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**ANSWERS
to QUESTIONS
about
ARKANSAS
MINERAL
RESOURCES**

by
George C Branner
STATE GEOLOGIST

Published Jointly by
STATE GEOLOGICAL SURVEY
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**MINES, MANUFACTURES
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JIM G. FERGUSON, Commissioner

WORK OF THE STATE GEOLOGICAL SURVEY

What Is Geology?

Geology is that science which treats of the earth and its history as revealed by the rocks. It therefore deals with the materials which compose the earth, the forces which control those materials and the record of past life on the earth insofar as that record bears on the relationship of the rocks. Geology is thus a broad composite science and continually utilizes the principles of astronomy, chemistry, physics and biology.

Is Geology of Practical Value?

Yes, it may be of great practical value, although, like other sciences, it may or may not be put to practical use. The principles of geology are continually used in the search for useful minerals, the development and conservation of mineral resources, the study of the rock origin and constitution of the soils, the study of ways and means to increase and maintain soil fertility, and the study of water power resources and drainage.

What Is a State Geological Survey?

It is an organization maintained by the State for the purpose of achieving the most extensive development of the State's mineral and water power resources. This development under normal conditions is carried on by a staff of trained specialists whose duty it is to accumulate and disseminate dependable information regarding the State's mineral resources.

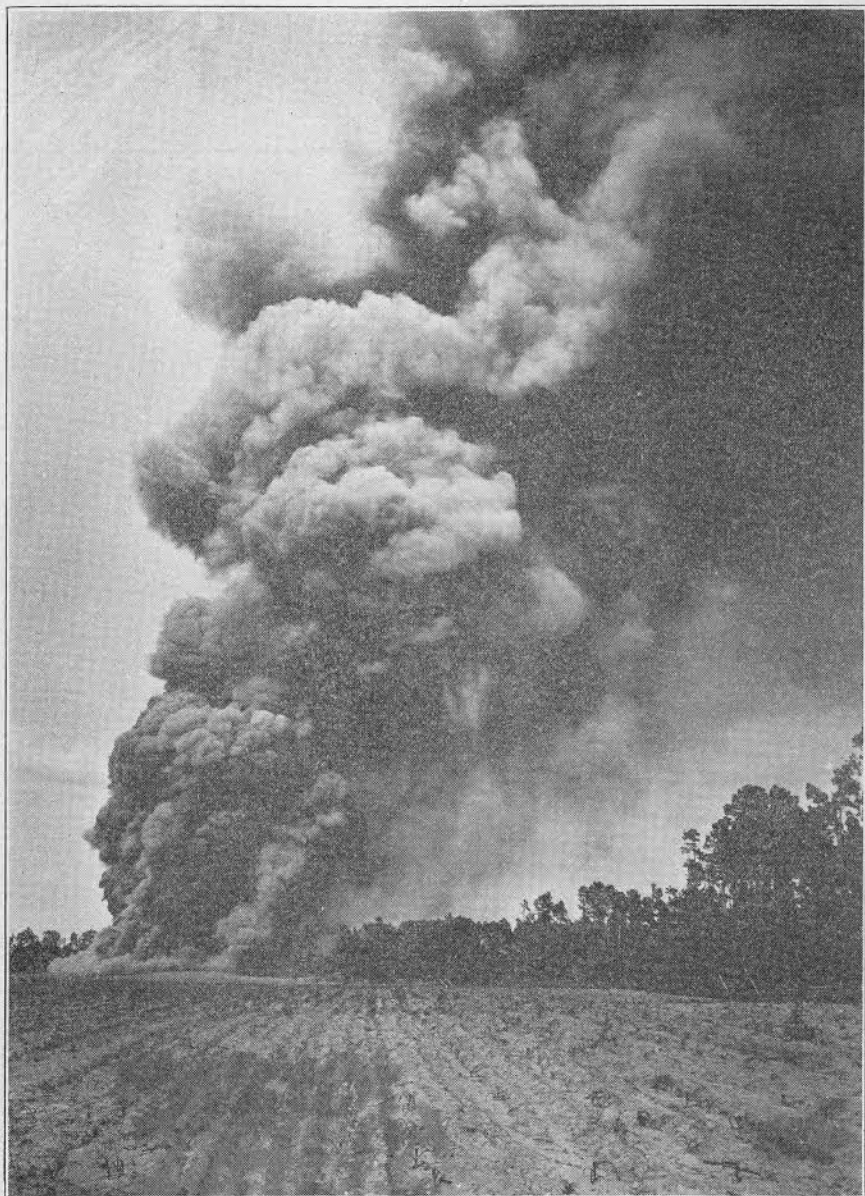
What Benefit Does the State Derive from the Development of Its Mineral Resources?

In general the State benefits in two ways:

1. From the increase of the State's revenue through (a) the Severance Tax on minerals; (b) the general property tax.
2. From the increase of capital invested in the State, which naturally follows the development of the State's resources.

How Much Have the Severance Tax On Minerals and the General Property Tax Increased the State's Revenue?

The State real and personal property tax on the mineral industries can not be accurately estimated. However, it is probable that the revenue from the real and personal property tax on the State's mineral industries is now about \$900,000 per year. The increase in the State and county general property tax of 28.7 mills in



Murphy Crater, Southern Smackover Field in Arkansas

Union and Ouachita counties between the years 1920 and 1923, due to the discovery of oil in those counties, is as follows:

	1920	1923	Increase
Union County Tax	\$256,517.96	\$655,114.98	\$398,597.02
Ouachita County Tax	254,529.50	307,794.12	53,264.62
TOTAL INCREASE			\$451,861.64

The income from the Severance Tax on minerals for the five quarters beginning April 1st, 1923, has been as follows:

	First 4 Qrs. April 1923 through March 1924	Last 4 Qrs. July 1923 through June 1924	Five Qrs. April 1, 1923 through June 1924
Oil and gas	\$ 657,128.18	\$ 853,594.54	\$ 986,556.43
Bauxite	22,122.15	19,915.60	26,313.85
Coal	13,685.18	12,664.88	14,843.67
Gravel	854.84	793.74	1,091.23
Stone	815.62	878.40	1,021.16
Manganese Ore	487.48	721.43	791.61
Diamonds	164.17	177.43	271.03
Clay	197.41	235.94	253.55
Sand	92.57	85.78	115.77
Pearls	14.38	15.03	15.03
Gypsum	2.25	2.25	2.25
Total	\$ 695,564.23	\$ 889,085.02	\$1,021,275.58

It follows, therefore, that the annual income to the State from taxes dependent upon the mineral industries is approximately as follows:

From the Severance Tax on minerals	\$ 890,000.00
From the general property tax	900,000.00
Total	\$1,790,000.00

How Much Capital Is Invested in the State's Mineral Industries?

The capital invested in the mineral industries in the State in 1923 was more than \$25,000,000 distributed as follows:

Oil and Gas	\$20,005,812.79
Coal	1,930,850.00
Diamonds	1,250,000.00
Bauxite	1,038,759.72
Clay	680,000.00
Sand and Gravel	276,875.00
Gypsum	67,000.00
Manganese Ore	50,000.00
Stone	50,000.00
TOTAL	\$25,349,297.51

Through bringing about the development of the mineral industries of the State the direct purpose of the State Geological Survey is to continually increase and maintain the State's revenue from mineral resources and the capital invested in mineral industries.

In Just What Way Does the Geological Survey Assist in the Development of Natural Resources?

It assists by making surveys of the different mineral values of the State and by the publication of the findings of these surveys and by the dissemination of geological reports, information and advice. In

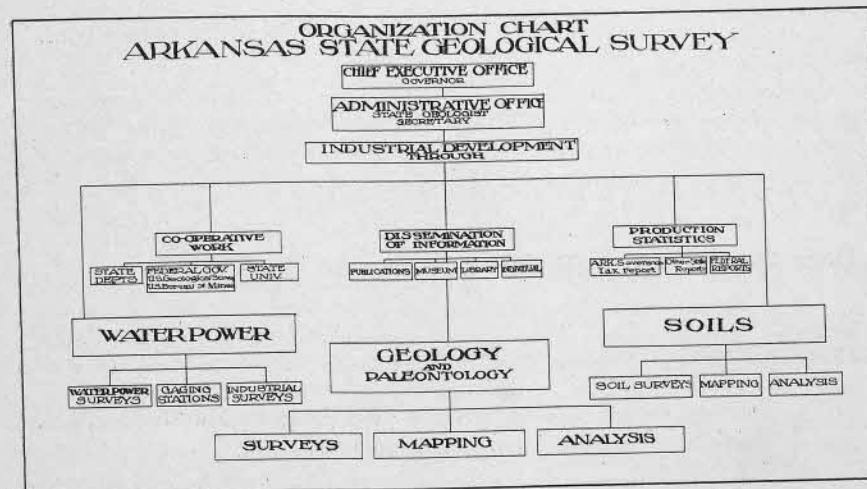
addition to this general method, an accurate record is kept of all developed and undeveloped resources of the State, and this information is supplied to interested individuals or firms.

Have Past State Geological Surveys Actually Assisted in the Development of the State's Mineral Industries?

There have been numerous instances in the past where State geological reports and detailed knowledge gathered through the State Surveys have resulted in developments both small and large. In Arkansas one of the most outstanding instances was the discovery of the bauxite area by J. C. Branner in 1891. This discovery has proved of great value to the State. A single discovery of an unknown mineral resource will easily pay for a Geological Survey several times over. Inquiries are continually received from mining and development companies at the office of the present Survey asking for definite information concerning many of the State's resources. Some of these have been as follows: Oil, gas and coal, zinc and lead, manganese, lignite, chalk, novaculite, fullers' earth, bauxite, pottery, fire and brick clays, tripoli, ochre and other paint materials, graphite, green-sand, phosphates, slate, soapstone, talc, whetstones, and others.

What Are the Requirements by Law for the Organization of the Survey?

Under the law the work of the Survey is divided into three general divisions, (1) Geologic, (2) Soil, and (3) Water Power. Information is gained directly in the field, from the study of past investigations and through co-operation with other agencies. This information is disseminated through the usual channels. A detailed chart of the organization of the Survey follows:



What Geological Surveys Has Arkansas Had in the Past?

From 1857 to 1860 D. D. Owen was State Geologist and published two reports.

From 1871 to 1875 W. F. Roberts, George Haddock, Wm. C. Hazeldine, Arnold Syberg were successively State Geologists. One publication was issued.

From 1887 to 1893 John C. Branner was State Geologist and during that time with the help of assistants issued 14 volumes of reports on various phases of the mineral wealth of the State.

From 1907 to 1923, the Professors of Geology of the University of Arkansas, A. H. Purdue, N. F. Drake, G. H. Cady, served under the law as ex-officio State Geologists, and devoted a portion of their time to the State work. Under A. H. Purdue three volumes of reports were published.

The present Survey was established by an act of the Legislature approved March 22, 1923, and the present State Geologist was appointed July 2nd, 1923.

What Personal Services May the Public Expect From the State Survey?

Free advisory service concerning the geology and mineralogy of different localities within the State, the location of areas containing undeveloped mineral resources, the quality, quantity and value of those resources, the distribution of areas favorable for oil and gas development, the identification in some instances of sub-surface formations encountered in drilling, the determination of the character of mineral specimens submitted; the furnishing of references to published reports and articles, etc.

When requested, information received is treated as wholly confidential.

If complete qualitative or quantitative analytic examinations are requested, unless such work bears directly upon the State Survey work, it is turned over to private chemists, who make such analyses for a fee of from \$2 to \$10, depending upon the nature of the examination.

Does the Survey Maintain a Well Log Department?

The law provides that all logs shall be filed with the Arkansas Railroad Commission. This law became effective March 23, 1923. Consequently, the Survey does not regularly receive copies of well logs. However, the Survey has on file several hundred logs which are for the most part, logs of wells drilled prior to March 23, 1923, and copies of these will be furnished upon request.

Operators are urged to file logs with this Department in order to

assist in the compilation of information concerning sub-surface conditions.

What Portions of the State Have Been Surveyed Geologically, Topographically and for Soil and Water Power (Gaging Stations)?

The maps shown indicate the distribution of work completed up to the present time by former Surveys, both Federal and State.

What Percentage of the Area of the State Remains to Be Geologically Surveyed?

The map shown of the geological work shows to date what has been accomplished. Only 8.6 per cent of the area of the State has been completed, or 4,498 square miles. Approximately 64.4 per cent or 33,843 square miles in addition to this has been partially surveyed, and 27 per cent or 14,181 square miles has had no survey. It is entirely possible that much of the territory which has been partially surveyed will yield unsuspected mineral values, particularly in coal, gas, and metallic minerals. Only a small portion of the geologic mapping has been done by the past State Surveys, the major portion having been done by the U. S. Geological Survey.

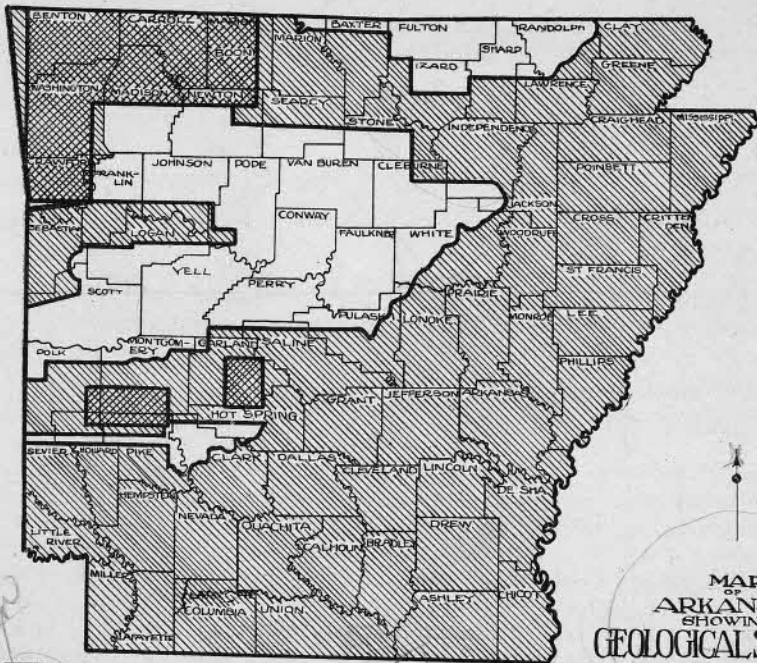
It is interesting to note that approximately 93 per cent of the mineral Severance Tax receipts in the State come from oil and gas. There has never been a State-wide survey for oil and gas. It is of great importance to the State to have such a survey as it might easily be the cause of increasing the number of oil and gas producing fields of the State.

What Is a Topographic Survey?

A topographic survey is a survey which has for its purpose the construction of accurate base maps on which elevations are shown by means of contours. All streams, highways, railroads, towns and cities are also shown. A topographic survey is thus a logical preliminary to the making of an accurate geological map of any area, and also furnishes base information for water power and drainage projects, the construction of railroads and highways, and for soil, timber and other surveys.

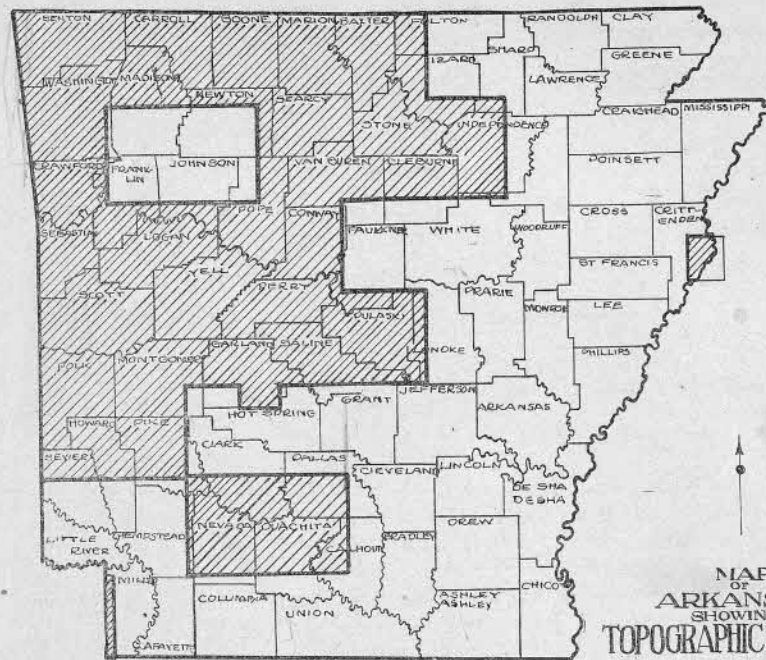
What Portion of the State Has Been Topographically Surveyed?

Approximately 40.9 per cent of the area of the State has been completed at the present time, or 21,494 square miles. Thus 59.1 per cent or 31,031 square miles remain to be completed. These topographic maps are not made by the State Surveys, but are made by the Federal Geological Survey with or without the co-operation of



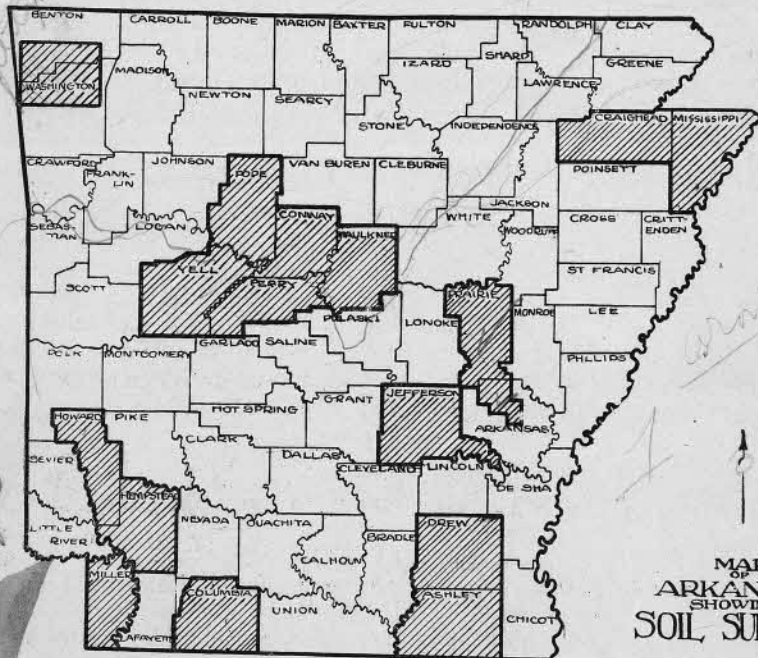
MAP OF ARKANSAS SHOWING GEOLOGICAL SURVEYS

 AREAS COMPLETELY SURVEYED 8.0% - 4,498 sq.m.
 AREAS PARTIALLY SURVEYED 04.4% - 33,943.25 sq.m.
 AREAS UNSURVEYED 27% - 14,181.75 sq.m.



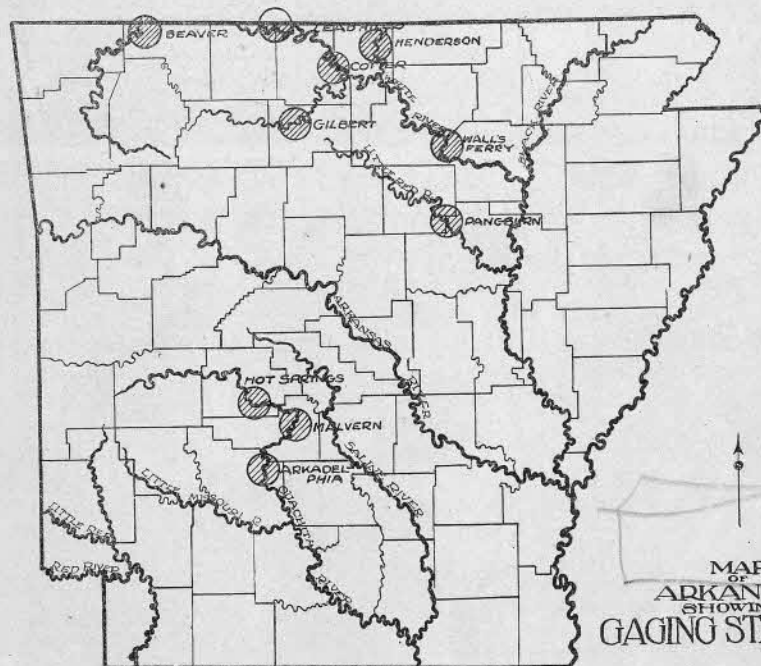
MAP OF ARKANSAS SHOWING TOPOGRAPHIC SURVEYS

 AREAS SURVEYED 40.9% - 21,494 sq.m.
 AREAS UNSURVEYED 59.1% - 31,031 sq.m.



MAP OF ARKANSAS SHOWING SOIL SURVEYS

 AREAS SURVEYED 22.8% - 11,466 sq.m.
 AREAS UNSURVEYED 77.2% - 42,059 sq.m.



MAP OF ARKANSAS SHOWING GAGING STATIONS

 GAGING STATIONS

State Surveys. They can be obtained from the U. S. Geological Survey, Washington, D. C.

What Is a Soil Survey?

A soil survey is one which shows the varying grades of soil distributed in any area, usually by counties, and specifies the kind of crops which can best be grown on any soil. These soil surveys are usually made by the U. S. Department of Agriculture by counties, with or without the co-operation of State Agricultural Schools or Geological Surveys. Soil surveys have been completed of about 22.8 per cent of the State, or 11,975 square miles, leaving 77 per cent unsurveyed, or 40,550 square miles.

What Is a Gaging Station?

A gaging station is a station established along a river for the purpose of keeping a record of the quantity of water flowing in the stream. This usually is done by taking daily readings on a gage in the stream. By maintaining gaging stations in operation the year round the flow of different streams can be calculated and the quantity of water power which may be derived from them estimated.

There have been three gaging stations maintained on the Ouachita River; one on the Little Red River and six on the White River system; a total of 10 points. At all of these points stations have in the past been maintained for from three to seventeen and one-half consecutive months by funds of the U. S. Survey and by State funds at the one point on the Little Red River and six on the White River System for twelve to fourteen and one-half consecutive months.

The amount of information obtained is inadequate for the complete estimation of water power resources as the gage readings do not extend over a sufficient period of time. This valuable service should in the future be given continuous support and may be maintained co-operatively by both the Federal and State Surveys.

How Much Support Does a State Geological Survey Require?

The financial support needed by the Survey depends, of course, on the amount of work which has to be done in the State. In Arkansas there has been no adequately maintained survey since 1892 and consequently, the geological work has been much neglected.

It is interesting to compare the amounts appropriated by the Legislatures of some of the Southern states during the past six years for the maintenance of their surveys:

	1919	1920	1921	1922	1923	1924
North Carolina	\$20,000	\$20,000	\$35,000	\$35,000	\$57,000	\$57,000
Georgia	15,500	16,500	16,500	15,000	15,000	15,000
Florida	7,500	7,500	7,500	7,500	7,500	10,345
Alabama	9,900	15,000	15,000	15,000	16,600	16,600
Mississippi	7,500	34,500	34,500	14,200	14,200	14,200
Louisiana		75,000	75,000	75,000	75,000	75,000
Texas	26,450	31,450	44,500	29,400	29,110	24,520
ARKANSAS					5,000	8,600
Tennessee	15,900	15,900	36,100	36,100	22,800	22,800
Kentucky		17,500	35,500	35,500	40,500	45,500

It is estimated that the Arkansas Geological Survey should have approximately \$26,612 per year as a minimum to effectively operate.

This would care for the maintenance expenses, and salaries as follows:

State Geologist	\$ 4,000
1 Chemist	2,000
1 Civil Engineer	3,000
1 Draftsman	2,100
1 Topographer	2,000
1 Asst. Civil Engineer	1,800
1 Asst. Geologist	1,800
1 Asst. Geologist	1,800
1 Asst. Geologist	1,800
1 Clerk-Stenographer	1,560
Equipment, Traveling and Publication Expense.....	4,752
TOTAL.....	\$26,612

GENERAL GEOLOGY OF ARKANSAS

What, in General, Is the Structure of the Earth?

It is a metallic ball, the surface of which is encrusted with comparatively light-weight minerals which have risen to the top of this molten metallic mass. It is estimated that 83 per cent of the weight of the earth's crust consists of oxygen, silicon and aluminum.

What Kind of Solid Rocks Are Found On the Surface of the Earth?

There are three kinds. These are known as Sedimentary, Igneous and Metamorphic rocks.

What Is a Sedimentary Rock?

A sedimentary rock is one which is made up of ocean or fresh water sediments, these often accumulating as extraordinarily thick beds. Later these beds were raised above the sea and became hard rock. They are usually found as sandstone, limestone, shale and clays.

What Are Igneous Rocks?

Igneous rocks are those which are made up of the hardened molten interior of the earth which has been brought to the surface of the earth either by movement or erosion. They have been cooled and we frequently find them as crystalline rock, such as lava or granite.

What Is Metamorphic Rock?

It is either sedimentary or igneous rock which has been changed from its early form through chemical action, heat or pressure.

What Kind of Rocks Compose the Surface of Arkansas?

Sedimentary, Igneous and Metamorphic, although ordinarily the term Metamorphic would not apply to many of the rocks of Arkansas.

How Are the Sedimentary Rocks Classified?

There are two great geologic divisions of sedimentary rocks in Arkansas, one is the Paleozoic group of rocks and the other the combined Mesozoic and Cenozoic groups.

What Are Paleozoic Rocks?

Paleozoic rocks are those rocks of sedimentary origin which were deposited in ancient sea beds during what is sometimes called the period of ancient life on earth. These rocks are usually consolidated and massive. They are commonly seen in the form of sandstone, quartzite, limestone, marble, dolomite, shale and slate.

How Are the Paleozoic Rocks Identified?

Primarily from the fossils or remains of animal life preserved in the rock. Certain forms of life are known to have existed only during the Paleozoic era. From examination we now know that nearly all of the rocks in the northern and western half of Arkansas are Paleozoic. Their surface area is about 25,153 square miles. See Geologic map in back.

What Are the Characteristic Minerals Found in the Paleozoic Area?

Coal, natural gas, zinc, lead, manganese, silver, copper, antimony, phosphate, novaculite, slate, sandstone, marble, dolomite, limestone etc.

What Are Mesozoic and Cenozoic Rocks?

These are sedimentary rocks which were deposited in the sea bed during the period of middle and recent life on earth. These rocks, compared to the Paleozoic rocks, are very much younger in age. They commonly occur as soft sand and clays, shales, gravels, marls and chalky marls. The area which they cover is usually referred to as the Gulf Coastal Plain, and occupies about 27,358 square miles or slightly more than one-half the State. See map in back of book.

What Are the Characteristic Minerals of the Mesozoic and Cenozoic Areas?

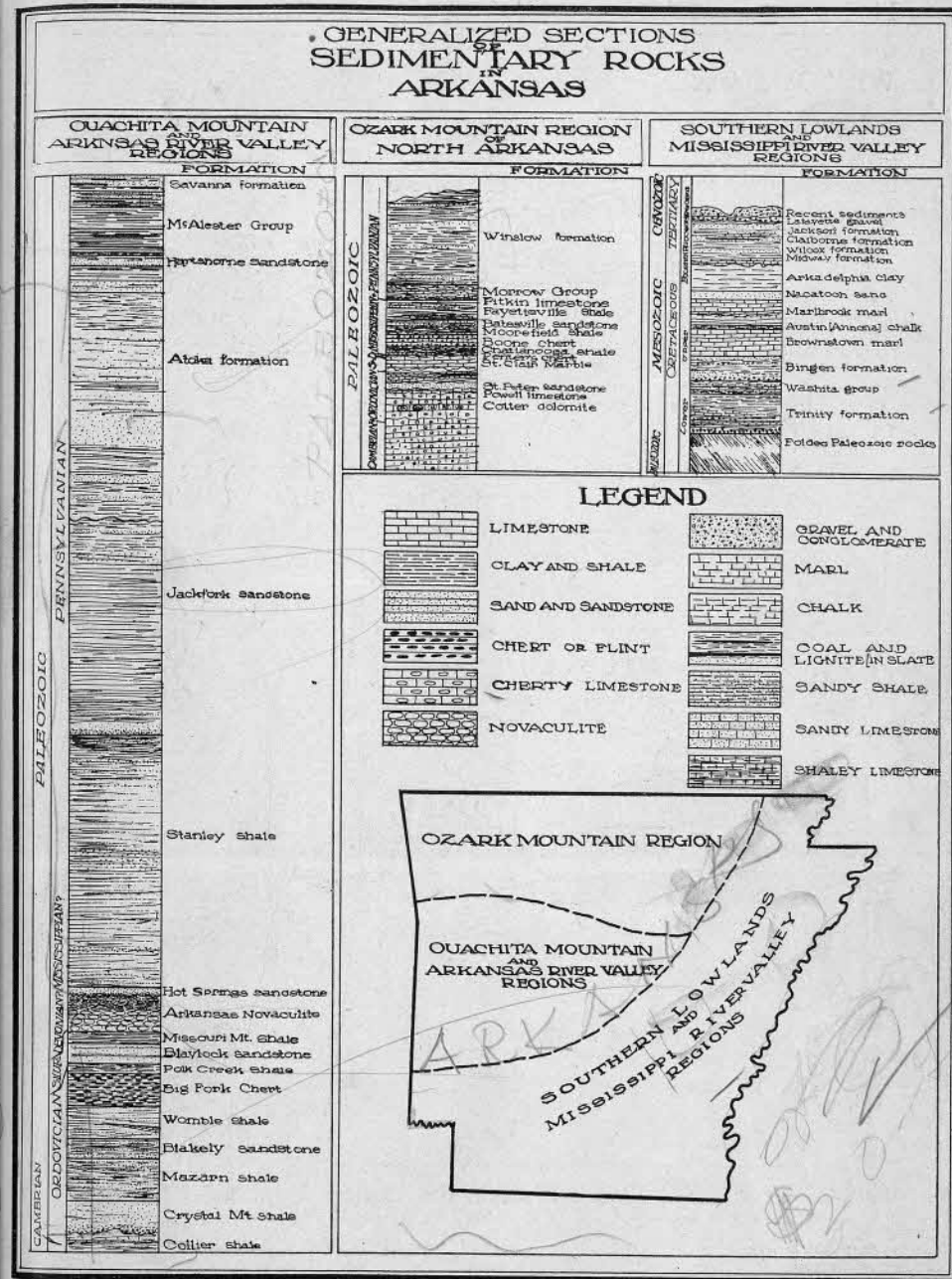
Oil and gas, lignite, asphalt, clay, chalk, marl, gypsum, sand, greensand, gravel, etc.

Where Are the Igneous Areas of Arkansas?

The igneous or volcanic rocks are found in comparatively small areas in Pike, Saline, Pulaski, Garland, Hot Spring and Scott counties.

What Are the Characteristic Minerals Found in the Igneous Areas of Arkansas?

Principally diamonds, bauxite, granite and many rare minerals.



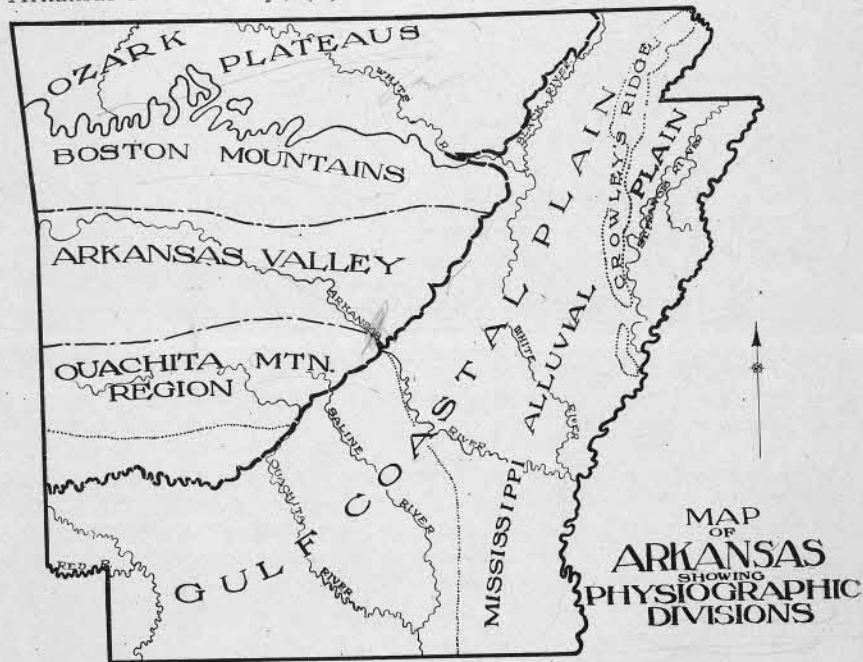
Arkansas Paleozoic rocks are sub-divided into systems known as the Cambrian, Ordovician, Silurian, Devonian, Mississippian and Pennsylvanian. These in turn are divided into formations such as the Atoka Formation or Jackfork Sandstone, as shown above. Mesozoic rocks of Arkansas are divided into the Upper and Lower Cretaceous systems which are in turn divided into formations such as the Arkadelphia Clay, Nacatoch Sand, etc. The Cenozoic rocks of Arkansas are represented by the Tertiary system and are further divided into formations such as the Jackson, Claiborne, etc.

What Is a Geologic Column?

A geologic column is a column representing a general vertical cross section through the rock formations of any given area. The accompanying sections show three different cross sections of the sedimentary rocks in (1) the Ouachita Mountain and Arkansas Valley region, (2) the Ozark Mountain and North Arkansas region, and (3) the Southern lowlands and Mississippi Valley region. The sedimentary rocks in the first section are estimated to have a thickness of approximately 2600 feet, the second section 6200 feet, and the third 4700 feet. These are probably underlaid by crystalline igneous rocks.

What Are the Physiographic Divisions of the State?

(1) The Ozark Plateaus; (2) The Boston Mountains; (3) The Arkansas River Valley; (4) The Ouachita Mountains; (5) The Gulf



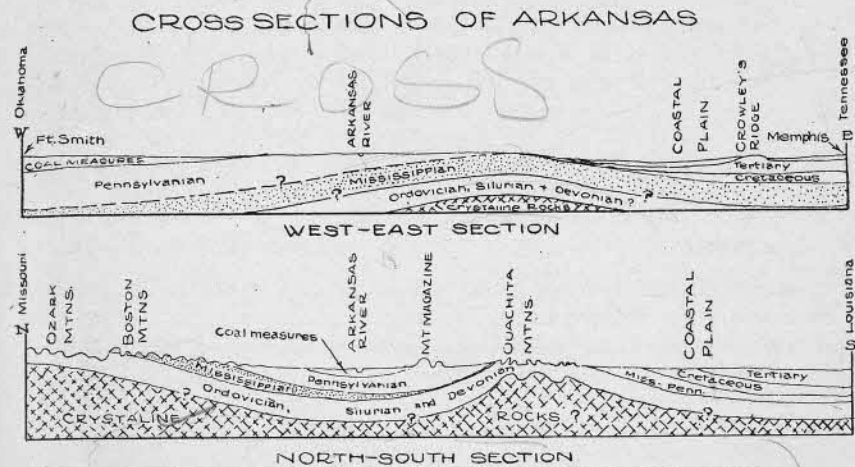
Coastal Plain. The Ozark Plateau, the Boston Mountains, the Arkansas River Valley and the Ouachita Mountains make up the Paleozoic area of the State. The Gulf Coastal Plain contains the Mesozoic and Cenozoic areas.

How Are the Rocks of Different Ages Distributed in the State?

These are shown on the map attached to the last page of this pamphlet.

What Would Cross-Sections of the State Show From North and South and East and West?

These would appear approximately as follows:



The vertical scale of the above sections is greatly exaggerated.

MINERAL RESOURCES

What Are Natural Resources?

The term "natural resources" usually includes agricultural products, timber, minerals and water power.

What Was the Value of Arkansas' Natural Resources in 1923?

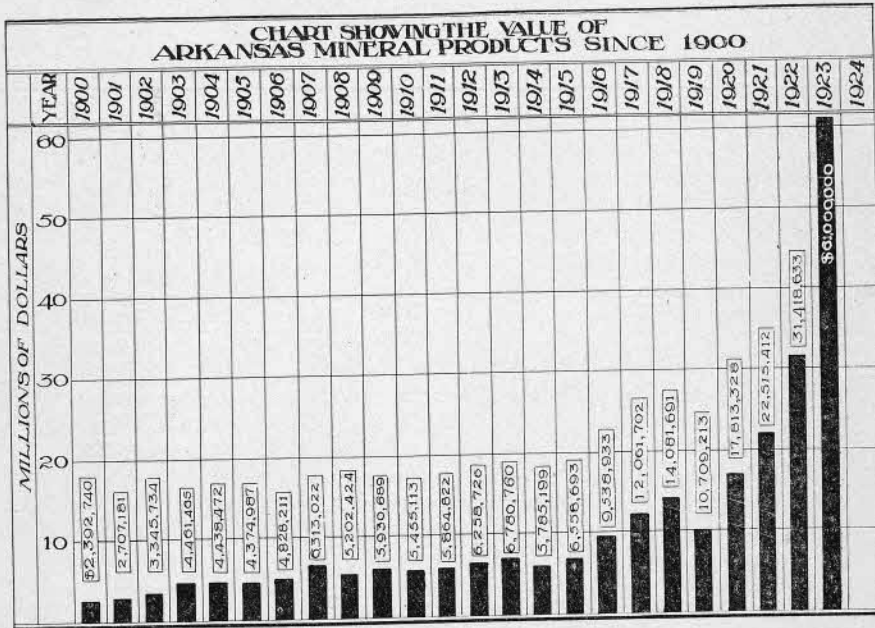
Their total value has been estimated at \$415,000,000. Of this sum the agricultural resources were valued at approximately \$270,000,000; timber, \$84,000,000; and the minerals estimated at \$61,000,000. The annual value of the water power is at present considerably below \$1,000,000. The value of the mineral resources is nearly fifteen per cent of the total value of the natural resources.

It is interesting to note that the value of the mineral products of Arkansas has increased greatly since the discovery of oil in January of 1921, the value of the mineral products in 1923 being nearly three and one-half times that of 1920. It is estimated that in 1923 the value of the oil and gas composed about 86% of the total value of the mineral products of the State. In 1924 Arkansas is the fourth petroleum producing State, being exceeded only by California, Oklahoma and Texas.

The hydrocarbon products, oil, gas and coal constituted 94% of Arkansas' mineral wealth in 1923.

How Has the Value of Mineral Production Varied Since 1900?

This is shown on the following chart:



What Was the Relative Value of the Mineral Products of Arkansas in 1922?

MINERAL PRODUCTION OF ARKANSAS IN 1922
(U. S. Geol. Survey)

Petroleum	12,712,000 Barrels	\$20,416,000
Coal	1,110,046 Short tons	4,592,000
Natural Gas.....	9,700,000 M. Cu. Ft.	1,798,000
Bauxite	266,790 Long tons	1,682,890
Clay Products.....		976,111
Natural-gas Gasoline.....	4,288,955 Gallons	629,491
Sand and Gravel.....	839,733 Short tons	522,121
Stone	300,970 Short tons	417,729
Miscellaneous		176,524
Lime	11,951 Short tons	115,008
Manganese Ore.....	2,264 Long tons	42,197
Mineral Waters.....	248,460 Gallons sold	28,866
Zinc	134 Short tons	15,276
Lead	42 Short tons	4,620
Clay, raw.....	176 Short tons	1,848
Gypsum	600 Short tons	1,800
Total value, eliminating duplications.....		\$31,418,633

PETROLEUM

What Is Petroleum?

It is hydrocarbon derived from organic matter, the major portion of which was probably vegetable. The organic materials from which oil was derived were probably covered over with sedimentary materials which sealed off the organic substances from the action of the air. Salt water was probably to some extent associated with the organic deposits. These ultimately changed partially or wholly into petroleum. It is thus seen that oil is necessarily derived from sedimentary beds.

What Is an Oil Field?

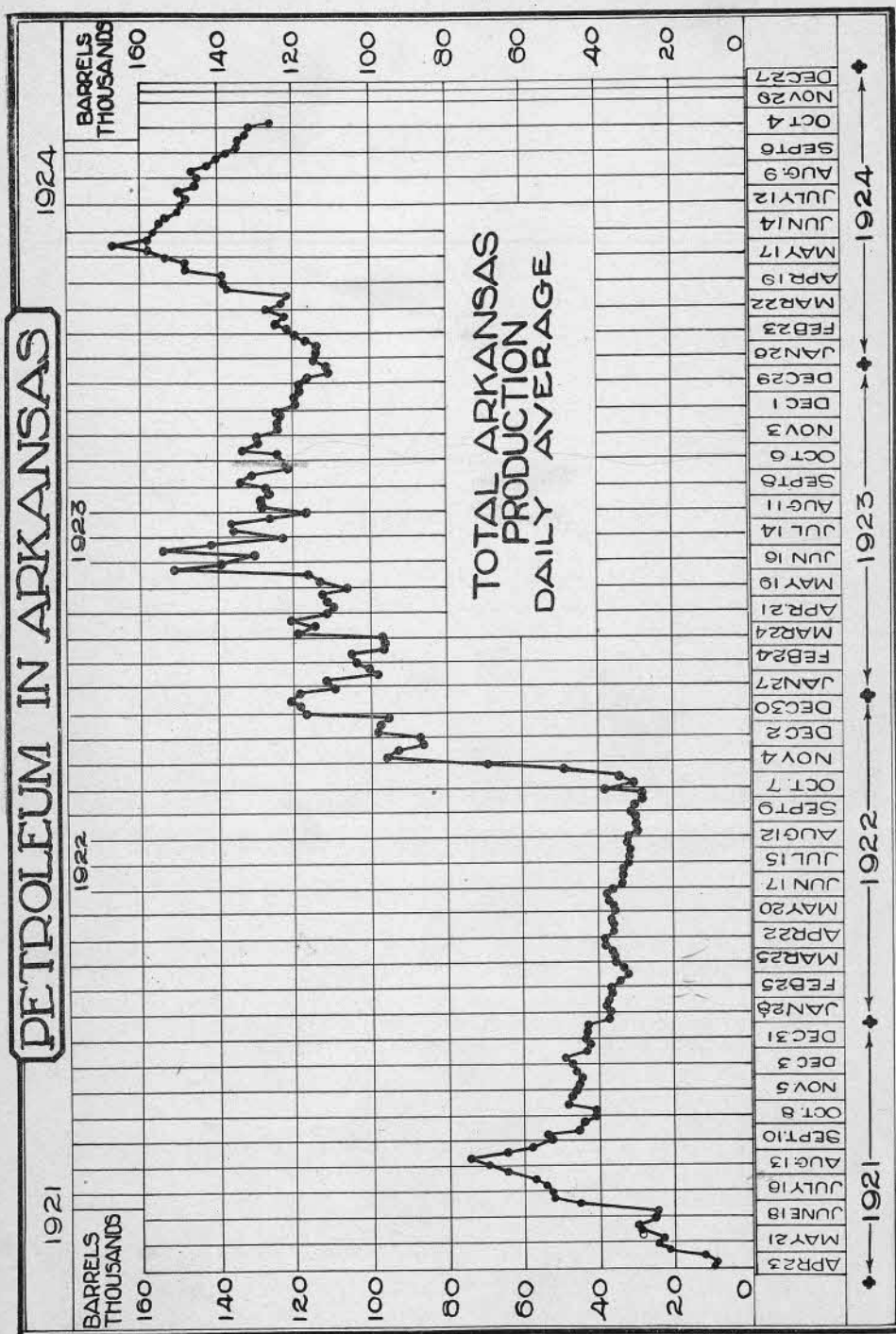
An oil field is an area under which oil has accumulated underground in beds of porous material. This material may be sand, sandstone, limestone, or any rock sufficiently porous to become saturated with oil. This saturation is due to concentration of oil in relatively small areas. It commonly happens that porous beds are encountered while drilling which contain traces of oil. Such oil is too widely disseminated to flow from the porous beds and is therefore of little or no commercial value. The concentration of oil is due to some structural condition which entraps the oil and gas which are often closely associated. These traps may be anticlines or folds in the oil-bearing beds, domes, faults, earth fractures, slopes with sudden breaks, lens shaped beds of sand which are sealed by impervious beds, etc. It thus would seem that when these structures can be located from the surface there is a greatly increased chance for the discovery of oil or gas.

Can Structures be Located From the Surface of the Ground?

In Arkansas they can often be located in the Paleozoic area in the northern and west central parts of the State, and it is often easy to locate folds or well-defined anticlines and domes in that area, as the rocks there are consolidated and strong enough to transmit the lateral pressures which bend them into folds. The Arkansas Coastal Plain beds, on the other hand, are made up of such soft and unconsolidated sediments that it is usually very nearly impossible to locate folds or structural conditions from the surface which may be expected to reflect the structure of the oil bearing sands. If, however, it is possible to definitely locate a structure, a greatly increased chance for the finding of oil is furnished, assuming that the oil bearing beds are present beneath such structure in sufficient thickness.

The El Dorado field has been found from the examination of well logs to consist of a series of underground faults which have tended to concentrate petroleum along a narrow area. The Smackover area, as has been determined from well logs, is in the nature of a series of

PETROLEUM IN ARKANSAS



low underground hills along the flanks of which oil has been concentrated. The Stephens and Irma fields seem to be local high points in the underground sands. It has proved to be exceedingly difficult and an untrustworthy process to attempt to gain specific knowledge of the Arkansas oil producing territory from an examination of the surface. On the other hand, fairly accurate knowledge of the underground conditions of these fields may be gained from a careful comparison of well records.

Are the Oil Fields of Arkansas Necessarily Limited to One Part of the State?

In general it may be said that the oil in Arkansas will probably come from the Coastal Plain series of beds which occupy the eastern and southern half of the State. The Paleozoic region of Arkansas is made up of beds which have for the most part either been altered or distorted to such an extent that there is little or no reasonable chance for oil occurring in them.

The Arkansas Valley region east of Fort Smith is favorable for gas, but oil in amounts which would flow from the porous beds will probably not be found in that locality. The Boston Mountain region is slightly less favorable for gas, and in the Ozark Plateau region there is scarcely any chance for either oil or gas. The Ouachita Mountain area has been subjected to intense folding and the rocks are much altered. It is probable that no reasonable chance exists there for either oil or gas. The counties most likely to produce new fields in Arkansas are Union, Ouachita, Columbia, Nevada, LaFayette, Hempstead, Miller, Little River, Southern Clark, Dallas, Calhoun, Bradley, Ashley, Drew, Cleveland, Grant, Jefferson, Lincoln, Arkansas, Southern Lonoke and Southern Prairie Counties. The other Coastal Plain counties of Arkansas are in possible oil bearing territory, but their location is probably not as favorable as those mentioned.

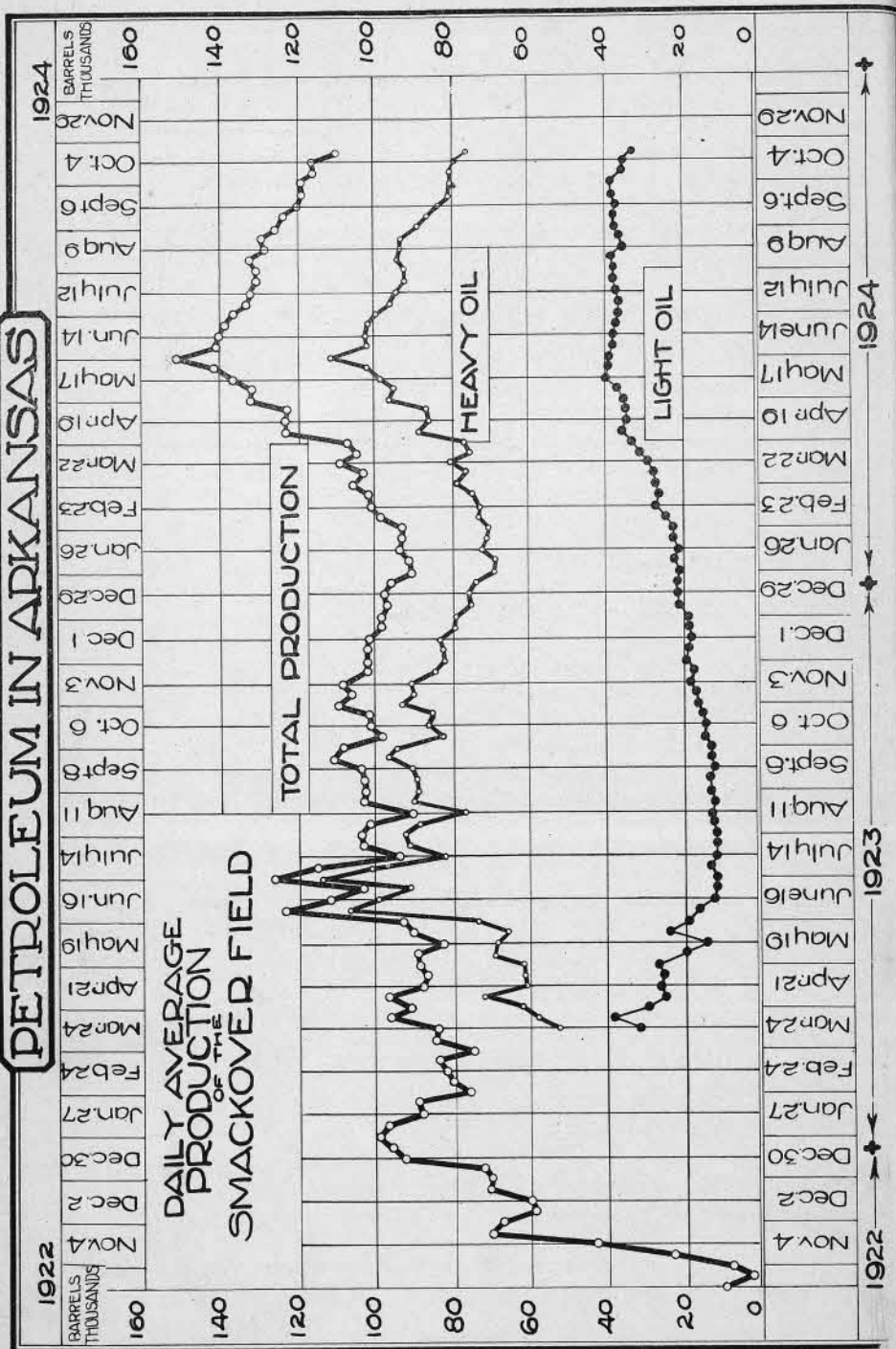
How Many Wells Have Been Drilled in the Producing Areas of Southern Arkansas?

They have been estimated at 2900 wells. By far the larger proportion of these have been drilled in the Smackover area.

What Is Meant by the Gravity of Oil?

By the gravity of oil is meant weight of the oil per cubic unit. Usually the more gasoline, naphtha and kerosene which an oil contains the lighter the oil, and the more gas oil, lubricating oil, paraffine or asphalt the oil contains the heavier it is. The usual index to the gravity or weight of oil is called the Baumé system, and is based on a constant relation to specific gravity at 60° F.

PETROLEUM IN ARKANSAS



Where Are the Producing Oil Fields of Arkansas Located?

In southwestern Arkansas; in Union, Ouachita, Columbia and Nevada counties. Union county contains the El Dorado, East El Dorado and Southern Smackover fields. Ouachita county contains the Northern Smackover area, and the eastern part of the Stephens field. The Irma, or Rosston field, is in Nevada county.

How Much Oil Do They Produce?

At present a total of about 123,000 barrels per day. The aggregate maximum production was 167,600 barrels per day during the week ending May 31st, 1924. The fields at the present (week ending October 25th) are producing as follows in average barrels per day.

Smackover	117,600
El Dorado	11,700
Stephens	2,250
Nevada County	1,400

What Is the Quality of Oil Produced?

Smackover oil varies from 18 to 28 degrees Baumé gravity. The El Dorado gravity varies from 19 to 42; Stephens from about 23 to 31, and the Nevada County oil varies from about 14.5 to 18. The gasoline content of these oils varies less than 1% to over 30%.

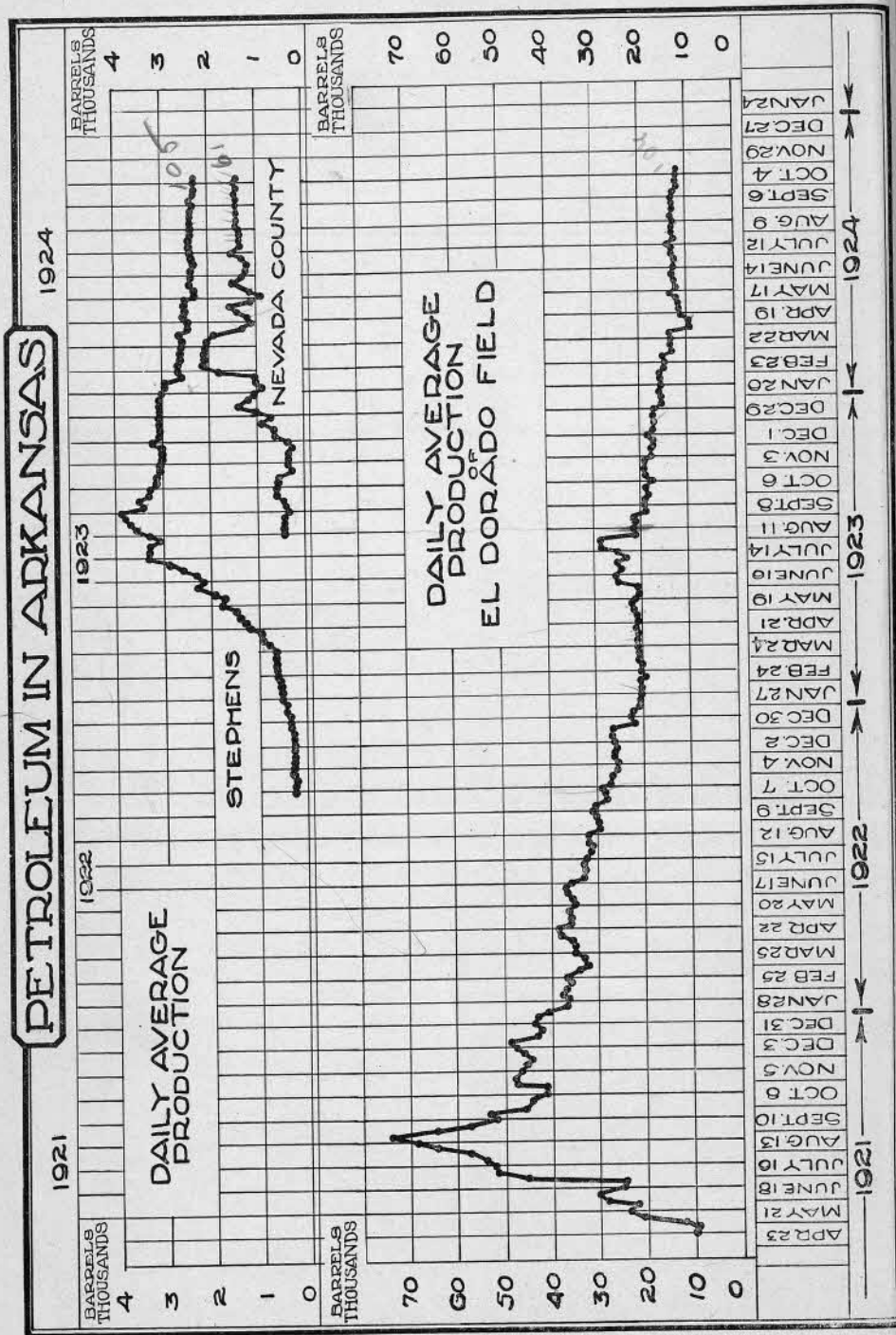
What Is the Producing Area in the Different Oil Fields?

The Smackover field has a producing area of about 33 square miles; the El Dorado and East El Dorado fields about 15 square miles; the Stephens field about 6 square miles; and the Irma field about 2 square miles. This is a total of 56 square miles.

In comparing the size of this developed area with the portion of the Coastal Plain beds which are most likely to produce oil, which embraces from 8,000 to 10,000 square miles, it seems reasonable to believe that oil fields will be discovered from time to time in Arkansas for many years to come, and that the oil production of the State will be kept up by the discovery of new fields.

What Are the Formations Which Produce the Oil in Arkansas?

Three sands have been found to be productive. These are known as the Nacatoch Sand, which is the principal producer; a sand at the base of the Marlbrook formation often referred to as the Meakin Sand; and the Blossom Oil Sand which is the top of the Bingen formation.



The sands which are now productive in Arkansas are all found in the upper Cretaceous system of beds.

At El Dorado and East El Dorado the principal producing sands are in the Nacatoch formation. The chief producing sand is encountered at about 2,150 feet. One well is producing from the Blossom sand in that area at about 2,900 feet. This is at the top of the Bingen formation. The main Nacatoch producing sand averages about ten feet in thickness.

In Smackover there are three producing horizons known as the Nacatoch, Marlbrook or Meakin, and the Blossom. The Nacatoch producing horizon is encountered at from about 1,920 feet to 2,050 feet. This has a thickness of about 150 feet, but is not all productive. This is the principal oil producing horizon. The Meakin, or Lower Marlbrook, occurs about 360 feet below the top of the Nacatoch at from about 2,280 to 2,410 feet. This produces some of the oil and the major portion of the gas. It has a thickness of from about 15 to 20 feet. The Blossom sand produces some oil, and is encountered at about 2,540 to 2,670 feet. Seven wells are now producing oil from this horizon. The thickness of the sand is about 10 feet.

In the Stephens field the Blossom sand is productive and is encountered at about 2,150 feet. It has a thickness of less than five feet.

The Irma field derives its oil from the Nacatoch formation at about 1,225 feet. The sand is from 20 to 25 feet in thickness.

COAL

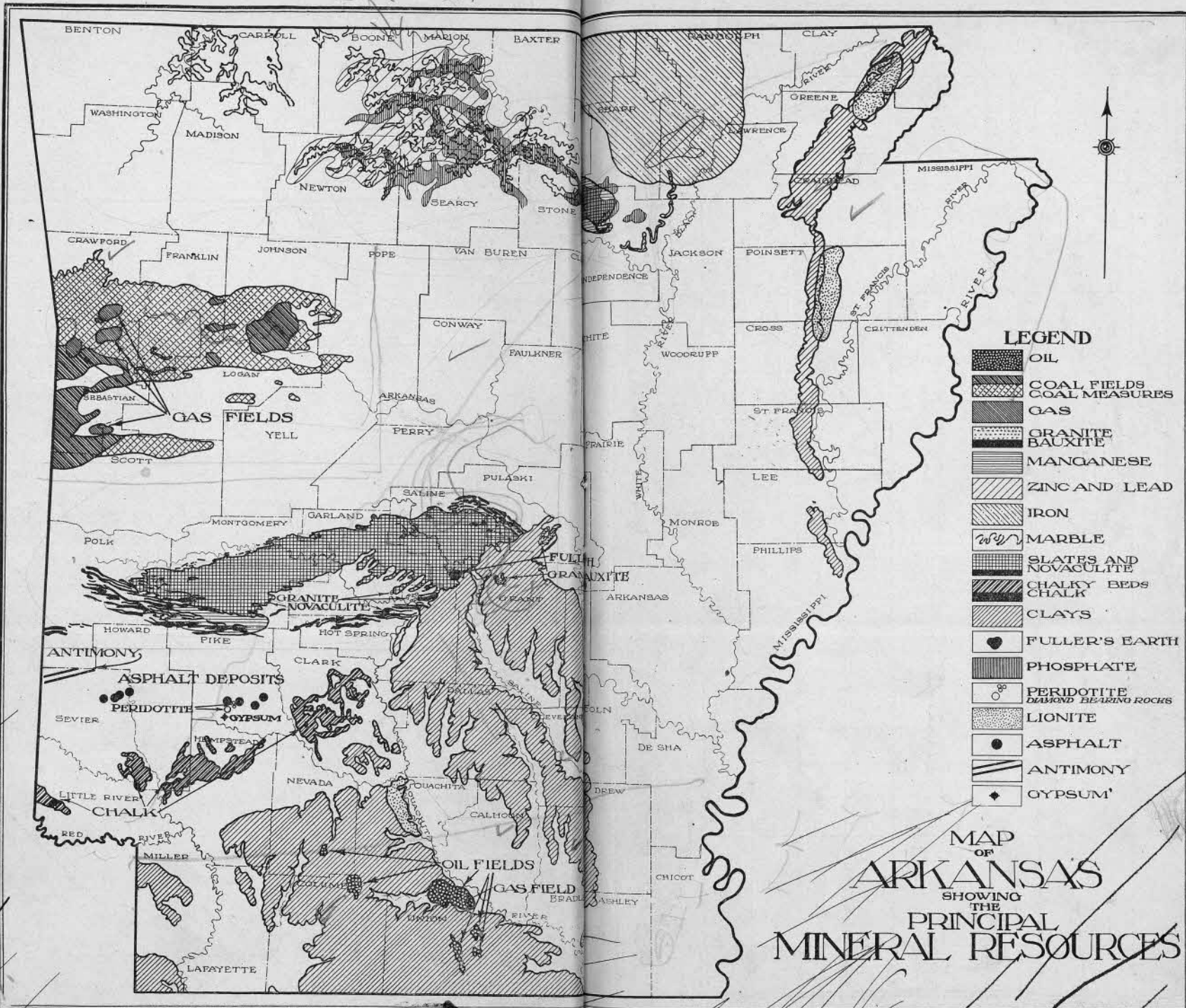
Where Is the Coal-Producing Area of Arkansas?

Sebastian, Scott, Franklin, Logan, Johnson and Pope counties. The coal fields extend eastward from Ft. Smith for about 80 miles, following roughly the course of the Arkansas river. From Ft. Smith they also stretch southward in a comparatively narrow belt for about 36 miles. The entire field is somewhat L-shaped and includes an area in which the beds are of workable thickness of 1620 square miles. The coal does not, however, underlie the whole area of any one of the counties named. The rocks with which the coal is associated are often folded and the tops of the folds in many cases have been washed away, leaving only the beds which do not contain the coal exposed at the surface. The barren area in Sebastian County between Greenwood and Jenson is due to this cause.

Sebastian County produces approximately 49% of the coal mined at the present; Franklin 20% Johnson 15% and Logan 10%; the remaining 6% being mined outside of these counties.

What Kind of Coal Is Produced in Arkansas?

It is classed as bituminous, semi-bituminous and semi-anthracitic. About 15% of the coal produced is semi-anthracitic.

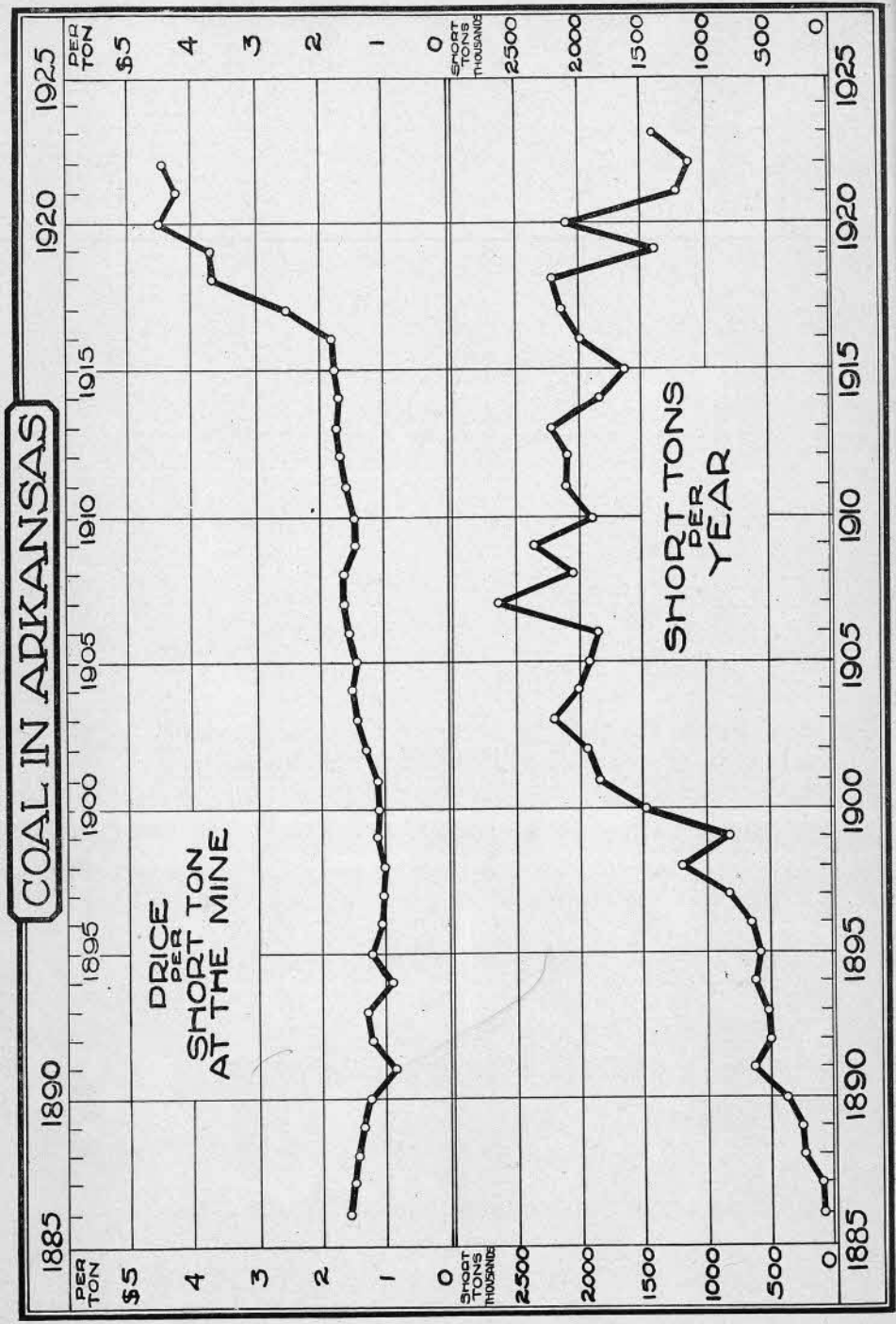


MAP
OF
ARKANSAS
SHOWING
THE
PRINCIPAL
MINERAL RESOURCES

- LEGEND**
- OIL
 - COAL FIELDS
 - COAL MEASURES
 - GAS
 - GRANITE
 - BAUXITE
 - MANGANESE
 - ZINC AND LEAD
 - IRON
 - MARBLE
 - SLATES AND NOVACULITE
 - CHALKY BEDS
 - CHALK
 - CLAYS
 - FULLER'S EARTH
 - PHOSPHATE
 - PERIDOTITE
 - DIAMOND-BEARING ROCKS
 - LIONITE
 - ASPHALT
 - ANTIMONY
 - GYPSUM

43700

43700



The semi-anthracitic coal comes almost entirely from the eastern part of the Arkansas coal field, in Pope and Johnson Counties.

It is usual to classify coals according to the ratio of fixed carbon in the coal to the volatile matter. In the Arkansas coals the ratio varies from about two and one-half to nine. The western coal area coals average about five, the eastern from seven to nine.

What Is the Heating Value of Arkansas Coal?

The heating value of coal is estimated on a heat unit known as the B. T. U.—British Thermal Unit. The Arkansas coal varies from approximately 13,200 to about 14,700, indicating a good heating value.

How Many Mines Are in Operation in the State?

About 80. Of these, 15 are strip-mines.

What Are the Geologic Formations in Which the Coal Is Found?

It is all found in the Pennsylvanian beds of the Carboniferous Age. The formations in which it occurs are known as the Savannah formation, Paris Shale, Fort Smith formation, Spadra Shale, Hartshorne Sandstone and Atoka formation.

How Many Short Tons of Coal Were Produced in Arkansas in 1922, and What Was the Value?

1,110,046 short tons valued at \$4,592,000. From the standpoint of value of mineral product, coal is second in importance in Arkansas.

The maximum production of Arkansas coals came in 1907, when 2,670,438 short tons were mined, having a value of \$4,473,693.

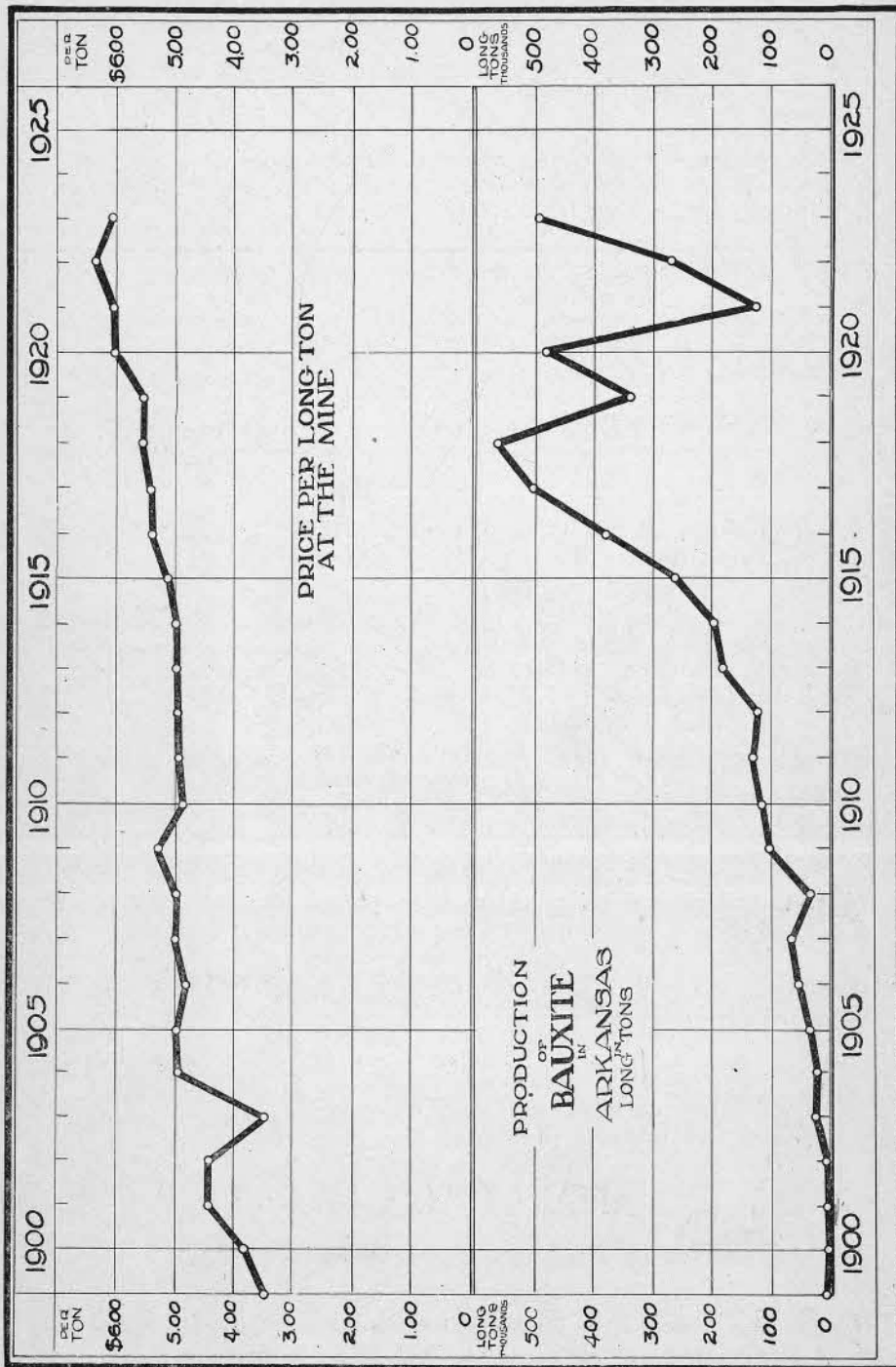
Is There Much Undeveloped Coal Land in the State?

Yes, there are undoubtedly large areas awaiting exploration. The coal area has only been partially surveyed geologically, and it is probable that a completion of this survey would bring to light new coal areas.

NATURAL GAS

What Counties in Arkansas Produce Natural Gas?

Crawford, Sebastian, Scott, Ouachita and Union counties. Crawford county contains the Kibler and Alma fields; Sebastian the Massard Prairie and part of the Mansfield field; Scott county contains part of the Mansfield field. The Smackover field is located partly in



Union and partly in Ouachita counties; the El Dorado and East El Dorado fields are located in Union county.

What Is the Production of These Fields?

No figures are available for the separate production of the Kibler, Alma, Massard Prairie and Mansfield fields. Their maximum record production was in 1920, 9,027,000 M. Cu. Ft., at a value of \$1,906,900. This is a daily average for the year of about 24,731,000 cubic feet.

The east part of the Smackover field has enormously increased the production of natural gas in the State. November 1, 1924, there were 47 producing gas wells in the East Smackover field, having an average production of about 32,000,000 cubic feet per day. Their total daily production is 1,506,000,000 cubic feet. There is undoubtedly a vast quantity of gas yet to be obtained and utilized from the Ouachita and Union county area.

Is There Any Geologic Difference Between the Gas Fields in the Northwestern Part of the State and Those of the Southwestern Part?

Yes, there is a decided difference. The Crawford, Sebastian and Scott county fields derive their supply from Paleozoic rocks known as those of the Pennsylvania system. They are folded into well defined structures and the gas fields follow these structures fairly well. The gas which has been discovered in Ouachita and Union counties is undoubtedly in a much larger quantity than that in the northwestern part of the State, although at the present time only a very small portion of the available gas is being used. This all comes from the eastern portion of the Smackover field and comes from the Upper Cretaceous beds. The surface of this field is comparatively flat and there are no well defined ridges or structures such as are found in the northwestern part of the State.

BAUXITE

map

What Is Bauxite?

It is probably not a definite mineral, but a mixture of oxides of aluminum and hydroxides of iron with hydrous aluminum silicate.

What Are the Uses of Bauxite?

Bauxite is the only commercial source of aluminum. It is also used in the chemical trades, in the manufacture of fire brick, and in the manufacture of such of artificial abrasives as are derived from the dehydration of the hydrated aluminum oxide.

Where Is Bauxite Found in Arkansas?

Up to the present time commercial deposits have been confined to Pulaski and Saline Counties. The bauxite in those counties has been

derived from intrusions of syenite or "granite." As has been stated, syenite is very similar to a granite, except that the percentage of quartz in it is very much lower. It is assumed that steam and hot water acted on the syenite rock and changed portions of it into bauxite masses. These syenites occupy an area of about 13 square miles in Pulaski and Saline Counties, and the bauxite is found over and around the edges of these masses of rock.

How Many Companies in Arkansas Are Engaged in the Mining of Bauxite?

Five. Four of these are reported from Saline County, and one from Pulaski.

What Is the Commercial Value of Bauxite?

The average price is about \$5.50 per ton for crushed and dried bauxite. Bauxite is sold wet, dried and calcined, the price being dependent upon the manner in which it is prepared for shipment, and also the quality of bauxite.

Is the Bauxite of Arkansas Necessarily Limited to Saline and Pulaski Counties?

It is not impossible that bauxite may be found either in the Paleozoic area of Arkansas or in the Coastal Plain area unassociated with syenite. Bauxite deposits found near Rome, Ga., and those found in Tennessee, are both derived from Paleozoic rocks. Deposits in Wilkinson County, Ga., occur in Coastal Plain beds not associated with igneous rocks. It would be, however, difficult to suggest where these deposits might be found in Arkansas not associated with syenite.

What Is the Present Output?

In 1923 the production was 495,117 long tons valued at approximately \$2,995,457.

What Has Been the Maximum Production of Arkansas?

The maximum recorded was in 1918 when 567,892 long tons were mined at an estimated value of \$3,162,054. It is interesting to note that although the bauxite industry in Arkansas is rated as fourth in value of annual product, it ranks second in the amount of mineral severance tax paid to the State.

MANGANESE

mip

What Is Manganese?

Manganese is a metallic element which has about the same specific gravity as iron.

What Is It Used For?

Metallic manganese is used principally as an alloy with other metals.

Spiegeleisen, an alloy of iron and manganese contains under 20% manganese, and ferro manganese has from 20 to 90%. Other alloys are with bronze, copper, aluminum, zinc, tin, lead, magnesium and silicon.

Manganese oxide is used widely in the chemical trades, as a coloring agent in cloth printing and dyeing, making of pottery, bricks, and paint, and in the manufacture of dry cells.

Manganese is found in several localities in the State, by far the most important of which is the area known as the Batesville area of about 100 square miles, located in northwest Independence County, Southeast Izard County, and Northeast Stone County. Other localities of less importance are in Pulaski, Saline, Garland, Hot Springs, Montgomery, Pike and Polk Counties. These last mentioned localities are known as the West Central Arkansas district. There have been as many as 100 manganese mines in operation in the Independence district, and five have been reported in the Montgomery, Pike and Polk County district. In addition to these, there have been over 100 prospects in the Batesville area, and nearly an equal number in the West Central Arkansas district.

What Ores of Manganese Have Been Found?

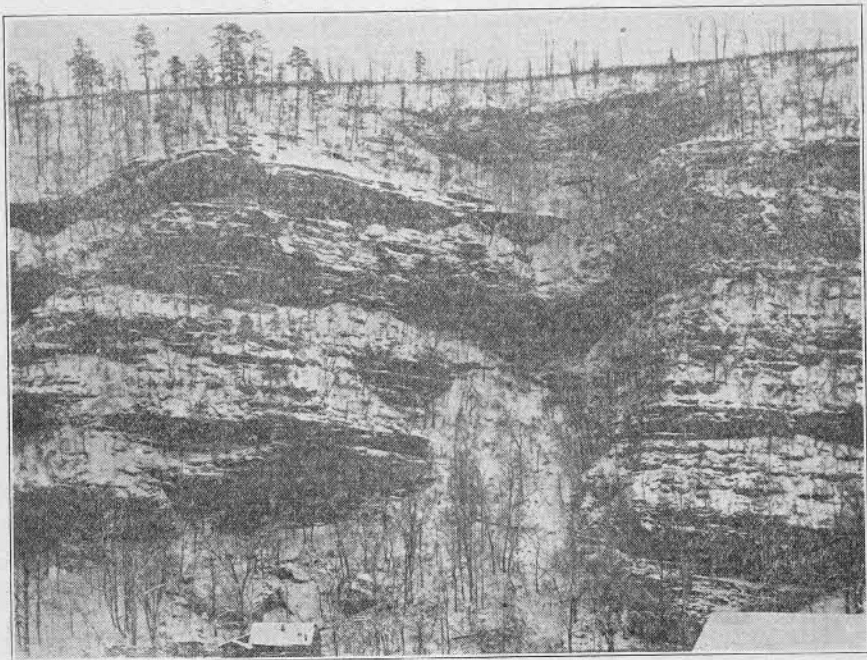
Principally oxides of manganese known as psilomelane, braunite, hausmanite, pyrolusite and wad. Of these, the first three are the most commonly encountered. These ores generally contain from 45 to 52% of manganese and sometimes rise to slightly over 60%.

What Is the Character of the Manganese Deposits?

In the Batesville district the manganese ores are found in irregular fragments and nodules which have probably been concentrated from the Cason shale formation of Ordovician age. These lumps of ore are found in pockets scattered through a red clay. Both the clay and the manganese ore nodules are probably residual products of the decomposition of the Cason shale. The West Central Arkansas ores are found in pockets scattered through the Arkansas novaculite formations of probably Devonian age. The West Central Arkansas deposits, however, although containing large amounts of ore are not sufficiently concentrated to permit profitable mining during normal prices of manganese. Probably not more than 500 tons altogether of manganese ore have been shipped from the West Central Arkansas district. The mines at the Batesville district during 1923 produced 3,768 tons of ore. At the present approximately two car loads a day are being shipped from this district. The present price is between 55 and 60 cents for each percent of manganese in an ore containing 40% or more of manganese and 50 to 55 cents for each percent of manganese in an ore containing 35 to 40% manganese.

What Has Been the Maximum Output of Manganese Ore in Arkansas?

In 1917 there was reported as having been mined in the State 10,140 long tons, valued at \$448,511.



Zinc Mines, Silver Hollow Bluff on Buffalo River, Marion County

ZINC

Is Zinc Ore Found in Arkansas?

In the north central part of the State. The principal discovered area at the present time embraces Boone, Marion, Newton and Searcy Counties. The ore occurs in rocks of Lower Carboniferous and Ordovician age.

What Kind of Ore Is Mined?

The zinc ore occurs in four forms—the sulphide of zinc or sphalerite, carbonate of zinc or smithsonite, silicate of zinc or calamine and oxide of zinc or zincite. The sulphide is the most importance of the group.

How Does It Occur in the Rocks?

Zinc ore occurs as bedded deposits, vein and fracture deposits, in portions of rock which have been partially crushed and reconsolidated, known as breccia deposits, and as alteration products.

What Has Been the Maximum Output of Zinc Ore in This State?

6,815 tons of concentrated ore were produced in 1916, which had a value of \$1,826,420. The greatest number of zinc mines reported in operation was in 1917 when 73 shippers were reported.

What Is the Present Condition in the Zinc Mining Industry?

There is very little activity owing to over production during the war, which resulted until very recently in abnormally low prices for the metal. The industry, however, is reviving at the present time.

The present price of zinc is approximately \$46.00 per ton for sulphide concentrates on a 60% basis. That is, the price is \$46.00 a ton and \$1.00 a ton more for each percentage of metallic zinc in the ore over 60%.

LEAD

Where Is Lead Found in Arkansas?

In the north central part of the State, and usually closely associated with zinc and as in the case of zinc, the principal producing area at the present time embraces Boone, Marion, Newton and Searcy Counties.

Lead ore occurs almost entirely in one form—the sulphide of lead or galena. It occurs in the same manner in which zinc occurs, as bedded deposits, vein and fracture deposits, and as breccia deposits.

The maximum output of lead recorded was in 1917 when 382 short tons of concentrated ore were mined at a value of \$65,704.00. The greatest number of exclusively lead mines in operation was in 1917 when eight shippers of lead were listed. Twenty-four zinc and lead mines were listed in 1900. Owing to the present high price of the metal the lead industry will probably revive rapidly within a comparatively short time, although there were no lead mines reported in operation in 1923.

What Is the Present Price of Lead Ore?

Approximately \$120.00 per ton is being paid for lead sulphide concentrates on an 80% basis. That is, \$120.00 is paid for each ton of lead sulphide concentrate containing 80% metallic lead and \$1.00 more per ton for each percentage over that.

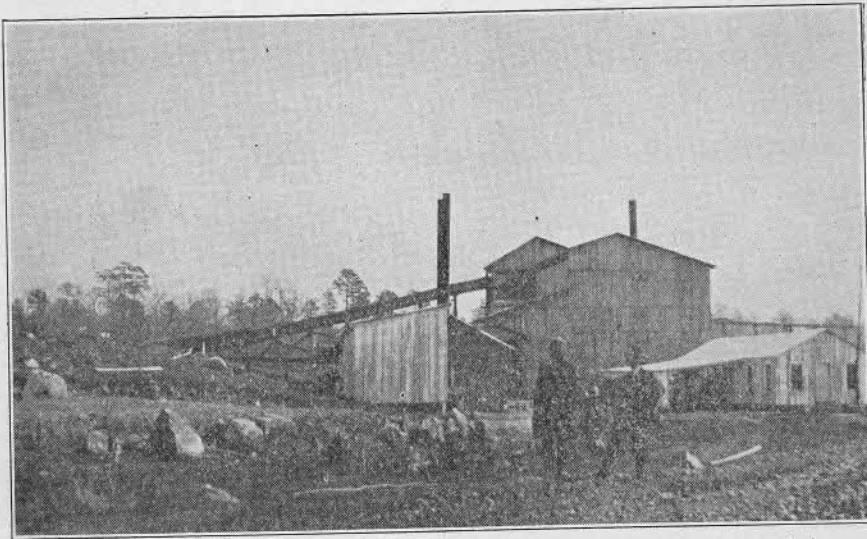
DIAMONDS

Does Arkansas Produce Any Precious Stones?

The only diamond mine on the North American Continent is located near the town of Murfreesboro, in Pike county, Arkansas.

What Are the Dimensions and Characteristics of the Diamond Producing Area?

The field does not exceed a total of one square mile, and the diamonds are found in rocks known geologically as intrusive peridotite, or kimberlite. In all probability the igneous material in which the diamonds are found forced its way up through the overlying Paleozoic and lower Cretaceous rocks following what must have been violent explosions which shattered the surrounding rocks and brought deep-seated sedimentary rocks to the surface.



Reduction Plant, Arkansas Diamond Corporation, Murfreesboro, Ark.

What Kinds of Diamonds Are Found Here?

Most of them are white, brown or yellow in color, and a well known gem expert declares that certain of them are absolutely perfect and equal to the finest stones found at the Jagerfontein mine in South Africa and to those ever found in India.

What Has Been the Output of Diamonds in this State?

Incomplete records indicate that from 1905 to 1922 at least 5,300 stones have been found. For the nine months from April to December, 1923, the State tax records show that 1,313.35 carats, valued at \$6,266.75, were extracted by the single firm now operating in Pike county, the individual diamonds varying in weight from a fraction of a carat to 40.23 carats.

Are Diamonds Likely to Be Found in Other Parts of the State?

Possibly so, as intrusions of peridotite have been discovered in some other counties.

NOVACULITE *map* ✓

What Is Novaculite?

A very fine grained sedimentary rock usually containing over 99 per cent silica. It is commonly known in the form of whetstones, which are called Ouachita Stones, Arkansas Stones or Pike Whetstones.

Are There Beds of Novaculite in Arkansas?

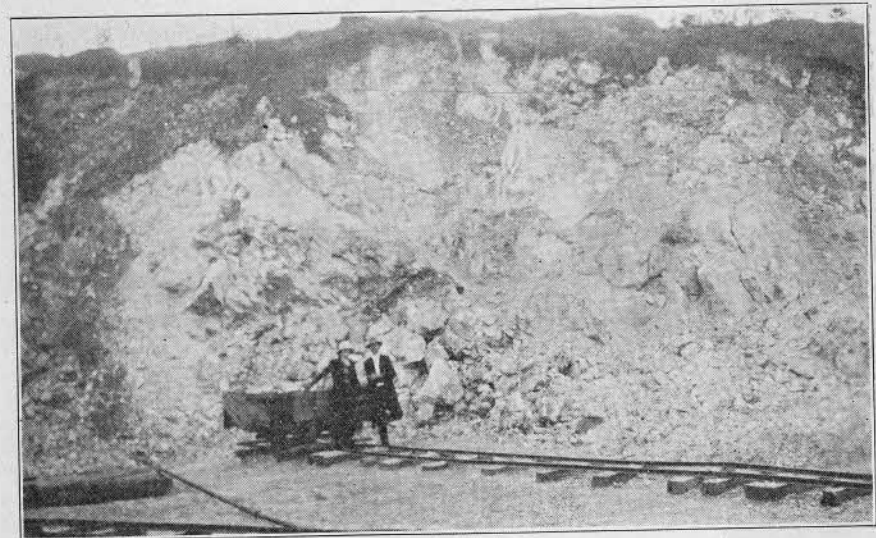
Yes, it is found in quantities in steeply sloping beds making up the borders of the Ouachita Mountain system.

For What Is Novaculite Used?

It is used extensively in the manufacture of oilstones and whetstones, while in crushed form it makes a very fine railroad ballast.

What Is the Value of the Annual Output?

In 1919 349 short tons were mined, having a value of \$126,408. The present output is used principally for railroad ballast.



Novaculite Quarry, Butterfield, Hot Spring County

MARBLE *map*

Is Marble Found in Arkansas?

Outcrops of marble occur along the southern flanks of the Ozark Plateau in the north and northwest part of the State.

What Is the Extent of the Deposits?

The quantity is almost unlimited. Outcrops can be traced for over 2,000 miles. The beds are workable and usually vary from 25 to 50 feet in thickness, attaining a maximum thickness of 155 feet.

What Is the Character of This Marble?

It is red, pink, gray, black and yellow in color, and possesses excellent structural qualities.

To What Extent Is It Being Worked?

It is being quarried on a limited scale only.

GRANITE**Is There Any Granite in Arkansas?**

Yes, granites are exposed for areas which total about 13 square miles in Pulaski, Saline, Hot Springs and Garland counties.

What Is the Character of This Granite?

It is not technically a granite, but is a syenite which possesses exceptional structural strength and weather-resisting qualities. It has great value for building and paving purposes. There are two types of granite in use, the blue granite and the gray granite. The blue is known as Pulaskite; the gray, as Fourchite.

What Is Syenite?

Syenite is much like granite except that it contains very little quartz. Granite grades into syenite by the reduction of the percentage of quartz it contains.

Is This Granite Being Quarried?

Granite for building purposes is now quarried in two places at Fourche Mountain, one mile south of Little Rock.

SANDSTONE**Where Is Sandstone Found in Arkansas?**

There are enormous quantities of sandstone to be found in the Paleozoic area of northern Arkansas. Sandstone is found in the Ozark, Boston and Ouachita Mountains and also in the Mississippian and Pennsylvanian rocks of the Arkansas Valley. They constitute one of the State's very valuable mineral assets. In 1920 it was estimated that 643,000 short tons of this stone was quarried in Arkansas with a value of \$908,969. It is used for building, riprap, as a concrete aggregate, for road building and as railroad ballast. Twenty-four quarries have been reported from eleven counties in the State. Crushed quartzite, which is a hardened variety of sandstone, is quarried at Big Rock in Pulaski County. The capacity of the plant is about 2000 tons per day. The rock is shipped to various points in the South.

FULLER'S EARTH**What Is Fullers' Earth?**

Fuller's Earth is a non-plastic clay or earth. It is principally a hydrous aluminum silicate, and has a variable chemical composition. It contains magnesium, iron, lime and usually a little potash and soda. It is also usually characterized by relatively high percentage of combined water.

What Is Fullers' Earth Used For?

It is principally used on account of its high absorbent power for certain substances and is used to decolorize and clarify mineral, vegetable and animal oils, fats and soaps. It is also used in small quantities in the manufacture of certain toilet preparations and in certain drugs. It is used to some extent as a water softener.

How Is the Quality and Value of Fullers' Earth Determined?

By practical test, the object of the test being to determine the cost and effectiveness of its clarifying power. Fullers' Earth is more frequently used ground to a size between 14 and 60 mesh as it is found that at that size it possesses the highest absorbent power. In preparing Fullers' Earth for the market it is pulverized, dried, sifted and sacked.

Where Are the Fullers' Earth Deposits in Arkansas?

At Olsen, Saline County, a very superior grade of earth is obtained. It is derived from a decomposed igneous dike, and it is used to clarify edible oils. The plant is not being operated at the present time due to the cost of mining the earth.

Fullers' earth has been reported as occurring in several localities in the State, particularly in Ouachita and Pike Counties. These deposits have never been developed.

Where Are the Fullers' Earth Deposits of the United States?

They are in Florida, Georgia, Texas, California, Illinois, Pennsylvania, Alabama and Massachusetts.

What Is the Market Value of Fullers' Earth?

The Florida Earth in 1924 is sold for from \$16.50 to \$18.00 per ton according to the mesh.

What Has Been the Maximum Annual Value of Fullers' Earth Produced in Arkansas?

The 1906 production of approximately 4,600 tons was valued at \$46,599.00.

ASPHALT

Are There Any Asphalt Deposits in Arkansas?

There are seven known deposits in Sevier and Little River Counties. These are distributed along the northern edge of the Lower Cretaceous series of Coastal Plain beds in a general east-west direction. The asphalt occurs in the base of the Lower Cretaceous beds, and may possibly have originated in the Lower Carboniferous beds on which they rest. That is, petroleum may have come from up in the Paleozoic beds and saturated the sand of the Lower Cretaceous beds which rest upon them. The quantity of asphalt available has never been accurately determined.

What Are the Characteristics of These Deposits?

There are sand, sandstone and sandy limestone beds which are partially or completely saturated with bitumen.

What Is Bitumen?

Bitumen is a general term which includes petroleum, native mineral waxes, native asphalts, asphaltites or certain asphaltic minerals. Four samples of Arkansas asphalt contained from approximately 4½ to 16½ per cent bitumen.

Have These Beds Been Developed?

Approximately 4,815 tons were mined in 1906 at the deposit near Pike, Pike County. Owing to the fact that the asphaltic sand did not receive entirely proper treatment, some of the pavement which was made from it did not prove satisfactory. Some of the asphalt is suitable for laying cold, while some needs to have bitumen added in order to make it suitable for paving. It is possible that due to the variation in the bitumen contents of the sand, and also to the fact that the shipment of the lime and sand is a considerable item of expense, that the deposits could best be worked by extracting the pure bitumen and shipping it to the point where it is expected to be used, and mixed with locally secured sand and ground limestone at such points.

At the present time approximately 75% of the asphalt used in Arkansas is derived from crude oil residues, and approximately 25% from Lake Trinidad asphalt. It is entirely reasonable to suppose that if the Arkansas product were properly and economically handled developments could be placed on a paying basis.

LIGNITE

What Is Lignite?

Lignite is sometimes called brown coal, and represents a stage in the formation of coal between peat and sub-bituminous coal.

Is Lignite Found in Arkansas?

Lignite is found in many localities in the Coastal Plain region of Eastern, Southeastern and Southern Arkansas. The best known bed

is in Ouachita county northwest of Camden. Other deposits of workable thickness are found in Southwestern and Southern Bradley counties, Central Poinsett county and Eastern Clay county. The bed in Ouachita county occupies an area of about 60 square miles, which is underlain by lignite usually from two to three and one-half feet in thickness. There are known to be at least 75,000,000 tons of lignite available in the Ouachita County field.

What Are the Uses of Lignite?

On account of the fact that Arkansas lignite contains between 30 or 40 per cent by weight of water it can not be used as a fuel, unless it is first dried. Upon drying it usually falls to pieces. Used as a fuel it is usually dried, pulverized and mixed with some bituminous substance and made into briquettes. This makes an excellent fuel which, however, only has about 75% of the heating value of bituminous coals. It has been reported that under test Arkansas lignites have distilled 38 gallons of lignite oil to the ton, and illuminating gas of 11,386 candle power.

CHALK

What Is Chalk?

Chalk is a fine white earthy limestone composed chiefly of the remains of minute sea animals, called foraminifera.

What Are the Uses of Chalk?

It is used in the manufacture of burnt or unburnt lime products, in the manufacture of Portland Cement and plaster, in the manufacture of fire brick, chemicals, soap, bone-ash, artificial gas, paper, pottery, glazes, disinfectants, polishing material, egg preservatives, tanning materials and material for the dehydration of alcohol. It is also used as a fertilizer on acid soils. Of the above uses, the most important are Portland Cement and plaster.

Are There Any Chalk Deposits in Arkansas?

There are immense beds of chalk in Little River and Sevier counties. At White Cliffs Landing in Sevier county it is estimated that 150,000,000 tons of chalk are available. These deposits average from 75 to 93 per cent calcium carbonate. There is an exposure of these beds 135 feet in thickness. The actual thickness, however, is probably considerably greater. The area at White Cliffs covers approximately 600 acres. The area at Rocky Comfort in Little River county has an exposed area of about 1500 acres, and an exposed thickness of at least 50 feet. The chalk is probably between 400 and 500 feet in thickness.

ANTIMONY

Has Antimony Been Mined in Arkansas?

Yes, antimony has been mined from vein deposits in northwestern Sevier county near Gilham. The antimony occurs as antimony,

sulphide, or stibnite, and is associated with small amounts of copper, iron, zinc and bismuth sulphides. The ore occurs in folded Paleozoic shales and sandstones and probably originated from the circulation of underground waters dissolving the antimony sulphide from volcanic rocks and precipitating and concentrating it above them. The mines have been worked from time to time since about 1873. They have not been worked of late years as the price of antimony has not permitted their being operated at a profit.

What Is Antimony Used For?

Metallic antimony is used principally in the making of alloys. These are used for the making of type metal, pewter, Britannia metal. Antimony sulphide is used to some extent in rubber manufacturing.

SLATE

What Is Slate?

Slate is almost always a sedimentary rock which has been formed from shale due to pressure extending over very long periods of time. It was originally laid down as mud or clay on the bottom of ancient seas.

What Is Slate Used For?

It is used principally for roofing, but it is also used for switchboards, mantles, billiard table-tops, floor tile, steps, flagging, slate pencils, acid towers, washtubs, etc.

Where Are the Slate Deposits of Arkansas?

They are distributed along the central portion of the Ouachita Mountain region which extends near Little Rock westward to near Mena. This area includes approximately 1,300 square miles.

Do Arkansas Slates Possess Any Commercial Value?

They are of workable quality, occur in various shades of green, gray, red, and can doubtless be mined profitably, although at the present time there is very little activity in the slate mining industry.

CLAY

What Is Clay?

Clay may be defined as an earthy substance which contains hydrous aluminum silicates and small amounts of other minerals in the form of oxides, carbonates, silicates, etc. It is usually plastic when wet and becomes hard when dried.

What Are Its Uses?

Clay is used for building, paving, fire brick, drain pipes, tile, the making of pottery, etc.

Are There Clay Deposits in Arkansas?

There are numerous clay deposits in this State. The finer types, or kaolins are suitable for manufacturing pottery and are found in general in the Tertiary Coastal Plain area south of the Arkansas River, and southeast of the Missouri Pacific railroad, although the coarser clays are to be found there in abundance also. Other clay deposits are to be found along the Arkansas River west of Pulaski County in White, Cleburne, Faulkner and Van Buren Counties. These latter deposits may be used for building, paving and fire bricks, drain pipes and tile.

All of the clay deposits in the State are practically undeveloped. It is apparent that the quantity and quality of the clays in Arkansas are all that could be expected, and since there is plenty of cheap fuel at hand, transportation facilities are good, and loss of the clay products due to freezing is almost eliminated due to the moderate climate, there seems to be no reason why the clay industry in Arkansas should not be successfully developed.

GYPSUM

What Is Gypsum?

Gypsum is a hydrated calcium sulphate. Most beds of this substance have probably been formed by the evaporation of salt water in inland seas or arms of the sea.

Is Gypsum Found in Arkansas?

Gypsum is found both in Pike and Howard counties. The gypsum occurs in beds in formations of Lower Cretaceous age. The principal outcrop is found near Plaster Bluff on the Little Missouri River southwest of Murfreesboro. The bed there is about 10 feet thick and contains pure gypsum of the granular type, much resembling loaf sugar. A few seams of satin spar gypsum are also found. This resembles compact white silk fibre.

What Is Gypsum Used For?

Gypsum is sold in a ground condition either uncalcined or calcined. The uncalcined gypsum is used for fertilizer purposes and is known as land plaster. It is also used as a retarder for Portland Cement, for the insulation of steam pipe covering, as a food adulterant, and also to a limited extent in the manufacture of paint. The calcined gypsum when in a comparatively pure condition is known as Plaster of Paris and is used for wall plastering, white-wash, stucco, statuary, etc. It is being used also as a body for certain brands of wall board.

Has Gypsum Ever Been Mined in Arkansas?

Yes, to a very limited extent. A few car loads of gypsum have been shipped from Plaster Bluff, but there is no mining at the present

time. The extent of the gypsum deposits in Pike county cover at least 100 acres. In Howard county near Locksburg beds of gypsum somewhat thinner outcrop. Gypsum has been reported as occurring in Drew county. The gypsum found there is in crystalline form known as selenite. The value of this deposit is yet to be determined.

FERTILIZERS

What Is Plant Fertilizer?

There are certain substances which are essential to plant life, and where any of these substances are entirely absent, plants can not grow. These are commonly known as phosphates, nitrogenous substances and potash. The phosphates enter primarily into the growth of the seed or fruit of the plant, and the nitrogenous substances and potash enter more particularly into the body of the plant.

Are Natural or Rock Fertilizers Found in Arkansas?

Phosphates are found in three general localities, the principal one being Northern Independence County. They are also found in river courses in Stone, Searcy, Marion, Newton and Boone Counties. Scattered deposits have been found in the southwest part of the State and also north and west of Hot Springs. They are not, however, being utilized at the present time. Phosphates were at one time quite extensively mined near the junction of East and West Lafferty Creek, Independence County, twelve miles northwest of Batesville. 50,000 tons were taken out, both by tunneling and stripping.

Potash is found in the greensands of Southwest Arkansas. The sand is also known as glauconitic sand on account of its containing the potash mineral glauconite. This greensand is found along the Little River and in Little River County near Morris Ferry in large quantities, and in the vicinity of Washington, Hempstead County. It contains from three to four per cent soluble potassium oxide, or potash. This solubility makes it available directly as food for plants.

Two other minerals which are extensively used for treating the soil are gypsum and marl. As described, gypsum occurs in Pike and Howard Counties in ample amounts for agricultural use. The agricultural marls, or limy clays, are widely distributed in the Cretaceous region in southwest Arkansas, and are distributed over an area of 400 square miles in Clark, Nevada, Pike, Hempstead, Howard, Sevier and Little River Counties. Their use would add enormous values to the lime impoverished soils of the State.

OCHRE

What Is Ochre?

Ochre is an earthy form of the minerals, hematite and limonite, which are oxide and hydroxide of iron. It is found in a variety

of colors from a dark red to a brown and yellow. It is used principally as a paint pigment. Uniformity of tint is the principal requirement for commercial use.

Are There Ochre Deposits in Arkansas?

There have been several ochre deposits found in the State, principally in Garland, Drew and Pulaski Counties. Brown ochre is found in many parts of the State, but it is of an impure quality. The ochre deposits have not yet been developed.

MINERAL WATERS

What Mineral Waters Has Arkansas?

Arkansas is well known for its mineral waters. In 1923, 248,460 gallons of mineral waters were sold for \$28,866.00. The State has an abundance of springs. Hundreds of flowing springs of variable qualities are to be found in the northwest half of the State through the Paleozoic area. The waters of Hot Springs claim primary place as a water of medicinal value in the State. The waters are decidedly radio active. There are 44 hot springs flowing over a million gallons per day. The average temperature of the water is 135° F. Twenty-four bath houses are operated which are connected with the hot springs and regulated through the Federal Government.

ROAD MATERIALS

Has Arkansas Material for Improving Its Highways?

Excellent road materials are widely distributed in Arkansas. In the Paleozoic region in the north part of the State are extensive beds of chert, which is a fragmentary quartz and makes a very resistant road metal. In the Ouachita Mountain District crushed novaculite is often used for roads. This is practically pure quartz, and when crushed makes an excellent road bed. The gravels of the Coastal Plain area are very widely distributed and can be found in almost every Coastal Plain County in large quantities. These are often known as terrace gravels. The wide distribution of road materials in the State, which are for the most part easily accessible, makes good road building easy and eliminates the idea that roads can not be built on account of lack of these materials.

OTHER METALLIC MINERALS

What Other Metallic Minerals Are Found in Arkansas?

Metallic minerals other than manganese, zinc, lead and antimony which are found in Arkansas are silver, copper, iron and traces of gold. A mineralized zone in the Paleozoic region of the State southwest of Little Rock through Pulaski, Saline, Garland, Hot Spring,

Montgomery, Pike, Howard and Sevier Counties has been found to have small bodies of manganese, zinc, lead, antimony, silver, copper, iron and ores with slight traces of gold. These minerals, however, in the localities referred to have never been mined successfully to any extent. It is entirely possible, however, that the Paleozoic region of Arkansas when thoroughly prospected and geologically mapped will provide some of these minerals in paying quantities in regions which are not now suspected.

MISCELLANEOUS MINERALS

Name Some of the Other Miscellaneous Minerals Found in the State?

In addition to the minerals listed, there are a great many minerals found in Arkansas which are of minor importance as compared to the principal minerals produced in the State, but which could be further developed in some localities. Such minerals are: Glass sand, which is now mined at Guion, Izard County; Tripoli, which is a soft porous silicious material which when ground is used as an abrasive for polishing in the metal working trades. It is used also as an adulterant in the manufacture of gunpowder, in making cement, and as a water filter and wood filler. This material occurs in several localities in the State, notably Garland, Hot Spring, Pike and Benton Counties. Other minerals are soapstone, talc, graphite and carbonaceous sand, natural cements, barytes, Magnet Cove rare minerals, and others.

WATER POWER

What Is the Water Power Situation in Arkansas at the Present Time?

The streams of Arkansas, as estimated by the Interior Department, may be used to generate 125,000 horse power available 90 per cent of the time, and 178,000 available 50 per cent of the time.

At the present time there are only three hydro-electric plants operating in the State, one on the Illinois Bayou near Russellville, which generates a maximum of 800 horse power, and two on the Spring River which is fed by Mammoth Spring, Fulton County, the upper dam supplying a maximum of 400, and the lower dam a maximum of 720 horse power. The total of the developed hydro-electric power in the State at the present is thus a maximum of 2020, which is but slightly more than one per cent of the horse power estimated as available 50 per cent of the time.

A dam is being at present constructed on the Ouachita River, known as the Rammel Dam, which will generate approximately 2,000 to 8,000 horse power.

This will be used to supplement the load requirements of an established light and power company. This company plans to erect two more dams on the Ouachita River in connection with this first

project. These three projects are expected to give practically complete control of the river and generate 80,000 primary and 80,000 secondary horse power.

Two dams on the Little Red River are planned by a second firm. These, it is estimated, will generate an aggregate of 107,000 horse power.

A third firm is engaged in the promotion of six water power projects on the White River and its tributaries. Four of these have a collective total of 147,000 horse power.

The water power available from the drainage of the Ozark Plateau, Boston Mountains and Ouachita Mountains has long been neglected. Interest has been steadily increasing, however, and it will probably be only a comparatively few years before the Ouachita, Arkansas and White Rivers and their tributaries will be supplying the industries of Arkansas and nearby states with cheaper electric power. It is probable that the drainage of the Coastal Plain beds can supply only a very small amount of hydro-electric power on account of the low relief of the country.

THE ARKANSAS STATE GEOLOGICAL SURVEY

is maintained for the purpose of assisting in the development of the

NATURAL RESOURCES OF ARKANSAS

and cordially invites you to visit its offices at

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for the purpose of taking advantage of the services of the Department and receiving any information regarding the distribution of the natural resources of the State. The services of the personnel of the Survey are at your disposal at all times.

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GEORGE C. BRANNER,
STATE GEOLOGIST

AVAILABLE REPORTS OF ARKANSAS GEOLOGICAL SURVEYS

The following reports of the Arkansas Geological Survey are available for distribution and may be obtained upon request and the payment of postage for each volume according to the table as shown. Orders may be addressed to Geo. C. Branner, State Geologist, 447 State Capitol, Little Rock, Arkansas.

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Vol. V—The Zinc and Lead Deposits, by J. C. Branner, pp. xiv, 395, illustrated; atlas of 7 maps.

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The Slates of Arkansas, by A. H. Purdue, with a bibliography of the Geology of Arkansas by John C. Branner.

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Coal Mining in Arkansas, by A. A. Steel. Parts I and II.

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Water Powers of Arkansas, a Preliminary Report on White River and some of its tributaries, by W. N. Gladson.

Reports of the Bureau of Mines, Manufactures and Agriculture

The following reports issued by the Bureau of Mines, Manufacture and Agriculture contain reference to the geology and mineralogy of Arkansas, and requests for copies should be addressed to Jim G. Ferguson, State Capitol Bldg., Little Rock, Ark.:

Minerals in Arkansas
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