State of Arkansas
ARKANSAS GEOLOGICAL SURVEY
George C. Branner
State Geologist

COUNTY MINERAL REPORT 1

POLK COUNTY

COMPILED UNDER THE DIRECTION OF
GEORGE C. BRANNER
Little Rock
1940

Reprinted
1959

STATE OF ARKANSAS

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June 1, 1940

Hon. Carl E. Bailey,
Governor, State of Arkansas
Little Rock, Arkansas

Sir:

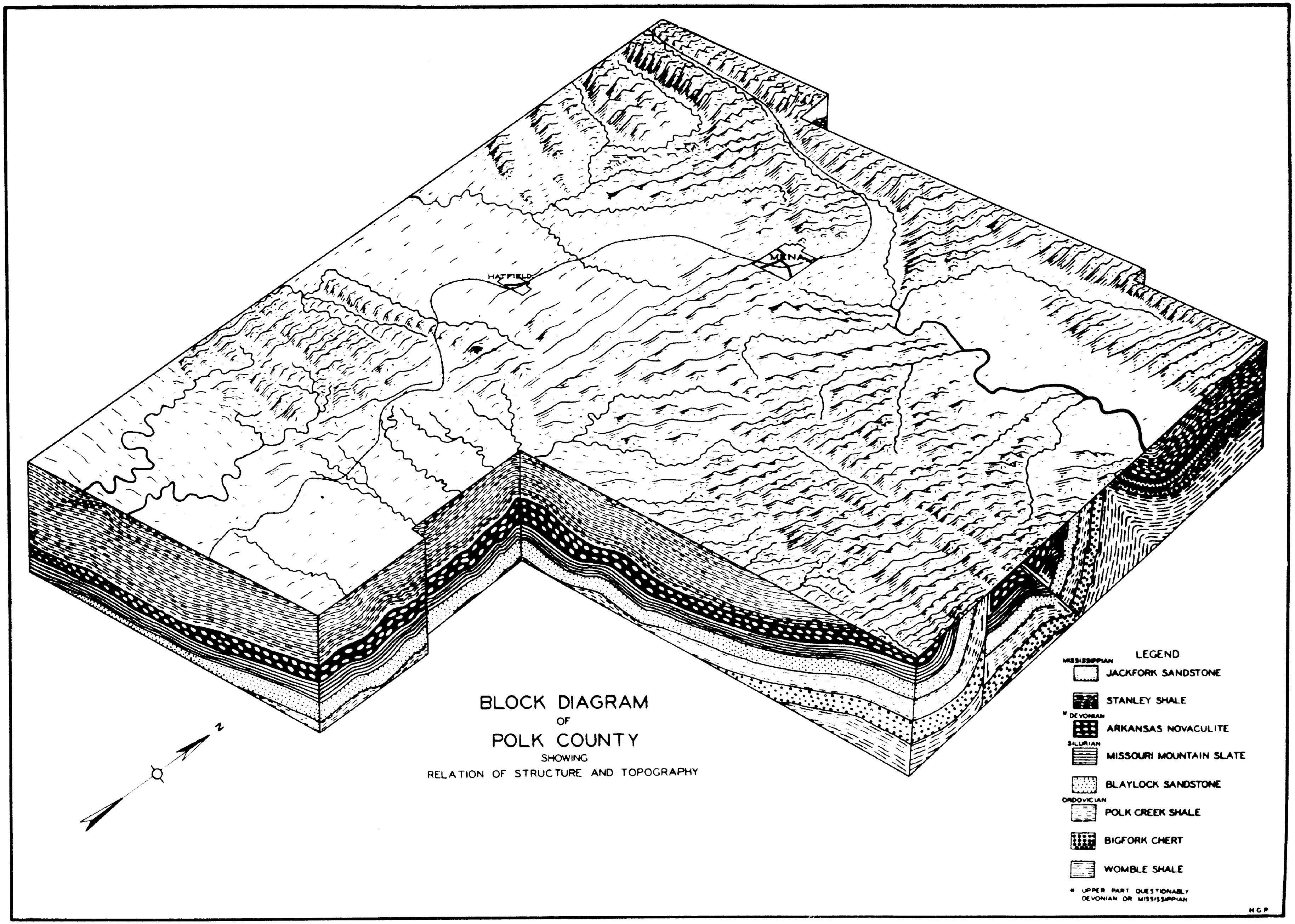
I have the honor to submit herewith County Mineral Report 1, Polk County, prepared under my direction.

The information in this report was compiled from field data collected by the Polk County section of the Works Projects Administration State Mineral Survey, which is being sponsored by this Survey, together with information contained in state and federal reports. It contains, therefore, practically all available information regarding the mineral resources of Polk County.

The State Mineral Survey has conducted a special investigation of the manganese deposits of the state and the results of the Polk County examination are contained in this report.

Respectfully submitted,

State Geologist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POLK COUNTY
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JACKFORK SANDSTONE
STANLEY SHALE
* DEVONIAN
ARKANSAS NOVACULITE
SILURIAN
MISSOURI MOUNTAIN SLATE
BLAYLOCK SANDSTONE
ORDOVICIAN
POLK CREEK SHALE
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WOMBLE SHALE
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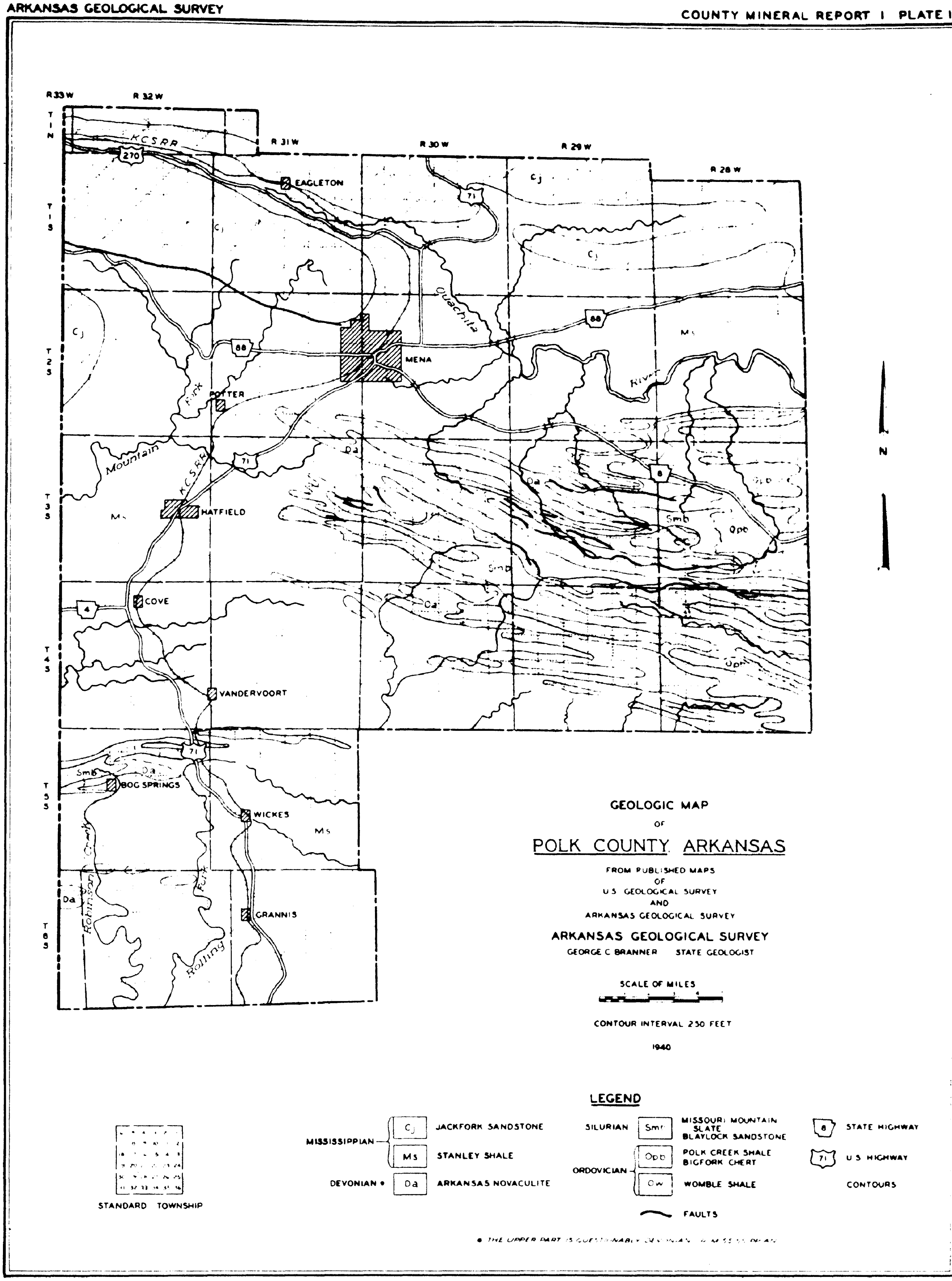
GEOLOGIC MAP
OF
POLK COUNTY ARKANSAS
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ARKANSAS GEOLOGICAL SURVEY
GEORGE C BRANNER STATE GEOLOGIST
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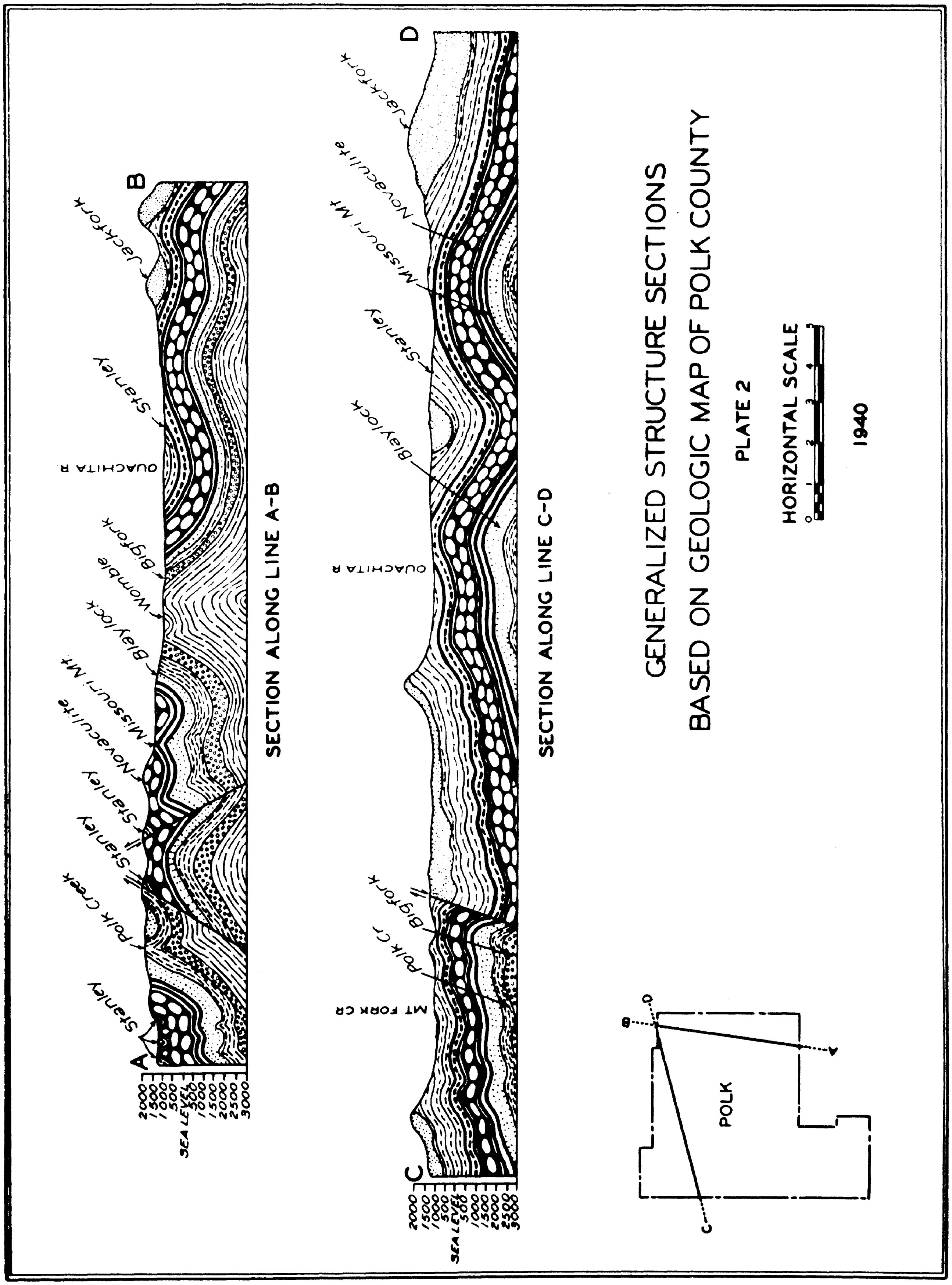
BOG SPRINGS
WICKES
GRANNIS
Ouachita
River
Mountain
Fork
Robinson Creek
Rolling Fork
N

System	Series	Formation	Section	Thickness in feet	Character of rocks
Carboniferous	Mississippian	Jackfork sandstone		5000 6600	Sandstone, shale, and millstone grit. Sandstone gray, fine to coarse grained; mostly quartzitic. Millstone grit containing quartz pebbles mostly in basal part of formation. Shale is green, fissile clay shale. The hard sandstone is used locally for rough building stone.
Carboniferous	Mississippian	Stanley shale		6000	Shale, sandstone, and some conglomerate. Shale fissile, bluish black in fresh exposures; green, yellow, or brown in weathered exposures. Sandstone hard, tough, compact, quartzitic, fine-grained, greenish or bluish gray. Conglomerate near base is composed of novaculite pebbles in dense siliceous matrix. Slate beds occur in the lower 300 feet.
		Unconformity			
Dev.?	Upper?	Arkansas novaculite		300-950	Massive gray novaculite.
Devonian	Upper				Thin-bedded dark novaculite and dark shale.
Devonian	Middle				Massive white novaculite. Formation in which manganese and tripoli occur.
Silurian		Missouri Mountain slate		50± 300	Red and green slate.
		Unconformity ?			
Silurian		Blaylock sandstone		0-1500	Hard, light to dark gray sandstone and dark shale.
		Unconformity?			
Ordovician	Upper	Polk Creek shale		0-175	Black, fissile carbonaceous shale.
Ordovician	Middle	Bigfork chert		700	Gray to black even-bedded fractured chert; black shale and black siliceous limestone.
Ordovician	Lower	Womble shale		1000	Shale in black and green layers; some blue limestone and sandstone.

GENERALIZED COLUMNAR SECTION OF ROCKS EXPOSED IN POLK COUNTY

FROM MISER, H.D., AND PURDUE, A.H., U.S.G.S., BULL. 808


GENERALIZED STRUCTURE SECTIONS
BASED ON GEOLOGIC MAP OF POLK COUNTY
PLATE 2
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1940
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SEA LEVEL
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2000
2500
3000
SECTION ALONG LINE C-D
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Missouri Mt
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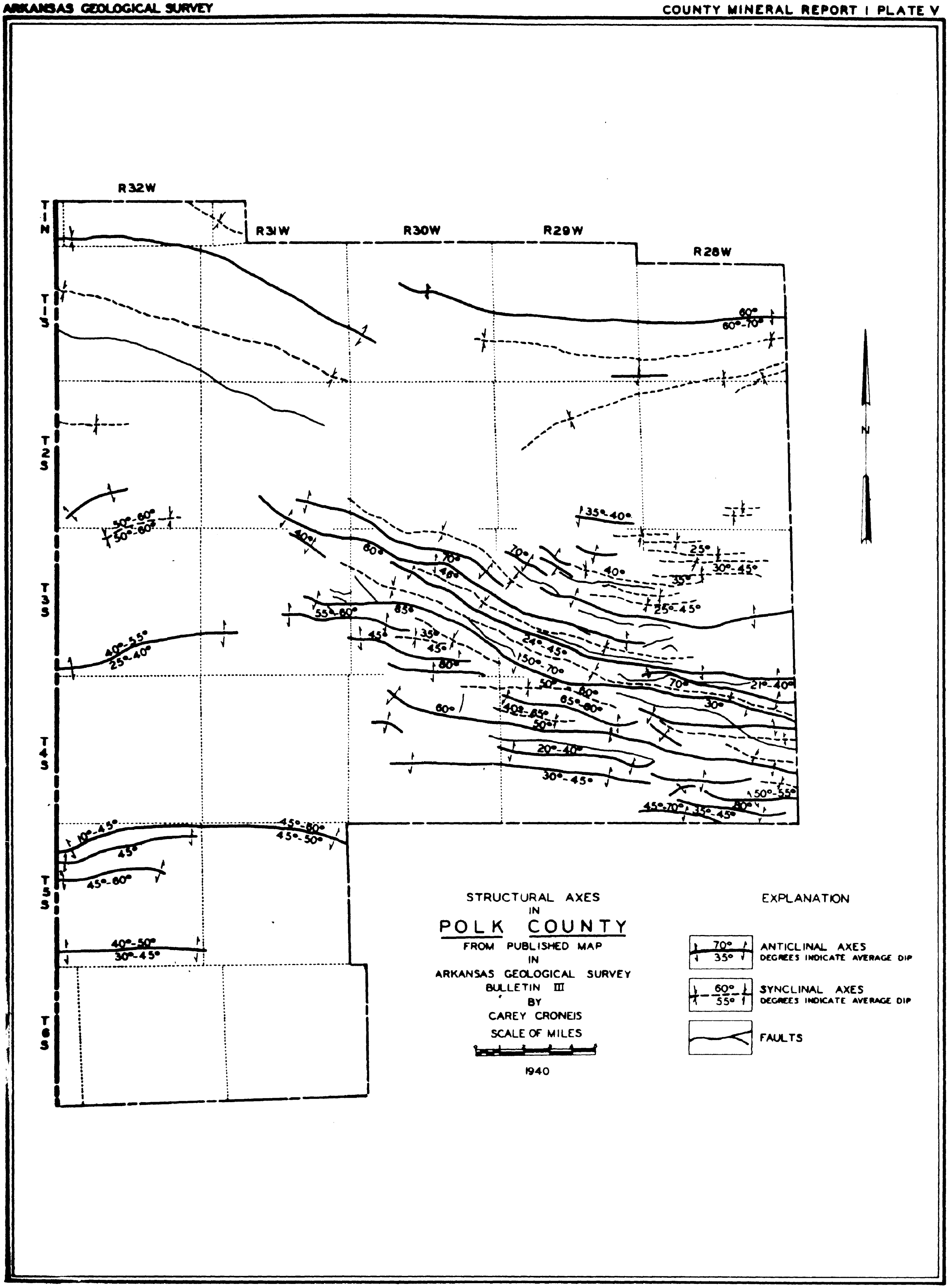
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STRUCTURAL AXES
IN
POLK COUNTY
FROM PUBLISHED MAP
IN
ARKANSAS GEOLOGICAL SURVEY
BULLETIN III
BY
CAREY CRONEIS
SCALE OF MILES
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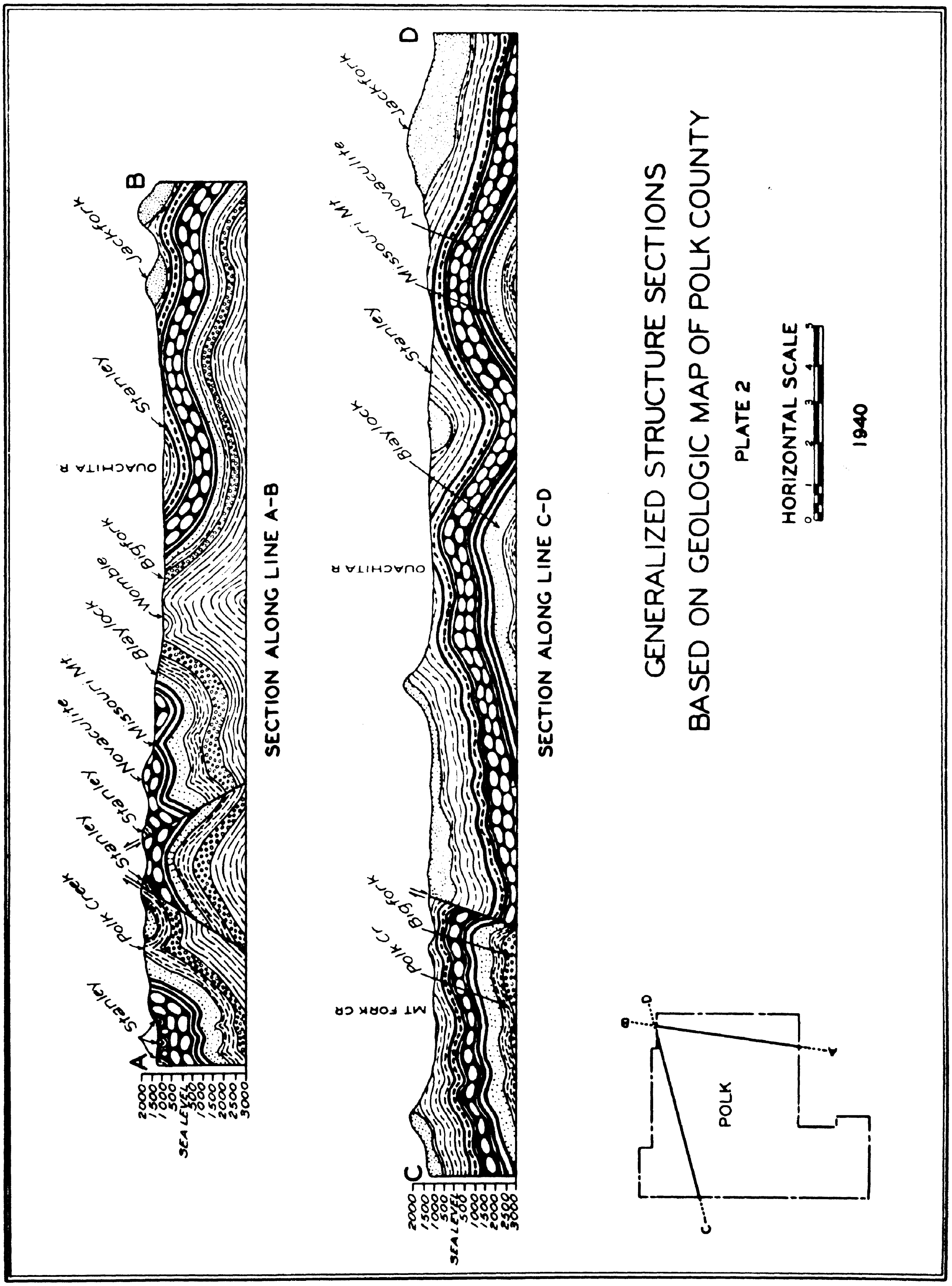
DEGREES INDICATE AVERAGE DIP
FAULTS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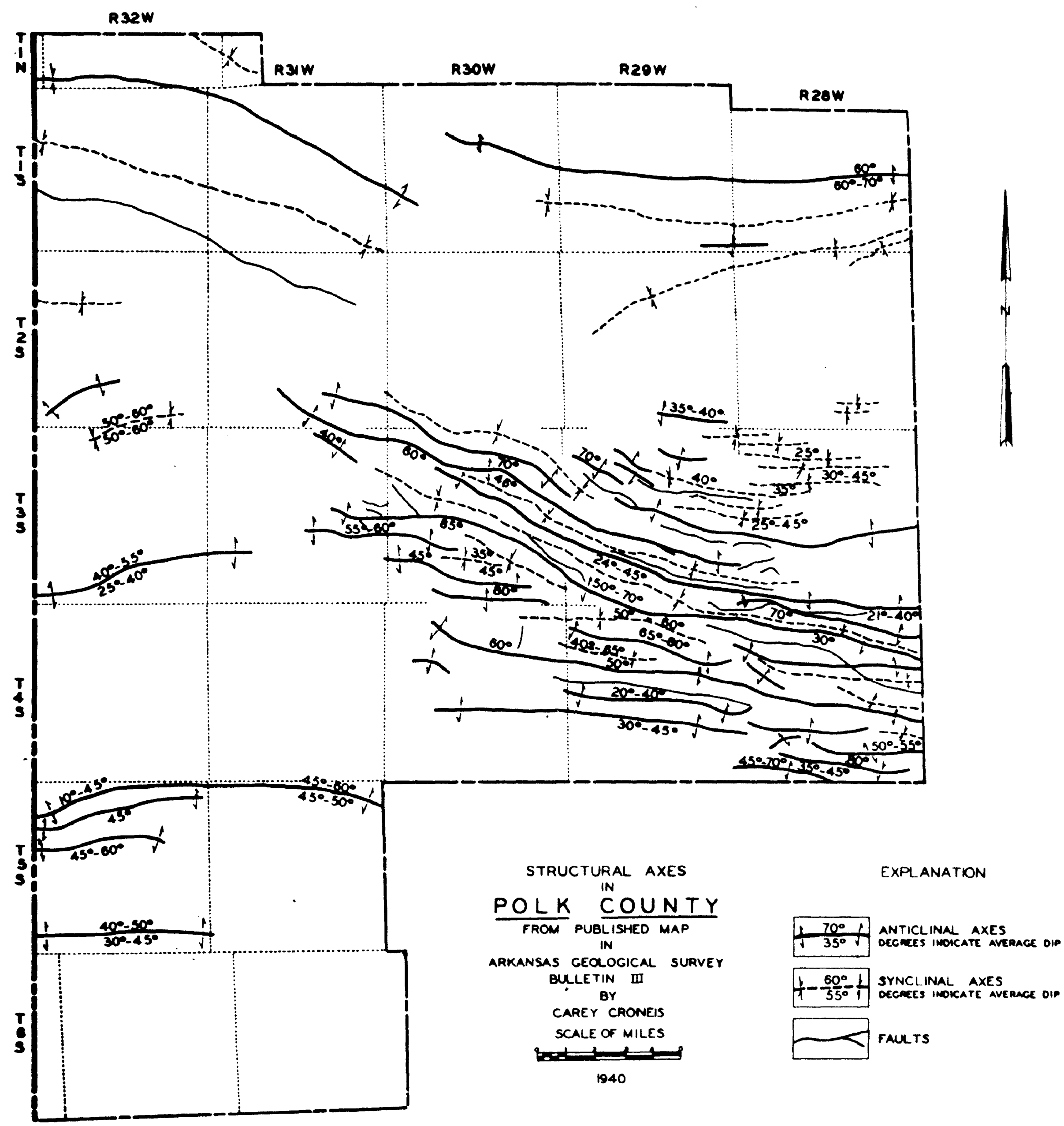
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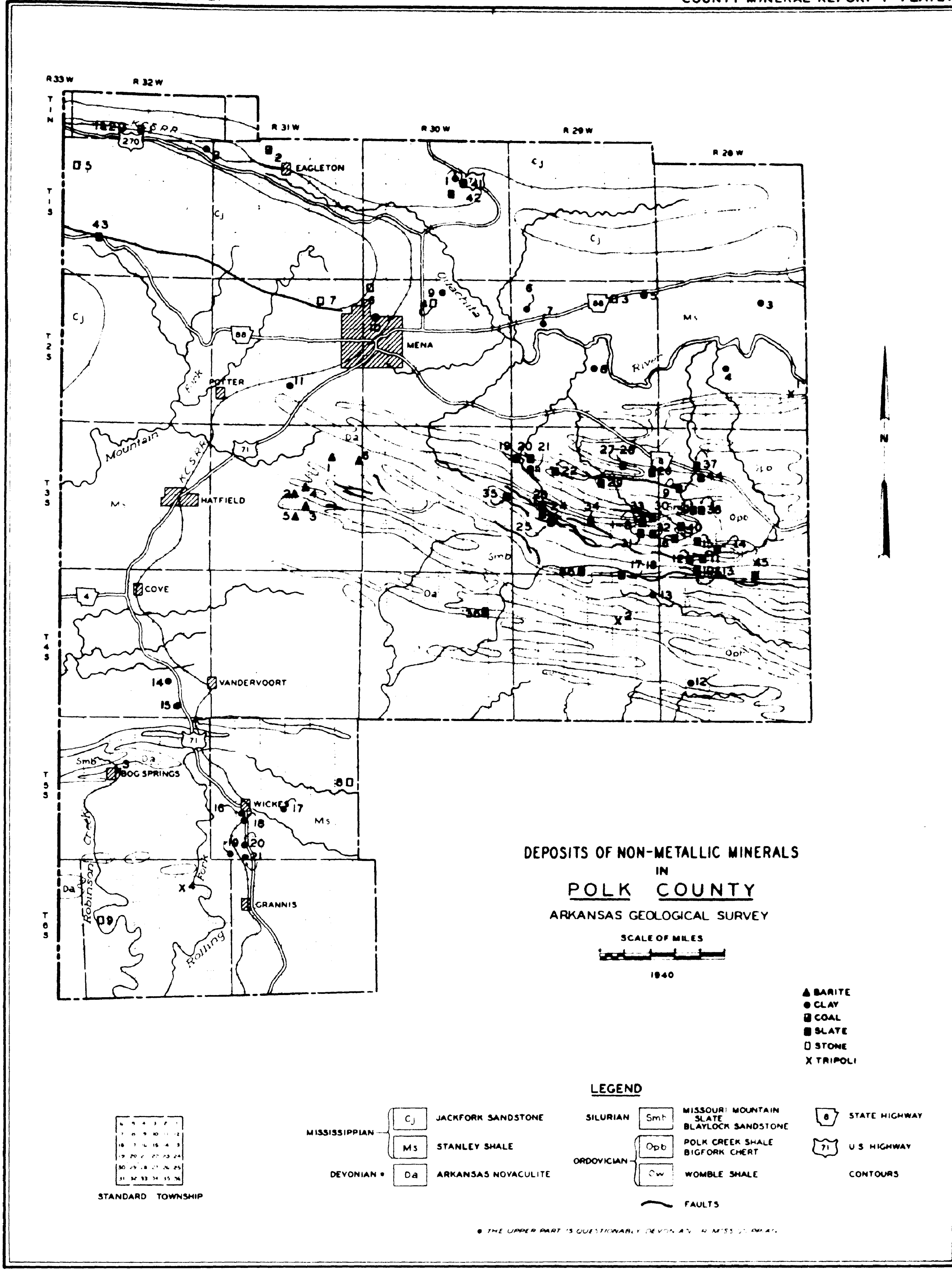
DEPOSITS OF NON-METALLIC MINERALS
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SCALE OF MILES
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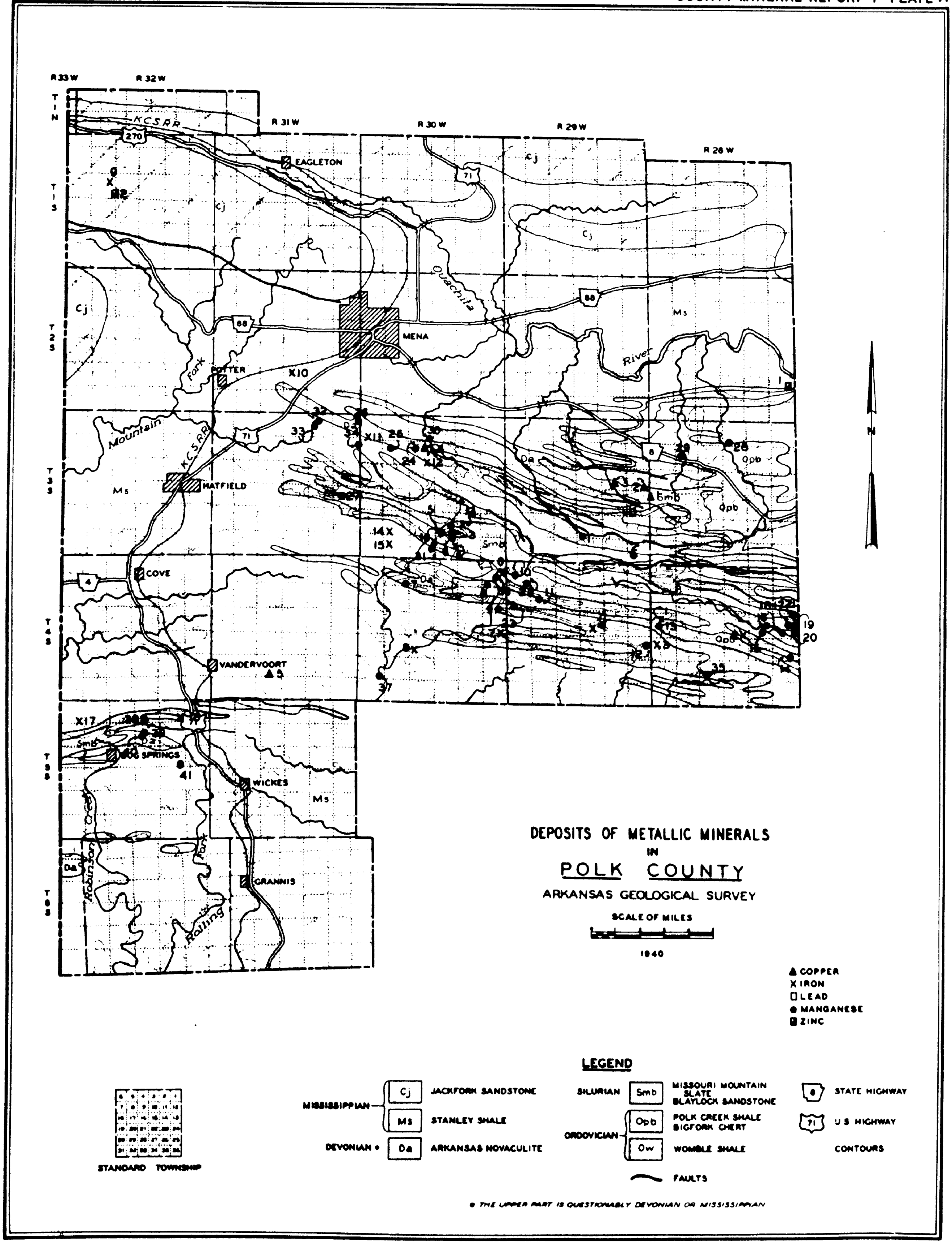
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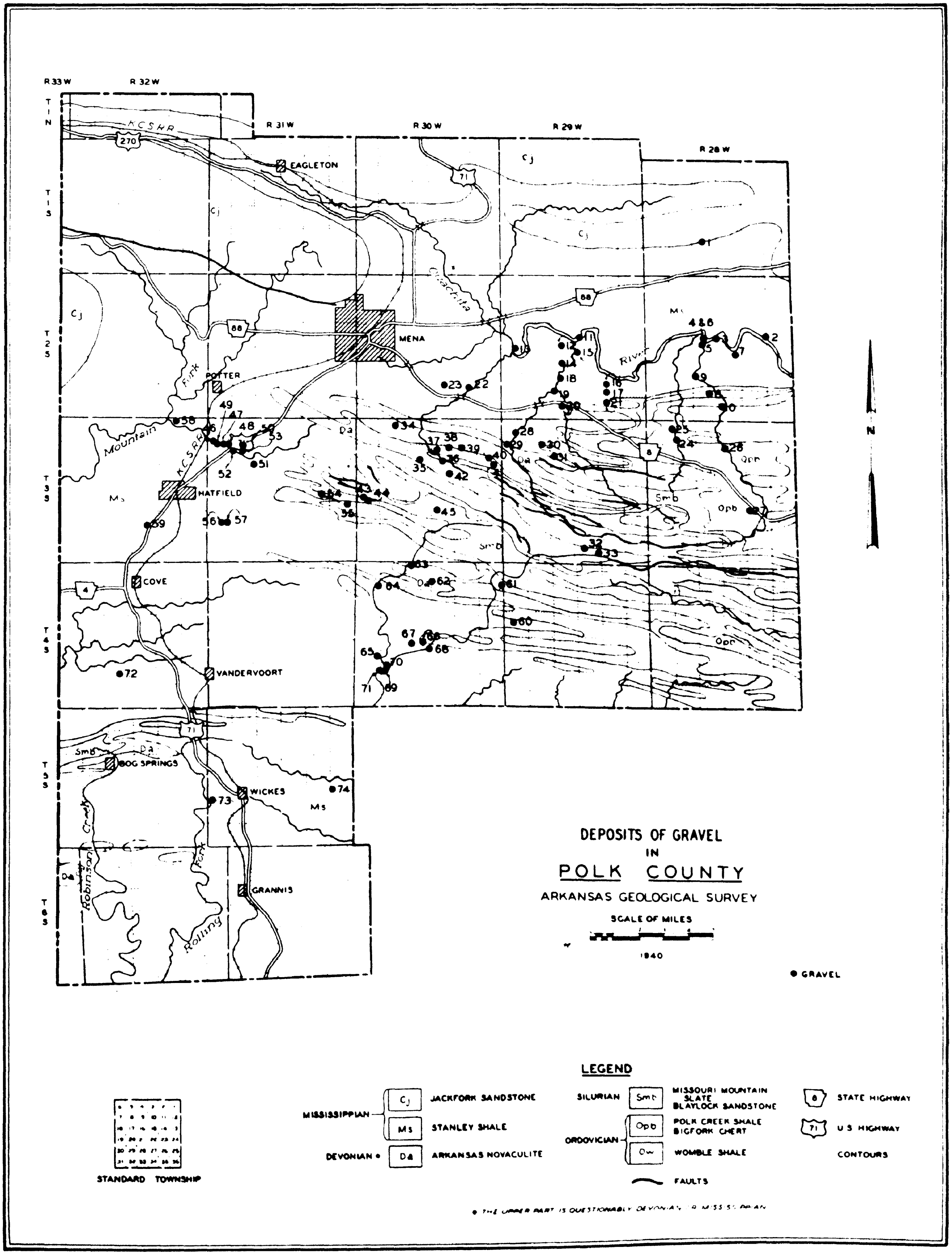
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VANDERVOORT
BOG SPRINGS
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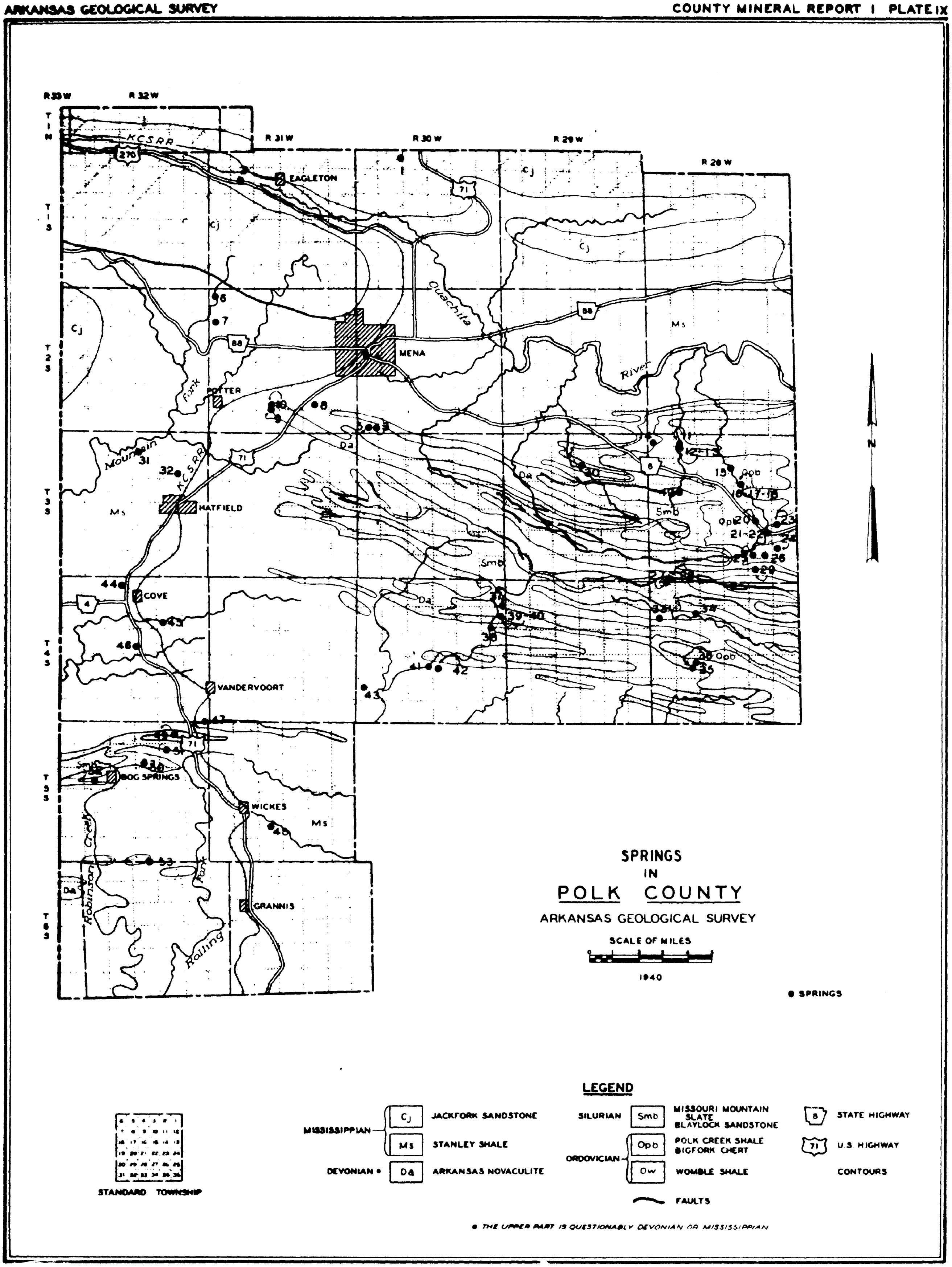
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ACKNOWLEDGMENT TO THE WORKS PROJECTS ADMINISTRATION OF ARKANSAS

The occasion for the publication of this report on the mineral resources of Polk County is the completion of a survey of that county by workers of the State Mineral Survey under the Works Projects Administration Project 6041-9.

This project was sponsored by the Arkansas Geological Survey, George C. Branner, State Geologist, and co-sponsored by the counties being surveyed.

Floyd Sharp is State Administrator for the Works Projects Administration and Capt. R. C. Limerick is Director of Operations.

E. E. Castleberry is Project Supervisor for the State Mineral Survey, and R. E. Vandruff is Project Engineer. Percy Upton was District Supervisor and Compere Pipkin was Polk County Supervisor at the time the field work for this report was done.

Raymond J. Wismer was the co-ordinator of the Arkansas Geological Survey with the State Mineral Survey project.

Special acknowledgment is made to the county officials of Polk County and to many others for contributions which made possible the project in Polk County.

The text of this report was prepared by the editorial staff of the State Mineral Survey, which is in charge of Clayton F. Johnson, assisted by Robert H. Tucker and Harold Pickleseimer. The report was further edited by George C. Branner, Mary L. Gibson, and J. B. Hanley of the Arkansas Geological Survey.

Typing for reproduction was by Carolyn Goldman of the State Mineral Survey.

Drafting was by Mary R. Dickson, chief draftsman, and Harold Pickleseimer of the State Mineral Survey, and Albert Hess of the Arkansas Geological Survey.

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INTRODUCTION

The stated purpose of the State Mineral Survey of the Works Projects Administration is 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 is also made for the publication of reports on counties, or groups of counties, as they were completed. The present report on Polk County is the first of these county reports.

Polk County is situated on the western boundary of Arkansas and is bounded on the north by Scott County, on the east by Scott and Montgomery counties, on the south by Howard and Sevier counties, and on the west by McCurtain and LeFlore counties, Oklahoma. (See fig. 1.) The county contains 24 complete geographical townships and parts of four others, and includes 846 square miles, or 541,490 acres.

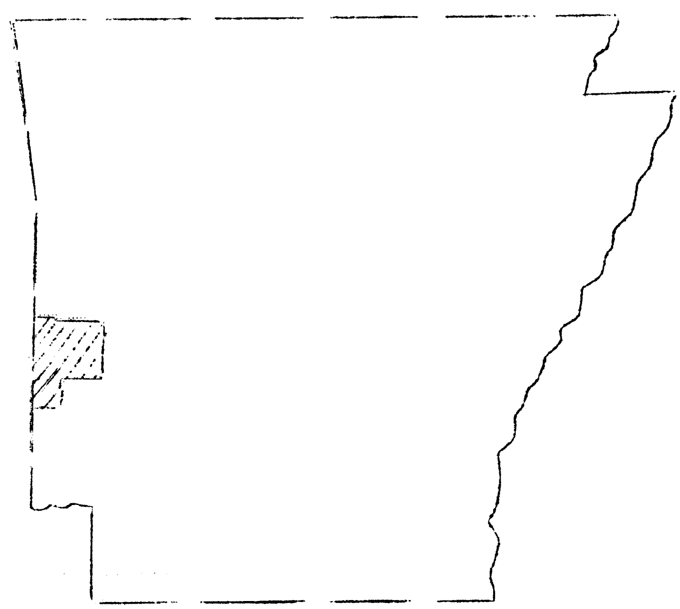


Figure 1. Location of Polk County in Arkansas

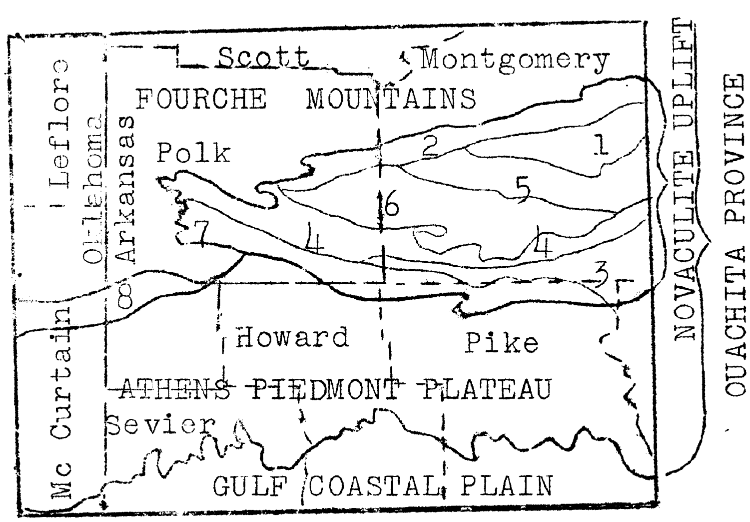
According to the 1930 census, the county had a population of 14,869, which, with the exception of the inhabitants of Mena, is classed as rural. The average density of the county population was 17.6 persons per square mile in 1930, which is to be compared to the state average of 35.3 persons.

Mena is the county seat and largest town in Polk County, having a population, in 1930, of 3,118. The four towns next in population rank are Eagleton (440), Cove (428), Vandervoort (416), and Hatfield (382). All of these are on the main line of the Kansas City Southern Railway which crosses the western part of the county in a general north-south direction.

U. S. Highways 71 and 270 meet north of Mena and State Highways 88 and 8 converge at Mena. State Highway 4, connecting with Oklahoma, joins Highway 71 near Cove. Improved gravel and dirt roads serve the county, and extend into the Ouachita National Forest, which includes most of the mountainous region in the eastern part of the county. A 13.2 KV Power line of the Southwestern Gas and Electric Company enters Polk County from Oklahoma, and passes through Cove to Mena.

The rainfall is usually between 50 and 55 inches annually, and is slightly greater in March, April and May, and less in August, September and October, than during the remainder of the year.

Rough surface features and sharp slopes are characteristic of four mountain ranges which extend into Polk County. These are the Cross, Cossatot, Caddo, and Fourche mountains. Cove, Mazarn, and Caddo Creek basins lie between the mountain ranges, and the Athens Plateau lies south of the mountain region. (See fig. 2.)



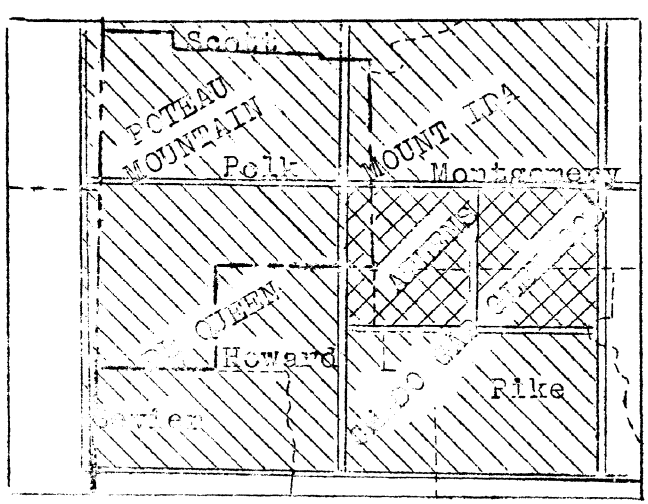
1. Ouachita Basin
2. Northern Mountains
3. Mazarn Basin
4. Caddo Mountains
5. Crystal Mountains
6. Caddo Basin
7. Cassatot Mountains
8. Cross Mountains

Figure 2. Physiographic map

Elevations above sea level range from slightly more than 500 feet in the Athens Plateau to nearly 2,400 feet in the Cossatot Mountains, and to approximately 2,700 feet in the Fourche Mountains. The highest recorded elevation is that of Rich Mountain (2,750 feet). The lowest is a small area about 600 feet above sea level in the southwest corner of the county.

The western and southern portion of Polk County is drained by tributaries of Little River. The Ouachita River, flowing to the east, drains the northeast part of the county.

U. S. Geological Survey topographic quadrangle maps, each covering 30 minutes of latitude and longitude, of the DeQueen, Poteau Mountain, Mount Ida, and Caddo Gap quadrangles, completely cover the county. One map of 15 minutes of latitude and longitude (the Athens quadrangle) covers a small area in the extreme southeastern part of the county. A geologic map of the DeQueen and Caddo Gap quadrangles covers the southern portion of the county. (See fig. 3.) A polk County Highway Planning Survey map and state Geologic map and topographic maps are also available.



LEGEND

U. S. Geological Survey
Surveyed before 1930
Published. Available

Scale 1: 125,000
Contour Interval 50 ft.

U. S. Geological Survey
Surveyed after Jan.,1930
Published. Available

Scale 1: 48,000
Contour Interval 20 ft.

Figure 3. Index of topographic and geologic quadrangle maps published by U. S. Geological Survey

Data, information, and maps used in this report were obtained from field sheets of the Works Projects Administration State Mineral Survey and from U. S. Geological Survey and Arkansas Geological Survey maps and publications.

GEOLOGY

DESCRIPTION AND SEQUENCE OF FORMATIONS

General Statement

The surface formations of Polk County are all sedimentary rocks and consist of shales, sandstones, cherts, novaculites, and a small amount of limestone. At some places the shales and sandstones have been altered to slate and quartzite, respectively.

The geologic ages of the rocks range from Lower Ordovician to Mississippian. (See pl. 1.) The older formations crop out in the eastern and central parts of the county. The younger formations are exposed in the northern, western and southern parts of the county. The Womble shale, Bigfork chert, and Polk Creek shale of Ordovician age, the Blaylock sandstone and Missouri Mountain slate of Silurian age, and the Arkansas novaculite of Devonian and Mississippian (?) age, form the central portion of the mountains that lie within the Novaculite Uplift. The Stanley shale and Jackfork sandstone of Mississippian age form the surface of the gently rolling and mountainous areas north, south, and west of the Novaculite Uplift.

Brief descriptions of the formations exposed in Polk County follow. They are described, from older to younger, that is, in the order of their deposition. (See pl. II)

Lower Ordovician

Womble shale. The Womble shale, which is the oldest formation exposed in Polk County and was, therefore, deposited before the other exposed formations, consists principally of dark-green to black shale, with thin layers of sandstone and limestone. The dark color of the shale is caused by the presence of carbon, part of which has been changed to graphite. In some localities the shale has been altered to slate. Most of the sandstone is near the bottom of the formation, and the limestone, found locally, has a maximum thickness of about 20 feet, and is usually near the top. The formation thickness ranges from 250 to 1,000 feet. It is exposed in the mountainous areas along the central part of the eastern boundary of the county.

Middle Ordovician

Bigfork chert. The Bigfork chert is composed of chert, black shale, and a small amount of limestone. The chert usually occurs in layers from 3 to 6 inches thick, with a maximum thickness of 3 feet. The shale in the formation is in thin layers from an inch to several feet in thickness. The limestone is found only near the top of the formation. The formation has a rather uniform thickness of about 700 feet. It is exposed in the mountainous areas along the central part of the eastern boundary of the county.

Upper Ordovician

Polk Creek shale. The Polk Creek shale is made up of black, graphitic shale, thin irregular beds of black chert and quartzitic sandstone, and ranges in thickness from a feather edge to 175 feet. It is exposed in the Ouachita Mountains in the southeastern part of the county.

Silurian

Blaylock sandstone. The Blaylock sandstone is composed of fine-grained, gray or green sandstone and dark shale containing flakes of mica. Most of the sandstone is hard and quartzitic and is found in even-bedded strata from 1 to 6 inches thick. The shale is highly jointed (broken along parallel planes). The joints in both the sandstone and shale are often filled with milky quartz. The thickness ranges from a feather edge to 1,500 feet. The formation is exposed in the mountainous region in the southeastern part of the county.

Missouri Mountain slate. The Missouri Mountain slate consists of (1) soft shale and slate, (2) conglomerate, where the formation is directly above the Polk Creek shale, and (3) quartzitic sandstone in layers from 3 to 5 inches thick. The latter occurs commonly at the top and bottom of the formation.

The shale is gray, green, black, or red, and has been changed by weathering to a green, buff, or dark-brown color near the surface. The slate is usually soft and does not ring when struck with a hammer, but, in some localities, it is of fair grade and is green or red. (See section on "Slate"). The green slate is lower and the red higher in the formation. Some of the red slate has green spots and streaks caused by the leaching of iron oxides.

In Polk County this formation ranges from a few inches to 300 feet in thickness. It is exposed in the mountainous region in the southeastern part of the county.

Devonian and Mississippian (?)

Arkansas novaculite. The Arkansas novaculite is divided into three rock types. These are, from bottom to top, (1) massive white novaculite, (2) thin beds of black novaculite and interbedded shale, and (3) massive calcareous novaculite.

The lower division consists of even-bedded layers from 2 to 10 feet thick, and is conspicuous because of its white color and massive character. The rock is compact, commonly bluish-white, although brown or gray in some places, caused by the content of iron and manganese oxides and carbonaceous material, and commonly contains 99 per cent or more silica. The lower division ranges from 10 feet to 410 feet in thickness.

Black, cleavable shale, altered to a poor grade of slate in some places, is the main material of the middle division. It occurs in beds ranging from an inch to 100 feet in thickness. The novaculite is darker than that of the lower division and is in thin layers from 1 to 6 inches thick. A conglomerate, composed of pebbles of novaculite and sandstone, occurs at the base of this division. The thickness ranges from 75 to 525 feet.

The upper division is composed of light-gray to bluish-black novaculite that contains both calcium and magnesium carbonate. Near the surface, the novaculite usually is weathered and the carbonates have been leached out, making the bluish-black novaculite more porous and lighter in color. This rock caps some of the low ridges north of Dog Mountain. This division ranges from 20 to 125 feet in thickness. The age of this division is questionable and may be either Devonian or Mississippian.

The whole formation ranges from 100 to 900 feet in thickness. The novaculite is found in the mountainous region in the southeastern portion of the county and is usually well exposed, as it resists the action of the weather better than most of the rocks with which it is associated.

Mississippian

Stanley shale. The Stanley shale is made up of cleavable clay shale, slate, sandstone, and conglomerate. The shale is blue-black or jet-black and is green or brown where weathered. It makes up about 70 per cent of the formation. The shale near the base of the formation has been changed to slate. (See section on "Slate.")

The sandstone is in layers from 2 inches to 3 feet thick in the shale. It is fine-grained, hard, and gray to bluish-gray when fresh and is soft, porous, and of dark shade when weathered. It constitutes about 25 per cent of the formation.

The conglomerate occurs at the base of the formation and is composed of sharp or waterworn pieces of material from the upper and lower divisions of the Arkansas novaculite.

The formation is commonly cut by veins of quartz, some 6 inches in thickness. The formation ranges from 3,500 to over 9,000 feet in thickness, and its average thickness in Polk County is probably about 5,000 feet. It is the most widespread formation in the county and is found in nearly all the lowlands outside of the Novaculite Uplift.

Jackfork sandstone. The Jackfork sandstone is the youngest formation in Polk County, and is composed of massive, compact, fine-grained, quartzitic sandstone, and green, blue, or black shale. The sandstone is bluish-gray to white when unweathered. Most of the sandstone beds range from 6 inches to 10 feet in thickness, although some beds 80 feet thick have been reported. This formation ranges in thickness from 3,500 to 6,500 feet. The Jackfork is exposed in the mountains in the northern part of the county.

Pleistocene and Recent

The deposits of chert and novaculite gravels formed by the streams that flow through the Novaculite Uplift are the only deposits of this age in the county. The thickness of these deposits is usually less than 10 feet and averages about 5 feet.

STRUCTURE

General Statement

The rocks in the Ouachita Mountains in Polk County have been severely folded by forces apparently acting from the south. Upfolds (anticlines) and downfolds (synclines) have been formed with their long dimensions (axes) trending nearly east-west. The folds are parallel and often overlap one another. Some of the folds are overturned. The severe folding of the rocks is often accompanied by faulting or breakage of the rock layers. Both minor and major movements have taken place along these faults or breaks. The presence of these faults often has an important bearing on the distribution of metallic minerals such as manganese. (See pls. IV and V.)

E C O N O M I C M I N E R A L R E S O U R C E S

METALLIC MINERALS

COPPER

Copper minerals in Polk County were studied in 1888 by T. B. Comstock in connection with a survey of gold and silver in the Ouachita Mountains for the Arkansas Geological Survey. His report is published as Arkansas Geological Survey Annual Report for 1888, Vol. I, "Report Upon the Geology of Western Central Arkansas, With Especial Reference to Gold and Silver."

Composition and properties. Malachite (hydrous copper carbonate) and chrysocolla (hydrous copper silicate) and native copper have been found in Polk County. These minerals usually occur as a green stain or coating on the rocks. Malachite contains 57.27 per cent copper and chrysocolla 35.70 per cent.

Uses. Copper is used principally in the electrical industries, in the manufacture of electric light and power lines, and in automobile equipment. It is also extensively used in the manufacture of alloys, such as brass and bronze, and as copper sheeting in building construction.

Prices. Prices of different copper ores are not usually published. The price paid for ores is based on the per cent of copper contained. In 1937 the maximum price per ton paid was $29.65. This was based on an average content of 1.29 per cent copper.

Occurrence. Malachite and chrysocolla occur as green stains on the Arkansas novaculite in Polk County. Table 1 shows the occurrence of copper minerals in Polk County. (See pl. VI.) Green and white dickite (a type of kaolin) is associated with the copper minerals in deposit No. 1, and native copper occurs in deposit No. 2.

Table 1. Occurrence and analyses of copper minerals

Map no.	Location S. T. R.	Name	Copper Per cent
1	(18-3S-28W (19-3S-28W (24-3S-29W	Unknown	Unknown
2	SE SE 13-3S-29W	Daut Heath, owner	Unknown
3	14-3S-29W	Silver World Mine	3.8
4	9-3S-30W	Worthington's Copper Queen Lode	2.0
5	28-4S-31W	Unknown	2.5

Nos. 1 and 2 located by State Mineral Survey. Information concerning Nos. 3, 4, and 5 from Ark. Geol. Survey Ann. Rept. for 1888, Vol. I, "Report Upon the Geology of Western Central Arkansas, with Especial Reference to Gold and Silver," by T. B. Comstock, 1888.

Economic importance. None of the known occurrences of copper in Polk County is of economic importance at present prices. Apparently the aggregate amount of ore available is small.

Production. A small amount of copper ore has been produced from prospect No. 1.

Iron

Composition and properties. The following iron minerals occur in Polk County: Limonite, hematite, pyrite, and marcasite. Limonite is a hydrous iron oxide and contains 59.8 per cent iron. It is frequently impure. Hematite is an iron oxide (Fe_2O_3), containing 70 per cent iron. Pyrite and marcasite are both iron sulphide (FeS_2), containing 46.6 per cent iron.

Uses. By far the greatest use of the iron oxide ores is in the manufacture of metallic iron and steel. On roasting, pyrite and marcasite yield sulphur dioxide, which is commonly used in the manufacture of sulphuric acid. Metallic iron is recovered as a byproduct.

Prices. Following are average prices, per gross ton, at mines in the United States for 1938, according to the U.S. Bureau of Mines Minerals Yearbook: hematite, $2.82; limonite, $2.31; pyrite and marcasite, $3.03.

Occurrence. Limonite and hematite occur in Polk County in pockets, small veins, and as filling along the bedding planes in the Arkansas novaculite. Pyrite and marcasite sometimes occur in small crystals in the same formation. Iron minerals occur at the following localities in Polk County (see pl. VI):

Table 2. Occurrence of iron minerals

Map no.	Location S. T. R.	Name	Thickness (inches)	Mineral
1	NE NW 18-4S-28W	Walston claim on Manganese Mt.	2 to 6	Br. Hematite
2	SE SE 15-4S-28W	J. Guy Lewis claim on Leader Mt.	24	Br. Hematite
3	NE NW 19-4S-28W	Pointed Rock Tunnel of Ark. Dev. Co.	1 to 12	Br. Hematite
4	Cen 15-4S-29W	High Peak of Hanna Mt.	24	Br. Hematite
5	NE NE 34-3S-30W	Tunnel No. 2 of Ark. Dev. Col	Few to 12	Br. Hematite
6	SW NE 1-4S-30W	C.C. Avant	1 to 6	Br. " a/
7	SE SW 13-4S-30W	Little Manganese Mt., Wm. Allen claim	1 to 4	Br. " a/
8	SW NW 21-4S-30W	Gillam Springs	Few to 60	Br. Hematite
9	NW NE 17-1S-32W	-	-	-
10	NW NW 27-2S-31W	-	-	-
11	SE SW 6-3S-30W	-	-	-
12	NW SE 9-3S-30W	-	-	-
13	SW NW 26-3S-30W	-	-	-
14	SW SW 29-3S-30W	-	-	a/
15	NW NW 32-3S-30W	-	-	a/
16	NE NE 33-3S-30W	-	-	-
17	NW SE 6-5S-32W	-	-	-
18	SE 2-5S-32W	Towry Lode	-	Pyrite

a/ Also contains manganese.
Nos. 1 to 8 according to Arkansas Geol. Survey Ann. Rept. for 1892, Vol. I, "The Iron Deposits of Arkansas," by R. A. F. Penrose, Jr., 1892.
Nos. 9 to 17 according to State Mineral Survey.
No. 18 according to Arkansas Geol. Survey Ann. Rept for 1888, Vol. I, "Report Upon the Geology of Western Central Arkansas, with Especial Reference to Gold and Silver," by T. B. Comstock, 1888.

Following are available analyses of iron minerals of Polk County:

Table 3. Analyses of iron minerals

Map no.	Location S. T. R.	Name	Iron Fe	Silica SiO_2	Phosphate P	Sulphur S	Manganese Mn
1	SE SE 15-4S-28W	J. Guy Lewis claim on Leader Mt.	16.22	19.32	0.773	0.137	Trace
	NE NW 19-4S-28W	Pointed Rock Tunnel of Ark. Dev. Co.	14.51	41.40	0.191	0.082	Little

From Arkansas Geol. Survey Ann. Rept. for 1892, Vol. I, "The Iron Deposits of Arkansas," by R. A. F. Penrose, jr., 1892.

The above analyses indicate that the ore is not sufficiently high grade to be of commercial value. The limits of commercial iron ore content is usually about as follows:

	From	To
Iron (Fe)	42.17	54.98
Silica (SiO_2)	6.75	29.30
Phosphorous (P)	0.039	0.416
Manganese (Mn)	0.33	6.36
Moisture	6.50	11.85

Economic importance. The known deposits of iron minerals in Polk County are not sufficiently large and the quality of the ore is too low to permit profitable mining.

Production. None reported.

Lead

Composition and properties. Lead is found in Polk County in the form of galena. This is lead sulphide (PbS), containing 86.4 per cent lead.

Uses. Metallic lead is used principally in making lead pipe, sheet lead, and shot, and as white lead (basic lead carbonate) and litharge (lead oxide) in the paint industry.

Prices. The average price of galena, according to Metal and Mineral Markets of April 25, 1940, was $58.77 per short ton.

Occurrence. Galena has been reported at one locality, occurring in veins with quartz in the Missouri Mountain shale and slate. This is at the Lehrack slate quarry in the SW. $\frac{1}{4}$ sec. 24, T. 3 S., R. 29 W. (See pl. VI.)

Economic importance. The size of the single deposit reported is apparently small, although it is difficult to estimate its value unless it is opened up more than it is at present.

Production. None reported.

Manganese

The occurrence of manganese minerals in Polk County was known for many years before 1890. In that year, R. A. F. Penrose, Jr., a geologist with the Arkansas Geological Survey, completed a detailed investigation of the manganese deposits of the state, which was published as Arkansas Geological Survey Annual Report for 1890, Vol. I, "Manganese, Its Uses, Ores, and Deposits." In 1917, Hugh D. Miser, of the U. S. Geological Survey, visited the mines and prospects in the Ouachita Mountains. The results were published in U. S. Geological Survey Bulletin 660-C, "Manganese Deposits of the Caddo Gap and DeQueen Quadrangles, Arkansas." The investigation made by the State Mineral Survey has added to this information.

Composition and properties. Manganese occurs in Polk County in the minerals psilomelane, manganite, pyrolusite, and wad. The chemical name, formula and manganese content of these minerals is as follows:

Table 4. Composition of manganese minerals

Mineral	Molecular composition	Chemical name	% Mn
Psilomelane	$MnO_2.(Mn, K, Ba)O.nH_2O$ & H_4MnO_5	Manganese oxide	45 to 60
Pyrolusite	MnO_2	Manganese dioxide	60 to 63
Manganite	$Mn_2O_3.H_2O$	Manganic oxide	62.4
Wad	-	Impure manganese oxide	Variable but low

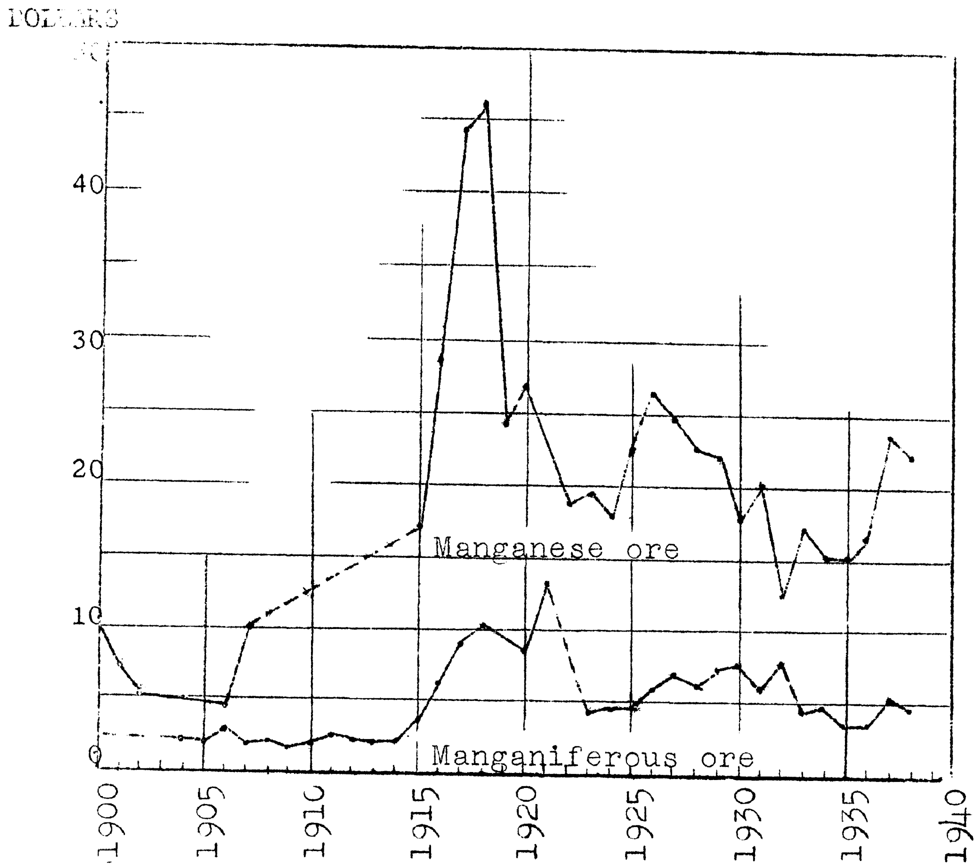
Psilomelane is a black or blue-black mineral that has a shell-like fracture. It is usually found in a massive, non-crystalline form but may occur in a concentric or stalactitic (icicle-like) form. It has a density of from 3.7 to 4.7 and a hardness of from 5 to 6. It can be scratched with a knife blade with difficulty, if at all. Pyrolusite is an iron-black mineral with either a crystalline or granular structure. It has a density of 4.75 and a hardness of from 2 to 2.5, and often soils the fingers. Manganite is a black, brittle, massive or crystalline mineral. It is about as heavy as pyrolusite and can be scratched with a knife blade. It often occurs with psilomelane. Wad is a soft, dark-brown or black, earthy mineral. It often occurs with psilomelane or manganite.

The manganese ores in Polk County are often found with the iron oxides, limonite and hematite. The manganese and iron are in varying amounts, from high manganese-low iron content to low manganese-high iron content. Limonite is usually brown in color and hematite red brown, but they may be black and be mistaken for manganese minerals.

Uses. Manganese is used almost entirely in the manufacture of an iron alloy known as ferromanganese, which contains from 78 to 82 per cent manganese and from 6 to 15 per cent iron. Spiegeleisen is another iron alloy containing from 18 to 22 per cent manganese and from 70 to 80 per cent iron. Both of these alloys are used in steel manufacture. The second use of importance is the use of manganese oxide in the manufacture of dry cells. It is also used to a minor extent in the chemical trades, as a coloring agent in cloth printing and dyeing, in the making of pottery, bricks, and paint. Minor alloys are made by combining manganese with copper, aluminum, zinc, tin, lead, magnesium, or silicon. Wad and other low-grade oxides are used to give a chocolate color to bricks.

Prices. Prices of manganese ore are quoted on a unit basis, the unit being one per cent of a long ton (2,240 pounds), or 22.4 pounds of metallic manganese. According to Metal and Mineral Markets of April 25, 1940, the price per long ton of manganese, c.i.f. Atlantic ports, exclusive of duty, for oxide ore containing 48 per cent manganese was 47 cents per unit of manganese contained, or $22.56 per long ton.

Figure 4 shows the average price of manganese and manganiferous iron ore, per long ton, from 1900 to 1938, according to U. S. Bureau of Mines Minerals Yearbooks. Figures for 1900 to 1931 are for average price in Arkansas and figures for 1932 to 1938 are for average price in the United States.



---Figures not available Data from U. S. Bureau of Mines

Figure 4. Average price of manganese and manganiferous ore per long ton, from 1900 to 1938

Occurrence. The manganese minerals in Polk County are found chiefly near the top of the lower division and in the upper division of the Arkansas novaculite. (See pl. VI.) The minerals occur as nodules, pockets, veins, and as a cementing material in brecciated (shattered) Arkansas novaculite. The deposits of manganese minerals usually contain a high percentage of barren rock. Masses of manganese minerals usually range in thickness from a fraction of an inch to 4 feet, but masses of the latter thickness are rare.

In the following list of deposits, information concerning Nos. 1 to 21 was obtained from Arkansas Geological Survey Annual Report for 1890, Vol. I, "Manganese, Its Uses, Ores, and Deposits," by R. A. F. Penrose, Jr., 1890. Information concerning Nos. 22 to 43 was obtained from the State Mineral Survey.

1. Cossatot Mountain. $SW\frac{1}{4}$ sec. 27, T. 3 S., R. 29 W.

[illegible] small pits have been sunk for manganese on the summit of the mountain, and a tunnel 40 feet long has been run into the north side, about 20 feet below the summit. The gray Arkansas Novaculite forms the crest of the ridge. The manganese is in the form of a crystalline pyrolusite, mixed with a hard, massive ore, and occurs in irregular nests from a quarter of an inch to 3 inches in diameter, and in thin seams from a sixteenth to a quarter of an inch in thickness. Such bodies are scattered irregularly through a 40-foot width of the Arkansas novaculite. The manganese oxide forms but a small portion of the mineralized layer, and, except in the richest places, the total amount of the scattered bodies of manganese oxide would form a very small percentage of the mass.

2. Grant Prospect. W.$\frac{1}{2}$ sec. 36, T. 3 S., R. 29W. The cut, which is 10 feet long, by 5 or 6 feet wide and from 4 to 6 feet deep , exposes pockets and veins of manganese and iron oxides reaching a width of 9 inches along cracks in the massive Arkansas novaculite. Some of these oxides cement many of the fractured pieces of novaculite. The manganese oxide is more abundant than the iron oxide and consists of hard, steel-blue psilomelane, some of which contains small crystals of manganite. The iron oxide is represented by both brown and red oxides. About a ton of manganese has been removed from the cut.

A shallow pit, from which a little manganese oxide, a larger amount of brown iron oxide, and some red iron oxide have been removed, is about 50 feet northeast of the main cut.

3. Shaft No.3 NW$\frac{1}{4}$ SE$\frac{1}{4}$sec. 27, T. 3S., R. 30 W. Shaft No. 3 is a pit 8 feet square and 20 feet deep, sunk for manganese oxide in the gray Arkansas novaculite. The mineral occurs in small nests and thin broken seams, from 1 to 6 inches in thickness. In places the seams follow joints, but the largest seams are in the bedding planes of the rock.

4. Shaft No. 4. SW.$\frac{1}{4}$ NE.$\frac{1}{4}$ sec. 27, T. 3 S., R. 30 W. The manganese oxide in this shaft, which is the same as Shaft No. 3 in size, is a hard, massive variety in a mammillary (Like bunches of large sized grapes) form and occurs in bedding planes and joint cracks. The largest seam exposed was 4 feet long and 4 inches thick.

5. Arkansas Development Company's Ward Mine. SW.$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 27, T. 3 S., R. 30 W. A shaft, 142 feet deep, was sunk on the north slope of an Arkansas novaculite ridge near the headwaters of Brushy Fork Branch of the Cossatot River, and a tunnel, about 500 feet long, was run into the northern side of the ridge at about the level of the branch. The manganese oxide occurs in the Arkansas novaculite as crystalline pyrolusite, associated with a hard, iron-gray, massive oxide, the former often coating the latter as a thin crust, and both occurring in kidney-shaped or stalactitic

(icicle-like) forms. In places small quantities of black iron oxide (limonite), showing a brilliant iridescent surface, are associated with the manganese oxide, but a large part of the latter is free from such impurity. The manganese-bearing deposit ranges from 1 to 2 feet in thickness. The mineral is only a small part of the total mass and usually occurs as thin seams and pockets from a fraction of an inch to over 2 inches in thickness, scattered irregularly through the rock. Occasionally, the manganese oxide widens out locally into pockets of somewhat larger size.

The deposit was worked in 1888 and 1889. About 20 tons of ore are said to have been taken from the shaft; none was found in the tunnel. The present owner is B. C. Stern.

6. Jumbo Pit. SW.$\frac{1}{4}$ SE.$\frac{1}{4}$ sec. 27, T. 3 S., R. 30 W. This pit is on the same ridge as deposit No. 5 and the manganese oxide impregnates the Arkansas novaculite in the same way as in that deposit. A pit, 15 feet deep and 8 feet square, has been sunk, and on all sides of it are seen thin, irregular, and broken "Stringers" of oxide, from 1 to 5 inches in thickness, either in the bedding planes or joints. The Arkansas novaculite is generally stained a buff or a brown color and is soft, often disintegrating into a powder.

7. West Hanna Mountain, Bowen Claim. SE.$\frac{1}{4}$ SE.$\frac{1}{4}$ sec 5, T. 4 S., R. 30 W. Manganese oxide in this claim is in a crystalline form, with smaller quantities of a hard, massive oxide. It occurs in thin, broken seams and cracks in joints in the Arkansas novaculite, and, in some places, forms the cement of a breccia. The largest mass of solid oxide exposed was 3 inches in thickness and 3 feet in length, thinning out at both ends.

8. West Hanna Mountain, William Allen Claim. SW.$\frac{1}{4}$ SW.$\frac{1}{4}$ sec. 1, T. 4 S., R. 30 W. The manganese oxide is in the gray Arkansas novaculite, near its contact with the shale. The oxide impregnates the rock for a width of 10 feet, in small seams and pockets from a quarter of an inch to 3 inches in thickness, and is both massive and crystalline. The manganese oxide is associated with small quantities of iron oxide.

9. East Hanna Mountain, West End. W.$\frac{1}{2}$ SE.$\frac{1}{4}$ sec 12, T. 4S., R. 30 W. Both manganese and iron oxides are scattered in small quantities through a belt of Arkansas novaculite ranging from 5 to 20 feet in width. In some places the oxide is iron and in others manganese; in still others both oxides are mixed together in varying proportions. They occur in thin seams along bedding planes or joints, or as cement of a brecciated Arkansas novaculite; in places they are in small nodules and often make only a stain on the rock.

10. C. C. Avant. SE.$\frac{1}{4}$ NW.$\frac{1}{4}$ sec. 6, T. 4 S., R. 29 W. Manganese oxide is found in the gray Arkansas novaculite on and near the summit of the mountain, and is of a hard, steel-blue variety, often in stalactitic

and mammillary forms. The oxide-bearing part of the rock ranges from 1 to 5 feet in thickness and contains the mineral in thin seams from a fraction of an inch to 8 inches in thickness along bedding planes or joints. This oxide deposit is traceable for several hundred yards along the mountain.

11. East Hanna Mountain, William Allen Claim. S½ NW. ¼ sec 8, T. 4 S., R. 29 W. The manganese oxide is in seams and pockets from a fraction of an inch to 10 inches in thickness, scattered through the Arkansas novaculite. The larger size is unusual, and the largest mass exposed was 10 inches long, 3 inches wide, and 6 inches deep. The oxide is both crystalline and massive, and the crystalline mineral often shows a feather-like structure. The massive oxide is hard and often in stalactitic and mammillary forms. The manganese oxide occurs with a glossy black iron oxide.

12. Tall Peak Mountain. NE.¼ NE.¼ sec. 24, T. 4 S., R. 29 W. The gray Arkansas novaculite is impregnated with manganese oxide for a width of about 20 feet. The oxide is in pockets and lenticular layers scattered through the rock, the largest seam being 2 feet long and from 3 to 6 inches in thickness. It occurs both in the form of a hard, massive, steel-blue oxide and as a finely crystalline variety, the crystals frequently being grouped in a plume-like form, and having a brown streak. Occasionally the manganese oxide contains small quantities of iron oxide, but it is usually comparatively free from that impurity. On the west the oxide-bearing stratum disappears under the gravel of a small creek bed; on the east it rapidly thins out on the slope of the mountain, and is replaced by the gray Arkansas novaculite.

13. Manganese Mountain. SE.¼ NW.¼ sec. 18, T. 4 S., R. 28 W. Manganese oxide is found in the gray Arkansas novaculite as a hard, massive, steel-blue mineral, changing in some places to a semi-crystalline form. It usually occurs in flat, botryoidal (like bunches of small grapes) form, or as concretionary masses, often having hollow interiors. It follows the bedding planes of the rocks but also occurs as a joint filling. The bedded layers are the larger, and one measured from 3 to 6 inches in thickness and 4 feet in length. The seams in the joints rarely measure over a quarter of an inch in thickness, though they are often so numerous as to honeycomb the rock in all directions. The lens shaped oxide layers lie scattered along different bedding planes and are separated along these planes by barren areas.

14. Leader Mountain Prospect. Cen. SE.¼ sec. 24, T. 4 S., R. 28 W. A cut, 72 feet long and from 6 to 10 feet deep, is in the massive Arkansas novaculite on the north slope of the mountain and near the divide in the saddle of the mountain. A zone of broken novaculite 6 feet wide is near the north end of the cut and contains lenses of manganese oxides lying mostly along the bedding planes. The largest is 8 inches wide at the widest part. Some veins have been found along joints and reach a thickness of 3 inches. In places the oxides cement novaculite fragments.

Farther south they are found in pockets and veins through a distance of 12 feet, but they constitute only a small percentage of the bulk of the rock. The manganese oxides here are wad, manganite, and psilomelane, mixed with much brown and red iron oxides.

15. Coon Creek. NW.$\frac{1}{4}$ SE.$\frac{1}{4}$ sec. 14, T. 4 S., R. 28 W. In an Arkansas novaculite hill bordering the creek on the south, a small pit has been opened on a deposit of manganese and iron oxides. Both occur in about equal amounts. They either form the cement of a brecciated Arkansas novaculite or occur in thin layers, nests, or pockets throughout the rock. The largest mass of ore seen came from one of these pockets and was 2 feet in diameter. Such masses, however, are rare.

16. He Mountain. SE.$\frac{1}{4}$ NE.$\frac{1}{4}$ sec. 14, T. 4 S., R. 28 W. A small pit, 3 feet deep, was sunk on the manganese oxide which occurs in small seams and pockets, rarely over 2 or 3 inches in thickness. The width of the oxide exposed in the pit is 6 feet and may be considerably wider. The oxide is scattered through the rock. It is a hard, massive, steel-blue type, frequently having a concretionary structure and a mammillary surface and occurs with massive brown iron oxide. The latter often encloses nodules of manganese oxide or forms the outside layers of pockets of that mineral. Small cavities in the Arkansas novaculite, from 1 to 6 inches in diameter, are often lined with layers of iron and manganese oxides. In some places both oxides are sharply separated from the Arkansas novaculite; in others, they blend into it, staining it brown or black.

17. W. A. Davis No. 1, SW.$\frac{1}{4}$ NE.$\frac{1}{4}$ sec. 13, T. 4 S., R. 28 W. A north-south cut, 38 feet long, a few feet wide, and 18 feet deep, near the east end of He Mountain, exposes manganese oxide veins in a vertical zone of broken Arkansas novaculite 4 feet wide on the east side of the cut and 6 feet wide on the west side. The oxide veins make up half the bulk of the zone but most of the oxide that is free from Arkansas novaculite fragments is confined to an irregular vein which, on the east side, is 12$\frac{1}{2}$ inches wide at a height of 6 feet above the bottom of the cut, 32 inches wide 3 feet from the bottom, and 7 inches wide at the bottom. The oxides are psilomelane and manganite. The psilomelane makes up the greater part of the deposit and is massive, hard, and steel-blue. Much of it has a banded structure and a surface resembling a bunch of grapes, and some is stalactitic. The manganite is, in places mixed with the psilomelane but the two oxides may be found in a single vein as separate layers. The deposit was worked in the summer of 1916.

18. W. A. Davis No. 2. NW.$\frac{1}{4}$ SW.$\frac{1}{4}$ sec. 13, T. 4 S., R. 28 W. A cut 60 feet long extends into the hillside and its southwest end is from 18 to 20 feet deep. Thin veins of wad, in places mixed with brown and red oxides of iron, occur along some of the joints in the Arkansas novaculite. They are usually less than half an inch thick, but one pocket, 2 feet or more wide, contains some red iron oxide and ferruginous manganese. Just west of the mouth of the cut is an exposure of a 2-foot

vein containing manganese oxide, brown iron oxide, and specular hematite, but half of the vein is Arkansas novaculite. Another exposure of Arkansas novaculite showing two veins of hard, massive psilomelane, one 1 to 6 inches wide, and the other 12 inches wide, is 60 feet southeast of the mouth of the cut.

19. Tellus Davis No. 1. SE.¼ NE.¼ sec. 13, T. 4 S., R. 28 W. The prospect is an east-west cut 25 feet long and 10 feet wide on the east end of He Mountain. Small pockets and veins of psilomelane, the largest exposed being 3 inches wide, are found in the Arkansas novaculite along the joints and bedding planes. The psilomelane is hard and steel-blue and, in places, shows concretionary structure and surfaces like bunches of grapes. Manganite occurs in smaller amounts.

20. Tellus Davis No. 2. Cen. E.½ sec 13, T. 4 S., R. 28 W. This prospect, which is on the south slope of He mountain, consists of a cut 40 feet long, 8 to 10 feet wide, and 10 to 12 feet deep at the north end. A lenticular vein 6 inches thick contains ferruginous manganese. A number of veins of brown iron oxide were found along bedding planes. The prospect was worked in the summer of 1916.

21. McKinley Mountain. SE.¼ SE.¼ sec. 12, T. 4 S., R. 28 W. The pit at this prospect shows manganese oxide scattered irregularly and in limited amounts through a zone 6 feet wide. In some places the oxide-bearing part of the rock is possibly still wider. The oxide is a hard, compact, steel-blue variety, frequently stained yellow or red by iron. It occurs throughout the rock in small seams and pockets from a fraction of an inch to 4 inches in thickness. In some places the oxide blends into the Arkansas novaculite, turning it black. In other places the line of separation is sharp and well defined.

22. Hatfield Claim. SE.¼ sec. 6, T. 4 S., R. 29 W. This is an undeveloped claim. Analysis of a manganese oxide sample from this claim, by the State Mineral Survey, indicated the presence of 21.40 per cent manganese. The occurrence of the oxide in this claim is believed to be much similar to that of deposit no. 10.

23. Avant Claim. SW.¼ sec. 7, T. 4 S., R. 29 W. This claim is undeveloped. An analysis by the State Mineral Survey indicated a manganese content of 9.65 per cent.

24. United States. NE.¼ NE.¼ sec. 8, T. 3 S., R. 30 W. A trench across the crest of the hill is 60 feet long and 7 feet wide. An analysis by the State Mineral Survey indicated a manganese content of 2.67 per cent.

25. J. F. Greene. NW.¼ NW.¼ sec. 8, T. 3 S., R. 30 W. A trench is 120 feet long, 6 feet wide, and 8 feet deep. An analysis by the State Mineral Survey indicated a manganese content of 8.44 per cent.

26. United States. NE.$\frac{1}{4}$ NE.$\frac{1}{4}$ sec. 1, T. 3 S., R. 31 W. A trench is 120 feet long, 3 feet wide, and 4 feet deep. An analysis by the State Mineral Survey indicated a manganese content of 4.96 per cent.

27. Camp Wilder. NE.$\frac{1}{4}$ sec. 24, T. 3 S., R. 31 W. A tunnel into the crest of the hill is 45 feet deep. An analysis by the State Mineral Survey indicated a manganese content of 10.91 per cent.

28. Dowzer. SW.$\frac{1}{4}$ sec. 3, T. 3 S., R. 28 W. Exposure 22 feet long and 8 feet thick.

29. W. H. Page. NW.$\frac{1}{4}$ sec. 8, T. 3 S., R. 28 W. Manganiferous deposit in residual clay.

30. United States. SE.$\frac{1}{4}$ sec. 4, T. 3 S., R. 30 W. Worked in 1917.

31. Unknown. SE.$\frac{1}{4}$ NE.$\frac{1}{4}$ sec. 33, T. 3 S., R. 30 W. Analysis by the State Mineral Survey indicated a manganese content of 7.32 per cent.

32. Unknown. NW.$\frac{1}{4}$ sec. 2, T. 3 S., R. 31 W. Old shaft, extimated 40 feet deep, filled with water.

33. Fitzsimmons. SW.$\frac{1}{4}$ NW.$\frac{1}{4}$ sec. 2, T. 3 S., R. 31 W. Two 30-foot tunnels connected by an 8-foot drift.

34. Unknown. NE.$\frac{1}{4}$ NE.$\frac{1}{4}$ sed. 12, T. 3 S., R. 31 W.

35. Unknown. SE.$\frac{1}{4}$ NW.$\frac{1}{4}$ sec. 28, T. 4 S., R. 28 W.

36. Ison Avants. Sec. 1. T. 4 S., R. 30 W. Claim undeveloped.

37. Hatfield. SE.$\frac{1}{4}$ sec. 30, T. 4 S., R. 30 W. Small drift near creat of hill.

38. Unknown. SW.$\frac{1}{4}$ sec 3, T. 5 S., R. 32 W. Shaft 8 feet in diameter and 35 feet deep.

39. Unknown. NW.$\frac{1}{4}$ sec. 10, T. 5 S., R. 32 W. Outcrop 35 feet wide across Bog Springs road.

40. W. F. Atleberry. SW.$\frac{1}{4}$ NW.$\frac{1}{4}$ sec. 10, T. 5 S., R. 32 W. Trench 2 feet deep.

41. J. F. Budd. SW.$\frac{1}{4}$ SE.$\frac{1}{4}$ sec. 14, T. 5 S., R. 32 W. Trench 800 feet long and 7 feet deep.

Table 5. Analyses of manganese minerals

Map No.	Location S. T. R.	Name	Manganese Mn	Iron Fe	Silica SiO_2	Phosphorous P	Analyst	Source
1	SW 27-3S-29W	Cossatot Mt.	59.55	0.74	0.52	-	1/	9/
			(60.66	1.43	1.00	-	1/	10/
			(78.30	-	-	-	1/	10/
5	SW SW 27-3S-30W	Ark. Dev. Co.	(58.36	-	9.02	0.41	2/	11/
		Ward Mine	(55.80	0.50	3.72	0.038	2/	11/
			(27.68	35.39	1.88	0.23	2/	11/
			(52.23	4.40	3.29	0.04	2/	11/
12	NE NE 24-4S-29W	Tall Peak Mt.	52.16	4.00	0.24	0.39	1/	9/
13	SE NW 18-4S-28W	Manganese Mt.	42.75	2.72	10.46	0.45	1/	9/
21	SE SE 12-4S-28W	McKinley Mt.	49.24	2.04	2.98	0.38	1/	9/
22	SE 6-4S-29W	Hatfield Claim	21.40	-	-	-	3/	12/
23	SW 7-4S-29W	Avant	9.65	-	-	-	3/	12/
24	NE NE 9-3S-30W	United States	2.67	-	-	-	3/	12/
25	NW NW 8-3S-30W	J. F. Greene	8.44	-	-	-	3/	12/
26	NE NE 1-3S-31W	United States	4.96	-	-	-	3/	12/
27	NE 24-3S-31W	Camp Wilder	10.91	-	-	-	3/	12/
31	SE NE 33-3S-30W	Unknown	7.32	-	-	-	3/	12/
			(53.10	-	3.00	0.13	4/	11/
			(71.20	-	2.77	Trace	5/	11/
			(54.27	2.70	1.19	0.09	6/	11/
			(47.00	17.00	-	0.06	7/	11/
			(60.28	-	-	0.413	2/	9/
			(51.54	-	-	0.167	2/	9/
	Unknown	Ark. Dev. Co.	(48.65	2.03	11.86	0.308	8/	9/
		property	(48.34	-	-	0.449	2/	9/
			(40.51	25.53	0.80	0.767	8/	9/
			(27.68	35.39	1.88	0.230	8/	9/
			(26.20	16.83	29.00	0.343	8/	9/
			(22.84	-	0.42	0.047	8/	9/
			(11.93	22.26	44.40	0.576	8/	9/
			(2.06	50.38	-	1.450	2/	9/

1/ Arkansas Geological Survey Laboratory, Little Rock, Ark.
2/ W. B. Potter and Regis Chauvenet & Bro., St. Louis, Mo.
3/ State Mineral Survey Laboratory, Little Rock, Ark.
4/ Average (?) of 26 specimens sent to Birmingham and Sheffield, England. Name analyst not given.
5/ Charles E. Wait of Missouri School of Mines, Rolla, Mo.
6/ J. Blodget Britton of Philadelphia, Pa.
7/ Smithsonian Institution.
8/ St. Louis Sampling and Testing Works, St. Louis, Mo.
9/ Arkansas Geological Survey Annual Report for 1890, Vol. I, "Manganese, Its Uses, Ores, and Deposits," by R. A. F. Penrose, Jr.
10/ Arkansas Geological Survey Annual Report for 1888, Vol. I, "Report Upon the Geology of Western Central Arkansas, with Especial Reference to Gold and Sil-

ver," by T. C. Comstock, 1888, p. 263.
11/ U. S. Geological Survey Mineral Resources of United States for 1887, p. 149.
12/ State Mineral Survey.

Economic importance. The possibilities of manganese mining in west-central Arkansas, which includes Polk County, are discussed by Penrose 1/ as follows:

> "The aggregate amount of manganese in the region is undoubtedly large, but it is distributed over an extensive area, and in almost all places it is hopelessly scattered through the rock in small nests and seams. If these nests and seams were in sufficient quantities the rock might be crushed and the ore concentrated by washing, but the pockets containing them are too small to permit the expense of machinery. It is a popular idea that the ore will increase in quantity at a depth, but there is absolutely no reason to expect this, as such deposits are just as likely, and sometimes even more likely to become poorer at a depth than they are to improve.
>
> "From the nature of the deposit it is to be expected that the ore at a depth is, at the very best, no more plentiful than in the surface outcrops of the so-called 'lodes, that is, that it exists as a series of pockets separated by greater or less distances of barren rock. With very few exceptions the pockets of ore seen on the surface cannot be worked at a profit, and in the rare cases where a small profit might be made the amount would not be enough to pay for sinking through the barren rock that separates the pockets from each other. The intervening thickness of barren rock is much greater than the depth of any one pocket."

The quantity of manganese ore which can be mined at a profit from any one deposit is apparently small and consequently, unless the price of manganese is abnormally high, manganese mining will probably never become of outstanding importance in Polk County. At the present time there has been only a relatively small development of any manganese deposits in western Arkansas.

Under abnormal conditions, if manganese reaches the price it did in 1918 ($45.82 per long ton), mining in some of the richest groups of of deposits can doubtless be carried on profitably.

Production. The manganese deposits in west-central Arkansas have been worked in a very small way and so far have yielded not more than a few hundred tons of ore that have been sold. Most of the work has been done during two periods of activity, one beginning about 1885 and ending in 1889, and the other during the World War. The only known production from Polk County was 20 tons from the Ward Mine of the Arkansas Development Company (No. 5) and one ton from the Grant Prospect (No. 2).

Zinc

Composition and properties. Sphalerite is the only zinc mineral that has been found in Polk County. It is zinc sulphide (ZnS), and contains 67 per cent zinc.

Uses. The principal uses of metallic zinc, in order of importance, are: galvanizing, brass and casting, die casting, rolled zinc, and other purposes, which include slab zinc used for the manufacture of French oxide, lithopone, atomized zinc dust, zinc for wet batteries, slush castings, and for the desiliverization of lead.

Prices. The average price of zinc blende, according to Metal and Mineral Markets of April 25, 1940, was $37.49 per short ton.

Occurrence. Sphalerite occurs as a fracture-filling mineral in the Stanley shale and the Arkansas novaculite. It occurs in Polk County in the NE.$\frac{1}{4}$ NE.$\frac{1}{4}$ sec. 25, T. 2 S., R. 28 W., and in sec. 17, T. 1 S., R. 32 W. (See pl. VI.)

Economic importance. The deposits of zinc in Polk County are small and, at present, are of no economic importance.

Production. Not known.

ROCKS AND NON-METALLIC MINERALS

Barite

Composition and properties. Barite is sulphate of barium ($BaSO_4$), containing 58.5 per cent barium. Its density is high for a non-metallic mineral (4.5), and it may be any color when impure. It not infrequently occurs in light shades of blue, yellow, red or brown. Two of the deposits in Polk County are known locally as "stink-rock," and are coarsely crystalline and dark-gray to black in color. The rock is easily broken and gives off a strong "rotten-egg" odor upon being struck sharply.

Uses. Barite is used principally in the manufacture of lithopone which is a white paint pigment, in the manufacture of heavy mud for rotary drilling operations, and in the manufacture of barium chemicals.

Prices. The prices of crude barite ore, per short ton, f.o.b. mines in the United States from 1900 to 1938, are shown in figure 5. These figures were taken from U. S. Bureau of Mines Minerals Yearbooks. The most recent price of crude barite ore, according to Metal and Mineral Markets of April 25, 1940, for 93 per cent $BaSO_4$, was $6.50 per short

ton f.o.b. Missouri mines.

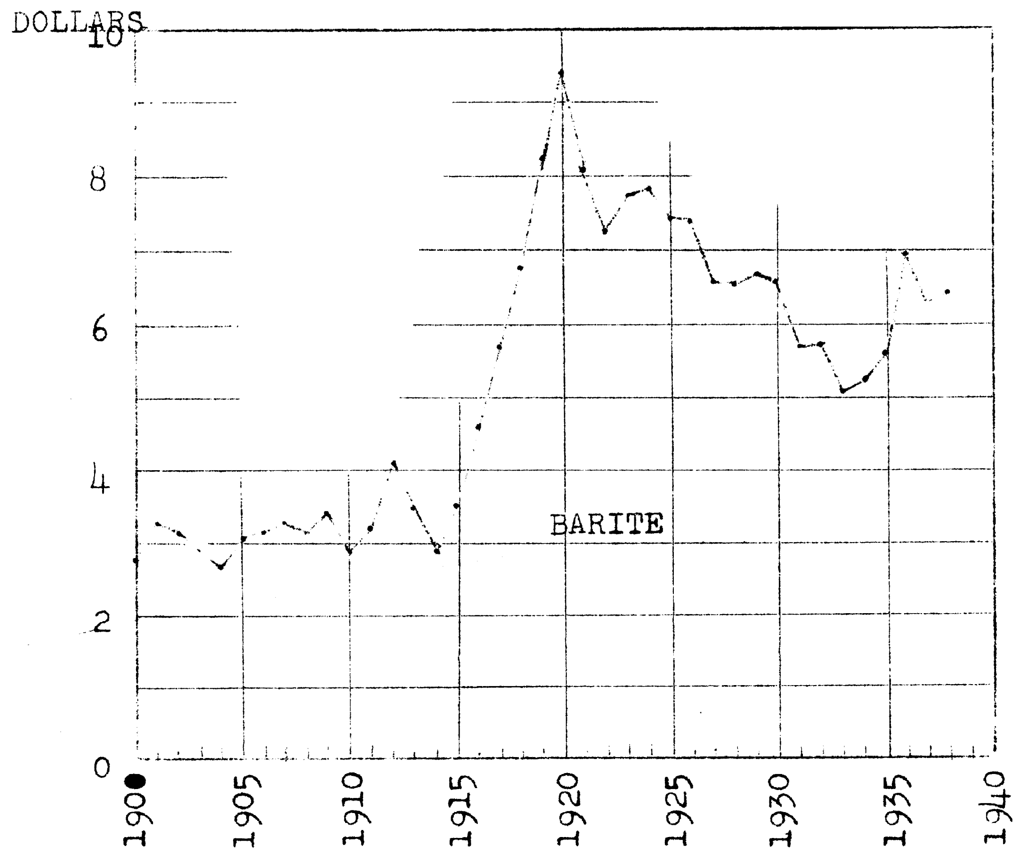


Figure 5. Average price of crude barite ore, per short ton from 1900 to 1938

Occurrence. Barite occurs in the following locations in Polk County (See pl. VII):

Table 6. Occurrence of barite

Map no.	Location S. T. R.	Thickness	Formation
1	11-3S-31W	8 to 14 inches	Missouri Mountain slate
2	15-3S-31W	8 to 14 inches	Missouri Mountain slate
3	22-3S-31W	8 to 14 inches	Missouri Mouhtain slate
4	NE NE 15-3S-31W	In pockets and seams	Arkansas novaculite
5	NE NE 22-3S-31W	In pockets and seams	Arkansas novaculite
6	SE NE 12-3S-31W	-	-

Barite occurs along a northeast-southwest trending line in sections 11, 15, and 22, T. 3 S., R. 31 W. (Nos. 1, 2, and 3.) The barite occurs as a vein from 8 to 14 inches thick in the Missouri Mountain slate. A layer of Arkansas novaculite crops out above the slate. A cut, 6 feet wide in this slate in sec. 22 (No. 3) reveals only one layer of the barite. If similar layers could be found near this one, the deposit might be of enonomic significance.

Small pockets and seams in the Arkansas novaculite have been found to be filled with barite in deposits Nos. 4 and 5. The known occurrences of this type are small and rare, but the mineral is of fairly high purity.

Economic importance. None of the known deposits of barite in Polk County appears to be of sufficient size to merit economic development. It may be that further prospecting will result in the discovery of more barite than as yet has been found.

Production. No Polk County barite has been sold but it is reported that 17.50 tons have been mined, from the following deposits:

Table 7. Production of barite

Map no.	Location S. T. R.	Production short tons
1	11-3S-31W	0.50
2	15-3S-31W	10.00
3	22-3S-31W	7.00
		17.50

Building Stone

Building stone now in use. A survey was made of buildings in Polk County to determine the use of native stone for building purposes. Of the 89 buildings surveyed, 45 are residences, 10 schools, 3 churches, 7 other public buildings, 7 garages and filling stations, 11 store buildings, 3 tourist cottages, and 3 warehouses. All of the exterior building material used was rough field stone gathered near the site of the building. Sandstone was the most common stone used although novaculite and chert were also used.

Approximately half of the buildings were built with solid stone walls, and the others with stone veneer. Some foundations were built of rough stone.

These buildings were constructed between 1919 and 1939. Nearly two-thirds were erected since 1930. More than 90 per cent are in good condition. Cracking and crumbling in some of the buildings is partly due to inferior mortar.

Physical tests, made by the U. S. Bureau of Standards on 3 samples of novaculite from Caddo Gap, about 10 miles east of Polk County, gave the following results:

Compression tests, specimens dry, average of three tests, 44,137 pounds to the square inch. Absorption tests, percentage of absorption by weight, average of three tests, 0.129. Apparent specific gravity, average of three tests, 2.614. Weight of dry stone, 163.4 pounds to the cubic foot.

Polk County slate is also suitable for certain building purposes. (See section on "Slates.")

Occurrence. Building stone suitable for various building purposes occurs in practically unlimited quantities in the Bigfork chert, Blaylock sandstone, Missouri Mountain slate, Arkansas novaculite, Stanley shale, and Jackfork sandstone. The following locations in Polk County are believed to be points at which building stone in considerable quantities may be obtained. (See pl. VIII.)

Table 8. Occurrence of stone

Map no.	Location S. T. R.	Name	Dimensions (feet)	Cu.ft.	Remarks
1	NE SE 31-1N-32W	Ark. Hwy Com., Little Rock	150x25x27	100,000	Sandstone
2	NE SE 31-1N-32W	B. S. Petefish, Mena	-	270,000	Sandstone in ledge
3	SW 2-1S-29W	United States	-	108,000	Sandstone in loose boulders
4	N½ SE 4-1S-30W	United States	200x200x20	800,000	Sandstone
5	Part 6-1S-32W	A. J. Reeder, Mena	1 ac. x 10 ft.	435,000	Semi blue trap rock in ledge and freed stone
6	W½ NW 6-2S-30W	City of Mena	75x10x30	22,000	Blue trap stone in ledge
7	SE SW 2-2S-31W	Mrs. Nelly McWilliams, Acorn	-	-	Stone in solid ledge
8	13-5S-31W	V. O. McCauley, Wickes	-	-	Stone in ledge
9	18-5S-32W	V. O. McCauley, Wickes	-	-	Stone in ledge

Production. It is assumed that there are about 149,175 cubic feet of stone in the 89 buildings referred to, which were surveyed. If the value of this stone is assumed to be approximately the same as that of building brick (92.59 cents per cubic foot), the total value of the stone used would be $138,125. The folowing table shows the estimated amount and value of the stone used in the 89 buildings:

Table 9. Amount and value of bldg. stone used in 89 buildings

Type of building	No.	Total cu. ft.	Average cu. ft.	Average value	Total value
Residences	45	54,675	1,215	$1,125	$50,625
Schools	10	31,050	3,105	2,875	28,750
Churches	3	12,150	4,050	3,750	11,250
Other public buildings	7	12,285	1,755	1,625	11,375
Garages and filling stations	7	10,395	1,485	1,375	9,625
Store buildings	11	23,760	2,160	2,000	22,000
Tourist cottages	3	2,835	945	875	2,625
Warehouse	3	2,025	675	625	1,875
	89	149,175			$138,125

Sandstone from a quarry on State Highway 88, 5 miles west of Mena, was used in the construction of the Mena Armory and several residences at Mena. Considerable stone from the quarry has been used as rip rap along State Highway 88, and some has been produced and crushed for concrete aggregate.

During 1938, about 150 carloads of loose stone, gathered along the Kansas City Southern Railway from north of Mena to Grannis, were shipped to Shreveport, La., and used as rip rap.

Clay

Composition and properties. Clay is a term applied to earthy materials that become plastic or semi-plastic when wet with water. Clays are given many classifications in accordance with their utility.

Uses. Preliminary tests indicate that certain clays of Polk County can be used in the manufacture of stoneware, ovenware, and heavy clay products such as brick, tile, and sewerpipe. A type of light-gray gumbo, known locally as "crawfish land," is used in the constructions of chimneys.

Prices. The value of clay varies widely in accordance with its utility. Following are average prices per short ton, f.o.b. mines in the United States, for 1935 to 1938, according to U. S. Bureau of Mines Minerals Yearbook:

Table 10. Average prices of clay, per short ton

Year	Kaolin	Fire and stoneware	Brick and sewer pipe
1935	$7.19	$2.64	$1.75
1936	7.10	2.48	1.29
1937	7.31	2.58	1.28
1938	7.97	2.78	2.21

Occurrence. Clay of definite utility is known to occur in several localities in Polk County. Samples of clay from 21 localities were collected by the State Mineral Survey. Superficial tests were made of some of these clays for plasticity and opinion concerning possible commercial value. The localities from which the samples were collected and the results of the tests are shown in Table 11. (See pl. VII.)

Table 11. Locations and tests of clay samples

Map no.	Location S. T. R.	Color	Character	Utilization
1	NE SE 10-1S-30W	Dark gray to black	-	Heavy clay products
2	NE SE 1-1S-32W	-	-	
3	SW SW 2-2S-28W	Tan	Hard, shaly. Will develop plasticity with weathering and grinding	Heavy clay products
4	SE NE 21-2S-28W	Tan	Hard, shaly. Will develop plasticity with weathering and grinding	Heavy clay products
5	1-2S-29W	-	Brittle, slaty. Will require excessive weathering & grinding	Heavy clay products
6	NW NE 7-2S-29W	Grayish tan	Plastic, shaly	Heavy clay products
7	SE SW 8-2S-29W	Grayish tan	Plastic, shaly	Heavy clay products
8	22-2S-29W	Grayish tan	Plastic, shaly	Heavy clay products
9	SW NW 3-2S-30W	Tan	Plastic, shaly	Heavy clay products
10	7-2S-30W	Tan	Plastic, shaly	Heavy clay products
11	NW 27-2S-31W	Gray	Soft, plastic	Stoneware & ovenware
12	NW NW 29-4S-28W	-	Kaolin-like	-
13	SW SE 1-4S-29W	-	-	-
14	SE NW 26-4S-32W	-	-	-
15	35-4S-32W	Light gray to mottled	Soft, plastic	Stoneware & ovenware
			-	-
16	SW SW 20-5S-31W	-	-	-
17	NE SE 21-5S-31W	-	-	-
18	NE NW 29-5S-31W	-	-	-
19	NW SE 31-5S-31W	-	-	-
20	NW NW 32-5S-31W	-	-	-
21	SW SW 32-5S-31W	-	-	-

Production. According to U. S. Geological Survey Bulletin 351, "The Clays of Arkansas," by J. C. Branner, 1908, common bricks were made by the Mena Brick Company at its plant 2 miles southwest of Mena from a thin bed of residual clay overlying shale. About 4,000 bricks were made daily. Another plant, belonging to the same company, was located $1\frac{1}{2}$ miles from Mena.

Novaculite

Composition and properties. The novaculite of Polk County occurs in the Arkansas novaculite formation. It occurs in two types, the Arkansas stone which, on broken surfaces, is smooth to the touch, compact and hard, and the Ouachita stone which, on broken surfaces, is rough to the touch and porous. The stone is usually white but varies in color from pink and light-gray to black. The hard variety closely resembles chert (flint).

The following table gives the chemical analyses of six samples of novaculite found near Hot Springs, Garland County, and the locations from which they were taken. These analyses are believed to be representative of the Polk County novaculite, as this type of rock does not vary much in composition throughout the Novaculite Uplift of central Arkansas.

Table 12. Analyses of Arkansas novaculite

	1	2	3	4	5	6
Silica (SiO_2)	99.45	99.47	99.49	99.06	99.12	99.635a/
Alumina (Al_2O_3)	(.26	.17	.13	.30	.48	.113
Iron (Fe)	(	.12	.06	.06	.02	Trace
Lime ($CaCO_3$)	.12	.09	.04	.09	.12	-
Magnesia (MgO)	Trace b/	.05	.08	.13	.06	.087
Potash (K_2O)	.19	.07	.16	.13	.14	Trace
Soda (Na_2O)	.54	.15	.10	.13	.24	.165
Loss on ignition	.06	.12	.14	.08	.22	-
	100.62	100.24	100.20	99.98	100.40	100.000

a/ By difference.
b/ Very slight
1/ "White novaculite." Hot Springs, Ark.
2/ "Gray Arkansas stone." Rockport, 2 miles northwest of Malvern, Ark.
3/ "Fine Ouachita." Sutton's quarry No. 6 on Indian Mountain.
4/ "Ouachita." Barnes big quarry on Indian Mountain.
5/ "White Ouachita stone." Ten Mile Quarry, 8 to 10 miles east of Hot Springs, Ark.
6/ "White novaculite." Hot Springs, Ark.
1-5 Analyst, R. N. Bracket. From Arkansas Geol. Survey Ann. Rept. for 1890, Vol. III, "Whetstones and the Novaculites of Arkansas," by L. S. Griswold, 1892, p. 161.
6 Analyst, C. E. Wait. From American Jour. Sci., 3rd ser., vol. 7, 1874, p. 520.

Uses and economic importance. Probably the best known commercial use of the novaculite has been for oilstones. Novaculite is quarried in Garland County for this purpose, but to date none of the Polk County novaculites has been used for oilstones. Novaculite has also been used in considerable quantities as railroad ballast and, to a minor extent, for road material and building stone. These uses are discussed under their respective headings. Worn novaculite pebbles are sometimes used in tube mills. The pebbles in greatest demand range from 2 to 4 inches in diameter. Pebbles of the required size and shape occur in the beds of the larger streams flowing through the Novaculite Uplift in Polk County.

Occurrence. The novaculite in Polk County occurs in the massive beds which make up the Arkansas novaculite formation, which is extensively exposed over much of the eastern part of the county. (See pl. III.)

Production. No figures available.

Road Materials

It is possible to use any sort of hard, durable rock of the right size and of sufficient quantity for road material. Gravels which contain much chert and novaculite, with some clay as a "binder," are used more than any other road material in the Ouachita Mountains.

Occurrence. Polk County is well supplied with road materials that can be used for both road foundations and surfaces. (See table 13.)

Alluvial gravel deposits are abundant in the Novaculite Uplift region, and are so distributed that long hauls are unnecessary for road building. Some of these deposits have been opened and the gravel used on the roads in the Ouachita National Forest. These alluvial deposits are located on Plate VIII.

Table 13. Gravel deposits

Map no.	Location S. T. R.	Dimensions of deposit	Est. cu.yds.	Components	Size of components	Remarks
1	28-1S-29W	870x270x6	52,200	Boulders and dirt		River gravel used
2	(SW NW 13-2S-28W (SE NE 14-2S-28W	-	130,000	-	40% oversize	[illegible] by WPA
3	(SW SW 15-2S-28W (SE SE 16-2S-28W	-	96,000	-	60% fine, 40% coarse	River gravel
4	Cen 16-2S-28W	-	312,000	-	60% fine, 40% coarse	River gravel
5	SE SW 16-2S-28W	-	88,000	-	60% fine, 40% coarse	River gravel
6	16-2S-28W	400x300x5	220,000	80% novaculite, 10% shale, 10% sandstone	-	Gravel bar. Used in constructing State Hwy. 270, and local county and WPA roads
7	N½ NE 22-2S-28W	-	175,000	-	60% fine, 40% coarse	River gravel
8	SW SE 28-2S-28W	500x100x6	10,000	-	60% 2" mesh	River gravel
9	NW NW 28-2S-28W	500x150x7	20,000	-	60% 2" mesh	River gravel
10	SW NW 34-2S-28W	300x100x7	8,000	-	60% small	-
11	NE SW 15-2S-29W	700x200x10	50,000	-	-	-
12	SW SE 16-2S-29W	500x150x7	20,000	-	-	-
13	(SW SE 18-2S-29W (NW NE 19-2S-29W	-	50,000	-	-	Near unimproved road
14	NW SE 21-2S-29W	300x50x8	4,000	-	-	-
15	NE NW 22-2S-29W	400x150x7	15,000	-	-	-
16	Cen 26-2S-29W	500x150x7	20,000	-	-	-
17	Cen S½ 26-2S-29W	300x20x4	1,000	-	-	-
18	W½ NE 28-2S-29W	-	15,000	-	-	-
19	SE SW 28-2S-29W	-	14,000	-	-	-
20	SW NE 33-2S-29W	-	9,000	-	-	-
21	Cen S½ 35-2S-29W	-	20,000	-	-	Three deposits.
22	NW SE 26-2S-30W	-	80,000	-	30% oversize	-
23	27-2S-30W	-	-	-	-	Creek gravel
24	SW SW 5-3S-28W	100x20x30	2,[illegible]	-	-	Creek gravel
25	(SW NW 5-3S-28W SE NE 6-3S-28W	1200x50x50	111,000	Gray novaculite with small % hard slate and [illegible]	Fine to coarse Small oversize	Several pits Polk County getting its rd. gravel from [illegible]

Table 13. Gravel Deposits (cont'd.)

Map no.	Location S. T. R.	Dimensions	Est. cu. yds.	Components	Size of components	Remarks
26	NW NW 10-3S-28W	-	1,500	-	15% oversize	Creek gravel.
27	NW SW 26-3S-28W	-	10,000	Brecciated novaculite, Big Fork chert and 10% shale	95% 2" mesh	1,000 yds. have been taken from this pit.
28	NW SE 6-3S-29W	200x40x6	2,000	60% novaculite, 40% sandstone	100% 1/6" mesh	Creek gravel.
29	NW NW 7-3S-29W	200x40x6	2,000	40% novaculite, 40% sandstone 20% shale	60% 2" mesh 40% oversize	-
30	NW NE 8-3S-29W	Small mtn.	-	Brecciated novaculite	60% 4" mesh 40% 6" mesh	-
31	NW SW 9-3S-29W	-	350	50% novaculite, 35% sandstone, 15% shale	75% 2" mesh	-
32	SE NW 34-3S-29W	226x20x5	1,000	Hard novaculite	80% 2" mesh 20% oversize	Rounded creek gravel
33	NE SE 34-3S-29W	50x25x5	200	-	80% 2" mesh 20% oversize	Rounded creek gravel
34	W½ NE 5-3S-30W	300x200x6½	15,000	Chert	16% uniform gradation	-
35	S½ 9-3S-30W	600x100x6	13,000	Broken novaculite	Non-uniform	-
36	S½ 10-3S-30W	600x100x6	13,000	Broken novaculite	Non-uniform	-
37	Cen NW 10-3S-30W	-	9,000	Vari-colored novaculite	-	On north side Hwy. 45
38	NE NE 10-3S-30W	-	280,000	Finely brecciated novaculite	-	-
39	NE NW 11-3S-30W	-	1,500	Hard, flinty novaculite	50% 2" mesh 30% 4" mesh 20% 5" mesh	-
40	NE SW 12-3S-30W	-	500	Hard, flinty novaculite	80% 2" mesh 20% large bldrs	-
41	SW SE 12-3S-30W	-	3,000	Novaculite	40% 2" mesh 60% 4" mesh	On mountainside
42	E½ NE 15-3S-30W	-	75,000	Brecciated novaculite	80% 2" mesh 20% 4" mesh	On east side of mtn.

Table 13. Gravel deposits (Contd.)

Map no.	Location S. T. R.	Dimensions of deposit	Est. cu. yds	Components	Size of components	Remarks
43	Cen NW 19-3S-30W	-	-	Novaculite	90% 2" mesh	With manganese stains
44	SE NW 19-3S-30W	-	75,000	Blue, white, & Black	95% 2" mesh	-
45	SW SW 22-3S-30W	-	1,000	Vari-colored brec-ciated novaculite	80% 2" mesh 20% 4" mesh	-
46	SW SW 6-3S-31W	-	2,500	-	- -	-
47	NW NE 7-3S-31W	300x300x4	13,000	Quartz, chert & SS	-	Clay gravel
48	NE NE 7-3S-31W	-	40,000	-	-	-
49	NE NW 7-3S-31W	-	10,000	-	Fine to crse	-
50	$N\frac{1}{2}$ 8-3S-31W	7920x300x8	704,000	85% novaculite, 5% slate, 10% Sandstone	- -	Gravel bar. Used in construction US Hwy 71
51	SE SE 8-3S-31W	-	60,000	-	-	Creek gravel
52	SW NW 8-3S-31W	-	-	-	-	Clay gravel
53	($S\frac{1}{2}$ NW 8-3S-31W ($S\frac{1}{2}$ NE 8-3S-31W	150x100x4	2,000	Clay gravel, quartz and sandstone	-	-
54	NW NE 23-3S-31W	-	25,000	Massive black and vari-colored nova-culite	- -	Near U.S. Forest Road Road ballast or con-crete work
55	NW SE 24-3S-31W	Pit about 10 ft. deep	10,000	Vari-colored nova-culite	90% 2" mesh	At foot of hill. US Forest Service has taken about 175 yds. from pit.
56	SW NW 30-3S-31W	-	1,200	Washed gravel, nova-culite, shale & SS	Some oversize	-
57	SE NW 30-3S-31W	-	1,200	Washed gravel, nova-culite, shale & SS	Some oversize	-
58	NW NE 2-3S-32W	-	1,050	Good grade	Few oversize	On Two Mile Creek. An-other deposit where creek enters mt. fork
59	Pt. 27-3S-32W	-	-	-	-	-
60	SE NW 18-4S-29W	-	5,000	Hard, flinty, brec-ciated novaculite	60% 2" mesh 50% oversize	-

Table 13. Gravel deposits (cont.)

Map no.	Location S. T. R.	Dimensions of deposit	Est. cu.yds.	Components	Size of components	Remarks
61	SE SE 1-4S-30W	-	1,500	Novaculite and sandstone	70% 2" mesh 20% 4" mesh 10% oversize	River gravel
62	(W½ SW 3-4S-30W (E½ SE 4-4S-30W	350 acres x 6 feet.	3,400,000	Brecciated novaculite	80% 2" mesh 16% 4" mesh	-
63	NW NW 4-4S-30W	-	1,000	-	-	-
64	SE SE 6-4S-30W	-	5,000	-	Oversize	Rounded creek gravel. Gravel bar. Used to surface WPA road bet. Athens and Vandervoort
65	SE 10-4S-30W	10 acres x 6 feet	96,800	80% novaculite, 10% sandstone	-	
66	NW NE 21-4S-30W	-	1,000	Novaculite and SS	60% 2" mesh 20% 4" mesh 20% oversize	-
67	NW NW 21-4S-30W	-	800	-	-	-
68	SE NE 21-4S-30W	-	110	-	-	-
69	SW NW 29-4S-30W	Pit 8 ft. deep	100,000	Novaculite and sandstone	85% 2" mesh	On east bank of Cossatot River approx. 10,000 yds. taken for Vandervoort-Hartley WPA rd. Good gravel rd from pit to Hartley rd
70	NW NW 29-4S-30W	570x180x6	23,000	-	-	-
71	SE NE 30-4S-30W	-	2,000	Novaculite and sandstone	80% 2" mesh	River gravel. West bank of Cossatot R.
72	28-4S-32W	-	-	-	-	-
73	(SW SW 19-5S-31W	450x150x4½	11,000	-	-	Loose gravel
74	(23-5S-32W (24-5S-32W	-	-	-	-	-

Gravel from Deposit 6 was used in the construction of State Highway 88, U. S. Highway 270, and local county and WPA roads.

Gravel has been taken from Deposit 50 since 1935 for the construction of U. S. Highway 71. It was used for both road foundations and surfaces and as aggregate in the concrete which went into the bridges and culverts. At present (March, 1940) this gravel is being used as a concrete aggregate for pavement in Mena.

The WPA road between Athens and Vandervoort was surfaced with gravel from Deposits 65. This gravel was used without screening or crushing, but care was taken in loading to eliminate excessive "oversize."

Table 14 shows screen analyses of gravels from the three deposits referred to.

Table 14. Screen analyses of gravel

Screen inch	Percentage retained on screen			Percentage passing screen		
	Deposit 6	Deposit 50	Deposit 65	Deposit 6	Deposit 50	Deposit 65
2	8.8	10.0	3.0	91.2	90.0	97.0
$1\frac{1}{2}$	5.0	8.5	13.8	86.2	81.5	83.2
1	21.3	11.6	21.6	64.9	69.9	61.6
3/4	7.0	6.9	26.1	57.9	63.0	35.5
1/2	23.1	19.3	13.8	34.8	43.7	21.7
No. 4	13.1	13.4	15.3	21.7	30.0	6.4

Deposit 6: sec. 16, T. 2 S., R. 28 W.
Deposit 50: sec. 8, T. 3 S., R. 31 W.
Deposit 65: sec. 19, T. 4 S., R. 30 W.

Hard, dark-gray sandstone, which occurs in the Stanley shale, has been quarried extensively at Cove, and crushed for ballasting the Kansas City Southern Railway.

Chert and novaculite often occur in quantities as talus at the base of the hills below outcrops of these rocks. Ordinarily, the chert is more finely fractured than the novaculite and produces material which is more evenly sized. When chert is used on roads the traffic usually pulverizes and compacts it into firm roadbeds and it is therefore preferred to the novaculite. Large deposits of chert and novaculite gravel have been formed by the streams that flow through the Novaculite Uplift.

Production of gravel. Gravel is the chief road material produced in Polk County. Table 15 shows gravel production statistics for 1930 through 1939, with the exception of 1932, 1933, and 1937, according to severance tax reports.

Table 15. Production and value of gravel

Year	Production cu. yds.	Value
1930	2,398.00	$ 1,978.35
1931	10,551.00	12,186.40
1934	282.00	198.81
1935	5,898.40	4,158.37
1936	11,938.70	8,416.78
1938	7,551.00	5,315.90
1939	52,961.20	42,104.16
	91,580.30	$74,358.77

The producers of gravel in Polk County, together with their individual production and years, according to severance tax reports, are given in Table 16.

Table 16. Producers of gravel

Map no.	Producer		Year	Production cu. yds.	Value
-	Felts Estate	Wickes	1930	529.00	$ 436.43
59	Fraker, G.T.	Hatfield	1931	1,875.00	2,165.62
23	Garr, Mrs. W.A.	Mena	1934 & 1938	342.00	241.05
2	Griffith, D.P.	Vandervoort	1930 & 1936	1,900.00	1,396.74
52	Henson, J.A.	Mena	1936	1,728.40	1,218.52
1	Holmes, Mrs. S.R.	Mena	1939	19,268.00	15,318.06
7	Holmes, J.W.	Hatfield	1930, 1935, 1936, 1938, 1939	43,771.30	35,019.20
53	Huddleston, Mrs. A.	Mena	1936 & 1939	10,802.60	8,274.09
70	Lein, F.J.	Vandervoort	1939	2,000.00	1,590.00
5	McBee, J.M.	Big Fork	1938 & 1939	1,415.00	1,067.05
73	McCauley, Henry	Wickes	1935 & 1939	1,862.00	1,476.69
-	Petefish, B.S.	Mena	1931	3,676.00	4,245.78
-	Rowe, O.B.	Hatfield	1938 & 1939	234.00	178.47
-	Salyers, Whit	Mena	1938 & 1939	585.00	4 441.87
-	Tate, Roy	Mena	1938	200.00	140.80
-	Williamson, J.T.	Mena	1930	1,392.00	1,148.40
				91,580.30	$74,358.77

Slate

Composition and properties. Slate may be defined as a fine-grained rock which has been derived from clays and shales and possesses cleavage, which permits it to be split easily into thin sheets. As to color, slate may be black, purple, red, or green. 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 (Fe_2O_3) and chlorite, red slate to the presence of iron oxide, and green slate probably to the presence of a large amount of chlorite.

Many of the slates of Polk County are sufficiently hard to ring when struck with a hammer (sonorous). This property is used as a rough index of the hardness and soundness of the slate. Polk County slate of good quality usually splits easily but it may be so badly fractured that large pieces cannot be quarried.

Harmful impurities, such as pyrite, hematite, and limonite, not infrequently occur in small quantities. Calcium carbonate is usually absent.

Red, green, black, buff, and mottled slates are found in Polk County. Physical tests show that color differences do not affect the strength of the slates.

Uses. At the present time, Polk County slates are used for the manufacture of roofing granules, which are used quite extensively for surfacing prepared roofing, and for slate "flour", which is employed as a filler in roofing mastic, linoleum, and other products.

Prices. Roofing slate is generally sold by the "square" (100 square feet). Slate granules and "flour" are sold by the short ton. The average price of roofing slate in the United States in 1938 was $6.98 per square. The average price of granules and flour in the United States in 1938 was $7.13 per short ton, according to U.S. Bureau of Mines Minerals Yearbooks.

Occurrence. Four of the formations exposed in Polk County are in part made up of slate. These are the Womble, Polk Creek and Stanley shales, and the Missouri Mountain slate. Slate occurs sparingly in the first two formations, and the quality is commonly poor. Better quality slate occurs through the whole section of the Missouri Mountain formation and in the lower 150 feet of the Stanley shale. The greater part of this slate occurs in the central and southeastern part of the county.

The occurrences of slate in Polk County are listed in Table 17 and shown on pl. VII. Tables 18, 19, and 20 show chemical analyses, transverse and absorption tests, and physical tests, respectively, of 9 specimens of slate from Polk County, made by the U. S. Geological Survey, according to Arkansas Geological Survey Report for 1909, "The Slates of Arkansas," by A.H. Purdue.

Quarrying. The Lehrack slate quarry, which is working deposit No. 33, in the SW$\frac{1}{4}$ sec. 24, T. 3 S., R. 29 W., is an open pit in the Missouri Mountain slate. The slate at that point has a thickness of about 75 feet. The quarry is "T" shaped; the stem of the "T" is 125 feet long and 35 feet wide, and the top of the "T" is 200 feet long and 102 feet wide. The main pit is about 35 feet deep. The quarry is operated on two levels, the lower being approached through a tunnel 138 feet long, 12 feet high, and 12 feet wide.

The slate is blasted free in the quarry and is split and loaded on trucks by hand. The slate from the lower level is removed through the tunnel, and from the upper level by means of a road directly serving the main pit. The trimming and grinding are done in a plant near the quarry.

The slate is crushed and sized into two products, granules and "flour." Red and green granules are artificially colored. Black granules are treated with paraffin oil to intensify the black shade..

Previous to 1930, this slate was made into shingles and tops for billiard tables, but, since that time, has been used for manufacturing granules and "flour" as a filler in composition roofing.

The cost of quarrying and crushing is $1.00 a ton and for hauling and loading at a railroad shipping point (Mena) $1.15 a ton, making a total cost, f.o.b. Mena, of $2.15 a ton.

Table 17. Occurrance of slate

Map no.	Location S. T. R.	Name	Formation	Color	Remarks
1	SW 24-3S-29W	M. J. Harrington	-	Black	-
2	SW 24-3S-29W	M. J. Harrington	-	Black	-
3	SW 24-3S-29W	M. W. Jones	-	Green	-
4	SW 24-3S-29W	M. W. Jones	-	Green	-
5	SW 24-3S-29W	M. W. Jones	-	Red	-
6	SW 24-3S-29W	M. W. Jones	-	Red	-
7	SW 24-3S-29W	M. W. Jones	-	Red	-
8	SW 24-3S-29W	M. W. Jones	-	Reddish brown	-
9	NE 18-3S-28W	C. B. Baker	-	Buff	-
10	32-3S-28W	American Slate Co.	Stanley shale	Gray	Can be split into thick or thin sheets Large peices cannot be obtained.
11	NE 32-3S-28W	Unknown	"	-	Should be prospected.
12	NE NW 32-3S-28W	Unknown	"	Black	Sonorous. Slabs large enough for shingles.
13	32-3S-28W	Unknown	"	Gray	Too soft for shingles
14	NE SW 28-3S-28W	Danville prop.	"	Dk. gray	Highly sonorous. Useful for shingles
15	29-3S-28W	Danville prop.	"	Gray	Sonorous. Worthy of prospecting
16	NE 30-3S-28W	Unknown	"	Gray	Sonorous. Uneven surface
17	S½ 35-3S-29W	Whisenhunt	"	Gray	Suitable for roofing slate.
18	S½ 35-3S-29W	Whisenhunt	"	Black	Splits easily into pieces ¼ to 1 inch
19	NW NW 7-3S-29W	Unknown	"	Dk. gray	Closely jointed.
20	SE NW 7-3S-29W	Harrison prop.	"	Gray	Sonorous. Suitable for roofing slate
21	NW SW 7-3S-29W	Unknown	Ark. novac.	Dark	Prospecting not advised.
22	SE 8-3S-29W	Unknown	-	-	Large blocks can be quarried.
23	NW 20-3S-29W	Boyer property	-	Red	Fine quality
24	SW NW 20-3S-29W	Unknown	Stanley shale	-	Cracks too closely spaced
25	SE SW 20-3S-29W	Spencer-Kelly property	-	Red	Small blocks superior quality can be quarried
26	N½ SE 12-3S-29W	Gulf Slate Co.	-	-	Fine looking blocks on dump.
27	11-3S-29W	Atlas Slate Co.	-	Red & green	Non-sonorous. Small blocks available
28	11-3S-29W	Standard Slate Co.	-	Red	Non-sonorous. Suitable for milling slate if cracking can be checked
29	NE 15-3S-29W	Andrews & Harrington	-	Black	Excellent quality would justify further prospecting

Table 17. Occurrence of slate (cont)

Map no.	Location S. T. R.	Name	Formation	Color	Remarks
30	S½ SE 24-3S-29W	Unknown	Stanley shale	Black & gray	Sonorous, easily split into slabs
31	NW NW 25-3S-29W	Unknown	Stanley shale	Black & gray	High quality. Slabs can be quarried
32	NE NE 25-3S-29W	Brannon prop.	-	Black & gray	Sonorous. Splits easily and appears to withstand weathering.
33	SW 24-3S-29W	South Wales Slate Co.	-	Red &	Splits into blocks 2 ft. square and ¼ inch thick.
34	SW SW 22-3S-29W	Unknown	Stanley shale	Black to gray & red	-
35	NE SE 13-3S-30W	Unknown	-	Green, brown, yellowish br. and red	Slabs large enough for shingles have been left at quarry for two years without weathering or cracking.
36	SE NE 11-4S-30W	Unknown	-	Red	-
37	SE NW 8-3S-28W	Unknown	-	Green	-
38	NW NE 20-3S-28W	Unknown	-	Buff	-
39	NE NW 20-3S-28W	Unknown	-	Green	-
40	SE SE 19-3S-28W	Unknown	-	Red	-
41	SW SW 11-1S-30W	Unknown	-	-	-
42	SW NE 15-1S-30W	Unknown	-	-	-
43	SE NW 29-1S-32W	Unknown	-	-	-
44	SW SE 8-3S-28W	Unknown	-	-	-
45	SE SE 34-3S-28W	Unknown	-	-	-
46	SE SE 33-3S-29W	Unknown	-	-	-

Information concerning Nos. 1 to 35 from Arkansas Geological Survey Report for 1909, "The Slates of Arkansas," A. H. Purdue.
Information concerning Nos. 36 to 46 from State Mineral Survey

Table 18. Chemical analyses of slate

Map No.	Location S.T.R.	Silica	Alumina	Iron	Manganese oxide	Lime	Magnesia b/	Sulphuric anhydrite	Ferrous oxide	Sodium oxide	Potassium oxide	Water at 100° C.	Ignition loss	Total
1	SW 24-3S-29W	68.90	14.03	a/	.02	.37	1.11	.56	4.65	.05	2.14	.66	7.69	100.18
2	SW 24-3S-29W	69.76	14.16	a/	.04	.38	1.32	.07	4.58	.13	1.94	.54	7.44	100.36
3	SW 24-3S-29W	52.50	26.31	3.98	.11	.28	2.27	.22	5.34	.04	3.32	.47	5.33	100.17
4	SW 24-3S-29W	55.71	25.20	2.46	.11	.26	1.74	Tr.	3.97	.22	4.51	.53	5.13	99.84
5) 6) 7)	SW 24-3S-29W	53.23	26.29	3.81	.06	.31	1.87	Tr.	4.21	Tr.	3.58	.59	5.82	99.77
8	SW 24-3S-29W	52.35	26.16	5.81	.10	.29	2.29	Tr.	3.16	.16	3.82	.37	5.19	99.90
9	NE 18-3S-28W	52.79	24.96	6.27	.06	.28	1.69	Tr.	3.81	.03	3.52	.72	5.79	99.92
10	SE NE 11-4S-30W	71.89	-	18.74	-	-	6.59	-	-	-	-	-	4.09	100.29
11	SE NW 8-3S-28W	81.13	-	12.30	-	.28	2.36	-	-	-	-	-	3.90	99.97
12	NW NE 20-3S-28W	78.43	-	14.05	-	1.67	2.05	-	-	-	-	-	3.70	99.87
13	NE NW 20-3S-28W	79.11	-	13.17	-	.08	2.36	-	-	-	-	-	3.40	98.12
14	SE SE 19-3S-28W	80.30	-	12.73	-	.05	2.13	-	-	-	-	-	3.10	98.31

a/ Owing to the large amount of volatile organic material, it is impossible to determine the ferrous oxide. Consequently, all iron has been assumed as being present in the lowest state and calculated as such.
b/ Figures for samples Nos. 10 to 14 are $MgCO_3$.
Analyses of Nos. 1 to 9 from Arkansas Geological Survey Report for 1909, "The Slates of Arkansas," by A.H. Purdue, p. 65.
Analyses of Nos. 10 to 14 by State Mineral Survey.

Table 19. Transverse and absorption tests of slate

Map no.	Specimen no.	Dimensions: Width (in.)	Dimensions: Depth (in.)	Span. (in.)	Transverse tests: Conditions at Max. load: Load center (lbs.)	Transverse tests: Conditions at Max. load: Deflection center (lbs.)	Transverse tests: Conditions at Max. load: Modulus of rupture (lbs. per sq. in.)	Transverse tests: Modulus of elasticity (constant up to nearly maximum)	Absorption tests: Weight ratio of absorp.: 30 min.	Absorption tests: Weight ratio of absorp.: 24 hours	Absorption tests: Weight ratio of absorp.: 48 hours	Absorption tests: Volume ratio of absorp.: 30 min.	Absorption tests: Volume ratio of absorp.: 24 hours	Absorption tests: Volume ratio of absorp.: 48 hours
	1	1.98	0.28	12	59	.0430	6,840	13,420,000	.0037	.0160	.0189	.0094	.0409	.0481
1	2	1.95	0.26	do.	56	.0790	7,640	8,820,000	.0012	.0114	.0146	.0031	.0293	.0375
	3	2.05	0.27	do.	80	.0855	9,640	11,030,000	.0041	.0167	.0201	.0105	.0425	.0512
	Av.	-	-	-	-	-	8,040	11,090,000	.0030	.0147	.0179	.0077	.0376	.0456
	1	1.94	0.85	12	210	-	2,700	2,900,000	.0023	.0120	.0157	.0058	.0305	.0402
2	2	2.04	0.77	do.	279	.0405	4,150	3,150,000	.0033	.0153	.0193	.0083	.0390	.0491
	3	1.94	0.78	do.	388	.0335	5,920	6,010,000	.0024	.0121	.0156	.0062	.0309	.0397
	Av.	-	-	-	-	-	4,260	4,020,000	.0027	.0131	.0169	.0068	.0335	.0430
	1	2.04	1.09	12	400	.0252	2,970	2,620,000	.0014	.0076	.0114	.0040	.0210	.0314
3	2	2.03	1.02	do.	318	.0134	2,710	4,810,000	.0010	.0081	.0093	.0027	.0225	.0257
	3	2.03	1.01	do.	791	.0233	6,880	6,920,000	.0015	.0080	.0093	.0041	.0221	.0257
	Av.	-	-	-	-	-	4,190	4,780,000	.0013	.0079	.0100	.0036	.0219	.0276
	1	2.03	0.24	12	35	.0660	5,390	9,240,000	.0010	.0089	.0109	.0028	.0243	.0300
4	2	2.07	0.23	do.	57	-	9,370	10,290,000	.0013	.0089	.0107	-	-	-
	3	1.96	0.24	do.	40	.0740	6,380	8,060,000	.0011	.0090	.0113	.0029	.0246	.0310
	Av.	-	-	-	-	-	7,050	9,200,000	.0011	.0089	.0110	.0029	.0245	.0305
	1	1.94	0.15	7	20	.0265	4,810	9,820,000	.0016	.0094	.0101	.0045	.0263	.0283
5	2	2.04	0.17	do.	36	.0330	6,410	9,410,000	.0010	.0081	.0096	.0028	.0227	.0272
	3	2.02	0.17	do.	32	.0250	5,760	15,810,000	.0010	.0089	.0098	.0027	.0252	.0279
	Av.	-	-	-	-	-	5,660	11,680,000	.0012	.0088	.0098	.0033	.0247	.0278
	1	1.99	0.12	7	9.75	.0430	3,570	5,730,000	.0088	.0251	-	-	-	-

Table 19. Transverse and absorption tests of slate (Contd.)

Map no.	Specimen no.	Dimensions: Width (in.)	Dimensions: Depth (in.)	Span. (in.)	Transverse Tests: Conditions at max. load: Load center (lb.)	Deflection center	Modulus of rupture (lbs. per sq. in.)	Modulus of elasticity (constant up to nearly max)	Absorption tests: Weight ratio of absorp.: 30 min.	24 hours	48 hours	Volume ratio of absorp.: 30 min.	24 hours	48 hours
6	2	1.93	0.13	do.	8	.0378	2,570	4,250,000	.0072	.0257	.0257	.0194	.0689	.0689
	3	1.97	0.14	do.	18	.0440	4,890	6,340,000	.0067	.0251	.0253	.0180	.0672	.0677
	Av.	-	-	-	-	-	3,680	5,440,000	.0076	.0253	.0255	.0187	.0681	.0683
	1	2.03	0.15	6	20	.0440	3,940	3,550,000	.0046	.0228	.0229	.0124	.0613	.0617
7	2	2.00	0.16	do.	20	.0300	3,520	4,420,000	.0062	.0243	.0243	.0167	.0652	.0652
	3	1.93	0.18	do.	24	.0180	3,450	6,480,000	.0061	.0241	.0244	.0163	.0640	.0648
	Av.	-	-	-	-	-	3,640	4,820,000	.0056	.0237	.0239	.0151	.0635	.0639
	1	1.99	0.17	7	48	.0317	8,760	13,150,000	.0010	.0073	.0088	.0029	.0203	.0244
8	2	2.00	0.14	do.	47	.0358	12,590	19,530,000	.0010	.0081	.0091	.0029	.0227	.0256
	3	2.00	0.22	4	120	-	7,440	-	.0009	.0082	.0091	.0026	.0229	.0255
	Av.	-	-	-	-	-	9,600	16,340,000	.0010	.0079	.0090	.0028	.0220	.0252
	1	1.97	0.53	9	139	.0181	3,390	4,720,000	.0183	.0410	.0410	.0467	.1045	.1045
9	2	1.94	0.51	do.	155	.0181	4,150	6,090,000	.0185	.0402	.0404	.0471	.1023	.1029
	3	1.93	0.52	do.	140	.0206	3,620	4,500,000	.0084	.0365	.0365	.0216	.0941	.0941
	Av.						3,720	5,100,000	.0151	.0392	.0392	.0385	.1003	.1005

Table 20. Physical tests of slate

Map no.	Spec. no.	Specific gravity a/ True	Specific gravity a/ Apparent	Absolute porosity $1 - \frac{A.S.G.}{T.S.G.}$	Weight per cubic ft. (lbs.)
1	1	2.696	2.550	-	158.9
	2	2.702	2.564	-	159.7
	3	-	2.544	-	158.5
	Av.	2.699	2.553	.0541	159.0
2	1	2.705	2.557	-	159.3
	2	2.704	2.544	-	158.5
	3	-	2.553	-	159.1
	Av.	2.705	2.551	.0570	159.0
3	1	2.860	2.771	-	172.6
	2	2.854	2.767	-	172.4
	3	-	2.769	-	172.5
	Av.	2.857	2.769	.0308	172.5
4	1	2.805	2.739	-	170.6
	2	2.810	-	-	-
	3	-	2.733	-	170.3
	Av.	2.808	2.736	.0256	170.5
5	1	2.863	2.801	-	174.5
	2	2.866	2.822	-	175.8
	3	-	2.838	-	176.8
	Av.	2.865	2.820	.0157	175.7
6	1	2.854	-	-	-
	2	2.857	2.682	-	167.1
	3	-	2.676	-	~~166.7~~
	Av.	2.856	2.679	.0620	166.9
7	1	2.862	2.691	-	167.6
	2	2.860	2.683	-	167.1
	3	-	2.658	-	165.6
	Av.	2.861	2.677	.0643	166.8
8	1	2.849	2.764	-	172.2
	2	2.845	2.806	-	174.8
	3	-	2.789	-	173.8
	Av.	2.847	2.786	.0214	173.6
9	1	2.828	2.552	-	159.0
	2	2.830	2.546	-	158.6
	3	-	2.576	-	160.5
	Av.	2.829	2.558	.0958	159.4

a/ Specific gravities corrected at 70° F.

Production. It is reported that 27 squares were produced by the Atlas Slate Company (No. 27). The quarry was opened in 1900 and work continued for about a year. Production figures prior to 1931 are not available. Since that time, the following production has been reported, according to severance tax reports:

Table 21. Production and value of slate

Year	Production short tons	Estimated value
1931-1932	4,995.00	$28,521.45
1933	5,300.00	33,549.00
1934	1,375.00	8,827.50
1935	1,568.70	9,396.51
1936	1,740.90	11,785.89
1937	2,099.40	14,170.95
1938	6,370.40	54,594.32
1939	927.00	7,944.39
	24,376.40	168,790.01

Tripoli

Composition and properties. Tripoli is a porous, siliceous rock of light weight, that is usually formed by the weathering of chert, chalcedony, novaculite, or highly siliceous limestone. Most of the tripoli in Polk County is white and compact, but some is stained along the joints by iron and manganese oxides.

Uses. Tripoli is utilized as an abrasive and polishing powder, as filters, and as a filler in paints, paper, and rubber. Compact tripoli, which occurs in Polk County in suitably large blocks, can be quarried and shaped for filters.

Prices. The average price per ton of tripoli, f.o.b. mines, was $14.50, according to Metal and Mineral Markets of April 25, 1940.

Occurrence. Although tripoli deposits have not been extensively examined and prospected in Polk County, several deposits are known. Some tripoli has been found in Montgomery and Pike counties in the Bigfork chert, which also is exposed in Polk County. The tripoli of Polk County is in the Arkansas novaculite formation (see pl. I) and probably was formed by the leaching of the lime from the rocks by solution.

Tripoli occurs in the following locations in Polk County (see pl. VII):

Table 22. Occurrence of tripoli

Map no.	Quarter	Quarter	Section	Township	Range
1	SE	NW	25	2 S	28 W
2	SW	SW	11	4 S	29 W
3	NW	NW	16	5 S	32 W
4	SE	NE	10	6 S	32 W

In Deposit 3, which is in the southwestern part of the village of Bog Springs, about 20 feet of tripoli is exposed in the upper division of the Arkansas novaculite.

Production. A small quantity of tripoli has been sold from two of the Polk County prospects, but no record of the location from which it was produced, nor the amount produced is available.

Fuel Minerals

Oil and gas. Only one prospect well has been drilled in Polk County. This was located at Mena and was drilled by the New York and Arkansas Oil Company. The well was started at an elevation of 1,142 feet above sea level, and was drilled to a depth of 1,615 feet. Only one trace of oil was reported, which was at 1,354 feet, but an abundant supply of water was encountered at 665 feet.

Coal. A seam of coal 2 or 3 inches in thickness has been found in shaly sandstone in the NW.$\frac{1}{4}$ NW.$\frac{1}{4}$ sec. 33, T. 1 N., R. 32 W. The coal crumbles easily and is obviously of low commercial value, locally or otherwise. (See pl. Vii.)

A seam about 4 inches in thickness was found on Rich Mountain in the SW.$\frac{1}{4}$ sec. 4, T. 1 S., R. 31 W. in the Jackfork sandstone.

Springs

Table 23 shows a list of the more important springs of Polk County. Their locations are shown on Plate IX.

Table 23. List of springs

Map no.	Location S. T. R.	Name	Depth	24-hour yield g.	Temp	Owner	Remarks
1	NE 5-1S-30W	Tannahill	-	-	-	-	-
2	SE NW 8-1S-31W	-	2'1"	-	-	C. E. Burk, Rich Mt.	-
3	NW SE 31-2S-30W	Bethesda	-	10,000	-	Mrs. W.E. Watkins	For recreation. Formerly called Dallas Town Spring
4	18-2S-30W	Janssen Pk.	-	10,000	-	City of Mena	In city of Mena.
5	NE SW 31-2S-30W	-	-	50,000	-	Mena Recreation Co.	-
6	NW NW 6-2S-31W	Dugan	3'	1,000	-	R.M. Dugan, Mena	-
7	NW NW 7-2S-31W	Willise	3'	1,000	-	B.A. Willise, Mena	-
8	NE SW 26-2S-31W	Willhelm	$2\frac{1}{2}$'	1,000	-	Fred Willhelm, Mena	-
9	SW SE 28-2S-31W	Old Potter	1'	5,000	-	-	-
10	NW SE 28-2S-31W	-	$1\frac{1}{2}$'	1,000	-	-	-
11	NW NW 5-3S-28W	McBee	4'	1,000	-	J.M. McBee, Big Fork	-
12	SW NW 5-3S-28W	McBee	5'	1,000	-	J.M. McBee, Big Fork	-
13	SW NW 5-3S-28W	McBee	4'	5,000	-	J.M. McBee, Big Fork	-
14	NW NW 6-3S-28W	Reeves	4'	5,000	-	R.M. Reeves, Mena	-
15	NE NW 10-3S-28W	Delbeck	2'	1,000	-	A.B. Delbeck, Opal	-
16	SE SE 10-3S-28W	Roberson	2'	5,000	-	W.H. Roberson, Opal	-
17	SE SE 10-3S-28W	Roberson	4'	1,000	-	W.H. Roberson, Opal	-
18	SE SE 10-3S-28W	Roberson	4'	2,000	-	W.H. Roberson, Opal	-
19	NW NW 17-3S-28W	-	3'	1,000	-	-	-
20	SE NW 23-3S-28W	Kirk	5'	1,000	-	R.E. Kirk, Big Fork	-
21	SE SE 23-3S-28W	Fowler	$2\frac{1}{2}$'	1,000	-	H.M. Fowler, Big Fork	-
22	SE SE 23-3S-28W	Abernathy	2'	7,200	-	L. Abernathy, Big Fork	-
23	SW NW 24-3S-28W	Abernathy	3'	750,000	-	P. Abernathy, Big Fork	-
24	SW NW 25-3S-28W	Abernathy	$2\frac{1}{2}$'	43,000	50°	R.S. Abernathy, Big Fork	2 springs 20 ft. apart. Water boils up. Weak chalybeate.
25	SW SW 26-3S-28W	Reed	3'	1,000	50°	Mose Reed, Big Fork	-
26	SE SW 26-3S-28W	Williamson	2'	1,500	-	J.T. Williamson, Big Fork	-
27	SE 31-3S-28W	Mine Creek	-	4,000	50°	United States	Water supply for Mine Creek Forest camp
28	SE SW 31-3S-28W	-	3'	2,000	-	-	-
29	SE NW 35-3S-28W	-	3'	3,000	-	United States	-

Table 23. List of springs (Cont.)

Map no.	Location S. T. R.	Name	Depth	24-hr. yield	Temp	Owner	Remarks
30	NW NW 10-3S-29W	Suggs	1'8"	53,000	-	J.T. Suggs, Mena	-
31	NW SW 3-3S-32W	-	1½'	1,000	-	-	-
32	NW SE 11-3S-32W	-	7'	2,000	-	-	-
33	SE NW 7-4S-28W	-	2½'	1,000	-	United States	-
34	NE NE 8-4S-28W	Vought	2'	1,000	-	Berry Vought, Mena	-
35	NE NE 20-4S-28W	-	-	6,000	-	United States	Flows out of rock on side of creek bank
36	SW NE 20-4S-28W	Bard	-	2,000	60°	United States	For recreation. Part of government camp ground
37	SE SE 1-4S-30W	Hullibran	3'	2,000	-	Hullibran, Texarkana	-
38	NE SW 12-4S-30W	United States	2'	2,000	-	United States	-
39	NE NE 12-4S-30W	Cold	-	25,000	45°	Louis Heilbron, Texarkana	Near junction of Holly Briar and Cossatot roads. Drains into Cossatot River
40	NE NE 12-4S-30W	Wiley	-	-	-	United States	Across river from Cold Spr.
41	NE 21-4S-30W	Gilham	-	-	-	-	Across river from Cold Spr.
42	SW NW 22-4S-30W	Gillam	-	-	-	-	Series of small sulphur springs
43	NW NW 30-4S-30W	-	2'	1,000	-	-	-
44	NW NE 4-4S-32W	Sims	10'	2,000	-	I. V. Sims, Cove	-
45	NW SW 11-4S-32W	Hotard	2' and 12'	1,000	-	Peny Hotard, New Orleans, La.	Two springs
46	NW SW 15-4S-32W	Brown	13'	1,000	-	C. H. Brown, Cove	-
47	SE SE 36-4S-32W	Crofford	3'	1,000	-	R.C. Crofford, Hatton	-
48	SE NW 28-5S-31W	Rose	5'	2,000	-	J.P. Rose, Wickes	-
49	2-5S-32W	Tyra	-	-	58°	-	On north bank of tributary of Rolling Fork of Little River west of Hatton Gap
50	S½ SW 10-5S-32W	Bog	-	--	-	Walter Jones, Bog Spr.	Summer resort
51	NW NW 11-5S-32W	-	3'	1,000	-	-	-
52	SE NW 17-5S-32W	Starkey	4'	2,000	-	Leonard D. Starkey, Grannis	-
53	SE SW 34-5S-32W	Lebow	7'	1,000	-	H.M. Lebow, Grannis	-

Table 23. List of springs (cont.)

Information concerning Nos. 1, 3, 4, 9, 40, 41, 49, and 50 from Mena Chamber of Commerce, Mena, Ark.
Information concerning Nos. 24, 27, 36, and 39 from U. S. Forest Service, Hot Springs, Ark.
Information concerning No. 42 from Arkansas Geol. Survey Ann. Rept. for 1892, Vol. I, "The Iron Deposits of Arkansas," by R. A. F. Penrose, Jr., 1892, p. 99.
Information concerning other numbers from State Mineral Survey.

S U M M A R Y

During 1939, only gravel, slate, and building stone were produced in Polk County. The other mineral resources are, at present, only of potential importance. Manganese is the most important metallic mineral. The importance of novaculite lies in the local demand for that rock for building stone and road material. Exploration for tripoli and barite may reveal deposits that can be economically worked. The thorough testing of representative slate specimens may result in the discovery of new uses to which Polk County slates can be put.

The table below is a recapitulation of all the minerals known to have been produced in Polk County. Production and value figures of gravel and slate are based on state severance tax reports filed with the State Department of Revenues:

Table 24. Production and value of minerals

Year	Mineral	Unit of measurement	Production	Value	Total value
-	Copper	Short tons	Small quantity	-	-
-	Manganese	Long tons	21.00	-	-
-	Barite	Short tons	17.50	-	-
-	Clay	Short tons	Unknown	-	-
-	Novaculite	Short tons	Unknown	-	-
-	Tripoli	Short tons		-	-
1919-1939	Building stone	Cubic feet	149,175.00	$138,125.00	$138,125.00
1930	Gravel	Cubic yards	2,398.00	1,978.35	1,978.35
1931	Gravel	Cubic yards	10,551.00	12,186.40	12,186.40
1932a/	Slate	Short tons	4,995.00	28,521.45	28,521.45
1933	Slate	Short tons	5,300.00	33,549.00	33,549.00
1934	Gravel	Cubic yards	282.00	198.81	
	Slate	Short tons	1,375.00	8,827.50	9,026.31
1935	Gravel	Cubic yards	5,898.40	4,158.37	
	Slate	Short tons	1,568.70	9,396.51	13,554.88
1936	Gravel	Cubic yards	11,938.70	8,416.78	
	Slate	Short tons	1,740.90	11,785.89	20,202.67
1937	Slate	Short tons	2,099.40	14,170.95	14,170.95
1938	Gravel	Cubic yards	7,551.00	5,315.90	
	Slate	Short tons	6,370.40	54,594.32	59,910.22
1939	Gravel	Cubic yards	52,961.20	42,104.16	
	Slate	Short tons	927.00	7,944.39	50,048.55
					381,273.78

a/ Includes 1931 production

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