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Chas. N. Gould, Director

BULLETIN No. 4

COAL IN OKLAHOMA

By
C. W. Shannon and Others

REVISED AND EDITED
By
C. L. Cooper

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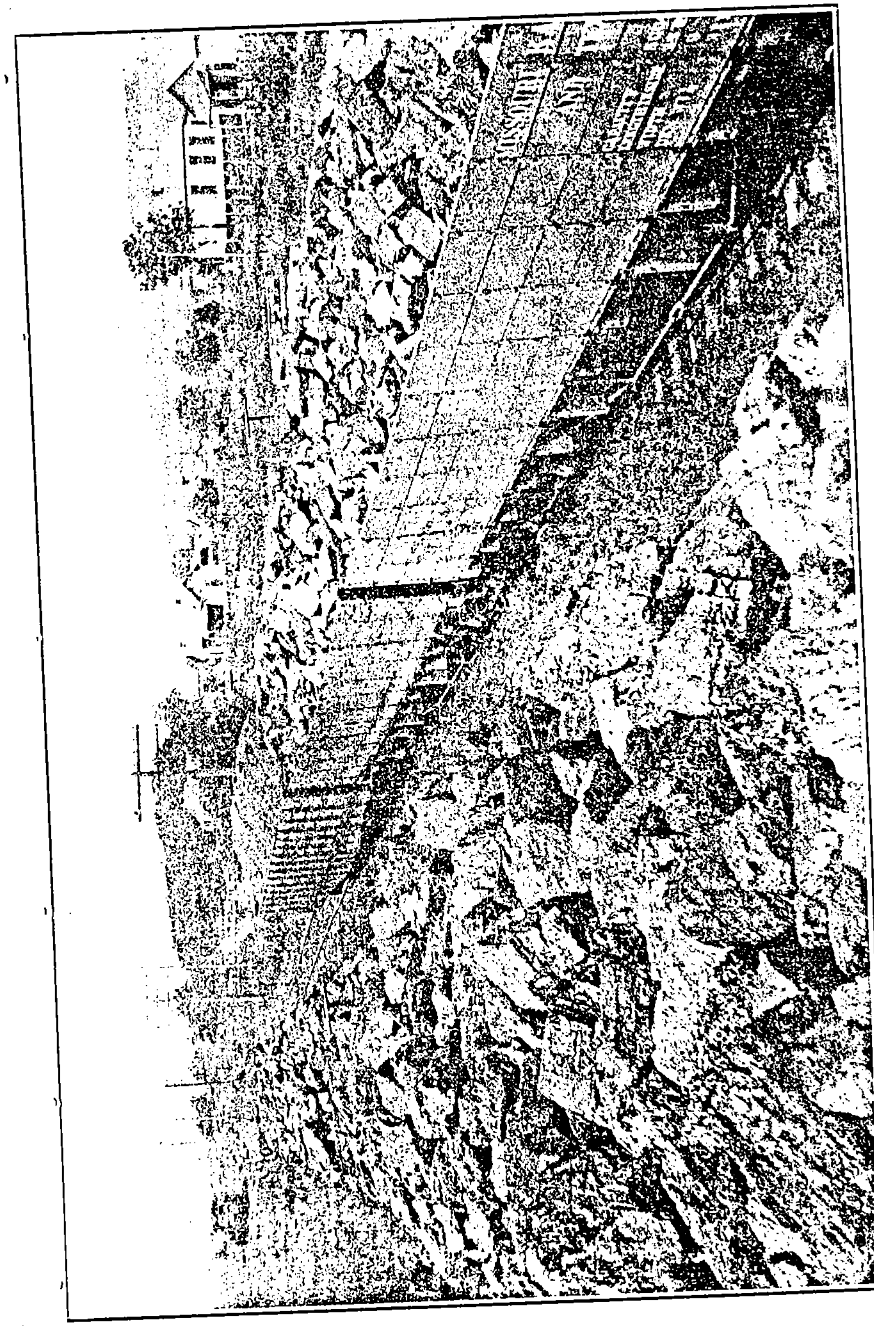


OKLAHOMA COAL READY FOR SHIPMENT

FOREWORD

A word of explanation is perhaps due to account for the fact that Bulletin No. 4, "Coal in Oklahoma," is issued at the same time when Bulletins No. 40 and 41 are coming from the press.

When the present Director organized the Oklahoma Geological Survey in 1908, and outlined the various objects to be accomplished, he designated the coal report as No. 4.

The preparation of the manuscript on this report was begun the next year. Other problems presented themselves, but data on coal was collected during the next few years. When Dr. D. W. Ohern became Director of the Survey in 1911, he assigned to Mr. C. W. Shannon the completion of the coal report. In 1914 Mr. Shannon became Director, and in 1915 he had the manuscript ready for printing. However, the legislature failed to provide a printing fund for this purpose, and for a number of years the manuscript and maps lay unpublished in the Survey vaults.

On again assuming the directorship of the Survey, July 1, 1924, the writer found this manuscript, among others, on file, but again the appropriations were insufficient for publishing. When new appropriations became available July 1, 1925, Mr. C. L. Cooper was assigned the task of revising and editing the coal report. It was found that a considerable part of the information contained in the manuscript was out of date, and it has been necessary to discard certain parts and to rewrite others.

To both Mr. Shannon and Mr. Cooper are due much credit for the preparation of this report; to the former for several years of hard and persistent work in the field and in the office in collecting and compiling information, and to the latter for a very careful revision of the manuscript.

Notwithstanding the delay in publication, it has been decided to issue the coal report under the old number, Bulletin No. 4. It is not considered good library practice to leave gaps in a series.

CHAS. N. GOULD, Director.

Norman, Okla.
July 21, 1926.

COAL IN OKLAHOMA

Part I. INTRODUCTION

ACKNOWLEDGMENTS

This report is the revision of a manuscript prepared by Mr. C. W. Shannon and others, written about 1914. Before publishing the manuscript it has been necessary to bring it up to date, which required the rewriting of certain parts, deleting here and adding there. In many places the form has been changed in order to conserve space, so, wherever data could be used in tabular form, it has been so placed.

The chapter on Geography has been added to the original manuscript, as has the outline of the coal areas of the United States. A number of tables have been compiled from Mineral Resources of the U. S. Bureau of Mines and added to Part I.

Much of the geology of the coal fields has been worked out in considerable detail, both by the U. S. Geological Survey and the State Survey. Supplemental structure and areal work was done by Mr. Shannon while working on this report during 1912 and 1913. The present author did most of the detailed work on the area in northeastern Oklahoma, and the map for this part of the state is the result of this work and that of D. W. Ohern[1] on the geology of the Vinita and Nowata quadrangles.

The following is Mr. Shannon's acknowledgments found in the original manuscript.

"In the course of the investigations in the field and in the preparation of the report, extensive use was made of all published information concerning the Oklahoma coal fields. Various reports on the coals of areas adjoining the Oklahoma fields were of value in the correlation and general information concerning the geological formations and horizons.

"In addition to the published reports, some material was on file in the offices of the Geological Survey. This consisted chiefly of sections, sketch maps, and field notes gathered in connection with other work.

"The survey is indebted to the various coal companies and many individuals for the liberal assistance in securing the fullest information. The superintendents and other officials of the companies operating in the field with few exceptions, gladly granted access to mine maps, records, statistics, gave all assistance possible for the examination of the mines, and answered in detail the many inquiries directed to them. In going over the field and through the mines much valuable

1. Ohern, D. W., Geology of the Vinita and Nowata quadrangles, Oklahoma: unpublished manuscript, Oklahoma Geol. Survey.

information was freely given by mine foremen, engineers, and miners. Many of the statistical data were secured in the first place from persons interviewed, and from records in the offices. These were supplemented and checked by comparison with the figures contained in the various reports of the Chief Mine Inspector of the State, and from the signed production cards of the operators, which are on file in the office of the Survey. Many tables and compilations were taken from the coal statistics published by the U. S. Geological Survey.

"Much of the historical matter was secured from persons who have been in the Oklahoma fields many years, and from the reports of the United States Mine Inspector for Indian Territory, prior to the year 1907."

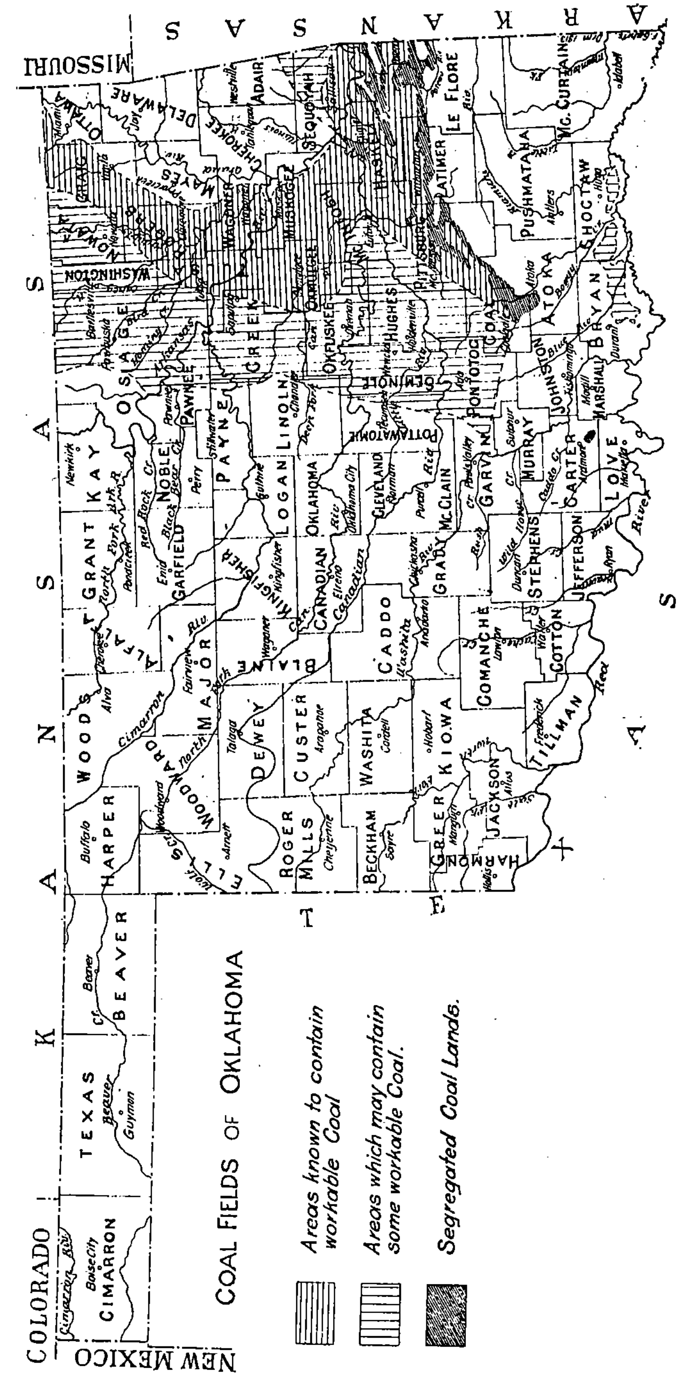


Figure 1

PREVIOUS WORK

In 1890 H. M. Chance examined a part of the coal measures of the Choctaw Nation between McAlester and Cavanal along the line of the Choctaw, Oklahoma and Gulf Railway and published a report in the proceedings of the American Institute of Mining Engineers for 1890, Vol. 6, pages 238-244, under the title of Geology of the Choctaw Field. This work was the first detailed account of the coal measures of Oklahoma.

In 1895 J. J. Stevenson made a reconnaissance of the coal bearing rocks and correlated the section made by Chance with an unpublished section of the coal-bearing formations of Arkansas by Arthur Winslow.

In 1896 N. F. Drake made a survey of the coal measures of Indian Territory north of the latitude of Hartshorne. He traced the coal bearing rocks from Kansas across the Cherokee, Creek, and Choctaw nations to the Arkansas coal fields. In this report the geology of the field is given in much more detail than in former reports.

In the Journal of Geology for 1897-98, page 352, is a review of the above paper, by C. R. Keys.

The United States Geological Survey has done much work in the Oklahoma coal fields. In 1895 the Survey began dividing the area into townships and sections, and making topographic maps. Most of these maps have been published and geologic folios covering parts of the area have been prepared. These folios include topographic sheets of the area, geologic maps, and a full description of the geology and the mineral resources. The folios which have been published on the area are the Coalgate, Atoka, Tishomingo, Tahlequah, and Muskogee folios.

In 1898 a paper by David White on the "Probable Age of McAlester Coal Group," was published in Science, New Series 7, page 512.

In 1898 a paper by C. R. Keys on "Structure of Coal Deposits Trans-Mississippian Field," appeared in Engineering and Mining Journal, Vol. 65, page 250 and following.

In 1899 a report by J. A. Taff on the "Geology of the McAlester-Lehigh Coal Field" was published in the Nineteenth Annual Report of the United States Geological Survey, Part III, pages 423-583.

In 1900 a report by J. A. Taff and G. I. Adams on the "Geology of the Eastern Choctaw Coal Field" was published in the Twenty-first Annual Report of the United States Geological Survey, Part II, page 257.

In 1901, a paper by C. R. Keys, on the "Horizon of Arkansas and Indian Territory Coals" was published in Engineering and Mining Journal, page 692.

In 1901, a review of the geology of the Choctaw Coal Fields, Taff and Adams, by C. R. Keys appeared in the American Geologist, Vol. 28, page 318.

In 1902 a report by J. A. Taff on the Southwestern Coal Field, was published in the Twenty-second Annual Report of the United States Geological Survey, Part III, page 367.

In 1903 an article by W. R. Crane, on "Coal Mining in Indian Territory and the Southwestern Field" appeared in Engineering and Mining Journal, page 577.

In 1903 an article by Franklin Bache, on the "Arkansas-Indian Territory Coal Field" was published in Engineering and Mining Journal, Vol. 76, page 390.

In 1905 a report by J. A. Taff, on the "Progress of Coal Work in Indian Territory" was made public through Economic Geology, Bulletin 260, pages 383-401.

In 1906 an article by W. R. Crane on "Coal Mining in Indian Territory" was published in Engineering and Mining Journal for April 7.

In 1910 a report on "Coal Land in Oklahoma" was given out as Senate Document No. 390. This document is a message from the President of the United States transmitting reports rendered in connection with the investigation to determine the extent and value of the coal deposits in and under the segregated coal lands of the Choctaw and Chickasha nations in Oklahoma. This includes the reports and maps which had been issued from 1904 to 1906 as Circular Nos. 1, 2, 3, 4, and 5 containing description and maps of the unleased segregated coal lands in the following areas:

The McAlester District
The Wilburton-Stigler District
The Howe-Poteau District
The McCurtain-Massey District
The Lehigh-Ardmore District

Much additional work has since been done by the United States Geological Survey, and other reports and bulletins are in the course of preparation.

The Oklahoma Geological Survey has carried on investigations on the coal and coal mining in the State ever since the survey has been established.

In 1909 a short article by Chas. N. Gould on the "Coals of Oklahoma" appeared in Mines and Minerals, pages 275-276, and in 1910 a paper by the same author, in Mining and Scientific Press, gives a general discussion of the field.

In 1910 a bulletin was prepared by Chas. N. Gould, D. W. Ohern, and L. L. Hutchinson, entitled "Proposed Groups of Pennsylvanian Rocks of Eastern Oklahoma," and was published as research bulletin No. 3, by the State University of Oklahoma.

In 1910 a paper by D. W. Ohern on the "Stratigraphy of the older Pennsylvanian Rocks of Northeastern Oklahoma" was published as research bulletin No. 4, by the State University of Oklahoma.

In 1910-11 D. W. Ohern with the assistance of a number of geologists prepared a manuscript (now unpublished) on the "Geology of the Vinita and Nowata Quadrangles, Oklahoma," in which the coals in that part of the State are discussed. This manuscript will be revised at an early date and published as separate reports on the geology of Craig, Nowata and Washington counties.

In 1912 in an article on the "Mineral Resources of Oklahoma," by L. C. Snider, published in Mining and Engineering World, page 231, is included a brief description of the Oklahoma coal fields.

COAL FIELDS OF THE UNITED STATES

The largest and most extensive coal fields in the world are found in the United States. It is estimated that two and one-half trillion tons of coal are to be found at a mineable depth (about 3,000 feet) below the surface, and of this amount, less than one per cent has been mined. The above figures show that the coal deposits of the United States are adequate to supply the needs of the country for an indefinite period of time. However, those coal beds which are now being worked, are the largest and most accessable to be found.

The following outline shows the distribution of the coal areas of the United States as developed by M. R. Campbell, and which has been adopted by the U. S. Geological Survey.

Outline of the Coal Areas of the United States

I. Eastern Province
  1. Anthracite region—Pennsylvania
  2. Atlantic Coast region—Triassic fields of Virginia and North Carolina
  3. Appalachian region—From northern Pennsylvania into Alabama, including parts of Ohio, Maryland, Virginia, West Virginia, east Kentucky, Tennessee and Georgia

II. Interior Province
  1. Northern region—Michigan coal field
  2. Eastern region—Illinois, Indiana and west Kentucky fields
  3. Western region—Iowa, Missouri, Nebraska, Kansas, Arkansas and Oklahoma fields
  4. Southern region—Central Texas fields

III. Gulf Province
  1. Mississippi region—Louisiana, Mississippi and Alabama fields
  2. Texas region—Eastern Arkansas and Texas fields

IV. Northern Great Plains Province
  1. Fort Union region—North Dakota, South Dakota, east Montana, and northeast Wyoming fields
  2. Black Hills region—part of Wyoming
  3. Assinniboine region—Montana
  4. Judith Basin region—Montana
  5. Denver region—Colorado
  6. Raton Mountain region—Colorado and New Mexico

V. Rocky Mountain Province
  1. Yellowstone region—Montana
  2. Bighorn Basin region—Wyoming
  3. Hams Fort region—west Wyoming
  4. Green River region—south Wyoming
  5. Uinta region—Utah and Colorado
  6. San Juan region—Colorado and New Mexico
  7. Southwest Utah region

VI. Pacific Coast Province
  (Not divided into regions, but embraces coal fields in California, Oregon, and Washington).

THE TRANSFORMATION OF VEGETAL MATTER INTO COAL

Vegetation, on changing into coal, passes through two stages of alteration. The first change is due to the action of bacteria and other low forms of life. The other change is brought about by the geological agencies which produce a chemical and physical alteration of the coal beds.

When plants cease to grow and fall into a bog or swamp, they become subject to the action of bacteria. In addition to bacteria, there are many large plants which produce chemical changes and aid in the alteration of the plant remains. This action (biochemical) goes on only in the upper layers of peat, because the lower portions are so charged with organic acids that bacteria cannot exist. The result of the chemical action is to change the hydrocarbon compounds of the plant into simple compounds accompanying the evolution of a gas, which is formed by the union of hydrogen and carbon. This gas is called methane (marsh gas). When bacterial action has reached the stage where the peat bog is so charged with organic acids that the bacteria can no longer exist, the coal forming action stops and the material remains in this condition until a second and different group of changes set in. These last influences regulate what is called the "fixed carbon content" of the coal. This action is accompanied by the evolution of more of the volatile constituents of the mass. The degree of carbonization depends upon the intensity of, and the time through which the second change (the dynamochemical) influence are in operation.

In addition to the two changes mentioned above, the following factors also influence the varieties of coal which may be obtained from vegetable matter:[2]

1. Differences in kind of vegetation and differences in climate in the coal forming regions.
2. Length of time during which the vegetation has been exposed to the air.
3. Length of time since burial of the material.
4. Depth of burial of the material.
5. Action of heat, due to compression, or igneous intrusions.
6. Possibility of escape of volatile constituents after burial beneath sediments.
7. Pressure resulting from the compression of the seam during dynamic changes in the enclosing rocks.

PHYSICAL AND CHEMICAL PROPERTIES OF COAL

In order that the various terms used throughout this report, and in the tables accompanying may be better understood, some of the physical and chemical properties will be briefly described.

PHYSICAL

Specific Gravity. The specific gravity of a substance is the ratio of its weight in air, to the weight of an equal volume of water at 4°C. When the specific gravity of a specimen of coal is desired, it can be roughly determined by first weighing the specimen in air **(W)**, then in water **(W_1)**. Since the volume of a substance is equal to the amount of water displaced, the specific gravity is found by the following formula:

$$\text{Sp. Gr.} = \frac{W}{W - W_1}$$

Hardness. The hardness of coal can be determined by its ability to withstand abrasion. The hardness of coal varies from soft lignite to that of hard anthracite. The hardness of anthracite varies 2 to 2.5 in Moh's scale of hardness, which means it is a little harder than the finger nail.

Fracture. Fracture describes the manner in which the coal breaks up into smaller fragments, and is an important factor in recognizing the types of coal by megascopic examination. Anthracite usually breaks with a conchoidal fracture, as also does cannel coal, but the other varieties of coal (bituminous) generally have a rectangular or cubical fracture. Lignite breaks into rough, flat and elongated blocks.

2. Moore, Edward S., Coal: John Wiley & Sons, Inc., N. Y., p. 160, 1922.

Color and Streak. The color of coal varies from light to dark brown (lignite) to grayish black or jet black of the higher grades (bituminous and anthracite). The streak is the color of the powdered coal, and can be determined by making a mark on a piece of unglazed porcelain. The streak of a coal below the grade of bituminous is brown to yellow. The bituminous and cannel coals have a brown to black streak, and anthracite a black streak.

Luster. Luster is the manner in which coal reflects light from its surface, and this property is often used to determine the variety of coal. Anthracite usually has a bright to almost sub-metallic luster, and that of mineral charcoal is always dull and earthy. In bituminous coal there are interlayered bright and dull bands.

CHEMICAL

In order to determine some of the chemical properties of coal, the method known as "approximate analysis" is used. By it is determined the moisture, volatile matter, fixed carbon, ash and sulphur content. This method is used for practical purposes, since it is more readily made and furnishes all data necessary for the purpose of determining the quality of coal.

Moisture. Moisture is the amount of water to be found in coal. It is determined by placing a weighed sample to be tested in a pre-heated oven (104° to 110°F), through which is passed a current of dry air. The difference in weight of the sample before and after heating in the oven gives the data for computing the percentage of moisture.

Volatile Matter. Volatile matter is the vaporizable material which the coal contains. The standard method of determining the volatile matter is by placing a weighed sample of coal into a specially constructed furnace where it is kept at a temperature of 950° F. (±20° C.) The sample is heated for seven minutes and then removed from the furnace. When cool, the sample is weighed again. The loss of weight minus the moisture content equals the volatile matter.

Ash. The ash of coal or coke is a non-combustible mixture of silicates, oxides, carbonates and sulphates of the various metallic elements. The composition of the ash is of no great importance unless the coal is to be used for metallurgical purposes. To determine the ash content, the sample is placed in a furnace at a low temperature, and gradually heated to redness. When cool, the difference in weight before and after heating will give the amount of ash contained in the sample.

Fixed Carbon. The fixed carbon content is always determined as follows: 100—(percentage of moisture+percentage of ash + percentage of volatile matter) = fixed carbon.

Sulphur. Sulphur is important only in coal that is to be used for metallurgical purposes. The method of determining it need not be given here.

Calorific Value. The unit of heat is the British Thermal Unit (B. t. u.) which is the amount of heat necessary to raise one pound of water 1° F. The expression "coal has a calorific value of 8,000 B. t. u." means that upon burning, one pound of coal will produce enough heat to raise 8,000 pounds of water 1° F, or it will raise 1,000 pounds of water 8° F.

Table No. 1. *Analyses of Oklahoma Coals*

SAMPLE NO.	MOISTURE	VOL. MATTER	FIXED CARBON	ASH	SULPHUR	PHOSPHOROUS	B. T. U.	AUTHORITY*
1.	5.96	36.03	44.44	10.48	3.09	....	11,849	a
2.	4.92	37.70	41.91	10.78	4.60	....	11,793	a
3.	2.15	42.10	38.18	14.07	3.50	....	5,545	k
4.	0.00	40.74	50.70	6.60	2.25	0.01	....	..
5.	4.68	37.73	33.93	15.39	8.27	....	10,502	a
6.	6.30	36.66	34.61	16.01	6.42	....	10,500	a
7.	5.65	38.55	40.48	10.90	4.42	....	11,768	a
8.	6.24	35.44	45.33	12.99	3.86	....	12,027	b
9.	3.56	41.61	41.12	13.71	4.56	0.024	....	b
10a.	3.75	38.15	45.77	12.33	3.83	....	....	b
10b.	4.69	39.76	46.06	9.49	3.74	....	12,071	b
11.	5.22	37.89	41.99	10.26	4.64	....	11,896	a
12.	3.32	41.09	43.36	9.11	3.12	....	13,017	a_1
13.	4.69	32.41	42.91	19.99	3.32	....	....	b
14.	5.54	38.12	40.42	11.16	4.76	....	11,726	a
15.	5.60	41.51	38.75	10.84	3.30	....	12,409	a
16.	5.42	36.47	49.18	6.98	1.95	....	12,557	a
17.	4.97	36.54	42.66	12.70	3.13	....	12,294	a
18.	4.66	38.25	43.94	9.84	3.31	....	12,732	a
19.	2.52	35.24	54.25	6.08	1.61	....	13,693	a
20.	2.44	37.73	50.91	7.91	0.38	....	13,529	a
21.	0.82	35.36	40.73	16.35	7.93	Trace	12,146	a
22.	1.04	36.10	44.73	13.45	4.77	Trace	13,209	a
23.	0.63	29.65	36.12	27.48	6.11	Trace	10,716	a
24.	0.91	33.95	41.85	18.12	5.21	Trace	12,376	a
25.	1.51	37.84	54.60	5.23	0.82	....	14,141	a_1
26.	2.32	38.06	53.09	5.04	1.49	....	14,049	a
27.	1.82	38.48	52.91	5.92	0.87	....	13,996	a_1
28.	3.56	36.22	51.44	6.81	1.97	....	13,053	a
29.	2.60	37.36	52.86	6.46	0.70	....	13,707	a
30.	1.68	38.05	54.44	4.62	1.21	....	14,547	a

SAMPLE NO.	MOISTURE	VOL. MATTER	FIXED CARBON	ASH	SULPHUR	PHOSPHOROUS	B. T. U.	AUTHORITY
31.	3.42	37.41	56.47	1.90	0.80	....	14,441	a
32.	3.32	37.20	53.96	4.05	1.47	....	13,932	a_1
33.	3.21	40.28	50.87	4.41	1.23	....	13,989	a_1
34.	3.55	35.85	56.43	3.07	1.10	....	13,788	a
35.	3.88	38.20	52.36	4.35	1.21	....	13,656	a
36.	1.42	38.37	49.30	8.46	2.45	....	13,449	a_1
37.	2.55	39.37	48.49	7.01	2.58	....	13,506	a
38.	1.01	39.58	52.45	5.52	1.44	....	14,058	a_1
39.	5.03	34.18	53.88	5.39	1.52	....	13,032	a
40.	4.80	33.91	57.47	2.42	1.40	....	13,169	a
41.	4.95	35.01	50.24	8.38	1.42	....	12,648	a
42.	2.56	37.69	48.86	8.11	2.78	....	13,077	a
43.	4.79	37.30	47.58	10.33	3.93	....	13,005	a
44.	2.12	39.37	50.47	6.95	1.09	....	13,781	..
45.	4.54	37.50	49.40	8.56	......	....	12,710	b
46.	2.97	40.43	48.22	8.38	3.05	....	12,591	b
47.	2.93	39.02	47.75	10.30	3.73	....	....	b
48.	3.45	37.45	47.82	11.28	3.67	....	12,258	..
49a.	3.00	37.10	50.03	9.87	3.20	....	....	b
49b.	3.61	38.99	49.73	7.67	3.27	....	....	b
50.	5.46	34.69	51.84	6.37	1.64	....	13,162	a
51.	2.19	40.35	48.23	5.96	3.27	....	13,529	a
52.	2.01	37.91	49.22	8.54	2.32	....	13,361	
53.	2.93	40.95	49.68	6.44	......	....	14,000	a
54.	2.09	35.72	56.12	3.80	1.37	....	13,915	a
55.	2.64	36.02	54.72	5.42	1.20	....	13,807	a
56.	2.50	35.82	53.50	6.79	1.39	....	13,687	a
57.	1.91	36.40	54.63	6.11	0.95	....	14,043	a
58.	1.98	36.06	55.37	5.52	1.07	....	14,173	a
59.	7.05	14.50	39.25	42.43	5.77	....	....	a
60.	1.74	37.00	56.86	4.40	0.65	0.014	....	b
61.	3.55	34.92	55.53	4.75	1.25	....	13,865	a
62.	3.23	35.86	56.66	3.04	1.21	....	14,343	a
63.	1.68	41.00	51.91	5.41	2.72	0.012	....	b
64.	4.32	38.57	48.42	7.30	1.39	....	13,353	a_1
65.	2.17	37.95	54.88	3.98	1.02	....	14,691	a
66.	1.71	37.46	55.47	4.48	0.88	....	14,310	a
67.	3.10	37.91	50.79	6.56	1.64	....	13,690	..
68.	2.42	40.06	48.02	6.36	3.14	....	13,764	a
69.	2.95	35.85	44.46	14.14	2.60	....	12,049	a
70.	1.85	39.01	46.43	9.53	3.18	....	13,094	a
71.	4.04	39.44	47.44	5.88	3.20	....	13,350	a_1
72a.	1.46	39.04	53.10	6.40	1.38	....	14,040	b
72b.	1.30	38.90	52.15	7.65	1.58	....	....	b
73a.	1.70	37.19	49.79	11.32	1.56	....	12,874	b
73b.	1.66	38.29	49.84	10.21	1.50	....	....	b
74.	3.71	36.21	50.31	9.77	1.39	....	13,414	b
75.	2.59	40.25	49.85	5.17	2.14	....	13,833	a_1
76.	3.00	39.34	50.86	5.66	1:14	....	13,701	a
77.	2.45	37.92	52.82	5.91	0.90	....	13,932	a
78.	2.25	38.01	47.39	10.08	2.27	....	13,112	a
79.	2.07	39.74	47.42	8.56	2.21	....	13,263	a
80.	2.08	37.52	56.02	4.38	0.80	0.016	....	b
81.	3.72	34.86	51.57	8.89	0.96	....	13,244	a

SAMPLE NO.	MOISTURE	VOL. MATTER	FIXED CARBON	ASH	SULPHUR	PHOSPHOROUS	B. T. U.	AUTHORITY
82.	3.33	34.47	52.87	8.45	0.83	....	13,297	a
83.	1.95	34.99	55.95	5.65	1.46	....	13,826	a
84.	1.82	37.95	54.07	5.46	0.70	....	14,055	a
85.	2.07	39.74	47.42	8.56	2.21	....	13,263	a
86.	1.00	35.00	58.00	6.00	......	....	13,960	c
87.	1.02	33.14	58.42	5.02	1.80	....	14,237	..
88.	2.92	32.45	60.26	3.47	0.90	....	14,389	..
89.	0.24	15.13	80.00	4.63	1.22	0.14	....	b
90.	0.94	15.88	72.47	9.25	1.46	....	13,975	a
91.	0.48	23.82	66.69	9.01	4.64	0.02	....	b
92.	0.57	26.39	66.64	5.25	1.16	....	....	d
93.	0.55	23.02	64.21	12.22	5.81	0.20	....	b
94.	1.52	32.76	59.90	4.52	1.30	....	14,389	..
95.	3.97	33.38	54.53	7.04	1.08	....	13,302	a
96.	6.59	33.17	51.99	7.24	1.01	....	....	a
97.	5.68	30.86	49.36	12.56	1.54	....	11,809	a
98.	5.20	32.60	60.10	2.10	0.90	....	13,316	e
99.	5.70	32.65	51.10	10.55	2.50	....	11,620	f
100.	4.82	27.93	45.29	21.96	1.48	....	....	g
101.	7.65	33.96	46.30	12.09	1.80	....	12,728	b
102.	5.91	36.99	50.82	5.03	1.25	....	13,478	a
103.	5.50	35.61	49.84	7.34	1.71	....	12,015	a
104.	5.80	32.82	53.82	7.56	1.90	....	12,900	f
105.	2.11	22.66	66.83	7.24	1.16	....	14,026	a
106.	2.87	41.19	48.65	5.02	2.27	....	13,812	..
107.	0.17	15.51	71.01	13.31	1.20	0.90	....	b
108.	0.17	16.53	78.27	5.03	0.88	0.33	....	b
109.	0.24	15.13	80.00	4.63	1.22	0.140	....	b
110.	0.64	14.29	76.66	8.41	1.24	....	....	b
111.	2.35	32.42	58.47	4.32	2.42	....	....	h
112.	0.22	23.54	66.16	10.08	4.33	0.031	....	b
113.	1.04	37.96	55.84	5.16	2.00	0.012	....	b
114.	2.54	30.90	62.37	3.56	0.60	....	....	h
115.	1.85	39.01	46.53	9.53	3.08	....	13,145	a
116.	3.61	20.02	66.10	9.32	0.95	....	13,300	..
117.	0.22	23.54	66.16	10.08	4.33	0.31	....	b
118.	5.60	34.83	47.38	11.29	2.91	....	12,820	b
119.	1.01	34.57	57.98	5.01	1.43	....	14,418	..
120.	1.66	23.01	72.47	1.92	0.91	....	....	i
121.	1.60	24.83	68.69	2.95	1.90	....	....	i
122.	6.26	27.16	64.17	1.84	0.56	....	....	i
123.	1.25	22.49	62.18	7.88	6.18	....	....	l
124.	6.30	30.78	59.92	2.11	0.87	....	....	h
125.	1.62	32.97	55.79	9.65	......	....	....	h
126.	1.43	38.15	50.76	9.66	1.38	0.052	....	b
127.	0.41	18.23	76.53	....	1.06	....	....	j
128.	0.45	20.89	68.86	9.80	0.69	0.63	....	b
129.	0.48	22.03	71.28	6.21	1.13	0.12	....	b
130.	1.18	16.32	10.51	69.53	2.46	....	13,737	a
131.	1.85	15.86	63.11	17.86	1.32	....	11,929	a
132.	2.55	41.58	42.36	9.99	3.52	Trace	13,162	a
133.	......	36.03	56.59	7.32	1.78	....	13,239	l
134.	......	36.87	58.81	4.32	1.40	....	13,090	l
135.	......	34.50	52.34	13.16	1.50	....	14,000	l

SAMPLE NO.	MOISTURE	VOL. MATTER	FIXED CARBON	ASH	SULPHUR	PHOSPHOROUS	B. T. U.	AUTHORITY
136.	......	35.37	54.42	10.21	1.47	....	13,449	l
137.	......	35.31	58.29	6.20	0.96	....	13,637	l
138.	2.83	34.14	55.40	6.93	0.70	....	13,770	a
139.	1.93	38.66	54.23	4.22	0.96	....	14,218	..
140.	2.28	38.61	52.86	5.22	1.03	....	14,009	..
141.	2.30	37.79	53.42	5.48	1.01	....	13,959	..
142.	2.64	35.25	54.85	6.05	1.21	....	13,804	a
143.	1.87	35.30	54.09	7.54	1.20	....	13,734	a
144.	1.49	37.83	53.06	7.62	1.01	0.023	....	b
145.	3.60	15.13	64.45	15.13	1.63	....	12,298	a
146.	2.80	36.51	53.53	6.73	1.38	....	13,826	a
147.	2.60	37.74	50.63	7.81	1.22	....	13,322	a
148.	2.58	35.62	50.98	10.82	4.91	....	13,085	m
149.	5.19	36.65	59.85	3.50	......	....	14,185	n
150.	4.17	36.51	55.58	7.91	......	....	13,350	n
151.	4.24	37.22	56.01	6.77	......	....	13,641	n
152.	5.53	37.08	57.63	5.29	......	....	14,012	n
153.	4.80	36.79	57.20	6.01	......	....	13,759	n

*a. Oklahoma Geological Survey. a_1. Oklahoma Geol. Survey and Coal Company. b. U. S. Geological Survey. c. Union Coal Co. d. Railroad Company. e. Fairbanks-Morse Mfg. Co. f. St. Louis Sampling and Testing Co. g. A. C. Fieldman, Chemist, Division of Mine Accidents. U. S. Geol. Survey. h. N. F. Drake. i. A. S. McCreath, State Chemist of Pa. j. Mexican Gulf Coal & Transportation Co. k. E. E. Burlingame & Co., Denver, Col. l. Bur. of Econ. Geol. & Tech. Univ. of Texas. m. Kansas City Testing Laboratory. n. U. S. Bureau of Mines.

Location and Description of Samples of Oklahoma Coals Used in Analysis Given in Table No. 1

SAMPLE NUMBER — **LOCATION AND DESCRIPTION**

1. Lehigh bed, Mine No. 5, Coalgate. Mine run coal, taken from fresh face. Six inches of bone at the top of coal.
2. Lehigh bed, Mine No. 5, Coalgate. Taken from car at tipple.
3. Lehigh bed, Mine No. 5, Coalgate. Sample taken from bony coal at top of seam.
4. Lehigh bed, Mine No. 5, Coalgate. Represents screened coal.
5. Lehigh bed, Mine No. 1, Midway. Taken from block of coal on exhibit at the Mineral Building, State Fair grounds, Oklahoma City.
6. Lehigh bed, Mine No. 1, Midway. Taken from carload designated as mine run coal.
7. Lehigh bed, Mine No. 5, Lehigh. Sample taken at mine from working face.
8. McAlester or Lehigh bed, Mine No. 5, one half mile north of Lehigh. Sample taken from carload lot, over one inch screen; 60 per cent small, 40 per cent slack.
9. Lehigh bed, Mine No. 5, Lehigh. Taken at mine from car ready for shipment.
10. (a and b) McAlester or Lehigh bed, Mine No. 5, Lehigh. Samples from mine. (a) from the 8th south entry, No. 5 slope; (b) from 3rd north entry, No. 4 slope.
11. Lehigh bed, Mine No. 6, Phillips. Mine run coal, taken in 10th south entry from fresh solid face.
12. Lehigh bed, Mine No. 6, Lehigh.
13. McAlester or Lehigh bed, Mine No. 5. Taken from carload of pea and slack mixed.
14. Lehigh bed, Mine No. 8, Lehigh. Taken in the mine at the first south entry. Represents a mine run sample.
15. Lehigh bed, Mine No. 8, Lehigh.
16. Lehigh bed, Mine No. 10, Coalgate. Taken in mine on fresh working face on the 10th west, upper left.

SAMPLE NUMBER	LOCATION AND DESCRIPTION
17.	Lehigh bed, Mine No. 12, near Coalgate. Represents carload of mine run coal being loaded at tipple.
18.	Lehigh bed, Mine No. 14, Coalgate. Sampled in the 7th west entry.
19.	McAlester bed, Mine No. 3, northwest McAlester. Taken from the mine on the 12th east entry.
20.	McAlester bed, Mine No. 4, Craig. Taken from carload of nut coal after delivery.
21.	Witteville bed, Mine No. 1, north of Quinton, Witteville. Taken from two mine cars which had just come from the mine.
22.	Witteville coal, Mine No. 6, northwest of Quinton. Taken from principal part of bed.
23.	Witteville, Mine No. 6, northwest of Quinton. Taken from coal chute from the compact, bony layer of the bed.
24.	Witteville coal, Mine No. 6, northwest of Quinton. Taken from coal after screening.
25.	Upper Hartshorne, Mine No. 2, Wilburton. Taken according standard specifications.
26.	Upper Hartshorne, Mine No. 3, Wilburton. Taken from a working face in the mine.
27.	Upper Hartshorne bed, Mine No. 3, Wilburton.
28.	McAlester bed, Mine No. 9, Baker, northwest McAlester. Taken from a working face, room No. 4, 5th east entry.
29.	Lower Hartshorne bed, Mine No. 29, Haileyville. Taken in the mine, and represents full thickness of coal.
30.	Lower Hartshorne bed, Mine No. 1, Haileyville. Taken from block of coal on exhibit at the Mineral Building, State Fair grounds, Oklahoma City.
31.	Lower Hartshorne bed, Mine No. 2, southwest of Haileyville. Taken from the mine, and represents full thickness of coal.
32.	Lower Hartshorne bed, Mine No. 2, Haileyville.
33.	Lower Hartshorne bed, Mine No. 3, near Haileyville.
34.	McAlester bed, Mine No. 6, southwest of Haileyville. Taken from carload of lump coal, ready for shipment.
35.	McAlester bed, Mine No. 6, southwest of Haileyville. Taken from working face of mine, and represents full thickness of coal.
36.	Lower Hartshorne bed, Mine No. 1, Lutie. Taken from a fresh face in the mine, near end of slope, 1,200 feet from the entry.
37.	Lower Hartshorne bed, Mine No. 4, Lutie. Taken from a fresh face in mine, near end of slope, 1,200 feet from the entry.
38.	Lower Hartshorne bed, Mine No. 4, east of Lutie.
39.	McAlester bed, Mine No. 1, Pittsburg. Taken in third west entry from a working face.
40.	McAlester bed, Mine No. 1, Pittsburg. Represents carload shipment of well screened coal.
41.	McAlester bed, Mine No. 1, Pittsburg. Taken from car of mine run coal.
42.	McAlester bed, Mine No. 1, Pittsburg. Selected sample, lump coal.
43.	McAlester bed, Mine No. 1, Pittsburg. Taken from carload; small coal, 50 per cent; slack, 50 per cent.
44.	McAlester bed, Mine No. 1, Pittsburg.
45.	McAlester bed, Mine No. 1, Pittsburg.
46.	McAlester bed, Mine No. 1, Pittsburg. Taken at mine in 2nd west air course.
47.	McAlester bed, Mine No. 1, Pittsburg. Taken at mine in 5th east air course.
48.	McAlester bed, Mine No. 1, Pittsburg. Car sample of mine run coal.
49.	(a and b) McAlester bed, Mine No. 1, Pittsburg. Sample (a) coal as shipped, (b) washed coal.
50.	McAlester bed, Mine No. 2, Pittsburg. From fresh face, 2nd east entry.
51.	McAlester bed, Mine No. 2, Pittsburg. Selected sample, lump coal.
52.	McAlester bed, Mine No. 2, Pittsburg.
53.	McAlester bed, Mine Nos. 1 and 2, Pittsburg. Taken from sack of washed slack from washer at Mine No. 2.
54.	McAlester bed, Mine Nos. 2 and 3, Dow. From a car being loaded from trips from both mines.

SAMPLE NUMBER	LOCATION AND DESCRIPTION
55.	McAlester bed, Mine No. 5, Dow. Taken at mine on 1st south, off north plane.
56.	McAlester bed, Mine No. 8, south of Krebs. Taken from face at end of mine slope, 4,500 feet from mouth.
57.	McAlester bed, Mine Nos. 2, 5, and 9, McAlester area. From carload of washed nut coal, as shipped from washer at Krebs.
58.	McAlester bed, Mine Nos. 2, 5, and 9. McAlester area. Taken from carload of washed nut coal, as shipped from washer at Krebs.
59.	McAlester bed, Mine Nos. 2, 5, and 9, McAlester area. Taken from refuse of the coal from washer at Krebs.
60.	McAlester bed, Mine No. 10, Krebs. From coal at mine, ready for shipment.
61.	McAlester bed, Homer slope (?) north of Krebs. From working face and represents full thickness of coal.
62.	McAlester bed, north of North McAlester. From pile of coal just removed from mine.
63.	Hartshorne bed, Mine No. 1, Hartshorne. Taken at mine from coal ready for shipment.
64.	Lower Hartshorne bed, Mine No. 3, Gowen.
65.	McAlester bed, Mine No. 5, Alderson. Taken from fresh working face in room 28, 2nd east entry.
66.	McAlester bed, Mine No. 5, Alderson. Taken from block of coal on exhibit at the Mineral Building, State Fair grounds, Oklahoma City.
67.	Lower Hartshorne bed, Mine No. 7, one mile east of Hartshorne. From working face in 1st north, 3rd east entry.
68.	Lower Hartshorne bed, Mine No. 7, one mile east of Hartshorne. Taken from carload of lump coal at tipple.
69.	Lower Hartshorne bed, Mine No. 7, one mile east of Hartshorne. Represents carload of slack coal.
70.	Lower Hartshorne bed, Mine No. 7, one mile east of Hartshorne. From block of coal on exhibit at the Mineral Building, State Fair grounds, Oklahoma City.
71.	Lower Hartshorne bed, Mine No. 7, Hartshorne.
72.	(a and b) Lower Hartshorne bed, Mine No. 8. (a) from room No. 14, off the east entry; (b) from room No. 16, off the 7th west entry.
73.	(a and b) Lower Hartshorne bed, Mine No. 8, Hartshorne. Mine run coal (a) car sample; (b) from quantity to be used for coking tests.
74.	Hartshorne bed, Mine No. 8, Hartshorne. From carload of nut and slack.
75.	Lower Hartshorne bed, Mine No. 8, Hartshorne.
76.	Lower Hartshorne bed, Mine No. 40, Gowen. From working face in the 1st west entry.
77.	Lower Hartshorne bed, Mine No. 2, Pocahontas. From a working face in the 6th east entry.
78.	Lower Hartshorne bed, Mine No. 2, Pocahontas. Represents carload of lump coal as loaded at tipple.
79.	Lower Hartshorne bed, Mine No. 2, Pocahontas. Sample carload of lump coal.
80.	McAlester bed, Mine No. 1, one mile west of North McAlester. From car ready for shipment.
81.	McAlester bed, Mine No. 2, west of North McAlester. Represents carload lot of mine run coal.
82.	McAlester bed, Mine No. 2, west of North McAlester. From mine car just loaded from 6th west entry.
83.	Panama bed, Mine No. 4, Ardmore. Taken at beginning of 9th west entry.
84.	Panama bed, Mine Nos. 3 and 4, Ardmore. From carload of lump coal as shipped.
85.	Panama bed, Mine Nos. 3 and 4, Ardmore. Carload sample of lump coal, loaded from both mines.
86.	McAlester bed, Mine No. 5, northeast of McAlester. Average from several analyses from the mine.
87.	Lower Hartshorne bed, Mine No. 1 (?) Hughes.
88.	Lower Hartshorne bed, Mine No. 2, Hughes.
89.	Panama bed, Mine No. 1, west of Panama. Standard sample taken.

SAMPLE NUMBER	LOCATION AND DESCRIPTION
90.	Panama bed, Mine No. 2, west of Panama. Taken from car at tipple; loaded two days before.
91.	Upper Witteville bed, (Mayberry), six miles from Witteville station, sec. 15, T. 7 N., R. 25 E. Standard mine run sample.
92.	Witteville coal, Mine near Witteville. Selected sample.
93.	Upper Witteville bed, (Mayberry), Mayberry Mine, sec. 11, T. 7 N., R. 24 E. Standard sample taken.
94.	Lower Hartshorne bed, Mine No. 1, Red Oak.
95.	Henryetta bed, Mine No. 1, Henryetta. Sample taken from block on exhibit at the Mineral Building, State Fair grounds, Oklahoma City.
96.	Henryetta bed, Mine No. 1, C. C. & M. Co., near Henryetta. Taken from working face in mine.
97.	Henryetta bed, Mine No. 1, C. C. & M. Co., near Henryetta. Represents car of mine run coal.
98.	Henryetta bed, Mine No. 1, Henryetta. From 100 pound sample of coal shipped by Creek Coal & Mining Co.
99.	Henryetta bed, near Henryetta. Sample furnished by coal company.
100.	Henryetta bed, Mine No. 1, near Henryetta. Sample of dust from near east roadway.
101.	Henryetta coal, Mine No. 1, near Henryetta. Taken from carload lot mine run; lump 20 per cent, small coal 40 per cent, slack 40 per cent.
102.	Henryetta bed, Mine No. 1, Victoria Coal Co., near Henryetta. From working face in mine.
103.	Henryetta bed, Mine No. 1, Victoria Coal Co., near Henryetta. Represents carload of mine run coal, as loaded from mine.
104.	Henryetta bed, Mine No. 5, Victoria Coal Co., near Henryetta.
105.	Pittsburg bed, Mine No. 5, we t of McCurtain.
106.	Lower Hartshorne bed, Mine No. 1, Double Day.
107.	Lower Pittsburg bed, Double Day. Standard sample taken.
108.	Lower Pittsburg bed, Double Day, near sec. 7, T. 8 N., R. 27 E. Standard sample taken.
109.	Pittsburg bed, Ozark Mine, Pittsburg, sec. 21, T. 8 N., R. 25 E. Standard sample taken.
110.	Pittsburg bed, Mine No. 2, Pittsburg. Designated as semi-anthracite.
111.	McAlester bed, Mine at Alderson.
112.	Cavanal coal, three-fourths mile north of Cavanal station. Standard sample taken.
113.	Hartshorne bed, Hughes, two miles east of Krebs. From product of mine ready for shipment.
114.	McAlester bed, Carbon (Cherryvale).
115.	Lower Hartshorne bed, Mine No. 7, Hartshorne. From block of coal on exhibit at the Mineral Building, State Fair grounds, Oklahoma City.
116.	Lower Hartshorne bed, Mine No. 3, Wilbur.
117.	Cavanal coal, three-fourths mile north of Cavanal station. Standard sample taken.
118.	Average analysis of four Oklahoma coals, taken from carload lots of Henryetta. Hartshorne, McAlester, and Lehigh beds.
119.	Lower Hartshorne bed, Mine No. 1, Oak Ridge Coal Co.
120.	McAlester bed, two miles west of Stigler.
121.	McAlester bed, three miles west of Sansbois.
122.	McAlester bed (?) four and one half miles west of Chelsea.
123.	McAlester bed, one and one half miles northwest of Starville.
124.	Mayberry bed (?) 12 miles south of Okmulgee.
125.	Mayberry bed (?) four miles northeast of Reams.
126.	Upper Hartshorne bed, Mine No. 1, west side of Wilbur. Standard sample taken.
127.	Hartshorne bed, Potter Mine No. 1, one and one half miles southwe t of Dow, sec. 3, T. 5 N., R. 25 E. Standard sample taken.
128.	Hartshorne bed, Potter mine. One and one half miles southwest of Dow, sec. 3, T. 5 N., R. 25 E. Standard sample taken.

NAME OF COAL	A Carbon-hydrogen ratio	B Fixed Carbon per cent	C vc = $\frac{C}{100}$ (a)	D $\frac{F.c. + \frac{1}{2}v.c.}{M + \frac{1}{2}v.c.}$ (b)	[illegible] Fuel Ratio $\frac{Fc}{vm}$ (c)	Calorific value	MEAN COMPOSITION Carbon	Hydro-gen	Oxygen and Nitrogen	Volatile matter
ANTHRACITE	26(?)-30(?)	93-up	-4	15-up	12-up	8000-8330	93-95	2-4	3-5	3-5
SEMI-ANTHRACITE	23(?)-26(?)	83-93	4-8	10-15 c	7-12	8390-8600	90-93	4.0-4.5	3.0-5.5	7-12
SEMI-BITUMINOUS	20-23(?)	73-83	10-15	6-10 d	g 4-7	8400-8900	80-90	4.5-5.0	5.5-12.0	12-15
BITUMINOUS*	17-20	48-73 a	20-32	3.5-6.0 e	1.2-7	7700-8800	75-90	4.5-5.5	6.0-15.0	12-26
	14.4-17		20-27		2.5-3.3 h	6600-7800	70-80	4.5-6.0	18-20	to-35
	12.5-14.4		32-44							
	11.2-12.5	48-73 b	27-44	3.0-3.5 f						
CANNEL		35-48				6600-8800				30-40
LIGNITE (black)	9.3-11.2	35-60	27-up	2.5-3.0	i 1.8-2.5	5500-7200	60-75	6.0-6.5	20-30	to-20 j
LIGNITE (brown)		30-35	27-up	1.2-3.5		k 4000-6000	45-65	6.0-6.8	30-45	20 j
PEAT	(?)-9.3	-55	-55							

*Four grades of bituminous coal are recognized in several classifications.

A. Campbell's classification.
B. Grout's classification based on carbon content.
C. Parr's classification.
D. Dowling's split volatile ratio classification.
E. Classification adopted by the International Geological Congress.

a. Total carbon = 82-88 per cent.
b. Total carbon = 76.2-82 per cent.
c. Includes anthracite coal.
d. High carbon bituminous.
e. Bituminous.
f. Low carbon bituminous.
g. Anthracite and high carbon bituminous.
h. $\frac{\text{Fixed carbon} + \frac{1}{2}\text{ volatile content.}}{\text{Hygroscopic moisture} + \frac{1}{2}\text{ volatile content.}}$
i. Lignitic or sub-bituminous.
j. Moisture in fresh mined commercial output.
k. Lignite.

(a) C = total carbon.
fc = fixed carbon.
vc = C — fc.
The inert volatile matter is obtained by subtracting from 100 per cent the sum of: total carbon + sulphur + ash + water + hydrogen, which is not united with oxygen and is free to burn and produce heat.

(b) F.c. = fixed carbon.
vc = volatile combustible.
M = moisture.

(c) Fc = fixed carbon.
vm = volatile matter.

SAMPLE NUMBER — **LOCATION AND DESCRIPTION**

129. Hartshorne bed, two miles southeast of Heavener, sec. 28, T. 5 N., R. 26 E. Standard sample taken.
130. Pittsburg bed, Mine No. 1, west of Bokoshe. From carload of mine run coal.
131. Pittsburg bed, Mine No. 3, east of Boko.he. Taken under screen at tipple, represents carload of slack and nut coal.
132. Witteville bed, northwest of Featherston. Standard sample taken.
133. McAlester bed. Average of 17 analyses of McAlester lump coal, sold to the State of Texas.
134. McAlester bed. Sample represents carload of pea coal.
135. McAlester bed. Results of analyses made on samples of slack coal as shipped for use at the University of Texas.
136. McAlester. Results obtained from the examination of samples from 12 cars of nut coal.
137. McAlester bed. Results obtained from the analyses from 25 cars of washed nut coal.
138. McAlester bed, Mine No. 5, northeast of McAlester. Taken in the mine at the face of the slope, and represents full thickness of coal.
139. Upper Hartshorne, Mine No. 5, north side of Wilburton.
140. Upper Hartshorne, Mine No. 6, west side of Wilburton.
141. Upper Hartshorne, Mine No. 21, near Wilburton.
142. Upper Hartshorne, Mine No. 19, Wilburton. Taken in room 14, "D" entry.
143. Lower Hartshorne, Mine No. 19, Wilburton. Mine run sample, taken from car being loaded at tipple.
144. Lower Hartshorne, Mine No. 6, west side of Wilburton. Standard sample taken.
145. Panama bed, Mine No. 4, Bokoshe. Taken from car being loaded at tipple.
146. Lower Hartshorne bed, Mine No. 19, Wilburton. Taken in room 14, "D" entry.
147. Lower Hartshorne bed, Mine No. 6, near Wilburton. From room 8 in 9th west entry.
148. Coal from strip pit of W. H. Stephenson, sec. 32, T. 28 N., R. 20 E. Averages 15 inches of both red and black coal.
149-53. Coal purchased by the U. S. from the Crowe Coal Co., and furnished from mine Nos. 5 and 6.

VARIETIES OF COAL

The trade has developed different names to describe the various kinds of coal which are mined. These terms, ranked from low to high fixed carbon content, are as follows: peat, lignite or brown coal, sub-bituminous, bituminous, cannel, semi-bituminous, semi anthracite and anthracite. In the true sense of the word, peat is not a true coal, being merely an accumulation of vegetal matter distinctly woody and fibrous in texture. Lignite and brown coal are now used as interchangeable terms for the first true coals. Sub-bituminous as the term is used by the U. S. Geological Survey, is a brown coal between a true bituminous and lignite, but which is of a considerable higher grade of coal than lignite.

Bituminous originally meant "possessing, or made up of bitumen." Among some writers there is a tendency to discard the term bituminous for the term humic, since the coal lacks true bitumen in important amounts. Bituminous coals are also divided into coking and non-coking varieties. The coking coal has the property of softening into a doughy mass just before the point of ignition is reached, and then at a higher temperature, of giving off the volatile constituents as bubbles of gas. If the heat is stopped after the expulsion of the gas there remains on cooling a gray, hard, cellular mass called coke. The non-coking coal may resemble the other in all outward appearances, but differs somewhat in the hydrogen-oxygen ratio. It burns without softening, and leaves a powdery mass instead of a cellular coke. The great majority of Oklahoma coal is bituminous.

Cannel Coal was originally known as candle coal, due to the fact that it burns with a bright flame much like the flame of a candle. It is dull black in color, has a distinct conchoidal fracture, and a low specific gravity. Ignition is very easy due to the high percentage of volatile matter which it contains. It differs markedly from other coals in the character of materials which compose it, being formed from the spores of plants.

Semi-Bituminous is the name adopted for coal containing from 11 to 15 per cent of volatile matter. This type is both coking and non-coking.

Semi-Anthracite is used for coals found between semi-bituminous and anthracite. The conchoidal fracture of anthracite is not so well developed, and it crumbles more readily in the fire and burns more rapidly due to high percentage of volatile matter. This coal has a greater value than anthracite for heating purposes because of this more rapid combustion, and is extensively used for steam coals. There is considerable semi-anthracite coal in Oklahoma.

Anthracite coal is more frequently known in the United States as hard coal. It is iron black in color, has a dull, sub-metallic luster, and does not soil the fingers when handled, as does bituminous coal. It burns with a pale blue flame, emits little odor, and does not coke. The calorific value of anthracite is not as great as that of semi-bituminous or lower grades, because the low volatile content does not permit rapid combustion and it therefore does not produce the high temperature which is necessary for some uses. Oklahoma has no true anthracite.

The table opposite shows the comparison of various coal classifications, which were built up, for the most part, from data obtained by the proximate analysis.

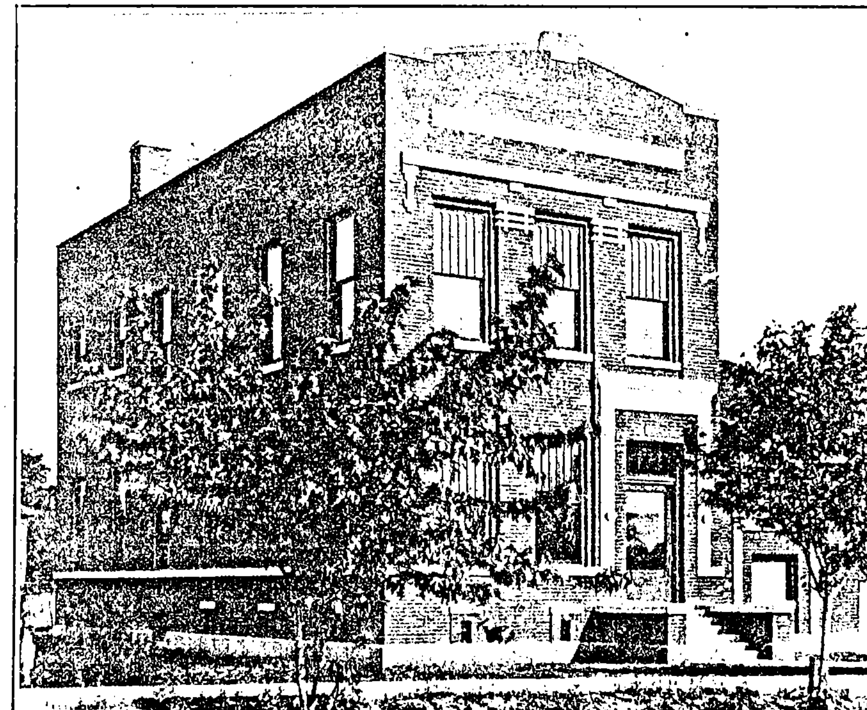
COAL IN OKLAHOMA

The workable coal area in Oklahoma comprises only a small portion of the State, active mining operations being carried on in all Latimer, LeFlore, Muskogee, Okmulgee, Pittsburg, Rogers, Tulsa, or part of 12 counties, which include Atoka, Coal, Craig, Haskell, Latimer, LeFlore, Muskogee, Okmulgee, Pittsburg, Rogers, Tulsa and Wagoner. The area actually underlain by the coal amounts to

approximately 12,000 square miles, and which, according to estimates of the United States Geological Survey, contains 79,000,000,000 tons of coal.

There are in Oklahoma at least seven beds of workable coal and several too thin to be considered of value. The workable beds range in thickness from two to six feet and locally reach seven or eight feet. The maximum aggregate thickness where average conditions exist would be about 20 feet. Except in a few places there are only one to three beds available in a given area. The average thickness of the beds in the main part of the field is about four feet. In a part of the workings of Mine No. 19, Wilburton, the two Hartshorne beds come together, having the appearance of a single bed separated by a thin clay parting, and giving a total thickness of nine feet of coal. In most parts of the field where these two beds occur they are about 40 feet apart.

PLATE II



BUREAU OF MINES RESCUE STATION, McALESTER

At the date of the earliest record of coal production in Oklahoma (1880) the production amounted approximately to 121,000 short tons. From that date to the beginning of 1925, the state has produced approximately 91,000,000 short tons of coal, with an almost steady increase from the date of the first recorded production. The state reached its peak of production in 1920, when 4,849,288 short tons of coal were produced.

Table No. 3.—Amount and Value of Coal Produced in Oklahoma[3]—1885-1924

Year	Short Tons	Value
1885	500,000	$ 800,000*
1886	534,580	855,328
1887	685,911	1,286,692
1888	761,986	1,432,072
1889	752,832	1,323,807
1890	869,229	1,579,188
1891	1,091,032	1,897,037
1892	1,192,721	2,043,479
1893	1,252,110	2,235,209
1894	969,606	1,541,293
1895	1,211,185	1,737,254
1896	1,366,646	1,918,115
1897	1,336,380	1,787,358
1898	1,381,466	1,827,638
1899	1,537,424	2,199,785
1900	1,922,300	2,788,224
1901	2,421,781	3,915,268
1902	2,820,666	4,265,106
1903	3,517,388	6,386,463
1904	3,046,539	5,532,066
1905	2,924,427	5,145,358
1906	2,860,200	5,482,366
1907	3,624,658	7,433,914
1908	2,948,116	5,976,504
1909	3,119,377	6,253,367
1910	2,646,226	5,867,947
1911	3,074,242	6,921,494
1912	3,675,418	7,867,331
1913	4,165,770	8,542,748
1914	3,988,613	8,204,015
1915	3,693,580	7,435,906
1916	3,608,011	7,525,427
1917	4,386,844	12,335,413
1918	4,813,447	17,508,884
1919	3,802,113	14,544,401
1920	4,849,288	23,294,000
1921	3,362,623	15,546,000
1922	2,802,511	11,527,000
1923	2,885,038	10,874,000
1924	2,800,000*	10,640,000*
TOTAL	**89,220,284**	**$246,277,457**

*Estimated.

3—From Mineral Resources, U. S. Geol. Survey.

There are a number of factors which have tended to curtail the production of coal in Oklahoma. Of the principal ones to be considered are the labor situation, the competition of coal from other states,* and especially the substitution of other fuels, chiefly natural gas, in place of coal. Another factor which may be mentioned is the increased economy in the use of coal.

There have been two strikes in the State which have effected the coal production. The first occurred in 1910, and the second in 1919. During the suspension of work, many of the miners went to other states where mines were in operation, and when the mines in this state reopened there was a shortage of labor, so that mines could not be operated to their full capacity. Also the car supply was directed to other districts, so that some time was required to restore normal conditions. It was at this time that coals from other states made such heavy inroads in the Oklahoma market. The state reached normalcy from the 1910 strike about 1912, and the production since then shows a steady increase until 1919, when the second strike occurred. By the end of 1920 the State had entirely recovered from its effects as far as production is concerned, as evidenced by the output of 4,849,288 short tons for that year, which is the peak production for the state.

Since then there has been a very material decrease in production due mainly to the increased use of oil and gas in place of coal as a fuel. The immense quantities of oil produced in the Mid-Continent fields has resulted in the adoption of oil burning engines by the railroads, and the discovery of a number of large gas fields has resulted in the adoption of this fuel in nearby cities and towns, all of which has resulted in a very material decrease in the domestic consumption of coal.

Figure 2 shows graphically the variations in the coal production of Oklahoma and adjoining states from 1912 to 1924. The total bituminous curve for the United States is also given to furnish a comparison with the production of the states in this region. The curves also show an increase from 1916 to 1918, and a sharp decline for 1919 with a recovery for the next year. Oklahoma is the only state shown having a greater production in 1920 than in 1918. The 1921-24 portion of the curve show marked declines as a rule, which is largely the result of the substitution of oil and gas for coal.

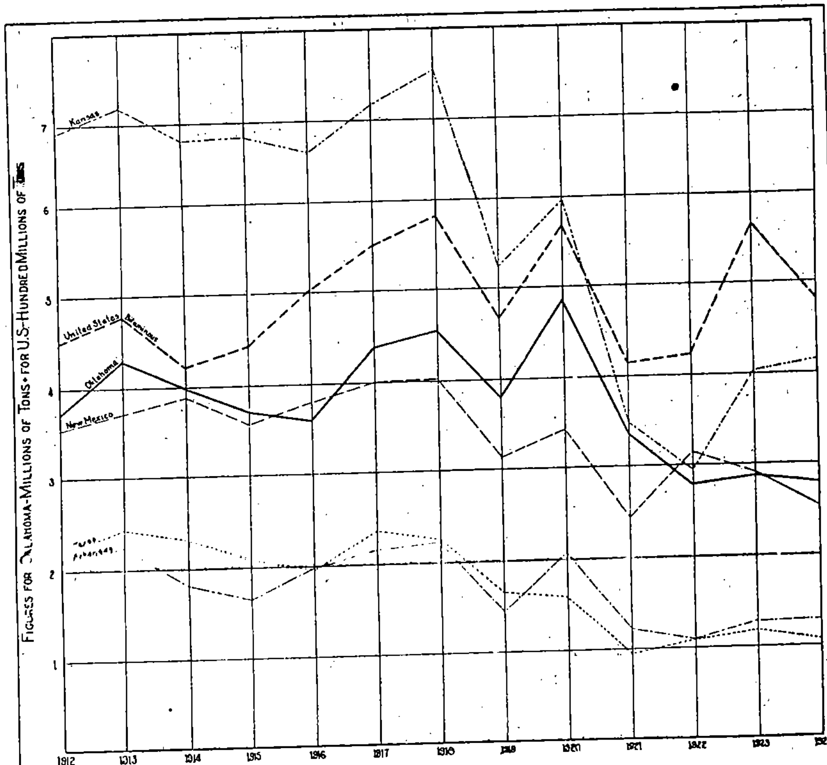
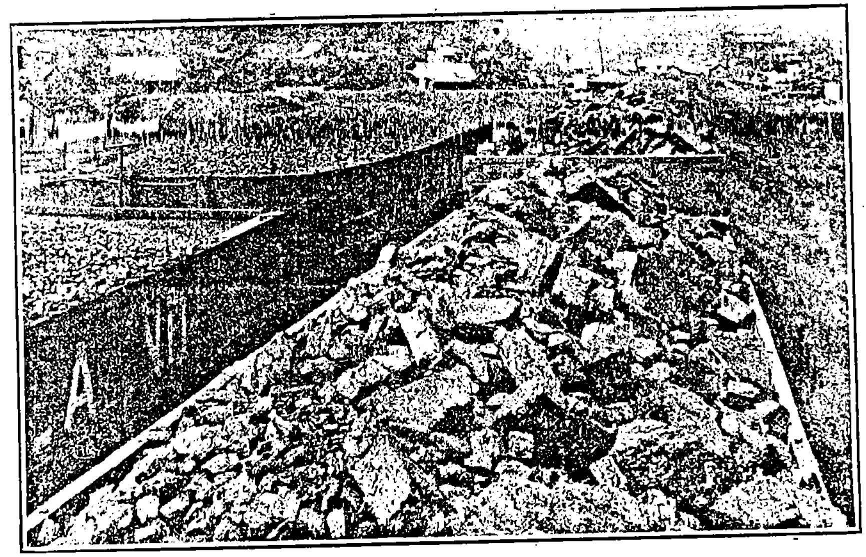


Fig. 2. Production Curves for Oklahoma and Abutting States—1912-1924. Compiled from Mineral Resources, U.S.G.S.

Figure 2

Oklahoma reached its highest rank among coal producing states during the last fifteen years (1914 and 1917), when the state was the 15th in rank. In this same 15 year period its lowest rank was 19th in 1923, but the next year it climbed back to the 16th place.

PLATE III



VARIOUS GRADES OF COAL READY FOR SHIPMENT

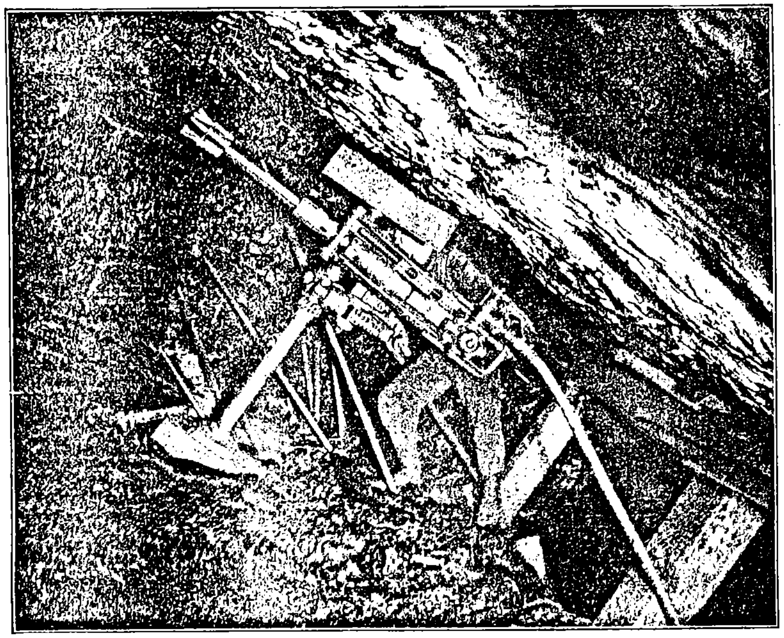
DESCRIPTION OF COAL SEAMS BY DISTRICTS

McALESTER DISTRICT

There are four beds of workable coal in the McAlester District, namely: the lower Hartshorne, the upper Hartshorne, the McAlester and the Secor. The deepest bed is the lower Hartshorne which is workable throughout most of the district. It averages about four feet in thickness, but in the Wilburton District in one or two tracts it has a thickness of six feet.

The upper Hartshorne bed is workable only in the Wilburton District, where it has a thickness of four feet of clean coal and occurs about 50 to 60 feet above the lower Hartshorne. The upper Hartshorne varies in thickness from two to four feet.

PLATE IV



MINE ROOM, SHOWING COAL BED DIPPING 38°

The McAlester bed lies from 1,200 feet to 1,300 feet above the upper Hartshorne and generally varies in thickness from three to four feet, but in few instances it reaches a thickness of five feet.

The Secor bed lies in a shallow basin above the McAlester bed southwest of the city of McAlester. It is considered to be the same as the Witteville and Jones Creek coals. It varies in thickness from two to two and a half feet, usually lying at low angles of dip close to the surface and can be easily stripped.

WILBURTON DISTRICT

There are three beds of coal in the Wilburton District, namely; the lower Hartshorne, the upper Hartshorne, and the McAlester. Only the Hartshorne beds are found to be workable; the McAlester, on account of its thinness, is considered unworkable under present conditions.

The deepest bed is the lower Hartshorne which lies from the outcrop to 1,000 feet beneath the surface. The upper Hartshorne lies from 60 to 90 feet above the lower Hartshorne, and the McAlester lies about 1,300 feet above the upper Hartshorne.

The upper and lower Hartshorne beds reach their greatest development in this district, the upper averaging three and a half to four feet thick, in some extreme cases reaching five feet thick, and the lower averaging four to five feet thick, in one or two places reaching a thickness of six feet. As a rule these two beds are about six feet apart, vertically, but in one or two places they approach close enough to be mined as one bed. These beds lie at dips varying from 10 to 60 degrees, though the average is from 15 to 20 degrees. On some leased land the upper bed is mined to the exclusion of the lower, while on others the reverse is the case. On few leases both beds are mined simultaneously. The quality of the coal in these beds varies, in some instances the upper bed yields coal of better quality than the lower, in others the reverse is true.

The coal produced from these beds is used mostly for railroad steam purposes and recently has proved satisfactory as bunker coal.

STIGLER DISTRICT

The so-called Stigler Coal Field, embracing 25,392 acres, is located in Haskell County, Oklahoma, the nearest point about one mile from Stigler, the county seat.

Mr. J. A. Taff, Geologist, United States Geological Survey, made an examination of the coal outcrop in this district and segregated this coal field, acting under instructions from the Secretary of the Interior, and submitted a report with reference thereto in 1904, which was approved by the Department.

In 1908 Mr. William Cameron, United States Supervisor of Mines examined and reported upon the value of the Stigler Coal Field, at which time there had been no drilling and very little exploring or prospecting work done in this field.

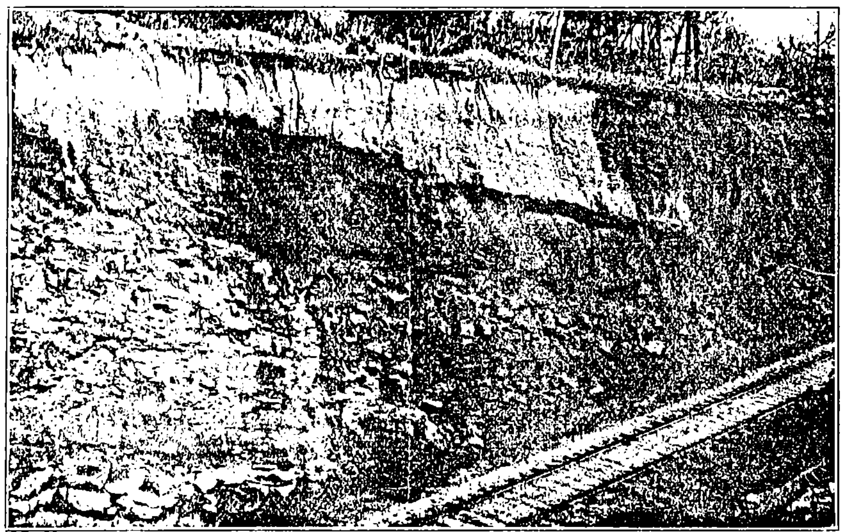
The Midland Valley Railroad had barely reached Stigler at that time and Mr. Cameron did not appraise each tract, but merely evalued the field as a whole and estimated at that time that one-half of the entire area was underlain with workable coal which he evalued at $20.00 per acre or a total of $253,920.

The coal bed in the field is from 22 to 30 inches thick and, from indications at or near the crop, lies from 18 to 60 feet below the surface and consists of clean bright coal which proves by analysis to be an excellent quality of blacksmith coal, ranking with the best in Oklahoma, and should supply the local demand for such fuel which is now entirely supplied from Pennsylvania and West Virginia; moreover, the coal lies at a low angle of dip making it easily workable by steam shovels. Similar thin coal seams are now being stripped by steam shovels in other parts of Oklahoma and recently steam shovels have been installed on adjoining lands underlain with this coal but which were not included in the segregated field. This improvement in the method of coal stripping gives the thin coal beds a value which they did not formerly have, and such deposits are now being eagerly sought by steam shovel operators, and it is therefore believed that this coal field will be attractive to such coal producers.

HOWE-POTEAU DISTRICT

There are seven seams of coal in the Howe-Poteau District, namely: the lower Hartshorne, the upper Hartshorne, the two McAlester coals, the Cavanal and two Witteville coals. In the Howe division of this district the only beds found are the two Hartshorne, and two McAlester, the lower Hartshorne being the most extensively worked. In the southern part of the Poteau division the Cavanal lies some distance above the McAlester beds. In the northern part of the Poteau division the Witteville beds lie some distance above the Cavanal coal.

PLATE V



EXPOSURE OF HARTSHORNE COAL IN RAILROAD CUT NEAR HEAVENER

The Lower Hartshorne in the Howe division, varies from three to five feet thick, averaging about four feet of clear coal, with a dip varying from 8 to 20 degrees. This coal is used for railroad steam purposes and in the manufacture of coke.

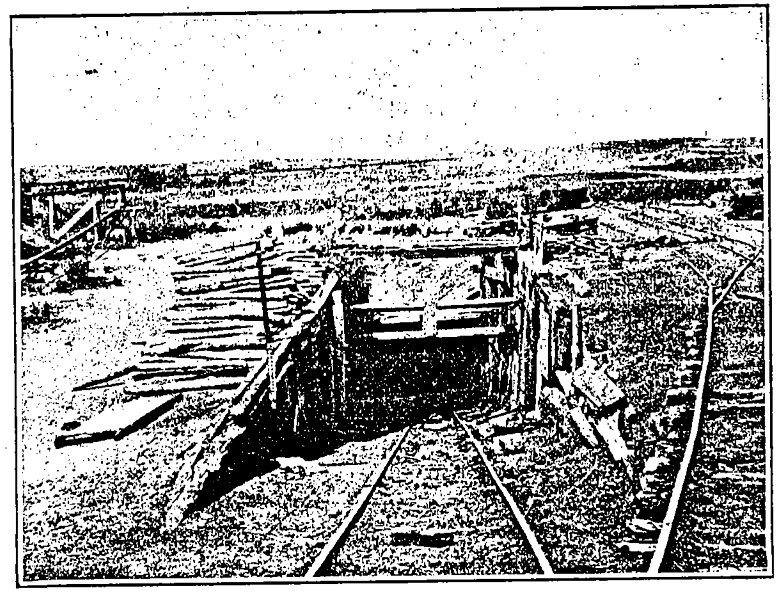
The upper Hartshorne is not worked in the Howe division on account of its thinness, where it is not known to occur in greater

thickness than three feet, reaching this thickness only occasionally. The upper Hartshorne does not outcrop in the Poteau division and is not considered workable because of its extreme depth.

The McAlester beds are not workable in the Howe division because of their thinness. They do not outcrop in the Poteau division and are considered unworkable because of their extreme depth.

The Cavanal coal outcrops along the foot of Cavanal Mountain, where it is from two and one-half to three feet thick, with a dip of from 6 to 10 degrees. This coal is apparently of good quality, with splendid appearance when freshly mined, of easy access to railroad transportation and susceptible to easy and cheap mining.

PLATE VI



A TYPICAL OKLAHOMA SLOPE OR DRIFT MINE

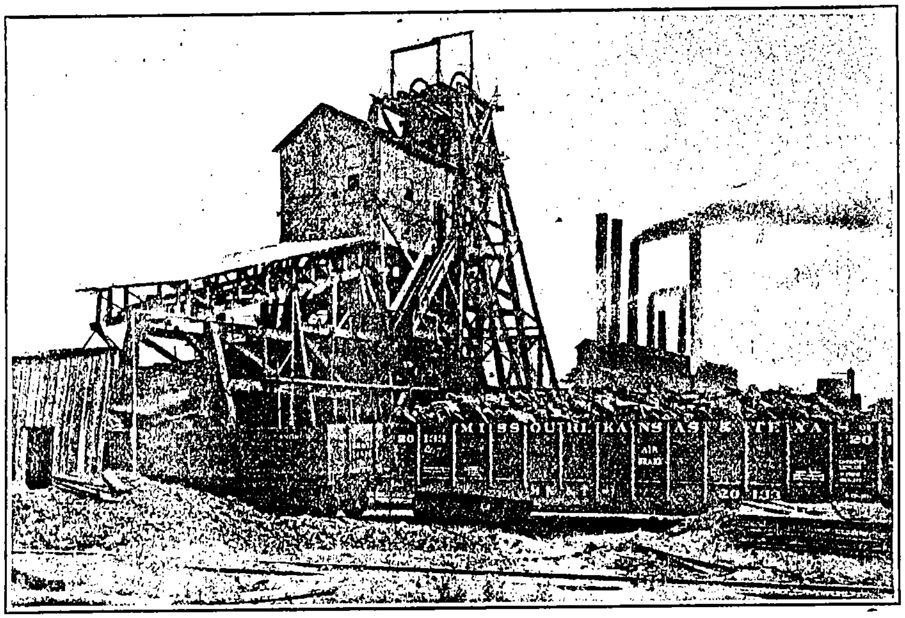
The two Witteville coals outcrop in Cavanal Mountain about 1,400 feet above the horizon of the McAlester seams. These beds are ~~about 200 feet apart, vertically, the upper about 3 ft. in. thick over~~ about 200 feet apart, vertically, the upper about 3 ft. 10 in. thick over all, having a thin parting of shale or bony coal from one-fourth to one-half inch thick above the center of the seam; the lower about 4 ft. 4 in. thick over all, having a dirt band in the middle ranging from 4 to 8 inches thick. At some places the upper coal is mined and at others the lower bed is mined, depending upon the condition in which the beds occur and the ease of mining.

McCURTAIN-MASSEY DISTRICT

There are two beds of coal in the McCurtain-Massey District, namely: the Jones Creek and the Panama.

The Jones Creek coal occurs in the Massey division and it is also called the Massey and Blocker coal. It is believed to be the same coal as the Witteville in the Howe-Poteau District, however, it is harder, cleaner, and contains fewer partings. While it is not as high quality as the coals in the McAlester District, still it is a very good coal.

PLATE VII



A TYPICAL OKLAHOMA SHAFT MINE

The Panama coal occupies about the same stratigraphic position as the Hartshorne coals. It varies greatly in thickness and structure. In some places it is found to be seven feet thick, of clean coal, and within a short distance frequently divided into two benches of coal by a shale band from 6 inches to 2 feet thick and generally in the center of the seam. In other places it is only three feet six inches to four feet thick, with thin partings of bony coal and at still other places there is four feet of clean coal. At McCurtain the coal is extremely faulty, which adds to the difficulty and expense of mining, also making it difficult of identification.

The Panama coal is excellent in quality, and soft in character as compared with the McAlester and Wilburton coals, also makes a good coke in bee-hive ovens, is splendid railroad steam fuel and bunker coal, and is also a good blacksmith coal. It compares favorably in analysis with No. 3, Pocahontas, West Virginia, coal.

The Kansas City Southern, St. Louis-San Francisco, Midland Valley and the Ft. Smith & Western railroads traverse this district.

LEHIGH-ARDMORE DISTRICT

There are two seams of coal in the Lehigh-Ardmore District, namely: the Atoka and Lehigh.

The Ardmore division of this district contains no segregated coal.

While the rocks containing the Hartshorne and McAlester coals are exposed from the Savanna division of the McAlester District southwest through the east and southeast sides of the Lehigh division, the outcrops of the Hartshorne and McAlester coals cannot be traced from McAlester to the Lehigh-Ardmore District on account of the disturbed condition of the rocks. Therefore, the exact condition of the beds of the two districts cannot be definitely determined, and accordingly the beds are named from the place where they are known and have been developed, namely: Atoka and Lehigh.

The Lehigh bed, which furnishes nearly all the coal mined at Lehigh and Coalgate, ranges in thickness from four to five feet, averaging about four feet. Generally this coal is clean and free from persistent bands. It has been mined for many years at Lehigh, Coalgate and Phillips. The Atoka coal underlies the Lehigh about 1,200 feet. It is quite variable in character and ranges in thickness from two to three feet, in some places five feet. In some places it is overlain and frequently cut out by a bed of soft black shale ranging in thickness from three to five feet, causing underground mining to be difficult and expensive. This bed has been extensively prospected, but only recently mined to any extent. For the past two years the St. Louis & Galveston Coal & Mining Co. on leased land, has been extensively and successfully stripping the coal with steam shovels. It is believed that the future may prove the Atoka seam to contain valuable coal, workable both with steam shovels and by underground operations.

The Atoka-Oklahoma City branch of the Missouri, Kansas & Texas Railway, the Ardmore-Haileyville branch of the Chicago, Rock Island & Pacific Railroad, and the Purcell-Lehigh branch of the Atchison, Topeka and Santa Fe Railroad, traverse this district.

HENRYETTA DISTRICT

The Henryetta district is included in an area about ten miles square, and is one of the most intensively mined districts in the

State. It has been an important producer for the last 20 years, but at the present time the production is very much below normal due to economic and labor conditions. There are at this time (June 1926) seven mines working on the Frisco Railroad and six on the K. O. & G. Railroad which are producing 50 per cent of the normal production for the district and which amounted to approximately 500,000 tons in 1925. Three years ago the production of this district was around one million tons. The coal mined in this area finds a market in this State and Texas, being used by the railroads, industrial plants and for domestic consumption.

The coal mined in this district, known as the Henryetta coal bed, has been traced from this district north through Okmulgee, Tulsa, across the northwestern corner of Wagoner, across Rogers and Craig counties to the Kansas line. In northeastern Oklahoma this bed of coal is known as the Cherokee coal and is to be correlated with the Weir-Pittsburgh bed of southeastern Kansas. The same bed has been traced south as far as Calvin, but becomes thinner in this region.

Mines now being operated in the Henryetta district are located near or within a few miles of the outcrop of the coal and the shafts range in depth from less than a hundred feet to three hundred feet. Those mines which are located nearest the outcrop of the bed are slope mines. The coal that is being worked now averages 34 to 36 inches in thickness and for the most part is a good clean coal from top to bottom. However, in a few places 2 to 4 inches of impure or bony coal are found in the center of the bed. Just north of Schulter the coal becomes extremely faulty and broken, so much that the coal cannot be economically recovered. This condition is maintained almost to Okmulgee; at Bald Hill and Morris the coal is again regular clean, and of good quality. It is possible that the forces which folded the rocks into the anticline found between Schulter and Henryetta (see map of Henryetta district) caused this faulty condition. Just to the west of the mined area, six diamond-drill holes have been put down to test out the occurrence of the coal and they show that the Henryetta bed becomes thicker (39 inches in two of the holes) and is of a better quality than that found near the outcrop. These drill holes found the coal at a depth of 580 to 630 feet below the surface. These borings show that the coal in this district is not in any way near exhaustion and that there are thousands of tons of coal yet to be mined when the present mines operating have exhausted the coal in their area.

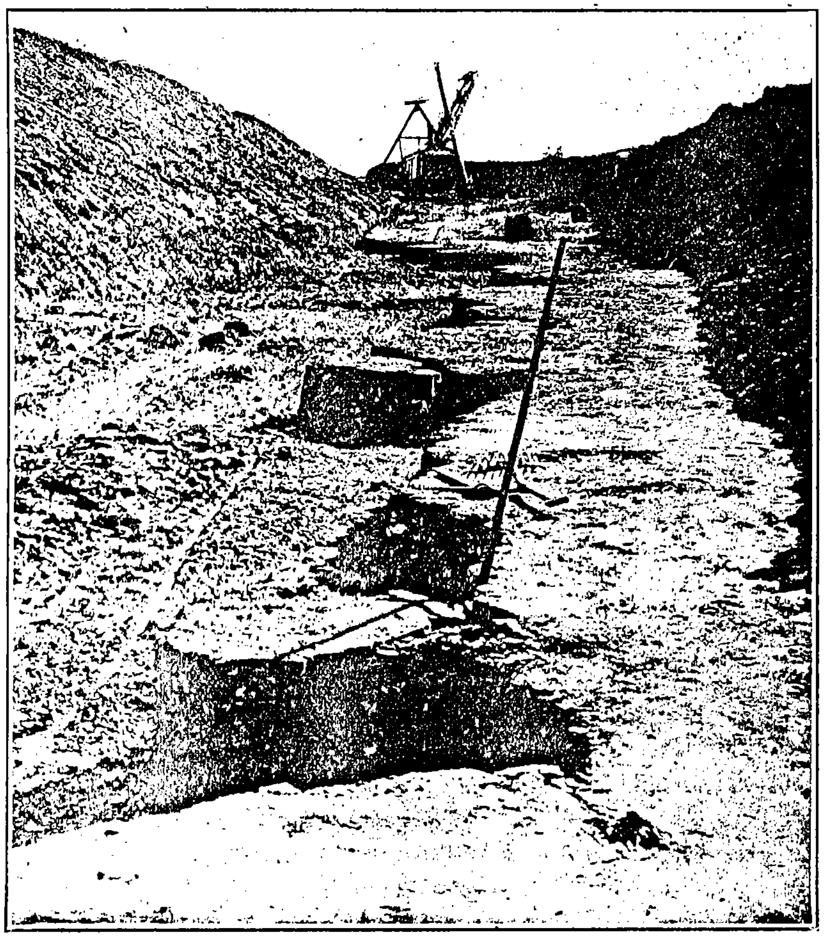
The only disadvantage found in mining in this district is the thinness of the coal bed, otherwise conditions for recovery of the coal are ideal. The mines encounter little or no trouble with squeezes and contain practically no gas or water, at least not in sufficient quantities to become a menace to the safety of the miners or to the economic recovery of the coal. The average recovery from the district is about 65 per cent. The coal itself is of a very good quality, and five analyses made by the U. S. Bureau of Mines of coal purchased by the Government from this district, show a B. t. u. content of 13,350 to 14,185, and a fixed carbon content from 55.58 to 59.85.

NORTHEASTERN OKLAHOMA

In the northeastern part of the State there are three extensive beds of coal that are of economic importance. The lowest bed is near the top (50-75 feet) of the Cherokee shale and varies from 10-48 inches in thickness with average thickness of 18-22 inches. For the most part this coal is hard and black and makes an excellent domestic and steam coal. In Kansas, miners have called this same bed the Cherokee coal and it is so named on the map accompanying this report. It has been traced almost without interruption from the western edge of T. 29 N., R. 21 E., southwest across Craig, Rogers, Mayes, Wagoner and Okmulgee counties and appears to be the same coal as the Henryetta bed.

In places the blue "fire clay" which normally overlies this coal has been removed by erosion and there has been deposited in its place a thick layer of yellow clay and gravel. Where this has occurred the variety of coal known as "red" coal is found. It appears that this exposure of the coal has in no way impaired its value, as is shown by analysis No. 148 in Table No. 1.

PLATE VIII



STRIPPING COAL WITH STEAM SHOVEL

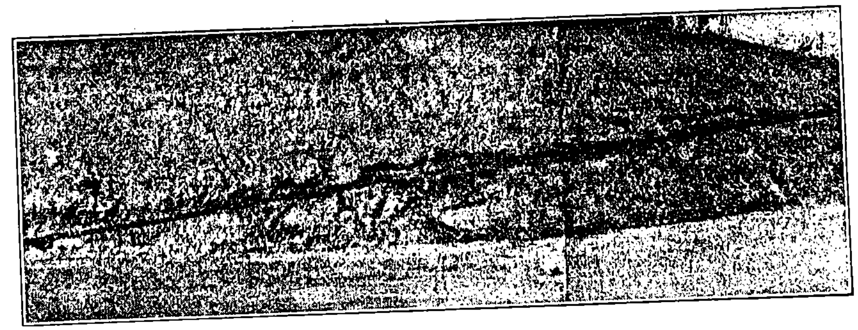
There are a number of mines and strip pits located along the entire extent of the outcrop of this coal. The following are the most important.

Mines and Strip Pits in the Cherokee Coal

Sec.	Twp.	Rge.	Thickness inches	Remarks
27	28N	20E	18-24	Stripped by steam drags
32	28N	20E	12-30	Stripped by steam shovel
14	26N	19E	34	Mine shaft 18 feet deep
5	25N	19E	26	Drift mine
14	24N	18E	Av. 30	Stripped by steam shovel
10	19N	15E	Av. 22	Stripped by teams
20	19N	15E	Av. 20	Stripped by teams

The next highest bed of coal, known as the Fort Scott, but found below the Fort Scott limestone in the upper part of the Cherokee shale, outcrops from the Kansas line southwest to the Arkansas River and a few miles west of the outcrop of the Cherokee-Henryetta bed. This coal is hard and black and in places there occurs what is known as "red" coal. The coal varies from a thin seam of black slaty coal a few inches in thickness to a maximum of 21 inches. The only extensive operations carried on in this coal are found west of Nowata, where the coal is taken out and hauled to Nowata in wagons, and in sec. 7, T. 21 N., R. 16 E., southeast of Claremore there is a small drift mine.

PLATE IX

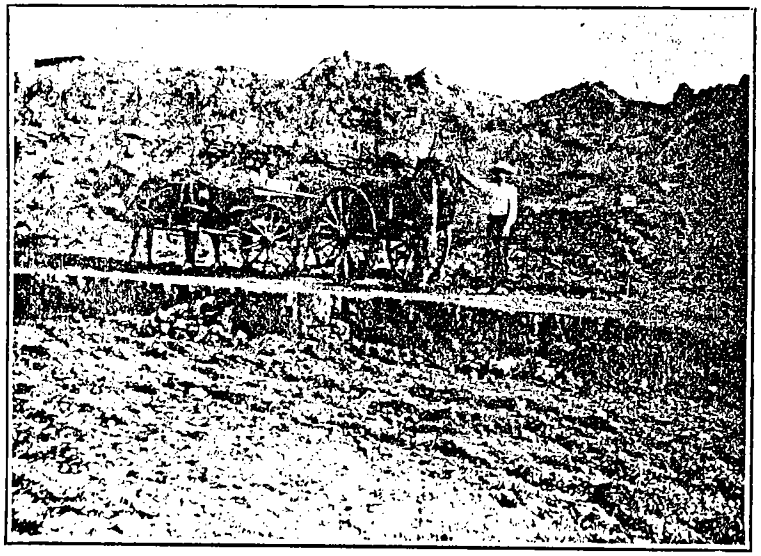


OUTCROP OF FT. SCOTT COAL, SEC. 30, T. 28 N., R. 20 E. THICKNESS 10 INCHES

The highest coal of commercial importance in this part of the State is the Dawson coal which outcrops at a point just west of Nowata, southwest through Collinsville and east of Tulsa to the Arkansas River. This coal is known as the Dawson coal from the village of Dawson, northeast of Tulsa, where extensive stripping operations are being carried on. This bed is also being operated at Collinsville and near Talala. The coal is of good quality and 12 to 18 inches in thickness.

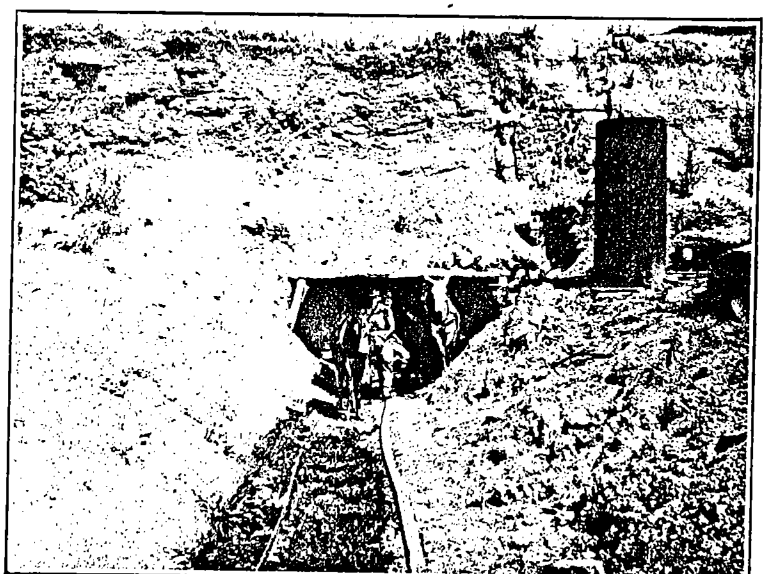
There are a number of small seams of coal in the northeastern part of the State but which have not been mapped in this report. The lowest of these is found about 30 feet below the base of the Bluejacket sandstone which is the basal member of the Bartlesville group of oil sands. At present two mines are being worked in this coal in secs. 25 and 26, T. 27 N., R. 20 E. The coal is about 30 inches thick in these mines and is 40 feet below the surface. There are a number of small strip pits south and east of Okmulgee and south of Wagoner which are operated in thin beds of coal which appear to be of local occurence only.

PLATE X



COAL STRIPPING AT COLLINSVILLE

PLATE XI



OPENING TO SLOPE MINE WEST OF BLUEJACKET

Several coal companies have recently completed extensive core drilling in central and northeastern Craig County and it is reported that a bed of very good coal averaging 5 feet in thickness is found at a depth of 220$\pm$ feet. In addition to this bed there is also a shallower bed at 80$\pm$ feet which runs from 2 to 3 feet in thickness The upper bed is probably the Cherokee coal. The lower one is below the Bluejacket sandstone horizon and is probably to be correlated with the McAlester or higher coals of east-central Oklahoma. However, nothing definite can be said regarding these correlations since the well records were not available for study.

Graphic sections of Oklahoma Coals

The following figures show graphically the character and thickness of the various coals just described. Figure No. 3 is a legend giving the symbols used in figures 4 to 12 inclusive.

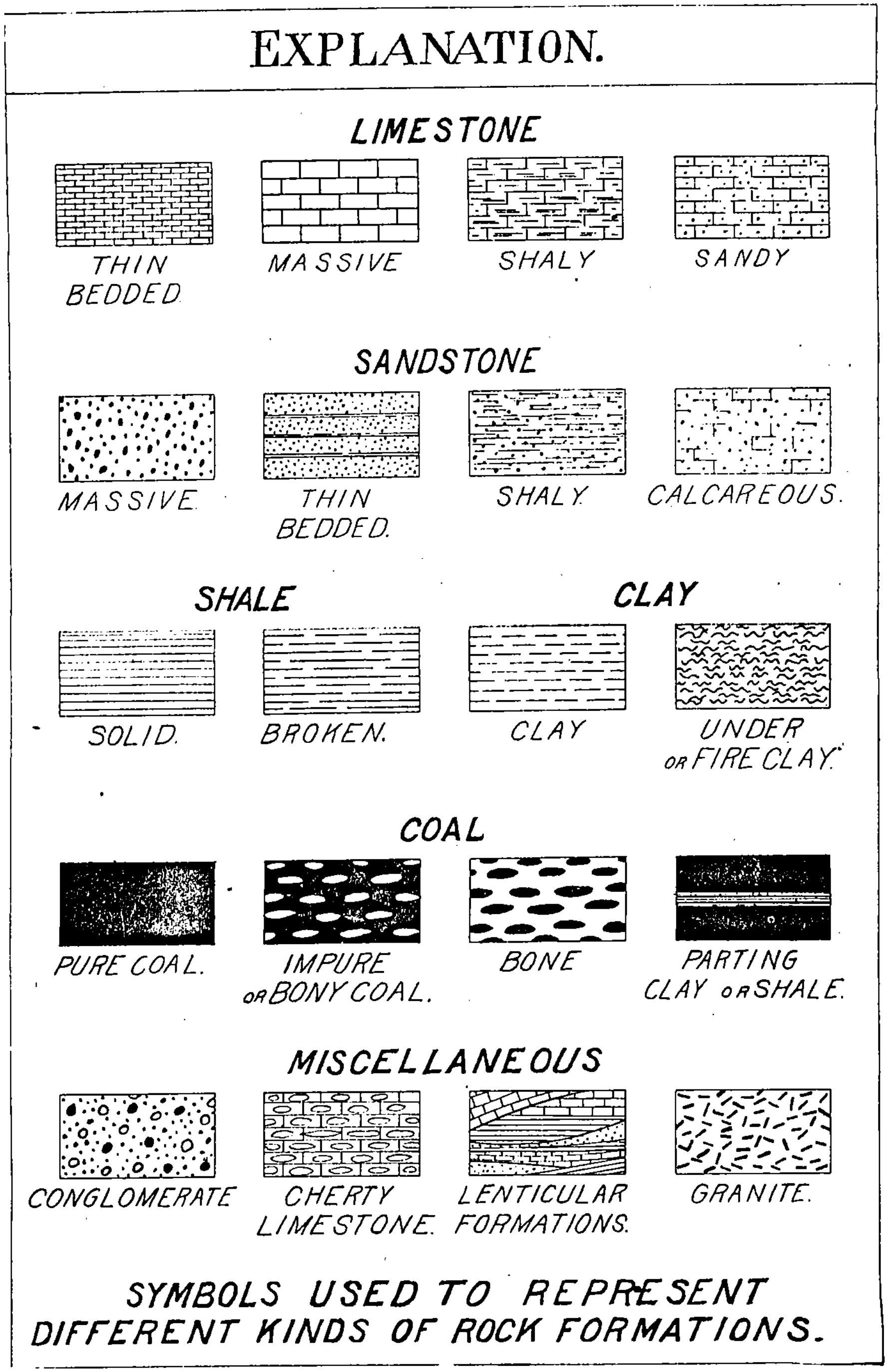


Figure 3

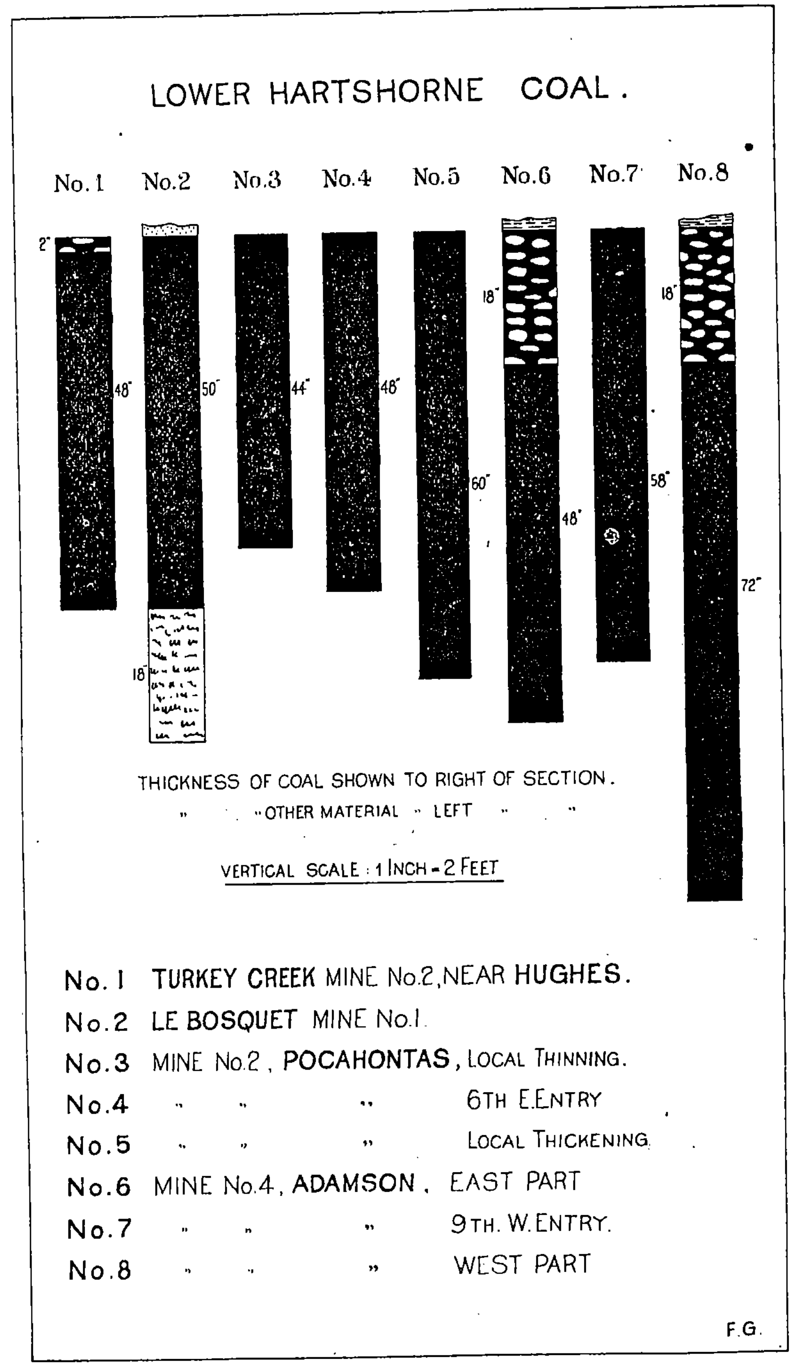


Figure 4

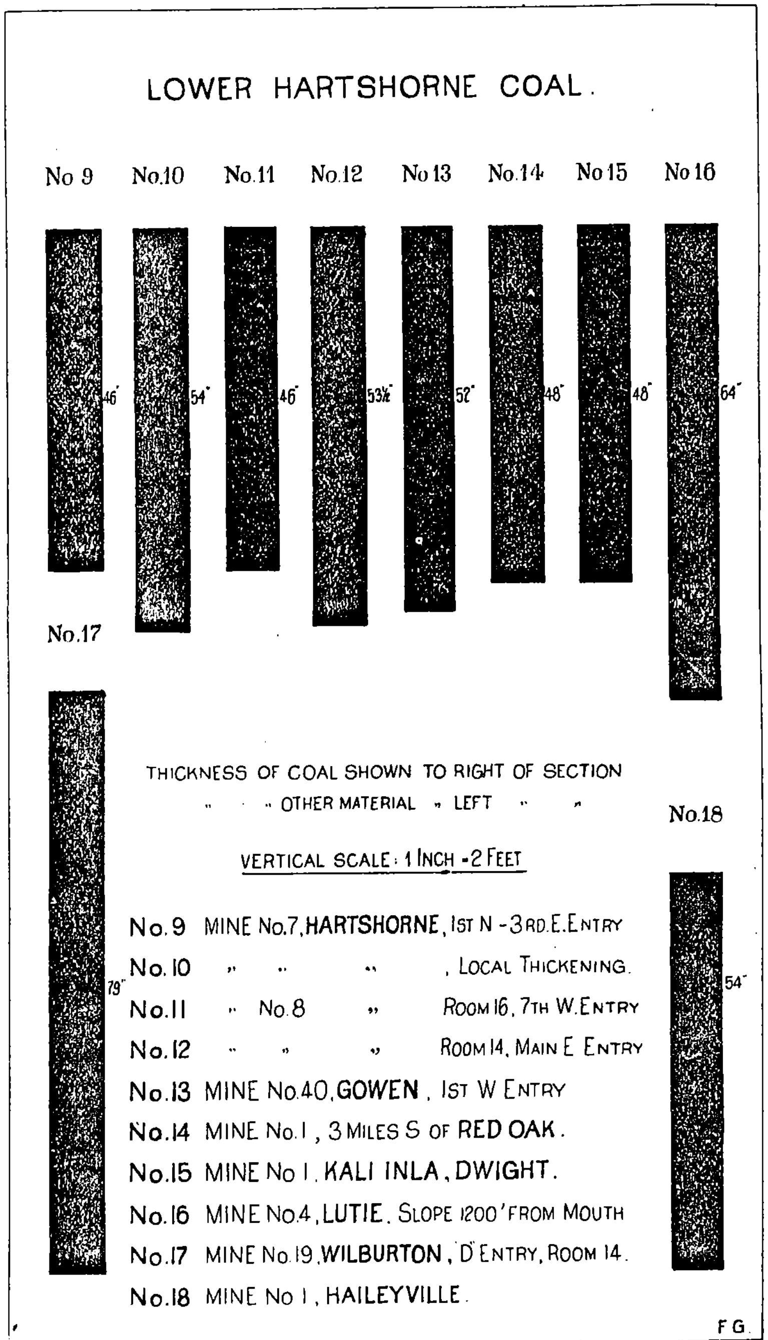


Figure 5

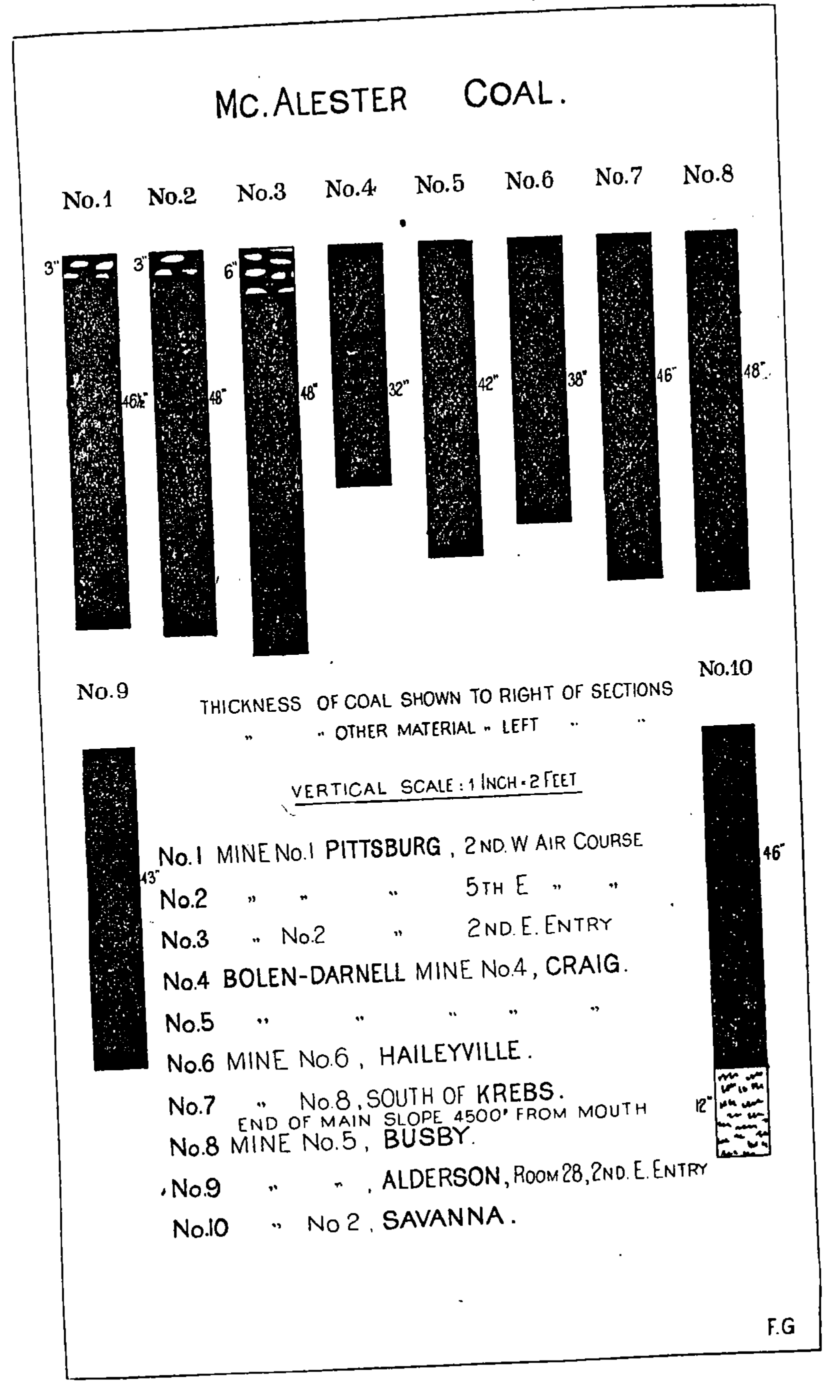


Figure 6

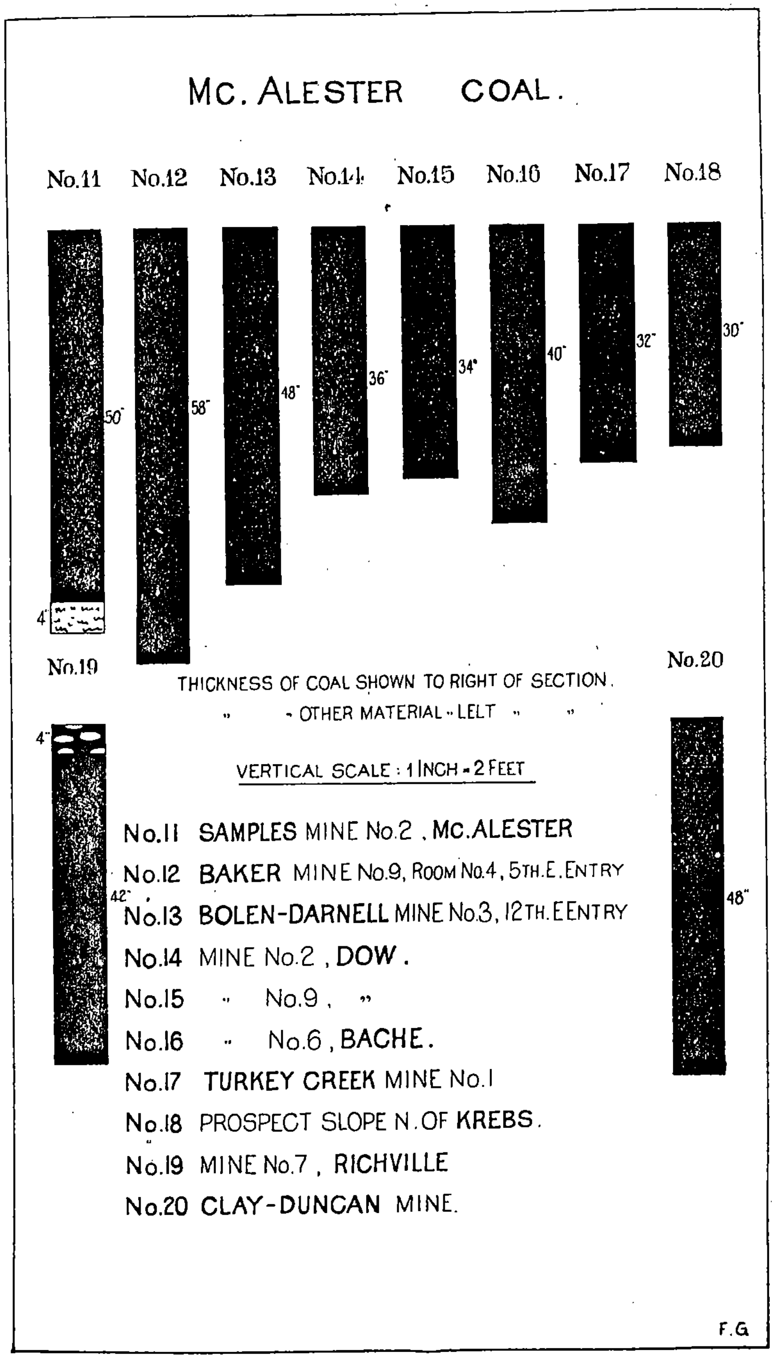


Figure 7

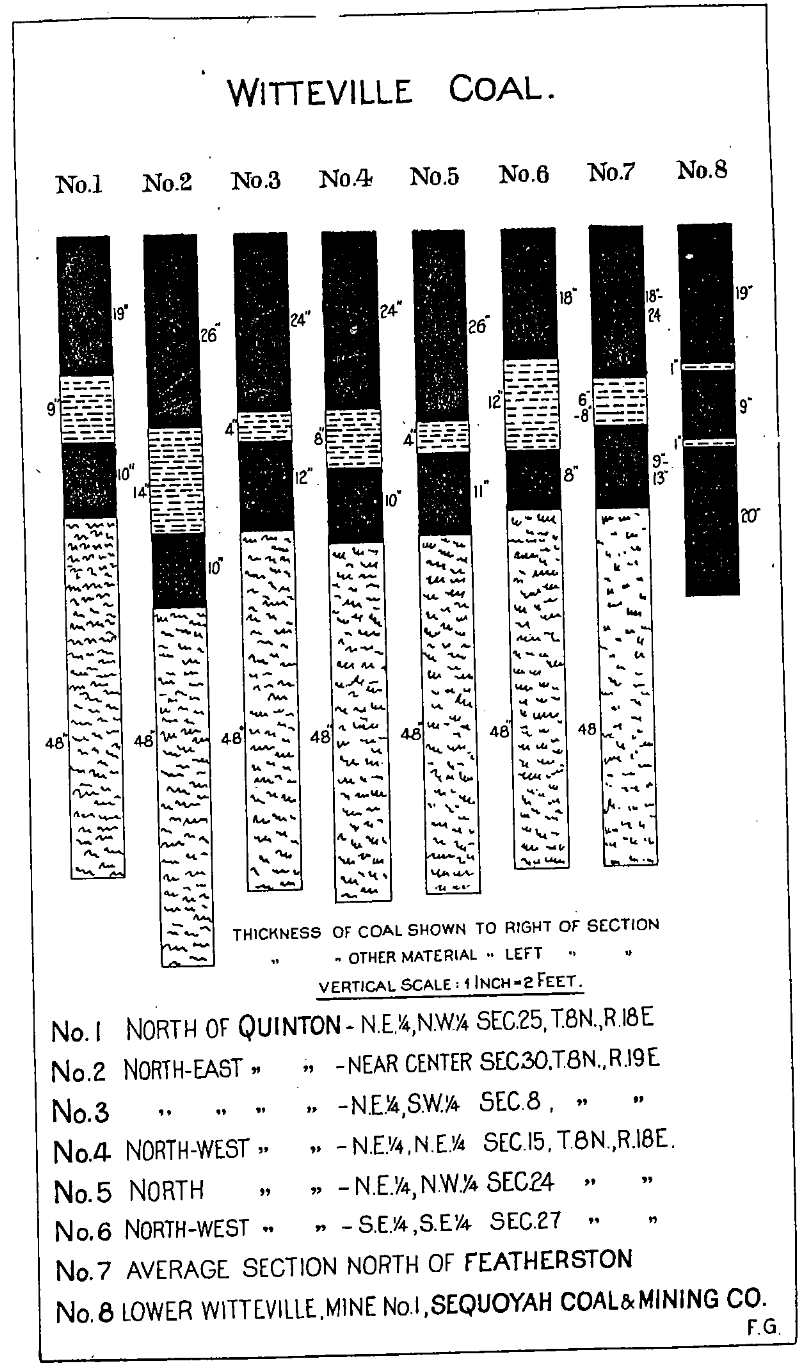


Figure 8

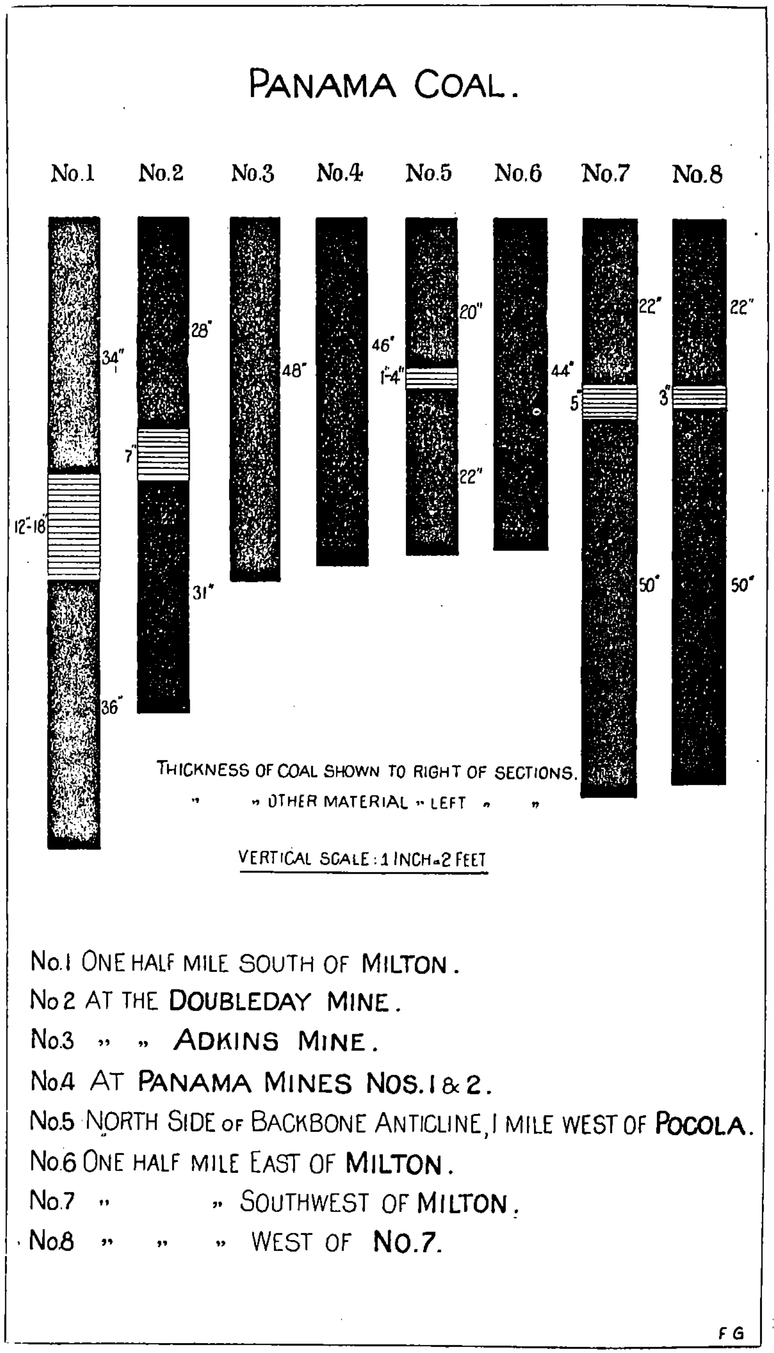


Figure 9

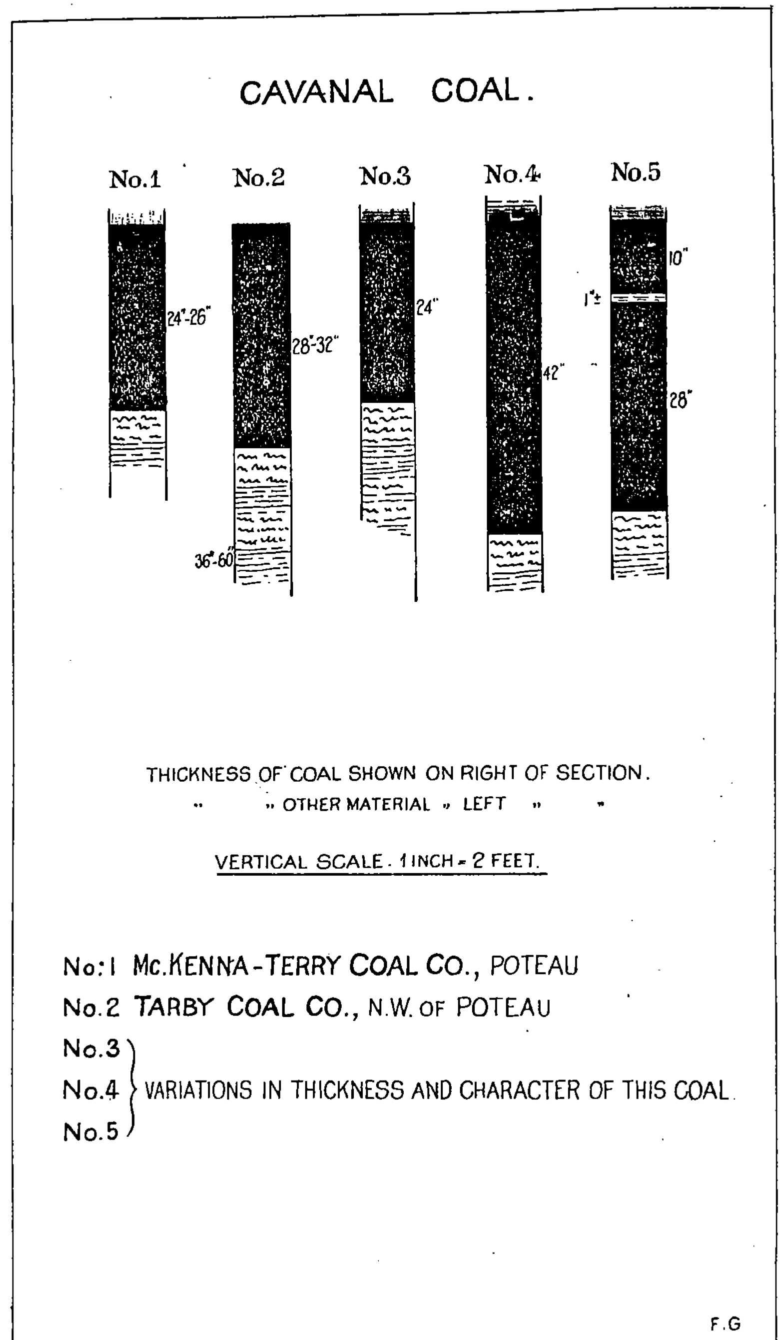


Figure 10

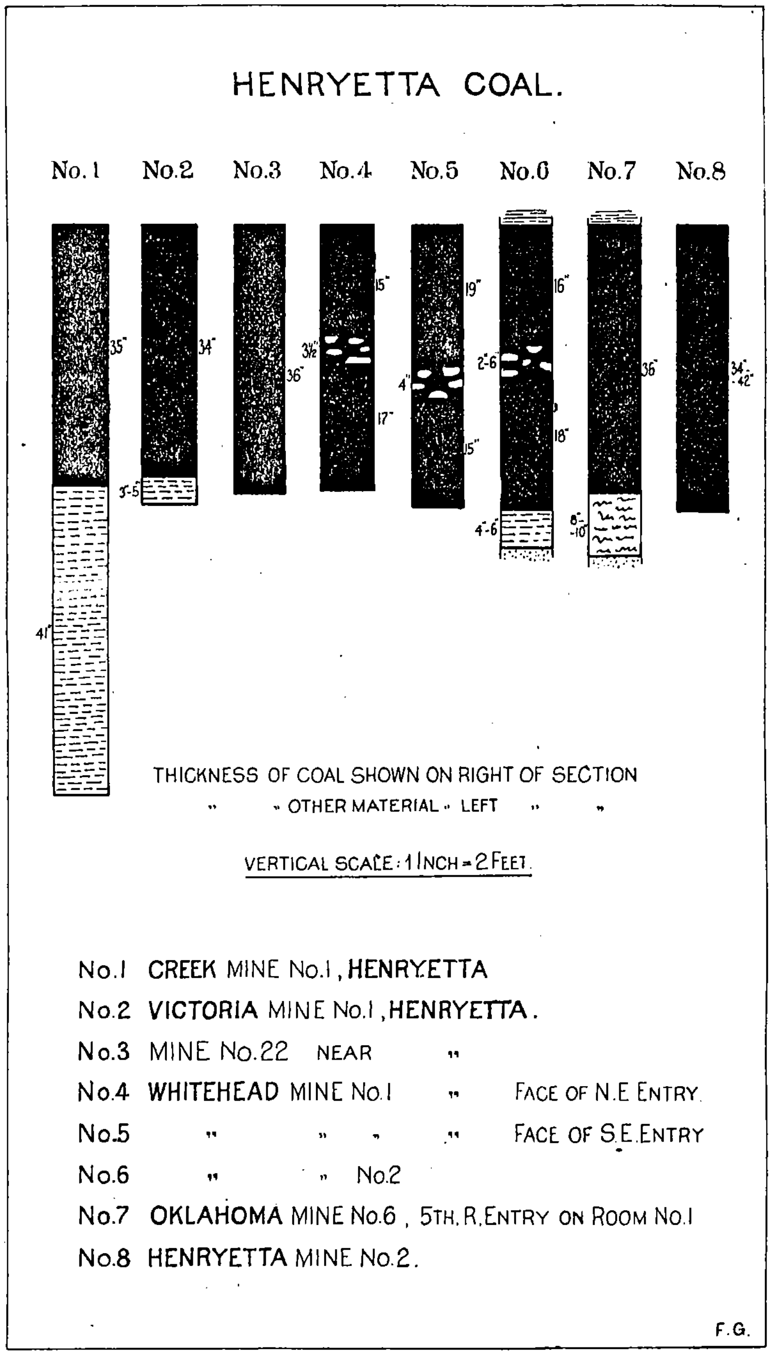


Figure 11

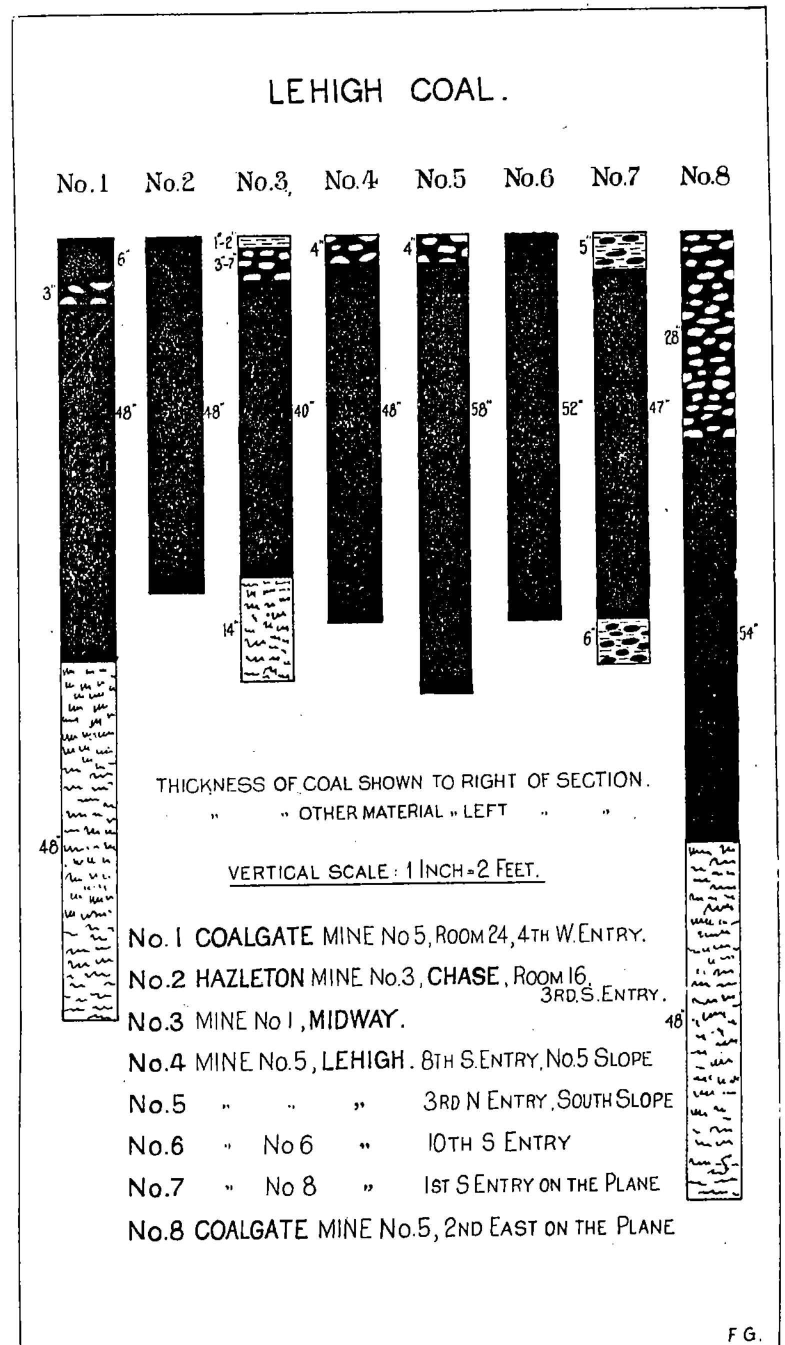


Figure 12

MISCELLANEOUS OCCURRENCES

Near Texanna there is an old strip pit which was in operation about four years but was abandoned in 1910. The coal bed is about 18 inches thick and has a small dip to the west. There is about 10 feet of stripping. The coal was marketed by wagon at Texanna and Checotah.

A strip pit was opened in the SW.¼ sec. 9, T. 16 N., R. 17 E., Wagoner County. The coal at this place is 22 inches thick and has a cover of 10 feet or over. The pit was opened about 1906.

A strip pit located near Cowlington in sec. 29, T. 10 N., R. 24 E., LeFlore County, showed a bed of coal 4 feet thick.

Coal is reported from near Wainwright, and some small prospects have been made in this locality.

At Rentiesville in McIntosh County some coal has been opened in a strip pit. The cover is from 5 to 12 feet. The coal is from 5 to 18 inches thick.

Coal 3 feet thick is said to occur in the SE.¼ sec. 12, T. 17 N., R. 12 E. in Tulsa County. It has been mined on a very small scale. Coal is reported in the oil drillings to the southeast and several good thicknesses indicated.

Near Bryant in Okmulgee County is a shaft mine 280 feet deep operating on a coal bed 32 inches in thickness.

Some strip pit work has been carried on near Vera.

A few inches of coal were reported from a drilling in sec. 8, T. 19 N., R. 11 E. at a depth of of 1,800 feet.

In the SW. ¼ sec. 30, T. 18 N., R. 13 E. near Jenks in Tulsa County there is a bed of coal 26 inches thick. It has been stripped to a small extent for local use.

In the vicinity of Hayden, sec. 10, T. 25 N., R. 17 E. in Nowata County are several strip pits, or "banks." The coal is about 5 feet below the surface and is 16 inches in thickness. It is sold to wagons at the mine for local use and some is hauled to Nowata, 10 miles distant.

About 2 miles west of Watova some small strip pits are operated on a coal bed about 12 inches in thickness and with about 5 feet of cover.

At Ruby the coal is 15 inches thick. A part of this bed is "red coal."

Some strip pit work has been done in the vicinity of Hollow in Craig County.

A strip pit which has been opened for many years is located near Oolagah in sec. 18 and 19, T. 23 N., R. 15 E., in Rogers County. The coal is from 24-27 inches thick. The bed has a slight dip to the northwest. The coal grades from black to peacock and red. The overlying shale is 20 feet thick. The floor is a hard fire clay. It is stated by the owner that this clay has been tested and proved a good brick clay. The maximum depth to which this coal has been stripped is 18 to 25 feet. The location is two miles from the railway station. Some other small openings have been made in the same locality.

In the vicinity of Akins and Hansen in Sequoyah County a bed of coal 7 inches in thickness has been stripped. It is covered with 5 to 10 feet of material.

Several small places have been opened near Muldrow and Roland. The coal bed varies from 10 to 24 inches in thickness. In general, the coal secured was of fair quality and burned well. In places it is shaly and produces a large amount of soot when burned.

Some coal has been mined one half mile west of Forman and is said to outcrop 3 miles east of this place. It is a peacock coal.

South of McKey, coal has been stripped for many years. This coal is in some places 24 inches thick and has from 10 to 40 feet of cover. In sec. 1, T. 15 N., R. 15 E., in Haskell County a bed of coal 12 inches thick has been prospected and some strip pit work done.

Coal 24 inches thick is found in several places in the vicinity of Hoyt. The cover is from 5 to 12 feet.

About 2 miles north of Sansbois two or three small strip pits have been operated. Coal is found to be from 18 to 30 niches thick.

Five miles west of Mazie coal is found and some small places have been operated for local use in that region. Some coal also occurs in the vicinity of Tullahassee in Wagoner County.

In sec. 8, T. 13 N., R. 16 E., near Boynton in Muskogee County a bed of coal 14 inches thick has been stripped in past years. The coal was very soft and only a few tons were removed.

An opening in the SE.¼ sec. 5, T. 13 N., R. 19 E. and NW.¼ sec. 1; T. 13 N., R. 18 E. shows a bed of coal from 10 to 15 inches in thickness. A small amount of coal for local use is removed during winter months. The surface covering is from 2 to 12 feet thick.

In the SW.¼ sec. 19, T. 14 N., R. 18 E. a small strip is operated on 10 inches of coal. A small amount of the coal is removed and marketed at Muskogee and Summit. Coal is found over a considerable area south of Muskogee and can be secured by stripping. A few years ago coal was sold from wagons on the streets of Muskogee by the farmers just as wood is sold in a timber region.

Near Victor in the NW. 1/4 sec. 29, T. 6 N., R. 24 E. the coal is 30 inches thick and has a northward dip of 30 degrees. A small slope was formerly in operation here.

Coal 18 inches thick occurs near Redland, chiefly to the northeast.

Croppings of coal are reported near Gilmore, but no mining or prospecting has been done.

Near Kennedy in the SE.1/4 sec. 3, T. 6 N., R. 24 E. in LeFlore County, coal is found which has a thickness of 36 inches.

Coal is reported 8 miles north of Calvin along the M. O. & G. Railroad.

Coal has been mined near Spiro where a slope was opened in the SE.1/4 sec. 11, T. 8 N., R. 24 E. The coal was from 36 to 48 inches thick and dipped to the north about 35 degrees. The slope was put down to a depth of about 60 feet.

A strip pit has been opened in the NW.1/4 sec. 10, T. 9 N., R. 19 E. The coal at this place is 30 inches thick and is underlain by 6 feet of fire clay and hard clay shale. The coal does not separate readily from the roof and floor materials. The location is about 12 miles from a railway station. The amount of cover removed is about 10 feet.

On Hogshooter Creek in Washington County in T. 26 N., R. 14 E. there is a small pit from which some coal has been removed. There are some outcroppings in T. 25 N., R. 12 E. and T. 23 N., R. 14 E.

Near Morris a bed of coal 48 inches thick is said to occur at a depth of 5 to 25 feet below the surface. A small pit was formerly in operation and a considerable amount of coal was removed.

In the region of Tamaha the coal occurs over a large area. It is from 24 to 60 inches thick and is 2 to 20 feet below the surface. A considerable amount has been removed by stripping for local use. One opening has in the past produced about 250 tons per year.

In the vicinity of Holdenville in sec. 32, T. 7 N., R. 11 E., there are some "freak" beds of coal reported. The coal is from 8 to 12 inches thick. A strip pit is located in the NE. corner of T. 8 N., R. 11 E. Some coal was removed and marketed locally.

Near Spiro in the north 1/2 of the S. E. 1/4 sec. 11, T. 8 N., R. 24 E. a place was opened up a few years ago as a prospect. The coal was found to be 44 inches in thickness and to dip to the north about 37 degrees.

A bed of coal varying in thickness from 5 to 15 inches was opened near Ralston in the N1/2 of the NE.1/4 sec. 2, T. 23 N., R. 5 E. About 200 tons of coal were removed and the place was abandoned.

Near Redbird in Wagoner County a small place has been in operation about 2 years. The coal was 33 inches thick and a total of about 500 tons of coal were removed from the opening.

Coal has been prospected in the NW.1/4 sec. 30, T. 7 N. R, 16 E. One entry was driven 120 feet but little or no coal was removed.

Some coal has been found near Fawn.

Coal has been stripped near Whitefield. It was used as gin fuel and reported good. The place was operated about 15 years. The coal was said to be 22 inches in thickness; the floor a hard clay shale and the roof a blue shale.

An opening has been worked in sec. 25 about 1 1/4 miles southwest of Muldrow. The coal here is 14 inches thick, and in the past some small operations were carried on here. There were several feet of material overlying the coal and the bed had a dip of several degrees.

At Agra in Lincoln County coal was reported in an oil well at depth of 400 feet. The well was drilled in September, 1912.

Just east of the town of Bluejacket in sections 25 and 26, T. 27 N., R. 27 E., there is a seam of coal about 30 inches in thickness and about 40 feet below the surface in what is called the "Timbered Hills." There are two mines in this coal which have only been working intermittantly, supplying coal for local consumption.

The Clark Coal Company is working a strip pit in a bed of coal 18 to 24 inches in thickness, three miles west of the town of Welch in sec. 27, T. 28 N., R. 20 E. The overburden is stripped by drags operated by steam winches. A little of the coal is shipped but the greater part of the output is used locally.

In sec. 32, T. 28 N., R. 20 E., is a strip pit operated by W. H. Stevenson of Welch. The coal runs from 12 to 30 inches in thickness with an average of about 15 inches. Both red and black coal are obtained and analysis shows that it has a very high B. t. u. content. About 12 feet of overburden is removed by a steam shovel.

In sec. 14, T. 26 N., R. 19 E., there is a small mine known as the Daw mine, which operates in a seam of coal 34 inches thick and 18 feet below the surface. At present this coal is used mostly for local consumption.

The Parker mine in the NW.1/4 sec. 5, T. 25, N., R. 19 E., operates in a seam of (Peacock) coal 26 inches thick.

In sec. 34, T. 29 N., R. 20 E., on the property of H. LeDuke there appears to be three distinct seams of coal. The lower one, twelve inches thick is clean black coal overlain by 18 inches of massive blue fossiliferous limestone. The middle coal, 14 inches thick contains abundant pyrite and limestone nodules, or concretions throughout the seam. This coal is overlain by 18 inches of black carbonaceous and fossiliferous shale, that is somewhat fissile in character. The lower seam is 12 inches thick and the coal is "red" and very clean and even. This bed is overlain by three feet of gray shale or "fire clay." The interval between these beds is about 10 feet. None of this coal is shipped and all that is taken out is used in the immediate vicinity.

On the east slope of the scarp formed by the Fort Scott limestone, between sections 30 and 31, T, 28 N., R. 20 E., there is a thin seam of coal 10 inches thick occurring just below the Fort Scott limestone.

In a strip pit at Catale south of the railroad, the coal is about 30 inches in thickness, "red" and of average quality. About 22 feet of overburden composed of about equal portions of blue shale or "fire clay", and soft unconsolidated yellow clay and gravel, is removed by steam shovel. The production at this pit ranges from 12 to 20 cars per day, with an average production of 15 cars per day.

At a strip pit 2½ miles south of Chelsea is found 18 inches of good hard, clean, black coal. A steam shovel is used to strip about 15 to 20 feet of overburden, including 3 feet of blue shale (fire clay).

In the southeast corner of sec. 4, T. 24 N., R. 15 E., there is exposed in an abandoned strip pit about 12 to 15 inches of the Dawson coal. This bed is overlain by 18 inches of black fissile shale and underlain by soft blue clay.

A small slope mine is being operated by William Nicholson in sec. 7, T. 21 N., R. 16 E., just west of Claremore. The coal averages 18 to 20 inches in thickness and is a good clean coal of the "Peacock" variety. The bed is overlain by 15 feet of blue shale and underlain by a shale of somewhat similar character. This mine is probably in the Fort Scott bed of coal.

In section 10, T. 19 N., R. 15 E., is a strip pit known as the Zellner coal bank. The stripping is done by teams.

In sec. 20, T. 19 N., R. 15 E., on what is known as the Bilbry ranch, there is a strip pit in the Cherokee bed which has an average thickness of 20 inches. The operator is authority for the statement that this bed attained a thickness of four feet on the south side of the pit. This is the thickest occurrence of the Cherokee coal noted throughout the entire extent of its outcrop.

A small area of coal bearing rocks occurs just to the southeast of Ardmore. There is only one bed of coal of mineable thickness and this is found from 2 to 6 miles southeast of Ardmore. As reported from prospect and mine openings the coal runs east from 30 inches to 4 feet in thickness and is separated by a shale parting 3 inches or more in thickness. The roof of the coal is a soft shale overlain by a bed of limestone. Underneath the coal, there is a soft clay. The coals of this district are not generally found under favorable conditions for mining so that it is not profitable to mine this coal under present economic conditions.

Part II. GEOGRAPHY.

The area of Oklahoma underlain by coal lies to the ~~east~~ west of the physiographic province known as the Ozark Plateau and to the north of the Ouachita Mountain region, and gradually merges into the Prairie Plains on the west. This area includes the whole of east-central and notheastern Oklahoma with the exception of an area of Mississippian rocks which are found in that part of northeastern Oklahoma occupied by Ottawa, Delaware, Cherokee, and Adair counties.

The rocks in the east-central Oklahoma coal fields are folded into anticlines and synclines as a result of the forces which formed the Ouachita Mountains. Erosion has later cut down the anticlines and today a large number of hills and mountains in that area are synclinal in structure. The rocks in this area are composed almost entirely of sandstones and shales, the sandstones in many instances forming permanent ridges and the shales well defined valleys or gently rolling prairie lands.

In northeastern Oklahoma the Pennsylvanian rocks dip to the west or to the southwest at a uniform rate of 35 to 40 feet per mile away from the Ozark Plateau. The rocks in this area consist of alternating sandstones and shales with several limestones especially in Craig, Nowata, and Washington counties. These sandstones and limestones form steep eastward facing scarps with gentle rolling prairie lands on their westward slopes.

PHYSIOGRAPHY

RELIEF

The western extension of the Ouachita Mountains forms the largest topographic feature of the coal fields area. Entering the state in eastern McCurtain and LeFlore counties, the mountains extend as a series of irregularly shaped hills and mountains, and short, high parallel ridges running east and west, bending south in Pushmataha County and terminating in the vicinity of central Atoka

County. This range of mountains is bounded on the north and west by the Choctaw fault, and on the south by the Cretaceous region. The valleys and ravines are markedly V-shaped, and the streams swift and choked with debris.

The rocks have been closely folded and faulted, so that high altitudes and reliefs mark the more resistent sandstone regions, while steep-sided, flat-bottomed valleys, mark the shale outcrops. The hills increase in height to the east, the main ridges making up the mountains proper. These high ridges are given names locally, and among the important ones with their elevations in feet above sea level are: Kiamichi Mountains, 2,450 feet; Winding Stair Mountain, 2,450 feet; Jackfork Mountain, 1,800 feet; Pine Mountain, 1,350 feet; Buffalo Mountain, 2,150 feet; Potato Peak, 1,500 feet; San Bois Mountain, 1,650 feet; and Cavanal Mountain, 2,300 feet. From the highest point (2,900 feet))on Rich Mountain, a continuation of Winding Stair Mountain, sec. 6, T. 2 N., R. 26 E., the elevation decreases to less than 400 feet at the Arkansas River in the extreme northeastern corner of the area. The relief of the area reaches a maximum of 1,650 feet at Rich Mountain although there are a large number of ridges that rise well over 1,000 feet above their valleys.

As a whole the elevation of the northeastern part of the coal fields area varies from 600 to 1,000 feet above sea level. The most pronounced relief is to be found in western Craig County along the scarp formed by the Fort Scott limestone where differences of elevation of 250 feet or more occur. The mesa or mound type of topography is found along these escarpments which are formed by outliers of these resistant formations. In general the valleys are board and U-shaped in cross-section. The streams are confined to their valleys by the escarpments mentioned above.

DRAINAGE

The southern coal field area is drained by two systems of streams, Winding Stair Mountain forming the divide between the two. South of the mountain the streams are tributary to Red River, and flow almost due south into that stream. To the north the drainage is northeast, and is carried by the tributaries of the Canadian. Arkansas, and Poteau rivers. The pattern of the streams is a combination of block and dendritic or branching types, the former type being confined, for the most part, to the secondary streams. The main streams, in order of their importance are: the Arkansas River on the northeast, the Canadian River on the north, the Kiamichi River in the central and southwestern portion of the area, the Poteau River and its tributary, Fourche Maline, flowing east and north in the east-central part, and Little River, Glover Creek, and

Mountain Fork River are south of Winding Stair Mountain, flowing into Red River. The area in northern Atoka and Coalgate quadrangles, lying west of the Ouachita Mountains is largely drained by Boggy Creek and its tributatries, Muddy-, Clear-, Caney-, and North Boggy creeks.

The Arkansas and Canadian rivers, flowing through broad valleys, with their tributaries, drain the entire northern portion of the area. These tributaries from east to west are: Cache, Sans Bois, Snake, Emanchaya, Longtown, Gaines, Scipio, Beaver, Shawnee, and Big creeks. Poteau River enters the area in the southeast corner of T. 5 N., R. 27 E., flows west for about 12 miles, turns back on itself and flows northeast and north leaving the state in T. 9 N., R. 26 E. Its principal tributary, Fourche Maline, flows due east draining the area between Winding Stair Mountain on the south and Cavanal Mountain, Potato Peaks, and Sans Bois Mountain on the north. Black Fork of the Poteau enters Oklahoma in T. 4 N., R. 27 E., flows west and north to Poteau River. Pigeon and Cedar creeks join in the center of T. 2 N., R. 24 E. to form the Kiamichi River which flows due west between Winding Stair Mountain and Kiamichi Mountain, thence south of west, leaving the area in T. 1 S., R. 16 E. Its principal tributaries are Rock, Buffalo, Anderson, Jackfork, Peal, Crumb, Crane, and Cedar creeks. Little River is formed by the joining of several unnamed creeks in T. 1 N., R. 23 E., and flows west and south to Red River. Its principal tributaries are Nonchonchonubbe and Black Fork creeks. The south-central part of the area is drained by East Fork of Glover Creek. Mountain Fork River enters the State in T. 1 S., R. 27 E., flows west and south, and is joined along its course by Dry, Eagle Fork, Rock, Buckhorn, and Buffalo creeks, all of which drain the southeast corner of the area.

Northeast Oklahoma is drained by the Neosho and Arkansas rivers and their tributaries. The Neosho and its tributaries are confined to a general southerly course and joins the Arkansas River near Ft. Gibson. These streams are fed to a considerable extent by abundant springs which furnish a supply of water the year around and which, together with the rainfall makes the streams in this part of Oklahoma permanent in contrast to the streams of the more arid regions farther west.

TRANSPORTATION

RAILROADS

There are about twenty lines of railroads operating in Oklahoma with a total mileage of 6,000 miles, and of these there are eight which have a mileage of 5,231 miles. These eight roads carry practically all the coal mined in the state. The names of the roads with the mileage in Oklahoma is given in the table below:

Table No. 4. Railroads carrying coal in Oklahoma.

Railroad	Mileage
Atchison, Topeka and Santa Fe, including 100 miles of Gulf, Colorado and Santa Fe	944
Chicago, Rock Island and Pacific	1345
Fort Smith and Western	220
Kansas City Southern	143
Midland Valley	258
Missouri, Kansas and Texas	695
Kansas, Oklahoma and Gulf	128
St. Louis and San Francisco	1498
	5231

NOTE: The branches of the Kansas City Southern, Poteau Valley Railroad, and various branch lines and connections are not included in this table.

The building of the Missouri, Kansas & Texas Railroad in 1872 and later, opened up the coal fields so that development really started on a commercial scale then. In the following year the Osage Coal & Mining Co. began operations, and connected its mines by a branch with the main line at McAlester. The building of the Choctaw, Oklahoma & Gulf Railroad, now the Rock Island, through the eastern portion of the field from southern McAlester gave great impetus to coal mining. The St. Louis & San Francisco Railway built across the eastern portion of the territory in 1885 brought about a large development in that part of the region, as also did the Kansas City Southern Railroad, built across the southern part of the field, which gave additional impetus to the development of that section. These four railroads are the only ones built until after 1899, when a branch of the Choctaw, Oklahoma & Gulf Railway was extended from the main line from near Hartshorne to Ardmore following the coal beds for a distance of approximately 50 miles. This gave an outlet for the Coalgate and Lehigh districts, and resulted in the opening of a large number of mines. Branches of these railroads and of the Missouri, Kansas & Texas Railroad are extended along the coal outcrops from Dow to Wilburton, adding 40 miles of road which opened up the coal area in those districts.

About 1900 the Ft. Smith & Western, and Midland Valley Railroads were built adjacent to the coal outcrops in the northern and eastern part of the Choctaw Nation. A little later a branch of the St. Louis and San Francisco Railway was built in the northern part of the field, north of the Cherokee and west of the Creek Nations, which brought about increased development of the Dawson and Henryetta fields.

The building of several additional lines and the extension of others, has given an opportunity for rapid development and excellent transportation facilities. In 1897 eighteen companies and individuals were mining coal on a commercial scale.

Coal has been mined in Oklahoma as early as 1872, but development was exceedingly slow until the coal fields were opened by railroads so that the coal could be shipped to other points of the State.

HIGHWAYS

The State is rapidly developing an elaborate system of highways throughout the east-central and northeastern part of Oklahoma. The majority of the roads which are maintained by the State are either hard surface (cement or asphalt), gravel or earth graded and are in good condition throughout all seasons. Those roads which are designated as State roads and are now earth graded, are rapidly being converted into either gravel or paved roads. These earth graded roads and gravel roads are under direct supervision of competent patrol and maintenance men, whose duty is to keep the roads in good condition. The standard for this patrol service is very high and consequently these roads seldom get too bad for driving and are usually passable even after the hardest rains.

PART III. GEOLOGY.

STRATIGRAPHY

The area of Oklahoma is about 70,420 square miles. The coal bearing formations cover approximately 20,000 square miles in the east-central and northwestern part of the state. Within this area there are about 12,000 square miles underlain with coal seams. The coal areas of Oklahoma are a part of the Interior Province, Western Region (see page 15) which includes the coal fields of Iowa, Missouri, Nebraska, Kansas, Arkansas, and Oklahoma. The Oklahoma area is continuous to the north with the Kansas fields and on the east with those of Arkansas.

The coal bearing formations consist chiefly of sandstone and shale with some limestone, especially north of the Arkansas River. Only those formations which are found within the area mapped in this report will be described. The correlation of these formations is shown in the table following:

Table No. 5. Correlations.

South-central & Southeastern Oklahoma		Northeastern Oklahoma	
Seminole conglomerate Holdenville shale Wewoka formation Wetumka shale Calvin sandstone	Broken Arrow formation	Oologa limestone (Nowata shale, Altamont limestone, Bandera shale, Pawnee limestone) Labette shale Ft. Scott limestone	Pennsylvanian
Senora formation, Stuart shale and Thurman sandstone Boggy shale Savanna sandstone McAlester shale Hartshorne sandstone	Winslow formation with Bluejacket sandstone at base	Cherokee formation	Pennsylvanian
Atoka formation*	Upper Jackfork sandstone	Cherokee formation	?
Wapanucka limestone*	Middle Jackfork sandstone		Mississippian
Upper Caney shale* Lower Caney shale* Stanley shale	Lower Jackfork sandstone		Mississippian
Tallihina chert			Ord., Sil. Dev.
Stringtown shale			Ordovician

*NOTE. According to investigations of Honess, the lower Jackfork equals the upper Caney and is of Mississippian age, while middle Jackfork equals the Wapanucka and the upper Jackfork is the lower Atoka.

NORTHEASTERN OKLAHOMA

The Pennsylvanian rocks cover the greater part of the eastern one-third of the State. The lower members of the series are the great coal, oil, and gas bearing horizons of Oklahoma, and some workable coals and good production of oil and gas occur well up in the series. The Arkansas River divides the area of Pennsylvanian rocks into two sub-divisions. South of the Arkansas River the rocks are practically all sandstones and shales, while north of the river many limestones are found.

PENNSYLVANIAN AREA NORTH OF THE ARKANSAS RIVER

The area of Pennsylvanian rocks north of the Arkansas River include all of Washington, Nowata, Rogers, Wagoner, and Osage counties; and the greater part of Craig, Mayes, and Tulsa counties.

The formations exposed in this area east of Osage County follows from the base up: Cherokee formation, Ft. Scott limestone, Labette shale, Pawnee limestone, Bandera shale, Altamont limestone, Lenapah limestone, Coffeyville formation, Hogshooter limestone, Nellie Bly formation, Dewey limestone, and Ochelata formation. Still higher there are other named formations of Pennsylvanian age which are of no importance in the consideration of the coals. The formations up to, and including the Ochelata, are described in the following paragraphs.

CHEROKEE SHALES

The Cherokee shales consist of a succession of shales with interstratified sandstones, thin beds of coal and lenticular limestones. The area covered by the formation is a broad area varying in width from 12 to 30 miles and extending from the Kansas line south to the 35° parallel, where the formation name changes to the McAlester and other formations of east-central Oklahoma. From the Kansas line southward the formation thickens rapidly from about 450 feet to 1,000 feet at Pryor Creek. Ohern gives the following section beginning one mile east of Pryor Creek and extending to Claremore:

Section of Cherokee shale, extending from one mile east of Pryor to Claremore

	Feet
Shale with a few interbedded sandstones	135
Sandstone, massive, medium grained	17
Sandstone, shaly	3
Limestone, argillaceous, heavily bedded, fossiliferous	2.5
Shale, bluish	35
Shale, carbonaceous, capped by 6 inches of ferruginous, siliceous limestone	3
Sandstone, gray, fine-grained	7
Shale, arenaceous	70
Shales and sandstone, alternating	70
Limestone, argillaceous, fossiliferous	8
Sandstone, massive, medium-grained	37
Sandstone, shaly	8
Sandstone, massive, medium-grained	14
Shale, bluish, weathering to a light-yellow and a few interstratified sandstones	550
	959.5

It is stated that at the base of the third member from the bottom, there is a stratum of carbonaceous shale which may accompany coal. The location where the exposure is found is about five miles due west of Pryor Creek. A very large amount of the oil in northeastern Oklahoma occurs in the Cherokee formation.

To the south the Cherokee is the equivalent of the Winslow formation, Savanna sandstone and Boggy shale in the Muskogee quadrangle, and of the Senora formation, Stuart shale, Thurman sandstone, and Calvin sandstone in the eastern part of the Okmulgee quadrangle.

FORT SCOTT FORMATION

Lying above the Cherokee shales is a series of limestones and shales, with a single sandstone of prominence, and two or more beds of coal. This formation is known as the Fort Scott. The thickness varies from 50 to 150 feet.

The following section by Ohern and Wolf, three miles west of Claremore, shows the character of the formations:

Section of Fort Scott Formation three miles west of Claremore

	Ft.	in.
Limestone, massive, fossiliferous, top eroded in front of school house	5	3
Shale, carbonaceous, seen at crossroads	2	6
Limestone, cherty, weathering to yellowish, spongy, siliceous fragments, fossils abundant	2	8
Sandstone, massive, fossiliferous, white	4	8
Shale	5	6
Sandstone, hard	2	0
Shale	21	6
Chert, giving polygonal fragments on surface	0	4
Shale, weathering to buff	0	10
Limestone, massive, bluish, fossiliferous	3	0
	48	3

LABETTE SHALES

These shales lie above the Fort Scott limestone, and extend south from Kansas into Oklahoma. In thickness the Labette increases from 30-80 feet in Kansas to 135-200 feet in this State. The shales occupy the depression between the limestone of the Claremore and Oologah formations, and this outcrop is two to three miles in width. The Verdigris River follows the outcrop from Coody's Bluff to Catoosa, and most of the shales lie buried beneath the alluvium formed by this stream. A fine grained yellowish to buff sandstone which lies in the upper part of the formation is a fairly constant marker.

PAWNEE LIMESTONE, BANDERA SHALE, ALTAMONT LIMESTONE

These formations include all rocks lying above the Labette shales and below the Nowata shales, and are known as the Oologah formation. Directly south of the Kansas line these formations cover an area ten miles wide, but the width decreases rapidly to the southward along the west bank of Big Creek to the Verdigris River, northeast of Nowata. From this point the formation consists of a narrow strip on the west bank of the river, until reaching Oologah where it widens. Opposite Claremore and Catoosa it widens to six or seven miles. It begins to narrow northwest of Broken Arrow and continues to the Arkansas River.

In the southern part of its extent these rocks consist of layers of siliceous and cherty limestones which in general may be considered as one bed of limestone, the Oologah limestone. Near Talala the limestone separates into two parts, and a carbonaceous shale fills in the interval. This shale thickens to the northward and is continuous with the Bandera shale of Kansas. The upper limestone is the equivalent of the Altamont limestone, and the lower is the continuation of the Pawnee limestone of Kansas.

Section four miles northeast of Nowata

	Feet
Limestone, bluish	10
Shale, bluish to black	35
Limestone, massive, fine-grained	6
Shale, black, carbonaceous, fissile	5
Limestone, bluish, shaly in lower part	14
Shale, black, base not seen	11
	81

The shale lens increases in thickness from nothing at Oologah to about 100 feet at the Kansas line.

NOWATA SHALES

This formation is a series of shales with a few interstratified sandstones and at least one bed of coal. The thickness increases from about 50 feet near the Kansas line to 130 feet at Nowata and 600 feet at Tulsa.

The stratigraphy of the Nowata shale is simple. The lower part is almost wholly a mass of shale. Near Oologah a massive sandstone about three feet thick lies about 35 feet above the base. This makes a well marked scarp which can be traced for a considerable distance along the strike.

In the vicinity of the mouth of Rabb Creek other sandstones make noticeable scarpments but sufficient data are not at hand to say whether they are more than mere local lenses.

Dawson Coal. One of the most persistent stratigraphic features of the Nowata shales is a bed of coal. The most northernly point at which it was observed is three miles southwest of Nowata. Outcrops occur frequently near Collinsville where the coal is mined as well as in the vicinity of Coal Creek and near Dawson, whence it is usually called the Dawson coal. The coal is from 20 to 30 inches thick and seems to extend far southward past the Arkansas River as shown by Taff.

LENAPAH LIMESTONE

This is a conspicuous limestone at the town of Lenapah. The area covered by this limestone is near the Kansas line and east of the Verdigris River. It is the caprock of most of the hills in the northeast part of the Nowata Quadrangle, and consists of a single massive bed, highly fossiliferous, varying in thickness from 20 feet in the north to 30 inches or less south of Nowata.

COFFEYVILLE FORMATION

Above the Lenapah limestone lies the Coffeyville formation of the Kansas geologists. In the present connection it is considered to have a thickness of about 370 feet, the increase in thickness from the Kansas line southward being constant and rather rapid. For the most part it is composed of shales but sandstones become prominent in the upper part. These are well exposed on the bluffs four miles west of Nowata and thence southward.

HOGSHOOTER LIMESTONE

The name Hogshooter has been applied to 10 feet of limestone lying about 75 feet below the base of the Dewey limestone. Throughout its outcrop it is generally thin bedded specially about Ochelata and Ramona and probably for this reason has not usually been recognized by the drillers. It is at present regarded as the southern extension of the lower part of the Drum limestone.

NELLY BLY FORMATION

About 75 feet of shale and sandstones intervene between the Dewey limestone above and the Hogshooter limestone below. They are regarded as the equivalent of the middle part of the Drum limestone which splits just west of Coffeyville, Kansas. The sandstones of this interval are thin and lenticular.

DEWEY LIMESTONE

Succeeding the Ochelata formation below is a mass of limestone about 23 feet in thickness to which the senior author in his preliminary paper applied the name of Dewey. It is well exposed in Bartlesville, near Dewey, and to the eastward is prominent on the bluffs west of Ochelata and Ramona. Tentatively it is regarded as the equivalent of the upper part of the Drum limestone of the Kansas section.

OCHELATA FORMATION

The Ochelata formation of the Independence quadrangle, following the general rule, thickens to the southward. In southern Kansas the thickness is 280 feet, but in the southeastern part of the Pawhuska quadrangle it is about 400 feet, an approximate section being as follows:

Approximate section of the Ochelata formation

	Feet
Sandstone, exposed near Torpedo	30
Shale, thin sandstones and thin limestones	240
Limestone (the Avant)	0-35
Shale, thin sandstones and thin limestones	45-90
Average total	350

PENNSYLVANIAN AREA SOUTH OF THE ARKANSAS RIVER

This area contains the greater part of the principal coal beds. The area extends from the Arkansas River south to the Arbuckle and Ouachita Mountains, and west from the Arkansas line to the red beds. A part of the red beds are also of Pennsylvanian age. A small area south of the Arbuckle Mountains known as the Ardmore District is of Pennsylvanian age and contains a little coal.

The principal area of the Pennsylvanian rocks includes all or part of the following counties: LeFlore, Latimer, Haskell, Muskogee, Okmulgee, Tulsa, Creek, Pawnee, Payne, Lincoln, Pottawatomie, Garvin, Pontotoc, Seminole, Okfuskee, Hughes, McIntosh, Pittsburg, Coal, and Atoka.

The Cherokee shales which have a total thickness of about 450 feet at the Kansas line, thicken rapidly to the south, both by normal thickening and possibly by overlap, until in the Coalgate quadrangle the rocks representing the same interval have reached a thickness of over 9,000 feet. In the Muskogee quadrangle the thickness is about 1,500 feet. In his description of this quadrangle, Taff describes the two formations, the Boggy and the Winslow, the latter being the equivalent of the Hartshorne, McAlester and Atoka formations as exposed in the coal fields farther south. The Boggy is given as 500 feet thick and the Winslow 800 to 1,000 feet.

Much detailed work has been done on the stratigraphy of the southern part of the area. The work has largely been done by Taff in his work for the United States Geological Survey in the Oklahoma coal fields. He began the study of these rocks in the vicinity of McAlester in 1885 and spent practically every field season in the area until his connection with the Survey ceased in 1910. Five folios and numerous other reports have been published, two dealing with the geology, structure, and economic resources of the coal area.

In the Coalgate folio the following formations are given as they occur in Coal and Hughes counties, the oldest below:

Section from Coal and Hughes Counties

	Feet
Calvin sandstone	200
Senora formation	500
Stuart shale	250
Thurman sandstone	200
Boggy shale	2,000
Savanna sandstone	1,200
McAlester shale	2,000
Hartshorne sandstones	200
Atoka formation	3,000
	9,550

This entire series of strata is coal-bearing. In Arkansas beds of considerable thickness occur in the Atoka formation, but in Oklahoma these beds are usually thin and inconspicuous. The McAlester formation contains four beds of workable coal and a number which may be developed eventually. The Savanna contains at least three workable beds, the Boggy formation two, and one in the upper part of the Senora which is mined at Henryetta, Schulter, and Morris. In the southeastern part of the area occupied by rocks of the Muskogee group the strata have been extensively folded, and in certain places faulted. A series of anticlines and synclines have their axes extending northeast-southwest.

SOUTH-CENTRAL AND SOUTHEASTERN OKLAHOMA

STRINGTOWN SHALE

The Stringtown shale is the oldest formation exposed in this area. It outcrops as a narrow band, parallel to the Choctaw fault, from Stringtown to Atoka. Taff's[4] description in the Atoka folio is as follows:

> "The upper part of the Stringtown shale crops out in the dome-like uplift eight miles northeast of Tuskahoma, near the center of the portion of the Ouachita uplift. It occurs in this locality in a flat circular cove surrounded by prominent ridges of the overlying Talihina chert. The upper part of the shale crops beneath the talus of this chert, while the soft green shales lower in the formation lie in the flat, partly wooded plain of the cove. The upper part is composed of black, siliceous, slaty shales similar to those in the vicinity of Atoka and contains lower Silurian graptolites (upper Ordovician age). Below these beds are greenish, fissile and friable shales with occasional inclusions of calcareous cone-in-cone and iron-stone concretions."

TALIHINA CHERT

The Talihina chert is a series of blue, green, black, and white flints and cherts, with occasional thin lentils of blue limestone.

4. Taff, J. A., U. S. Geol. Survey, Geol. Atlas, Atoka folio (No. 79), 1902.

These flints and cherts are for the most part found in sheets rarely exceeding six inches in thickness, while the shales occur as thin laminae or fissile layers. It has a thickness of approximately 1,150 feet and occurs in Black Knob Ridge, east and northwest of Atoka. It is composed of beds of Ordovician, Silurian, and Devonian age.

STANLEY SHALE

The Stanley shale is a thin bedded, ripple-marked, fine grained, hard sandstone, with blue shales and slates interbedded with it. There are two cherty members, 30 to 40 feet in thickness, at 550 and 800 feet respectively above the base of the formation. These beds greatly resemble the thin cherts of the Talihina formation. The green and blue shales alternating with drab or brown sandstones are found continuing upward in the section until the top is reached. It attains a thickness of 6,000 feet and is exposed through a greater part of the Ouachita Mountains. The age of this formation is thought to be upper Mississippian.

JACKFORK SANDSTONE

This formation represents an almost continuous sedimentation of 5,000 feet of sandstone, and generally consists of a series of even-textured, fine-grained, brown and gray sandstone strata ranging from thin layers to massive beds 50 feet in thickness. Occasionally interstratified with these beds are thin strata of clay shale and shaly sandstone. The shaly beds are very rarely exposed on account of the protection afforded by the sandstone beds and sandstone talus.

There has been much controversy on the age of the Jackfork. A Morrow, (lower Pennsylvanian) fauna has been found by Honess[5] at the base of his "Upper Jackfork" sandstone, which he correlates with the Atoka formation. Miser[6], therefore, excludes the "Upper Jackfork" of Honess from the Jackfork formation and maps it as Atoka on the State map. The true Jackfork sandstone is classified as of Mississippian age by the United States Geological Survey.

CANEY SHALE

The Caney shale is a black bituminous shale, extremely fissile in character containing slate and limestone concretions, with occasional sandy members. It is 800 to 1,600 feet in thickness, and is especially well exposed in the Arbuckle Mountains, but there are numerous exposures in the area covered by this report. The

5. Honess, C. W., Oklahoma Geol. Survey, Bull. 32, 1923.
6. Miser, H. D., Geologic Map of Oklahoma, U. S. Geol. Survey in cooperation with Oklahoma Geol. Survey and oil companies of Oklahoma.

Caney shale throughout is laminated, fissile, friable, and in consequence is rarely exposed. On account of the softness of the rock it is almost universally worn down to level ground or is to be found in the lower slopes of hills which are surmounted by harder rocks of adjacent formations. There is considerable controversy regarding the age of the Caney shale, but the present consensus of opinion seems to place the lower part of this formation in the Mississippian and the upper part in the Pennsylvanian.

WAPANUCKA LIMESTONE

The beds at the top of this formation are white, massive, and often oolitic. Cherty, sandy limestone and shales occur in the central part of the formation. Below these variable beds, a massive white limestone occurs, but it is not constant in thickness and character and in places could not be found. At the base of the formation there are calcareous and cherty sandstones which grade into shales on the one hand and into nearly pure ferruginous sandstone on the other. In Limestone Ridge, the lowest strata are thin cherts and flint plates, interbedded with siliceous limestone. In the vicinity of Wapanucka sandstone beds occur at the base.

The whole formation grows thinner westward, until but little else than the massive oolitic limestone can be found. In limestone Ridge the thickness is estimated to be about 200 feet. At the western border of the Coalgate quadrangle it probably does not exceed 30 feet.

ATOKA FORMATION

This formation outcrops over a large area in the valley of Clear Boggy Creek, in the northwestern part of Atoka County and southern Coal County, and extends in a belt of varying width among the north side of the Choctaw fault to the Arkansas line. On an average the thickness of the formation is about 3,000 feet. It consists largely of blue clay shales and sandy shales, with occasionally thin beds of limestone and calcareous cherty sandstone. The thickest beds of sandstone are about 100 feet. The combined thickness of the shales is about five times that of sandstone and limestone.

To the east in Arkansas the proportion of sandstone is greatest. The Arkansas region contains some coal but chiefly in lentils too thin to be worked. Some of the beds have been mined locally, and attempts to prospect more fully are in progress, though nearly all the old openings have been abandoned. The coal seems to be more common in the eastern than in the western part of the field. Oil and gas have been found in the formation in some of the sandstone lenses.

HARTSHORNE SANDSTONE

This sandstone is economically the most important formation, on account of its association with the lowest and most valuable coal beds in a large part of the field. The coal lies directly above the sandstone, with a thin parting of shale, but in some places this shale parting is cut through and the two coals are in contact with each other.

The formation varies in thickness from 100 to 200 feet. It consists chiefly of sandstone, some of which are thick bedded and massive, while others are very thin. In general the upper beds are thickest. Very thin layers of clay shale and sandy shale occur between the layers of sandstone causing them to separate into thin shaly beds. At a distance the sandstones seem gray in color, heavy and massive, but closer observation shows them to be a light to rusty brown color, thin bedded with layers from one-half to four inches thick, having rarely a solid ledge one foot or more in thickness. The thickest layers produce prominent narrow ridges and whenever they can be traced serve as good markets for the location of the coal beds. Ripple-marks are common in the slabs of rock but fossils are few. The sandstone outcrop is usually marked by one or more of the prominent massive ledges of rock in place and by large broken fragments scattered along the immediate exposure. A line of post oaks and barren oaks grows along the outcrop.

South of Hartshorne the formation is well developed and is steeply inclined along a considerable part of its outcrop. Between Gowen and Cherryvale the rocks have their broadest expanse and lowest dips. From Cherryvale east for several miles the sandstone is on edge or dips steeply to the north and forms a sharp ridge except where worn by Gaines Creek. The dip ranges from 10 degrees east of Hartshorne to 24 degrees in the vicinity of the old mines directly south of the town, and to the westward where the outcrop makes an abrupt turn to the south a very high dip is attained, and at Craig the rocks are vertical. In the region east and south of Kiowa and in the Savanna arch southeast of Savanna the formation is worn down level with the plain and only occasionally a ledge of sandstone may be seen above the surface. One mile south of Savanna it occurs in a high hill and narrow ridge along the south side of Chun Creek.

McALESTER SHALE

This formation consists of a great series of shales and sandstones with an estimated thickness of 2,000 feet. The total thickness of the shales is nearly ten times that of the sandstone. The shales consist of blue and black clay shales, sandy shales, and some shaly sandstones. Taff has divided the formation in the McAlester quadrangle into three parts for convenience of discussion. The lowest division is composed almost entirely of shale with thin sandstone and coal, and having a total thickness of 800 feet. In some places near the center of the formation sandstone occurs in thin beds. The Hartshorne coal occurs at the base of this shale, or just above the Hartshorne sandstone as previously stated.

The second division of the formation consists of three or four beds of sandstone separated by 100 to 200 feet of shale. The total thickness is about 500 feet. The lowest of these sandstones reaches a thickness of almost 200 feet where it caps Belle Starr Mountain and the ridge northwest of Hartshorne. The upper division consists almost entirely of shale, about 700 feet in thickness, with the McAlester coal 50 feet above its base. Several thin beds of coal also occur in the sandstones, but none have been found of sufficient thickness to be classed as workable. However, these thin beds have been worked in some places to a limited extent.

A thin band of buff fossil iron ore occurs below the McAlester coal. This iron ore, which may not be widespread in its occurrence, associated with the thin-bedded sandstone nearly 50 feet thick, may prove a valuable aid to the prospector in locating the McAlester coal. A striking feature of the McAlester shale is its surface characteristics. Almost entirely a soft shale throughout its thickness, it is worn down to a level plain. In the region of McAlester, Krebs, and Alderson, the smooth plain is upon the upper division of this shale. The basin plain north of Hartshorne, called by Dr. Chance the Grady Basin, is upon the lower division of this shale. If it were possible, it would be desirable to map the middle division of the McAlester shale as an aid to the prospector in locating the McAlester coal. Where the dips are as steep as they are over a large part of the outcrops, the sandstones are worn down to a level with the plain and are concealed.

The three divisions of the McAlester formation are represented on the Arkansas side by the Spadra shale with a thickness of 350 to 500 feet; the Fort Smith formation 400 feet; and the Paris shale 700 feet thick. The Paris coal of Arkansas is the equivalent of the McAlester coal. These divisions are described in detail by Collier[7], and a part of this description such as applies to conditions of the eastern part of the Oklahoma field is given.

"The Spadra shale, named from the town of Spadra, in Johnson County, stands next in economic importance to the Hartshorne sandstone, which it overlies, since at is base it contains the most important coal beds. In general this formation consists of fine-grained blue, black, or gray clay shales, but locally it contains sandy beds and in some places thin sandstone lenses, none of which extend for very great distances. The most prominent sandstone lens is one observed near Burma, in Sebastian County, which forms the parting between the upper and lower Hartshorne coals. This sandstone which has a maximum thickness of 60 feet, is irregularly cross-bedded, contains mud lumps, and resembles the Hartshorne sandstone in hardness, but it thins out and disappears within a few miles in each direction from its thickest part. At many other places sandstones having a thickness as great as 20 feet occur, but these are of irregular distribution and of no great extent. The thickness of the formation, which is well known not only from surface observations but from many drill holes that have penetrated it, varies from 350 to 500 feet.

"The outcrops of the Fort Smith formation are more widely distributed than those of any other formation within the coal field. The formation consists of a group of thin and to some extent variable sandstone beds, with interbedded shale members. In general the sandstones are ripple-marked, the markings presenting considerable variety in both size and form, and many of the individual beds are characterized by a wavy cleavage approximately parallel to the minor undulations of the bedding planes. False bedding or cross-bedding, which is a common feature of the Hartshorne sandstone, is unusual in the Fort Smith formation, though it is not entirely absent. The shales are nearly everywhere more or less arenaceous and the resulting soils are reddish or yellowish and sandy. The formation here consists of a lower member, 20 to 50 feet thick of hard, flaggy, ripple-marked sandstone, above which there is 40 to 60 feet of shale overlain by hard sandstone and shaly sandstone nearly 100 feet thick. Near the upper part of the formation there is a coal bed which was formerly mined.

"The Paris shale resembles the Spadra shale, but is almost invariably more sandy and contains a greater number of sandstone lenses. The sandstone lenses, however, are generally softer than those included in the Spadra formation, and no not contrast so strongly in topographic expression with the including shales. The total thickness is estimated from the dips of the outcrops to be between 600 and 700 feet. The base of the formation is believed to be nowhere less than 800 feet above the horizon of the Hartshorne coal. The Paris coal bed occurs from 200 to 300 feet above the base of the Paris formation and about 400 feet below its upper limit."

7. Collier, A. J., U. S. Geol. Survey, Bull. 326, p. 15, 1907.

McALESTER COAL

McAlester coal occurs from 1,200 to 1,500 feet above the Hartshorne coal. The bed has an outcrop length of 70 miles in the southern part of the district. The coal varies in thickness from four and one-half feet in the west end of the district to about three feet in the east, and contains no shale partings. It is of high quality, mines well, and is a good steam coal.

There are two beds of coal within the McAlester shale in this field which occur in the stratigraphic position of the McAlester coal as it is known in the Dow, Alderson, Krebs, and McAlester districts, in the western part of the Choctaw coal field. These two coals are there separated by about 60 feet of shale, and lie from 600 to 800 feet below the top of the formation. Below the coal there are a number of sandstone beds which together make low ridges or hills, and which are excellent horizon markers for determining the position of the coal. The dip of the sandstone through the south side of the field is regular toward the north, and when the position of the coal and its relation to the sandstone is determined, as it is inclined toward the center of the basin at angles from 2 to 10 de- traced readily throughout its occurrence.

STIGLER COAL

In the area lying directly south of the junction of Canadian and Arkansas rivers is a considerable area of coal known as the Stigler coal. It occupies approximately the same position geologically as the McAlester coal, but has not been determined definitely whether it is the exact equivalent. In this region there is but one bed of any considerable value and the chief bed is thinner than the McAlester coal in the vicinity of McAlester, the thickness being less than 50 inches. The coal lies in a basin, the axial part of which extends in a northeast-southwest direction. The coal is inclined toward the center of the basin at angles from 2 to 10 degrees at the outcrop.

Several small mining operations have been carried on in this vicinity. The coal is of good quality, and is well suited for mining and is at no place in the district at a great depth. The coal contains on the average less than 1 per cent sulphur and the ash content is low. Some large blocks of this coal, which were mined several years ago, have been lying near the railroad station at Stigler and were found to be in good physical condition showing the ability of the coal to withstand weathering.

The coal on the McAlester arch is well situated for mining, especially on the south side. The anticlinal arch, by pitching westward, carries the coal beneath the surface a few miles west of McAlester. East of McAlester, by the rising of the arch and by the great amount of erosion which has worn the rocks down, the outcrop of the coal on the north side diverges from that on the south side. The outcrop on the south side bears southeastward through Krebs and Alderson to mine No. 9 on Bushy Creek, where it turns south and southwest upon the south side of Kiowa basin. The crop of this coal upon the north side of the arch bears eastward from McAlester for six miles, where it turns toward the south and west and approaches within two miles of Krebs. From this point it curves south for a short space and then bears east to the border of the McAlester quarangle by way of Cherryvale. Upon the south

side of the arch in the vicinity of McAlester the coal dips south at 20 to 29 degrees. Eastward, the dips grow less until in the region of Krebs they are 6 to 10 degrees toward the west and southwest. From Krebs to Alderson the dips are toward the southwest and south and increase nearly 20 degrees. Eastward from Alderson they grow less until at mine No. 9 the dip is west about 6 degrees. Throughout this course the McAlester coal may be mined probably for a mile or more from the outcrop. These conditions are well understood, as the extensive mining operations at McAlester, Krebs, and Alderson will attest.

Upon the north side of the arch, from the vicinity of McAlester eastward six miles, the coal dips north from the surface 60 to 80 degrees. This coal can not be worked profitably until the more advantageous ground upon the south side of the arch has been exhausted. North of Cherryvale, as the coal outcrop turns toward the south and southwest, the dips become low. At Cherryvale, the dip is about 16 degrees north, and eastward from Cherryvale the dip increases until it is about 25 degrees at the eastern border of the McAlester quadrangle.

The shallow basin north from Cherryvale, which has an area of nearly two square miles, is the most valuable field of this extent upon the north side of the McAlester arch. The axis or trend of this small basin bears nearly east and west, and pitches at a low angle toward the east. North of Cherryvale the coal at the center of this basin is not more than a few hundred feet beneath the surface. Northward from the outcrop of the McAlester coal, east of Cherryvale, the dips grow rapidly less, until at depth of about 700 feet they are not greater than 10 degrees. The area of coal on the McAlester arch that may be mined from the outcrop to a depth of 1,000 feet is 35 square miles.

In the Kiowa syncline. The conditions of the structure under which the McAlester coal occurs are very nearly the same as those attending the appearance of the Hartshorne coal in this basin. The McAlester coal outcrops above and nearly parallel with that of the Hartshorne. It dips toward the northwest at various angles, ranging from 40 to 60 degrees, and generally above the average of these extremes. It is not known whether the coal is continuous through the southeast side of the basin. The high dip of the rocks and the generally obscure surface exposures have deterred the prospector and miner from making any serious attempt to develop the coal.

The area of the McAlester coal in the south side of this basin that may be worked under the most favorable conditions is nearly fifteen square miles.

In the Krebs basin. Except at the northeast end, bordering the McAlester arch, which has already been described, and on the sharp fold of the Savanna arch, which will be described below, the McAlester coal is so far beneath the surface in the Krebs basin that the question of its being mined in the near future need not be discussed. At South McAlester and along the Missouri, Kansas and Texas Railroad from this town nearly to Savanna the McAlester coal is at a depth of 1,500 to 1,800 feet. From South McAlester southwest along the axis or center of the basin, the coal gradually grows deeper until the limits of this coal field are passed.

On the Savanna arch. There is a small area of McAlester coal on the Savanna arch available for mining, and its favorable location along the Missouri, Kansas and Texas Railroad gives it additional importance. The coal occurs here as in the south side of the Kiowa basin, almost parallel with the Hartshorne coal and sandstone. It lies above the Hartshorne sandstone and is separated from it, as usual, by about 1,300 feet of shale and sandstone. In the mine near Savanna this coal dips northwest nearly 55 degrees. In the mines at Johnstown and Fairview, two and four miles respectively south of Savanna, it dips 48 degrees. East of Savanna the dips become lower as the outcrop passes across the arch, where it pitches towards the northeast. As the crop approaches the southeast side of the arch, southeast of Savanna, the rocks are broken and the dips become very steep, and from this locality southwest along the arch the coal continues dipping steeply toward the southeast. The area of coal now workable on the Savanna arch is about 10 square miles. The total area of McAlester coal that may be worked in this district is about 60 square miles.

In the Sansbois syncline. From the south sides of the Sansbois and Cavanal synclines the McAlester coal beds crop in the low and nearly level plain, almost parallel with the Hartshorne coal and sandstone, which occur below and to the south. They have not been mined, and have been prospected but little west of Red Oak, hence the thickness and character of the coals are not known.

In the Brazil anticline. Brazil Creek flows in the center of the Brazil anticline from its source to the vicinity of Walls postoffice, its valley being wide and flat. Several hundred feet of the upper part of the McAlester shale are exposed in the sides and bottom of the valley. Rocks in the horizon of the McAlester coal bed occur in the bottom of the creek valley, and several exposures of coal occur in the bed of Brazil Creek. One coal bed 18 inches thick has been mined for local use in Brazil Creek, at the mouth of Jefferson Creek, in the NE¼ sec. 10, T. 6 N., R. 22 E. Other outcrops of coal in this horizon occur along Brazil Creek north of Red Oak. As far as known, these coal beds are not of sufficient thickness to be mined successfully. The rocks have low dips toward the north and south in the north and south sides of the valley respectively. Thus conditions are favorable for successful operation of mines should coal of workable thickness be found.

In the Cavanal syncline. From Red Oak to the Wister District the McAlester coal has been prospected and located at a number of places, and has been mined at Red Oak, Turkey Creek, and Fanshawe. From Red Oak to a point opposite the abandoned mines at Pocahontas the coals crop on the south side of the Choctaw, Oklahoma and Gulf Railroad. Throughout this course the dip is about 10 degrees north. The crop lies south of Wister, in the valley of Mountain Creek. From near the mouth of Mountain Creek east of Wister the crop of the coal turns from east to northeast, in the flood plain of Poteau River. In the nearly level valley of Poteau River the dips are low toward the northwest, hence the crop is irregular and can be located only by prospecting. Rocks in the horizon of the McAlester coal outcrop in the northwestern side of the Cavanal syncline from the state line, two and one-half miles south of Jenson, westward toward Shady Point. A coal bed has been prospected in the horizon of this coal about two miles west of Cameron. Beyond this prospect toward the west the coal is not known north of Cavanal and Sansbois mountains. Its horizon, however, may be located with fair accuracy by taking into consideration the associated sandstone beds, which usually outcrop in ridges and hills of more or less relief.

In the Poteau syncline. The McAlester coal horizon occurs at the base of Poteau Mountain, dipping about 20 degrees northwest, on the south side, and nearly 10 degrees south on the north side. Around the west base of the mountain the dip is usually less than 5 degrees east. The thickness and quality of this coal in the Poteau syncline are not known, it having been prospected but little and not at all developed.

Likewise little is known of the McAlester coal in the Sugarloaf syncline in Sugarloaf Mountain. Some prospecting has been done near the horizon of the McAlester coal in the northwestern base of the mountain, but it has not been exploited except for local purposes.

WINSLOW FORMATION

This formation derives its name from a town on the crest of the Boston Mountains in northwestern Arkansas. The formation occurs in Oklahoma, in northern Haskell and LeFlore counties and eastern Muskogee County. To the south, the Winslow dips beneath the surface in the deep trough of the Arkansas Valley, south of the Muskogee quadrangle. On the south side of this trough the formation is divisible into the three parts, the Atoka formation, the Hartshorne sandstone, and the McAlester shale. Its thickness is about 1,100 feet. Since the rocks in the northern area cannot be separated, they are grouped into the one formation.

The Winslow formation consists of bluish clay shale, brown sandstone, and thin beds of coal. The sandstone beds for the most part occur in two groups, one near the base and the other above the middle of the formation.

The rocks near the base and below the lower body of sandstone are interstraified sandstone and shale beds. The sandstones are for the most part thin and shaly, but in places are thick and massive and occur at the base in contact with the limestone of the underlying Morrow formation. Locally they are coarse-grained at the base and may contain small rounded pebbles of quartz. This pebbly character increases eastward until, in the northern foothills of the Boston Mountains of northwestern Arkansas, the rocks become conglomeratic. It may be said that these alternating sandstone and shale beds culminate in the thicker sandstone deposits which lie 200 to 400 feet above the base of the formation. These sandstone beds gradually become thinner towards the north and at the same time the amount of lime in the shale increases, so that parts of it become very calcareous and contain beds of shaly limestone.

On the lower group of sandstone and shaly beds rests a deposit of shale composed chiefly of clay. Locally sandy shale or thin sandstone may occur in this position, but not of sufficient thickness or hardness to become apparent on the surface of the land. The shale dips approximately 2 degrees toward the southwest in the southern part of the quadrangle, and its outcrop is limited to the valley of Dirty Creek. Toward the middle and in the northern part of the Muskogee quadrangle the dip of the rocks becomes less and the sandstone both above and below decreases in thickness, so that the surface extent of the shale cannot be outlined. A thin coal which occurs in the upper part of this shale has been prospected near the source of Spaniard Creek and on Sam Creek south of Muskogee. Thin coal beds, presumably in the same shale, have been prospected two miles south of Wagoner. Like the deposits lower in the formation the shale becomes more limy northward. Limestone beds, probably of local extent, occur in the vicinity of Wagoner, and others are reported to have been penetrated by drills in deep wells in Muskogee.

The upper group of sandstones consists of yellowish-brown beds interstratified with bluish clay shales. These beds are in part ferruginous and are generally soft, except where segregations of iron have locally indurated the rock. The uppermost beds are thickest, and cap the escarpments and low hills that mark the outcrops of the deposits west of Dirty Creek and those at the sources of Spaniard, Sans, and Pecan creeks. The low dip slopes of the uppermost beds extend from the top of the low escarpments down to the wide valley at the base of the Rattlesnake Mountains and to Butler Creek, toward the northwest. The thickness of these sandstone beds, with their included shales near the southern boundary of the quadrangle, is estimated to be more than 100 feet. Toward the northwest the sandstones become thinner and softer, and it is believed that they cannot be traced north of Arkansas River.

From the top of the upper group of sandstone beds shale continues to the top of the formation. Locally variable shaly sandstone beds and beds of thin coal occur in the shale. Accurate determination could not be made, but it is estimated that the thickness of this shale does not exceed 100 feet. This shale is the westward continuation of the Atkins shale member of the Winslow formation described in the Tahlequah folio.

SAVANNA SANDSTONE

This formation covers a comparatively large area in the Oklahoma coal field. The group consists of three more or less massive and thick bedded sandstones with intervening shaly members, aggregating 1,150 feet in thickness. It outcrops in the lower slopes of the Cavanal, Sansbois, Poteau and other mountains of the eastern side of the State. The sandstones vary in color from white to rusty brown, and break into more or less rectangular blocks. In many places nodules are found in the slabs of sandstone and on the bedding planes are small ridges and striations having the appearance of fossil forms.

In the Coalgate-Lehigh region the sandstone becomes cherty. The sandstone forms a range of hills southwest from McAlester past Savanna to near Coalgate, where the outcrop splits one branch extending in the direction of Atoka, the other passing to the east of Coalgate and Lehigh, and thence turning eastward to unite with the first branch. The ridges so formed surround the syncline of the Lehigh basin. Another branch extends from Coalgate past Nixon. Across the Arkansas line only the lower part of the formation is present, capping several of the isolated hills in a few small areas.

The shaly beds combined are probably thicker than the sandstones, but since the sandstones are better exposed and their presence is so strongly impressed upon the observer in the prominent ridges which they make, sandstone seems the more appropriate term, There are five principal sandstone beds, which have different thickness from 50 feet to 200 feet, the one at the top and the one at the base being generally thicker than the intermediate ones. These sandstones may be distinguished only by their position in the section and by their thickness of bedding. They are brown, or grayish-brown, fine-grained and compact. Except in the uppermost beds, upon which the town of McAlester is built, the beds are generally thin and in part shaly. The uppermost sandstone occurs in two members, 75 to 100 feet thick, separated by variable blue clay shales. The uppermost beds of this sandstone are found in many places to be massive, and those in contact with the shale are often beautifully ripple-marked. No coal of any value has been found associated with these beds of sandstone in the McAlester district, though a thin bed has been reported to occur in the upper part of the series. Where the rocks dip at low angles they make ridges. The ridges are prominent features of the landscape in the vicinity of South McAlester, south of Krebs and of Alderson and north of Gaines Valley, near the eastern border of the quadrangle. Southwest of Kiowa and upon the east side of the Lehigh coal field these sandstones are prominent ridge makers. It is true that they are tilted at very high angles on the east side of the Lehigh district, but the drainage of North Boggy Creek is generally parallel with the trend of the ridges, beside which the soft shales are easily eroded. Both east and west of McAlester between Hartshorne and Kiowa, and in the district southwest of Savanna, these beds dip at angles varying from 40 to 50 degrees. In these localities the sandstones and shales have been nearly equally worn down almost to a level plane. Near stream channels, however, where recent erosion has removed adjacent soft rocks, low ridges occur upon the crops of the sandstones. Elsewhere sandstone ledges are elevated but little, if any, above the generally smooth prairie.

THE CAVANAL COAL

The Cavanal coal is found in the eastern part of the field in the northern part of LeFlore County, and was named for Cavanal station on the Frisco Railroad. The coal outcrops at the foot and almost entirely around the Cavanal Mountain, and the dip is 6 to 10 degrees toward the center of the Mountain. It is not known to be of workable thickness except on the east and south sides. The bed varies in thickness from two to three and one-half feet, and except in places, is generally very free of impurities. Thin bands of shaly and bony material with sulphur concretions occur near the top of the bed. The roof is hard, slaty shale and the floor is a compact clay. The coal contains considerable sulphur but is excellent for steam and domestic purposes.

In the Cavanal syncline. In the Cavanal syncline the coal crops a little more than 100 feet stratigraphically beneath the series of sandstone beds which make a line of prominent ridges surrounding the base of the mountain. The prospects one and a half miles north of the mines north of Cavanal Station, at Poteau Station, and those three miles west of Wister, are located upon this coal. From the mine west of Wister the horizon of this coal strikes nearly due west through secs. 29 and 30, T. 6 N., R. 24 E., secs. 35 to 30, inclusive, T. 6 N., R. 23 E., and in secs. 25 and 26, T. 6 N., R. 22 E. In sec. 27, T. 6 N., R. 22 E., the strike curves north and then northeast beneath the escarpment of a high ridge. The position of this ridge bears northeast and east around the west and north sides of Cavanal Mountain. In the north base of Cavanal Mountain the ridge above the coal is generally worn down, but the sandstone ledges outcrop in many places, and from these the crop of the coal may be easily located.

The Cavanal coal, as far as known, is three feet to three and one-half feet thick, and is well situated structurally for mining. This coal dips beneath Cavanal Mountain at an angle varying from 6 to 20 degrees. The lowest dip is on the southeast side, between Wister and Poteau Station. From Wister westward to Fanshawe the dip gradually increases from 10 to 20 degrees. Beyond Fanshawe and upon the north side of the mountain it is nearly 10 degrees.

From the outcrop of the Cavanal coal inward toward the mountain the dip changes but little as a rule for a distance of between two and three miles. Considering the surface to be level and the dip of the rock to be 10 degrees the coal would descend at the rate of nearly 140 feet for each thousand feet of horizontal distance. The area of the coal in the syncline to a depth of 1,000 feet beneath the outcrop is nearly 65 square miles.

In the Sansbois syncline. As far as the survey has been carried, the Cavanal coal has not been prospected in this syncline. A coal bed of workable thickness in the stratigraphic position of the Cavanal coal crops out in a branch of Fourche Maline Creek, nearly four miles north of Wilburton.

From the head of Brazil Creek eastward the horizon of the Cavanal coal gradually descends from the lower slope of Sansbois Mountain into the foothills which surround the base at the east end. The rocks at the horizon of the Cavanal coal in this portion of Sansbois Mountain dip beneath the mountain at angles varying from 10 to 20 degrees. From the west end of Brazil Creek Valley westward to the border of this field the crop of the Cavanal coal lies in the steep lower slopes of Sansbois Mountain, dipping north. On account of the steep slope and the presence of boulders and rock debris, the sandstone near the coal, as well as that of higher beds, either outcrops as benches or as cliffs, or the edges are concealed in the mountain side. In the spur of Sansbois Mountain northwest of Red Oak and in the high knob northeast of the same point the rocks in the horizon of this coal dip inward from the sides at angles of 3 degrees and less. On the strike of the coal in the south side of Sansbois Mountain the dip of the rocks increase from 10 degrees in the vicinity of Red Oak to 30 degrees in Fourche Maline Creek. From Fourche Maline Creek westward for three miles the dip increases 30 to 70 degrees, and then decreases rapidly to 30 degrees again and so continues to the western border of this field.

BOGGY SHALE

This formation is named from Boggy Creek in the Choctaw nation. In the Coalgate quadrangle there are extensive exposures along Boggy Creek and the formation attains a maximum thickness of more than 2,000 feet. In the McAlester area it has been estimated to be almost 2,600 feet thick, while in the Muskogee district to the north, about 500 feet is exposed. The formation consists largely of shales with some sandstones, and a few limestone beds. The greatest development of the sandstone members is along the Canadian River Valley to the southwest of the Muskogee quadrangle. Extending southwest and northeast there is a gradual thinning of the sandstone beds and of the entire formation. With the thinning of the sandstone, thin limy beds are introduced. The sandstone members have so graded into shaly deposits that the formation cannot be distinguished north of the Arkansas River. Certain formations above the Boggy have been traced from Arkansas River to the Oklahoma-Kansas line, indicating that 2,000 feet or more of the Boggy formation in the Canadian River Valley must be correlated with a part of the Cherokee shale of southeastern Kansas.

The following description of the formation is given by Taff for the McAlester, Muskogee, Atoka, and Coalgate quadrangles and gives in detail the character and extent of the formation.

In the Boggy shale there are probably not less than sixteen beds of sandstone ranging in thickness from 20 to 150 feet, separated by shale from 100 to 600 feet thick. One coal bed, about two feet six inches thick is located about 400 feet above the base of the Boggy shale.

The shales of these series are exposed to a very slight extent where observed. On a few hill slopes and in stream valleys the shales are bluish, fissile clay, containing ironstone concretions, thin wavy sandstone plates, and shaly sandstone strata. The sandstones fall in one general class and vary but little in minor detail of texture.

They are generally brownish or gray and some beds are quite ferruginous. In some of these the iron ore cuts the face of the ledge or particular bed into a network of angular blocks, filling a plexus of mud cracks. All the sandstones are fine-grained and were without doubt deposited under very similar conditions. These beds, being high in the series of this coal field, occupy the central portions of the synclinal basins and the regions of least disturbance in the northeast and northwest parts of the McAlester quadrangle. Under these conditions they lie many places in nearly horizontal positions. By erosion the soft clays are removed from above and they cap elevated flat hills and mesas and form terrace-like benches around their slopes. Through parts of the field, then, these beds are well exposed for inspection.

In the Muskogee quadrangle, only the lowest sandstone and its inclosed shale members are exposed. The basal deposit is a comparatively soft shale, approximately 200 feet thick. The overlying sandstone is a gray to yellowish-brown rock, and occurs for the most part in thick or massive moderately hard beds. The lower sandstone beds are usually exposed in cliffs and bluffs at the crests of the escarpments which they produce. The upper layers make flat and gently rolling tracts of sandy loam which slope westward from the escarpment of Rattlesnake Mountains. Toward the northwest this sandstone gradually grows thinner, more shaly, and softer, the decrease in thickness and the change of the character being emphasized by the topographical expression of the rock. Near the southern boundary of the quadrangle the sandstone is marked by the strong escarpment and timbered table-land of the Rattlesnake Mountains. Northwestward the escarpment becomes gradually lower and less distinct until it is lost in the rolling prairie north of Oktaha. The lowest shaly strata, lying above the sandstone occurs in the southwest corner of the quadrangle. A bed of bituminous coal, 30 inches thick, occurs in this shale near the base. It should be found to crop out across the southwest corner of the quadrangle.

THE WITTEVILLE COALS

There are two beds of coal separated by about 250 feet of shale and sandstone, which will be known as the Witteville coal beds, from the mines upon them at Witteville, in the east end of Cavanal Mountain.

The upper Witteville coal is three feet ten inches thick, separated into nearly equal benches by a thin parting of shale. This coal has been mined at intervals since 1894, and is delivered to the main line of the St. Louis and San Francisco Railroad at Poteau Station over a branch road belonging to the mining company.

The lower Witteville coal is four feet eight inches thick, and is separated into three benches by two variable bands of bone and carbonaceous shale. It has been opened for exploitation on the crop at the tipple from which the coal from the upper mine is discharged for shipment.

The lower coal occurs at the top of the Savanna formation, while the upper bed is in the lower part of the Boggy shale, about 800 feet and 1,000 feet respectively, above the Cavanal coal.

The quality of the Witteville coal, as expressed by the proximate analysis given in the tables is nearly the same in all respects as that of the Cavanal coal, the percentages of volatile matter, carbon, and sulphur being a fraction higher, and the ash a little more than one per cent less.

In the Cavanal syncline. The Witteville coal beds are not known in this field outside the Cavanal syncline. The lower Witteville coal being at the top of the Savanna formation, its approximate crop may be located by reference to the contact between the Savanna and Boggy. The area of each of the Witteville coal beds in the Cavanal syncline is nearly 60 square miles.

The crop of the upper Witteville coal being 250 feet above the base of the Boggy shale, it may be located approximately by reference to the structure of the associated rocks in the syncline and the contact between the Savanna and Boggy formations. Where the slope of the mountain is steep, as at the Witteville mine, the crops of the coals will fall near together. At other places, as upon the northwest and southeast sides of the syncline, where the surface is nearly level, the crops will be more widely separated. The dip of the rocks at the crop of the coal around Cavanal Mountain varies from 6 to 10 degrees. The dip becomes rapidly lower from the crop of the coal toward the center or axis of the syncline, and toward the mountain, so that relatively large areas may be mined by slopes. In the more level areas in the vicinity of Kennedy and north of Potato Peaks, still larger areas may be worked by shaft.

In the section across the syncline the coals do not descend more than 1,000 feet beneath the level of their crops. From a shaft in the valley near the north line of sec. 12, T. 6 N., R. 23 E., or from one in the valley of Mountain Creek in sec. 4, T. 6 N., R. 24 E., several square miles of coal can be brought to the hoisting plant by gravity.

THURMAN SANDSTONE.

In the McAlester district the Thurman sandstone is represented by a thickness of about 200 feet. The lower 50 feet is a conglomerate composed of angular or slightly rounded chert fragments imbedded in a brown sandstone matrix. The sandstone of the upper part of the formations cap the flat-topped hills and ridges north of Coal Creek and the highlands in the northwest corner of the McAlester quadrangle.

The Thurman sandstone represents the beginning of a marked change in the character of the sediments which were brought into the sea and spread across this region in Carboniferous time. Shales and fine sandy sediments of the Boggy shale were followed by coarse pebbles of white chert mixed with coarse quartz sand forming the Thurman sandstone. After the deposition of this conglomerate, which reached a thickness of about 50 feet in the eastern half of the area now occupied by the Thurman sandstone in the Coalgate quadrangle, finer sands were deposited until a maximum depth of more than 200 feet was attained.

STUART SHALE

This formation consists of blue clay shales, beds of sandstone, and attains a thickness of 280 feet. It was named by J. A. Taff from the town of Stuart in eastern Hughes County. This shale extends northeast from eastern Pontotoc County, across northwestern Coal and southeastern Hughes, and into northwestern Pittsburg, western McIntosh and eastern Okmulgee counties. It is Pennsylvanian (Alleghany) in age, and correlates with the upper part of the Cherokee shale.

There is a gradual transition upward from the Thurman sandstone through thin beds of shaly sandstone and shale interstratified into the Stuart shale, which has a thickness of about 275 feet in the northeastern and central parts of its exposure and about 100 feet in its western part. It is composed of three members, an upper and a lower one of shale separated by a variable sandstone 10 to 50 feet thick. A thin sandstone and chert conglomerate lentil occurs in the lower shale member. This lower member of the formation ranges in thickness from about 120 feet to about 50 feet, and is composed chiefly of bluish and black laminated clays. It crops in a level and rolling tract of prairie land which borders the timber belt of the Thurman sandstone on the east. The upper member of this formation is composed of bluish shales and has a thickness of 50 to 120 feet. This shale, unlike the lower members, outcrops in the steep slopes of the escarpments and hills which are surmounted by the succeeding Senora sandstone and is, for the most part, wooded and concealed by talus.

SENORA FORMATION

This formation was named from the old Postoffice of Senora, in southern Okmulgee County. It occurs in eastern Pontotoc County, northeast across northwest Coal, east of Hughes, and southeast o Okmulgee counties as far as the Arkansas River near Stoneblooc Wagner County.

This formation is composed of interstratified sandstones an shaly beds having a thickness of nearly 500 feet in the northeaster corner of the Coalgate quadrangle. The thickness of the formatio decreases chiefly by thinning of the sandstone beds until it doe not exceed 150 feet. The lower 320 feet of the formation is compose almost entirely of sandstone which grades upward through thi sandy beds into shale strata which are approximately 160 feet i thickness.

Near the middle of the Coalgate quadrangle the lower massive sandstone becomes divided and shale beds 20 to 75 feet in thickness appear. In the western part of the quadrangle the sandstone beds become quite variable in thickness and in their position in the formation. The outcrop of the formation here varies in width from one to four miles depending chiefly upon the erosion of the streams which cross it. The upper and more shaly member has a variable thickness from 100 to 120 feet in this western part.

In texture the sandstones are generally fine-grained and are gray or reddish-brown in color. The shales, which occupy the more level land in the western and northern parts of the outcrop, are rarely well exposed. Bluish clay shales and brownish sandy shales belonging in the upper part of the series, are exposed in the deeper cuttings of the streams which flow from the higher land of the succeeding Calvin sandstone.

CALVIN SANDSTONE

This formation is made up almost entirely of thick bedded, hard sandstone, with a few thin layers of shale. The shales are more resistant than the shales of the upper Senora and the lower Wetumka, and for that reason weather out as low, rounded ridges. The formation extends from eastern Pontotoc County, northeast across Hughes, Okfuskee and Okmulgee counties, ending near Stone Bluff, Wagoner County.

Above the Senora formation there is a deposit of massive and thin-bedded sandstone with some shaly beds in the upper part having a thickness of 140 to 240 feet. For nearly 140 feet upward from the base, the rock is massive but not very hard sandstone. In the northern part of its occurrence this lower and more massive member of the formation crops in the steep hillsides and bluffs overlooking the more level Senora formation toward the east. In the southern part of its outcrop the lower sandy member becomes shaly, and even

the massive beds which occur are more friable than the same deposits in the northern part of the quadrangle. Near the middle of this lower sandstone member, west of Sand Creek, there is a shaly and slightly calcareous bed which contains iron in the form of hematite. On account of the bright-red color of the iron upon weathering this bed is a marked feature of the formation.

The upper part of the Calvin sandstone is least shaly in the northern part of the area, and many of the beds are hard and weather into slabs and hard plates. The upper 90 to 100 feet of the formation here contains two, and in places more, shaly beds 10 to 20 feet in thickness. The sandstone beds of this upper portion decrease southwestward from 40 feet in thickness to layers interstratified with shales.

WETUMKA SHALE

The Wetumka shale is composed of clay shale, sandy shale and thin sandstone. The large amount of shales result in its being cut from beneath the resistant sandstone of the overlying Wewoka formation.

The formation extends from eastern Pontotoc, northeast across Hughes, Okmulgee, Okfuskee and Tulsa counties to the Arkansas River. It attains a maximum thickness of 120 feet.

The shaly beds of the Calvin sandstone grade into the succeeding Wetumka shale, so that the division line between the formations cannot be easily determined stratigraphically and cannot be very accurately mapped. With the exception of thin shaly sandstone layers near the center, the Wetumka shale is composed of friable, laminated clay shales. It is estimated to be about 120 feet thick throughout its occurrence in the Coalgate quadrangle.

From the head of Big Creek to the Canadian River Valley this shale crops in gently rolling prairie land and produces a soil more fertile than is usually found upon other formations in this region. Beds near the top are exposed in many places in the escarpment beneath the sandstone beds of the succeeding Wewoka formation. In the western part of its occurrence the Wetumka shale lies in the nearly level plain of Muddy Boggy Creek Valley.

WEWOKA FORMATION

This formation is made up of massive, brown, friable sandstone with interbedded blue shales in the upper part, and a thin limestone in the lower part. Morgan[8] describes the basal sandstone as grading into chert conglomerate which represents a local development of what is normally a sandstone that occurs about 90 feet above the bottom of the formation. Many other sandstones in the formation also carry small quantities of chert conglomerate.

8. Morgan, Geo. D., Geology of the Stonewall Quadrangle, Oklahoma: Bureau of Geology, Bull. 2, p. 694, 1924.

HOLDENVILLE SHALE

Composed of blue and yellow clay, beds of sandstone and thin siliceous sandstone. Morgan[9] recognizes the two limestone members, the Sasakwa and the Homer. The thickness of the Sasakwa is quite variable. At the northeast corner of the Stonewall quadrangle it is about two feet thick, but just south of the town of Sasakwa its thickness is at least 15 feet, gradually thinning out southward until it eventually disappears. The Homer limestone lies 70 feet below the Sasakwa member, and is best developed in the northeastern part of the Stonewall quadrangle. The color of the limestone is dark gray or almost black. Between these two beds throughout all the northern part of the Homer outcrop, there are a number of sandstones. One or several of these quite often developes into a massive chert conglomerate that sometimes attains a thickness of 30 feet. The basal formation is marked by a sandy limestone which generally occurs at the top of the upper member of the Wewoka formation.

SEMINOLE CONGLOMERATE

Composed of white chert, in a brown matrix succeeded by brown sandstone. The formation attains a maximum thickness of about 150 feet. At the base there occurs a 50 foot member above which is found a thin limestone, which is separated from the base of the Seminole by an interval averaging 150 feet, which Morgan describes as the DeNay limestone. This limestone has an average thickness of a little more than one foot which on weathering breaks into elongated blocks. A bright yellow color is developed on weathered stones.

STRUCTURE

GENERAL

Structure is that part of the geology of a region which pertains to the way in which the rocks are found with reference to a horizontal plane; or in other words, the nature and amount of folding which the rocks have undergone, and the distribution and mutual relations of these folded features. Sedimentary rocks are arranged in more or less distinct layers and the original position of the beds is normally level or horizontal, or nearly so. Modifications of the original or level position of the rocks result from movements by which the layers or strata of rocks are folded, bent, faulted, or broken. In the greater part of the earth's surface the rocks lie

9. Op. cit.

almost level, but in mountainous regions and surrounding territory structural features are very marked, due to the mountain making movements. The inclination of the beds from the horizontal is called dip. In determining the structure of an area it is essential to understand the stratigraphy of the region and to be able to determine the direction and amount of the dip. In many localities the dip of the rocks is so pronounced that it can readily be observed, while in others it is necessary to make use of instruments to determine the amount of dip. Beds inclined in a single direction form a monocline, but when folded or arched the upward fold is the anticline and the downward fold the syncline.

The Oklahoma coal fields throughout the east-central area present well-defined structural features. In part, the coal beds lie practically level or with a gentle dip to the west or southwest, which is the normal dip for that part of the state. For example, in the Henryetta district the average inclination of the coal bed is about 20 to 40 feet per mile. In the part of the field south of the Canadian River the area is characterized by broad, low folds increasing in intensity from the north to the south as the series approaches the much faulted and folded Ouachita Mountain region. Some faulting has occurred north of the Choctaw fault, as is evidenced by off-sets in the coal outcrops, by the displacement of coal beds as seen in some of the mines, and by the displacement of Backbone anticline which extends north and east from Bokoshe into Arkansas. Along the axis of this anticline the force has been sufficient to break the strata and force the rocks south of the break over those to the north, thus causing the anticline to be faulted for several miles of its length.

The structural folds in the coal fields are of such a nature that the rocks were broken along the axes of the upward folds and the agents of erosion readily brought about a rapid cutting down of the surface along the axes of the anticlines, so that at the present time many of the anticlinal axes are indicated by the valleys, while the synclinal axes lie in the hills and mountains. Originally the coal beds extended over the entire area between the present outcrops but because of these erosional features they have disappeared from the area of the anticlinal folds and, in some cases are well down toward the axes of the syncline. The coal beds of the state as they are today lie in synclinal basins. The coal dips from the outcrops toward the center of the basin, and the depth of the coal below the surface increases rapidly. The inclination of the beds vary from practically level, well down in the synclinal basin, to an angle of 90 degrees as found in some of the outcrops and small mine openings in the region of Blanco, between Haileyville and Edwards, and also in the vicinity of North McAlester. In many places dips of 60 to 80 degrees are common. Sharp folding and faulting is also shown along the axes of the McAlester anticline. From the vicinity of Carbon eastward, the Hartshorne coal dips northward 45 to 90 degrees, but northward from the outcrop of the Hartshorne coal the dip increases rapidly (15 to 30 degrees) on the outcrop of the McAlester coal. In a small basin which pitches at a low angle toward the west just to the northwest of Carbon, the McAlester coal lies in such a position that it can be profitably mined. At the Richville mine, the coal is badly crushed due to the pressure resulting from the folding. From McAlester westward, a fault extends parallel with and very near the axis of the fold upon the north side displacing the Hartshorne coals. Outcrops of these beds are found at intervals along the fold, but as a whole, the rocks including the coal have been displaced downward with respect to the beds on the south side.

A large amount of detailed work has been done by Taff in his studies of the Oklahoma coal fields in regard to the structure and the results of his investigations published in 19th Annual Report, Part 3, U. S. Geological Survey. The Oklahoma Geological Survey with a field party in charge of L. C. Snider carried on detailed investigations in the area to the east and northeast of that covered in detail by Taff. The results of this work are published in Bulletin No. 17, of the Oklahoma Geological Survey. This bulletin also contains Taff's description of the McAlester-Lehigh region above noted. In the investigations in the southern part of the area covered by Snider the work of Taff which had been published in 21st Annual Report, Part 2, U. S. Geological Survey, is used as a basis, and the axes of the folds shown on the maps are but little changed from the location on Taff's original maps.

In the following discussion of the structure of the Oklahoma coal fields Taff[10] and Snider[11] are quoted in detail. The structural axes are indicated upon the maps of the various coal fields.

McALESTER-LEHIGH DISTRICT

Taff's description of the structure in the McAlester-Lehigh coal field is as follows:

> "**General:** At the eastern border of the McAlester quadrangle the general strike of the rocks is east and west. In Arkansas the same general strike of the rocks prevails from the Arkansas line down the Arkansas River Valley to the Tertiary overlap of the Mississippi embayment, as shown by the work of the Arkansas Geological Survey. From the eastern border of the McAlester quadrangle westward the strike of the rocks changes from west to southwest and then south to the Cretaceous border near Atoka.

10. Taff, J. A., The McAlester-Lehigh Coal Field, Indian Territory: U. S. Geol. Survey, Nineteenth Ann. Rept., pt. 3, pp. 442-448, 1899.
11. Snider, L. C., Geology of east-central Oklahoma, Oklahoma Geol. Survey, Bull. 17, pp. 11-16, 1914.

> "From the Chickasaw Nation eastward these rocks have the same general structure, which is that of wide canoe-shaped synclines lapping upon narrow, compressed, and often slightly overturned anticlines. This is also the typical structural character of the northern Appalachian region. Like the structure of the Appalachian region, again, the folding here becomes less intense toward the north and west, nearer the interior of the coal field. The belt of folded coal-bearing strata varies from 10 to 15 miles in width. North and west of this folded belt the rocks are somewhat crumpled, but maintain a slight downward grade toward the north and west.

> "**The Kiowa syncline.** The Hartshorne sandstone is at the base of the productive coal measures of this coal field. South of Hartshorne this sandstone is a ridge maker and is usually exposed at its crop, where it dips to the north at about 30 degrees. The dip decreases northward, and is horizontal at the center of the basin, three miles distant, where the sandstone lies not more than 600 feet beneath the surface. At Gowen, three miles still farther north, it comes up on the north side of the basin, forming a prominent ridge. From Hartshorne it strikes westward and then southwestward to the limits of the quadrangle, with dips varying from 40 to 80 degrees toward the north and northwest. From Gowen, on the north limb of the syncline, the rocks bear a little north of west to the vicinity of Alderson, where they turn toward the north and pass across the axis of the McAlester anticline. The axis of this syncline pitches abruptly westward at the east end, northeast of Hartshorne, for a short space, and then becomes nearly horizontal north of Hartshorne. Sandstones which cap the flat topped mesa of Belle Starr Mountain appear at the same elevation in the ridge northwest of Hartshorne, pitching 6 degrees toward the west. From the vicinity of Hartshorne southwest this syncline becomes rapidly broader and deeper for six to eight miles, and then grows narrower, with a gradually rising axis to the vicinity of Kiowa. Opposite Kiowa this synclinal basin is about four miles wide. From Kiowa toward the southwest the basin grows gradually broader to the limit of the McAlester quadrangle, where it divides into two synclines separated by an anticline: one of these extends nearly due south, ending in the Lehigh Basin, while the other bears southwestward into the southern part of the Coalgate quadrangle, where it becomes broad and flat.

> "The contraction of the Kiowa syncline near Kiowa appears to be due to a northwestward movement of the strata from the south side of the basin. The northwestward overtrust of the older rocks southeast of Kiowa corresponds in strike and movement with those of the coal-bearing beds on the south side of Kiowa basin.

> "**The McAlester anticline.**—The axis of the McAlester anticline enters the quadrangle upon the east side, in the valley of Gaines Creek, and bears very nearly west for ten miles, where, at a point between Alderson and Cherryvale, it divides into two folds. One of these divisions of the fold bears southwest by way of Savanna to and beyond the border of the quadrangle. This south division of the anticline is called the Savanna anticline. The other, a more direct

continuation of the main fold, bears northwest from Cherryvale for nearly three miles and then west to McAlester, where it curves southwest and passes the limits of the quadrangle parallel with the Savanna anticline.

"The strata involved in the McAlester anticline from the eastern border of the quadrangle to Cherryvale have been trust over toward the north, so that the beds upon the north side are on edge in places. At other places, especially south of Cherryvale, the Hartshorne sandstone has been overturned and, it is believed, faulted.

"Through its course from Cherryvale eastward the axis of the anticline is almost horizontal. From Cherryvale westward it pitches downward rather abruptly at from 16 to 20 degrees. The Krebs syncline crosses the McAlester arch east of Krebs and depresses it as well as deflects it northward. North of Krebs, however, the McAlester arch regains its normal condition as an unsymmetrical fold, and continues westward with nearly horizontal axis, to a point about six miles southwest of McAlester, where it pitches rapidly for a short space, then becomes a low, wide symmetrical arch, and as such continues to the western limit of the McAlester quadrangle. Upon the south limb of the McAlester anticline, near the axis, the rocks dip usually from 10 to 25 degrees, while upon the north limb, except where the arch is low, and near the western border of the quadrangle, they dip from about 30 to 90 degrees, and in a few places, as noted, are overturned and faulted, dipping southward nearly 90 degrees.

"**The Savanna anticline.**—This fold joins the McAlester anticline about two miles east of Krebs, and thence bears almost due southwest to the western border of the quadrangle. In the northeastern part of its course it is not a well defined fold. It is little more than a southwestward pitching swell upon the southern limb of the McAlester anticline. South of Krebs the ill-defined axis of this fold pitches southwest probably 10 degrees, and south of McAlester it begins to rise. South of Savanna this axis rises rather abruptly at an angle of nearly 20 degrees. From Savanna it continues southwestward almost level to a point northwest of Kiowa, where it begins to pitch downward, and so continues beyond the limit of the McAlester quadrangle.

"Northeast from Savanna the rocks dip gradually away toward the northwest and southeast, from the axis of the fold. South and southwest of Savanna the fold near the axis becomes sharply contacted and elevated, so that the rocks dip northwest 40 to 60 degrees and southeast 55 to 90 degrees. This fold between Savanna and Kiowa may be compared to an inverted and narrowly contracted canoe. The south side of this inverted canoe is so crushed near the northeast end that the rocks are vertical, while at the end near by the dip will not exceed 20 degrees. The same is true near the southeast end, northwest of Kiowa, except that there has been greater compression upon the northwest side of the fold.

"**The Krebs syncline.**—Southwestward from the vicinity of South McAlester, for a distance of nearly ten miles, the Krebs syncline is a normal canoe basin. Upon the sides and end of the canoe the rocks dip nearly equally—about 15 degrees. Upon the southern side of the syncline farther southwest, opposite Savanna, the dips increase to 45 degrees and from Savanna to the western border of the quadrangle this dip is generally maintained, though it is in places greater. From the southeast side of this basin the dip decreases rapidly toward the northwest from 45 to 10 degrees within the space of a mile. For a wide space the rocks in the central part of this basin are nearly horizontal, and upon the north side of the basin, near the west side of the quadrangle, the beds rise gradually upon the low arch of the McAlester anticline.

"The syncline from Krebs eastward across the McAlester anticline can not be easily defined. It is shallow and rises with a gradual upward incline to the axis of the McAlester anticline. From the same point on the McAlester anticline this syncline pitches at a low angle downward toward the east. Northeast of Cherryvale the axis bears northeastward and then east, crossing the side of the quadrangle about two miles south of the northeast corner. As is the case in the vicinity of Savanna, the rocks here in the south side of the basin dip steeply toward the north over about one mile, and then for a wide space the rocks are nearly horizontal. From the center of the basin northeast of Cherryvale the rocks rise at a low angle to the limit of the quadrangle.

"**Minor folding north of the McAlester anticline.** Nearly due north of Krebs a narrow and short anticlinal fold extends eastward from the McAlester anticline. Upon the north side the rocks are steeply upturned, while upon the south side the dips are very low. This local anticline is a well-defined structural feature for more than three miles from the McAlester anticline. The rocks upon the north side dip at continually lower angles as they are folded eastward. Upon the south side they become horizontal near the axis for three or four miles, where the anticline becomes simply a swell upon the northern limb of the Krebs syncline and is lost as a structural feature.

"An ill-defined shallow basin occurs north of the McAlester anticline west and northwest of McAlester. The axis of this basin lies two and one half to three miles north of the McAlester anticlinal axis and is nearly parallel with it. North of the town of McAlester this basin takes a more northerly turn and passes beyond the limits of the quadrangle. Within six miles of the western border of the quadrangle the northern limb of this syncline is nearly horizontal, and further west the fold loses character as a structural feature, becoming simply a wide and very shallow depression upon the northern limb of the McAlester anticline.

"**Local folding near Hartshorne.**—From Hartshorne southwestward for nearly six miles the Hartshorne sandstone, with shale, minor sandstone beds, and coal overlying it, is crumpled in an unusual manner. This structure is upon the southern limb of the Kiowa syncline. South and west of Hartshorne the Hartshorne sandstone dips north at 15 to 25 degrees. One-half mile southwest of Hartshorne this sandstone strikes almost due north for nearly one mile with dips toward the east, then west for nearly a mile with dips toward the north, and then south nearly a mile with dips toward the west, where it takes a southwest bearing with steep dip toward the northwest. Thus a short and almost square anticlinal fold is indicated with axial trend almost perpendicular to the general structure of the Kiowa syncline. Six miles southwest of Hartshorne the same sandstone turns in strike from southwest to almost directly northwest, and continues for half a mile with dips toward the northeast. At this point it turns in strike nearly 90 degrees and bears again southwest. Rocks which lie 600 to 1,200 feet above the Hartshorne sandstone show in their outcrop a local syncline and anticline, one lying above the other upon the south limb of the Kiowa syncline, between the structures noted one-half mile and six miles, respectively, southwest of Hartshorne. The axes of these folds are parallel with the trend of the Kiowa syncline.

"The cause of this buckling of the Hartshorne sandstone and associated rocks may be suggested by the location of the structures in the obtuse angle at the junction of the major east-west and northeast-southwest trends of folding in this district.

"**Faults and shear zones.**—The faulting in this coal field is of minor importance and local extent. The sandstone beds, which are exposed in ridges, curve back and forth across the field, so that faults of much magnitude may be easily detected. A fault that may be called the Cherryvale fault occurs on the north limb of the McAlester anticline with strike parallel to the folding. Its location could not be determined with precision, but it occurs between the mines in Cherryvale and the crest of the ridge about one-fourth of a mile south of the town. The fault is an overthrust from the south. It is believed to extend not far from Cherryvale toward the east, and but a few miles toward the west.

"The local faulting occurs in the sandstone ridge of the town of South McAlester, as may be seen in the railroad cut north of the station. It is of small extent and does not displace the sandstone which forms the ridge to more than barely appreciable extent.

"In the vicinity of Kiowa, where the beds in the south side of the Kiowa basin have been deflected toward the northwest, the sandstone beds have been broken by cross faults or zones of shearing in a number of places. This structure is especially prominent in the limestone ridge, below the coal-bearing beds, immediately south of Kiowa, where it has been thrust strongly over toward the northwest. Near the south side of sec. 25, T. 3 N., R. 13 E., the Hartshorne sandstone is broken and displaced laterally 200 feet. The sandstone on the east side is thrust toward the north with respect to the sandstone on the west side. This sandstone is inclosed in several hundred feet of shale, so that it is not possible to trace the displacement farther than the limit of the sandstone. Near the middle of sec. 3 and the north side of sec. 10, T. 2 N., R. 13 E., other shear zones or cross faults occur in the Hartshorne sandstone. In the first instance the sandstone on the southwest side of the break is thrust northward and overturned, while that on the other side remains with normal northwest dip. In section 10 the displacement is in the opposite direction.

"These features of structure are not of great importance of themselves, but a knowledge of their occurrence and character will be of much value to the prospector and miner who operate coal in their vicinity.

"**The Lehigh basin.**—This basin is a southern prolongation, in part, of the Kiowa syncline. It is broad and deep in the central part, opposite Lehigh, and much contracted and elevated at the north end, where it joins the Kiowa syncline. The contraction at the north end is due to the eastward bearing and enlargement of the Coalgate anticline at its north end. The Lehigh basin in surface outline is elliptical. It is relatively deep and its axis lies near its eastern side. The Savanna sandstone series and other associated beds which outcrop on the east side of this basin are upturned until they are almost vertical. Along their outcrop they form a prominent ridge. As they extend around the south end of the basin, west of Atoka, these beds separate in outcrop as the dips become less, and the thick sandstone strata form low ridges which curve, one after the other, in gradually widening lines. From the vicinity of Lehigh on the west side for a distance of six miles inward toward the axis the beds dip about four degrees. Beyond this the rocks increase in dip to nearly 10 degrees toward the center of the basin. It will be seen by this description and by reference to the section and map that the Lehigh basin is structurally unsymmetrical. Extensive westward overthrusting and faulting of the beds lying beneath the coal-bearing strata, between Limestone Gap and Atoka, immediately east of the Lehigh basin, have pressed the coal-bearing rocks westward and upward, while the same beds on the west side of the basin have been but little disturbed. The basin is canoe-shaped, its axis rising at both the north and the south end.

"**The Coalgate anticline.**—This anticline is a peculiar structural feature. From Coalgate southwestward this fold is broad and very obtuse. The strata below the Lehigh coal bear westward around the south end of the Lehigh basin and then northward toward Coalgate. Southwest of Coalgate these beds curve gradually westward and then southwestward into the swamps of Clear Boggy Creek. The Lehigh coal bed in its outcrop emphasizes the character of this anticlinal structure more strongly. From Lehigh the strike of the coal bears nearly due north, with low east dip to Coalgate, where it turns abruptly southwestward. One mile northeast of Coalgate, this coal rises and is exposed for nearly eight miles in an elongated dome bearing northeastward. The Lehigh coal and the sandstones and shales for several hundred feet, above the coal dip 10 to 15 degrees from the axis of this dome. From a point about seven miles northeast of Coalgate the rocks upon the axis of the Coalgate anticline pitch rapidly northeastward. This pitch gradually grows less until the anticline is lost as a structural feature in the center of the Kiowa syncline near the west end of the Kiowa Hills, southwest of Kiowa.

"Three to five miles northwest of the axis of the Coalgate anticline there is a parallel shallow syncline whose axis is nearly parallel to that of the Coalgate. The axis of this syncline rises toward the northeast and the syncline dies out or coalesces with the Kiowa syncline opposite the northeast end of the Coalgate anticline."

EAST-CENTRAL OKLAHOMA

Snider's discussion of the structure of east-central Oklahoma is as follows:

"In the following paragraphs the folds are described in turn beginning at the southeast part of the area and continuing to the north and west.

"**Poteau syncline.**—This syncline is named from Poteau Mountains which lie in the syncline and extend from near Howe and Heavener eastward to the State line and for a considerable distance into Arkansas. West of the end of the mountains the axis of the syncline crosses the Kansas City Southern Railway between Heavener and Petros switch and soon turns a little to the north of west and continues across the southern part of T. 5 N., Rs. 24 and 25 E. The syncline ends in a basin-shaped structure near the west line of R. 25 E.

"**Heavener anticline.**—The Heavener anticline lies to the north of the western portion of the Poteau syncline. The axis extends eastward along Fourche Maline. From this point eastward the axis rises very rapidly for a distance of about four miles and then descends as rapidly to a point about two miles northwest of Heavener. The Hartshorne sandstone and coal outcrop around the north side and east end of the anticline and make a pronounced loop to the westward on the south side. The rocks exposed in the anticline, therefore, belong to the Atoka formation. Measurements across the upturned edges of the rocks indicate that a thickness of 6,000 to 7,000 feet of this formation have been removed from above the axis of the anticline and the bottom of the formation is not yet exposed. The dips from the axis of the Heavener anticline are quite steep. The general dip to the south is about 30 degrees and to the north and east is from 20 to 40 degrees. The steepest dip observed is about one mile south of Glendale postoffice where there is a dip of about 65 degrees almost directly south. This is very near the axis of the anticline since one-fourth mile to the north there is a dip of 40 degrees to the north. The rocks exposed in the axis of this anticline are the lowest in the entire area under consideration.

"**Howe anticline.**—An anticline, called by Taff the Howe anticline, branches from the east end of the Heavener anticline and extends northeast past Howe. Near the Chicago, Rock Island & Pacific Railway east of Howe this anticline branches, one branch continuing to the east past Hartford, Ark., and one continuing to the north to a point about five miles east of Poteau where it turns to the northeast and continues across the State line. The name of Howe anticline was applied by Taff to the fold near Howe and to both branches as well. The eastward branch of the Howe anticline has been described by Collier[12] and by Smith[13] as the Hartford anticline and the northward branch by Smith as the Poteau anticline. These names will be accepted in this report and the name Howe anticline will be retained for the portion between the Heavener anticline and the junction of the Hartford and Poteau branches. Taff's[14] description of the Howe anticline is as follows:

"On the northeastern side of the Heavener anticline an anticlinal fold, which may be considered as a branch of the Heavener

12. Collier, A. J., The Arkansas Coal Field: U. S. Geol. Survey, Bull. 326, 1907.
13. Smith, Carl D., Structure of the Fort Smith-Poteau Gas Field, Arkansas and Oklahoma: U. S. Geol. Survey, Bull. 541 B., 1913.
14. Taff, J. A., U. S. Geol. Survey, Nineteenth Ann. Rept., pt. 3, 1899.

anticline, bears northeastward through the vicinity of Howe. From the location of Howe, nearly upon its axis, this anticline is known as the Howe anticline. A peculiar relation of the Howe to the Heavener anticline is that their axes do not join, yet the folds are not separated by any indication even of a syncline. * * The crop of the Hartshorne sandstone southwest of Howe does not bear any indication of the effect of a branch fold. The next sandstone above the Hartshorne, however, diverges from the Heavener anticline near Poteau River and bears northeastward beyond Howe, where it crosses the axis of the Howe anticline and turns southward in the Poteau syncline. Between Howe and Monroe the Howe anticline divides into two folds, one of which bears due east between Poteau and Sugarloaf mountains and then east into Arkansas, north of Sugarloaf Mountain. Both branches of this fold are wide and flat. The valleys occupied by the Howe anticline are eroded in McAlester shale. The grades of the streams are very low and the valleys are practically level places stretching between the mountains from base to base."

"**Hartford anticline.**—As has been said, the east branch of the Howe anticline is known as the Hartford anticline from Hartford, Arkansas. This anticline is eroded into a valley in the McAlester shale so that it is difficult to locate the axis accurately but it is almost coincident in Oklahoma with the course of Sugarloaf Creek. Farther east in Arkansas the Atoka formation is exposed near the axis of this anticline.

"**Poteau anticline.**—From its junction with the Hartford anticline the Poteau anticline extends almost northeast to a point about due east of Poteau where it gradually turns more nearly to the east and across the state line into Arkansas in an almost straight east-west direction. It continues into Arkansas for about 12 miles. As is the case with the Hartford anticline the rocks in the Poteau anticline are those of the McAlester shale. Exposures near the country town of Gilmore indicates that the axis passes very near that place, from which fact the anticline has been called by some the Gilmore anticline. The name Gilmore in some respects is preferable to Poteau since Poteau is well down on the western limb of the anticline and is as near the axis of the syncline (Cavanal) as it is to the axis of the anticline. The dip of the rocks away from the axis of the Poteau anticline is not very steep; the dip to the northwest being three to five degrees and that to the southeast less than that.

"**Sugarloaf syncline.**—This syncline lies between the Hartford and Poteau anticlines and is named from Sugarloaf Mountains which are very conspicuous topographic features occupying the portion of the syncline near the axis. The mountains are composed principally of the Savanna formation and are topped by Boggy shale. The dip of the rocks into the syncline is low, not exceeding five degrees and usually considerably less than that. The strata in the mountains near the axis are practically level. The syncline extends from near the junction of the Hartford and Poteau anticlines northeastward across the State line and for several miles into Arkansas.

"**Cavanal syncline.**—The Cavanal syncline is a broad trough which extends from the vicinity of Red Oak eastward and northeastward across the State line and for many miles into Arkansas. Potato Peaks and Cavanal Mountain lie in this syncline.

"**Brazil anticline.**—The Brazil anticline extends from the head waters of Brazil Creek northeastward to the vicinity of Walls. Taff describes the fold as rising again and continuing as far as the neighborhood of Bokoshe, but a careful search by the writer and his assistants failed to find any north dips in the territory between the Ft. Smith & Western Railway and Brazil Creek in this vicinity while a large number of undoubted southward dips were found. So far as our examinations show the axis of the anticline plunges within two or three miles of Walls and the rocks in the region south of Bokoshe all dip to the south under Cavanal Mountain. The lowest formation exposed in the anticline is the McAlester shale. The dip of the southeastern limb of the Brazil anticline is from five to eight degrees and that of the the northwestern limb from 12 to 18 degrees.

"**Backbone fault and anticline.**—The Backbone anticline extends eastward from a point about two miles south of Bokoshe, eastward past Panama and north of east as far as Greenwood, Arkansas. The anticline is faulted for a considerable portion of its length, the beds on the south side of the fault being thrust over younger beds to the north. The Atoka formation is brought to the surface in the axial portion of the anticline, and the Hartshorne sandstone and coal outcrop around it. The dips in both directions from the axis of this anticline (or the fault) are rather steep, ranging from 12 to 20 degrees or even more.

"**Bokoshe syncline.**—This syncline extends north of east from Bokoshe to Spiro. From Spiro eastward and northeastward the country is all sand-covered and the axis of the syncline cannot be definitely located.

"**Milton anticline.**—Beginning about at Lequire, the Milton anticline extends east and northeast, passing through or near Lequire, McCurtain, Milton, and Bokoshe, and to Arkansas River near Redland. Near McCurtain this fold rises in a dome around which the Hartshorne (Panama) coal outcrops. In this dome the rocks are considerably disturbed and there are several local faults which are shown by the displacement of the coal in the mines, but which are seldom noticeable on the surface. For a short distance west of Lequire the Ft. Smith & Western Railway lies practically on the axis of the anticline. East of Lequire the railroad swings to the north of the axis, but crosses it again about two miles west of McCurtain. From this place to Milton the railroad is approximately one-half mile south of the axis. At Milton the axis swings somewhat to the north and passes nearly midway between the old and new towns of Bokoshe, and extends northeastward about one-half mile west of Redbank Creek, to the confluence of that stream with Cache Creek, and on to the Arkansas.

"**Siloam syncline.**—The short syncline lying between the southwestern portion of the Milton anticline, and the northeastern part

of the Kinta anticline, is called the Siloam from the church of that name in sec. 14, T. 8 N., R. 21 E. The axis lies in the range of hills on the southeast side of Sansbois Creek between Sansbois and Ironbridge.

"**Kinta anticline.**—The Kinta anticline enters the area from the west of Featherston and extends eastward in the valley of Sansbois Creek past Quinton to near Kinta, turns somewhat to the north and crosses the Ft. Smith & Western Railroad between Lewisville and Kinta. It then continues to the northeast in a somewhat curved course, passing through Shropshite Valley, and dies out opposite the northeastern end of the Siloam syncline near Ironbridge. The dips are low, usually less than five degrees. Some local disturbances give westward dips near the axis between Quinton and Featherston.

"**Cowlington syncline.**—The axis of this fold passes through the hills north of Quinton, through Beaver Mountain, then to the east and northeast through the hills between Pruitt and Shropshire valleys, across Sansbois Creek and through the hills northwest of Keota, then curves to the east passing at short distance northwest of Cowlington and through Short Mountain.

"**Enterprise anticline.**—This fold enters the area from the west, where House Creek crosses the western boundary and extends northeast across Longtown Creek, passing about a mile southeast of Enterprise, and continues to a point about two miles southwest of Whitefield, where it apparently forks. The exposures in this vicinity are not numerous, and it is possible that the eastern branch does not quite join the main anticline, but the exposures found indicate that such a junction does take place, and it is so considered in this report. The dip to the northwest from the axis is six degrees or less, and to the southeast is about eight degrees at the maximum. The name Enterprise is applied only to the fold southwest of Whitefield. The northern branch is called the Vian anticline, and the eastern the Kanima anticline. The syncline between them is named the Stigler syncline.

"**Kanima anticline.**—Branching from the Enterprise anticline southwest of Whitefield, the Kanima anticline extends almost east to a point three miles south of Stigler, where it turns to the northeast passing about a mile east of the Antioch school house, about one-half mile west of Kanima, and on the Arkansas along the west side of Sansbois Creek. The dips are about the same as those on the Enterprise anticline.

"**Stigler syncline.**—The axis of the Stigler syncline extends north of northeast from Whitefield, passing about two miles northwest of Stigler, through the range of hills on the east side of Canadian River, and to the Arkansas, between Tamaha and Hisaw. The Stigler coal, equivalent to the McAlester coal, outcrops around this syncline.

"**Vian anticline.**—The name Vian is applied to the anticline that forms the northern branch of the Enterprise anticline. It passes near Whitefield, and continues along Canadian River to the confluence of that stream with the Arkansas, crosses the latter stream and continues to the northeast, passing west of Vian. This anticline is almost certainly responsible for the Canadian's abrupt turn from an easterly to a northeasterly direction at Whitefield. From this turn of the river northeast to the Arkansas the axis of the anticline lies in the alluvium-covered river valley and its exact location cannot be determined. All that can be done is to draw the line about midway between the bluffs on the opposite sides of the river. The dips from this anticline are rather gentle, the majority of the recorded dips being three to five degrees.

"**Porum syncline.**—From the crest of the Vian anticline, the rocks dip gently to the west for six or eight miles into the Porum syncline. The axis of this fold is well defined in the hills west of Porum and it extends to the southwest through Brooken Mountain. To the north of the hills west of Porum the country is almost flat and exposures are few. The axis cannot be definitely located but some small hills extending north and slightly east from the large hills are believed to be very near the axis.

"**Warner anticline.**—This fold occurs in the extreme northwestern part of the area examined by the writer. It rises near the Muskogee-McIntosh County line about four miles north of Canadian River and extends northeast through Gap Prairie. Farther north there are very few exposures and the axis cannot be definitely located. However, it is believed to extend almost directly north and to pass very near the town of Warner. From near Warner a branch extends southwest along the head waters of Georges Fork. This branch appears to end near the Pleasant View School in sec. 8, T. 11 N., R. 18 E."

Part IV. SEGREGATED COAL LANDS

About the year 1900, 500,000 acres of coal land chiefly in the Choctaw Nation of what was then Indian Territory, were segregated or set apart for the benefit of the Choctaw and Chickasaw Indians. The segregation was done before these Indians took their allotments as a result of a treaty by these nations with the Government. The work of segregation was done by the United States Geological Survey, and five years were spent in investigating the field, mapping the outcrops of the coal deposits and estimating the amount of available coal. The treaty provided that the Government was to sell the land. The area was divided into tracts of 960 acres each, and offered for sale in August, 1906. All bids were rejected and a second attempt was made to sell the land, but with the same result. Much of the segregated land has been leased to individuals and companies which are operating mines on these lands. A royalty of eight cents per ton is paid the Government for the benefit of the Indians, the value of which is from $250,000 to $300,000 per year. The United States Geological Survey has estimated the amount of coal in the State at 79,000,000,000 tons, while other estimates place the available coal under present mining conditions at 8,000,000,000 tons. Either estimate gives Oklahoma an abundant supply of coal for fuel purposes.

All the coal lands of the State are not included in the segregation. Lying chiefly to the north of the segregated area and extending north to the Kansas line, much good coal is found.

The United States Geological Survey began the survey of the Choctaw coal field in 1897. In this work the entire field was surveyed and the outcrops of the coal beds and associated formations were mapped. Later, when the work of segregating the coal lands was commenced, the previous work was carefully checked and investigation made as to the position and structure of the coal beds and the amount of coal available under present mining conditions, with a view to proper development of the lands or the placing of value on the land. The following conditions governed the sales of the lands for segregation and sale.

(1) The coal should be of a quality and hardness to create a demand for its use for commercial purposes.
(2) It should be thick enough to be worked successfully.
(3) Its structure or position and depth in the earth should assure profitable mining.

In the published description of each tract or lease only those coal beds were considered in which the above qualifications could be applied.

After the segregation had been completed and the amount of available coal calculated from the data at hand, considerable controversy arose as to the figures given for the quantity of workable coal contained in the various beds in the segregation.

By Act of Congress on June 21st, 1906, the Secretary of Interior was authorized and directed to make practicable and associative investigation of the character, extent, and value of coal deposits in and under the segregated coal lands of the Choctaw and Chickasaw Nations in Indian Territory, and the expenses thereof, not exceeding the sum of $50,000, should be paid to the Treasury of the United States from the funds of the Choctaw and Chickasaw Nations[15].

A careful examination of the coal lands followed. Arrangements were made whereby a considerable amount of diamond core drilling was done to determine the extent, dip and character of coal at various distances from the outcrops in localities where mining operations had not been carried on from which the data could be secured.

The plans for the investigation were arranged for by the director of the United States Geological Survey and J. George Wright,

15. Results of investigations published in Coal Lands in Oklahoma, U. S. Senate, 61st Congress, 2nd session, Sen. Doc. No. 390, 1910.

Commissioner to the Five Civilized Tribes. Mr. William Cameron, Supervisor of Mines and formerly United States Mine Inspector for Indian Territory, was placed in charge of the work together with the mining industries for the Choctaw and Chickasaw Nations. Mr. A. H. Reed, of McAlester, was employed to superintend the drilling, and Mr. A. W. Thompson of Indiana as geologist in charge. The machinery was sold after the drilling was completed thus reducing the actual cost of the work. Of the $50,000 appropriated for the work, the records show that the work cost approximately $49,200, and that about $6,000 was obtained from the sale of the drilling outfit and carbons. Thirty-seven holes were drilled ranging in depth from 225 feet to 1,510 feet, giving a total drilling depth of 16,896 feet. A condensed tabular record of the drilling operations is given in Table No. 6.

Considerable drilling has also been done by the Rock Island Coal Company. Most of this drilling showed coal at depths ranging from 245 to 568 feet and two holes were drilled at a depth of 1,439 and 1,134 feet respectively. At that time this company did not consider the lands of any value when the coal occurred below a depth of 1,000 feet. In the drilling done by the Government two holes were drilled, both near McAlester, to a depth of more than 1,000 feet; one to a depth of 1,510 feet showing no workable coal and the other 1,225 feet showing three feet five inches of coal at 1,221 feet. The shallow holes range from 113 feet to about 500 feet. It was not thought advisable to make any explorations beyond a depth of 1,500 or 2,000 feet, as drilling beyond that depth is very expensive and should any coal be found at such a depth it could not be practically or profitably mined.

The detailed reports[16] submitted by Mr. Cameron show the amount and value of coal underlying the segregated area; the thickness and depth of the beds, and the tracts that do not contain coal that could be profitably mined.

The following table gives the amount and value of workable coal as estimated for each district by Mr. Cameron in his report of November 5th, 1909.

16. Op. cit.

*Table No. 6. Tabulation of Data Obtained from Drilling Operations on Segregated Coal Land, Choctaw Nation**

Boring		Tract	Total	Workable Coal			
No.	Location	No.	Depth	Depth Ft. in.	Thickness Ft. in.	Dip Degrees	Seam
1	S 5° E. 400 ft. fr. E¼ cor. sec. 10, T. 4 N., R. 14 E.	72	1,510	....	none	13	e
2	S 77° W 360 ft. fr. E¼ cor. sec. 16, T. 4 N., R. 14 E.	69	677	597 9	3 10	......	L. Hartshorne
3	N. 110 ft. fr. E¼ cor. sec. 9, T. 3 N., R. 13 E.	61	221	160 0	3 4	13	U. Hartshorne
4	S 30°, W 1100 ft. fr. NE cor. sec. 17, T. 3 N., R. 13 E.	60	335	....	none	14	e
5	660 feet N of cen. sec. 31, T. 2 N., R. 12 E. on W bor. of	47	835	....	none	5½	e
6	47° N, 1150 ft. E. of SE cor. sec. 11, T. 3 N., R. 14 E.	53	423	410 3	3 11	45	McAlester
7	N 20°, E 1920 ft. fr. W ¼ cor. sec. 19, T. 4 N., R. 16 E.	1	460	441 6	4 0	22	McAlester
8	N 70°, E. 1450 ft. fr. W ¼ cor. sec. 12, T. 1 N., R. 11 E.	7a	467	....	none	8	e
9	S 25°, E 1050 ft. fr. cen. sec. 4, T. 5 N., R. 16 E.	30	560	551 8	3 2	26	McAlester
10	N 1155 ft. fr. E ¼ cor. sec. 34, T. 1 S., R. 10 E.	18-19b	677	....	none	4	e
11	N 30° E 990 ft. fr. SW cor. sec. 2, T. 5 N., R. 16 E.	31	390	379 4	2 10	25	McAlester
12	S 80°, W 1450 ft. fr. NE cor. sec. 28, T. 1 S., R. 10 E.	17	461	....	none	3½	e
13	N 8°, W 1400 ft. fr. SE cor. sec. 1, T. 5 N., R. 16 E.	32	310	306 9	3 1	23	McAlester
14	S 1400 ft. fr. NW cor. sec. 8, T. 1 S., R. 10 E.	10-11c	320	242 8	3 1	8	U. Hartshorne
15	S 45°, W 570 ft. fr. E ¼ cor. sec. 4, T. 5 N., R. 17 E.	35	249	242 2	2 5	23	McAlester
16	N 23°, W 1400 ft. fr. cen. sec. 4, T. 5 N., R. 20 E.	11	321	....	none	14	e
17	S 50°, E 500 ft. fr. cen. sec. 25, T. 6 N., R. 18 E.	d	270	....	none	35	e
18	N 80°, W 1050 ft. fr. SE cor. sec. 25, T. 6 N., R. 18 E.	4	339	....	none	19	e
19	N 55°, W 530 ft. fr. E¼ cor. sec. 31, T. 6 N., R. 21 E.	20	174	106 8 167 3	2 3 2 9	4	e
20	W 300 ft. fr. cen. sec. 33, T. 6 N., R. 22 E.	40	389	381 11	2 11	17	McAlester
21	N 5°, E 756 ft. fr. E¼ cor. sec. 35, T. 6 N., R. 22 E.	41	580	517 0 576 0	2 2 2 8	15	e
22	S 1000 ft. W fr. N¼ cor. sec. 4, T. 5 N., R. 23 E.	45	155	....	none	38	e
23	S 40°, E 790 ft. fr. cen. sec. 20, T. 6 N., R. 26 E.	27	996	....	none	6	e
24	S 25° W, 1500 ft. S¼ cor. sec. 14, T. 6 N., R. 24 E.	46	434	380 8	3 2	20	e
25	S 45° W, 1000 ft. fr. cen. sec. 28, T. 6 N., R. 24 E.	13	441	....	none	20	e
26	S 50°, W 1490 ft. fr. E¼ cor. sec. 31, T. 6 N., R. 25 E.	17	487	462 8	4 2	20	e
27	N 30°, E 1000 ft. fr. S¼ sec. 23, T. 8 N., R. 25 E.	40	273	235 0	3 8	14	e
28	N 55° E. 900 ft. fr. cen. sec. 14, T. 8 N., R. 26 E.	49	375	....	none	8	e
29	100 ft. SE. of NW. cor. sec. 29, T. 9 N., R. 27 E.	77	294	223 0	4 0	6	Hartshorne
30	900 ft. S. N¼ cor. sec. 19, T. 8 N., R. 25 E.	33	273	204 3	3 6	12	U. Hartshorne
31	S 35°, W 1850 ft. fr. N¼ cor. sec. 22, T. 8 N., R. 24 E.	26	216	....	none	12	e
32	N 27°, W 800 ft. fr. E¼ cor. sec. 32, T. 9 N., R. 26 E.	71	113	87 0	4 8	10	e
33	S 5°, W 1450 ft. fr. NE cor. sec. 35, T. 9 N., R. 23 E.	52	357	....	none	6	e
34	N 50°, W 1600 ft. fr. SE. cor. sec. 1, T. 8 N., R. 25 E.	43	467	....	none	12	e
35	S 25°, E 1820 ft. fr. N¼ cor. sec. 20, T. 9 N., R. 24 E.	55	404	....	none	8	e
36	N 50°, E 1825 ft. fr. S¼ cor. sec. 1, T. 8 N., R. 24 E.	32	418	....	none	12	e
37	S 5°, E 1575 ft. fr. N cor. sec. 29, T. 5 N., R. 15 E.	20	1,225	1221 2	3 5	none	McAlester

*Compiled from U. S. Senate Document No. 390, 1910.

a. On lease No. 7, Southwestern Development Co.
b. Between Tracts 18-19.
c. Between Tracts 10-11.
d. On creek north of segregated land line

Table No. 7. Area and Value of Workable Coal on Segregated Coal Land.

Unleased Lands

DISTRICT	AREA	VALUE
McAlester	30,442	$ 978,950
Wilburton	28,861	1,188,295
Wilburton-Stigler	12,696	253,920
Howe-Poteau	38,421	1,581,815
McCurtain-Massey:		
McCurtain	50,840	2,746,475
Massey	7,021	210,630
Lehigh-Ardmore	33,239	1,485,425
	201,520	$ 8,445,510

Leased Lands

McAlester	36,696	$ 1,367,460
Wilburton	15,871	889,090
Howe-Poteau	8,097	404,850
McCurtain-Massey	8,760	547,590
Lehigh-Ardmore	12,705	664,539
Total	82,129	3,873,529
Grand Total	283,649	$ 12,319,039

The total area of workable coal in the segregated lands as given by Mr. Cameron is 283,649 acres, showing 201,520 acres of unleased land and 82,129 acres on the leased land. The figures shown for the unleased acreage are larger than those contained in Mr. Cameron's first report because of the addition of 12,696 acres of coal in the vicinity of Stigler and Tamaha which, at the time the first report was made, had not been considered of commercial value on account of the thickness of the bed and the large amount of impurities intermingled with the coal.

INDEX TO OPERATORS OF MINES SHOWN ON COAL FIELD MAPS*

*These maps are the original maps prepared by Mr. Shannon, and which have been revised and brought up to date by the use of a "Map of Coal Segregation, Choctaw Nation, Oklahoma" prepared from official data under the direction of the coal appraisers, and is correct as of June, 1925. All mines that were on the old maps and not shown on the coal appraisers' map have been marked "(ab)" abandoned for want of more definite information. The leased areas of the segregated lands have also been checked and brought up to date.

See index map of coal field area on last page.

COALGATE-LEHIGH COAL FIELD

Mine Number	Operating Company	Mine
1	St. Louis & Galveston C. & M. Co.	No. 1 slope
2	St. Louis & Galveston C. & M. Co.	No. 2 slope
3	St. Louis & Galveston C. & M. Co.	No. 4 slope
4	Folsom Morris C. M. Co.	No. 6 shaft
	Folsom Morris C. M. Co.	No. 1 shaft

Mine Number	Operating Company	Mine
5	Folsom Morris C. M. Co.	No. 3 shaft
6	Folsom Morris C. M. Co.	No. 2 slope
7	Folsom Morris C. M. Co.	No. 5½ shaft
8	Folsom Morris C. M. Co.	No. 5 shaft
9	Folsom Morris C. M. Co.	No. 8 shaft
10	Folsom Morris C. M. Co.	No. 4 shaft
11	Folsom Morris C. M. Co.	No. 4 old shaft
12	Folsom Morris C. M. Co.	No. 3 slope
13	Folsom Morris C. M. Co.	No. 1 slope
14	Folsom Morris C. M. Co.	shaft
15	Folsom Morris C. M. Co.	No. 7 shaft
16	M. K. & T. Ry Co., Coal Dept.	No. 4 new shaft
17	M. K. & T. Ry. Co., Coal Dept.	No. 4 old shaft
18	M. K. & T. Ry. Co., Coal Dept.	No. 12 old shaft
19	M. K. & T. Ry. Co., Coal Dept.	No. 12 new shaft
20	M. K. & T. Ry. Co., Coal Dept.	No. 1 slope
21	M. K. & T. Ry. Co., Coal Dept.	No. 3 shaft
22	M. K. & T. Ry. Co., Coal Dept.	No. 10 shaft
23	M. K. & T. Ry. Co., Coal Dept.	No. 5 shaft
24	M. K. & T. Ry. Co., Coal Dept.	No. 2 shaft
25	Coalgate Company	No. 1 slope
26	Coalgate Company	No. 5 shaft
27	Coalgate Company	No. 2 slope
28	Coalgate Company	No. 3 slope
29	Coalgate Company	No. 4 slope
30	Keystone C. & M. Co.	No. 1 slope
31	Hazleton Coal Co.	No. 1 slope
32	M. K. & T. Ry. Co., Coal Dept.	No. 14 slope
33	M. K. & T. Ry. Co., Coal Dept.	No. 9 shaft
34	M. K. & T. Ry. Co., Coal Dept.	No. 17 shaft

McALESTER-HARTSHORNE COAL FIELD

Mine Number	Operating Company	Mine
35	Great Western C. & C. Co.	No. 9 slope
36	McAlester-Choctaw Coal Co.	Jeannette
	McAlester-Choctaw Coal Co.	Wild Cat and Redman
37	McAlester-Choctaw Coal Co.	
38	Samples C. & M. Co.	Pasco Slope
39	Samples C. & M. Co.	No. 2 slope
40	Samples C. & M. Co.	No. 4 slope
41	Samples C. & M. Co.	No. 1½ slope
42	Samples C. & M. Co.	Halstead
43	Samples C. & M. Co.	No. 1 slope
44	Samples C. & M. Co.	Pasco slope
45	N. McAlester Coal Co.	Harris slope
46	Osage Coal & Mining Co.	No. 5 slope
47	Osage Coal & Mining Co.	Elliott slope
48	Osage Coal & Mining Co.	Homer slope
49	Osage Coal & Mining Co.	Water slope
50	Osage Coal & Mining Co.	Air slope
51	Osage Coal & Mining Co.	No. 8 shaft
52	Osage Coal & Mining Co.	No. 7 slope
53	Osage Coal & Mining Co.	Story and Bond
54	Osage Coal & Mining Co.	Bailey's
55	McAlester C. & C. Co.	No. 6 slope

Mine Number	Operating Company	Mine
56	McAlester C. & C. Co.	No. 21 slope
57	McAlester C. & C. Co.	No. 22 slope
58	C. O. & G. R. R.	No. 5 shaft
59	C. O. & G. R. R.	No. 38 slope
60	C. O. & G. R. R.	No. 9 shaft
61	Central C. & Lbr. Co.	No. 1 slope
62	Central C. & Lbr. Co.	No. 2 slope
63	Central C. & Lbr. Co.	No. 3 slope
64	Union Coal Co.	No. 8 slope
65	Milby & Dow C. & M. Co.	No. 10 slope
66	Milby & Dow C. & M. Co.	No. 5 slope
67	Milby & Dow C. & M. Co.	No. 9 shaft
68	Hailey Ola Coal Co.	No. 1 shaft
69	Union Coal Co.	No. 7 shaft
70	Union Coal Co.	Richard's
71	Union Coal Co.	Sunkinnis
72	Pierce Coal Co.	No. 1 slope
73	Union Coal Co.	No. 6 slope
74	C. O. & G. R. R. Co.	Gowen No. 40 slope
75	C. O. & G. R. R. Co.	McAlester Colliery Co.
76	C. O. & G. R. R. Co.	No. 10 shaft
77	Hartshorne Coal Co.	No. 1 slope
78	C. O. & G. R. R. Co.	No. 24 slope
79	C. O. & G. R. R. Co.	No. 42 slope
80	C. O. & G. R. R. Co.	No. 7 slope
81	Hailey Ola Coal Co.	No. 3 slope
82	Hailey Ola Coal Co.	No. 2 slope
83	Hailey Ola Coal Co.	No. 7 slope
84	Hailey Ola Coal Co.	No. 6 slope
85	Craig C. & M. Co.	Hamilton and Foster slope
86	Craig C. & M. Co.	Rosco slope
87	Craig C. & M. Co.	Schriner slope
88	C. O. & G. R. R. Co.	No. 12 slope
89	Kali Inla Coal Co.	No. 1 slope
90	Phoenix Coal Co.	No. 2 slope
91	Dow Coal Co.	So. slope
92	Dow Coal Co.	slope
93	Southern Fuel Co.	No. 1 slope
94	Southern Fuel Co.	No. 1½ slope
95	Southern Fuel Co.	No. 3 slope
96	McAlester Edwards Coal Co.	No. 1 slope
97	McAlester Edwards Coal Co.	No. 2 slope
98	Storrie and Rice	No. 1 slope
99	Thomas Coal Co.	No. 1 slope

WILBURTON-RED OAK COAL FIELD

Mine Number	Operating Company	Mine
100	M. K. T. Coal Company	No. 19 shaft
101	Eastern C. & M. Co.	No. 21 shaft
102	Degnan & McConnell	No. 5 shaft
103	Degnan & McConnell	No. 6 slope
104	Great Western C. & C. Co.	No. 3 slope
105	Great Western C. & C. Co.	No. 7 slope
106	Hailey Ola Coal Co.	No. 4 slope

Mine Number	Operating Company	Mine
107	Hailey Ola Coal Co.	No. 5 slope
108	Hailey Ola Coal Co.	Kattikan's
129	Moore	No. 1 slope
130	Moore	No. 2 slope

HUGHES-HOWE-POTEAU COAL FIELD

109	Bache and Denman	No. 2 slope
110	Texas Coal Company	No. 2 slope
111	Le Bosquel C. & M. Co.	No. 2 slope
112	Le Bosquel C. & M. Co.	No. 1 slope
113	Le Bosquel C. & M. Co.	Sturgeon
114	Degnan & McConnell C. & C. Co.	No. 3 slope
115	Degnan & McConnell C. & C. Co.	No. 4 slope
116	C. O. & G. R. R. Co.	Johnston's
117	Central Coal and Lbr. Co.	No. 8 slope
118	Poteau Coal & Merc. Co.	No. 4 slope

McCURTAIN-BOKOSHE-PANAMA COAL FIELD

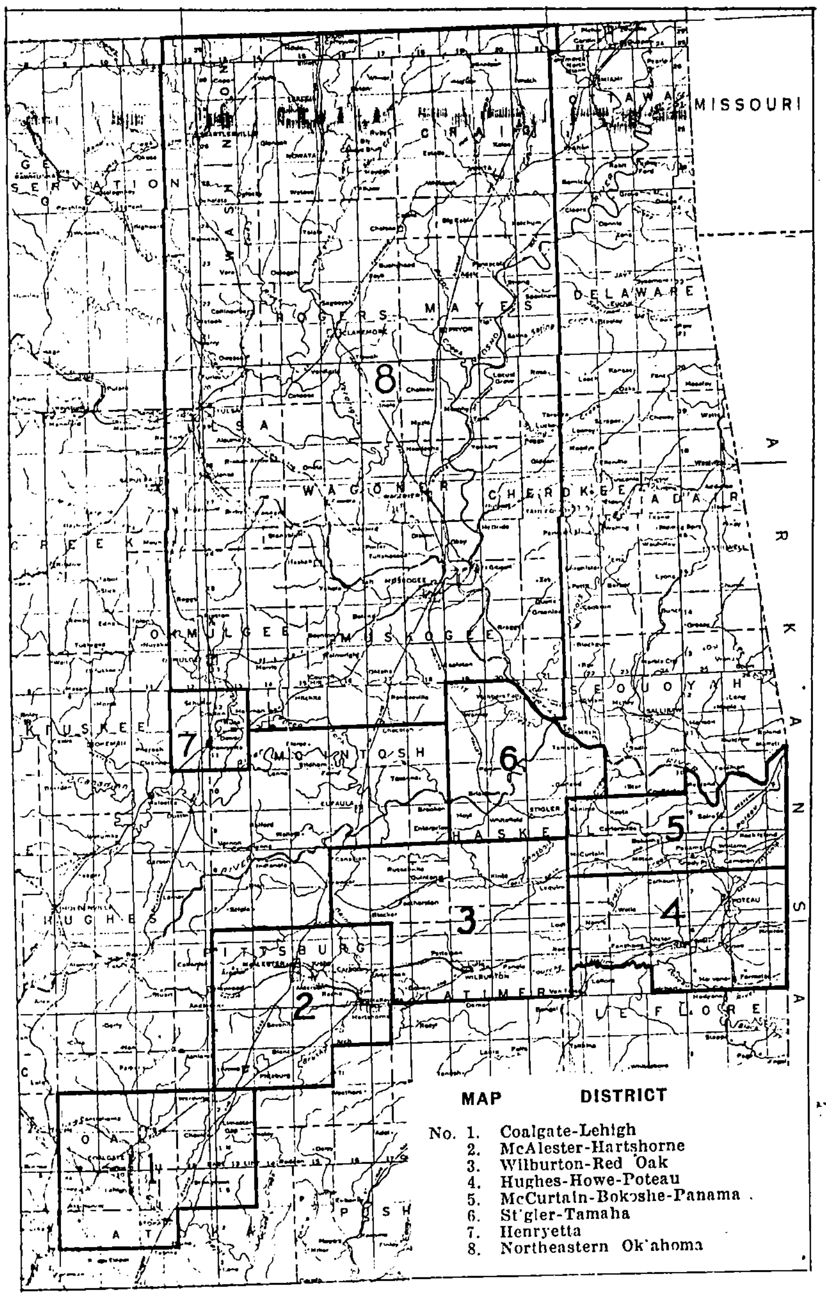
119	Blue Ridge Coal Co.	No. 3 slope
120	Blue Ridge Coal Co.	No. 4 slope
121	Blue Ridge Coal Co.	No. 5 slope
122	East McCurtain Coal Co.	No. 1 slope
123	Milton Co-oper. Colony	No. 2 slope
124	Milton Co-oper. Colony	No. 3 slope
125	Mazzard C. & M. Co.	No. 3 slope
126	Andrew P. Gunther	No. 7 slope
127	Superior Smokeless C. & M. Co.	No. 1 slope
128	Cameron Coal and Merc. Co.	No. 1 slope

HENRYETTA COAL FIELD

129	B and A Mining Co.	Shaft
130	Sun Coal Co.	Slope
131	Furman Coal Co.	Slope
132	Kincaid Coal Co.	Slope
133	Deep Fork Coal Co.	Slope
134	Crowe Coal Co.	No. 3 slope
135	Oklahoma Coal Co.	No. 2 slope
136	Oklahoma Coal Co.	No. 1 slope
137	Crowe Coal Co.	No. 4 slope
138	Blue Ridge Coal Co.	Slope
139	Oklahoma Coal Co.	No. 3 slope
140	Atlas Coal Co.	No. 2 slope
141	Southwest Coal and Oil Co.	No. 3 slope
142	Atlas Coal Co.	No. 1 slope
143	Star Coal Co.	Slope
144	Southwest Coal and Oil Co.	No. 2 slope
145	Oklahoma Coal Co.	No. 5 slope
146	Oklahoma Coal Co.	No. 6 slope
147	McDonald Coal Co.	Slope
148	Oklahoma Coal Co.	No. 7 slope
149	Wadsworth Coal Co.	Slope
150	Oklahoma Coal Co.	No. 4 slope
151	Dawson Coal Co.	Slope

Mine Number	Operating Company	Mine
152	King Coal Co.	No. 1 slope
153	King Coal Co.	No. 2 slope
154	Lantz Coal Co.	Slope
155	Warden Coal Co.	No. 2 shaft
156	Old Cato Coal Co.	Shaft
157	Glen Coal Co.	Shaft
158	Oklahoma Coal Co.	No. 9 slope
159	Whitehead Coal Co.	No. 1 shaft
160	Pittsburg and Midway Coal Co.	Shaft
161	McGennes Coal Co.	Shaft
162	Whitehead Coal Co.	No. 2 shaft
163	Wise-Buchanan Coal Co.	Shaft
164	Crowe Coal Co.	No. 5 shaft
165	Crowe Coal Co.	No. 7 shaft
166	Crowe Coal Co.	No. 6 shaft
167	Warden Coal Co.	No. 1 shaft

PLATE XV



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