and younger beds that prevent accurate measurements on the coal. The structure of the Carboniferous rocks in these parts of the district is unknown and can be determined only when a sufficient number of wells have been drilled to furnish accurate measurements to some recognizable bed. This statement applies equally well to all parts of the Gulf Coastal Plain in Alabama, where the Carboniferous beds are concealed beneath Cretaceous and younger formations.

In places where the structure contours are solid lines elevations obtained on recognizable beds are sufficiently numerous to warrant the assumption that they are approximately correct. The broken contours, though based on some accurate data, may be considerably in error. The accuracy of those contours that bear interrogation marks is in doubt. Care should always be taken in using these contours to give due allowance for errors that are likely to creep into work based on insufficient data or on data not known to be accurate.

MAIN STRUCTURAL FEATURES.

The structural contours on the map show clearly that the deformation in the Carboniferous beds of this particular area has been relatively slight and that the beds lie in broad, open, irregular folds,

U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, DIRECTOR

R. 12 W.

R. 11 W.

T. 15 S.

T. 16 S.

FAYETTE

Zion Church

Newtons Mill

Pleasant Hill Church

Oak Grove Church

Hook Hill School

Cordon Mill

Cleveland Church

Gas Wells

Boxes

Sipsey

Parkston

Liberty Church

Fosterdevys Mill

Whites Mill

Simmons School

Dardons Mill

Shady Grove Church

RIVER

SIPSEY

Creek

RAILROAD

SOUTHERN

FAULT

PROBABLE FAULT

R. B. Marshall, Chief Geographer.
Frank Sutton, Geographer in charge.
Topography by R. H. Reineck and J. M. Rawls.
Surveyed in 1910-1911.
SURVEYED IN COOPERATION WITH THE GEOLOGICAL SURVEY OF ALABAMA.

Contours showing differences in elevation of surface.

MAP OF FAYETTE DISTRICT, ALABAMA

Showing structure on the coal horizon of the Clear Creek and Deadwater sections.

Scale 1/31680

1 ½ 0 1 2 Miles

1 ½ 0 1 2 Kilometers

Contour interval 10 feet.
Datum is mean sea level.
1912

THE HORRIS PETERS CO., WASHINGTON, D. C.

Structure lines on the coal horizon, showing dip of rocks over part of district

UNFINISHED WELLS
Depths unknown
Show of gas — Dry hole

FINISHED WELLS
Dry hole — Show of gas — Gas — Diamond drill hole

Geology by M. J. Munn,
Under the supervision of David White,
Surveyed in 1910-1911.
SURVEYED IN COOPERATION WITH THE GEOLOGICAL SURVEY OF ALABAMA.

trending generally northwest and southeast in the eastern part of the mapped area and probably more nearly east and west farther west.

The principal structural features, as partly brought out by the contours on the east side of the map, are the belts of relatively steep southwest dip. One of these belts passes through the eastern parts of secs. 28 and 33 and the western parts of secs. 27 and 34, T. 15 S., R. 11 W., and continues southeastward through secs. 3, 2, and 11, T. 16 S., R. 11 W. Southwest of this belt of relatively steep dip is a shallow syncline, the bottom of which passes through the central parts of secs. 29 and 33, T. 15 S., R. 11 W., and secs. 3, 10, 15, 14, and 23, T. 16 S., R. 11 W. Southwest of this trough the rocks appear to rise gently to the axis of a very low, broad anticline which appears to pass through secs. 30, 29, and 32, T. 15 S., R. 11 W., and secs. 4, 10, 15, 22, and 27, T. 16 S., R. 11 W.

Southwest of this anticline Cretaceous sand obscures the structure, which can not be determined with any degree of certainty except in portions of secs. 4, 9, 10, 15, and 16, T. 16 S., R. 11 W., where the steep dip of the rocks discloses what appears to be the east end of a syncline of considerable magnitude, pitching west-northwest under the Cretaceous beds. The lowest portion of this trough probably has not been contoured, but in the southeast corner of sec. 9 the key surface is at least 200 feet lower than it is in the central part of sec. 35, T. 16 S., R. 11 W. There may be faults in this area which render the observed dips misleading, but no direct evidence of a fault was seen in the field.

On Boxes Creek no well-defined fold is revealed by the structure contours in the area of Carboniferous rocks exposed. The very gentle dip toward the south and southwest appears to be interrupted by a shallow syncline passing through secs. 1 and 2, T. 16 S., R. 12 W., and by another small syncline, the beginning of which is shown at the southeast corner of sec. 35 of the same township and range.

LOCAL ANTICLINES.

In the southwestern part of sec. 1, T. 16 S., R. 12 W., there is evidence of a small anticline which brings the sandstones of the Pottsville formation up into a very sharp fold, having a general northeast-southwest trend, with dips of 40° to 80°, but with a total width of only a few feet. Structure of this type is apparently very common to this region. On the road in the southern part of the NE. ¼ NE. ¼ sec. 11, T. 16 S., R. 12 W., a similar buckle brings up the Pottsville at an angle of 50° to 70°. Two similar buckles only a few feet in width are finely exposed on the Fayette-Bankston road in the NE. ¼ NW. ¼ sec. 1, T. 16 S., R. 12 W. These appear to have a northwest-southeast trend. Another of these local buckles occurs on the road near the western edge of the NW. ¼ NW. ¼ sec. 36, T. 15 S., R. 12 W.

Others of less magnitude were seen, but as these miniature anticlines were probably formed by local compression due to the subsequent wrinkling of slightly folded beds across the major folds, they are probably very local features that extend only to shallow depths.

FAULTS.

Few faults occur in the area mapped and these appear to be due entirely to tension. They seem to be local in extent and to show small vertical displacements. One of these faults is exposed on the road leading southeastward from Cotton's mill, in the NE. ¼ SE. ¼ sec. 33, T. 15 S., R. 11 W. Here the downthrow appears to be to the north and the displacement is probably between 40 and 50 feet. The trend of this fault seems to be northwest and southeast.

Another fault is thought to occur on Rock Creek about a quarter of a mile west of the road crossing in sec. 27, T. 16 S., R. 11 W. Here the sandstones of the Pottsville disappear abruptly and are succeeded upstream by dark bluish-brown sandy shale, which closely resembles beds of shale lying from 40 to 80 feet below the sandstone. If these identifications are correct the fault has an almost due north-south trend, with the downthrow to the east.

At Newton's mill, in the southern part of sec. 33, T. 15 S., R. 12 W., is a well-marked fault with a general northwest-southeast trend, but the lack of good exposures at this place leaves the writer somewhat in doubt as to its character. It may either have a displacement of 70 or 80 feet with the downthrow to the southwest, or the downthrow may be to the northeast with 20 or 30 feet displacement.

A mile north of Newton's mill, near the northeast corner of sec. 33, a fault is exposed in the bluff at the foot of the river hill. This fault has a displacement of less than 40 feet, the downthrow being to the southwest.

In the core-drill hole of the Cosmos Oil & Gas Co. (section E, Pl. V) the black shale (No. 16) shows many slickensided surfaces which suggest faulting, but other evidence of a fault at this place is obscured by wash of Cretaceous débris which hides the Carboniferous rocks.

The faults in the Fayette district are probably due to differential tension developed locally by the wrinkling of slightly folded strata almost at right angles to the major folds. This wrinkling was apparently so slight that only faults of very small extent could have been developed. The depths to which the displacement of strata extends along these faults are, of course, unknown, but on account of the slight amount of folding, the local nature of the tension thus developed, and the predominance of soft, yielding shale below the surface, it seems reasonable to assume that the depth of displacement was very slight.

STRUCTURE OF THE FAYETTE GAS SAND.

The available data relative to the structure of the Fayette gas sand in and surrounding the gas field are too meager to justify an attempt to draw structure contours on this bed. Therefore, instead of attempting to represent the structure of the sand, the altitudes of the mouths of the wells and the depths to the gas sand in each are shown on Plate V. From these figures the depth of the gas-bearing sand below sea level can be easily calculated.

No records of wells N, P, R, S, T, and U were obtained, and the Fayette gas sand is not shown in well sections C and D. In all these wells a sandstone near the top has been correlated with the massive sandstone which is exposed at Newton's mill, at Gas Wells station, and on the south side of Boxes Creek, southeast of this station. As already stated, this sandstone is believed to be the upper sandstone (No. 2) of the Deadwater Creek section, which is exposed up Boxes Creek and in the eastern part of the area mapped. Altitudes obtained on this bed have been reduced to equivalent ones on the coal used as a key stratum, and contours have been drawn to show the approximate dip of the key rock in the gas field, in order to give some idea of the structure, the details of which can not be shown with the available data.

ECONOMIC FEATURES OF THE FAYETTE DISTRICT.

As stated at the beginning of this paper, drilling in the Fayette district has resulted in the finding of gas in considerable quantities in Providence wells Nos. 1, 6, 8, 9, and 10. These wells are marked on the map by the letters G, I, H, S, and J, respectively. Nos. 9 and 10 (S and J) have shown more or less salt water, and No. 10 is said to have been badly damaged by injudicious shooting. The writer obtained no records of Providence wells Nos. 11, 12, and 13 (R, P, and U) or any direct evidence as to their depth and the nature of the rocks encountered in them. So far as he knows, they may or may not have been drilled to the Fayette gas sand. None of them shows oil or gas in paying quantities. Providence well No. 5 (F) is said to have been drilled first to about 1,690 feet and later deepened to more than 2,200 feet. No record of the second drilling could be obtained. The bottom portions of the records of Providence wells Nos. 2 and 4 (D and C), which would be of greatest value, are not given. (See Pl. V.) The only positive data regarding the character of the gas sand in the immediate vicinity of the producing area are given by Providence wells Nos. 3 and 5 (L and F) and the Fayette Gas Co.'s well No. 1 (K), the records of which are shown on Plate V. These three wells have undoubtedly passed through the Fayette gas sand without finding gas in paying quantities. A well was also started about 4½ miles northwest of Fayette by the Providence Oil & Gas

Co., but it is said to have been abandoned after being sunk to a depth of a few hundred feet. The well of the Fayette Gas Co. (M), situated about 3 miles southwest of Kennedy, has not been completed at this writing and no data regarding it are available other than those given on Plate V.

The Woods well No. 1 (B) of the Alabama Central Oil & Gas Co., located on the railroad about 1½ miles west of Bankston, passed through the Fayette gas sand between 1,350 and 1,440 feet, finding a slight "show" of oil and a little gas. Small "shows" of oil and gas were noted at many places in the Freeman well No. 1 (A), but not in paying quantities. The well at Bankston (U) was drilled to a depth of about 800 feet by the Providence Oil & Gas Co. Work on it was suspended during the time the writer was in the field, but it is reported to have been drilled later to a depth of 1,600 or 1,700 feet, finding salt water, when it was again temporarily abandoned. At a still later date work was resumed and the hole reached a depth of more than 2,200 feet. It is reported to have furnished a large flow of gas from a point near the bottom, but this was later shut off by an invasion of salt water from beds above the gas sand.

A well is being drilled by the Five Rivers Oil & Gas Co. near Newtonville, about 13 miles south of Fayette, but neither oil nor gas in paying quantities has yet been reported from it. Another deep well was started near Reform, about 25 miles southwest of Fayette, but no data relative to it are at hand. A derrick was built near Berry, about 18 miles east of Fayette, but no drilling had been done at the time field work in this district was closed.

To sum up the situation, the developed part of the Fayette gas pool is about 2,500 by 1,000 feet in area, and contains five producing wells with initial capacities ranging from probably 250,000 to 4,500,000 cubic feet a day. One of these wells (Providence No. 8) supplies the town of Fayette with gas. The others are closed. The eight other wells drilled in search of gas within 2 miles of this pool and the six other holes drilled in the region have reported neither gas nor oil in paying quantities, except possibly in the well at Bankston above mentioned.

FUTURE PROSPECTING IN WESTERN ALABAMA.

The following questions probably cover the crux of the commercial oil and gas situation in western Alabama:

1. Is the Fayette gas pool fully outlined by the wells already drilled?
2. From the indications shown by the present developments, are pools of oil and gas likely to be found in the Warrior coal field and adjacent localities in the Gulf Coastal Plain?
3. If the Warrior coal field offers favorable inducements for testing, where should the test wells be located?

The remaining pages of this report will be devoted to an attempt to answer these questions so far as the few data available permit.

PROBABLE EXTENT OF THE FAYETTE GAS POOL.

In answer to the first question, the Fayette gas pool does not appear to be fully developed, though it very probably is not a large pool. There is no evidence available to show that a well located 800 or 1,000 feet due north of Providence well No. 8 (H) should not get gas, and if this one should prove successful, gas or oil may reasonably be expected in other wells drilled along the strike of the rocks in this direction to and beyond the Fayette-Sipsey road. The Cosmos well No. 1 (E) is favorably located for either oil or gas if the Fayette gas sand is soft and porous at this point. To the east, southeast, and south of the producing area Providence wells Nos. 11, 12, and 13 (R, P, and N) seem to mark good positions for tests. If these have all found the Fayette gas sand unproductive, the limit of the pool in that direction appears to have been reached unless a well located about 800 feet north of No. 9 (S) and the same distance southeast of No. 1 (G) should find gas sand of good quality, in which case it may be productive. If this well should prove to be successful, a well located midway between Providence wells Nos. 11 and 12 (R and P) would have a chance for either oil or gas in paying quantities. On the assumption that the Fayette gas sand is uniformly good over this area and that Providence wells Nos. 11, 12, and 13 have not been drilled to it, No. 11 (R) probably offers the best chances. No. 12 (P) seems less favorably located, and the position of No. 13 (N) appears to be unfavorable. No. 13 will most likely furnish salt water from the gas sand. The wells R and E, when finished to the gas sand, should go far toward determining the extent of this pool, as, from structural indications, the area northeast of the producing wells is the most favorable. The prospects for an extension in this direction are greatly reduced, however, by the failure of Providence well No. 5 (F) to find gas. This failure may have been due to a locally poor sand which, if soft and porous farther northeast, may again become productive. If either well R or well E should prove to be productive, a well located 2,000 feet a little south of east of well E and the same distance from well R should give valuable evidence as to the extent of the pool. Providence well No. 4 (C) should be drilled deeper as a test toward the north.

In brief, the Fayette gas pool is probably not fully developed. The most favorable opportunity for its extension is toward the north from Providence wells Nos. 1 and 8 (G and H) and, if the unfinished well E is successful, the trend of development should be east as well as north. The writer doubts, however, if this pool will prove to be large, especially if Providence wells Nos. 2 and 11 (D and R) have reached the Fayette gas sand.

POSSIBILITY OF OIL POOLS OCCURRING NEAR THE FAYETTE GAS POOL.

The presence of this gas pool can not be taken as a sure sign that oil has been accumulated somewhere near it. Many large gas fields, without accompanying pools of oil, occur in other parts of the Appalachian region. Most oil pools, however, are accompanied by pools of gas, or else the oil is associated with gas in the same pool. In the Fayette gas pool there is little available evidence to suggest the direction in which a pool of oil is most likely to occur in the gas sand. Such meager data as are at hand seem to slightly favor the NE. ¼ of sec. 9 and to a much less degree the S. ½ SE. ¼ sec. 9 and adjoining parts of sec. 16.

"Shows" of oil and gas have been noted in a number of sandstone beds in the wells of the Fayette district, and it is possible that some of these may be found to contain pools of oil of paying size in this vicinity. The most favorable indications for oil appear to have been found in sandstones relatively near the surface. Of these, Nos. 8 and 13 of section E, Plate V, appear to be the same sands that carry oil in the Brennan diamond-drill holes (T) noted in the driller's record of section F, Plate V.

A study of the core of Cosmos well No. 1 shows that enough oil has accumulated in the sandstone to form a pool and that it only lacks more pressure and a more porous pay sand to furnish wells of commercial size. In a theoretical way the data furnished by this core are intensely interesting. Beginning with No. 5 of this section (E, Pl. V) a bed of dark-gray shale is underlain by massive green shale (No. 6), which grades downward into fine greenish micaceous sandstone (No. 7); this in turn changes abruptly to massive brown (discolored by oil) sandstone (No. 8), which is saturated with oil and is, so far as the writer could detect, of practically the same texture and hardness as No. 7, being in fact a continuation of that bed. This sandstone is continuous downward unchanged, except for a thin sandy shale parting (No. 9) which contains no oil. Below No. 9 the sequence described above is repeated, No. 10 being a dark fine-grained shale, No. 11 a massive greenish shale grading into massive gray micaceous sandstone (No. 12), and then into a coarser phase of the same bed (No. 13), saturated with oil, with a nonpetroliferous sandstone (No. 14) below. A study of this core section leads to the conclusion that these oil beds represent true accumulations and that lack of pressure behind the oil and of porosity in the sandstones in which it occurs may be the only reason why they do not furnish oil in commercial quantities. Sandstone No. 8 of this well appears to be a part of the sandstones Nos. 7 to 9, inclusive, of section L, Plate V, in which good indications of oil were found. These facts suggest that this sand-

stone is oil bearing over a considerable area, and that in places where it is unusually coarse grained and porous small oil wells may be secured.

Another zone which shows more or less oil in almost every well is marked by Nos. 22 and 24 in section F, No. 16 in section G, No. 17 in section H, No. 22 in section I, No. 24 in section J, Nos. 17 or 19 in section L, and No. 11 in section M. Similar oil zones may be traced out on Plate V. These general oil zones indicate that the process of accumulation has gone on to a certain extent in this vicinity, and also that the Carboniferous strata contain appreciable quantities of oil which at favorable places may have been gathered into valuable pools.

The writer thinks it very probable that other and larger pools of gas and valuable pools of oil exist at places in the Warrior coal field. This belief is based on the age and character of the rocks which underlie this territory within reach of the drill. From these formations has been obtained a large part of the oil and gas of Oklahoma, and much of that of West Virginia, southeastern Ohio, and portions of Pennsylvania. The general structure of the coal basin and the detailed structure, as shown by the small area mapped, are apparently as favorable as that of the great oil and gas regions mentioned above, with the possible exception that there may be too many faults in certain parts of the Warrior coal field to offer ideal conditions. From the scanty data available, it seems that the general conditions governing the occurrence of underground water in this region are such as to offer almost ideal opportunities for this most important factor of oil and gas accumulation to exercise its function. These facts taken in connection with the known existence of one gas pool (though it may be a small one) and the presence of more or less gas and oil in sandstones at a number of points (indicating that the rocks have an appreciable amount of these hydrocarbons scattered through them), seem to show that all the general geologic conditions considered essential for the formation of valuable accumulations of oil and gas are present in this region.

FAVORABLE AREAS FOR TESTING OUTSIDE OF THE FAYETTE FIELD.

With but a very small amount of information at hand relative to the age and character of the unexposed rocks of this region in which oil and gas pools may occur, and still fewer facts regarding underground-water conditions, together with the lack of a map of the Warrior coal basin showing in detail the structure of the rocks, it is impossible to pick out with confidence small areas that are especially favorable for testing. The area in which the structure of the rocks is shown on the topographic map, though large enough to indicate

the character of the folds to be found in this region, is far too small to be of much value in determining the best places for future drilling in a prospective oil and gas territory as large as the Warrior coal field.

Gas in paying quantities has been found only in the Fayette field, where it comes from a sandstone in the lower part of the Pottsville formation. The few wells that have been drilled below this sand, though unproductive, can in no sense be considered as serious evidence against the possibility of valuable pools existing in the Mississippian series and even in lower formations. If the oil and gas of this region have been subjected to the same general processes of accumulation as those of the Appalachian region farther north, in New York, Pennsylvania, Ohio, and West Virginia, the accumulations in the upper sands will be found at places where those beds lie at a lower level than they do where the deeper sands are productive. Therefore, if it is assumed that the Fayette gas sand is near the middle of the vertical section of oil and gas bearing beds of this region, we should expect to find that the sands above this bed, which show oil and gas in the Fayette field, will contain the largest number of paying pools at places where they are at a lower level, or toward the south and west. Conversely, if the Mississippian series or any lower formations are productive, the pools are more likely to be found at points where they are as high as or higher than they are in the Fayette field, especially if on deeper drilling in the Fayette field these lower beds are found to be not productive and to furnish little or no salt water.

From this it is clear that there is no way of determining where drilling should be done until a detailed map showing the dip of the rocks over a considerable portion of the Warrior coal basin is available for study. With such a map and facts regarding the underground-water conditions in a number of widely scattered deep wells of this region, the uncertainty regarding the best localities for testing would disappear. It is therefore highly important from the point of view of the business man as well as the scientist not only that the geology of this region should be thoroughly studied, but also that the greatest care should be taken in future deep drilling to find out and record the water conditions of the beds. The kind of rock in which water is found, the kind of water, whether fresh or salt, the height to which it rises in the well, and its relative volume are facts of prime importance in selecting those areas in which valuable pools of oil and gas are most likely to occur. In using these data the geologist bases his deductions on the unquestioned laws of cause and effect, which have been more clearly worked out in other oil and gas fields that have been thoroughly developed. Such deductions, though based on imperfect data in a new field (and therefore not unquestionable) will if consistently followed, eliminate a large percentage of the

element of chance which is present and which will always be present in oil and gas operations.

With the above limitations before the reader, the writer ventures to suggest that the area lying north of the Fayette district (see fig. 1) has not received the attention from drillers that it deserves, though in making this suggestion he does not wish to minimize the value of testing in other directions.

From what is at present known of the geologic conditions of this region it seems probable that the northern part of Fayette County, the western part of Walker County, the eastern part of Lamar County, at least the southern part of Marion County, and the western part of Winston County contain small areas in which all the structural conditions necessary to the occurrence of oil and gas are present. This suggestion is advanced in the hope that future wildcat drilling will be more evenly distributed over the western part of the Warrior field and adjacent parts of the Coastal Plain. Such testing will not only more quickly determine the value of this region for oil and gas but will also furnish valuable geologic data which may be used to great advantage in outlining the areas that are worthy of thorough testing.

In this region no well should be considered a complete test unless it has penetrated 200 feet into the Chickamauga limestone, or at least has reached water in that formation, at points where the top of the limestone is less than 4,000 feet from the surface.

The axes of broad anticlines in regions of this kind offer from 20 to probably more than 50 per cent advantage for wildcat wells over other structural positions, but the superiority of one anticline over another in a different part of the region is dependent on general geologic conditions, the determination of which was beyond the scope of this work.