STATE OF ARKANSAS

ARKANSAS GEOLOGICAL SURVEY

RICHARD J. ANDERSON

ACTING STATE GEOLOGIST

COUNTY MINERAL REPORT 3

MINERAL RESOURCES OF

MONTGOMERY, GARLAND, SALINE,

AND

PULASKI COUNTIES

LITTLE ROCK

1942

STATE OF ARKANSAS

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Richard J. Anderson
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County Mineral Report 3

Pulaski, Saline, Garland, and Montgomery Counties

Compiled by the staff of the
Arkansas Geological Survey

Little Rock

1942

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June 24, 1942

Hon. Homer M. Adkins,
Governor, State of Arkansas,
Little Rock, Arkansas.

Sir:

I have the honor to submit herewith County Mineral Report 3, Mineral Resources of Montgomery, Garland, Saline, and Pulaski counties, prepared by the staff of the Arkansas Geological Survey.

The information in this report was compiled from field data collected by the Montgomery, Garland, Saline, and Pulaski county sections of the Work Projects Administration, State Mineral Survey, together with information contained in state and federal reports. It contains, therefore, important information regarding the mineral resources of these counties.

The purpose of the State Mineral Survey, sponsored by the Arkansas Geological Survey, was to locate and determine the extent and value of mineral deposits, rocks, and ground waters of Arkansas, which may contribute to the wealth of the state. Provision has been made for the publication of mineral resource reports on counties or groups of counties. This report is the third in this series.

Respectfully submitted,

Richard J. Anderson

Acting State Geologist

ACKNOWLEDGMENT TO THE WORK PROJECTS ADMINISTRATION OF ARKANSAS

This report on the Mineral Resources of Montgomery, Garland, Saline, and Pulaski counties was compiled in order to make public the information gathered during the surveys of these counties by workers of the State Mineral Survey under the Work Projects Administration Project 6041-9.

This project was sponsored by the Arkansas Geological Survey, and co-sponsored by the counties surveyed.

Floyd Sharp was State Administrator for the Work Projects Administration, and Captain R. C. Limerick was Director of Operations.

E. E. Castleberry was Project Supervisor for the State Mineral Survey, and Rex E. Mhoon was Project Engineer. Oscar F. Suggs and Rex E. Mhoon were the District Supervisors at the time the field work for this report was done.

Special acknowledgment is made to the county officials for their assistance, and to others for their contributions, which made the execution of the project possible in these counties.

The text of this report was prepared by A. D. Hoagland, Harold G. Picklesimer, Frank V. Stevenson, and Edith Ann Pierce of the Arkansas Geological Survey.

Typing for reproduction was by Carolyn Goldman of the State Mineral Survey, and Floy Parsons of the WPA Aid to State and Local Defense Councils.

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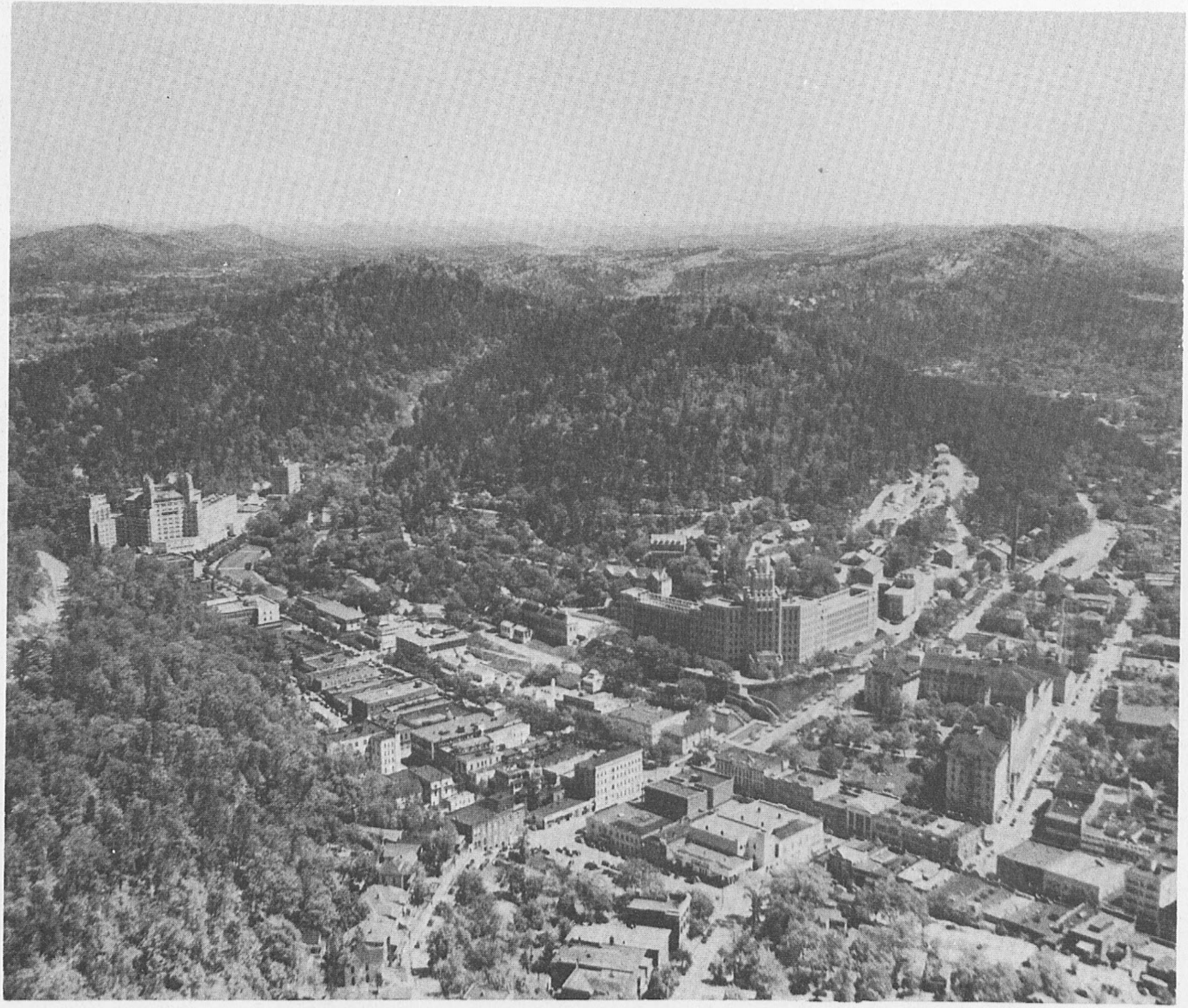


CITY OF HOT SPRINGS, GARLAND COUNTY, ARKANSAS

I N T R O D U C T I O N

Montgomery, Garland, Saline, and Pulaski counties make up an elongated area extending from the west-central to the central part of the state. Montgomery County is the westernmost county of the group.

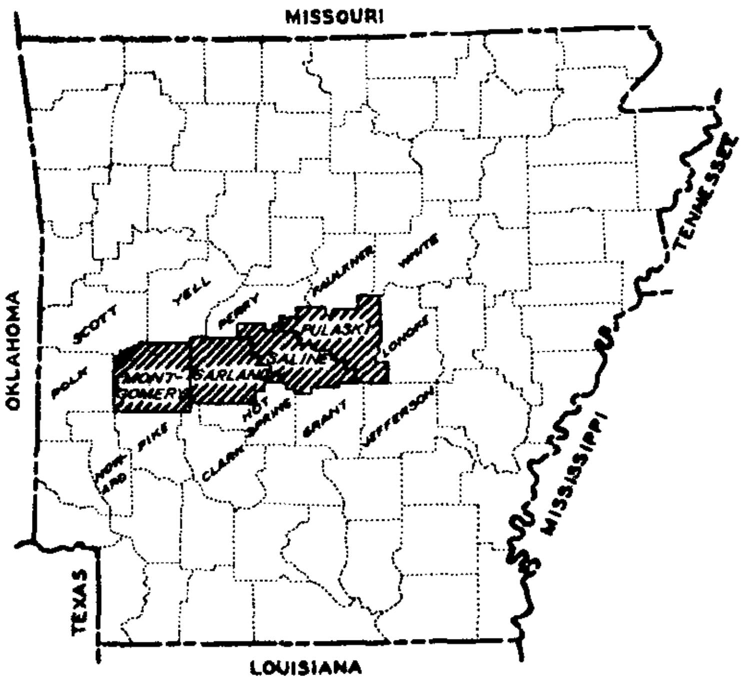


Figure 1. Location map of Montgomery, Garland, Saline, and Pulaski counties

Montgomery County has an area of about 784 square miles or 501,760 acres. The population, entirely rural, is 8,876 1/. (Rural population includes all inhabitants living outside the limits of towns or cities of 2,500 or more persons.) Mount Ida, the county seat, is the largest town and has a population of 490. The density of population in Montgomery County is 11.3 persons per square mile which is considerably less than the average density in Arkansas (37.1). A decrease of 17.6 per cent in population between 1930 and 1940 is converse to the trend of the state as a whole.

Garland County has an area of about 738 square miles or 472,320 acres. It has a population of 41,610 of which 48.8 per cent is classed as rural. Hot Springs with a population of 21,370, located within the National Park, is the county seat and largest town. The density of population in Garland County is 56.5 persons per square mile which is considerably more than the average density in Arkansas. The population of Garland County increased 13.4 per cent between 1930 and 1940, a greater increase than that of the state as a whole (4.9).

The area of Saline County is about 743 square miles or 475,520 acres. It has a population of 19,163 of which 81.8 per cent is classed as rural. Benton, the county seat and largest town, has a population of 3,502. The density of population in Saline County is 25.8 persons per square mile. This is somewhat less than the average density of population in Arkansas. There was an increase of population in Saline County of

1/ All population figures are according to the 1940 census reports.

18.2 per cent between 1930 and 1940, which is considerably greater than the increase in the state as a whole.

The area of Pulaski County is approximately 779 square miles or 498,560 acres. It has a population of 156,085 of which 30 per cent is rural. Little Rock, the state capitol and the county seat of Pulaski County, is the largest city in the state and has a population of 88,039. North Little Rock, is the second largest city in Pulaski County and has a population of 21,137. The density of population in Pulaski County is 200.4 persons per square mile. Pulaski County increased 11.8 per cent in population between 1930 and 1940.

The climate of the entire area is mild, although the summers are usually long with temperatures of 100° F. or more reported almost every year. The winters are usually mild, especially in the lowlands, although on rare occasions temperatures below zero are recorded. The average annual temperature for the period 1879 to 1940, in the highlands is 62.0° F.; the average in the lowlands is 63.5° F. The humidity is high, especially in the lowlands. The average annual precipitation for the area is about 48 inches. The yearly average in the highlands ranges from 44 to 56 inches, and from 39 to 52 inches in the lowlands.

Montgomery and Garland counties lie within the physiographic division known as the Ouachita province, which usually is subdivided into the Fourche Mountains, the Novaculite Uplift, and the Athens Piedmont. The northern portion of Montgomery and Garland counties are located within the Fourche Mountains subdivision and the remainder within the Novaculite Uplift subdivision. The northern part of Saline and Pulaski counties lies within the Fourche Mountains, and the southwest part in the Novaculite Uplift. The southeast portion of these two counties falls within a physiographic division known as the Gulf Coastal Plain. (See Fig. 2.)

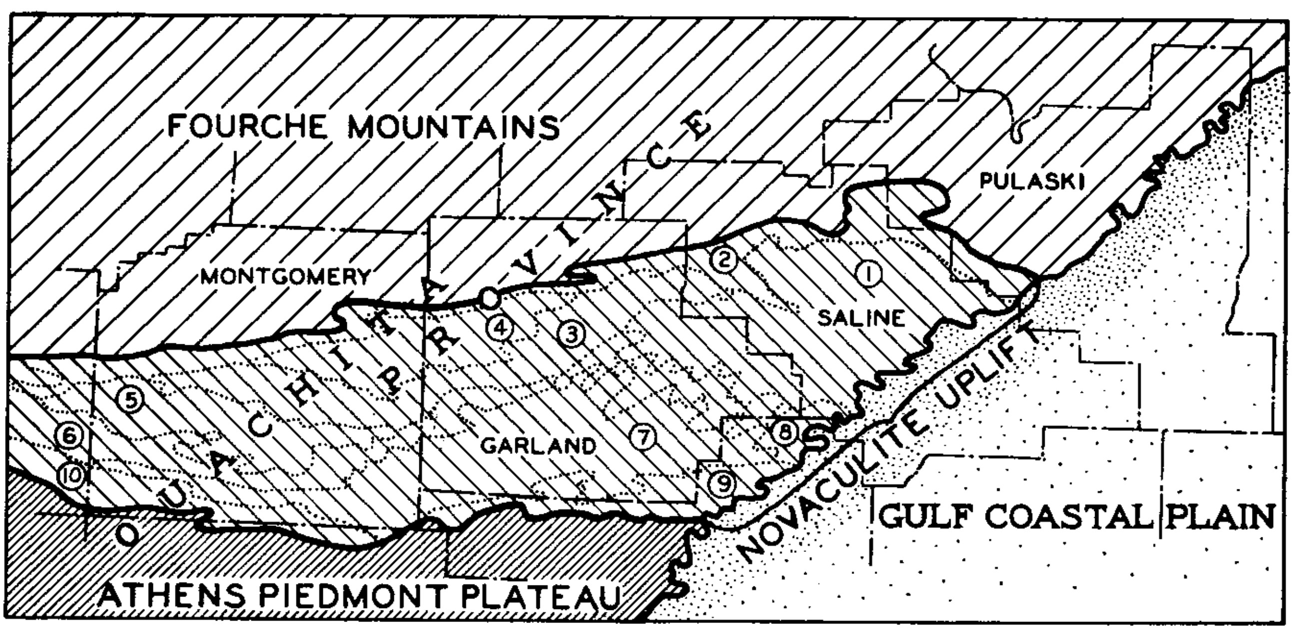
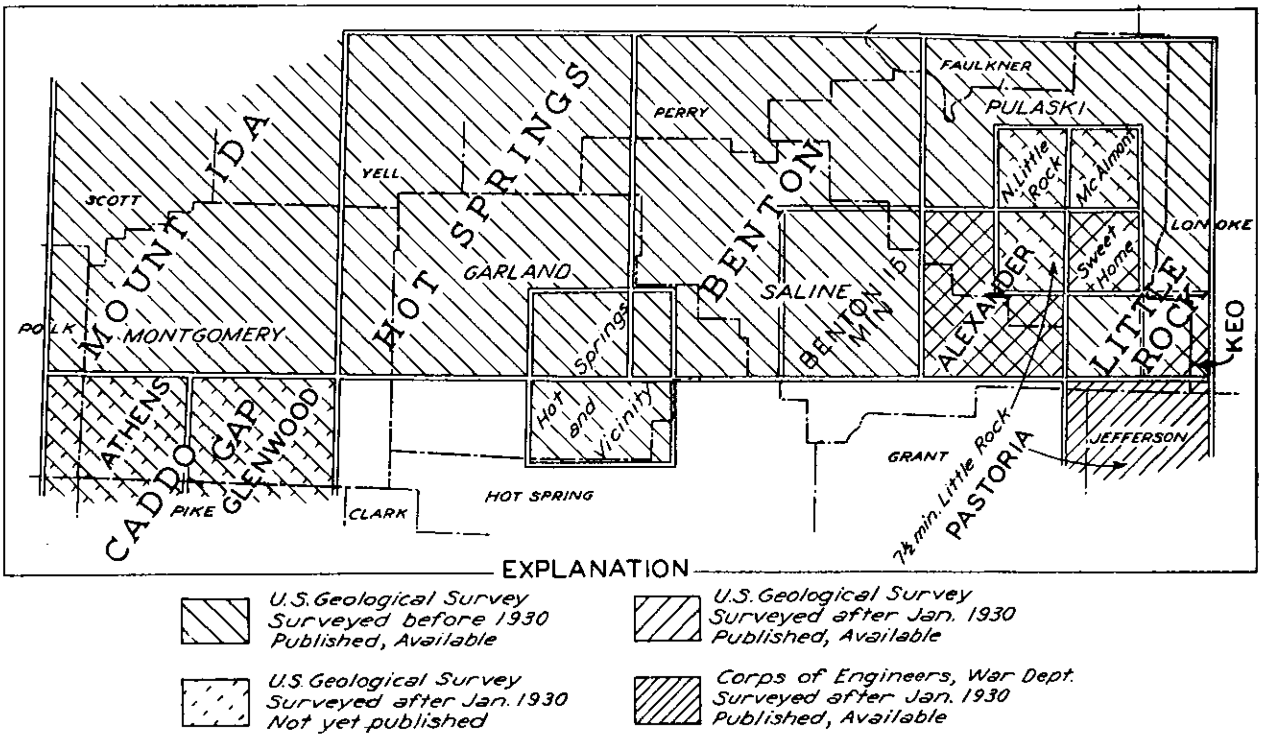


Figure 2. Physiographic map

LEGEND

1. Saline Basin
2. Northern Mountains
3. Crystal Mountains
4. Ouachita Basin
5. Caddo Basin
6. Caddo Mountains
7. Mazarn Basin
8. Zigzag Mountains
9. Trap Mountains
10. Cossatot Mountains



Montgomery and Garland counties and the northern part of Saline and Pulaski counties have irregular topography. The southern part of Saline and Pulaski counties, in the Gulf Coastal Plain, is either flat or consists of gently rolling lowlands. Elevations above sea level range from 200 feet at Fourche Dam, about 6 miles south of Little Rock in Pulaski County, to 2,400 feet at Fourche Mountain in the northwestern part of Montgomery County. These irregular topographic features affect transportation facilities which in turn influence industrial development and commercial exploitation of natural resources.

Most of the area of Montgomery, Garland, and Saline counties is drained by the Ouachita River and its tributaries, which drain to the southeast. Pulaski County is drained by the Arkansas River and its tributaries. The drainage overflows of Montgomery and Garland counties are not destructive; however, large overflows causing considerable damage occur occasionally in parts of Saline County along the Saline River, and in Pulaski County along the Arkansas River.

U. S. Geological Survey maps of the Caddo Gap, Glenwood, Athens, Mount Ida, Hot Springs, Hot Springs and Vicinity, Benton, Benton 15 minute, Alexander, North Little Rock, McAlmont, Sweet Home, Little Rock 7½ minute, Keo, and Little Rock quadrangles cover most of the area. They may be obtained by writing Director, U. S. Geological Survey, Washington, D. C. County highway planning survey maps may be procurred from the county seat, and state geologic and topographic maps from the Arkansas Geological Survey, State Capitol, Little Rock, Arkansas. (See Fig. 3.)

The data used in this report were compiled from original investigations of the State Mineral Survey, from U. S. Geological Survey and Arkansas Geological Survey maps and publications, and from other scientific and engineering literature.

G E O L O G Y

General features

The surface formations exposed in Montgomery, Garland, Saline, and Pulaski counties consist chiefly of sedimentary rocks, although some exposures of metamorphic and igneous rocks occur in the area. The sedimentary rocks consist of shale, sandstone, chert, novaculite, and small amounts of limestone. Shale and sandstone in some localities have been altered to slate and quartzite,respectively. The most extensive areas of exposed igneous rocks are located in south central Pulaski, southeastern Saline, and southeastern Garland counties. Many of these rocks were formed originally at considerable depths below the surface and have been uncovered at the above localities by erosion.

The geologic ages of the exposed rocks in these counties range from Cambrian to Tertiary. The older formations outcrop in the central western portion of the area with the youngest formations to the east. The formations become progressively younger in age to the north and to the south. Tertiary sediments cover folded Paleozoic rocks in southeastern Saline and Pulaski counties.

Brief descriptions of the formations exposed in the area follow. They are described in the order in which they were deposited. The oldest formation is described first, and the youngest last. (See pl. I.)

DESCRIPTION AND SEQUENCE OF FORMATIONS

Cambrian (?) System

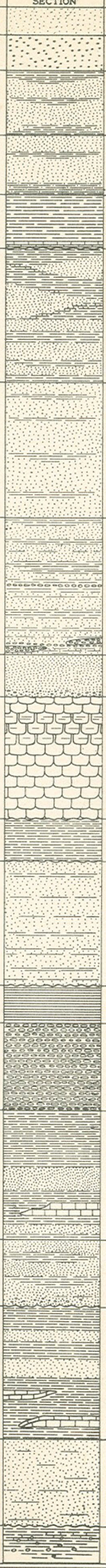
Collier shale. The Collier shale is the oldest sedimentary formation exposed in the entire state. It outcrops only in Montgomery County, in a westward trending valley which lies between the towns of Mount Ida and Womble. The exposure, which is about 15 miles long and from 1 to 3 miles wide, covers about 25 square miles. Its age has not been ascertained by paleontologic evidence; however, it underlies disconformably, the Crystal Mountain sandstone, which is Ordovician in age, and has been assigned logically, if somewhat arbitrarily, to the Cambrian system.

The thickness of the Collier is unknown as the base of the formation is concealed. Exposed sections measure fully 500 feet. The formation is composed chiefly of soft, dark, graphitic clay shale which has been intensively crumpled. The upper 100 feet contain thin dark crystalline lenses of limestone about 1 inch thick. In places, the limestone is conglomeritic. In the lower part of the formation about 100 feet of steel-gray to bluish-gray or black limestone are found in layers from a few inches to 2 feet in thickness. These are interbedded with thin seams of graphitic shale. All the limestone beds are compact, greatly jointed, brittle, and contain many thin veins of white calcite. The surface becomes dark blue on weathering.

Beds of dense, black, fractured chert occur at widely separated horizons. Smooth slickenslided surfaces are common in the shale and in many places intense folding has removed all traces of bedding, giving rise to incipient slaty cleavage.

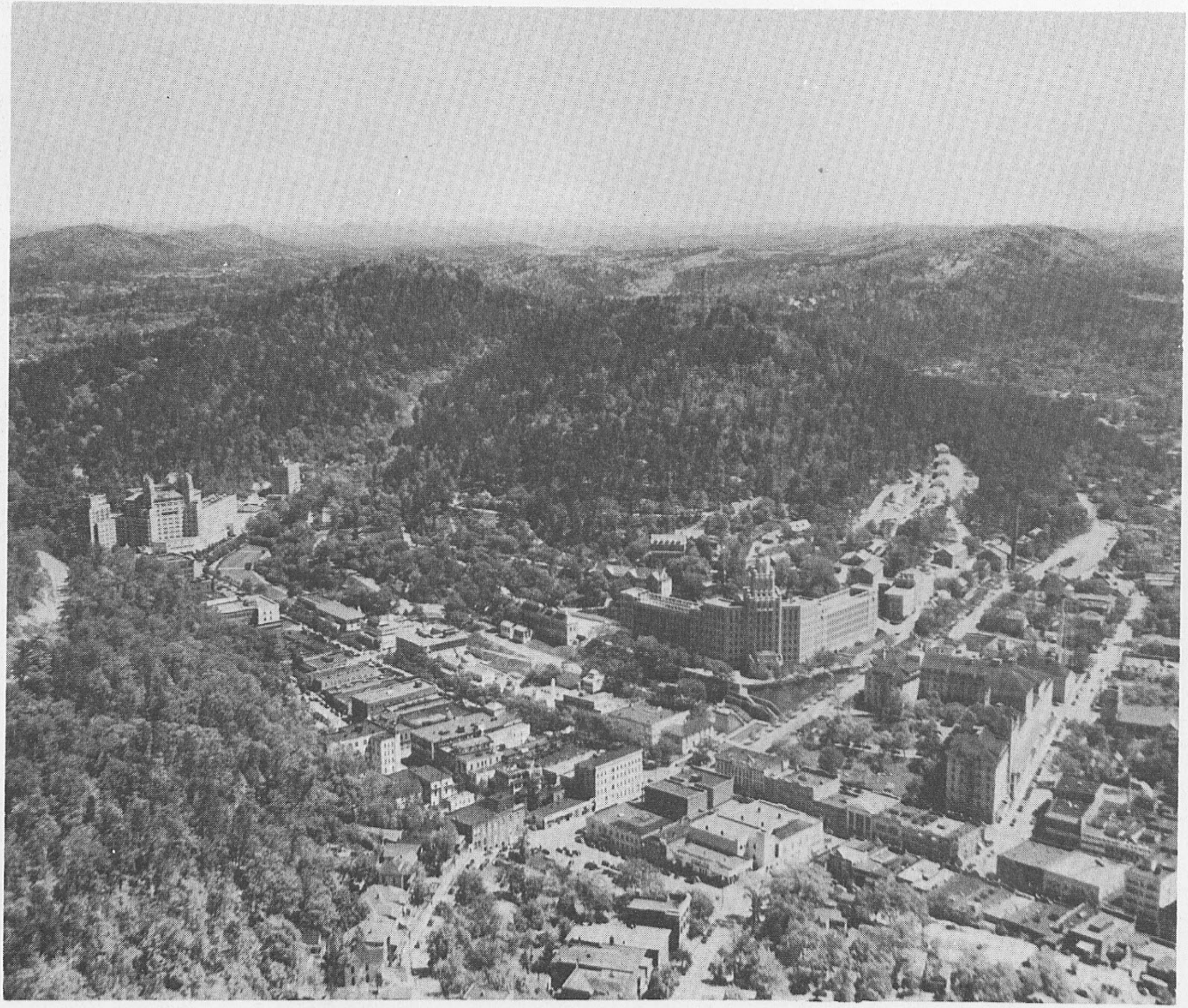
Ordovician (?) System

Crystal Mountain sandstone. As exposed in Montgomery County, the Crystal Mountain sandstone forms a group of high, rugged, east-west trending ridges south of Mount Ida. Many rock ledges protrude through a surface mantle of rock fragments and fine material derived from the parent formation.



PERIOD	FORMATION	THICKNESS IN FEET	CHARACTER OF ROCKS
QUATERNARY	*Alluvium*	0-200	Silt and clay.
QUATERNARY	*Terrace deposits*	?	Gravel and sand overlain at most places by silt and clay.
TERTIARY	*Claiborne*	0-50	Sand, clay, lignite; quartzite locally.
TERTIARY	*Wilcox*	0-650	Sand, clay, quartzite and lignite.
TERTIARY	*Midway*	0-110	Black calcareous clay and white limestone.
	Major Unconformity		
PENNSYLVANIAN	*Atoka*	1500-9500	Compact sandstone of variable character and dark sandy shale in varying proportions.
PENNSYLVANIAN	*Jackfork*	3500-6600	Fine- to coarse-grained, massive light gray sandstone, with some millstone grit at base. Green fissile clay shale.
PENNSYLVANIAN	*Stanley*	3500 to 6000+	Black, fissile clay shale with some fine-grained compact blue-gray sandstone.
PENNSYLVANIAN	*Middle chert member*	(25)	Black cherty shales and thin black cherts.
PENNSYLVANIAN	*Hatton tuff lentil*	(0-90)	Several (possibly 5) beds of volcanic ash.
PENNSYLVANIAN	*Hot Springs sandstone*	85 to 200+	Hard quartzitic, laminated, gray sandstone; heavy-bedded conglomerate at base.
	Unconformity		
DEVONIAN	*Arkansas novaculite*	900±	Lower portion heavy-bedded, siliceous and wholly novaculite; upper portion novaculite with intercalated layers of soft black shale.
	Unconformity ?		
SILURIAN	*Missouri Mountain*	0-300	Dark greenish-drab to black clay shale, locally red in color. In places altered to slate.
	Unconformity ?		
SILURIAN	*Blaylock*	1500±	Fine-grained light to dark gray or green compact sandstone, and dark fissile shale.
	Unconformity ?		
ORDOVICIAN	*Polk Creek*	100-200	Black graphitic shale, in places siliceous and in other places clayey.
ORDOVICIAN	*Bigfork*	700+	Thin-bedded, gray to black chert, much shattered, interbedded with thin layers of black shale.
ORDOVICIAN	*Womble*	250 to 1000	Black to green clay shales, with thin layers of blue-black limestone.
ORDOVICIAN	*Blakely*	0 to 500	Siliceous gray sandstone, with calcareous darker layers, and minor amounts of black and green clay shale.
	Unconformity ?		
ORDOVICIAN	*Mazarn*	1000±	Black and green banded clay shale, with thin layers of gray sandstone and lenses of bluish-black limestone.
?	*Crystal Mountain*	850-	Coarse white sandstone, with well-rounded grains. In places contains many quartz veins and crystals.
	Unconformity		
CAMBRIAN	*Collier*	500	Dark, graphitic clay shale; limestone near top; some beds of dense black chert.

COLUMNAR SECTION OF EXPOSED ROCKS IN MONTGOMERY, GARLAND, SALINE, AND PULASKI COUNTIES



CITY OF HOT SPRINGS, GARLAND COUNTY, ARKANSAS

The formation is composed essentially of sandstone and in Arkansas has a maximum observed thickness of 850 feet. The formation also contains a thin basal conglomerate, and a very small quantity of black clay shale. The sandstone is composed of well-rounded, translucent quartz grains cemented mainly by silica and rarely by lime. The limy beds are brown and become friable on weathering. The silica cemented sandstone is light-gray in color, hard and dense, and breaks into large and small blocks covering much of the surface. Joints are abundant in the sandstone. They are in many places very even and nearly parallel and their surfaces may be mistaken for bedding planes. Much of the sandstone is cut by a network of white quartz veins ranging from a fraction of an inch to several inches in thickness. In places fissures from a few inches to several feet in width are lined with clusters of both milky and transparent quartz crystals. Quartz crystals sold in the vicinity of Hot Springs to museums and private collectors, usually are obtained from veins in this sandstone.

The basal conglomerate has a maximum thickness of 10 or 12 feet. It is composed of rounded quartz fragments reaching the size of peas,rounded and sub-angular pebbles, and cobbles of bluish limestone as much as 6 inches in diameter imbedded in an earthy, calcareous matrix. The small quantity of shale interbedded with the sandstone is predominantly black, although occasionally thin interbedded layers of a greenish color are found.

Ordovician System

Mazarn shale. The Mazarn shale outcrops in each of the four counties discussed in this report. The exposures occur only in the valleys. For this reason, and because the beds are intricately folded, the thickness of the formation has not been accurately determined, although it is estimated to be 1,000 feet. West of the Crystal Mountains in Montgomery County the Mazarn shale has not been mapped independently.

The Mazarn consists predominantly of shale,although in places it contains small quantities of limestone, sandstone, and chert. The shale is mainly black, clayey, and fissile; however,thin layers of green shale, alternating with the black are not uncommon. Straight, well-defined joints cut the shale at most places. Slaty cleavage has been developed at many localities and at a few places almost all traces of the original bedding have been lost. In instances of obscure bedding the differently colored layers form a ribboned slate. The clay resulting from the weathering of the shale is plastic and is either red or light yellow. Quartz veins are numerous in certain areas and cut the formation in all directions. Occasionally the residual quartz from the veins forms a veneer over the surface.

The limestone occurs near the apparent middle of the formation. It is dark-blue on weathered surfaces and black on freshly fractured surfaces. The rock is compact, thin-bedded, and finely crystalline. The beds do not aggregate a total thickness of more than 10 or 15 feet. They are interbedded with shale similar to that above and below. Locally interbedded with the limestone is a sandy conglomerate containing small limestone pebbles. The sandstone, though present in small quantities, occurs at many places. It is gray, laminated, fine-grained, and quartzitic, occurring in layers less than 2 feet thick.

Blakely sandstone. The Blakely sandstone is exposed in Garland County in a series of ridges that extend northeast from Womble, Montgomery County, across Garland into Saline County. The formation ranges in thickness from a feather edge to about 500 feet and consists chiefly of interbedded shale and sandstone. Shale comprises three-fourths of an average section. Several beds of conglomerate are present in the formation. The sandstone in the Blakely thins out at Womble and is absent west of that place except for its possible occurrence at Black Springs in Montgomery County. As the shale in the Blakely is similar to the Womble and Mazarn shales, it cannot readily be distinguished from these shales west of Womble.

Notwithstanding the preponderance of shale, sandstone is the conspicuous part of the formation, and it stands out in short rugged ridges, many of which are prominent topographic features. The sandstone usually occurs in beds less than 10 feet thick. The sand grains are generally medium sized and are firmly cemented either by silica or lime. The sandstone with the silica cement is quartzitic, light-gray to blue, extensively jointed, and resistant to weathering. The crests of the ridges formed of this resistant sandstone are strewn with angular rock fragments. However, many thin beds of calcareous sandstone occur. These are interbedded with shale and do not form ridges. The calcareous sandstone is darker than the quartzitic variety and it weathers rapidly to a friable material. Both varieties of sandstone are extensively cut by thin quartz veins, and clear quartz crystals commonly line the fissures along bedding and joint planes.

The shale forms few outcrops although it makes up about three-fourths of the formation. It is predominately black with green bands present locally. A thin bed of conglomerate, composed of small, rounded chert fragments in a sandy matrix is locally present near the base of the formation. Near the middle of the formation another conglomerate bed several feet thick occurs, which consists of small round chert and limestone pebbles in a dark, calcareous sandstone matrix. In the Hot Springs vicinity a thick conglomerate bed, composed of small sandstone pebbles in a matrix of black shale with numerous rounded cavities, is present near the top of the formation.

Womble shale. Exposures of the Womble shale trend in an easterly direction through Montgomery, Garland, and Saline counties, and into the southwestern corner of Pulaski County. The shale usually forms valley areas in which there are low irregular hills. Prominent rock exposures are present at many places especially along the streams and roads. The formation ranges in thickness from 250 to 1,000 feet. It is composed chiefly of black graphitic shales in this area. Thin beds of sandstone occur near the base of the formation. Thin beds of limestone occur near the top. At the top of the Womble shale there are some thin layers of black chert very similar to those in the overlying Bigfork.

The shale is black, hard, and splits into thin pieces when struck with a hammer. Veins of white quartz commonly cut the shale in all directions. The quartz remains after the shale is weathered, forming a conspicuous surface mantle. Slaty cleavage is seen at many places and is particularly characteristic of the lower beds. The shale of the Womble formation resembles that of the Mazarn, but the Womble is usually darker and green layers are less numerous. Sandstone is commonly present through the formation, and is predominant in the lower portion. It is hard, compact, bluish-green, quartzitic, and fine-grained and weathers to gray or brown. Limestone is present locally as lenses in the upper 75 to 150 feet of the shale. It is not confined to any definite horizon but may be present anywhere within the upper part of the formation. It is compact, fine-grained, and even-bedded, and is blue on weathered and black on fresh surfaces. A network of quartz and calcite veins one-half inch or less in thickness cuts the limestone.

Bigfork chert. The Bigfork chert is exposed typically near Bigfork post office in Polk County and outcrops in a narrow belt which trends eastward through southern Montgomery and Garland counties into the southwestern part of Saline County. The areas of its outcrop are characterized by shallow valleys, low, steep-sided hills, and rounded knobs. The formation has been intensely crumpled, making accurate measurement of its thickness difficult. The chert is at least 700 feet thick in this area. The formation consists of thin-bedded, gray or black shattered chert, interbedded with varying amounts of shale and small amounts of sandstone and cherty limestone.

The chert generally occurs in thin, even-bedded layers which have a thickness of 1 inch to 3 feet. However, the average thickness ranges from 3 to 6 inches. It is extremely brittle and can be broken easily with a hammer into numerous fragments which show uneven to conchoidal fracture. The chert beds are cut by numerous closely-spaced joints which account for the rapid weathering of the formation. Most of the joints have a quartz or quartz-calcite filling. Shale is present in even-bedded layers which range from a fraction of an inch to several feet in thickness. The shale is black, siliceous, and carbonaceous. It is distinct throughout the formation except near the base. Black siliceous limestone, in lenses and layers only a few inches thick, is locally present near the base and top of the formation.

Polk Creek shale. The Polk Creek shale outcrops in Montgomery, Garland, Saline, and Pulaski counties, and is present on steep slopes and in narrow valleys in close association with the Bigfork chert. The thickness of the formation has not been accurately determined, but it is probably between 100 and 200 feet.

The shale is black, fissile, graphitic, and may be either very soft or hard and slaty. The softer beds contain enough graphite to soil the fingers. Harder beds, which are most common near the base of the formation, have been altered to slate. The shale weathers to a bluish-gray, platy rock or disintegrates to clay. Thin beds of dense, black chert and layers of quartzitic sandstone are relatively common in the formation but they make up only a minor part of it. The formation is much jointed and crumpled. Small pyrite crystals commonly are disseminated through the shale, and quartz veins occur along the joints and bedding planes.

Silurian System

Blaylock sandstone. The Blaylock sandstone outcrops in small and isolated narrow belts in Montgomery and Garland counties, and extends into the southwestern part of Saline County. Outcrops occur as rough, rocky, narrow strips with an east-west trend, on mountain slopes and in narrow valleys. Rock ledges are common, but at most places the sandstone is covered by debris. Along its southernmost outcrops the Blaylock has an estimated thickness of 1,500 feet, but it thins rapidly to the north and to the east. It is approximately 550 feet thick near the town of Mountain Valley, Garland County, and approximately 300 feet thick at the southeast corner of the county. The formation consists of fine-grained, light to dark-gray or green, compact sandstone which is interbedded with shaly sandstone and dark shale.

The sandstone is even-bedded with layers ordinarily from 1 to 6 inches in thickness but at a few places several feet thick. Much of the sandstone is hard, quartzitic, and massive, but it is occasionally soft and laminated. Joints are numerous, many of them filled with veins of milky quartz. The interbedded shale, which in places makes up a large part of the formation, is micaceous, dark-gray or black, and generally fissile. At some places the shale is buff in color and resembles the Missouri Mountain slate. In general, these shale beds appear to thicken toward the east.

Missouri Mountain formation. The Missouri Mountain formation outcrops as high ridges in essentially the same areas as the Blaylock sandstone and extends from Polk County eastward to Pulaski County. However, it is absent at a few places near Mount Ida. The formation is known as a slate but is little different from the altered Collier, Mazarn and Polk Creek shales. It ranges in thickness from a feather edge to 300 feet in this area. The thickness decreases toward the northeast in the Hot Springs district but in other areas appears to thin toward the south. The Missouri Mountain formation consists of shale, slate, conglomerate, and sandstone.

The shale is soft and on fresh surfaces it is gray, green, black, or red. The weathered shale is ordinarily buff, green, yellow, or reddish-brown. Slaty cleavage is well developed at many places. This cleavage makes it possible to split the rock in thin pieces which have smooth glossy surfaces. The red and green slates are remarkably homogeneous. Joints, striking in two or more directions, cut the slates in most places. The joints are from a few inches to 10 or 12 feet apart where the folding has been least intense. Where the folding has been very intense, they are a quarter of an inch or less apart. The slate, or weathering, breaks into small prisms which resemble "shoe pegs." Conglomerate which occurs at the base of the formation is best exposed in the western part of the Hot Springs district, where it is about 4 feet thick. This basal member is composed of rounded chert and limestone pebbles embedded in a matrix of black sandy shale. Beds of sandstone and quartzite which average from 3 to 5 inches in thickness are common near the top and bottom of the formation.

Devonian System

Arkansas novaculite. The Arkansas novaculite outcrops almost continuously in nearly parallel ridges which trend east-west across Montgomery, Garland, and Saline counties into Pulaski County. As the novaculite resists the action of weathering better than any of the other sedimentary rocks in this area it usually is well exposed. The southern outcrops of the novaculite attain a maximum thickness of 900 feet, northern exposures are much thinner. Part of the thinning to the north is thought to be due to an unconformity at the top of the formation and to several local disconformities within it. The novaculite commonly consists of three divisions. The lower is made up almost entirely of massive white novaculite as much as 425 feet thick in the southern part of the area; the middle division, ranging in thickness from 10 feet to perhaps 525 feet, is composed of thin-beds of black novaculite interbedded with shale and with one or more thin conglomerate beds; and the upper division, ranging up to 125 feet in thickness, is essentially massive calcareous novaculite. The divisions vary greatly from place to place, both as to thickness and character, but they can be identified at most localities.

The lower division consists of even-bedded layers of very fine-grained, dense novaculite from 2 to 10 feet thick. The highest ridges often are capped by this very resistant rock and it is conspicuous because of its white color, massive character, and extreme hardness. Iron and manganese oxides and carbonaceous matter, however, are responsible for the brown or gray coatings on novaculite in some places. In general, the novaculite of this division is remarkably pure and commonly contains 99 per cent or more of silica. It usually is jointed complexly, the most prominent set of joints being perpendicular to the bedding.

Black shale, altered to a poor grade of slate in some places, is the principal material of the middle division. Beds of dark-colored novaculite from 1 to 6 inches thick, which in places grade laterally into conglomerate beds, are interbedded with the shale. The aggregate thickness of the shale beds ranges from a few inches to as much as 100 feet. A conglomerate, composed of pebbles of novaculite and sandstone, is locally present at the base of the middle division. The cement of this conglomerate is very compact silica.

The upper division, like the lower one, is resistant and forms many low ridges. It is composed of light-gray to bluish-black novaculite that contains both calcium and magnesium carbonate. Near the surface this novaculite usually is weathered and the carbonates have been leached out, making the bluish-black novaculite more porous and lighter in color. The division also contains a few thin beds of very fine-grained novaculite similar to those found in the lower division.

Stone suitable for the manufacture of whetstones is present in considerable quantity in 2 distinct horizons of the formation. The most important horizon is situated near the base of the massive white novaculite of the Hot Springs region. This dense, fine grained novaculite is known commercially as "Arkansas stone." (See section on "Novaculite.") However, at some places in the Hot Springs vicinity, the "Arkansas stone" grades into the coarse, more porous, novaculite known as "Ouachita stone," so that a stratigraphic relationship is not always well defined between the two types.

Pennsylvanian System

Hot Springs sandstone. The Hot Springs sandstone is a formation known to be present only in the Hot Springs district. The sandstone is 137 feet thick at Hot Springs, but elsewhere it ranges from 85 to 200 feet within relatively short distances. The formation consists principally of sandstone but some shale and conglomerate are found. Shale is common only near the top of the formation and the principal bed of conglomerate occurs at its base.

The sandstone is composed of well-cemented, fine to medium-sized quartz grains. The rock is gray in color and hard. Many of the beds are 5 or 6 feet thick but the average is about 6 inches. The rock is cut extensively by joints, most of which contain quartz and are nearly perpendicular to the bedding. The sandstone gradually diminishes in quantity toward the top of the formation and the beds of black shale become thicker. The basal conglomerate, which apparently is a continuous bed, makes up a conspicuous part of the formation. The conglomerate is approximately 12 feet thick, but at several places it is as much as 25 or 30 feet.

Stanley shale. The Stanley shale outcrops in this area in Montgomery and Garland counties, in the northern part of Saline County, and in western Pulaski County. Although the formation is, in general, relatively soft, it is the surface rock over a large part of the Ouachita Mountain region. Large areas of Stanley shale occupy basins between the mountain areas. The formation probably is not more than 3,500 feet thick in the Hot Springs district in Garland County, but the upper beds are missing there. Its thickness has been estimated to be 6,000 feet at Glenwood in northeastern Pike County. It is probable that the Stanley thickens to the south and west of the Hot Springs district, and becomes progressively thinner eastward from that locality.

The formation is composed of dark, fissile, clay shale interbedded with fine-grained greenish-gray or bluish-gray sandstone. At some places the basal shale has been altered to a slate formerly called the "Fork Mountain" slate. This part of the Stanley has been prospected for commercial slate in Polk, Montgomery, and Garland counties. The formation also contains some tuff and conglomerate. The thickest bed of tuff, which is near the base of the formation in Polk County, has been named the Hatton tuff lentil.

The greater part of the formation is a clay shale although some sandy shale is present. The shale breaks into thin hard plates with smooth glossy surfaces showing small mica flakes. In most places the shale is a bluish-black or black and weathers to green, yellow, or brown. Joints commonly cut the shale in all directions and many are occupied by quartz veins.

Sandstone interbedded with shale is present throughout the formation but is most abundant in the upper and lower parts. The beds rarely exceed 3 feet in thickness and are separated by greater thicknesses of shale. The sandstone is fine-grained, hard, compact, quartzitic, and ranges in color from greenish-gray to bluish-gray. The weathered rock is soft, clayey, and porous, and colors ranging from green to dark brown predominate. It is estimated that less than 25 per cent of the formation is sandstone.

Jackfork sandstone. The Jackfork is exposed in two belts which trend from east to west. The northernmost belt outcrops in the northern part of Montgomery, Garland, and Saline counties, and in the northwestern part of Pulaski County, where it forms high ridges. With the possible exception of the Arkansas novaculite, the Jackfork is the most prominent formation of this area. Sandstone makes up the major part of the formation, although some shale and a small amount of grit also are present. The amount of shale present in the formation is greater in the northern than in the southern belt. Even where the shale makes up a prominent part of the formation it is inconspicuous, because the weathered sandstone conceals the softer beds. The total thickness of the formation is between 3,500 and 6,600 feet. The beds of sandstone range from a few inches to 50 feet thick.

In its northern outcrops, the Jackfork consists of a massive, compact, fine-grained, light-gray to brown sandstone. Brown iron-stained beds of sandstone are firmly cemented and resistant, but the beds of lighter color usually are softer. At some places the sandstone is quartzitic and forms prominent knobs, ledges, and cliffs. As a result of the weathering of the sandstone, great piles of rock fragments collect on the surface, particularly on the tops of ridges and at breaks in the slopes. Most of the weathered sandstone is light-gray but some is yellow or brown. The shales usually weather easily, and commonly are sandy, but they may be carbonaceous or clayey at some localities. Their predominating colors are green, blue, gray, or black.

Atoka formation. The Atoka covers small areas in the northwestern parts of Montgomery and Saline counties and is the surface rock in several townships in Pulaski County. It has the greatest areal extent of any Paleozoic formation exposed in Arkansas. The formation consists chiefly of beds of sandstone and shale. The ratio of sandstone to shale varies from place to place, but usually there is more shale than sandstone. In general, the sandstone becomes more abundant toward the north and especially toward the east. The total thickness of the Atoka formation is estimated to be between 9,000 and 9,500 feet in Montgomery, Saline, and Pulaski counties. The thickness varies from place to place and diminishes rapidly north of the Arkansas Valley.

The sandstone of the Atoka formation usually is hard, contains mica and quartz grains of medium size, and is light-gray to greenish-gray in color. The beds are commonly ripple-marked and range from a few inches to 12 feet in thickness. In some beds near the base, the sandstone is coarse-grained and contains grit. The usual color of the sandstone is brown. Dikes composed of very fine, dark-brown sandstone cutting the coarser sandstone of the Atoka often occur. These dikes have a maximum width of about 6 inches, but their average width is less than 2 inches.

The shale in the Atoka ordinarily is poorly exposed. It is sandy, micaceous, and from dark-to coal-black. The shale usually outcrops in valleys and on the lower slopes of ridges and hills, where it weathers to a yellowish or blue material. The unweathered shale is from blue to black where clayey and from yellow to brown where sandy. It differs from the shale of the underlying Mississippian formation in that it has a darker color, and breaks down into small splinters and granular fragments instead of flakes.

Small quantities of asphalt are found at a few places in the sandstone. The Atoka also contains thin coal lenses at several localities, particularly in the eastern part of the Arkansas Valley.

Tertiary System

Midway formation. The Midway formation is exposed in Saline and Pulaski counties in a narrow belt which varies from half a mile to 5 miles in width. The exposed belt extends southwestward from the vicinity of Little Rock through the southwest corner of Saline County. The formation dips gently under younger sediments in the southeastern parts of Saline and Pulaski counties, and in general lies at a progressively greater depth eastward and southward from its exposures in this area. The formation rests upon the eroded edges of folded Paleozoic rocks at most places in this area. However, in at least two localities, one in the vicinity of Bauxite and Bryant in Saline County and another north and northwest of Sweet Home in Pulaski County, the limestone lies upon nephelite syenite. Farther southward and eastward the Midway lies upon Cretaceous sediments, but the contact is not exposed in this area. Limestone commonly is present at the base of the formation. It becomes thin-bedded and soft at the top and grades through a few feet of marly clay into an overlying bed known as "blue" clay. This overlying blue clay member commonly is separated from the limestone by a few feet of marl and calcareous clay. It is generally from 40 to 60 feet thick, but at some places in Saline and Pulaski counties it is about 100 feet thick. Beds containing concretionary siderite or iron carbonate, less than 6 inches thick, are present at various horizons in the blue clay at some localities. The blue clay grades upward into buff and mottled red clays which represent an oxidized zone of varying thickness and have a maximum thickness of 20 feet.

The conditions that prevailed after the Midway sediments were deposited were apparently favorable for rock weathering as the rocks which were exposed during that time in Saline and Pulaski counties were highly altered, and the bauxite in Arkansas is believed to have been formed because of those conditions.

Wilcox formation. Except where erosion has removed it, the Wilcox formation overlies the Midway formation. The Wilcox outcrops immediately southeast of the Midway in southeastern Saline and in southwestern Pulaski counties. The formation is between 500 and 600 feet thick where it is fully developed, but it is considerably thinner at most places in the area in question.

In general, the Wilcox formation consists of non-marine beds of sand, clay, and lignite. Although lignite beds are common only in the lower part of the formation, many of the clays and some of the sands are more or less lignitic. The beds of sand, clay, and lignite are extremely variable in thickness and in many places they lens out within short distances. However, a dark-brown silty clay in the lower part of the Wilcox is thick and persistent over a large area south of Bryant in T. 1 S., R. 14 W. Clays, at about the same horizon toward the east, near Vimy Ridge, are generally light greenish-gray. In a few areas, the Wilcox includes some dark bluish-gray clay that resembles the "blue" clay of the Midway formation although it is not as thick as the Midway clay. The Wilcox clay generally is interbedded with sand or lignite and is therefore unlikely to be confused with the thick bed of blue clay of the Midway, which is underlain by limestone. Lenticular beds of sand and clay, and concretions of iron carbonate are common in the Wilcox.

Claiborne formation. The Claiborne formation is exposed in the extreme southeastern part of Saline County in T. 2 S., R. 12 W., and in a small area in the vicinity of Jacksonville, T. 3 N., R. 10 W., in northeastern Pulaski County. The formation is composed chiefly of sand with ferruginous and carbonaceous clays. Glauconite is present at some places. The Claiborne is between 900 and 1,000 feet thick where it is fully developed, but in T. 2 S., R. 12 W., it probably has only a small fraction of this thickness.

Quaternary System

Terrace deposits. Terrace deposits of compacted clay and fine sand cover small areas in eastern and southern Pulaski County and a small area in the extreme southeastern part of Saline County.

Alluvial deposits. Alluvial deposits cover approximately 5 townships in southeastern Pulaski County and extend northwestward along the Arkansas River. Similar deposits are found along the Saline River in Saline County. These consist of alluvial loams, clays, sands, and gravels. It is estimated that alluvial deposits of the Arkansas River bottom lands have a thickness of from 100 to 200 feet.

Igneous Rocks

General description. Three distinct areas of igneous rocks are exposed in the area covered by this report. These are; (1) the Fourche Mountain or Pulaski County region, (2) the Saline County region, and (3) the Potash Sulphur Springs region of Garland County. The total area of the exposures is probably not more than 10 square miles, but the value of these rocks as building and paving material gives them much economic importance (see section on "Building Stones".) In addition to the main masses of igneous rocks, many dark-colored basic dikes occur in each of the areas and these dikes cut both the igneous and sedimentary rocks.

The igneous rocks in these three regions are popularly called "granites." In a strict mineralogical sense they are not granites, but are syenites and nephelite syenites. Physically they closely resemble granite and are quite as satisfactory for structural purposes as true granites. In mineral and chemical composition they differ from granites in being deficient in silica, as they contain no quartz.

Fourche Mountain region[2]. Two igneous rocks of importance are present in the Fourche Mountain region, the "blue granite" and the "gray granite." The blue granite (or pulaskite) is a syenite. It is exposed over most of the hills of the Fourche Mountain region. The rock is blue and differs from the gray granite in that it contains but minor amounts of nephelite. Alkali feldspar, present as tabular bluish crystals, is the prominent mineral constituent. Other minerals readily recognized are flakes of biotite, minute crystals of shiny black amphibole, and some pyroxene. One of the largest exposures of gray granite (or nephelite syenite) is at the base of Allis Mountain along the Arch Street Pike south of Little Rock. The most important mineral is alkali feldspar which is present as tabular white crystals that range from a fraction of an inch to over an inch in length. Nephelite, or its alteration product, analcite, occurs as grains having a grayish-green color and a greasy luster. This mineral has been mistaken for quartz. Other important minerals are pyroxene (small dark prismatic crystals) and biotite mica (dark brown flakes).

Saline County region. Several types of syenite occur in the area near Bauxite in Saline County. For practical purposes it is not necessary to differentiate between the various kinds. Most of this igneous rock is nephelite syenite which is very similar to that of Fourche Mountain. Other types of syenite and basic dike rocks occur in the region but they are not numerous.

Potash Sulphur Springs region. Most of the igneous rocks in Garland County outcrop on a hill west of Potash Sulphur Branch. The important rocks are nephelite syenites which at some places contain large crystals of dark-brown mica. These rocks do not closely resemble the nephelite syenites of Fourche Mountain or of Saline County. They are usually pinkish, brown, or greenish-colored on unweathered surfaces. As in the other igneous areas described, dikes of syenitic and basic rocks cut both the main syenite mass and the sediments.

The masses of syenite were intruded into the Paleozoic sediments at moderate depths. It generally is believed that the intrusions occurred in Cretaceous time (post-Atoka and pre-Midway), although at present it is certain only that the igneous rocks are younger than the enclosing Paleozoic strata. It is probable that the greater part of the erosion which has modified the topography of the region to such an enormous extent had largely been completed before the intrusion of the igneous rocks.

GENERAL STRUCTURAL FEATURES

The four counties discussed in this report fall within two distinct structural provinces: (1) the area of intensely folded Paleozoic rocks lying within the Ouachita Mountains, (2) the area of unconsolidated or loosely consolidated Tertiary sediments of the Gulf Coastal Plain.

The rocks in the Ouachita Mountains consist of Paleozoic sandstones, shales, novaculites, and cherts, which have been folded intensely into anticlines (upfolds) and synclines (downfolds), the major part of which have an east-west trend. The resistant rocks, particularly the novaculites, form the most prominent ridges. The valleys commonly are underlain by less resistant rocks, chiefly shales. Both low and high angle faults have been developed as a consequence of severe folding. The faults often are

2/ Not to be confused with Fourche Mountain in Montgomery County.

overthrust toward the north especially on the southern flank of the Ouachita Mountains. In Saline and Pulaski counties the surface developed on folded Paleozoic rocks slopes southeastward under a cover of coastal plain sediments of Tertiary age.

The Tertiary sediments, chiefly sands and clays in the four counties, are not folded and have a southeast dip of about 20 feet to the mile. In general, the formations thicken to the southeast.

MINERAL RESOURCES

SUMMARY OF ECONOMIC MINERALS

A summary of the mineral production of Montgomery, Garland, Saline, and Pulaski counties is given in Table 1. From the table it is evident that bauxite, on the basis of commercial production, is the most important mineral resource in the area. Since it first was produced in 1896, 9,835,376 long tons have been mined. Reported gross income was $57,571,391. The known reserves as of January 1, 1942 amount to approximately 20,695,000 long tons.

Structural stone ranks next to bauxite, with a value of $4,739,720 for the period from 1923 to 1940. Figures on production are not available for years prior to 1923, and the total production is much larger than the figures given. In addition, no record is available for the stone used for residential building purposes.

Gravel and sand rank third in importance and have a value of $2,170,287 and $1,124,257 respectively, for the period from 1923 to 1940. The production of these materials is also of greater importance than is indicated in Table 1. There is no record of their production prior to 1923, and small producers subsequent to that year have not reported production in every case. Large quantities of gravel are used on public roads, and only a part of the production for this purpose is reported.

Novaculite for use as whetstones ranks fourth in importance, 4,816 tons with a value of $2,887,912 having been produced during the period from 1885 to 1940. The reserves of raw novaculite are extremely large.

Clay and clay products rank fifth in importance, the combined value of production being $2,060,157 for the period from 1923 to 1939. There are a variety of clays present in the area, and the utility of these clays constitutes an important technical and economic problem. This is particularly true of the clay deposits in Saline and Pulaski counties. Fuller's earth has been produced, and at one time the production from Saline County, although very small by present-day standards, ranked second to the state of Florida in quantity and value produced in the United States. For the last 25 years, however, there has been no production of fuller's earth from Arkansas. From 1933 to 1938, inclusive, 3,484 tons of bentonite were produced. However, the deposits of bentonite appear to be small.

METALLIC MINERALS

Bauxite

Composition and properties. The term bauxite applies to an earth or rock consisting principally of hydrated oxide of aluminum. Small percentages of silica, and iron and titanium oxides usually are present. The highest grade of Arkansas bauxite approaches the composition of the mineral gibbsite or aluminum trihydrate, which theoretically contains 65.5 per cent alumina (Al_2O_3) and 34.5 per cent combined water; however, commercial Arkansas bauxite seldom exceeds 61 per cent alumina.

Table 1. Summary of Mineral Production in Montgomery, Garland, Saline, and Pulaski counties

YEAR	BAUXITE Prod. (Lg. T.)	BAUXITE Value	GRAVEL Prod. (Cu. Yds.)	GRAVEL Value	SAND Prod. (Cu. Yds.)	SAND Value
	a/ d/	b/ c/				
1885-1922	P and S 3,978,431	$21,666,040	-	-	-	-
1923	P and S 482,069	2,909,292	M and S 273,404	$ 237,861	P and S 9,699	$ 10,039
1924	P and S 328,187	1,984,219	M and S 530,332	477,299	M,P, and S 77,473	79,023
1925	P and S 295,509	1,873,229	M and S 387,128	284,539	M,P, and S 160,218	110,550
1926	P and S 368,070	2,276,880	M,P, and S 322,622	246,806	M,P, and S 106,018	93,826
1927	P and S 305,827	1,904,995	M,P, and S 246,023	210,350	M,P, and S 93,690	81,510
1928	P and S 362,987	2,203,697	M and S 144,096	129,687	M,P, and S 120,115	126,121
1929	P and S 351,174	2,181,842	M and S 218,429	186,757	M,P, and S 98,414	85,620
1930	P and S 314,383	1,818,394	G,M, and S 127,967	105,573	M,P, and S 68,636	61,772
1931	P and S 192,775	1,116,553	M and S 127,641	147,425	P and S 46,425	36,212
1932	P and S 98,207	555,264	M and S 6,553	6,782	M,P, and S 32,897	23,192
1933	P and S 153,158	919,563	M and S 15,288	10,778	M and P 42,317	32,372
1934	P and S 154,018	1,116,786	M and S 25,469	17,956	M and P 41,365	31,644
1935	P and S 333,492	2,418,147	M and S 16,662	11,747	M and P 49,426	37,811
1936	P and S 421,845	2,812,439	M and S 28,660	20,206	M and P 130,551	99,871
1937	P and S 473,456	2,786,762	M and S 13,412	6,840	M and P 54,389	46,503
1938	P and S 333,857	1,929,692	P and S 15,620	10,997	P 66,452	69,774
1939	P and S 400,254	2,293,455	M,P, and S 18,062	14,359	M and P 46,889	52,984
1940	P and S 487,677	2,804,145	M and S 70,137	44,327	M and P 60,575	45,431
TOTAL	9,835,376	$57,571,394	2,587,505	$2,170,289	1,305,549	$1,124,255

Table 1. Summary of Mineral Production in Montgomery, Garland, Saline, and Pulaski counties (cont.)

YEAR	BENTONITE		CLAY (RAW)		CLAY PRODUCTS (BRICK)		FULLER'S EARTH	
	Prod. (Sh. T.)	Value	Prod. (Sh. T.)	Value	Prod. (Thousands)	Value	Prod. (Sh. T.)	Value
1885-1922	-	-	-	-	-	-	17,799	$169,210
1923	-	-	S 1,651	$ 3,945	P 20,903	$ 271,112	-	-
1924	-	-	S 1,711	3,388	P 20,632	249,647	-	-
1925	-	-	S 1,494	3,123	P 29,754	348,419	-	-
1926	-	-	S 937	2,070	P 32,335	379,290	-	-
1927	-	-	S 565	1,378	P 20,148	223,643	-	-
1928	-	-	S 1,010	2,191	P 17,503	189,207	-	-
1929	-	-	S 5,779	12,020	P 25,896	276,051	-	-
1930	-	-	S 331	639	P 8,255	85,027	-	-
1931	-	-	S 585	1,346	-	-	-	-
1932	-	-	S 529	877	-	-	-	-
1933	S 200	$ 1,692	S 638	1,346	-	-	-	-
1934	S 325	2,171	S 731	1,294	-	-	-	-
1935	S 674	4,482	S 650	1,287	-	-	-	-
1936	S 1,283	9,866	S 491	973	-	-	-	-
1937	S 695	5,317	S 71	141	-	-	-	-
1938	S 307	2,192	-	-	-	-	-	-
1939	-	-	S 949	1,880	-	-	-	-
1940	-	-	-	-	-	-	-	-
TOTAL	3,484	$25,720	18,122	$37,898	175,426	$2,022,396	17,799	$169,210

Table 1 . Summary of Mineral Production in Montgomery, Garland, Saline, and Pulaski counties (cont.)

YEAR	STONE		NOVACULITE		SLATE		
	Prod. (Sh. T.)	Value	Prod. (Sh. T.)	Value	Prod. (Sh. T.)	Value	Total Value
1885-1922	-	-	G e/ 3,239	$1,788,058	-	-	$23,623,308
1923	P 226,755	$ 306,119	f/	-	-	-	3,738,368
1924	P 306,843	432,649	G 214	143,264	-	-	3,369,489
1925	P 218,450	286,169	G 255	165,018	-	-	3,071,047
1926	P 174,821	230,763	G 158	106,317	-	-	3,335,952
1927	P 249,693	277,159	f/	-	-	-	2,699,035
1928	P 208,420	250,104	G 194	113,140	-	-	3,014,147
1929	P 286,762	321,174	G 171	115,684	-	-	3,179,148
1930	P 389,023	420,145	f/	-	-	-	2,491,550
1931	P 230,973	233,283	G 59	38,379	-	-	1,573,198
1932	P 125,093	138,853	G 40	25,129	-	-	750,097
1933	P 92,425	104,655	G 20	10,417	-	-	1,080,823
1934	P 97,677	109,398	G 82	49,741	-	-	1,328,990
1935	G and P 123,906	138,952	G 93	64,651	-	-	2,677,077
1936	G and P 193,131	216,387	G 119	64,817	-	-	3,224,559
1937	G and P 235,418	256,628	G 47	44,465	-	-	3,146,656
1938	P 251,588	314,485	G 41	43,777	M 98	$ 559	2,371,476
1939	P 199,381	293,218	G 46	49,433	M 744	6,372	2,711,701
1940	P 322,028	409,579	G 40	66,081	-	-	3,369,563
TOTAL	3,932,387	4,739,720	4,818	$2,888,371	842	$6,931	$70,756,184

a/ G=Garland M=Montgomery P=Pulaski S=Saline
b/ 1899-1922 (incl.) production for bauxite.
c/ Estimated from U. S. Bureau of Mines production figures.
d/ Estimated 91.3% for production from Saline County and 8.7% for production from Pulaski County.
e/ Production after 1897 is for finished product.
f/ Figures not available.

The following Table 2 gives analyses of several samples of bauxite from various localities in Saline and Pulaski counties:

Table 2 . Chemical analyses of bauxite samples from Saline and Pulaski counties[a].

Location Sec. T. R.	Al_2O_3	SiO_2	Fe_2O_3
E½ SE 35-1N-12W	55.16	10.42	3.25
NW SW 2-1S-12W	58.25	4.41	3.21
S½			
NW NE 9-1S-12W	61.51	5.88	1.88
SE SW 9-1S-12W	53.90	6.26	10.70
NW NW 2-2S-14W	47.25	22.50	1.75
SE SW 11-2S-14W	52.06	9.21	7.35
E½			
SE NE 13-2S-14W	56.50	5.41	5.82
SW NE 15-2S-14W	57.66	3.78	4.41
		3.76	4.80
N½			
NW NE 24-2S-14W	55.10	7.20	4.20
SW SW 24-2S-14W	49.00	23.50	2.50
NE SW 28-2S-14W	59.48	5.01	2.11

a/ Analyses of bauxite in Arkansas compiled by Arkansas Geological Survey, August 1, 1941.

Arkansas bauxite is commonly light buff in color, but brown, red, and gray ores also occur.

The hardness of the bauxite varies considerably. Locally, the ore is soft enough to be shoveled without picking. For the most part, however, the ore must be broken, usually with blasting powder, and some of the ore is as hard as a well-cemented sandstone. The upper part of the ore bodies is usually the hardest and there is commonly a crust about a foot thick at the top which is well-cemented and often high in silica. This top crust is referred to as "hard pan," and when mined by the open-pit method is usually stripped off the ore body as waste.

The bauxite ore is characteristically very porous, the average porosity being about 38.5 per cent. The weight of the average ore (containing 13 per cent moisture) is about 100 pounds to the cubic foot. Twenty-five and seven-tenths cubic feet of dry ore are required to make a long ton (2,240 pounds).

Uses. Approximately 48 per cent of the bauxite produced in the United States in 1940 was used for the production of metallic aluminum. Artificial abrasive manufacturers consumed 29 per cent during that year. Eighteen per cent of the domestic production of bauxite was used in the manufacture of chemicals, principally aluminum sulphate, sodium aluminate, sodium aluminum sulphate, aluminum chloride, and alum. Since 1937, activated bauxite has been used as a decolorizing agent in oil refining in the United States. In 1937, 3,095 tons of activated bauxite ore were used and 8,298 long tons were used in 1938. In 1940, bauxite used for oil refining and as a refractory, amounted to approximately 5 per cent of the total production of that year.

Prices. According to the Minerals Yearbook for 1941, the average selling price for crude (undried) bauxite, f.o.b. mines and processing plants, was $3.44 per long ton in 1940. The average selling price was $5,51 for crushed dried bauxite; $14.30 for calcined bauxite; and $36.97 for activated bauxite. The average value for all grades of domestic ores as shipped by mine producers was $5.93 per ton ($5.77 in 1939). See Plate II for average annual price of bauxite in Arkansas. Table 3 gives range of quotations on bauxite, 1938-1940.

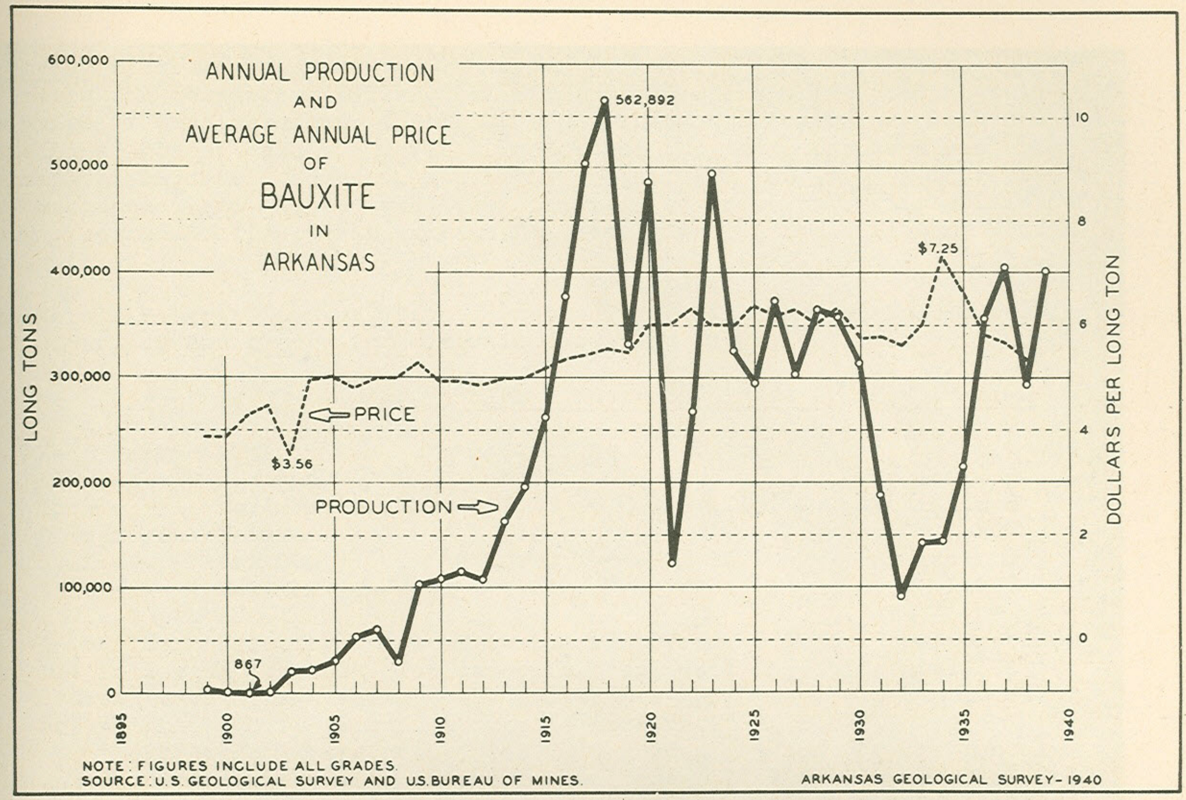
Occurrence. The bauxite in Arkansas is known to occur only in Saline and Pulaski counties. The known commercial bauxite is limited to two areas. The most productive of these has an area of about 7 square miles and is 5 miles east of Benton; the other has an areal extent of about 8 square miles and is about 3 miles southeast of Little Rock. The bauxite of commercial grade that has been developed to date is, for the most part, closely associated with masses of nephelite syenite. The bauxite commonly grades downward into kaolin, the kaolin grades downward into kaolinized syenite which grades downward into fresh syenite. Deposits of bauxite of this character not infrequently have been transported beyond the syenite and rest upon the blue clay at the top of the Midway formation. Such bauxite is known as "transported ore." Lignite or lignitic clay commonly lies directly above the bauxite. The bauxite ore bodies usually are gently undulating and relatively flat; dips over 10° are uncommon. Single deposits are usually not more than a few acres in extent. The thickness of the bauxite ore varies from place to place, the maximum thickness being about 36 feet and the average between 10 and 11 feet

Bauxite generally is considered a residual product resulting from the intensive weathering of aluminum bearing rocks under unusually favorable climatic conditions. In Arkansas, the bauxite has been formed as a result of the weathering of nephelite syenite and the process of its formation involved the solution and removal of constituents other than aluminum from this rock.

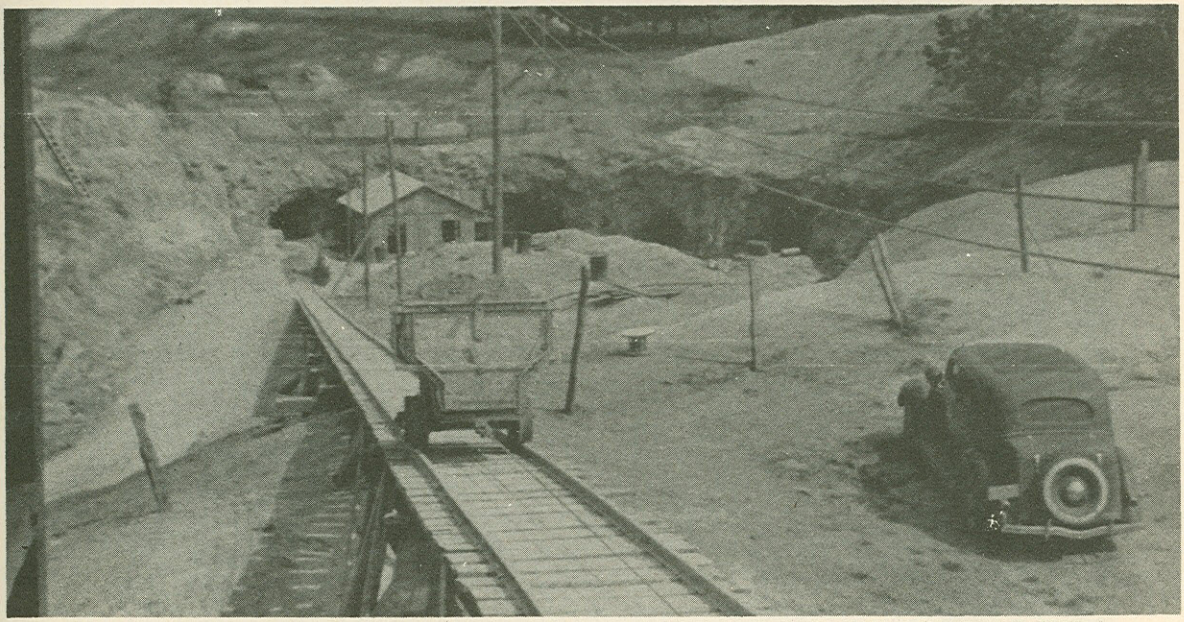
There are three physical types of the Arkansas ore (1) the pisolitic, (2) "sponge ore" or "granite ore", (3) the amorphous type or clay. The pisolitic ore is the most common type, and the pisolites (small spherical bodies resembling peas) range in size from less than 0.1 inch to over an inch in diameter. The sponge ore is less abundant and except for its porous character has a texture similar to that of nephelite syenite. The sponge ore commonly lies below the pisolitic ore and grades upward into it. The sponge ore commonly grades downward into clay (kaolin) which in turn grades into fresh syenite. The amorphous type is the least abundant. It is without definite texture and resembles clay. This ore is definitely distinguished from clay only by chemical analyses. The principal bauxite mines are shown on Plate IV.

Production. Active development of the Arkansas bauxite field began in 1895 with the purchase of land and mineral rights only 8 years after John C. Branner, State Geologist, had identified deposits near Sweet Home, Pulaski County. The first reported production of bauxite in Arkansas was 20 long tons in 1896. Plate II shows the annual production of bauxite in Arkansas from 1899 to 1940, inclusive. Table 4 shows the production of bauxite by counties for the same period.

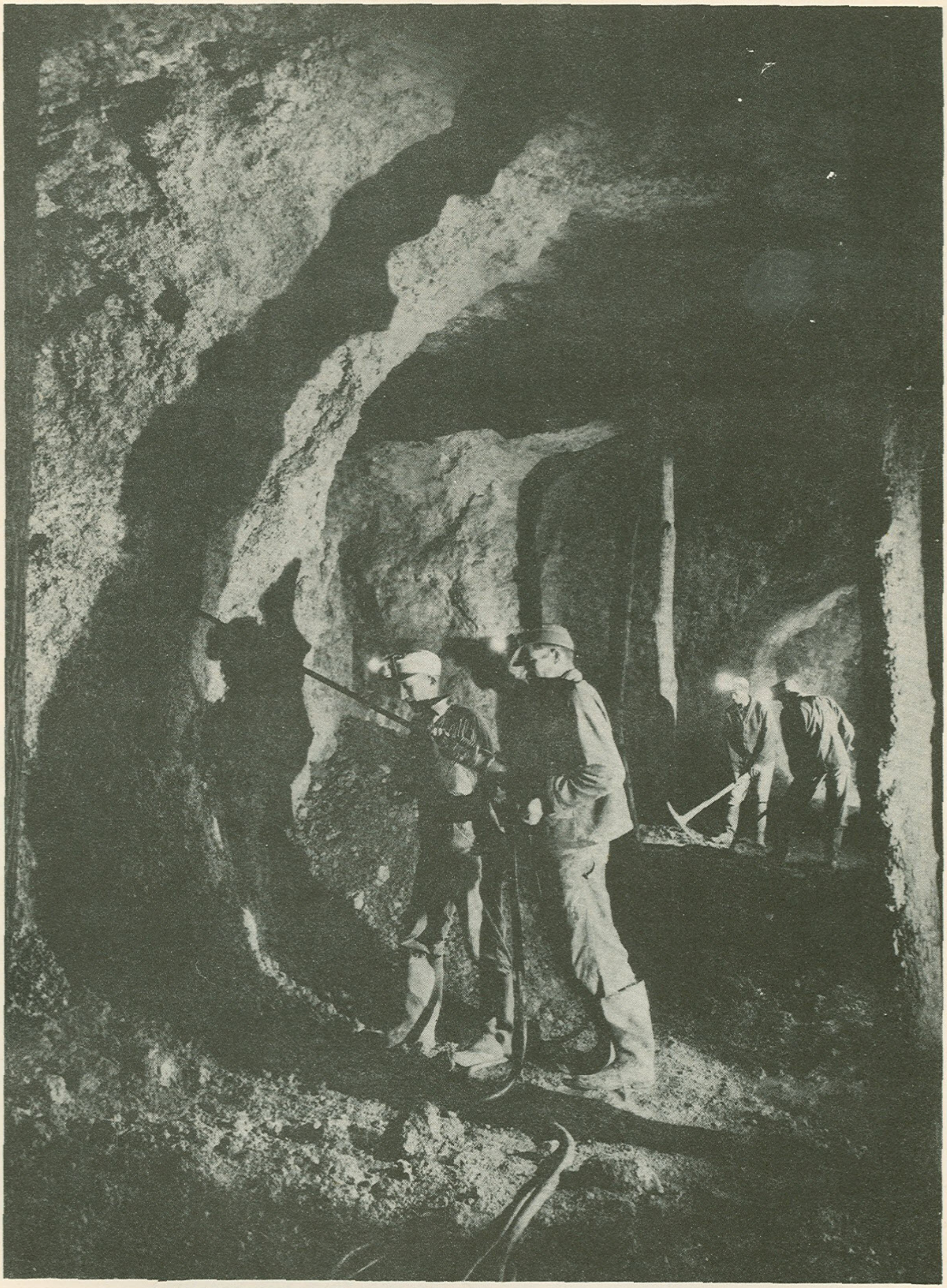
Reserves. Bauxite reserves in Arkansas, containing 45 per cent or more alumina total 21,527,108 long tons.



ANNUAL PRODUCTION AND AVERAGE ANNUAL PRICE
OF BAUXITE IN ARKANSAS.



MINING BAUXITE UNDERGROUND BY MEANS OF A SLOPE
FOLLOWING THE DIP OF THE ORE FROM THE OUTCROP,
PULASKI COUNTY, ARKANSAS. Photo by R. W. Smith



INTERIOR OF BAUXITE MINE, SALINE COUNTY, ARKANSAS.
Photo by Margaret Bourke-White

Locations of bauxite mining operations
in
Pulaski and Saline counties, Arkansas,
July 1942

Map no.	Owner	Quarter	Sec.	T.	R.	County
1.	Dixie Bauxite Co.	NW SW	19	1N	11W	Pulaski
2.	" " "	SW NW	36	1N	12W	"
3.	" " "	SE SW	25	1N	12W	"
4.	American Cyanamid & Chemical Corp.	S½ NW NE	9	1S	12W	"
5.	" " " " "	NE SW	9	1S	12W	"
6.	" " " " "	SE SW	9	1S	12W	"
7.	" " " " "	E½ SE	28	2S	14W	Saline
8.	" " " " "	SE NE	28	2S	14W	"
9.	" " " " "	SE SW	11	2S	14W	"
9.	" " " " "	SW SE	11	2S	14W	"
10.	" " " " "	NE SW	24	2S	14W	"
11.	" " " " "	SW SW	24	2S	14W	"
12.	" " " " "	S½ NW NE	24	2S	14W	"
13.	Percy C. Upton	NW NE	2	1S	12W	Pulaski
14.	Roy Prewitt	SW NE	25	1N	12W	"
15.	Dulin Bauxite Co.	NE SW	2	1S	12W	"
15.	" " "	NW SW	2	1S	12W	"
16.	" " "	SE SE	24	1N	12W	"
16.	" " "	NE SE	24	1N	12W	"
17.	" " "	N½ S½ SW	35	1S	14W	Saline
18.	Republic Mining & Manufacturing Co.	SW SW	10	2S	14W	"
19.	" " " " "	NE NE	14	2S	14W	"
20.	" " " " "	SE NW	14	2S	14W	"
21.	" " " " "	SW SW	15	2S	14W	"
22.	" " " " "	NE SW	16	2S	14W	"
23.	" " " " "	NW SE	16	2S	14W	"
24.	" " " " "	SW NW	26	2S	14W	"
24.	" " " " "	SE NW	26	2S	14W	"
25.	" " " " "	NE NW	27	2S	14W	"
26.	" " " " "	NE NW	22	2S	14W	"
27.	" " " " "	SE SE	22	2S	14W	"
28.	" " " " "	SW SW	23	2S	14W	"
29.	" " " " "	NE NW	26	2S	14W	"
29.	" " " " "	NW NW	26	2S	14W	"
29.	" " " " "	NW SW	26	2S	14W	"
30.	" " " " "	NE NE	27	2S	14W	"
31.	" " " " "	SE NE	27	2S	14W	"
32.	" " " " "	NE SE	26	2S	14W	"
33.	Reynolds Metals Co.	SW	12	2S	14W	"
34.	The Norton Co.	SW NE	15	2S	14W	"

BAUXITE MINING DISTRICT OF CENTRAL ARKANSAS

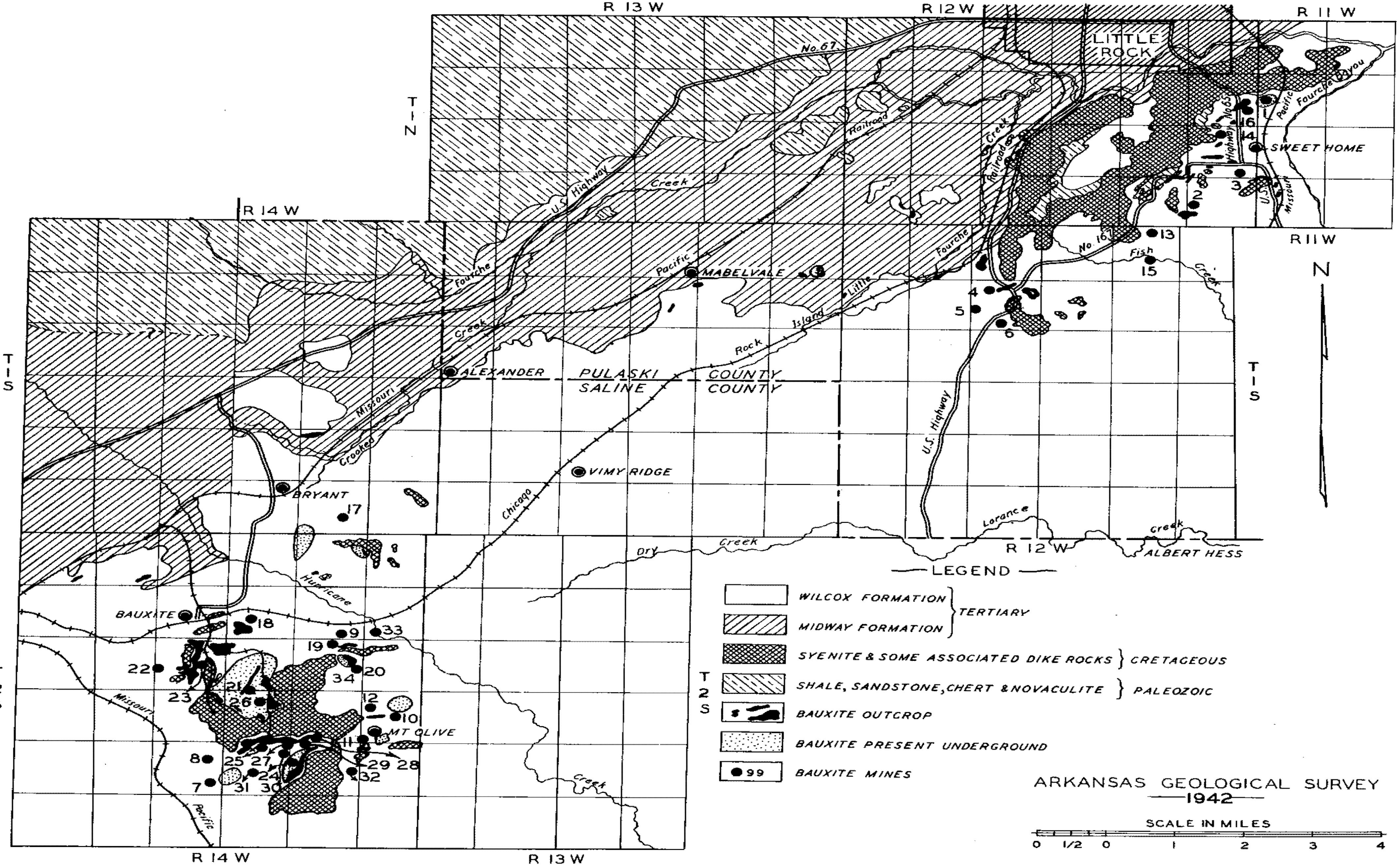


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Table 3 . Range of quotations on domestic bauxite, 1938-1940[a]

Type of ore	Chemical specifications (per cent)		Prices during year		
	Al_2O_3	SiO_2	1938	1939	1940
Domestic ore (per long ton):					
Chemical, crushed and dried -	55-58	b/	$6.00-$7.50	$6.00-$7.00	$6.00-$8.00
Other grades ----------------	56-59	5- 8	6.00- 7.50	6.00- 7.00	6.00- 8.00
Pulverized and dried --------	56-59	8-12	9.00-12.00	9.00-11.00	9.00-16.00
Abrasive grade, crushed and calcined ------------------	78-84	c/	12.00-15.00	12.00-14.00	12.00-14.00

a/ U. S. Bureau of Mines, Minerals Yearbook, Review of 1940, p. 635, 1941.
b/ SiO_2 not specified; Fe_2O_3, 1.5-2.5 per cent.
c/ Not specified.

The following companies produced or processed bauxite in Arkansas in 1941:

American Cyanamid & Chemical Corp.
Main office: 30 Rockefeller Plaza, New York, N. Y.
Arkansas address: Box 41, Route 4, Bauxite, Ark.
Pulaski County: Rauch (leased), Rauch (owned), Heckler, and Berger (crushing and drying plant) mines.
Saline County: Fletcher, Townsend, Ozark No. 24, Ozark No. 28, Cargill, Old Globe, west Bauxite (crushing, drying and calcining plant), and Section 28 (sintering plant for crushing and sintering) mines.
Produces abrasive (calcined) and chemical ore.
W. L. Powers, Supt.

Consolidated Chemical Industries.
Main office: Houston, Texas.
Arkansas address: Route 4, Little Rock, Ark.
Pulaski County: Bierman mine.
Produces chemical ore.
S. M. Stelling, Supt.

Crouch Mining Co.
Arkansas address: Box 342, Route 4, Little Rock, Ark.
Saline County: Reynolds mine.
Produces abrasive (dry) and chemical ore.
Wm. J. Crouch, Supt.

Dixie Bauxite Co.
Address: Sweet Home
Pulaski County: Dixie No. 2 and Dixie No. 3 mines.
Produces abrasive (calcined) and chemical ore.
J. Floyd Brown, Supt.

Dulin Bauxite Co.
Arkansas address: 2222 Vance St., Little Rock, Ark.
Pulaski County: Reichardt mine.
Produces crude ore.
Wilford Olsen, Supt.

Norton Co., The
Arkansas address: Box 509, Arch St. Pike, Little Rock, Ark.
Pulaski County: Norton mine.
Began operations early in 1942.
J. F. Gibbons, Supt.

Porocel Corp.
Arkansas address: Box 509, Little Rock, Ark.
Pulaski County: Porocel Corp. plant.
Process crushed and dried bauxite ore purchased from others.

Republic Mining & Mfg. Co., The
Main office: 230 Park Ave.
Arkansas address: Bauxite, Ark.
Pulaski County: Ratcliff-Graves mine.
Saline County: Section 10, Section 14, Section 15-22, Alexander Hill, Pruden, Davis, Section 26, Bertha, Nelson, and Section 27 mines.
Produces metallic, abrasive, and chemical ore.
L. R. Branting, Supt.

Iron

General statement. Small deposits of iron ore in the form of limonite, a dark brown to nearly black mineral with a yellowish-brown streak and submetallic to nonmetallic luster, occurring either alone or associated with manganese ore, are found in various locations in Montgomery, Garland, and Pulaski counties.

Two deposits of material resembling hematite in physical properties but containing 8.05 per cent of water occur in Montgomery County, N½ sec. 29, T. 3 S., R. 23 W. and SW¼ sec. 23, T. 3 S., R. 23 W. These deposits are of high iron and low silica content but the high percentage of phosphorous present has prevented commercial exploitation as an iron ore[3/].

Another iron-bearing mineral, Pyrite (FeS_2), has been found in Garland County SW¼ SE¼ sec. 2, T. 3 S., R. 20 W. in quartzitic sandstone that has been much deformed and shattered by faulting. This mineral never has been used as an iron ore, its chief value being in the production of sulphuric acid. There has been no record of production in Garland County.

For locations of other iron deposits, see Table 6 on occurrences of iron and manganese.

Lead, Zinc, and Precious Metals

Lead and Zinc. Galena (lead sulphide) and sphalerite (zinc sulphide), also known as zinc blende or black jack, have been reported from one locality in Pulaski County and three in Montgomery County. Zinc blende was reported from one locality in Saline County. Lead and zinc ores are not of economic importance in the three counties mentioned; however, hand picked specimens have shown a high content of these minerals. See Table 5 .

Gold. Nowhere in Garland or Montgomery counties has there been discovered a deposit containing a sufficiently high average per-ton in gold to pay for treatment. Indeed it may be said of the gold mines in Arkansas in general that it is very doubtful whether a single one of them has ever legitimately returned a single ounce of

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3/ Penrose, R. A. F.,Jr., Manganese, Its Uses, Ores and Deposits: Arkansas Geol. Survey Ann. Rept. for 1890, Vol. I, 1891.

Table 4 . Production and value of bauxite in Saline and Pulaski counties, 1899-1940

Year	Saline County		Pulaski County		Total	
	Production short tons	Value	Production short tons	Value	Production short tons	Value
1899-1922a/	3,632,307.51	$19,781,094.52	346,123.49	$1,884,945.48	3,978,431.00	$21,666,040.00
1923b/	445,280.49	2,687,268.70	36,789.00	222,023.30	482,069.49	2,909,292.00
1924c/	305,447.03	1,846,732.74	22,740.00	137,486.04	328,187.03	1,984,218.78
1925	274,085.52	1,737,428.11	21,423.00	135,800.39	295,508.52	1,873,228.50
1926	382,637.83	2,032,953.61	39,432.00	243,926.35	368,069.83	2,276,879.96
1927	279,219.80	1,728,982.72	26,606.92	176,011.92	305,826.72	1,904,994.64
1928	298,711.91	1,813,480.01	64,275.54	390,216.79	362,987.45	2,203,696.80
1929	283,514.12	1,761,473.23	67,659.64	420,369.34	351,173.76	2,181,842.57
1930	266,612.16	1,542,084.73	47,771.25	276,308.91	314,383.41	1,818,393.64
1931	155,215.24	899,006.67	37,559.76	217,546.13	192,775.00	1,116,552.80
1932	53,598.00	303,043.09	44,609.23	252,220.58	98,207.23	555,263.67
1933	80,054.43	480,646.80	73,103.92	438,915.93	153,158.35	919,562.73
1934	110,429.11	800,721.48	43,589.06	316,064.27	154,018.17	1,116,785.75
1935	278,455.13	2,019,078.14	55,036.37	399,068.72	333,491.50	2,418,146.86
1936	302,473.25	2,016,589.16	119,371.45	795,849.46	421,844.70	2,812,438.62
1937	362,577.10	2,134,128.81	110,878.90	652,633.21	473,456.00	2,786,762.02
1938	291,338.70	1,683,937.68	42,518.04	245,754.27	333,856.74	1,929,691.95
1939	330,335.99	1,892,825.22	69,917.95	400,629.85	400,253.94	2,293,455.07
1940	403,576.67	2,320,565.85	84,100.64	483,578.68	487,677.31	2,804,144.53
	8,481,869.99	$49,482,041.72	1,353,506.16	$8,089,349.62	9,835,376.15	$57,571,390.89

a/ Estimated from U. S. Geological Survey production figures by using 91.3 per cent for Saline County and 8.7 per cent for Pulaski County.

b/ Estimated for four-quarters on following figures for three quarters, from severance tax figures: Saline County, 333,960.49 long tons, valued at $2,015,451.55; Pulaski County, 27,592.00 long tons, valued at $166,517.72.

c/ Production figures from 1924 to 1940, inclusive, from severance tax reports. Value estimated by using U. S. Bureau of Mines average unit price of bauxite in Arkansas.

Table 5. Available assays of gold, silver, copper, lead, and zinc ores from Montgomery Garland, Saline, and Pulaski counties *

Map no.	Location Sec. T. R.	Name	Material	Gold oz. per ton	Silver oz. per ton	Copper per cent	Lead per cent	Zinc per cent	Assayer
	PULASKI COUNTY								
1	25-3N-12W or 30-3N-11W	Kellogg Mine	Average assorted ore running high in galena1/	Trace	30-60	-	-	-	Ark. Geol. Survey
			Zinc blende1/	0	18	-	-	-	Ark. Geol. Survey
			Selected galena1/	Trace	60	-	78	-	Ark. Geol. Survey
			Galena and copper pyrites1/	-	-	12	52	-	Ark. Geol. Survey
			Selected copper pyrites1/	-	31	26	-	-	Ark. Geol. Survey
			Selected zinc blende1/	-	18	-	-	64.5	Ark. Geol. Survey
			Carefully selected argentiferous gray copper (freibergite)1/	-	788	5	-	Small amount	Ark. Geol. Survey
			Sack of 95 pounds2/	-	-	-	-	62.5	Matthiessen & Hegeler Zinc Co., LaSalle, Ill.
			Cube galena free from gangue3/	-	$604/	-	81	-	U. S. Mint, Philadelphia
			Cube galena free from gangue3/	-	$524/	-	77	-	U. S. Mint, Philadelphia
			Selected Tetrahedrite3/		$1234/	-	-	-	U. S. Mint, Philadelphia
			Average galena ore		26.6	-	31.1	-	F. W. Gibb
			Copper pyrites	Trace	7.2	-	-	-	F. W. Gibb

Table 5. Available assays of gold, silver, copper, lead, and zinc ores from Montgomery Garland, Saline, and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Name	Material	Gold oz. per ton	Silver oz. per ton	Copper per cent	Lead per cent	Zinc per cent	Assayer
	PULASKI COUNTY (cont.)		Average zinc blende	-	0.6	-	-	-	F. W. Gibb
			Selected sample of galena	-	70.4	-	72	-	F. W. Gibb
			Selected gray copper (tetrahedrite)	-	1112	-	-	-	F. W. Gibb
2	30-1N-13W	McRae mine	Shaley pyritous ore with little galena	0	3.5	-	-	-	Ark. Geol. Survey
3	30-1N-14W	Fletcher Diggings	Manganiferous limonite	Trace	1	-	-	-	Ark. Geol. Survey
	SALINE COUNTY								
4	26-1N-16W		Black zinc blende in "float"	0	9	-	-	56	Ark. Geol. Survey
			Quartz (Crucible assay)	0	1	-	-	-	Ark. Geol. Survey
5	33-1N-18W	Sandcarbonate mine	Quartz (Scorification assay)	0	1	-	-	-	Ark. Geol. Survey
6	5-1N-17W	Bradfield's	Impure limonite	Trace	1	-	-	-	Ark. Geol. Survey
	GARLAND COUNTY								
7	23-2S-19W	Pleasant Run	Rusty quartz	.06	0	-	-	-	Ark. Geol. Survey
8	28-2S-19W	Glenpatrick lode. Patsy's Pride shaft	Siliceous sinter	.08	0	-	-	-	Ark. Geol. Survey
9		Shippey mine Hot Springs	Rusty quartz	.04	0	-	-	-	Ark. Geol. Survey

Table 5. Available assays of gold, silver, copper, lead, and zinc ores from Montgomery Garland, Saline, and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Name	Material	Gold oz. per ton	Silver oz. per ton	Copper per cent	Lead per cent	Zinc per cent	Assayer
	MONTGOMERY COUNTY								
10	10-2S-21W	Mammoth lode Bear City	-	-	7	-	-	-	F. W. Gibb
11	16&17-2S-23W	Montezuma mine	Galena, etc., from ore house[5]	0	31	-	-	-	Ark. Geol. Survey
			Large piece, assorted, from ore house; galena and zinc blende	-	-	1.5	43	14	Ark. Geol. Survey
12	17&20-2S-23W	Walnut mine	Galena and zinc blende[5]	Trace	17	-	-	-	Ark. Geol. Survey
			Assorted galena ore	-	-	2	76	4	Ark. Geol. Survey
			Quartz, copper stain	-	99.3	-	-	-	F. W. Gibb[6]
			Tetrahedrite	-	18.8	-	-	-	F. W. Gibb[6]
			Selected galena	-	103.6	-	-	-	F. W. Gibb[6]
13	30-2S-23W	Waterloo mine	Zinc blende and galena from vein[5]	Trace	23	-	-	-	Ark. Geol. Survey
			Specimens of rich ore said to have come from old "bonanza" now worked out[7]	Trace	346	-	-	-	Ark. Geol. Survey
14	30-2S-23W	Minnesota mine (Diamond Joe)	Samples from dump showing galena and zinc blende[5]	Trace	36	-	-	-	Ark. Geol. Survey

Table 5. Available assays of gold, silver, copper, lead, and zinc ores from Montgomery Garland, Saline, and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Name	Material	Gold oz. per ton	Silver oz. per ton	Copper per cent	Lead per cent	Zinc per cent	Assayer
	MONTGOMERY COUNTY (cont.)								
		Minnesota mine (Diamond Joe)	Quartz with spots of green and red mineral in place[5]	0	1.5	-	-	-	Ark. Geol. Survey
15		Eureka lode	Galena and zinc blende	Trace	19.5	-	-	-	Ark. Geol. Survey
			Assorted ore, carefully picked specimens, largely galena	-	-	4	49	15	Ark. Geol. Survey
16		Zarelda mine Silver City district	Galena	-	40.3	-	-	-	F. W. Gibb[6]
			Iron pyrites	-	11.8	-	-	-	F. W. Gibb[6]
17		Marga mine Silver City district	Probably a carbonate	-	26.2	-	-	-	F. W. Gibb
18	10-4S-27W	Specimens submitted by L.L. Beavers, Mount Ida	Light ore	.30	.09	-	-	-	W. F. Manglesdorf
			Dark ore	.12	.40	-	-	-	W. F. Manglesdorf
19	10-4S-27W	Statehouse Mountain	From NW$\frac{1}{4}$ NW$\frac{1}{4}$	-	-	.18	-	-	W. F. Manglesdorf
			From creek bed in SE$\frac{1}{4}$	-	-	.02	-	-	W. F. Manglesdorf
			From sump hole bottom of shaft	-	-	.10	-	-	W. F. Manglesdorf
			Immediately over sump hole	Trace	-	.14	-	-	W. F. Manglesdorf

Table 5. Available assays of gold, silver, copper, lead, and zinc ores from Montgomery Garland, Saline, and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Name	Material	Gold oz.per ton	Silver oz.per ton	Copper per cent	Lead per cent	Zinc per cent	Assayer
	MONTGOMERY COUNTY (cont.)								
19	10-4S-27W	Statehouse Mountain	Four feet above sump hole	Trace	-	.10	-	-	W. F. Manglesdorf
			Harder material 4 feet above sump hole	-	-	.03	-	-	W. F. Manglesdorf
			Left of sump hole near rim	Trace	-	.50	-	-	W. F. Manglesdorf
			Six feet above floor of shaft	-	-	.07	-	-	W. F. Manglesdorf
			Seven feet above floor of shaft	-	-	.08	-	-	W. F. Manglesdorf
			Near SW corner of shaft 6 feet above floor	-	-	.07	-	-	W. F. Manglesdorf
			Center west face 7 feet above floor	-	-	9.50	-	-	W. F. Manglesdorf
			NE corner 10 feet above floor	Trace	-	.06	-	-	W. F. Manglesdorf
			30 feet down shaft from tunnel	Trace	-	.24	-	-	W. F. Manglesdorf
			Ceiling of tunnel immediately over shaft collar	-	-	3.36	-	-	W. F. Manglesdorf
			Wad specimen 30 feet north of shaft on east wall of tunnel	-	-	.12	-	-	W. F. Manglesdorf

Table 5. Available assays of gold, silver, copper, lead, and zinc ores from Montgomery Garland, Saline, and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Name	Material	Gold oz. per ton	Silver oz. per ton	Copper per cent	Lead per cent	Zinc per cent	Assayer
	MONTGOMERY COUNTY (cont.)								
			Bottom of shaft	.40	-	.25	-	-	W. F. Manglesdorf
			Bottom of shaft	0	-	.30	-	-	W. F. Manglesdorf
		Statehouse Mountain	Bottom of shaft	.20	-	.12	-	-	W. F. Manglesdorf
			West wide of tunnel about 10 feet from heading of tunnel	-	-	.10	-	-	W. F. Manglesdorf

1/ From German slope of Kellog mine.
2/ Reported by F. W. Gibb.
3/ Material furnished by G. M. Howell, Secretary Arkansas and Ohio M. & M. Co. Assayed February 8, 1867.
4/ Value per ton, basis not stated.
5/ Results do not represent average ore in any case. The mines were mostly filled with water and the assays are only rough approximations of what the ores will yield when fairly assorted. The value of the properties will depend upon the relative proportions of ore and "dead" rock, at present a very uncertain element. The quartz and shale assays are from rock in place.
6/ Specimen collected and analyzed by F. W. Gibb. Locations not vouched for by him.
7/ Specimen furnished by postmaster at Silver City.

* Comstock, Theo B., Report upon the geology of Western Central Arkansas, with especial reference to gold and silver; Arkansas Geol. Survey Ann Rept. for 1888, Vol. I, 1888.

gold[4/]. In 1888 the chemist of the Arkansas Geological Survey assayed 171 specimens from Pulaski, Saline, Garland, and Montgomery counties. Of these only three (from Garland County) contained gold. The results of the assays are shown in Table 5, together with other analyses.

Silver. Silver-bearing ores occur in the four counties of this report but not in sufficient quantities to involve commercial mining at present prices. The Kellogg mine, located in NE¼ NE¼ sec. 25, T. 3 N., R. 12 W., Pulaski County, has been worked intermittently since about 1840. The U. S. Bureau of Mines has a record of production in 1925 of 3,118 troy ounces of silver, valued at $2,614, which it is believed was derived from lead ores from Kellogg mine. See Table 5 for analyses.

Copper. Very little copper has been produced in Arkansas to date; however, deposits of copper are found at the North Mountain mine, sec. 10, T. 4 S., R. 27 W., where manganese is now being mined, and plans for the commercial exploitation of this copper are being developed. Small quantities of malachite have been shipped from the Big Bear mine near Ferndale, Pulaski County, but the mining of this ore has not proved profitable in the past. Copper occurs in association with other minerals in all four counties and possibly may be extracted from other metallic ores as a by-product. See Table 5 for analyses.

Manganese

Composition and properties. Four manganese minerals, pyrolusite, manganite, psilomelane, and wad, all oxides of manganese, are found in the counties under discussion. Normally the metallic manganese content in these minerals is: pyrolusite, 60 to 63 per cent; manganite, about 62.4 per cent; psilomelane 45 to 60 per cent. This content is variable as is the manganese content of the ore which is composed of different associations of these minerals.

Pyrolusite, MnO_2, is one of the most important of the manganese minerals. It is grayish-black to black with either a crystalline or earthy structure and is much softer than the other minerals frequently rubbing off on the hands. Manganite, $Mn_2O_3 \cdot H_2O$, is brittle, is massive or crystalline in form, has a dark steel-gray to iron-black color and a reddish-brown or nearly black streak. It is found associated with other manganese minerals and frequently alters to pyrolusite.

Psilomelane contains manganese in the forms of MnO_2 and MnO together with water and oxides of other elements including barium and potassium. It is a black or steel-blue mineral, has a brownish-black streak, is massive in structure, and is distinguished from the other manganese oxides chiefly by its greater hardness. Its usual occurrence is with pyrolusite. Wad, an impure mixture of manganese oxides, is a soft, dark-brown or black earthy mineral and occurs alone or with psilomelane and with the iron oxides, limonite and hematite.

Uses. The chief use of manganese is as an alloy with iron to be employed in the making of steel and for this purpose it is delivered to the steel producers in the forms of ferromanganese, containing 78 to 82 per cent manganese and 8 to 15 per cent iron, and as spiegeleisen containing 18 to 22 per cent manganese and 70 to 80 per cent iron. Other uses are as an oxidizer in dry batteries, for decolorizing glass, as a drier in paints, as coloring material in pottery, tile, brick, and some types of cloth. Other non-ferrous alloys are made by combining manganese with copper, aluminum, zinc, tin, lead, magnesium, or silicon.

4/ Comstock, Theo B., Report upon the Geology of Western Central Arkansas, with especial reference to Gold and Silver: Arkansas Geol. Survey Ann. Rept. for 1888, Vol. I, 1888

Prices. According to the U. S. Bureau of Mines, Minerals Yearbook, Review of 1940, "Prices for domestic metallurgical manganese ore are not cuoted, but in 1940 the average value of ores reported to the bureau was about 50 cents per long-ton unit for ore containing 35 per cent or more Mn." Most of the manganese used in the United States has been imported; however, since the present war has greatly increased the demand for manganese and at the same time has made it practically impossible to import it in any great quantities,great impetus has been given to the development of domestic deposits.

The Metals Reserve Company, United States purchasing agency, issued the following schedule of prices and grades for domestic producers on May 4, 1942:

	High Grade	Low Grade A	Low Grade B
Manganese---Minimum	48.00%	44.00%	40.00% a/
Alumina-----Maximum	6.00	10.00	No maximum
Iron--------Maximum	7.00	10.00	No maximum
Phosphorous-Maximum	0.18	0.30	0.50%
Silica------Maximum	10.00	15.00	No maximum
Zinc--------Maximum	1.00	1.00	1.00%

Price: Effective May 4, 1942, contracts will be considered on the following schedule for domestic ores, within continental United States (excluding Alaska); all prices per long ton (2,240 pounds) of dry weight, f.o.b. cars at stockpile designated by Buyer.

"High Grade"- Base price, $48.00 per long dry ton for ore containing 48.0% manganese with an increase of one dollar ($1.00) per ton for each unit (22.4 pounds) in excess of 48.0%; fractions prorated. "High Grade" ore containing not less than 48.0% manganese but otherwise falling below specifications will be accepted subject to penalties b/.

"Low Grade A" - Base price, $35.20 per long dry ton for ore containing 44.0% manganese with an increase of eighty cents ($.80)per ton for each unit (22.4 pounds) in excess of 44.0%; fractions prorated.

"Low Grade B" - Base price $26.00 per long dry ton for ore containing 40.0% manganese with an increase of sixty-five cents ($.65) per ton for each unit (22.4 pounds) in excess of 40.0%; fractions prorated a/.

In addition to the above prices, an allowance will be made for each long ton shipped equal to the freight tariff per long ton from Seller's nearest convenient rail station to Buyer's stockpile.

The cost of sampling and analysis by the Buyer, weighing, and unloading onto stockpile will be for the account of Buyer.

Each lot of ore delivered pursuant to a contract will be graded in accordance with the specifications hereinabove setforth, and the price to be paid for such ore shall be governed accordingly.

a/ Under "Low Grade B", manganese ore will be accepted to 35.0% minimum with a penalty of $1.30 per ton for each unit (22.4 pounds) less than 40.0%; fractions prorated.

b/ See Metals Reserve Company release "Information Concerning Purchase of Domestic Manganese Ores," May 4, 1942.

Occurrence. Manganite, pyrolusite, psilomelane, and wad, the four manganese minerals found in the four county area, are secondary deposits. Primary manganese is present in most igneous rock, but is not concentrated in any appreciable amount. Concentration depends on secondary processes of solution and redeposition in the forms of manganese oxides. Either thermal solutions or meteoric ground waters may be the agents of redeposition which ordinarily takes place along fractured zones, in joints, and in cavities in the bedrock. The world's outstanding deposits of manganese are of secondary origin.

Scattered through hard novaculite, in many places occurring in bedding planes and joint cracks or forming a cement in novaculite breccia, manganese minerals are present here as coatings, nodules, pocket fillings, and veins. Iron oxides and manganese oxides frequently are mixed intimately due to the similarity of origin. The most common material associated with the iron and manganese minerals, other than novaculite, is clay.

Occurrences of manganese minerals in Montgomery, Garland, Saline, and Pulaski counties are shown in Table 6 .

Production. Since very little high-grade ore (48 per cent or more Mn), which is generally used in making standard "ferro" grades added in steel manufacture, is found in the United States, manganese production heretofore has been limited. According to the Bureau of Mines Minerals Yearbook, Review of 1940, "manganese mining in the United States improved somewhat in 1940 but supplied only 3 per cent of the apparent domestic comsumption and less than 1 per cent of the world output."

The recent impetus given by the war to the search for domestic manganese resources has aided the development of deposits in Montgomery County, which previously received little attention as far as commercial exploitation was concerned. At present the ores are being mined and stockpiled.

Companies and individuals now operating include the Dixie Manganese Corporation with holdings on Sugartree Mountain (secs. 17 and 18, T. 4 S., R. 27 W.) and on Polk Creek Mountain (sec. 13, T. 4 S., R. 27 W., and sec. 18, T. 4 S., R. 26 W.); M. C. Stenger at North Mountain mine (sec. 10, T. 4 S., R. 27 W.); and the Montgomery Manganese Corporation in sec. 16, T. 4 S., R. 25 W. Psilomelane is being mined at Pidgeon Roost Mountain by Mr. Plemmons, engineer for the city of Hot Springs, and at Nelson Mountain by Mr. Hamby of Glenwood, Arkansas. Captain Elmer Bird is operating at Fodderstack Mountain, near Caddo Gap. In 1940, the North American Manganese Corporation began working the old Fagan mine in Pike County just across the Montgomery County line.

This area probably will assume increasing importance as the demand grows for domestic manganese for production of war materials.

NON-METALLIC MINERALS

Barite

General statement. Barite, $BaSO_4$, is a colorless, white or light shade of blue, yellow, or red mineral, transparent to opaque, with a vitreous luster. The chief use for the Arkansas production of barite is to weight muds used in drilling oil and gas tests. Other uses are in the refining of sugar, as a white pigment, and to give weight to cloth and paper.

Small amounts have been found in veins with calcite or in limonite deposits in Pulaski, Saline, Garland, and Montgomery counties, but the mineral is too impure and in too small quantities to be of any commercial value. One occurrence of this has been located in Montgomery County, NW¼ NE¼ sec. 24, T. 4 S., R. 27 W., where barite underlies a limonite deposit.

Barite deposits of commercial value occur in Hot Spring County and there is a possibility that additional deposits may be found in Garland County.

Table 6 . Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	PULASKI COUNTY		
1	SW NW 19-1N-13W	Seams of manganese ore and limonite 1/4 to 1 inch thick. Nests of same material from 1 to 6 inches in diameter. Very small quantities of both. In novaculite formation1/.	Two small pits on summit of a hill immediately south of McHenry Creek.
2	SW SW 19-1N-13W	Numerous seams of limonite frequently forming circular layers around masses of novaculite1/.	No production.
3	N½ 19-1N-13W	Lenticular areas of iron ore 1 to 3 inches thick1/.	Small cut about 20 feet long by 6 feet wide in siliceous shale.
4	NW NW 33-1N-13W	Soft gray novaculite in places stained almost black with manganese is easily mistaken for good ore. Thin seams of manganese occupy cracks and joints1/.	Shaft sunk 27 feet passed through 9 feet of this rock. Very high siliceous content.
5	NW 14-1N-14W	Bog manganese and iron ores1/.	Immediate vicinity of Martindale.
6	NE SW 14-1N-14W and SE NW 14-1N-14W	Impure rusty-brown bog iron ore containing fragments of rock and inclusions of clay1/.	On banks of McHenry Creek.
7	S½ 24-1N-14W	Manganese ore and limonite in small irregular seams and pockets. Manganese and iron mixed or separate1/.	Summit of hill south of McHenry Creek.
8	NE 24-1N-14W	Bright-red bog ore containing practically no manganese1/.	On north side of McHenry Creek.
9	SE NW 24-1N-14W	Fairly good quality bog ore rapidly blending into poorer ore1/.	South bank of McHenry Creek.
10	SE NW 24-1N-14W	Rusty-black bog ore in patches in clay and gravel underlying several acres1/.	North bank of McHenry Creek.
11	SW NE 24-1N-14W	Soft and impure bog ore containing considerable quantity of iron and pebbles1/.	In a field on north side of McHenry Creek.

Table 6. Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	GARLAND COUNTY		
12	SW SW 35-1N-20W	Large lumps of limonite seen for distance of 1,000 feet together with broken sandstone2/.	On narrow anticlinal ridge running at right angles to the mountain side.
13	31 & 32-2S-22W	Manganese ore as fracture filling in sandstone2/.	Approximately 50 tons recently shipped to Pine Bluff, Arkansas. Being worked on very small scale with hand tools.
14	NW SW 4-3S-22W	Incrustation of limonite on sandstone boulders and as band in shale. Manganese ores associated with limonite in residual clays 2/.	Outcroppings exposed on hillside approximately 30 feet above creek level.
15	16-3S-22W	Hard, black manganese ore in very small quantities1/.	On ridge running west from Meyer Creek.
16	S½ SE 3-4S-19W	Limonite in gray novaculite or near its contact with shale. Masses of ore and slabs of rock found along line where formation would outcrop. High percentage of iron, low percentage of silica, injurious amount of phosphorous1/.	No production.
17	S½ 10-4S-19W	Thin seams and pockets of iron ore from a fraction of an inch to 3 inches in thickness, impregnating the gray novaculite for a width of about 10 feet often giving the rock a brecciated appearance. In novaculite just above contact with siliceous shale1/.	Not seen in workable quantities.
	MONTGOMERY COUNTY		
18	SE NE 22-3S-23W	Massive, bright submetallic, steel-gray ore with reddish-brown streak resembles hematite in physical properties but contains water. Large amount of this ore in gray novaculite at its contact with siliceous shale. Beds of limonite interstratified with siliceous shale1/.	Hematite-like ore of high iron and low silica content but amount of phosphorous is injurious.

Table 6 . Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY (cont.)		
19	SW 23-3S-23W	Fragments of hematite-like iron ore scattered over surface. Fragments often made up of stalactitic branches 1/16 to 1/4 inch in diameter1/.	
20	N½ 29-3S-23W	Seam, thin layers, and pockets of porous brown iron ore1/.	North side, half way up slope of novaculite ridge.
21	NE NE 30-3S-23W	Steel-gray iron ore cementing soft, angular, novaculite fragments. Usually in thin seams1/.	Last claim on summit of gray novaculite ridge.
22	NW 31-3S-23W	Brown, dull, earthy, pourous iron ore cementing novaculite fragments. Occasional masses of pure ore weighing from 1 to 200 pounds1/.	
23	NW SE 36-3S-24W	Veins of iron and manganese oxides only a few inches thick in hard novaculite. No workings2/.	On south slope near crest of east-west ridge about 10 miles east of Norman.
24	E½ SW 31-3S-27W	Irregular pockets and veins of limonite and a little psilomelane along joints in novaculite. Largest vein 3-1/2 inches wide3/.	Near summit of Missouri Mountain.
25	SW SW 10-4S-23W	Small veins of manganese oxide in novaculite2/.	Prospecting during World War, 1917-18. Pit 4 by 4 by 6 feet deep. West of Pigeon Roost Forest Tower on south side of road.
26	S½ NW SW 11-4S-23W	Hard, black manganese oxides in novaculite. Cut east to west 20 feet wide, 10 feet deep, 70 feet long2/.	Shaft in SW corner of cut 20 feet deep. About 20 tons removed July 1940 to end of August 1940 by R. L. Plemmens, City Engineer, Hot Springs, Arkansas. In 1937 two cars of ore were shipped to Birmingham, Alabama by Jester Stevens. Some production 1936 not shipped.
27	SW SE 4-4S-24W	Brown iron ores with a little manganese ore in novaculite2/.	No record of production.

Table 6. Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY (cont.)		
28	NW NW 11-4S-24W	Iron oxides in novaculite. Very little manganese2/.	No road to cuts. No production.
29	W½ NE NW 11-4S-24W	Manganese and iron oxides in novaculite. Manganese ore better than the average for this region2/.	On north slope near top of novaculite ridge south of Sharp Top Mountain. Five miles east of Caddo Gap.
30	SW NW 13-4S-24W	Stringer veins of iron and manganese oxides in novaculite. Little manganese2/.	Prospect pit made in January 1940. On Nelson Mountain about 500 feet northwest and higher than the Nelson mine.
31	NW SW 13-4S-24W	In thin disconnected veins and in pockets along bedding planes and joints. Hard psilomelane and a small quantity of crystalline magnetite in novaculite 3/2/.	Worked from August to December 1915 by Chester Stevens. Yielded 58 long tons. Nelson mine.
32	NE NE 18-4S-24W	Low-grade manganese oxide in brecciated novaculite2/.	Two cuts were made. No production.
33	NW 19-4S-24W	Thin veins of psilomelane occupying some of joints and bedding planes in novaculite. Plus much smaller amounts of limonite3/.	One mile south of Caddo Gap in narrow gorge. S. A. Hanna prospect. Probably 1 ton of psilomelane has been removed but no shipment has been made.
34	SW SE 32-4S-24W	Pockets of limonite which in places contain a small percentage of manganese. In novaculite3/.	Fields Prospect.
35	E½ 19-4S-25W	Veins and pockets of psilomelane and manganite. Parts of deposit might be worked on a small scale3/.	Janes Prospects. Several small openings made February to June 1916.
36	19-4S-25W	Small pieces of psilomelane in massive novaculite at top of lower division of Arkansas novaculite3/.	Near west line of sec. 19. Well up south slope of Caddo Mountain pit made in July 1916 by Mr. Janes.
37	W½ 13-4S-26W	Narrow psilomelane veins cementing brecciated fragments of novaculite3/.	Caddo Mountain Prospect near west boundary of sec. 13.

Table 6 . Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY (cont.)		
38	SW SW 13-4S-26W	Very hard manganese oxide with hematite in small stringer veins and pockets2/.	On top of Gap Mountain about 10 miles west of Caddo Gap. No road up mountain. Four cuts made in about 1918. Too little ore for ordinary commercial development.
39	SE SE and SW SE 14-4S-26W	Veins and pockets of hematite and manganese oxide not more than 1 square foot in area2/.	At top of Gap Mountain about 11 miles west of Caddo Gap. Three prospects in SE¼ SE¼ and one in SW¼ SE¼ date date back to 1917. Joe Monroe and Lewis Knold mined several tons in 1937. Lee Hunter mined and sold 4 tons of ore at $10.00 per ton in March 1940.
40	SE SE 15-4S-26W	Limonite as "blisters" on novaculite. Very little manganese showing at surface2/.	No operations.
41	16-4S-26W	4/	Collins mine. Land leased by Montgomery Manganese Corporation. Limited operations at present.
42	SE NE 16-4S-26W	Manganese and iron oxides in fractures and veins in novaculite2/.	Very little prospecting. No production to date.
43	SE 17-4S-26W	Thin veins and pockets of manganese and iron oxides in novaculite and clay3/.	W. R. Porter Prospect on south slope of Bald Mountain about 400 feet above base. Cut made June 1916.
44	SW 18-4S-26W	Numerous flat masses of limonite from 3 to 12 inches thick on crest of hill at contact of siliceous shale and novaculite. Larger quantities of similar ore in hollow between this hill and mountain to the north1/.	
45	NW 28-4S-26W	A 4-foot vein of ore in upper cut. Boulders of iron and hard, black manganese oxides in novaculite. Ore-bearing stratum forms crest of a small ridge and dips almost vertically 3/2/.	About 200 feet above South Fork on north slope of Fancy Hill Mountain. Two cuts made in spring and summer of 1916. Robert Porter Prospect. September 1940 a stratum 4-6 feet thick of red siliceous clay with manganese ore being worked by 8 workman and Mr. Boone.

Table 6. Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY (cont.)		
45			Fifty to 75 tons of unwashed ore in two 2 piles at these 2 holes. One hundred-fifty to 200 cubic yards mined to sort out ore.
46	NW 28-4S-26W	Larger cut shows botryoidal and stalactitic psilomelane and smaller quantity of manganite embedded in pocket of clay. Probably 1/2 ton of mineral has been taken out and placed on dump. approximately 500 pounds of psilomelane has been derived from surface clay and rock debris on smaller cut3/.	Cady Prospect about 1/4 mile east of Robert Porter Prospect. Two cuts in spring and summer of 1916.
47	NW 10-4S-27W	Manganese in veins, pockets, or ore-bearing breccia. Tunnels, surface cuts and pits show 3 horizons of ore in the Arkansas novaculite. Fissure vein cutting upper horizon is exposed in the old "Burns Pit"3/4/.	North Mountain mine near head waters of the Little Missouri River. North Mountain is name applied to broken novaculite ridge which is part of State House Mountain. It has been extensively explored and is now being operated by M. C. Stenger who is producing considerable ore for use in defense.
48	NW 10-4S-27W	Seams of manganese ore rarely over 1/4 inch thick penetrate novaculite in all directions. Frequently stained with iron and often small masses of manganese inclose kernels of limonite3/.	Crooked Creek Prospect.
49	13-4S-27W and 18-4S-26W	4/	Operations by Dixie Manganese Corporation on Polk Creek Mountain.
50	16-4S-27W	Hard black manganese ore associated with iron ore in a pocket in novaculite1/3/.	Morrell claim. Accords closely with workings of Dierks Lumber & Coal Company.
51	16-4S-27W	Cuts from west to east show: Cut 1. Few short veins of manganese oxides less than 1 inch wide. Cut 2. Pockets, seam, vein of wad.	Dierks Lumber & Coal Company prospect. Workings in 4 cuts. No shipments made for past 5 or 10 years.

Table 6. Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY (cont.)		
51		Cut 3. Several pockets and veins along bedding planes and joints in novaculite up to 24 inches wide. Hard psilomelane plus small percentage of manganite. Cut 4. Badly caved. Pocket of manganiferous clay3/5/.	
52	SE NW 16-4S-27W	Two veins of soft black manganese oxide, ore 6 inches thick, the other 2 inches thick, at contact of Stanley shale and Arkansas novaculite2/.	Three old prospect holes two of which are being reopened by Mr. Joe Keener of Dierks, Arkansas. On north side of Little Missouri River about 17 miles southwest of Norman.
53	17-4S-27W	Minor amounts of psilomelane, wad, and manganite in veins and pockets3/.	Sugartree Mountain Prospect on north slope of mountain. Several cuts made.
54	18-4S-27W	Some pits contain small amounts of manganese oxide in veins. Others contain boulders of manganese, some weighing over 100 pounds and containing fragments of novaculite3/.	Rainwater Prospect. Nine small pits made in June 1917.
55	17 & 18-4S-27W	4/	Operations by Dixie Manganese Corporation. On Sugartree Mountain.
56	Line between 21 & 22-4S-27W	Manganite in small quantities cements novaculite debris and occurs as veins between the ledges3/.	Eureka Prospect at east end of Brice Creek Mountain.
57	NW SE 23-4S-27W	Small veins and pockets of manganese and iron oxides in novaculite2/.	No production.
58	NE 27-4S-27W	Two pockets and a vein of hard, steel-blue psilomelane with a small quantity of minute manganite crystals in massive shattered novaculite3/.	Bluff Mountain Prospect on the crest of Bluff Mountain just north of Albert Post Office. Approximately 1 ton of minerals on dump.

Table 6. Occurrences of manganese and iron in Pulaski, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY (cont.)		
59	19,28 29,30-4S-27W 24-4S-28W	Wad, manganite, and psilomelane found in small amounts in lenses, veins, and pockets in novaculite3/1/.	Leader Mountain Prospect. Fourteen claims located here. Manganese in small amounts in claims 5, 6, 12, and 14. About 500 pounds of ore were shipped from the Webb-Thornton claim.
60	SE SE 31-4S-27W	Soft, black pyrolusite in soft white novaculite easily crushed in the fingers. Largest exposure of ore in pocket 4 inches in thickest part3/.	Webb-Thornton claim on steep bluff in south face of Little Musgrove Mountain.
61	SW 32-4S-27W	One cut exposed bog ore as much as 6 feet wide and 20 feet thick. Second cut a surficial deposit of iron oxide with a small amount of manganese. Third cut veins of iron oxides with some manganese oxides (psilomelane and a little manganite)3/.	Slatington Mountain Prospect on south slope of mountain. Three cuts made in June 1916.

1/ Penrose, R. A. F., Jr., Manganese: Its Uses, Ores and Deposits: Arkansas Geol. Survey Ann. Rept. 1890, Vol. 1.
2/ Special Investigation, State Mineral Survey.
3/ 660-C Miser, H. D., Manganese Deposits of The Caddo Gap and De Queen Quadrangles, Arkansas: U. S. Geol. Survey Bull. 660-C., 1917.
4/ Stenger, Mrs. M. C., Personal Communication, Feb. 22, 1942.
5/ Owner.

Bentonite

Composition and properties. The term bentonite usually refers to a clay-like material which is composed chiefly of montmorillonite, $(Mg,Ca)O.Al_2O_3.5SiO_2.nH_2O$, but beidellite, $Al_2O_3.3SiO_2.nH_2O$, may be the chief mineral constituent.

Bentonites are divided into two general classes: (1) those that absorb large quantities of water, swelling enormously in the process, and that have the property of remaining in suspension in water; (2) those that absorb practically no more water than ordinary plastic clays or fullers earth, do not swell noticeably, and settle rapidly in water. There are some intermediate gradations.

The known Arkansas bentonite deposits belong to the second class. The material is yellowish with a slight green cast. It is always damp when encountered, has little plasticity, and the physical characteristics are somewhat similar to those of compact cheese. The material is brittle and commonly breaks with a conchoidal or shell-like fracture. When dried it hardens, cracks, and becomes creamy white. The following chemical analysis of bentonite from the Palmer deposit is given by W. F. Manglesdorf.

	Per cent
Loss on ignition (102° C. to red heat)	10.52
Silica (SiO_2)	58.30
Alumina (Al_2O_3)	22.58
Ferric oxide (Fe_2O_3)	6.10
Titanium oxide (TiO_2)	.11
Calcium oxide (CaO)	.02
Magnesium oxide (MgO)	2.18
	99.91

Uses. The most important uses of bentonite are for clarifying mineral and vegetable oils, fats, and greases, and as an ingredient of molding sands. Other uses are listed below.

1. As a thickener in drilling mud used in drilling oil wells.
2. For stopping water flow or leakage in engineering works.
3. In laundries, for washing heavily soiled articles.
4. As an additive plasticizing and bonding agent to improve burned clay products.
5. As a bonding medium in sound insulating blocks, plasters, and cements.
6. As a standard suspending, spreading, and adhesive agent in horticultural sprays and insecticides.
7. For clarifying turbid waters and purifying sewage.
8. For emulsifying asphalts and other water immiscibles.
9. As an admixture in concrete.
10. To inhibit the gumming of screens in dewatering wood pulp.
11. To gelatinize wet-mash poultry foods.
12. For clarifying wines.
13. In cosmetics and pharmaceuticals.

Prices. Table 7 shows the average annual price of bentonite in the United States, per short ton, from 1933 to 1940, inclusive.

Occurrences. Table 8 shows the known deposits of bentonite in Saline County. The occurrence of bentonite has not been reported from the other counties covered in this report.

Production. The Palmer deposit was mined intermittently in 1904 and 1905 by the Fullers Earth Company of America. According to local residents, about 250 tons were removed. Robert V. West of Tulsa, Oklahoma, worked the Palmer and Long-Bell deposits from 1933 to 1939, inclusive. These deposits have been worked, also, by T. P. Foster of Little Rock.

Table 7 shows the production of bentonite in Saline County since 1933:

Table 7 . Production and value of bentonite in Saline County, 1933-1940

Year	Production short tons a/	Average price in U. S. b/	Estimated value
1933	200	$8.46	$ 1,692
1934	325	6.68	2,171
1935	674	6.65	4,482
1936	1,283	7.69	9,866
1937	695	7.65	5,317
1938	307	7.14	2,192
1939	c/	7.75	-
1940	c/	7.64	-
	3,484		$25,720

a/ According to severance tax reports filed by producer.
b/ According to U. S. Bureau of Mines.
c/ Not reported.

Building Stone

Composition and properties. Durability and appearance are the most important qualities demanded of building stone. Hardness, toughness, porosity, and resistance to chemical and physical weathering are factors which determine the durability and a number of chemical and physical tests may be applied to define these factors. Ease of cutting and dressing the stone, and color and texture are other considerations. Observation of a particular type of stone over a period of years is the most satisfactory test.

Building stone quarried in these four counties consists of sandstone and syenite. Novaculite is used for oil stones and railroad ballast and is discussed under the section headed "Novaculite." A separate section is devoted to limestone.

Uses. The most important uses in construction are in retaining walls, foundations, residences, public buildings, and as veneer rock or flagging. Syenite, commonly called "granite" because of the similarity of physical properties, is used extensively as riprap. Large amounts of both syenite and sandstone are crushed and used in road construction and for other purposes.

Prices. Reliable prices of building stone are not available; however, according to state severance tax figures, the average value of stone produced from this area for the period of 1923 to 1940, inclusive, is $1.21 per short ton. This value includes stone used for road construction, but does not include novaculite. Production and value of stone produced in Garland and Pulaski counties are given in Table 9 .

Table 8 . Deposits of bentonite in Saline County

Map no.	Location Sec. T. R.	Name	Area covered	Average thickness (feet)	Overburden (feet)	Estimated tonnage	Owner	Remarks
	SALINE COUNTY							
1	NW NE 20-2S-12W	Wilkerson	1/2 acre	5-16	5-21	12,000	J. R. Wilkerson, Hensley, Ark.	True bentonite from Wilcox formation.
2	SE SE 13-2S-13W	Palmer	-	5- 9	0-10	20,000 40,000	J. Ernest Smith, Industrial Trust Bldg., Wilmington, Del.	True bentonite from Wilcox formation. See Fullers earth analysis.
3	NE NE 23-2S-13W	Long Bell	200-300 ft.	-	0-10	3,000	Long Bell Lumber Co., Sheridan, Ark.	Reworked bentonite Iron Wilcox formation.
4	SW NE 14-2S-15W	Gingles	30 acres	30-40	2-50	-	H. J. Gingles, Benton, Ark.	See bleaching test in Table 15.

Table 9. Stone produced in Pulaski and Garland counties, 1923-1940

Year	Pulaski Production Short tons	Pulaski Value	Garland Production Short tons	Garland Value
1923	226,755	$ 306,119		$
1924	306,843	432,649		
1925	218,450	286,169		
1926	174,821	230,763		
1927	249,693	277,159		
1928	208,420	250,104		
1929	286,762	321,174		
1930	389,023	420,145		
1931	230,973	233,283		
1932	125,093	138,853		
1933	92,425	104,655		
1934	97,677	109,398		
1935	122,918	137,668	988	1,284
1936	193,131	216,307	62	80
1937	235,049	256,203	369	425
1938	251,588	314,485		
1939	199,381	293,218		
1940	322,028	409,579		
	3,931,030	$4,737,931	1,419	$1,789

Occurrence. Most of the syenite is obtained from the Fourche Mountain district near Little Rock, although some has been quarried at an exposure near Bauxite. Syenite is quarriable near Potash Sulphur Springs, but no production has been reported from this area. The sandstone quarried has been from the Atoka and Jackfork formations and from the Hot Springs sandstone member of the Stanley shale. Locations and descriptions of quarries are given in Table 10.

Production. The total production of stone from the four counties, according to severance tax reports, is 3,932,449 short tons. This figure is not limited to building stone, but excludes novaculite production.

Clay

Composition and properties. The term "clay" is used in a rather broad sense to include material which is plastic when wet, when shaped and dried will retain its shape, and when fired to full redness becomes hard and stone-like.

Since clay is derived from the decomposition of rock, its composition varies to a certain extent; however, the principal constituents of all clays are hydrated aluminum silicates. The more pure of these have a composition resembling that of kaolinite, $H_4Al_2Si_2O_9$. Common impurities are quartz, hydrated silicas, feldspars and other silicates, iron oxides, various forms of mica, aluminum oxides, titanium oxide, calcite and other carbonates, oxides of manganese, and organic matter. The quantity and nature of these present in any particular clay determine to a large extent its physical properties and its value.

Plasticity, which is an essential property, is probably due to the size and shape of the particles and to the percentage of colloidal matter contained. The amount of shrinkage during firing or air drying is an important consideration and depends on the moisture content and particle size. Carbonaceous matter, sulphur, or carbon dioxide which are given off during burning also increase the shrinkage.

Table 10. Sandstone and syenite quarries in Garland, Montgomery and Pulaski counties

Map no.	Location Sec. T. R.	Kind of material and formation	Occurrence and operations	Remarks
	PULASKI COUNTY			
1	SW NE 3-3N-11W	Sandstone Atoka	Fine to coarse-grained sandstone interbedded with thin layers of shale. Sandstone is hard and ranges in color from gray to blue. Opening about 75 by 30 by 15 feet. Average thickness 20 feet. Overburden 2 to 9 feet thick.	The quarry was opened in April, 1937 as a county WPA project. Past production estimated at 13,500 cubic yards of stone. Reserves amount to several times this figure.
2	NE SE 10-3N-11W	Sandstone Atoka	The material locally is called "blue gravel." It is a hard compact sandstone which is highly fractured. Thickness of deposit (exclusive of overburden which averages 5 feet) is from 12 to 40 feet. Average 30 feet.	It is estimated that 931,000 cubic yards of rock suitable for crushing are available.
3	NW SE 33-3N-12W	Sandstone Atoka	A blue quartzitic, micaceous flagstone containing disseminated pyrite is found in beds from 3 to 8 inches thick. Total aggregate thickness in quarry is 2.5 feet. The quarry is 600 by 30 feet. Overburden averages 8 feet. Deposit covers approximately 20 acres.	Quarry opened in 1937 by WPA. Last worked in 1939. There is an estimated reserve of 806,000 cubic yards. In government reservation on west side of Cato road.
4	SE NE 2-2N-12W	Sandstone Atoka	A relatively soft coarse-grained reddish sandstone is found in beds ranging from 1½ to 5 inches in thickness. Two small openings from which building stone is being quarried.	The sandstone is sold locally as flagstone and rock veneer at $2.00 per cubic yard.
5	NE NE 23-2N-12W	Sandstone Jackfork	The rock ranges from light-gray to blue in color. It is compact, quartzitic, and well-jointed. The deposit vers approximately 25 acres and has average thickness of 30 feet. andstone ranges from 5 to 40 feet in thickness and overburden from 1 to 10 feet.	It is roughly estimated that 1,000,000 cubic yards of rock suitable for crushing are present at the locality. Pulaski County Quarry, Park Hill.

Table 10. Sandstone and syenite quarries in Garland, Montgomery and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Kind of material and formation	Occurrence and operations	Remarks
	PULASKI COUNTY (cont.)			
6	SW SW 28-2N-12W	Sandstone Jackfork	Hard, fine to coarse-grained, blue sandstone is interbedded with shale which composes approximately 10 per cent of the material present. Quarry is about 1,600 by 700 by 200 feet. Deposit covers about 600 acres. Overburden averages 5 feet.	The deposit is favorably located with respect to both rail and water transportation. Rock has been crushed and used in cement. Operated by Big Rock Stone and Material Co.
7	NW NE 32-2N-12W	Sandstone Jackfork	A blue to gray quartzitic sandstone known locally as "blue trap rock," it is compact, hard, and well-jointed. There are three openings, in which sandstone has average thicknesses of 30, 75, and 30 feet, respectively. Overburden ranges up to 10 feet in thickness.	Approximately 70 per cent of rock removed, or 250,000 cubic yards, was suitable for crushing. The quarry contains large reserves. Operated by Little Rock Granite Co.
8	SW SW 33-2N-12W	Sandstone Jackfork	The rock is hard, quartzitic sandstone which ranges in color from blue to gray. The total thickness of the beds being quarried is about 35 feet. The overburden averages approximately 6 feet in thickness at the quarry. Covers area of approximately 10 acres.	It is estimated that 58,300 cubic yards of stone have been removed. The quarry was operated by WPA from 1935 to January 1938. Since then it has been operated intermittently by the city of North Little Rock.
9	NW NW 20-2N-14W	Sandstone Jackfork	A deposit of hard, light gray to brown quartzitic sandstone containing many fractures covers at least 10 acres. Thickness of the exposed rock is about 40 feet and the overburden is not greater than 1 foot.	Five hundred cubic yards of stone were removed in 1937 for construction of the Little Rock Boys Club Camp by WPA. Other production figures are not available.
10	NE SE 13-1N-12W	Syenite "blue granite"	The rock is very hard and ranges in color from gray to blue. Face of the quarry is approximately 60 feet high.	Quarry was opened in 1939 by the Little Rock Granite Co. Reserves are very large.

Table 10. Sandstone and syenite quarries in Garland, Montgomery and Pulaski counties (cont.)

Map no.	Location Sec. T. R.	Kind of material and formation	Occurrence and operations	
	PULASKI COUNTY (cont.)			
11	SW SW 22-1N-12W	Nephelite syenite "gray granite"	The rock is crystalline, light-gray, coarse-grained, very hard, and in places well-jointed. The workings are approximately 225 by 90 by 40 feet. Thickness of the overburden ranges from 1 to 4 feet.	Tobin Quarries, Inc., of Kansas City, Missouri have worked this intermittently. It can be worked profitably when large tonnage is contracted. Reserves are very large.
	GARLAND COUNTY			
12	SW SW 18-2S-19W	Hot Springs sandstone member of Stanley shale	Gray, fine-grained sandstone is being quarried in blocks which range from 2 to 10 square feet, and from 2 to 4 inches in thickness. Most of this is of the flagstone type; however, some quarries out in larger blocks for use as building stone.	The price paid for the stone ranges from $3.00 to $4.50 per cubic yard, delivered in Hot Springs. Ernest Nichols, owner.
13	SW NW 19-2S-19W	Hot Springs sandstone member of Stanley shale	Ledges of gray fine-grained sandstone, stained red, brown, or yellow due to the presence of iron oxides, and containing some quartz veins are being quarried from low ridges. The beds have been worked to a depth of 6 feet. Fieldstone makes up part of the production from this locality.	Approximately 1,000 cubic yards of stone are estimated to have been quarried since 1935 from 4 openings. Large reserves of quarrable stone are present. Jesse Lowery, owner.
14	NE NW 2-3S-20W	Hot Springs sandstone member of Stanley shale	Beds of light and dark-gray, fine-grained sandstone from 6 inches to 2 feet thick. There are two small similar openings. Bedding partings and fractures colored by iron oxides.	Quarry was opened in 1935 by Mr. F. M. Neel who reported an average annual sale of 100 cubic yards. The rock sold for $1.00 per cubic yard at the quarry.
	MONTGOMERY COUNTY			
15	E½ SE 23-3S-24W W½ SW 24-3S-24W	Blakely sandstone member of Womble shale	Lenticular beds of hard, gray sandstone from 6 inches to 2 feet in thickness are being quarried to a depth ranging from 4 to 8 feet.	Quarried by WPA and CCC for building stone.

Other qualities which are important in determining the commercial use of the clay include the color and color changes on firing, and the fusibility. Iron oxides form the prominent coloring agents. Porosity has an important influence on the drying and burning processes and proper tensil strength is necessary if the clay is to withstand molding. Clays frecuently are blended in order to obtain the desired combination of properties.

Commercially, clays are classified according to use, and include: china clay, ball clay, slip clay, refractory or fire clays, stoneware, tile, sewer pipe, and brick clays. These classes overlap to a certain extent as one clay may have a number of uses or one product may be made from more than one type of clay; however, in general the classes designate clays having specific properties.

Uses. Most of the clay mined in Arkansas is consumed in the manufacture of brick, sewer pipe, and building tile. The most important ceramic uses of clay (aside from the above products) are in the manufacture of refractories, pottery, and stoneware. In addition to these, clay has a great many non-ceramic uses including filler and coating material in paper manufacture, filler in rubber goods, some textile fabrics, and other products, and as a mild abrasive.

Occurrence. Deposits of several varieties of clay which can be used for many different purposes are found in Pulaski and Saline counties. In the northwestern parts of these counties Paleozoic shales are potential sources of materials for clay products. In the southeastern areas, sedimentary and residual clays of Tertiary and Quaternary age are of considerable importance.

Sedimentary clays of the Midway formation have not been found valuable for ceramic purposes; however, little work has been done, as yet, to discover other uses. It is possible that efforts to find uses for the bluish clay which occurs in considerable thickness at the top of the Midway formation would prove worth while. This clay has been referred to as a "joint clay," because of the manner in which cracks occur on drying.

In the vicinity of Benton, Saline County, the sedimentary clay of the Wilcox formation has been used widely. This clay is more or less refractory and appears to be well adapted to the manufacture of art pottery, open stoneware, refractory brick, face brick, and tile.

Residual kaolins are present in the vicinity of Little Rock, Bauxite, and Mabelvale. They are associated with the bauxite deposits in these areas, and are a product of the weathering of the nephelite syenite, into which they commonly grade. In sec. 16, T. 2 S., R. 14 W., residual clay forms a relatively thick mantle over the syenite. The physical properties and ceramic possibilities of this class of clay have not been studied adequately.

Near Hot Springs, Garland County there are decomposed Paleozoic shales which possibly are of ceramic value, but little has been done to determine their utility. Clays occurring in Hot Springs National Park are not of such value as to justify damage to a public park.

A peculiar form of kaolinite to which the name rectorite has been given, is found in Garland County in sec. 27, T. 1 N., R. 19 W. This material is tough and leathery, but it has the smooth, soapy feel characteristic of the kaolins and of steatite. It occurs in association with the Ordovician sandstones of the region, but the deposits, so far as known, are only about a foot thick. Rectorite, as it comes from the ground, ranges in color from pure white to reddish-brown. Although rectorite is not known to have any practical commercial value at present, it is mentioned here as of scientific interest and of possible future importance.

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties

Map no.	Location Sec. T. R.	Description and uses	Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	PULASKI COUNTY									
1	9, 16, 20, 29-2N-11W	In vicinity of village of Mc-Almont, over considerable area is a bank of yellowish loam that is plastic, greasy to the touch, and works smoothly. Other clays of similar nature vary from gray to red. Might be suitable for brick1/.	-	-	-	-	-	-	-	-
2	NE 4-1N-12W	Northwest of Union Depot, Little Rock. Chocolate brown clay, usually sandy. Makes smooth paste of uniform color when washed. Occurs in patches. Possible use as base in terra cotta ware. Must be dried at uniform rate to prevent breaking1/.	70.05	14.56	6.20	.74	1.12	-	-	4.45
3	NE SE 17-1N-12W	In stream along St. Louis, Iron Mountain, and Southern Railway. Dark-bluish bottom land clay which becomes ash-gray when dried. Iron stained. Comparatively free of sand. Tough when wet. Parts with water slowly. For pressed front or ornamental brick and possibly for ordinary drain tile. Will work better and easier if dug in fall and worked over during winter preparatory to its final tempering and manufacture in the following summer1/.	-	-	-	-	-	-	-	-
4	?-1N-12W	Iron Mountain railroad cut, Little Rock. Carboniferous clay shale2/.	62.36	25.52	2.16	.51	.29	1.90	.66	5.32

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties (cont.)

Map no.	Location Sec. T. R.	Description and uses	Chemical analyses Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	PULASKI COUNTY (cont.)									
5	?-1N-12W	Railroad cut south end of upper bridge, Little Rock. Carboniferous clay shale2/.	53.30	23.29	9.52	.36	. 1.49	1.36	2.76	5.16
6	SW NE 25-1N-12W	Ridgwood. Tertiary pottery clay2/.	67.90	22.07	1.33	.05	.59	1.15	.38	6.86
7	36-1N-12W	In wells dug to depth of 16 or 18 feet. Soft milk-white residual clay with small patches of iron stain1/.	45.28	37.39	1.71	1.83	.29	-	-	13.49
8	NW 23-1N-13W	Carboniferous clay shale2/.	69.34	22.56	1.41	Trace	Trace	.04	2.31	5.12
9	NE and NE NW 9-1S-12W	Fourche Mountain. Dark pearl color becoming cream on drying. Comes out in angular blocks. Very hard and requires crushing. Stained with iron near surface but this probably does not extend to very great depths. Burns a beautiful white but iron causes rusty brown specks. When ground and well-mixed, it burns ivory color. Cracks on firing but not enough to prevent use. Glazes well. May be suitable for pottery not requiring pure white body1/.	46.27	38.57	1.36	.34	.25	.23	.37	13.61
10	SW SE 2-1S-13W	Nearly or quite on line between secs. 2 and 11. At surface appears pisolitic, hard, and iron-stained. Softer and white below surface. Due to fireproof qualities, surface fragments								

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties (cont.)

Map no.	Location Sec. T. R.	Description and uses	Chemical analyses Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	PULASKI COUNTY (cont.)									
10		have been used somewhat for building chimneys and setting boilers1/.								
11	NE NE 10-1S-13W	One-half mile southeast of railway station at Mabelvale. White pisolitic clay. Well record shows that clay becomes softer with depth1/.	48.05	38.92	1.19	.58	.45	.18	.28	10.86
12	NW NE 10-1S-13W	Well at Mabelvale. Soft, dove-colored clay popularly known as soapstone. Contains a few large hollow masses of iron oxide. Beds horizontal. Thickness 10 to 15 feet1/.	(65.27 (60.79	18.75 19.73	7.34 5.94	.81 .37	1.26 .72	1.10 1.93	.81	6.88 10.77
13	SE NW 10-1S-13W	At Mabelvale. Residual gray pisolitic clay containing considerable iron near the surface. Outcrops at various points but mostly is concealed1/.	45.20	37.60	3.00	.89	Trace	.06	.69	13.54
	SALINE COUNTY									
14	SW NE 15-1S-14W	On Crooked Creek about 3/4 mile west of Collegeville. Blue, white, and variegated shales. Soapy feel. Thickness 2 to 3 feet1/.	82.45	11.80	.80	.31	.25	-	-	2.79
15	SW SW 36-1S-15W	Firm, white clay, about 9 feet. Tertiary kaolin. Requires special treatment and has not been successful for ordinary pottery1/.	48.34	34.58	1.65	.81	Trace	.44	1.26	12.94

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties (cont.)

Map no.	Location Sec. T. R.	Description and uses	Chemical analyses Silica SiO	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	SALINE COUNTY (cont.)									
16	SE SE 3-2S-13W	Outcrops in a series of small gullies. About 10 feet of cream-colored clay which becomes nearly white on exposure to the sun. Conchoidal fracture1/.	63.29	18.19	6.45	.31	2.44	.56	Trace	9.47
17	NW SE 16-2S-14W	Kaolin of considerable thickness1/.	45.62	34.18	4.05	.20	Trace	.53	.54	13.82
18	SE SE 16-2S-14W	White or grayish-white clay with occasional patches of iron and pinkish or brownish clay. Kaolin. Has been produced on small scale for outsides of chimneys and lining flues and hearths1/.	44.97	38.87	1.34	.25	Trace	.20	.34	14.37
19	SE SE 11-2S-14W	Goodman Spur, CRI&P railway. Residual clay, closely associated with bauxite and nepheline syenite. "Arkhola" clay. Plastic. Air shrinkage 2.5 per cent; fire shrinkage at 1,200° C, 3.5 per cent; additional fire shrinkage at 1,400° C., 3.5 per cent. Clay fires well. Can be converted for use for building brick, refractory brick, stone linings, and pottery3/.	41.50	41.86	.79	.13	-	-	-	14.32
20	NE 1-2S-15W	Woosley clay bank, Benton. Light pinkish-brown when moist. Drys to faint pink. Thickness 4 to 6 feet. Pottery clay. Burns to a solid stone body and takes both salt and Albany slip glaze1/2/.	64.49	23.86	2.11	.31	Trace	.11	1.82	8.11

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties (cont.)

Map no.	Location Sec. T. R.	Description and uses	Chemical analyses Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	SALINE COUNTY (cont.)									
21	NW NE 2-2S-15W	Henderson clay bank, Benton. About 14 feet of potter's clay, ranging from light blue or pink on top to almost black at base. Lower strata contain impressions of leaves and roots of plants. Burns to a stone body that takes both salt and slip glazes1/.	71.09	19.86	1.81	.11	Trace	1.45	.81	5.67
22	NW SE 2-2S-15W	Davis clay bank, Benton. About 11 feet of brownish colored potter's clay. Burns to white or cream color and takes both salt and slip glazes1/.	69.95	22.34	1.44	Trace	.08	1.28	.18	5.98
23	NW SW 11-2S-15W	Womack clay bank, Benton. Dark, lead-colored clay too stiff to be worked in ordinary pugs. Deposit contains mica flakes, pyrite nodules, and, rarely, crystals of selenite gypsum. At least 30 feet thick. Inferior potter's clay when used alone, but possibly useful mixed with other clays. Might be used for vitrified brick1/.	66.23	22.31	2.12	.92	Trace	.04	1.59	7.38
24	NE NE 12-2S-15W	Hick's clay bank, "Old Leach Bank," Benton. Clay pinkish-brown when damp, light gray with faint pink tinge when dry. Contains varying amounts of sand. Wanting in body and will not burn to a solid stoneware. Very absorbent. Mixed with other clays for use in pottery1/2/.	65.79	23.92	1.94	.23	Trace	1.15	1.08	7.07

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties (cont.)

Map no.	Location Sec. T. R.	Description and uses	Chemical analyses Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	SALINE COUNTY (cont.)									
25	SW NE 12-2S-15W	Rodenbaugh clay bank. Fine-grained clay pinkish-brown when moist. Loses color on drying. About 10 feet thick. Addition of sand gives clay more body and in burning enables ware to take a hard finish1/.	72.44	18.97	1.59	.18	Trace	1.35	.91	5.39
	GARLAND COUNTY									
26	4/ 27-1N-19W	Pure white to reddish-brown rectorite. Resembles kaolin but is tough and leathery. About one foot in thickness. Becomes vitreous and strong when heated. No commercial use known1/.	(52.88 (52.72	35.51 36.60	.25 .25	.45 .45	.51 .51	.26 .26	2.83 2.83	7.72 7.76
27	?18-1S-19W	East pit, Cedar Mountain near Mountain Valley. Light-gray clay with interbedded yellow clays and a few layers of light-colored sandstones. Thickness 30 to 40 feet. Has been shipped to Chicago in small quantities for use in art pottery5/.	74.55	13.68	1.27	.20	2.03	3.84	.10	3.63
28	?18-1S-19W	West pit, Cedar Mountain near Mountain Valley. About 10 feet of light-gray clay overlain by 5 or 6 feet of thin interbedded sandstones and clays. Has been shipped to Chicago in small quantities for use in art pottery5/.	72.06	15.31	1.24	.17	2.26	4.53	.15	3.50

Table 11. Analyses of clays in Pulaski, Saline, and Garland counties (cont.)

Map no.	Location Sec. T. R.	Description and uses	Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O	Water H_2O
	GARLAND COUNTY									
29	S½ 8-2S-18W	Barnes Big Quarry. Thin clay seam in novaculite6/.	59.31	23.73	6.11	.31	.71	1.45	.93	8.33
30	?28-2S-19W	North Mountain. Light-gray clay with fine sand and no red streaks. Can be used for pressed brick or flooring tile, second-grade fire brick, body for art pottery5/.	70.31	17.27	1.85	.23	.91	3.51	.26	4.36
31	?29-2S-19W	Northeast end of Sugarloaf Mountain near waterworks. Very soft decayed gray, green, and reddish shale. Can be used for pressed brick or flooring tile, second-grade fire brick, body for art pottery5/.	70.29	16.74	2.03	.10	1.50	2.76	.08	5.00
32	?33-2S-19W	Southeast side Hot Springs Mountain. Light-gray clay with occasional thin red bands. Free of coarse sand and grit. Can be used for pressed brick or flooring tile, second-grade fire brick, body for art pottery5/.	73.07	16.40	1.12	.25	.64	2.75	.26	4.46
33	?6-2S-19W	Sugarloaf Mountain on edge of reservation. Gray and red mottled clay with coarse sand. Probably unfit for any use5/.	73.96	14.54	2.17	.15	.49	2.64	.80	3.76

1/ Branner, J. C., Clays of Arkansas: U. S. Geol. Survey Bull. 351, 1908.
2/ Taff, Joseph A., Chalk of Southwestern Arkansas: U. S. Geol. Survey 22d Ann. Rept. 1900-1901, Vol. III, p. 687, 1902.
3/ Manglesdorf, W. F., Little Rock, Analyst. E. W. Whitney, president Arkola Bauxite Co.
4/ Deposit is in Garland County, although location as given in Clays of Arkansas is sec. 27-2N-19W.
5/ Eckel, Edwin C., Clays of Garland County, Arkansas: U. S. Geol. Survey Bull. 285, 1906.
6/ Griswold, L. S., Whetstones and the Novaculites of Arkansas: Arkansas Geol. Survey Ann. Rept. 1890, Part III, p. 161.

Table 12. Results of ceramic laboratory tests on clays from Saline and Garland counties[1/]

	Location	Unfired Properties						Fired Properties				
Sample number	Sec. T. R.	Color	Texture	Workability	Water of plasticity, per cent	Shrinkage volume, per cent	Modulus of rupture, pounds per square inch	Drying behavior	Steel hardness at cone	Best apparent burning range between cones	Color at cones	Uses for which the sample appears to be adaptable
	GARLAND COUNTY											
G- 1	NW 20 1S 19W	Black, lignitic	Very fine	Good plastic	24.0	10.8	88	Some warping, no cracking	03	below 2	Buff 03 to 2 Dark gray 4 to 8	Low-fired face brick.
G- 2	NW 20 1S 19W	Gray	Very fine	Brittle	27.1	12.7	70	Considerable warping, no cracking	03	below 2	Buff 03 to 2 Dark gray 4 to 8	Low-fired face brick.
	SALINE COUNTY											
S-12	NW 5 1S 14W	Gray	Coarse, sandy	Tough, fairly plastic	10.2	7.2	70	Slight warping, no cracking	01	03 to 4	Tan 03 to 2 Red 4 to 8	Common brick, possibly face brick or tile.
S-14	NW 16 1S 15W	Red	Shale coarse, fine grit	Medium plastic, molded well	36.3	30.7	333	No warping, no cracking	8	03 to 8	Tan 03 to 2 Red 4 to 8 Black 10	Face brick, hollow tile, or drain tile.
S- 9	NW 5 2S 12W	Gray	Fine grain, little grit	Very sticky plastic	24.5	27.8	262	Regular warping, no cracking	2	01 to 10	White 03 to 2 Light buff 4 to 6 Buff 8 to 12	Face brick, earthenware, or stoneware.
S- 3	NW 28 2S 12W	Light pinkish tan	Medium grained, sandy	Sticky plastic, molded well	24.3	28.0	437	Regular warping, no cracking	4	01 to 6	Buff 03 to 4 Tan 6 to 12	Face brick or earthenware.
S- 7	NW 35 2S 12W	Gray, iron stained	Coarse-grained, sandy	Medium plastic, molded well	25.6	29.8	338	Irregular warping, no cracking	12	2 to 12	Tan 03 to 2 Red 4 to 12	Common brick or drain tile.
S-20	SE 27 2S 14W	Cream	Coarse, sandy	Not plastic	33.1	9.4	23	Fair	10	8 to 12	White 03 to 12	Possible refractory use.
S- 5	NE 12 2S 15W	Light gray, iron stained	Fine to medium	Good plasticity, molded well	25.7	18.3	74	Some warping, no cracking	8	4 to 12	White 01 to 6 Light buff 8 to 12	White wares (pottery, earthenware, porcelain, or refractories).
S- 2	NW 14 2S 15W	Pinkish tan	Very smooth, fine grained, no grit	Very plastic, molded well	32.2	26.2	130	Irregular warping, no cracking	2	01 to 6	White 03 to 01 Buff 2 to 6 Gray 8	Face brick or low-fired pottery.
S-21	NW 8 2S 16W	Yellow-tan	Shale, fine, sandy	Very plastic, molded well	26.7	28.7	317	No warping, no cracking	6	01 to 6	Red 03 Tan 01 to 2 Red 4 to 8 Black 10 (overfired)	Common brick.
S-22	NE 13 2S 16W	Gray to tan	Shale, no grit	Medium plastic, molded well	25.5	11.0	71	Regular warping, cracking on cross-section	2	03 to 4	Buff 03 to 4 Tan 6	Face brick.
S-10	NW 5 3S 14W	White	Medium, with fine sand	Medium plastic, molded well	26.7	16.2	123	No warping, no cracking	8	2 to 8	White 01 to 6 Light buff 8 to 12	Low-fired white wares, face brick, or refractories.
S-30	NW 5 3S 14W	Black	Fairly fine, sandy	Good plastic	30.0	23.6	254	No warping, no cracking	4	03 to 6	Tan 01 to 2 Red 4 to 8 Black 10	Common brick, low-grade face brick.
S- 6	NE 6 3S 14W	Gray, tan mottled	Coarse-grained, sandy	Plastic, tough, molded well	24.0	19.7	143	No warping, no cracking	above 12	4 to 8	Buff 03 to 4 Tan 6 to 12	Face brick or common brick.
S- 8	NW 9 3S 14W	Tan	Fine, slightly gritty	Very plastic, sticky	35.0	41.8	231	Slight warping, no cracking	6	01 to 6	Red 01 to 2 Dark red 4 to 6 Black 8 (overfired)	Common brick.
S- 4	SW 3 3S 15W	Gray, some iron stains, organic matter	Medium-grained, gritty	Sticky plastic, molded well	20.4	9.7	362	Slight warping and slight cracking	4	03 to 12	Buff 03 to 2 Tan 4 to 12	Face brick, hollow tile, or drain tile.
S-25	NW 1 3S 16W	Pale red	Fine	Sticky plastic	24.6	26.8	485	-	8	4 to 10	Tan 03 to 2 Red 4 to 12	Face brick, hollow tile.
S-26	NE 2 3S 16W	Gray	Coarse, sandy	Fairly plastic	19.9	15.5	32	Little warping	above 12	4 to 12	Buff 03 Tan 01 to 4 Red 6 to 10	Face brick.
S-27	SW 12 3S 16W	Gray	Coarse, sandy	Plastic	25.5	21.0	520	Some warping, no cracking	6	2 to 6	Tan 03 to 4 Red 6 Black 12	Face brick.
S-28	NW 24 3S 16W	Tan	Coarse, sandy	Plastic, tough	20.5	43.2	331	No warping, no cracking	12	4 to 12	Tan 03 to 8 Red 10 to 12	Common brick, low-grade face brick.

1/ State Mineral Survey.

Clays are not widespread in Montgomery County, but clay shales may have value in some localities. Alluvial clay along the Ouachita River near Story has been used for stoneware.

Occurrences and analyses of clays in Pulaski, Saline, and Garland counties, are shown in Table 11.

The results of tests run by the Ceramic Laboratory of the State WPA Mineral Survey on clays from Saline and Garland counties are given in Table 12.

Production. Records of the production of clay and clay products by counties are not available prior to 1923. The following Table 13 shows the production of raw clay in Saline County by the Niloak Pottery Company:

Table 13 . Production and value of raw clay in Saline County, 1923-1940

Year	Production Short tons a/	Estimated Value
1923	1,651	$ 3,945
1924	1,711	3,388
1925	1,494	3,123
1926	937	2,070
1927	565	1,378
1928	1,010	2,191
1929	5,779	12,020
1930	331	639
1931	585	1,346
1932	529	877
1933	638	1,346
1934	731	1,294
1935	650	1,287
1936	491	973
1937	71	141
1938	b/	---
1939	949	1,880
1940	b/	---
	18,122	$37,898

a/ According to severance tax reports filed by company.
b/ Production not reported.

Clay was produced for the manufacture of brick in Pulaski County in 1923, 1924, and 1925 by the Arkansas Brick and Tile Company and from 1926 to 1931 by the Acme Brick Company. No production has been reported since 1930. Total production is shown in Table 14.

The Niloak Pottery Company in Benton, Saline County, is the only producer of clay products at present in the area included in this report. Both artware and stoneware are manufactured. The normal daily production of Niloak artware is rated at about 1,000 pieces, and the plant has a daily capacity of 600 gallons for stoneware and earthenware.

Six sources of clay supply the plant of the Niloak Pottery Company. Part of the clay now used is purchased from the Acme Brick Company and comes from their large clay pit at Perla, near Malvern in Hot Spring County. A sedimentary clay in the Wilcox formation is used as it is plastic, refractory, light-gray to white, and burns to a light buff. Some of the clay used comes from the "Leach pit" in Benton, also a sedimentary clay of the Wilcox formation.

Table 14. Production and value of brick clay in Pulaski County, 1923-1930

Year	Production short tons a/	M. brick b/	Average value in U. S. c/	Estimated value
1923	52,257	20,903	$12.97	$ 271,112
1924	51,580	20,632	12.10	249,647
1925	74,385	29,754	11.71	348,419
1926	80,838	32,335	11.73	379,290
1927	50,370	20,148	11.10	223,643
1928	43,757	17,503	10.81	189,207
1929	64,741	25,896	10.66	276,051
1930	20,637	8,255	10.30	85,027
	438,565	175,426		$2,022,396

a/ According to severance tax reports filed by companies.
b/ Estimated by assuming 2.5 short tons of clay equal one thousand brick.
c/ According to U. S. Bureau of Mines.

Fuller's Earth

Composition and properties. Fuller's earth resembles other clays in its chemical content; however, it contains a much higher per cent of water than ordinary clays. Its outstanding characteristic and the one which determines its commercial value is the ability to absorb the basic coloring matter from various fats and oils. The clarifying value of fuller's earth cannot be told by chemical analysis but must be determined by laboratory tests under conditions as nearly as possible like those of large scale operations. Comparative cotton seed oil values of fuller's earth from Saline and Pulaski counties are given in Table 15.

The Saline County fuller's earth deposits are alteration products of basic dikes and the original texture of the dikes is often well preserved. The material is yellowish or reddish-brown near the surface, but below the surface the color ranges from light-gray to light-olive-green. The degree of alteration decreases with increasing depth, and the clay becomes less plastic and harder as the unaltered dike material is approached. Calcite, quartz, chalcopyrite, pyrite, and limonite are present in small quantities in the fuller's earth.

Uses. The most important use of fuller's earth is that of clarifying or filtering animal, vegetable, and mineral oils, fats, and greases. It also is used as a constituent in some toilet articles and drugs, and a small amount is consumed in the fulling of cloth. The Saline County fuller's earth has been used principally for clarifying cotton seed oil, lard, peanut oil, tallow, and stearin.

Prices. The average price of fuller's earth in the United States, according to the U. S. Bureau of Mines, in 1940 was $10.03 per short ton.

Occurrence. The first discovery of fuller's earth in the United States was made in Pulaski County near Alexander, in the SW¼ SE¼ sec. 8, T. 1 S., R. 13 W. The results of tests, however, did not prove altogether satisfactory. Three analyses of

Table 15. Comparative cotton seed oil bleaching tests of fuller's earth from Saline and Pulaski counties

Map no.	Location Sec. T. R.	Deposit	Comparative bleaching values: Unbleached Oil Yellow	Unbleached Oil Red	Oil bleached by standard earth Yellow	Oil bleached by standard earth Red	Oil bleached by sample Yellow	Oil bleached by sample Red	Analyst and date of analysis
	SALINE COUNTY								
1	13-2S-13W	Olsen	35	7.0	20	3.3	20	3.3	Barrow Agee Labs., Memphis, Tenn. 8-14-29
	13-2S-13W	Olsen	35	7.8	20	3.5	20	3.8	Barrow Agee Labs., Memphis, Tenn. 8-14-29
	13-2S-13W	Olsen	35	5.8	20	2.8	20	2.8	L. B. Forbes Lab., Little Rock, Ark. 8-16-29
	North of Benton	Not given	35	7.4	20	2.7	20	2.7	L. B. Forbes Labs., Little Rock, Ark. 3-10-38
2	SW NE 14-2S-15W	Gingles	35	7.0	20	3.0	20	3.0	L. B. Forbes Labs., Little Rock, Ark. 2-8-35
	1 mi. from Olsen Switch	Lambdin	35	5.2	20	1.6	20	1.6	L. B. Forbes Labs., Little Rock, Ark. 12-16-29
	PULASKI COUNTY								
	10 mi. SW of Little Rock, Ark.	Brooks	35	6.2	20	2.0	20	2.0	L. B. Forbes Labs., Little Rock, Ark. 2-2-34

earth from this deposit are given in Table 16[5].

Table 16. Analyses of fuller's earth from SW¼ SE¼ sec. 8, T. 1 S., R. 13 W., Pulaski County

No.	Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Lime CaO	Magnesia MgO	Potash K_2O	Soda Na_2O
1	62.92	18.24	7.62	.76	1.77	.54	1.44
2	63.19	16.76	7.05	.78	1.68	.21	1.50
3	64.38	17.29	8.25	1.11	.80	.42	1.41

The developed deposits of fuller's earth in Arkansas occupy an area about 3 square miles in Saline County along the Missouri Pacific Railroad at Olsen Switch, 7 miles west of Benton. The country rock in this area is shale which is cut by basic and syenite dikes ranging in width up to 9 feet. The most important dikes have a maximum width of about 4½ feet. None of these dikes is known to be of greater length than one-half mile. The basic dikes have altered to fuller's earth to a maximum known depth of 180 feet, but in most cases the alteration zone is much shallower. The dikes strike in a northeast direction, and dip to the southeast at angles of 45° or more.

Production. Figures on fuller's earth production in Arkansas previous to 1906 are not available. It has been stated by Miser[6] that Arkansas was the second largest pro-

Table 17. Production and value of fuller's earth in Saline County, 1901 to 1922

Year	Production short tons	Value
1901	a/	$ -
1904	a/	-
1906	4,613	46,599
1907	4,901	36,273
1908	1,400	16,800
1909	2,314	18,313
1910	2,563	29,137
1911	1,004	10,040
1912	1,004	12,048
1913	a/	-
1914	a/	-
1915	a/	-
1916	a/	-
1917	a/	-
1918	a/	-
1919	a/	-
1920	a/	-
1921	a/	-
1922	a/	-
	17,799	$169,210

a/ Small quantity produced but figures not available.

5/ Branner, J. C., An early discovery of fuller's earth in Arkansas: American Institute of Mining Engineers Transactions, 1912.

6/ Miser, Hugh D., Developed deposits of fuller's earth in Arkansas: U. S. Geol.Survey Bull. 530-q, p. 219, 1913.

ducer of fuller's earth in the United States during the years 1904, 1905 and 1907 and that during the years 1909, 1910 and 1911, Arkansas was the third largest producer. The figures available on the production of fuller's earth in Arkansas according to the U. S. Geological Survey are given in Table 17. No production is on record at the present time.

Gravel and Sand

Composition and properties. Gravel may be defined as unconsolidated or loosely consolidated granular rock material finer than 3½ inches and coarser than one-fourth of an inch in diameter. Sand consists of similar unconsolidated granular rock material finer than one-fourth inch and coarser than 200 mesh. Gravel is commonly composed of several kinds of rock types and it usually contains some sand or even clay. Most sand is composed predominantly of quartz grains.

Uses. Highway construction and the building trades consume the principal production of gravel and sand. Both commonly are used as constituents in concrete. Gravel is widely used as a surface material for roads, and some is used for railroad ballast. Sand is an essential constituent of mortar and plaster, and has a wide variety of minor uses including sand for foundry use, manufacture of glass, friction sand used chiefly by the railroads, and abrasive and filter sand.

Prices. Sand used for commercial operations in the United States during 1940 ranged from 27 cents per short ton for railroad ballast to $1.77 per short ton for glass sand. Building and paving sands averaged 52 and 53 cents per short ton respectively. The average price for all sand used in commercial operations was 63 cents per short ton.

During the same period, gravel ranged from 33 cents per short ton for railroad ballast to 65 cents per short ton for building gravel. That used for paving averaged 59 cents per short ton. Fifty-six cents was the average price per short ton for all commercial gravel sold or used in the United States during 1940.

The following Table 18 gives figures on sand and gravel production in Arkansas during 1940, based on use of the materials.

Table 18. Sand and gravel sold or used by commercial producers in Arkansas in 1940, by uses a/

	Short tons	Value	
		Total	Average
SAND			
Glass	Small	amount	
Building	235,653	$126,108	$ .54
Paving	150,946	69,543	.46
Engine	small	amount	
GRAVEL			
Building	89,217	$ 67,075	$ .75
Paving	336,602	207,504	.62
Railroad Ballast	548,968	149,329	.27
Other	28,290	10,858	.38

a/ U. S. Bureau of Mines, Minerals Year Book for 1940, pp. 1182-1186, 1941

Occurrence. Extensive bedded Tertiary gravels occur in southeastern Saline County. Other gravel deposits occur in stream and river beds and flood plains and as piedmont talus slopes.

Data on gravel deposits are given in Table 19. The locations of these and other deposits are shown on **Plate V**.

Fine-grained sand, relatively high in silica, is present in the Wilcox formation. This sand is well exposed at Whitlock Spur near Bryant, Saline County. It has possible value as an abrasive, friction, or filter sand.

Production. Nearly all of the sand produced from the four counties discussed has come from the Arkansas River in Pulaski County, and by far the greatest production of gravel has come from the bedded gravels of Saline County. The production and value of gravel and sand by years from 1923 through 1940 is given in Tables 20 and 21, respectively.

Following is a list of the gravel and sand producers in Saline, Pulaski, and Montgomery counties in 1941:

Saline County
Name of company: Benton Gravel Co.
Office Address: Box 735, Pine Bluff, Ark.
Location of Plant: Edge of town of Benton, Saline County
Material produced: Clay surfacing gravel.

Pulaski County
Name of company: Big Rock Stone & Material Co.
Office Address: Little Rock, Ark.
Location of Plant: Little Rock, Ark.
Material produced: Washed river channel sand from Arkansas River.

Name of company: J. B. Sprick Co.
Office address: Little Rock, Ark.
Location of plant: Unknown.
Material produced: Unknown.

Montgomery County
Name of company: Hope Brick Works.
Office Address: Hope, Ark.
Location of plant: Junction Spur near Glenwood, Ark.
Material produced: Sand and gravel from Caddo River.
Plant abandoned in 1941.

Limestone

Composition and properties. Limestone is a sedimentary rock composed essentially of calcium carbonate; however, in addition to this, a great many limestones contain large percentages of the double carbonate of magnesium and calcium. Other impurities which may or may not be present are iron oxides, iron carbonate, silica, carbonaceous or bituminous matter, and clay minerals. If pure, limestone is white, but it is found more commonly in buff, gray, or black colors. It varies also as to texture and hardness.

Uses. Table 23 shows the uses for which most of the limestone was produced in 1934, and the comparative value. Limestone from these counties may be used as riprap, as crushed stone, and for agricultural purposes.

Occurrence. The Midway, a fossiliferous limestone of marine origin, outcrops in

Table 19. Gravel deposits

Map no.	Location Sec. T. R.	Screen size 2": Per cent retained	2": Per cent passed	1½": Per cent retained	1½": Per cent passed	1": Per cent retained	1": Per cent passed	3/4": Per cent retained	3/4": Per cent passed	1/2": Per cent retained	1/2": Per cent passed	3/8": Per cent retained	3/8": Per cent passed	No. 4: Per cent retained	No. 4: Per cent passed	Approximate size of deposit or of opening	Remarks
	PULASKI COUNTY																
1	SW SW 30-2N-11W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Has not been prospected.	Possibly 20 acres at each end and along south slope of a ridge with considerable surface gravel principally of hard rounded sandstone.
2.	NE SE 24-1N-13W	-	100	6.0	94.0	5.0	89.0	13.3	75.7	9.0	66.7	-	-	20.0	46.7	Semicircular excavation covers about 5 acres to a depth of about 20 feet. Possibly more gravel to northeast, east, and south.	Known as the "County Gravel Pit". The gravel has a stiff red clay binder. Used by WPA on the Ironton road.
3	NW SW 3-2N-14W	-	100	3.3	96.7	13.3	83.4	18.5	64.9	9.0	55.9	-	-	20.9	35.0	Area covers 15 acres or more. Maximum depth, 20 feet. Present excavation is 550 by 60 by 15 feet.	Gravel has considerable clay binder. Pebbles, 85 per cent sandstone, 15 per cent shale.
4	SE NE 30-2S-14W	-	100	6.6	93.4	10.9	82.5	13.3	69.2	8.3	60.9	-	-	27.0	33.9	Four hundred feet long by 75 feet wide. About 1 foot thick above water level.	Gravel bar is on Maumelle Creek near Joseph Pfeifer camp. Gravel composed of about equal parts of shale and sandstone. Has been used for surfacing local roads.
	SALINE COUNTY																
5	35-1S-16W	-	100	-	100	8.5	91.5	10.1	81.4	14.2	67.2	13.0	54.2	26.6	27.6	Five hundred feet long by 300 feet wide. Six feet thick above water level.	Bar of gravel in Ten Mile Creek at Benton-Lonsdale road crossing. Gravel composed of 80 per cent novaculite and 20 per cent shale. Considerable material has been used in concrete bridges and for surfacing WPA and county roads.
6	Cen. 21-2S-13W	-	100	-	100	15.0	85.0	10.0	75.0	17.0	58.0	10.0	48.0	15.0	33.0	From 10 to 15 acres have been worked. Thickness of gravel from 4 to 12 feet. Gravel appears to cover about 200 acres.	Sardis pit. Rounded novaculite mixed with red clay. Gravel is being used, without screening or washing, on local roads.
7	NE SE 11-2S-15W and S½ NE 11	-	100	4.0	96.0	16.0	80.0	6.0	74.0	12.0	62.0	10.0	52.0	26.0	26.0	Excavation covers approximately 20 acres. The gravel averages about 18 feet in thickness.	Haskell Dickinson pit, 1/4 mile north of Missouri Pacific Railway. Rounded novaculite pebbles, red clay binder. Gravel thins toward south. Overburden thickens to north and northeast.
8	N½ SW 12-2S-15W	-	100	5.0	95.0	5.0	90.0	12.5	77.5	10.8	66.7	8.3	58.4	16.0	42.4	About 25 acres have been worked. Average thickness of gravel is 15 feet. No operations at present.	Kertin pit. Round white novaculite pebbles. A 10 per cent mixture of red clay binder. Overburden of red clay about 4 feet in thickness.
9	NW SW 14-2S-15W and SW NW 14	-	100	-	100	-	100	12.0	88.0	8.0	80.0	14.0	66.0	26.0	40.0	The excavation covers approximately 60 to 70 acres.	Locally known as the "Ball-Benton Gravel Pit." Rounded novaculite pebbles with considerable sand and very little clay. Upper gravel bed from 5 feet to 15 feet to 20 feet thick. From 2 to 5 feet of sand between the layers of gravel.
10	1-2S-16W	-	100	6.6	93.4	12.5	80.9	6.0	74.9	8.3	66.6	10.0	56.6	19.0	37.6	Three hundred feet long, 30 feet wide, 4 feet thick above water level.	Bar of gravel in Caney Creek. Shale and novaculite in about equal proportions. Gravel has been used on local WPA roads.
	GARLAND COUNTY																
11	33-1S-18W	44.0	56.0	8.0	48.0	14.0	34.0	14.0	20.0	5.0	15.0	-	-	12.0	3.0	In broad valley with 30 acres or more of gravel to a depth of 5 feet. At least 3,700 cubic yards of washed and screened gravel is stockpiled.	On south fork of Saline River at Highway 70. Pebbles flat and rounded, about 40 per cent sandstone, 40 per cent novaculite, and 20 per cent shale.
12	SE 20-2S-18W	23.1	76.9	17.0	59.9	16.0	43.9	13.0	30.9	7.7	23.2	-	-	11.6	11.6	An opening 600 by 10 by 5 feet deep. Apparently much more of this gravel is available.	On Mill Creek. Gravel composed of angular pieces of hard blue sandstone. This is a talus gravel and has been used by WPA for local roads.

Table 19. Gravel deposits (cont.)

Map no.	Location Sec. T. R.	Screen size 2" Per cent retained	2" Per cent passed	1½" Per cent retained	1½" Per cent passed	1" Per cent retained	1" Per cent passed	3/4" Per cent retained	3/4" Per cent passed	1/2" Per cent retained	1/2" Per cent passed	3/8" Per cent retained	3/8" Per cent passed	No. 4 Per cent retained	No. 4 Per cent passed	Approximate size of deposit or of opening	Remarks
	GARLAND COUNTY																
13	SE NE 2-2S-19W	18.3	81.7	15.0	66.7	17.5	49.2	15.0	34.2	13.3	20.9	-	-	16.0	4.9	Depth about 5 feet. About 1,000 cubic yards have been removed. Large quantity of similar material available in this area.	Just west of Highway 7. Talus gravel composed of hard angular fragments of novaculite. Used in repairing Highway 7.
14	SE SE 4-2S-20W	8.4	91.6	1.7	89.9	18.3	71.6	18.0	53.6	20.0	33.6	-	-	21.6	12.0	Semi-circular area of about 2 acres. Average depth, about 5 feet above water level.	On Glazypeau Creek by the Mountain Pine railroad. Used for WPA roads. Would make good concrete aggregate.
15	SE SW 4-2S-20W	22.5	77.5	-	77.5	25.0	52.5	33.3	19.2	7.0	12.2	-	-	5.3	6.9	Excavation is 350 by 10 by 5 feet. Large amount of material available.	Very hard novaculite talus gravel. Material used for WPA and county roads.
	MONTGOMERY COUNTY																
16	SW SW 21-1S-25W	12.0	88.0	10.5	77.5	16.0	61.5	15.0	46.5	8.0	38.5	5.5	33.0	14.5	18.5	Deposit is 1,200 feet long by 200 feet wide. About 3 feet thick above water level.	Gravel is on Ouachita River at the crossing of the Sims-Mount Ida road. Pebbles are about 75 per cent sandstone, 20 per cent novaculite, and 5 per cent shale. There is considerable sand. Some of this gravel has been used on local roads.
17	SW SE 33-1S-26W	-	100	5.7	94.3	23.5	70.8	19.0	51.8	15.7	36.1	11.5	24.6	9.0	15.6	Deposit is 1,200 feet long by 300 feet wide. Average thickness 4 feet above water level.	Gravel is on Ouachita River just west of the crossing of the Oden-Mena road. Pebbles are about 60 per cent novaculite, 35 per cent sandstone, and 5 per cent shale.
18	5-2S-25W	12.4	87.6	5.0	82.6	11.3	71.3	13.0	58.3	10.0	48.3	9.4	38.9	9.4	29.5	Excavation is 500 by 150 by 4 feet. Deposit is 1,300 feet long by 250 feet wide. Average thickness above water level is 5 feet.	Gravel bar in Ouachita River, 1/2 mile south of Highway 270. Material consists of 80 per cent sandstone, some novaculite and a small amount of shale. Used for black-topping a part of Highway 270.
19	SE NE 20-2S-27W	5.0	95.0	4.3	90.7	5.6	85.1	10.0	75.1	6.2	68.9	15.0	53.9	13.2	40.7	Deposit is semi-circular with an area of about 5 acres. Thickness of gravel is 6 to 7 feet.	Located along Kates Creek. Gravel consists of about equal proportions of sandstone, novaculite, and shale.
20	E½ 28-3S-25W	-	100	25.0	75.0	18.0	57.0	23.8	33.2	10.0	23.2	-	-	17.2	6.0	Deposit is 1,300 feet long by 200 feet wide. Average thickness of 3 feet above water level.	Gravel bar on the Caddo River at Norman. Gravel is composed of novaculite and sandstone in about equal proportions. This gravel was used in patching Highway 8.
21	NE NE 19-4S-24W	3.3	96.7	21.6	75.1	35.9	39.2	13.0	26.2	11.0	15.2	-	-	13.6	1.6	Fan-shaped deposit covering 2 or 3 acres. Thickness of 2 feet above water level.	On Caddo River. About equal proportions of sandstone and novaculite. Contains large boulders. It is reported that the gravel is used in making precast concrete piling.
22	NE NE 13-4S-25W	4.2	95.8	6.6	89.2	10.0	79.2	11.6	67.6	13.3	54.3	14.1	40.2	19.1	21.1	Deposit is 1,300 feet long, by 200 feet wide. About 6 feet thick above water level.	On Caddo River west of Caddo Gap, above old dam. Pebbles are novaculite and sandstone in about equal proportions. A very small amount of shale.

Table 20. Production and value of gravel in Montgomery, Garland, Saline, and Pulaski counties, 1923-1940[a]

Year	Montgomery County Production cu. yds.	Montgomery County Value	Garland County Production cu. yds.	Garland County Value	Saline County Production cu. yds.	Saline County Value	Pulaski County Production cu. yds.	Pulaski County Value	Total Production cu. yds.	Total Value
1923	2,727.00	$2,372.49	-	$ -	270,676.94	$235,488.94	-	$ -	273,403.94	$237,861.43
1924	9,302.00	8,371.80	-	-	521,030.13	468,927.12	-	-	530,332.13	477,298.92
1925	3,608.00	2,651.88	-	-	383,519.82	281,887.07	-	-	387,127.82	284,538.95
1926	10,040.00	7,680.60	-	-	311,387.68	238,211.58	1,194.00	913.41	322,621.68	246,805.59
1927	10,636.00	9,093.78	-	-	235,234.93	201,125.87	152,00	129.96	246,022.93	210,349.61
1928	10,636.00	9,572.40	-	-	133,460.31	120,114.28	-	-	144,096.31	129,686.68
1929	9,138.50	7,813.41	-	-	209,290.40	178,943.29	-	-	218,428.90	186,756.70
1930	41.50	34.24	6,821.00	5,627.33	121,104.84	99,911.49	-	-	127,967.34	105,573.06
1931	11,104.00	12,825.12	-	-	116,536.65	134,599.83	-	-	127,640.65	147,424.95
1932	831.42	860.52	-	-	5,721.71	5,921.97	-	-	6,553.13	6,782.49
1933	685.65	483.38	-	-	14,602.73	10,294.92	-	-	15,288.38	10,778.30
1934	1,070.20	754.49	-	-	24,398.83	17,201.17	-	-	25,469.03	17,955.66
1935	1,427.61	1,006.47	-	-	15,234.37	10,740.23	-	-	16,661.98	11,746.70
1936	2,183.94	1,539.68	-	-	26,476.49	18,665.93	-	-	28,660.43	20,205.61
1937	1,153.91	588.49	-	-	12,257.87	6,251.51	-	-	13,411.78	6,840.00
1938	-	-	-	-	15,380.08	10,827.58	240.00	168.96	15,620.08	10,996.54
1939	976.70	776.48	-	-	15,952.80	12,682.48	1,132.00	899.94	18,061.50	14,358.90
1940	1,187.76	750.66	-	-	68,949.70	43,576.21	-	-	70,137.46	44,326.87
	76,750.19	67,175.89	6,821.00	5,627.33	2,501,216.28	$2,095,371.47	2,718.00	2,112.27	2.587.505.47	$2,170,286.96

a/ Production figures according to severance tax reports filed by the companies. Value estimated by using U. S. Bureau of Mines average annual price of gravel in Arkansas.

Table 21. Production and value of sand in Montgomery, Saline, and Pulaski counties, 1923-1940 a/

Year	Montgomery County		Saline County		Pulaski County		Total	
	Production cu. yds.	Value	Production cu. yds.	Value	Production cu. yds.	Value	Production cu. yds.	Value
1923	-	$ -	7,531.13	$ 7,794.72	2,168.32	$ 2,244.21	9,699.45	$ 10,038.93
1924	2,181.00	2,224.62	8,080.91	8,242.53	67,211.23	68,555.45	77,473.14	79,022.60
1925	626.00	431.94	12,407.06	8,560.87	147,185.01	101,557.66	160,218.07	110,550.47
1926	1,335.00	1,181.48	13,900.57	12,302.00	90,782.38	80,342.40	106,017.95	93,825.88
1927	1,509,00	1,312.83	1,297.37	1,128.71	90,883.73	79,068.85	93,690.10	81,510.39
1928	3,569.00	3,747.45	21,111.43	22,167.00	95,435.05	100,206.80	120,115.48	126,121.25
1929	1,678.59	1,460.37	2,120.36	1,844.71	94,614.93	82,314.99	98,413.88	85,620.07
1930	60.00	54.00	1,201.00	1,080.90	67,374.97	60,637.47	68,635.97	61,772.37
1931	-	-	2,340.82	1,825.84	44,084.58	34,385.97	46,425.40	36,211.81
1932	121.62	85.74	180.00	126.90	32,595.53	22,979.85	32,897.15	23,192.49
1933	45.45	34.77	-	-	42,271.23	32,337.49	42,316.68	32,372.26
1934	238.40	182.38	-	-	41,126.18	31,461.53	41,364.58	31,643.91
1935	381.26	291.66	-	-	49,045.13	37,519.52	49,426.39	37,811.18
1936	797.58	610.15	-	-	129,753.03	99,261.07	130,550.61	99,871.22
1937	275.95	235.94	-	-	54,113.53	46,267.07	54,389.48	46,503.01
1938	-	-	-	-	66,451.53	69,774.11	66,451.53	69,774.11
1939	75.00	84.75	-	-	46,813.84	52,899.64	46,888.84	52,984.39
1940	206.91	155.18	-	-	60,367.62	45,275.72	60,574.53	45,430.90
Total	13,100.76	12,093.26	70,170.65	65,074.18	1,222,277.82	1,047,089.80	1,305,549.23	1,124,257.24

a/ Production figures according to severance tax reports filed by the companies. Value estimated by using U. S. Bureau of Mines average annual price of sand in Arkansas.

eastern Saline and southwestern Pulaski counties. It ranges in thickness up to 18 feet, but in most places it is less than 10 feet thick. Thickness of the limestone is variable within short distances and has an irregular distribution. Along Fourche Creek, near Limerock Dairy, in sec. 8, T. 1 S., R. 13 W., Pulaski County, the limestone outcrops as a bluff about 16 feet high. In 1938 and 1939 there were 130 holes drilled in Pulaski and Saline counties for the purpose of testing the limestone. At Limerock Dairy, and near the Alexander railway station, lenses of limestone were encountered in irregular patches, several acres in extent ranging from 3 to 18 feet thick. Surface samples taken across the 16 foot vertical section at Fourche Creek indicate this limestone is approximately 60 per cent calcium carbonate. Rock of commercial value is confined within the radius of a few miles of the outcrop, where it can be quarried profitably for use as agricultural lime. Additional testing of this limestone, particularly in the vicinity of Bauxite, where it is much thicker, may reveal beds of higher lime content than those present at the Fourche Creek outcrop. Indications are that the limestone in the Bauxite vicinity is at too great a depth for commercial development.

The results from test holes drilled in Pulaski and Saline counties may be found in the Arkansas Geological Survey, Information Circular 13, "Tertiary Limestones of Pulaski and Saline Counties, Arkansas" by Milton W. Corbin and George R. Heyl, which was published in 1941.

Limestone, interbedded with thin beds of shale, outcrops at several places in Montgomery and Garland counties. In general this is neither pure enough nor thick enough to be a source of chemical lime. Agricultural lime may be quarried profitably on a small scale for local use in several localities. Some occurrences of limestone in the Womble shale are described in Table 22.

Table 22. Limestone in the Womble shale

Map no.	Location Sec. T. R.	Description and Remarks
	GARLAND COUNTY	
1	SW 34-1S-20W	Outcrop on hillside about ¼ mile from Little Glazypeau Creek. The exposure is about 1,000 feet long, 300 feet wide, and has a maximum thickness of 50 feet. The rock is hard, black, and fine-grained. It has been used for burning.
	MONTGOMERY COUNTY	
2	SE SE 27-2S-25W	Outcrop 150 feet east of Highway 27, 1-3/4 miles south of Mount Ida. Dark-gray, hard limestone. Small pit 40 to 50 feet across and 1 to 10 feet deep. Rock was crushed and used to pave about 1 mile of street in Mount Ida. Might be used locally for agricultural purposes. Several analyses indicate $CaCO_3$ content between 75 and 90 per cent.
3	NW SW 26-3S-24W	North side Rattle Snake Branch. Small outcrop of dense, bluish limestone several feet thick. Possible local use in agriculture or as building stone.
4	NE NE 35-3S-26W	About ½ mile from Highway 8 on west bank of branch flowing NE into Caddo River. About 15 feet dark-gray, hard limestone exposed. Possible local use in agriculture or as building stone.
5	SE SW 26-3S-26W	On south bank of Caddo River. Dark-gray, hard limestone. Ten or more feet of beds 1 to 8 inches thick exposed. In 1915, 120 tons of limestone were burned. Used for agricultural purposes.

Production. No commercial production of limestone has been reported in the four counties included in this report. United States production is shown in Table 23.

Table 23. Limestone sold or used by producers in the United States in 1934, by uses. a/

Use.	Short tons	Value
Building stone	386,420	$ 3,391,455
Riprap	2,490,760	2,668,215
Crushed stone	36,824,340	33,298,227
Fluxing stone	9,230,880	6,297,579
Sugar factories	479,900	658,502
Agriculture	1,612,380	1,788,142
Alkali works	3,814,060	2,015,506
Road base	583,410	409,357
Others	2,079,360	7,263,863
	57,501,510	$57,790,846

a/ Exclusive of 19,730,000 tons of limestone and cement rock used in the production of Portland cement and natural cement and 4,800,000 tons of limestone used in the production of lime. Data after U. S. Bureau of Mines.

Novaculite

Composition and properties. Novaculite is a compact quartzose rock of almost pure silica content. Two varieties of commercial value as whetstones are known as Arkansas stone and Ouachita or "Washita" stone.

The Arkansas stone is very fine-grained, hard, and compact, and breaks with an uneven to conchoidal fracture. Novaculite is typically a white stone but may be found in blue, pink, gray, black, brown, or yellow tints due to the amount and nature of the impurities present. Due to the high water content, freezing has an injurious effect on this stone, as its compact structure does not allow for expansion between the grains. Fine quartz veins commonly intersect the rock in all directions and, in many instances, are too small to be visible to the naked eye.

The Ouachita stone resembles unglazed porcelain and has approximately the same composition as the Arkansas stone. It is relatively more porous and has fewer joints and quartz veins, but contains more cavities. The Ouachita stone has unevenly distributed bands of different density appearing as areas of unequal hardness in the unfinished product. It is not injured by freezing but long drying causes it to lose its easy fracture and to become tough and hard.

Table 24 shows analyses of novaculite in Garland County. Table 25 gives the results of absorption tests for various whetstones in Garland County.

Uses. A well known use for novaculite is for the manufacture of oilstones or whetstones. It is of value also for abrasives in general and for some construction work. Rounded novaculite pebbles ranging from 2 to 4 inches in diameter are in demand for tube mills. The Arkansas stone is especially suitable for sharpening fine-edged instruments and small tools used by surgeons, dentists, engravers, and jewelers. It has had limited use as an ornamental stone.

Table 24. Analyses of novaculite in Garland County a/

Map no.		Silica (SiO_2)	Alumina (Al_2O_3)	Iron Fe_2O_3)	Lime (CaO)	Magnesia (MgO)	Potash (K_2O)	Soda (Na_2O)	Loss on ignition	Total
	White novaculite, Hot Springs	99.45		.26	.12	Tr.	.19	.54	.06	100.62
24	Fine Ouachita, Sutton's No. 6	99.49	.13	.06	.04	.08	.16	.10	.14	100.20
7	Ouachita, Barnes Big Quarry	99.06	.30	.06	.09	.13	.13	.13	.08	99.98
17	White Ouachita, Ten Mile Quarry	99.12	.48	.02	.12	.06	.14	.24	.22	100.40
17	Black Ouachita, Ten Mile Quarry	99.27	.23	.03	.08	.08	.10	.11	.60	100.50

a/ Griswold, L. S., Whetstones and the novaculites of Arkansas: Arkansas Geol.Survey Ann. Rept. 1890, vol. III, 1892, p. 161

Table 25 Absorption of water by whetstones in Garland County a/

Map no.	Quarry	Weight fresh from quarry, metric grams	Minimum weight after drying in air	Loss of water	Percentage of loss	Weight after soaking in water	Percentage of gain	Percentage of space occupied by water
28	Whittington's Arkansas	491.96	491.63	0.33	0.067	492.05	0.085	0.225
31	Sutton's Arkansas	507.27	506.88	0.39	0.077	507.38	0.098	0.259
11	Sutton's No. 3	329.15	327.55	1.65	0.504	332.02	1.370	3.630
	Sutton's No. 5	505.81	470.82	24.99	5.306	485.58	3.140	14.060
24	Sutton's No. 6	304.13	285.36	18.77	6.580	305.61	7.990	18.788
25	Sutton's No. 7	454.22	426.52	27.70	6.490	449.35	5.350	17.198
3	Whittington's Red	393.07	388.26	4.81	1.240	395.66	1.890	5.008
5	Whittington's Sec. 8	399.46	398.65	0.81	0.230	405.80	1.790	4.743
7	Barnes Big Quarry	257.05	251.12	5.88	2.340	185.53 b/	0.733	6.216

a/ Griswold, L.S., Whetstones and the novaculites of Arkansas: Arkansas Geol. Survey Ann. Rept. 1890, vol. III, 1892, p. 106

b/ Specimen broken; weight of largest piece dry, 184.18 grams.

Prices. There is a considerable range in value between the different grades of stone. In 1940 the price of crude novaculite for whetstones, f.o.b. Hot Springs, ranged from less than \$148 to \$400 or more per short ton. The average value was \$276 per ton.

Occurrence. Novaculite occurs as massive beds in the Arkansas novaculite formation, varying from a few inches to 15 feet in thickness. This formation is distributed throughout the Ouachita Mountain area. Large blocks of Arkansas stone are seldom, if ever, shipped, but are broken into pieces weighing from 5 to 15 pounds. The Ouachita stone is usually shipped in blocks weighing from 40 to a maximum of 1,500 pounds.

Table 26 shows the locations of novaculite quarries and prospects in Saline, Garland and Montgomery counties.

Table 26. Novaculite quarries and deposits in Saline, Garland and Montgomery counties.

Map no.	Location Sec. T. R.	Name of quarry, owner, and operator.	Description	Size of quarry and estimated production	Remarks
	SALINE COUNTY				
1	6-1N-16W		Very porous Ouachita stone known locally as white sandstone. Good whetstone for broad-edged tools requiring a soft stone1/.		Brazil's Post Office.
	GARLAND COUNTY				
2	SW SW 7-2S-18W	Harry Howard, Hot Springs, Ark., owner.	White, coarse-grained medium Ouachita stone 40 feet thick2/.	500 by 40 by 35 feet. 12,000 cubic yards removed. Whetstone recovery 10 per cent, remainder grindstone material.	On northwest slope of Indian Mountain 5 miles northeast of Hot Springs.
3	SW SE 7-2S-18W	Whittington's Red Quarry.	Pure white Ouachita stone with bluish tint1/.		On Indian Mountain.
4	NW SE 7-2S-18W	Harry Howard, Hot Springs, Ark., owner.	White, coarse-grained, medium Ouachita stone, 10 feet thick. Blocks range in weight from 75 to 850 pounds2/.	200 by 20 by 29 feet. 2,400 cubic yards removed. Whetstone 10 per cent.	On northwest slope of Indian Mountain 6 miles northeast of Hot Springs.
5	S½ 8-2S-18W	Whittington's Section 8 Quarry.	Pure white Ouachita stone with bluish tint. Secondary quartz filling cavities is well shown1/.		On Indian Mountain.
6	SE SW 7-2S-18W	Norton-Pike Co., Littleton, N. H., owner.	Fine-grained hard Arkansas stone, 20 feet thick2/.	350 by 32 by 40 feet. 8,000 cubic yards removed. Whetstone 10 per cent.	On Indian Mountain 5¼ miles northeast of Hot Springs. Inactive for 20 years.

Table 26. Novaculite quarries and deposits in Saline, Garland and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Name of quarry, owner, and operator.	Description	Size of quarry and estimated production	Remarks
	GARLAND COUNTY				
7	S½ 8-2S-18W	Barnes Big Quarry.	Dense, pure white Ouachita stone. Secondary quartz filling the cavities is well shown1/.		On Indian Mountain
8	8-2S-18W	Sutton's No. 1 Quarry.	Chalky-white, dense Ouachita stone1/.		On Indian Mountain at end of spoon. Last quarry on lead.
9	SE SW 13-2S-18W	Dalton Quarry. Norton-Pike Co., Littleton, N. H., owner and operator.	3/		
10	NW SE 13-2S-18W	Fosdick Quarry. Gil H. Wootten, Hot Springs, Ark., owner and operator.	Light-blue Ouachita stone4/.	Small prospect. Operating on small scale.	
11	SW NW 18-2S-18W	Sutton's No. 3 Quarry. Norton-Pike Co., Littleton, N. H., owner and operator.	3/		Active. Shipping rough stone.
12	SE NW 24-2S-18W	D. B. Murry, Hot Springs, Ark., owner; W. E. Lewis, Hot Springs, Ark., operator.	Hard, dense Arkansas stone which ranges in color from white to dark-gray2/.	200 by 20 by 20 feet. 3,000 cubic yards removed. Whetstone 20 per cent.	On crest of ridge about 10 miles northeast of Hot Springs.
13	NW NW 24-2S-18W	D. B. Murry, Hot Springs, Ark., owner. W. E. Lewis, Hot Springs, Ark., owns whetstone rights.	Hard, dense, dark-gray Arkansas stone. Good quality for use as whetstone. Large reserves2/.	Main quarry: 12 by 8 by 4 feet. 300 feet west is opening 6 by 6 by 3 feet. Southwest are 20 or more similar openings within half a mile.	On northwest slope of novaculite ridge about 10 miles northeast of Hot Springs.

Table 26. Novaculite quarries and deposits in Saline, Garland and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Name of quarry, owner, and operator	Description	Size of quarry and estimated production	Remarks
	GARLAND COUNTY				
14	26-2S-18W	Norton-Pike Co., Littleton, N. H., owner and operator.	Coarse-grained Ouachita stone4/.		Active.
15	SW NW 27-2S-18W	Norton-Pike Co., Littleton, N. H., owner.	Hard, flint-like stone, light-gray, with uniformly fine texture2/.	Two openings in bed from a few inches to 6 inches thick. 240 cubic yards removed. Whetstone 20 per cent.	On a novaculite ridge 7 miles east of Hot Springs.
16	NE NW 35-2S-18W SE SW 26-2S-18W	Norton-Pike Co., Littleton, N. H., owner.	White, coarse Ouachita stone quarried chiefly for whetstones. Some of this stone has been used for building purposes2/.	Eight openings in one stratum 10 to 16 feet thick, 2 openings in other stratum 7 feet thick. 3,000 cubic yards removed.	On a novaculite ridge 8½ miles east of Hot Springs.
17	NW NW 35-2S-18W	Ten-Mile Quarry. Norton-Pike Co., Littleton, N. H., owner.	White and black Ouachita stone3/.		Active. Shipping rough stone.
18	NW NW 35-2S-18W	Norton-Pike Co., Littleton, N. H., owner.	Hard, flint-like, light-gray Arkansas stone. Used for whetstones. Beds from 2 inches to 3 feet thick2/.	200 by 10 by 12 feet. 900 cubic yards removed. Whetstone 10 per cent.	On west side of old Hot Springs-Benton highway, 8 miles east of Hot Springs.
19	NW NW 35-2S-18W	Norton-Pike Co., Littleton, N. H., owner.	Good grade Ouachita stone. Quarried in irregular blocks weighing from 5 to 50 pounds2/.	16 feet wide, from 10 to 50 feet deep, and cut 500 feet into hill.	Along old Hot Springs-Benton road. Stone has been shipped to Germany.

Table 26. Novaculite quarries and deposits in Saline, Garland and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Name of quarry, owner, and operator	Description	Size of quarry and estimated production	Remarks
	GARLAND COUNTY				
20	NW NW 35-2S-18W		2/		In February 1941 deposit was being reopened, and 50,000 pounds of rock in large blocks averaging more than one foot irregularly cubical, were being shipped to Norton-Pike Co., Littleton, N. H., to fill orders.
21	36-2S-18W	Formerly owned by Malvern Lumber Co. sold in 1926.	Black and white novaculite4/.		Has been worked.
22	SW NW 21-2S-19W	J. A. Thomas, Hot Springs, Ark., owner.	Black with gray coating. Texture is intermediate between Arkansas stone and Ouachita stone2/.	In bed of novaculite of which 6 feet is exposed. 100 cubic yards removed. Whetstone 10 per cent.	On northwest base of Indian Mountain 4 miles northeast of Hot Springs.
23	E½ SE 22-2S-19W	Fordyce Quarry. Gil H. Wootten, Hot Springs, Ark., owner and operator.	White Ouachita stone4/.	About 100 by 30 by 20 feet.	Active in 1941. Operating on small scale.
24	24-2S-19W	Sutton's No. 6 Quarry.	Grayish-white, homogeneous, porous Ouachita stone1/.		On Indian Mountain.
25	24-2S-19W	Sutton's No. 7 Quarry.	Good Ouachita stone1/.	100 yards long and 10 to 15 feet deep.	On Indian Mountain.

Table 26. Novaculite quarries and deposits in Saline, Garland and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Name of quarry, owner, and operator	Description	Size of quarry and estimated production	Remarks
	GARLAND COUNTY				
26	NE NW 24-2S-19W	Norton-Pike Co., Littleton, N. H., owner and operator.	White, coarse-grained, medium hard Ouachita stone. Aggregate thickness of about 20 feet2/.	1,500 by 20 by 30 feet. 35,000 cubic yards removed.	On northwest slope of Indian Mountain, 5 miles northeast of Hot Springs. Quarry has not produced whetstone for last 20 years. Material now being crushed to chat-size for making terrazzo.
27	NW NE 26-2S-19W	Robert Lenders, Houston, Texas, owner. J. A. Thomas, Hot Springs, Ark., operator.	Hard, dense, and flint-like Arkansas stone, varying in color from white to black. Deposits of high-grade stone cover several acres2/.	Three small openings in beds 2 feet or less in thickness. 500 cubic yards removed for whetstone and jewelers' stone manufacture.	On northwest slope of Indian Mountain, 3 miles northeast of Hot Springs.
28	27-2S-19W	Whittington's Arkansas Quarry.	Arkansas stone1/.	Has produced a large quantity of very fine Arkansas stone.	On Indian Mountain.
29	27-2S-19W	W. E. Lewis, Hot Springs, Ark., owner and operator.	4/		Not operating at present.
30	NW SE 27-2S-19W		White, smooth Arkansas stone of extremely fine quality. Beds range from 2 to 13 inches in thickness2/.	100 by 50 by 10 to 30 feet. Considerable rock has been removed.	Has recently been in operation. On east side of Gorge Road, about 2 miles northeast of Hot Springs.
31	NE SE 27-2S-19W	Sutton's Arkansas Quarry.	Dense, hard, pure white Ouachita stone with bluish watery tint1/.		On Indian Mountain.

Table 26. Novaculite quarries and deposits in Saline, Garland and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Name of quarry, owner, and operator	Description	Size of quarry and estimated production	Remarks
	GARLAND COUNTY				
32	NW 27-2S-19W E½ 28-2S-19W	Garland Whetstone and Kaolin Co., John Wolfe, Hot Springs, Ark., operator.	White, coarse-grained, medium hard Ouachita stone. Similar stone below that now being quarried. Beds range from a few inches to 5 feet in thickness2/.	Series of quarries extending for 3/4 mile are from 10 to 12 feet wide. 21,000 cubic yards removed.	On northwest slope of North (Quarry) Mountain at city limits of Hot Springs.
33	28-2S-19W		White, buff, and pink Arkansas stone of good quality.	Several open cuts, drifts, and quarries. Extensive workings follow contour of hill about 150 feet above its base. Has been worked for past 50 years and much material has been shipped2/.	On top of steep mountain near intersection of highway 70 and Gorge highway 2 miles north of Hot Springs.
	MONTGOMERY COUNTY				
34	NE 18-1S-23W		Thin-bedded type of novaculite. Some of float pieces could be used for rock veneer construction2/.	No production.	
35	21-2S-27W		Gray, porous Ouachita stone, looking like quartzose sandstone though lacking the vitreous luster. Should make good whetstone for coarser kinds of work1/.	No production.	

1/ Griswold, L. S., Whetstones and novaculites of Arkansas Geol. Survey Ann. Rept. 1890, Vol III, 1892
2/ State Mineral Survey Special Investigation.
3/ Owner.
4/ Rex Mhoon.

Production. The demand for Ouachita stone greatly exceeds that of Arkansas stone, and it is found in larger quantities. All Arkansas novaculite is shipped from the state for processing into commercial whetstones. The manufacture of synthetic abrasives has adversely affected the production of novaculite for whetstone.

The annual production of novaculite used for oilstones, all of which came from Garland County, is shown in Table 27. No production has been reported from Montgomery County. Production of novaculite for construction material is included under "Building Stone."

Table 27. Production and value of oilstones in Garland County, 1885-1940

Year a/	Production short tons	Value	Year	Production short tons	Value	Year	Production short tons	Value
1885	265.00	$ 7,420 b/	1911	c/	$ 95,617	1927	c/	$ c/
1886	325.00	9,100 b/	1912	c/	112,047	1928	194.00	113,140
1890	380.67	12,384 b/	1913	c/	c/	1929	171.00	115,684
1891	237.50	75,000	1914	c/	65,215	1930	c/	c/
1892	210.00	72,000	1915	c/	c/	1931	59.00	38,379
1893	156.00	57,000	1916	c/	c/	1932	40.00	25,129
1894	157.50	60,000	1917	c/	c/	1933	20.00	10,417
1895	132.50	60,000	1918	325.00	112,031	1934	82.00	49,741
1896	120.00	50,000	1919	349.00	126,408	1935	93.00	64,651
1897	250.00	75,000	1920	209.00	120,671	1936	119.00	64,817
1905	c/	104,761	1921	122.00	80,626	1937	47.00	44,465
1906	c/	125,205	1922	c/	c/	1938	41.00	43,777
1907	c/	106,860	1923	c/	c/	1939	46.00	49,433
1908	c/	81,837	1924	214.00	143,264	1940	40.00	66,081
1909	c/	72,334	1925	255.00	165,018		4,818.00	$2,888,371
1910	c/	100,542	1926	158.00	106,317			

a/ Figures from 1885 to 1938 from U. S. Geological Survey and U. S. Bureau of Mines. Figures for 1938, 1939, and 1940 furnished by producing companies.
b/ Value of rough stone.
c/ Not available.

Producers. Following are producers of novaculite in Arkansas:

Garland Whetstone & Kaolin Co.
John C. Wolf, owner and operator.
Box 1037,
Hot Springs, Ark.

Lewis Whetstone Co.
W. E. Lewis, owner and operator.
23 Westbrook Ave.,
Hot Springs, Ark.

Norton-Pike Co.
Main office, Littleton, New Hampshire.
Arkansas office: 901 Central Ave., Hot Springs, Ark.

Gil H. Wootten
Arkansas National Bank Bldg.,
Hot Springs, Ark.

Quartz Crystals

Composition and Properties. Quartz, or silica (SiO_2), is a very hard, brittle to tough, refractory mineral which is resistant to most acids. There are a great many different varieties of quartz occurring in veins and geodes, assuming crystalline, stalactitic, concretionary or mamillary forms. Rock crystal quartz is a colorless form commonly found in distinct crystals.

Uses. Most of the quartz crystals found in Pulaski, Saline, Garland, and Montgomery counties are sold to tourists, museums, schools,and private collectors. Others, which are essentially free from flaws, are cut into "Hot Springs diamonds" and are used for various ornamental purposes.

Quartz crystals, clear,transparent,and free from color or cloudiness have assumed an important position in the construction of radio equipment, range finders, construction-finding apparatus, periscopes, gun sights, polariscopes, and other precision equipment.

Prices. The price for individual specimens ranges from 5 cents to $50 depending on the size, shape, clearness, or unusual characteristics. Single crystals in quantities sell for about 60 cents per pound for mine-run specimens and $2.50 per pound for choice, clear, selected stones.

It is reported that three clusters of quartz crystals from Garland County were sold for $200, $150, and $100, respectively, to the Smithsonian Institute at Washington, D. C.

Demands for quartz crystals, complying with definite specifications necessary for use in various defense materials, have increased with the rapid expansion in defense production. Prices on these vary.

Occurrence and Production. The crystal fields have been hunted so thoroughly in recent years that it is virtually impossible to find good specimens on the surface. At present, most crystals are obtained by mining. A large part of the supply produced in this area comes from the Crystal Mountains east of Norman, Montgomery County, and from the vicinity of Crystal Springs in western Garland County. Most of these are found associated with residual clay which has filled the cavities and fractures in the Crystal Mountain sandstone.

Mines in Montgomery County have been opened in the center of sec. 20, near the center of the west line of sec. 21, and in the NW¼ of sec. 29, in T. 3 S., R. 24 W. In the SW¼ NE¼ sec. 20, T. 3 S., R. 24 W., quartz crystals have been mined intermittently for more than 50 years. Recently, mining has been carried on by Mr. Garfield Lewis in sec. 10, T. 3 S., R. 24 W.and on land leased by the United States Government in the SE¼ SW¼ sec. 4, T. 3 S., R. 23 W. About 5 to 10 per cent of the crystals found here are clear. The average size ranged from 1/4 to 3 inches in diameter; however, the largest weighed approximately 10 pounds. The total production from this mine, as reported in July 1941,has been about 40,000 pounds of which 20,000 pounds was produced in 1940. These have been used both for tourist trade and for industrial purposes. There has been "gopher" mining of quartz crystals along the crest and down the southwest slope of the ridge in NE¼ NW¼ sec. 22, T. 1 S., R. 24 W.

Large deposits of crystals are found in secs. 30 and 31, T. 1 N., R. 19 W., and in secs. 25, 26, and 36, T. 1 N., R. 20 W., Garland County. Workings in this county have been reported in sec. 2, T. 1 S., R. 21 W., and in secs. 29, 30, and 31, T. 2 S., R. 22 W., along the Garland-Montgomery County line.

Production of crystals has been intermittent from the Willis Mine in secs. 21 and 22, T. 2 N., R. 17 W., Saline County. Many of these crystals are very large and some as much as 26 inches long and 14 inches across have been found. A number of crystals are present on Crystal Mountain in the extreme northwestern portion of Saline County, and along Maumelle River west of Natural Steps, Pulaski County.

The following produce or have produced quartz crystals in Montgomery, Garland, and Saline counties:

Harris & Cogburn, Caddo Gap, Montgomery County.

Garfield Lewis, Crystal Springs, produces crystals 1/4 to 3 inches in diameter, from SE¼ SW¼ sec. 4, T. 3 S., R. 23 W., Montgomery County.

S. P. Rodgers, Silver, Montgomery County.

J. A. Bauer, 435 Whittington Ave., Hot Springs, produces mostly groups and small crystals from sec. 2, T. 1 S., R. 21 W., Garland County.

H. Coffman, Crystal Springs, Garland County.

J. J. Hendrix, Mountain Valley, Garland County.

J. W. Fairchild, Paron, produces from Willis Mine in secs. 21 and 22, T. 2 N., R. 17 W., Saline County.

Slate

Composition and properties. Slate is a fine-grained rock derived from shale probably by the action of heat and pressure. As a result of the pressure, cleavage entirely independent of the original bedding planes of the shale was formed. Slate may be black, purple, red, or green in color. Black slate, like black shale, owes its color to finely-divided carbonaceous matter deposited with the shale from which the slate was derived; purple slate to a mixture of iron oxide and chlorite; red slate to the presence of iron oxide; and green slate probably to the presence of a large amount of chlorite.

Most of the slate in the area has a good ring, splits easily, and can be quarried in large blocks, but it is too low in quartz and too high in chlorite to be considered a high-grade slate. It is generally too soft to be used as a roofing slate. Small crystals of iron pyrite, when present, form an objectionable constituent in slate.

Uses. The principal use of slate in the United States is for roofing. Other uses of milled slate are for electrical slate, grave vaults and covers, blackboards, billiard table tops, school slates, and a small amount for flagstones. Slate granules are used extensively in surfacing prepared roofing, and slate flour is employed as a filler in paints, road asphalt-surface mixtures, roofing mastic, oilcloth, linoleum, and various other products. Practically all of the slate quarried at present in Arkansas is used as roofing granules. A small amount has been used for slate roofs.

Prices. The average price of roofing slate in the United States in 1940 was $7.00 per square (100 square feet). The average price of granules and flour in the United States in 1940 was $8.71 and $3.30, respectively, per short ton, according to the U. S. Bureau of Mines.

Occurrence. The area in which the slates of Arkansas are located includes a part of the Ouachita Mountains and extends from near Little Rock, Pulaski County, westward through Saline, Garland, and Montgomery counties, and into Polk County. Its length is about 100 miles and its average width probably is about 15 miles.

Table 28 is a summary of the more important slate prospects and quarries in this area.

Table 28. Occurrences of slate in Pulaski, Saline, Garland, and Montgomery counties

Map no.	Location Sec. T. R.	Formation	Description	Remarks
	PULASKI COUNTY			
1	32-2N-15W	Stanley shale	Slate very hard and has a clear ring. Good for roofing shingles1/.	Near center of section.
2	34-2N-15W	Stanley shale	Slate very hard and has a clear ring. Splits into good roofing shingles. Joints far enough apart to get out blocks 5 to 6 feet in diameter. Small crystals of iron pyrite scattered through shale1/.	Quarry about 30 feet square and 50 feet deep. Worked in 1888 and 1889.
3	NW SW 8-1N-13W	Stanley shale	Bluish-black, hard slate with a clear ring and smooth cleavage surface. Contains small crystals of pyrite1/.	Workable slate about 4 feet in quarry which is about 30 feet long, 20 feet wide, and 70 feet deep. Worked in 1885.
	SALINE COUNTY			
4	NE 16-1N-15W	Womble shale	Hard, bluish-black shale with clear ring. Numerous pyrite crystals. Smooth cleavage surface and does not check on exposure to air. Dip and strike joints 8 inches to 2 feet apart1/.	Several quarries opened 1891 and several carloads of shingles made between 1891 and 1894.
	GARLAND COUNTY			
5	SE 2-2S-20W	Slate in Bigfork chert (?)	Black slate containing iron pyrite crystals. Splits into good shingles1/.	Considerable prospecting between 1897 and 1908.
6	9-2S-20W	Missouri Mountain slate	Massive, thick-bedded, hard red slate with uneven and irregular jointing and some particles of pyrite. Some gray slate present2/.	About 1/4 mile east of Hot Springs. Pine Mountain road 1-1/2 miles southeast of village of Mountain Pine.
7	NW NE 11-2S-20W	Missouri Mountain slate in Polk Creek shale or Bigfork chert (?)	Several small openings of black, red, and gray slate1/.	Openings of black and red slate on north side of hill; of gray slate, on south side of hill.

Table 28. Occurrences of slate in Pulaski, Saline, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Formation	Description	Remarks
	GARLAND COUNTY (cont.)			
8	NE NW 11-2S-20W	Slate in Bigfork chert	Black and red slate with good ring. Splits into thin shingles with smooth cleavage surfaces. Joints few. Crystals of iron pyrite1/.	Quarry about 20 feet square and 50 feet deep. About 8,000 to 10,000 roofing shingles made between 1902 and 1906 but none were shipped.
9	19-2S-20W	Stanley shale	Black slate1/.	Opening 15 by 20 feet and 30 feet deep. When first opened, blocks used in neighborhood for chimneys and foundations.
10	23 & 24-2S-21W	Missouri Mountain slate Fork Mountain slate Stanley shale	Uniform dark red shale with considerable jointing. Bluish-gray slate, cleavage parallel with bedding, unusual flexibility, strength, and sonority. Some hard, sandy layers. Bluish-gray slate with well-defined dip and strike joints. Cleavage with bedding. Strength not very great. No sonorous1/.	Three small openings, one large. Prospect in $NW\frac{1}{4}$ sec. 24 is 30 feet square and 10 feet deep. Main opening 100 by 50 feet and 65 feet deep. Another opening 50 feet up and down slope, 10 feet wide, and 4 feet deep.
11	$N\frac{1}{2}$ 3-3S-22W	Missouri Mountain slate	Red slate with fair cleavage, and average sonority and hardness. Infrequent, well-developed strike and dip joints1/.	Two openings about 500 feet.
12	$N\frac{1}{2}$ 3-3S-22W	Missouri Mountain slate	Red slate with good cleavage1/.	Quarriable in blocks of considerable size.
13	$S\frac{1}{2}$ 5-3S-22W	Missouri Mountain slate	Deep red with streaks of green. Well-defined dip and strike joints and numerous irregular joints. But slightly sonorous1/.	In small ravine about 50 feet above base of hill. Opening 100 by 10 to 15 by 4 to 6 feet.
14	$S\frac{1}{2}$ 5-3S-22W	Missouri Mountain slate	Dark red with a few green streaks along joints. Cleavage above average. Lumpy due to small pyrite accumulations1/.	Two openings.

Table 28. Occurrences of slate in Pulaski, Saline, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Formation	Description	Remarks
	GARLAND COUNTY (cont.)			
15	NE 7-3S-22W SE 6-3S-22W	Missouri Mountain slate	Dark red slate. Poor cleavage1/.	Two openings.
	MONTGOMERY COUNTY			
16	SE NW 4-2S-26W	Slate in Polk Creek shale or Bigfork chert (?)	Soft dark-blue slate highly jointed, breaking into thin, small irregular size pieces2/.	Exposed for 200 feet in bed of a small stream (tributary of Kates Creek one mile west of Oden).
17	SW NE 13-2S-26W	Womble shale	Gray, hard shale2/.	Too si[liceous] for clay use and too s[of]t for slate use.
18	E½ 10-3S-23W	Missouri Mountain slate	Red, somewhat sonorous slate. Thickness appears to be about 125 feet at this point1/.	Near [to]p on south slope of mountain. Stripped surface 40 by 60 feet.
19	29-3S-23W	Missouri Mountain slate	Red slate not sonorous. Cleavage poor. Falls to pieces on weathering. Joints numerous and irregular1/.	
20	NE 35-3S-24W	Missouri Mountain slate	Red slate with irregular but infrequent jointing. Not sonorous. Near north end of quarry a streak of yellow slate due to weathering of the red1/.	In ravine on north slope of mountain.
21	NW 36-3S-24W	Missouri Mountain slate	Red somewhat sonorous slate with irregular but not frequent jointing. Splits easily with rather rough surface1/.	North slope of mountain on east side of small ravine.
22	NE SE 9-3S-26W or NW SW 10-3S-26W	Womble	Hard green slate with clear ring. Free from crumbling, splits well, divided into rather large blocks by jointing1/.	

Table 28. Occurrences of slate in Pulaski, Saline, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Formation	Description	Remarks
	MONTGOMERY COUNTY (cont.)			
23	W½ 31-3S-26W	Missouri Mountain slate	Red slate of varying thickness in different exposures. Not highly jointed1/.	North slope of mountain at elevation of 1380 feet. Three openings.
24	SW SE 32-3S-26W	Missouri Mountain slate	Red slate with some green parts. Weathers and splits into thin pieces. Cut by a one inch quartz vein2/.	Opened 1929 and mined for flagstone until 1933. More recently opened for shingles but none were sold.
25	E½ SE 33-3S-27W	Missouri Mountain slate	Red and green soft, thin-splitting shale2/.	Four large workings. No production for several years.
26	E½ 34-3S-27W or W½ 35-3S-27W	Missouri Mountain slate	Deep red slate practically horizontal. Only slightly jointed. Good cleavage with fairly smooth surface. Not sonorous1/.	Bluff at head of small ravine.
27	35-3S-27W	Missouri Mountain slate	Red slate which can be quarried in large blocks1/.	On north side of mountain at elevation of about 1600 feet. Has been worked to considerable extent.
28	35-3S-27W	Missouri Mountain slate	Red slate which has suffered much crushing and jointing1/.	On south slope of mountain. A large amount of milled stock has been supplied from here.
29	E½ 36-3S-27W	Missouri Mountain slate	About 30 feet of green or brown slate, color resulting from weathering of red slate. Very poor cleavage1/.	
30	4S-24W Near line between 2 and 3	Missouri Mountain slate	Red slate with dead ring. Splits only into thick pieces. Highly jointed. Cleavage surface transversely into numerous small slickenslides1/.	

Table 28. Occurrences of slate in Pulaski, Saline, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Formation	Description	Remarks
	MONTGOMERY COUNTY (cont.)			
31	SE 7-4S-25W	Missouri Mountain slate.	Red slate, neither hard nor sonorous. Taken out in large blocks which split well1/.	Several prospect holes on east end of Fodderstack Mountain.
32	7 & 8-4S-26W		3/	Arkansas Slate Manufacturing Co. producing slate for roofing granules.
33	NE NE 18-4S-26W	Missouri Mountain slate Stanley shale	Red, green, and gray slate suitable for roofing granules2/.	Mine first opened 1909. Arkansas Slate Manufacturing Co. started operations in 1937 for roofing granules. Slate dust used as linoleum filler.
34	NE NW 32-4S-26W	Stanley shale	Gray slate, slightly calcareous2/.	No workings.
35	3-4S-27W	Missouri Mountain slate	Red to green and brown on weathered surface. Cleavage good. Joints numerous. Thin layers of fine-grained sandstone are common1/.	On south side of mountain at height of 1750 feet.
36	N½ 3-4S-27W	Missouri Mountain slate	Red slate with straight, clean cut, infrequent joints1/.	In ravine on north slope of mountain.
37	N½ 3-4S-27W	Basal Missouri slate	Green slate with cleavage parallel to bedding. Contains thin layers of fine sandy material1/.	In small creek that runs along north side of sec. 3.
38	4-4S-27W	Stanley shale	Grayish-blue, micaceous slate or bluish-black, non-micaceous slate. Former sonorous and cleaves with rather rough surface. Latter not sonorous and cleaves with smooth, glossy surface1/.	On east side of small branch flowing into Crooked Creek. Quarry 100 feet square by 50 feet deep.

Table 28. Occurrences of slate in Pulaski, Saline, Garland, and Montgomery counties (cont.)

Map no.	Location Sec. T. R.	Formation	Description	Remarks
	MONTGOMERY COUNTY (cont.)			
39	N½ 9-4S-27W	Missouri Mountain slate	Uniform red, sonorous slate. Small green spots noticeable on close inspection. "Curl" common1/.	On north steps of Statehouse Mountain.
40	W½ 4-4S-27W or E½ 5-4S-27W	Stanley shale	Dark-blue slate with poor cleavage. Disintegrates rapidly on exposure1/.	Small prospect.
41	N½ 5-4S-27W	Stanley shale	Exposure 180 feet thick of thin-bedded, greenish to chocolate-brown slate highly jointed. Near middle portion is a bed of conglomerate about 180 feet thick1/.	On south slope of Missouri Mountain at height of 1800 feet.
42	SE NW 11-4S-27W	Missouri Mountain slate	Blue, gray, red, and green slate2/.	Only surface prospecting. No production.
43	S½ 23-4S-27W N½ 26-4S-27W	Missouri Mountain slate	About 75 feet of red slate. Exposure badly weathered. Contains layers of dark chert one to 3 inches thick1/.	Along small branch between Arkansas novaculite on hill to north and Stanley shale on hill slope to south.

1/ Purdue, A. H., Slates of Arkansas: Arkansas Geol. Survey, 1909.
2/ Special Investigation, State Mineral Survey.
3/ Saviak, C. P.; President, Arkansas Slate Manufacturing Co.; Personal communication, August 1, 1941.

Table 29. Chemical analyses of slate from Montgomery County
sec. 33, T. 3 S., R. 27 W

	1 E line NE¼ SE¼	2 E line NE¼ SE¼	3 SE¼ SE¼
Silica	53.81	54.83	57.79
Alumina	25.40	23.53	22.92
Ferric oxide	6.17	5.06	5.19
Manganese oxide	.06	.14	.07
Lime	.31	.28	.23
Magnesia	1.74	3.05	1.97
Sulphuric anhydrite	Trace	.26	.08
Ferrous oxide	2.75	3.41	2.62
Sodium oxide	.49	.21	.12
Potassium oxide	4.27	3.21	4.66
Water at 100° C.	.66	.43	.48
Ignition loss	4.62	6.01	4.13
	100.28	100.42	100.26

Table 31. Physical tests of slate from Montgomery County
sec. 33-3S-27W

Map no.	Spec. no.	Specific gravity		Absolute porosity		Weight per cubic foot (lbs.)
		True	Apparent	1	A.S.G. / T.S.G.	
1	1	2.863	2.714		-	169.1
	2	2.859	2.712		-	169.0
	3	-	2.689		-	167.5
	Av.	2.861	2.705		.0545	168.5
2	1	2.813	2.738		-	170.6
	2	2.816	2.747		-	171.1
	3	-	2.744		-	171.0
	Av.	2.815	2.743		.0256	170.9
3	1	2.862	2.748		-	171.2
	2	2.857	2.776		-	173.0
	3	-	2.741		-	170.8
	Av.	2.860	2.755		.0367	171.7

Table 30. Transverse and absorption tests of slate from Montgomery County, sec. 33, T. 3 S., R. 27 W

Map no.	Specimen no.	Dimensions: Width (in.)	Dimensions: Depth (in.)	Dimensions: Span. (in.)	Transverse Tests, Conditions at maximum load: Load center (lbs.)	Transverse Tests, Conditions at maximum load: Deflection center (lbs.)	Transverse Tests, Conditions at maximum load: Modulus of rupture (lbs. per sq. in.)	Modulus of elasticity (constant up to nearly max.)	Absorption Tests, Weight ratio of absorption: 30 min.	Weight ratio of absorption: 24 hours	Weight ratio of absorption: 48 hours	Volume ratio of absorption: 30 min.	Volume ratio of absorption: 24 hours	Volume ratio of absorption: 48 hours
	1	2.00	0.95	9	322	.0190	2,410	2,100,000	.0017	.0189	.0189	.0047	.0511	.0513
1	2	1.98	0.97	do.	674	.0148	4,880	4,640,000	.0005	.0175	.0193	.0014	.0475	.0523
	3	1.98	0.98	do.	854	.0196	6,060	4,250,000	.0011	.0164	.0786	.0031	.0439	.0500
	Av.	-	-	-	-	-	4,450	3,660,000	.0011	.0176	.0189	.0031	.0475	.0512
	1	1.94	1.00	9	920	.0134	6,400	6,430,000	.0004	.0089	.0105	.0010	.0243	.0286
2	2	1.97	0.98	do.	959	.0150	6,840	6,040,000	.0004	.0075	.0095	.0012	.0205	.0260
	3	1.99	0.97	do.	920	.0170	6,630	5,470,000	.0003	.0087	.0101	.0009	.0238	.0276
	Av.	-	-	-	-	-	6,620	5,980,000	.0004	.0084	.0100	.0010	.0229	.0274
	1	2.07	0.30	12	93	.0600	8,990	11,820,000	.0026	.0113	.0121	.0072	.0310	.0332
3	2	1.98	0.27	do.	64	.0560	7,980	12,420,000	.0009	.0087	.0114	.0025	.0241	.0315
	3	1.99	0.29	do.	80	.0615	8,600	11,570,000	.0013	.0112	.0122	.0036	.0307	.0334
	Av.	-	-	-	-	-	8,520	11,940,000	.0016	.0104	.0119	.0044	.0286	.0327

Tables 29, 30, and 31 show chemical analyses, transverse and absorption tests,and physical tests, respectively, of three specimens of slate from Montgomery County, made by the U. S. Geological Survey7/.

Production. As early as 1859 a slate quarry was opened northwest of Little Rock, Pulaski County. A company was formed to quarry this slate for roofing purposes, but it was found that weathering caused the slate to check and split. A few years later a quarry was opened near the mouth of Glazypeau Creek,12 miles northwest of Hot Springs, Garland County, but no reliable report of utilization of this slate has been secured. From 1885 to 1908 several quarries were opened in the western part of Pulaski County and the eastern part of Saline County, and from some of these a small amount of roofing slate was shipped. In 1908 milling slate was marketed from Montgomery County.

A record of slate production by counties is not available. Following, Table 32, gives the production from Montgomery County in 1938 and 1939:

Table 32. Production of slate in Montgomery County

Year	Production short tons a/	Average price b/	Estimated value
1938	98.12	$5.70	$ 559.28
1939	743.58	8.57	6,372.48
	841.70		$6,931.76

a/ From severance tax reports filed with State Department of Revenues.
b/ Average price of granules in United States, according to U. S. Bureau of Mines.

Producers. The Arkansas Slate Manufacturing Company, Glenwood, Arkansas, is at present operating a slate quarry in Montgomery County 16 miles west of Caddo Gap. This slate is used in the manufacture of roofing granules.

Soapstone

Composition and properties. Soapstone is a term used loosely in reference to soft rocks with a soapy feel, composed essentially of the mineral talc, a hydrous magnesium silicate which contains other minerals such as chlorite, mica, pyroxene, tremolite, magnetite, quartz, calcite, dolomite. In some instances, it is used synonymously with "steatite." Most soapstone is sufficiently massive to be quarried in large pieces, and commonly is cut into dimension blocks or ground. It usually contains too many impurities to be marketable as talc.

The principal impurities found in the soapstone of Saline County are limonite, serpentine, and magnetite. The limonite (hydrous iron oxide) probably is derived from pyrite by oxidation. The mineral serpentine is predominately green and when abundant the soapstone assumes a dark-green color. Magnetite is distributed in fine grains through the rock although it is not an abundant constituent. The plate-like character of some soapstone is responsible for its being broken easily into small pieces.

Properties important in determining the uses of soapstone are: resistance to weathering or water action, resistance to chemical action, low absorptive qualities, high dielectric strength, easy workability, and ability to resist and to retain heat.

Uses. Soapstone is used for laboratory sinks, hoods, and table tops, acid resisting tanks, kitchen sinks, laundry tubs, structural purposes, electrical switch-

7/ Purdue, A. H., The slates of Arkansas: Arkansas Geol. Survey Report for 1909, pp. 62-65.

boards, griddles, heating stones for fireless cookers, and as cores for electrical heating elements, such as electric flat irons.

Ground soapstone is used for foundry facings, lubricant, dusting agent in making prepared roofing, low-grade paints, and for a few other minor uses as a substitute for low-grade talc. Recent developments in flotation indicate that impure talc may be improved in grade, thus opening to producers the possibility of marketing a higher grade product.

Prices. The average sales value of all grades of talc, pyrophyllite, and ground soapstone, as reported to the U. S. Bureau of Mines by producers, has been about $11.00 per ton, ranging between $12.50 per ton in 1928 and $10.43 in 1932. In 1940, it was $10.69 per ton. The average value per short ton of ground soapstone sold by producers in the United States, 1935-1939, was as follows:

1935	$10.72
1936	10.72
1937	11.01
1938	10.93
1939	10.75
1940	10.50

Price quotations have varied with the grade of the material and the competition involved in the marketing. The lower grades of talc, such as the roofing variety, have sold as low as $4.00 per ton f.o.b. mines.

Occurrence and origin. The soapstone considered here is found in Ordovician shales of either the Womble formation or the Bigfork formation. Several light-colored chert lenses from 2 to 4 inches thick and containing a few minute grains of pyrite are found in the soapstone which probably was formed by hydrothermal metamorphism of the shale in which the deposit occures.

Three cuts showing the soapstone are found in the northern part of Saline County, T. 1 N., R. 15 W. At both cuts 1 and 2 the wall rock is dark-gray to black cherty shale with beds ranging in thickness from one-half inch in the more shaly parts to 6 inches in the chert. Some of the wall rock has been altered to talc. Several light-colored chert lenses from 2 to 4 inches thick are included in the talc. These lenses contain a few minute grains of pyrite not present in the other chert beds.

Cut 1, the old Wallis soapstone quarry, located in the northeast corner of sec. 15, has been worked most extensively. The cut is about 75 feet long and 5 to 20 feet high. The soapstone here is approximately 18 feet thick. The formation strikes approximately N. 80° W., and dips from 10° to 40° to the northeast. At the lower end of the cut is a pit approximately 18 feet in diameter which is filled with water. It is reported to have a depth of 60 feet. There are several test pits and one large pit from which several tons of soapstone have been removed.

Cut 2 is somewhat smaller being 50 by 20 feet and averaging 6 feet in depth. The soapstone appears as a vein in cherty rocks which strike N. 70° E. and dip from 30° to 70° NW. At least locally the vein is parallel to the bedding plane. Thirty-five feet northeast and 10 feet above this excavation is an old shaft 4 feet in diameter and approximately 25 feet deep, which penetrates earthy soapstone stained by limonite.

Cut 3, the smallest of these, is in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ SE$\frac{1}{4}$ of sec. 12, T. 1 N., R. 15 W. It consists of two pits approximately 10 feet square with an average depth of 4 to 5 feet. Table 33 gives the log from a hole drilled near cut 3.

Production. A few tons of soapstone have been taken from cut 1 for local use; however, no commercial production has been reported.

Table 33. Log of soapstone deposit in $NE\frac{1}{4}$ $NW\frac{1}{4}$ Sec. 12, T. 1 N., R. 15 W., Saline County[a/]

Depth feet	
2	Top soil and iron-stained soapstone.
$4\frac{1}{2}$	Iron-stained soapstone.
$9\frac{1}{2}$	Gray soapstone.
$14\frac{1}{2}$	Gray soapstone.
$19\frac{1}{2}$	Light-gray soapstone.
$24\frac{1}{2}$	Light-gray soapstone. Soapstone seems to be gradually approaching white in color and drilling is easier than at first.
$29\frac{1}{2}$	Light-colored soapstone. Drilling seems to be much easier and faster. Very soft spots are encountered but no clay was noted in the cuttings. Water was struck at 25 feet, this being the first soft spot Water stands above level of creek. Soapstone when dry is white.
$34\frac{1}{2}$	Soapstone,(gray, white, and blue-white),and pyrite.
$39\frac{1}{2}$	Soapstone,(gray, white, and blue-white),and pyrite.
$44\frac{1}{2}$	Soapstone,(gray, white, and dark-green), pyrite, olivine (?), serpentine.
$49\frac{1}{2}$	Soapstone, (gray, white, and dark-green), pyrite, olivine (?), serpentine (tested).
$54\frac{1}{2}$	Soapstone, (gray, white, and dark-green), pyrite, olivine (?) serpentine.
$59\frac{1}{2}$	Soapstone, (gray, white, and dark-green), pyrite, olivine (?), serpentine.
$72\frac{1}{2}$	Soapstone,(gray, white, green, and black), pyrite, serpentine (?), chlorite.
$75\frac{1}{2}$	Soapstone,(gray, white, green, and black), pyrite 2 per cent, serpentine (?), chlorite.
$80\frac{1}{2}$	Soapstone,(gray, white, green, and black), pyrite 2 per cent, serpentine (?), chlorite.
$85\frac{1}{2}$	Soapstone,(gray, white, green, and black), pyrite, serpentine, chlorite.
$90\frac{1}{2}$	Soapstone,(gray, white, and green), black shale, pyrite, serpentine, chlorite.
$90\frac{1}{2}$	Black shale, soapstone.
$101\frac{1}{2}$	Black shale

a/ Special investigation of State Mineral Survey, 1941.

TRIPOLI

Composition and properties. Tripoli is a term designated to include a number of soft, porous, friable, and very fine crystalline silicas. It is a product of weathering of cherts and siliceous limestones. Pure tripoli would be 100 per cent silica (SiO_2). All exploited deposits of tripoli contain material ranging in color from white to red.

The following analysis is of a sample of pure white tripoli from the $SE\frac{1}{4}$ $SW\frac{1}{4}$ sec. 12, T. 4 S., R. 26 W., Montgomery County[8/]:

8/ Griswold, L. S., Whetstones & novaculites of Arkansas: Arkansas Geol. Survey Ann. Rept. for 1890, vol III, 1892.

	Per cent
Silica (SiO_2)	97.32
Alumina (Al_2O_3)	1.61
Ferric Oxide (Fe_2O_3)	0.35
Lime (CaO)	Trace
Magnesia (MgO)	Slight trace
Potash (K_2O)	0.13
Soda (Na_2O)	0.12
Loss on ignition (H_2O)	0.63
	100.16
Water at 110-115° C.	0.029

Uses. Tripoli is chiefly used for abrasives, fillers, filter blocks, foundry facings, a concrete admixture, and in drilling muds.

Prices. The average price of tripoli in 1940 (including Pennsylvania rottenstone) sold or used by producers in the United States, was $12.13 per short ton, according to the U. S. Bureau of Mines.

Occurrence. Table 34 lists the more important of the known tripoli deposits in these counties. All occur in the Arkansas novaculite formation except Map no. 8 which is found in the Bigfork chert.

Production. There has been no commercial exploitation of tripoli in the area covered by this report. There are, however, very probably many places in the novaculite district of Garland and Montgomery counties where a good grade of tripoli formed by the alteration of novaculite can be located.

Wavellite

Composition and Properties. Wavellite, $(AlOH)_3(PO_4)_2.5H_2O$, is white, yellow, green and brown in color, is translucent, has a vitreous luster, and usually is found in radiating globular aggregates.

Uses, Occurrence, and Production. A rare hydrous aluminum phosphate of no present commercial value, wavellite was mined near Mount Holly Springs, Pennsylvania between 1900 and 1906 and was processed for phosphorous used chiefly in the manufacture of matches. The deposits in Arkansas are mainly of mineralogical interest and have been mined to some extent and sold to mineral collectors. A small amount has been sold for ornamental use.

Wavellite is found in Garland and Montgomery counties in the following locations:

Map no.	Location
	Garland County
1	Secs. 10 and 11, T. 1 S., R. 22 W.
2	SE¼ NE¼ Sec. 3, T. 2 S., R. 20 W.
	Montgomery County
3	SE¼ NE¼ Sec. 35, T. 3 S., R. 24 W.
4	NE¼ NW¼ Sec. 8, T. 4 S., R. 24 W.

Table 34. Tripoli deposits in Garland and Montgomery counties

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	GARLAND COUNTY		
1	NW NW 25-2S-18W	Outcrop 8 feet wide and 50 feet thick exposed by recent road construction. Decomposed novaculite. Pure white silica, fine-textured and friable[a].	On west bank of cut on old Little Rock-Hot Springs Highway, 1-3/4 miles NE of CRI&P Ry crossing.
2	SE SE 26-2S-18W	Decomposed novaculite 12 to 15 feet thick. Soft, white, fine-grained silica[a].	Has been worked; 200 yards E of CRI&P Railway 8 miles E of Hot Springs.
3	5?-3S-19W	Bed 50 feet thick. Novaculite in middle part of formation has weathered to a soft, porous, fine-grained, white to cream-colored tripoli. Material at surface may be crushed to a fine powder; that a few feet lower may be harder[b].	On east side of Central Avenue.
	MONTGOMERY COUNTY		
4	NE SW 10-3S-23W	Beds from 1 to 12 inches thick; 6 feet of overburden. Gray, texture from coarse to fine. Not completely altered from no vaculite to tripoli[a].	Owner, M. C. Burrow, Route 1, Norman.
5	NW SE 22-3S-23W	Outcrop. Bed 15 feet thick. Buff, weathered[a].	On west end of mountain 12 miles east of Norman on National Forest road.
6	SW SW 7-4S-24W	Outcrop 2 to 8 feet thick extends along road 300 feet. Weathered, thin-bedded novaculite. All shades of gray, buff and pink, chiefly gray. Hardness and texture not uniform[a].	15 to 20 feet above branch on NW side of graded road ¼ mile from MP RR switch at Caddo Gap.
7	SE NE 17-4S-24W	Outcrop. Excavation 15 feet long, 12 feet wide, and 2 to 6 feet deep. White or slightly gray, soft and fine-textured[a].	On west side of branch at foot of mountain, 2½ miles SE of Caddo Gap on Highway 8.
8	SW SW 13-4S-25W	Exposure. Largest mass free of chert is 5½ feet wide and several feet high. Half yellow, remainder white[c].	After subjected to slight grinding, practically all passed through sieve with 100 meshes to the inch, and a large portion passes through sieve with 150 meshes to the inch.

Table 34 . Tripoli deposits in Garland and Montgomery counties (Continued)

Map no.	Location Sec. T. R.	Mode of occurrence	Remarks
	MONTGOMERY COUNTY		
9	SE SW 12-4S-26W	Exposure. Cut 50 feet long extends into mountain about 10 feet. Pure white tripoli. Firm and would require grinding to reduce it to powder. Some of it might be suitable for small filter stones. Consists of sharp quartz grains from 0.01 to less than 0.001 mm in diameter c/.	On north edge of bed of dry branch on Fodderstack mountain. A few hundred pounds have been shipped for use as polishing powder.
10	SE SW 12-4S-26W	Exposure 6 feet thick. Shattered altered novaculite has softened to tripoli a few inches thick. Yellow but may become whiter with depth from surface c/.	On north side of dry branch on Fodderstack mountain underground mining would be necessary because of the nearly horizontal position of beds and steepness of mountain slope.
11	S½ NE 33-4S-26W	Shaft 40 feet deep penetrated 12 feet of tripoli without reaching bottom. Contains lumps and nodules d/.	If surface outcrop could be found, it might prove profitable to work.

a/ State Mineral Survey Special Investigation.
b/ Purdue, A. H., and Miser, H. D., U. S. Geol. Survey Geol. Atlas, Hot Springs folio (no. 215),p. 11, 1923.
c/ Miser, H. D., and Purdue, A. H., Geology of the DeQueen and Caddo Gap quadrangles, Arkansas: U. S. Geol. Survey Bull. 808, pp. 162-164, 1929.
d/ Williams, J. Francis, The Igneous Rocks of Arkansas, Arkansas Geol. Survey, Ann. Rept. 1890, vol. II, p. 384, 1891.

FUEL MINERALS

Oil and Gas Possibilities

General statement. The following general conditions are considered essential for the accumulation of commercial quantities of oil and gas.

(1) The rocks in the region under consideration must be of sedimentary origin.
(2) There must be a suitable source rock for the oil and gas.
(3) There must be a reservoir rock for the oil and gas.
(4) There must be a relatively impervious cap or cover rock to prevent the escape of the oil and gas.
(5) There must be a structure or "trap" present.
(6) Regional metamorphism (heat and pressure) must not have been so great as to drive off the oil and gas.

Apparent physical conditions do not favor the accumulation of oil and gas in Montgomery, Garland, Saline, or Pulaski counties.

In the Ouachita Mountain province the rocks of Paleozoic age have been intensely folded and highly fractured. Oil or gas which originally might have been present was volatilized due to the excessive heat and pressure which altered the rocks.

Structures suitable for oil and gas accumulation are absent in southeastern Saline and Pulaski counties which lie within the Gulf Coastal Plain province. A complete section of Tertiary formations is not developed here.

Results of drilling in these four counties are summarized in Table 35. Drilling results, although not conclusive, add evidence in support of the improbability of oil and gas accumulations in this area.

Lignite

Composition and properties. Lignite, often called brown coal, represents the second stage in coal formation and appears as a rather soft, brown or black, dull, woody or clay-like material. It has a high water content and slacks very quickly in dry air, forming powder or thin platy fragments. The heating value is low, and it occasionally has a high ash content.

Uses. Lignite is used extensively as a fuel in Europe. In the United States, the only deposits which have been of commercial importance as fuels up to the present time are found in Montana, North Dakota, South Dakota, and Texas. Brown lignite has been used to some extent as a pigment in the manufacture of paints and dyes, and wax has been derived from the oil extracted from lignite.

Occurrence. Several localities in Saline and Pulaski counties contain lignite and lignitic beds. These are thickest and most numerous in the basal part of the Wilcox formation of lower Eocene age. Where lignite is found at the open pit bauxite mines, it usually rests directly upon the bauxite. Locations and thicknesses of lignite beds encountered in drill holes are shown on Plate V. A summary of the drill logs is given in Table 36.

A bed of lignite in the SW¼ SE¼ Sec. 8, T. 3 S., R. 14 W., Saline County averages about 6 feet in thickness and extends at least one-half mile in four directions. The highway runs within 100 yards and the Missouri-Pacific Railroad has a line between Benton and Sheridan one-half mile from the deposit. The lignite has an overburden of 4 feet or more. Another large deposit is found near Sweet Home in Pulaski County. (See drill logs, Table 36.) Holes drilled in sec. 2, T. 1 S., R. 12 W., showed an average of 8 feet of lignite with an overburden ranging from 21 to 26 feet.

Table 35. Summary of wildcat oil drilling in Montgomery, Garland, Saline, and Pulaski counties

Map no.	Location Sec.	T.	R.	Owner	Lease	Driller	Date of drilling	Total depth (feet)	Remarks
1	SW NE 25	2N	11W	Fred Van Waggoner	Mark Valentine	C. W. Ross	1912	2072	Paleozoic at 465'.
2	SE NE NW 27	1N	11W	Stiles Interests	Vera Stiles	J. W. McCarroll	1928	1006	-
3	Do.	do.	do.	do.	Frazier Plantation	J. A. Young	1923-1925	660	Oil showings at 60' and 90'.
4	SE SE SW 2	1S	13W	A. L. Kitselman	A. L. Kitselman, Jr.	Joe Longoria	1936-1937	788	-
5	Do.	do.	do.	do.	do.	H. H. Schwartz	1937-1938	4080	-
6	SW SE SE 17	2S	17W	Chawood Oil Co.	Malvern Lumber Co.	-	1927	1665	Oil showings from 1400' to 1430'.
7	NE NE SW 21	2S	11W	Wonder State Development Co.	Wilson	Liggett Drilling Co.	1929	1547	A small amount of gas at 600', and an oil showing at 890'. Igneous rock at 1544'.
8	20	2S	15W	McRae and Jones	Bell	-	1921	3775	Showing of oil at 3220', 3413', 3515', 3628', and 3750'.
9	NE SW 1	3S	19W	H. H. Given	Garratt	H. H. Given and Southern Drilling Co.	1926-1930	3756	Gas producing formation from 2925' to 2975'.
10	SE SE SW 6	3S	14W	W. W. Haley	Arkansas Short Leaf Lumber Co.	-	1923-1924	725	Paleozoic at 700'.

Table 36 . Logs of Lignite deposits in Pulaski and Saline counties.

Map no.	Location Sec. T. R.	Material	thickness	depth	source
	PULASKI COUNTY				
1	NW NW 30-1N-11W (Hole P)	Clay	25	0-25	a/
		sand	32	25-57	
		gravel	3	57-60	
		LIGNITE	7	60-67	
2	SW NE 25-1N-12W (Hole #1 - John Lewis, 140' W. of E. property line and 90' N of S property line)	soil	2	0- 2	b/
		red clay	6	2- 8	
		white clay	8	8-16	
		black clay	5	16-21	
		LIGNITE	27	21-48	
		blue clay and LIGNITE	7	48-55	
		blue clay	8	55-63	
		LIGNITE	4	63-67	
		blue clay	6	67-73	
3*	SW NE 25-1N-12W (Lot #17)	soil	2	0- 2	b/
		gravel	1	2- 3	
		red clay	8	3-11	
		blue clay	5	11-16	
		clay and LIGNITE	14	16-30	
		white clay	4	30-34	
4*	SW NE 25-1N-12W (Gussie, Lot #6)	gravel and soil	2	0- 2	b/
		red clay	5	2- 7	
		white clay	9	7-16	
		LIGNITE	2	16-18	
		black clay	2	18-20	
		LIGNITE	7	20-27	
		white clay	4.5	27-31.5	
		top of bauxite		31.5	
5*	SW NE 25-1N-12W (Lot #7)	soil	2	0- 2	b/
		gravel	2	2- 4	
		red clay	4	4- 8	
		white clay	3	8-11	
		LIGNITE and black clay	12	11-23	
		top of bauxite		27	
6*	SW NE 25-1N-12W (Lot #18)	soil and gravel	2	0- 2	b/
		red clay	8	2-10	
		white clay	7	10-17	
		black clay	3	17-20	
		LIGNITE	14	20-34	
		blue clay	4	34-38	
		LIGNITE	9	38-47	
		white clay	2	47-49	

Table 36. Logs of Lignite deposits in Pulaski and Saline counties

Map no.	Location Sec. T. R.	Material	Thickness	Depth	Source
	PULASKI COUNTY				
7*	SW NE 25-1N-12W (Lot #4--Store)	soil	1	0- 1	b/
		yellow clay and sand	9	1-10	
		gravel	1	10-11	
		white clay	8	11-19	
		LIGNITE	1	19-20	
		blue clay and LIGNITE	8	20-28	
		LIGNITE	6	28-34	
		white clay	5	34-39	
8*	SW NE 25-1N-12W (Patterson Lot)	soil	4	0- 4	b/
		yellow sandy clay	14	4-18	
		yellow sand	20	18-38	
		LIGNITE and gravel	3	38-41	
		(hole abandoned because of gravel)			
9*	SW NE 25-1N-12W (Lot #32)	red clay	19	0-19	b/
		LIGNITE	1	19-20	
		LIGNITE and blue clay	8	20-28	
		hard strata LIGNITE	4"	28	
		LIGNITE and blue clay	11	28-39	
		LIGNITE	10	39-49	
		white clay	5	49-54	
10*	SW NE 25-1N-12W (Lot #6)	soil	4	0- 4	b/
		red clay	24	4-28	
		sand (gravel)	4	28-32	
		LIGNITE	1	32-33	
		blue clay	2	33-35	
		sand		35	
		red clay (sand)	4	35-39	
		LIGNITE	6	39-45	
		top of bauxite		45	
11*	SW NE 25-1N-12W (Lot #22)	soil	2	0- 2	b/
		red and yellow clay	12	2-14	
		clay and sand	30	14-44	
		blue clay and LIGNITE	9	44-53	
		LIGNITE	1	53-54	
		sand	1	54-55	
		white clay	3	55-58	
12*	SW NE 25-1N-12W (Lot #26)	soil	2	0- 2	b/
		clay and sand	24	2-26	
		gravel	1	26-27	
		yellow clay and sand	16	27-43	
		LIGNITE	1	43-44	
		white clay	4	44-48	
		LIGNITE	17	48-65	
		top of hard bauxite		65	

Table 36. Logs of Lignite deposits in Pulaski and Saline counties

Map no.	Location Sec. T. R.	Material	Thickness	Depth	Source
	PULASKI COUNTY				
13*	SW NE 25-1N-12W (Lot #20)	red clay	4	0- 4	b/
		red clay sand	23	4-27	
		blue clay	4	27-31	
		blue sand and clay	5	31-36	
		LIGNITE	6	36-42	
		blue and white clay	6	42-48	
		LIGNITE	12	48-60	
		white clay (bauxite)	36	60-96	
14*	SW NE 25-1N-12W (Jackson Home)	gravel	10	0-10	b/
		yellow clay	12	10-22	
		sand	4	22-26	
		blue clay	4	26-30	
		LIGNITE	6"	30	
		fine gravel	4	30-34	
		blue shale	16	34-50	
		LIGNITE	9	50-59	
		white clay	2	59-61	
15	SE SW 35-1N-12W (Hole L)	white clay	46	0-46	a/
		LIGNITE	4	46-50	
16	SE SW 36-1N-12W (Hole M)	sand	20	0-20	a/
		black clay	50	20-70	
		LIGNITE	6	70-76	
17	NE SW 36-1N-12W (Hole N)	clay	30	0-30	a/
		sand	10	30-40	
		black clay	25	40-65	
		sand	8	65-73	
		LIGNITE	4	73-77	
18	NW SW 2-1S-12W (Hole J)	sand	15	0-15	a/
		gravel	2	15-17	
		clay	23	17-40	
		LIGNITE	4	40-44	
19	SE SE 2-1S-12W (Hole K)	yellow clay	20	0-20	a/
		sand	30	20-50	
		black clay	40	50-90	
		LIGNITE	10	90-100	
20	NE SW 3-1S-12W (Hole O)	red clay	14	0-14	a/
		gravel	4	14-18	
		brown clay	12	18-30	
		sand	10	30-40	
		LIGNITE	12	40-52	

Table 36. Logs of Lignite deposits in Pulaski and Saline counties

Map no.	Location Sec. T. R.	Material	Thickness	Depth	Source
	PULASKI COUNTY				
21	SW SW 3-1S-12W (Hole I)	sand	30	0-30	a/
		brown clay	10	30-40	
		blue clay	17	40-57	
		rock	1	57-58	
		white clay	4	58-62	
		LIGNITE	12	62-74	
22	$S\frac{1}{2}$ NW NW 9-1S-12W (Hole H)	sand	14	0-14	a/
		gravel	4	14-18	
		sand	4	18-22	
		LIGNITE	2	22-24	
	SALINE COUNTY				
23	NW NW 19-2S-13W (Hole #3)	soil	6	0- 6	b/
		white clay	2	6- 8	
		gravel and sand	3	8-11	
		brown clay	16	11-27	
		sand	1	27-28	
		brown clay	12	28-40	
		brown sand with clay seams	11	40-51	
		brown clay	17	51-68	
		brown sand	11	68-79	
		LIGNITE and brown clay	2	79-81	
24	NW NW 19-2S-13W (Hole #4)	soil and clay	5	0- 5	b/
		gravel	1	5- 6	
		sandy clay (yellow)	10	6-16	
		brown clay	6	16-22	
		sand rock--streaks of LIGNITE	6	22-28	
		brownish-yellow clay	21	28-49	
		sand and LIGNITE	9	49-58	
		brown clay	37	58-95	
25	SW SE 19-2S-13W (Hole E)	sand	6	0- 6	a/
		gravel	2	6- 8	
		sand	18	8-26	
		sandstone	1	26-27	
		sand	20	27-47	
		sandstone	1	47-48	
		sand	2	48-50	
		black clay	40	50-90	
		sand	8	90-98	
		LIGNITE	6	98-104	

Table 36. Logs of Lignite deposits in Pulaski and Saline counties.

Map no.	Location Sec. T. R.	Material	Thickness	Depth	Source
	SALINE COUNTY				
26	SE NW 11-2S-14W (Hole C)	sand	10	0-10	a/
		gravel	10	10-20	
		black clay	42	20-62	
		LIGNITE	8	62-70	
		black clay	2	70-72	
		LIGNITE	4	72-76	
27	NW SE 12-2S-14W (Hole D)	sand and gravel	10	0-10	a/
		black clay	50	10-60	
		white sand	40	60-100	
		white clay	22	100-122	
		sandstone	11	122-133	
		white clay	5	133-138	
		sand rock	1	138-139	
		sand clay	6	139-145	
		LIGNITE	5	145-150	
28	SW NE 15-2S-14W (Hole B)	yellow sand	30	0-30	a/
		LIGNITE	3	30-33	
29	NE SW 24-2S-14W (Hole F)	sand	8	0- 8	a/
		black soil	5	8-13	
		LIGNITE	2	13-15	
30	NW SW 26-2S-14W (Hole G)	sand	25	0-25	a/
		LIGNITE	8	25-33	
31	NE SW 28-2S-14W (Hole A)	clay	4	0- 4	a/
		sand	196	4-200	
		black clay	20	200-220	
		white clay	21	220-241	
		LIGNITE	4	241-245	

* Map nos. 2-14 inclusive shown on map as 2.
a/ Logs by J. Claude Childress
b/ Logs by Percy Upton

Mr. C. L. McWilliams, Route 4, Little Rock, reports that he has located a deposit in the NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 11, T. 1 S., R. 12 W., (Holman Subdivision), Pulaski County. This deposit is 20 to 25 feet thick with an overburden of 8 to 12 feet, and occurs over an area of about 20 acres.

Production. At the present time there is no commercial production of lignite in the area covered by this report. Elsewhere, however, lignite is being mined as a raw material for use in the dye industry. Certain brown types of lignite are suitable for the manufacture of "Van Dyke" brown.

Peat

Composition and properties. Peat is formed by partial decomposition in water of vegetable matter, resulting in both chemical and physical change. The plant structure may be seen in these deposits, which vary from place to place depending on the kinds of plants from which they were derived.

The only peat found in Arkansas is an extremely humus type. The lower portion of the deposit consists almost wholly of the remains of oak trees while the upper portion contains pine pollen mixed with the oak material. Interbedded between these portions, large amounts of pollen of sour gum are found[9/]. Samples analyzed by Dr. W. F. Manglesdorf showed one per cent combined nitrogen.

Uses. Peat is used mainly as a fuel in Europe, however in this country 93 per cent of domestic and imported peat is used for soil improvements, and 2 per cent in mixed fertilizers. Other uses include litter for poultry and stock yards and material for packing of shrubs, eggs, fruits, and vegetables.

The properties of the peat thus far found in Arkansas would limit its use to that of a base for mixed fertilizers.

Occurrence. The only deposit of peat known in Arkansas occurs in sec. 25, T. 2 N., R. 12 W., an area of several hundred acres known as Dark Hollow and located near the city limits of North Little Rock, Pulaski County. Most of this land is owned by F. D. Watkins and Justin Matthews of Little Rock. One exposure, located in a drainage ditch on the property, is approximately 5 feet thick. There are undoubtedly other occurrences, but no further information is available.

It is not improbable that there are peat deposits of considerable size present in the flat, former Arkansas River bottom lands, especially in the area mentioned above and extending southward nearly to Jacksonville, along the Missouri Pacific tracts.

Prospecting along the Arkansas River bottom lands in the Gulf Coastal Plain in Arkansas probably would result in the discovery of deposits of peat. No investigations of this character have been undertaken.

Production. There has been no commercial production of peat reported in the State of Arkansas.

MINERAL WATERS

The most notable of all mineral waters in the four county area issue from a large number of hot water springs in the vicinity of Hot Springs, Arkansas. These have received widespread publicity because of their reported medicinal properties and therapeutic value (which is attributed not only to the mineral content but also to the temperature of the waters).

9/ Sears, Paul B., Department of Botany, University of Oklahoma, personal communication, April 1, 1931.

The first National Park area in the United States included these springs and the ground around them, and was created by Act of Congress in 1832. However, because of private claims to ownership, they remained in the hands of private citizens until 1877 when the Supreme Court handed down a decision favorable to the federal government.

According to Mr. P. P. Patraw, Superintendent of Hot Springs National Park, the daily flow from the 46 hot springs is approximately 900,000 gallons and the average temperature of the water is about 143 degrees Fahrenheit.

The approximate chemical composition of the Hot Springs waters is as follows:10/

	Parts per million
Silica (SiO_2)	45
Iron (Fe)	.05
Manganese (Mn)	.26
Calcium (Ca)	46
Magnesium (Mg)	5.8
Sodium (Na)	5.1
Potassium (K)	1.6
Bicarbonate (HCO_3)	165
Sulphate (SO_4)	9.1
Chlorine (Cl)	2.1
Fluoride (F)	0
Nitrate (NO_3)	0
Total dissolved solids	197

Gases in cubic centimeters per liter at 0° C. and 760 millimeters pressure: nitrogen (N), 8.8; oxygen (O), 3.8; free carbon dioxide (CO_2), 6.9; hydrogen sulphide (H_2S), none. Radioactivity, 0.45 millimicrocurie per liter.

The underground reservoir for these hot waters is the highly fractured Bigfork chert which outcrops at various localities in the anticlinal valleys, the particular collecting area for the Hot Springs area being in the valley between North and Sugarloaf mountains. The most generally accepted theory concerning the heat of these waters was advanced by John C. Branner in his report on Mineral Waters of Arkansas. He suggested that the descending waters were heated by contact with hot masses of rock at some time during their underground course.

Cold water springs in this area, whose waters have attained commercial importance, include Chewaulka Springs, Lithox Springs, McClendon Mineral Springs, McFadden Three Sisters Springs, Mountain Valley Springs, Pine Mountain Spring, Potash Sulphur Springs, and Radio Magnesia Springs.

10/ Analysis and chemical data from U. S. Dept. of Interior, National Park Service, Guidebook to Hot Springs National Park, U. S. Government Printing Office, Washington, D. C., 1939.

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