STATE OF ARKANSAS
ARKANSAS GEOLOGICAL SURVEY
GEORGE C. BRANNER
STATE GEOLOGIST

COUNTY MINERAL REPORT 2

MINERAL RESOURCES OF

BENTON, CARROLL, MADISON, AND WASHINGTON COUNTIES

COMPILED UNDER THE DIRECTION OF
GEORGE C. BRANNER

LITTLE ROCK
1940
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STATE OF ARKANSAS

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January 15, 1941

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

Sir:

I have the honor to submit herewith County Mineral Report 2, Mineral Resources of Benton, Carroll, Madison, and Washington Counties, prepared under my direction.

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

The purpose of the State Mineral Survey, sponsored by the Arkansas Geological Survey, 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 mineral resource reports on counties or groups of counties.

Respectfully submitted,

George C. Branner

State Geologist

ACKNOWLEDGMENT TO THE WORK PROJECTS ADMINISTRATION OF ARKANSAS

The occasion for the publication of this report on the mineral resources of Benton, Carroll, Madison, and Washington counties is the completion of surveys of those counties by workers of the State Mineral Survey under the Work Projects Administration Project 6041-9.

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

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

E. E. Castleberry is Project Supervisor for the State Mineral Survey, and Howard A. Millar is Project Engineer. Roy Ward, later succeeded by Lewis Crutchfield, were the District Supervisors at the time the field work for this report was done.

Milton W. Corbin of the Arkansas Geological Survey is the coordinator for the State Mineral Survey Project.

Special acknowledgment is made of the assistance of the county officials of Benton, Carroll, Madison, and Washington counties, and of many others for contributions which made the prosecution of the project possible in these counties.

The text of this report was prepared by Clayton H. Johnson and Harold G. Picklesimer of the editorial staff of the State Mineral Survey, and A. D. Hoagland of the Arkansas Geological Survey.

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

The drafting was done by Mary C. Dickson, chief draftsman, Floyd Winkler, and Carl McConnell, of the State Mineral Survey.

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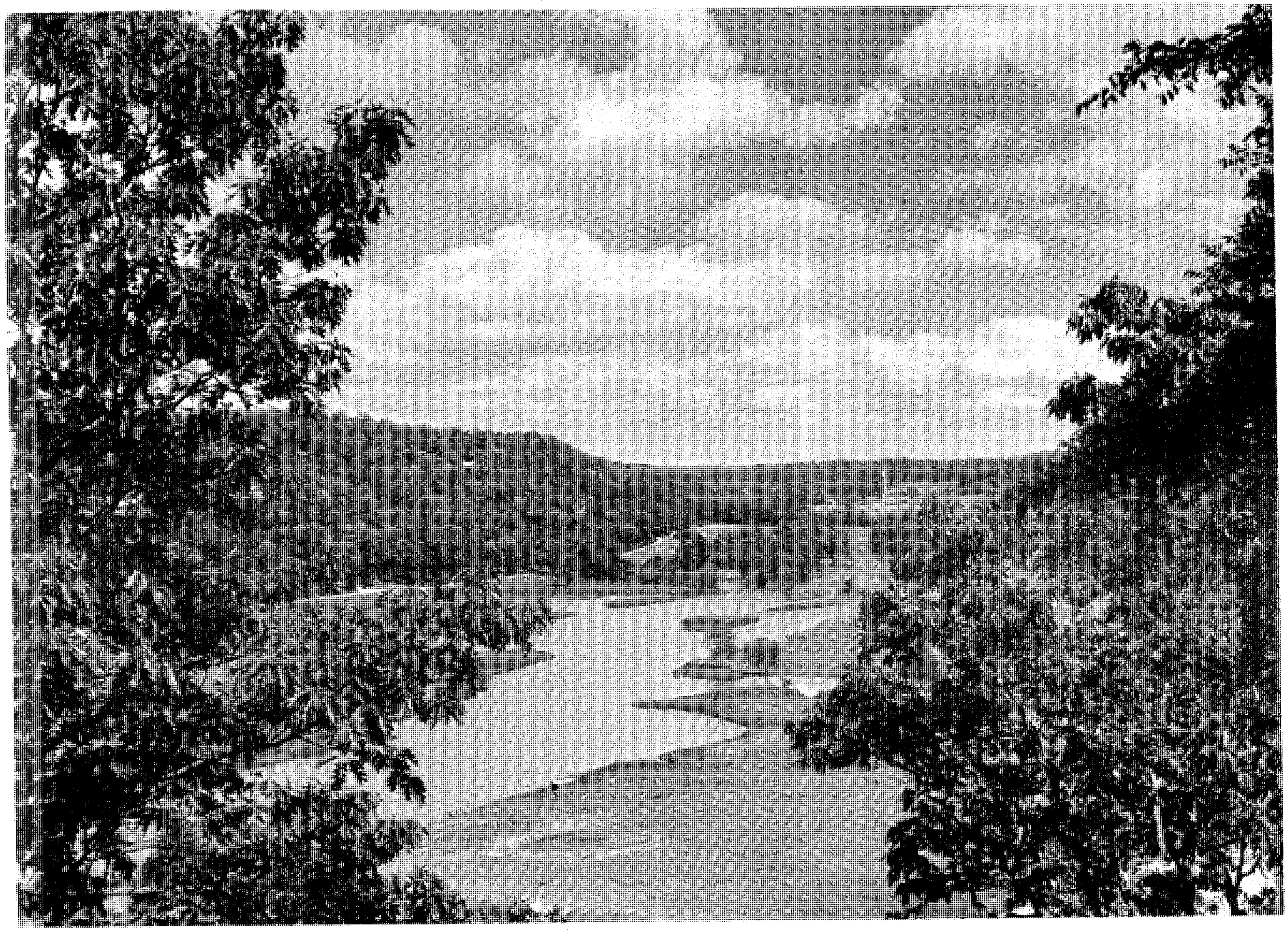


VIEW AT BELLA VISTA, BENTON COUNTY LOOKING NORTHEAST
LITTLE SUGAR CREEK AND TYPICAL TOPOGRAPHY OF THE SPRINGFIELD PLATEAU
(PHOTO BY ARKANSAS STATE PUBLICITY DEPARTMENT)

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

Washington County is situated in the northwestern part of Arkansas and is bounded on the north by Benton County, on the east by Madison County, on the south by Crawford County, and on the west by Adair County, Oklahoma. (See fig. 1.) The county contains 20 complete geographical townships and parts of 16 others, and includes 955 square miles, or 611,200 acres.

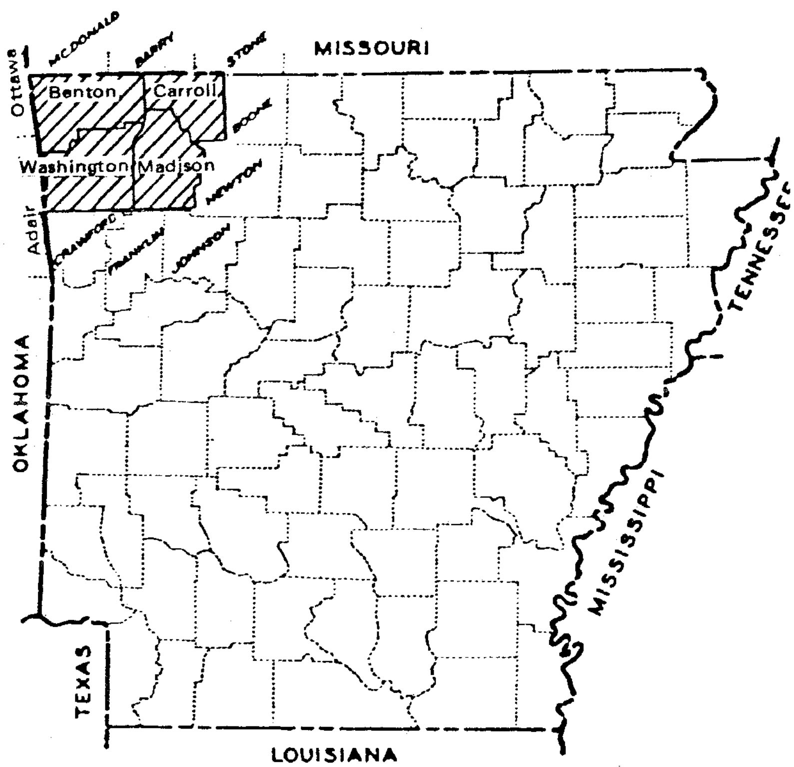


Figure 1. Location map of Benton, Carroll, Madison, and Washington counties

According to the 1930 census, the county had a population of 39,255, of which 74 per cent is classed as rural (the term rural is here used to designate population outside incorporated towns of 2,500 or more inhabitants.) The average density of the county population was 41.1 persons per square mile, which is to be compared to the state average of 35.3 persons.

Fayetteville is the county seat, site of the State University and the largest town in Washington County, with a population of 7,394. The four towns next in population rank are Springdale (2,763), Prairie Grove (743), Lincoln (687), and West Fork (392).

Benton County is situated in the extreme northwestern corner of Arkansas and is bounded on the north by McDonald and Barry counties, Missouri, on the east by Carroll and Madison counties, on the south by Washington County, and on the west by Delaware and Adair counties, Oklahoma. (See fig. 1.) The county contains 15 complete geographical townships and parts of 20 others, and includes 876 square miles, or 560,640 acres.

In 1930 the county had a population of 35,253, of which 90 per cent is classed as rural. The average density of the county population was 40.2 persons per square mile, which is to be compared to the state average of 35.3 persons.

Bentonville is the county seat and third largest town in Benton County, with a population of 2,203. The four largest towns in population rank are Rogers (3,554), Siloam Springs (2,378), Bentonville (2,203), and Gravette (812).

Carroll County is situated on the northern boundary of Arkansas. It is bounded on the north by Barry, Stone, and Taney counties, Missouri, on the east by Boone County, on the south by Newton and Madison counties, and on the west by Benton County. (See fig. 1.) The county contains 8 complete geographical townships and parts of 17 others, and includes 641 square miles, or 410,240 acres.

In 1930 the county had a population of 15,820, all of which is classed as rural. The average density of the county population was 24.7 persons per square mile in 1930, as compared to the state average of 35.3 persons.

Eureka Springs and Berryville are the county seats of Carroll County. Eureka Springs, the largest town, had a population of 2,276 in 1930. The four towns next in population rank are Berryville (1,286), Green Forest (745), Dry Fork (161), Mundell (135).

Madison County is situated in northwestern Arkansas and is bounded on the north by Carroll County, on the east by Newton County, on the south by Johnson, Franklin, and Crawford counties, and on the west by Washington and Benton counties. (See fig. 1.) The county contains 14 complete geographical townships and parts of 20 others, and includes 836 square miles, or 535,040 acres.

In 1930 the county had a population of 13,334, all of which is classed as rural. The average density of the county population was 15.95 persons per square mile in 1930 as compared to the state average of 35.3 persons.

Huntsville is the county seat and largest town in Madison County, with a population of 602 in 1930. The four towns next in population rank are Delaney (300), Combs (214), Pettigrew (210), and St. Paul (198).

The climate of the entire area is mild, although the summer temperature sometimes reaches 100° F. The average annual rainfall ranges from 40 to 55 inches, being greater in the eastern part of the area. The rainfall is slightly greater in March, April, and May, and less in August, September, and October, than during the remainder of the year.

Washington, Benton, Madison, and Carroll counties lie within the physiographic division known as the Ozark Plateaus. The southern portion of Washington and Madison counties exhibits a rough topography, and lies within the physiographic subdivision known as the Boston Mountains. The northern portions of Washington and Madison counties and most of Benton County have relatively little relief and lie within the Springfield Plateau physiographic subdivision.

A small portion of eastern Benton County and a large portion of northern Carroll County lie within the Salem Plateau physiographic subdivision. This plateau, although lower than the Springfield Plateau, has been deeply cut by numerous streams. (See fig. 2.)

Elevations above sea level range from more than 2,250 feet in the Boston Mountains (at the village of Sunset in Washington County and, the villages of Heath and Redstar in Madison County) to 908 feet in the Springfield Plateau (at Sulphur Springs in northwestern Benton County).

Most of the area covered by Washington, Benton, Madison, and Carroll counties is drained by White River and its tributaries which flow in a general northward direction from the Boston Mountains. The western portion of Benton County and the northwestern portion of Washington County are drained by the Illinois River. Northwestern Benton County is drained by Spavinaw Creek, which flows generally westward from the area. Drainage of the entire area is good, and overflow is virtually unknown.

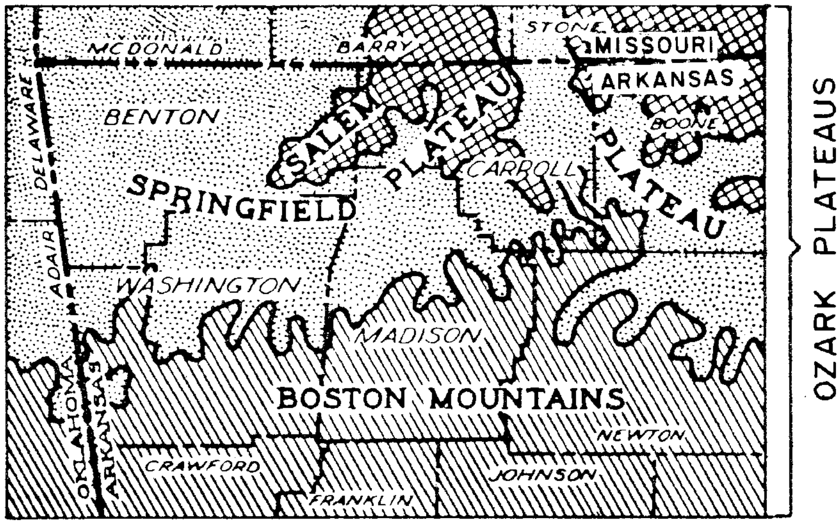


Figure 2. Physiographic map

U. S. Geological Survey topographic quadrangle maps of the Winslow, Tahlequah, Siloam Springs, Fayetteville, Eureka Springs, and Harrison quadrangles cover most of the area. (See fig. 3.) Each map covers 30 minutes of latitude and longitude. County Highway Planning Survey maps and State Geologic maps and topographic maps are also available.

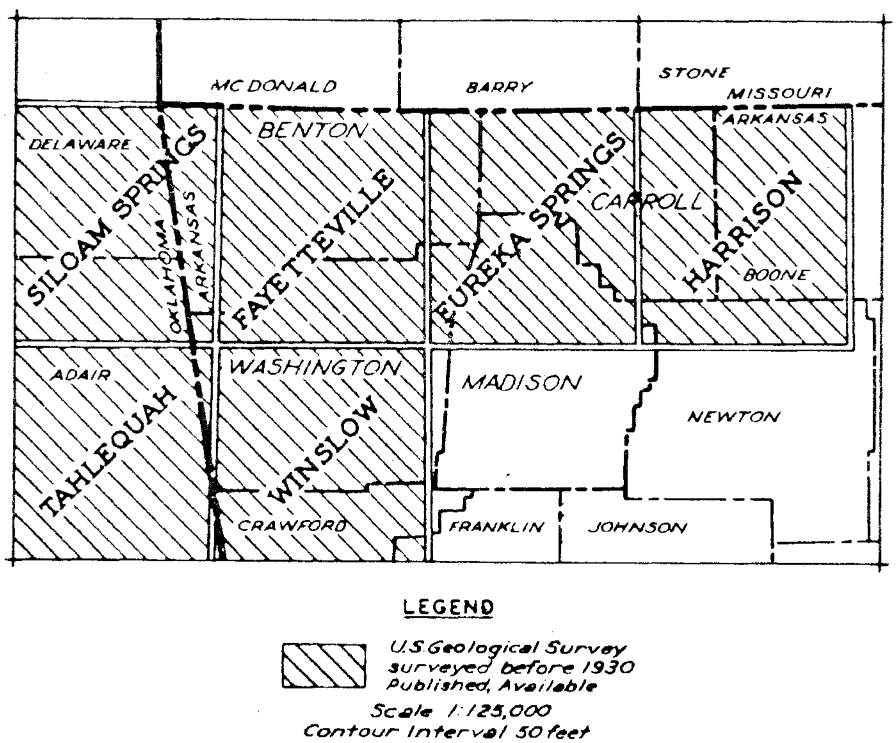


Figure 3. Geological and topographic maps available

Data, used in this report were obtained from field sheets of the Work Progress Administration State Mineral Survey, from U. S. Geological Survey and Arkansas Geological Survey maps and publications, and from reports of private investigations. Published literature has been freely used, but where reference to specific material is made, acknowledgment of the source is given.

GEOLOGY

DESCRIPTION AND SEQUENCE OF FORMATIONS

General Statement

The surface formations of this area are all sedimentary rocks, and consist of limestone, dolomite, sandstone, shale, and chert.

The rocks range in age from Lower Ordovician to Pennsylvanian. (See pls. I and II.) The older formations crop out in eastern Benton County and northwestern Carroll County. The younger formations are present in the Boston Mountains. The Cotter dolomite, Powell formation, Everton formation, and St. Peter sandstone are of Ordovician age; the Clifty limestone is of Devonian age; the Sylamore sandstone and Chattanooga shale are placed in the Devonian (?) in this report; the Boone formation, Batesville formation, Fayetteville shale, and Pitkin limestone are Mississippian in age; and the Hale sandstone, Bloyd shale, and Atoka formation are Pennsylvanian in age.

Brief descriptions of the formations exposed in this area follow. They are described in the order in which they were deposited. (See pl. II.)

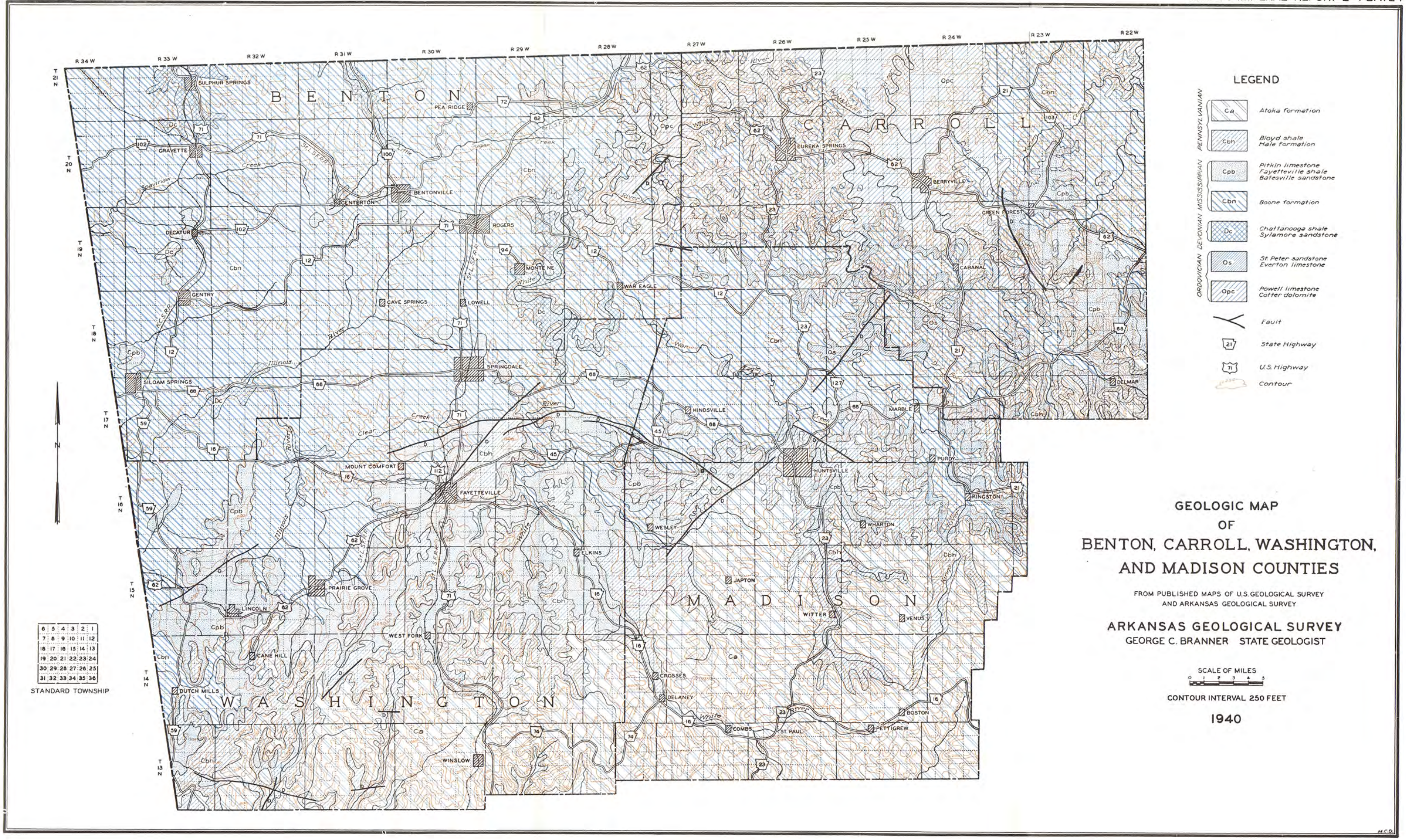
Lower Ordovician

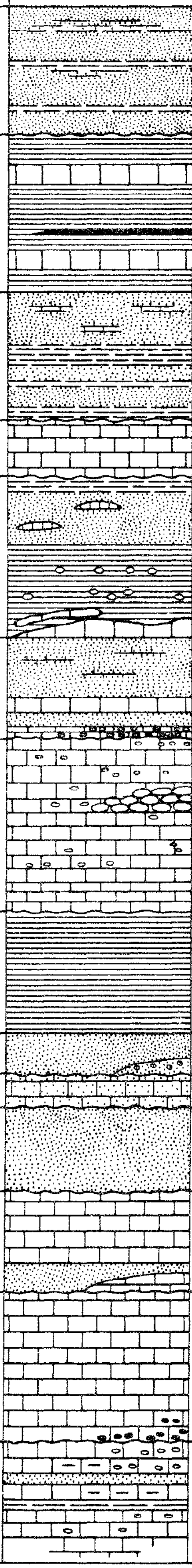
Cotter dolomite. The Cotter dolomite is the oldest formation exposed in this area. As its name implies, it consists largely of dolomite rock but includes shale, chert, and sandstone in minor amounts. Berryville in Carroll County is built upon this formation. The formation is composed of two kinds of dolomite, (1) a massive, medium-grained gray rock, which becomes dark on exposure, and (2) a fine-grained, earthy white to buff rock, known locally as "cotton rock." These two types are interbedded with each other and with thinner layers of sandstone and shale or chert. The lime and magnesia occur in almost the exact proportions of a true dolomite. The Cotter dolomite is approximately 500 feet thick, and is exposed in northwestern Carroll County and eastern Benton County.

Powell formation. The Powell formation is composed of magnesian limestone and calcareous shale; at most places there is a conglomerate at the base. White chert, in the form of concentrically banded nodules, is distributed through parts of the limestone, but at no place abundantly. Most of the Powell limestone effervesces (fizzes) readily with cold dilute hydrochloric acid, a reaction which cannot ordinarily be obtained with rocks from the underlying Cotter dolomite. The Powell formation is a few feet to 200 feet thick. It is exposed in northwestern Carroll County, eastern Benton County, and northern Madison County.

Everton formation. The Everton formation consists of three divisions or members, which differ considerably in character and distribution. The thickness of the formation is variable but probably does not exceed 100 feet in Benton, Carroll, or Madison counties. The Kings River sandstone member is best represented in this area. This stone is white, friable, finely laminated sandstone, composed of well-rounded, medium-sized quartz grains. At its base there are pebbles of chert and limestone, which were derived from underlying rocks. The greatest thickness of the Kings River member is about 40 feet. There are magnesian limestone beds both above and below the sandstone member. Locally, the limestone beds below the sandstone are missing, and at Little Clifty Creek only the Kings River sandstone is present. The Everton formation crops out in western Carroll, eastern Benton, and northwestern Madison counties.

St. Peter sandstone. The St. Peter sandstone consists of sub-angular, medium-


LEGEND
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
ORDOVICIAN
Ca Atoka formation
Cbh Bloyd shale Hale formation
Cpb Pitkin limestone Fayetteville shale Batesville sandstone
Cbn Boone formation
Dc Chattanooga shale Sylamore sandstone
Os St Peter sandstone Everton limestone
Opc Powell limestone Cotter dolomite
Fault
State Highway
U.S. Highway
Contour
BENTON
CARROLL
WASHINGTON
MADISON
STANDARD TOWNSHIP
GEOLOGIC MAP
OF
BENTON, CARROLL, WASHINGTON, AND MADISON COUNTIES
FROM PUBLISHED MAPS OF U.S. GEOLOGICAL SURVEY AND ARKANSAS GEOLOGICAL SURVEY
ARKANSAS GEOLOGICAL SURVEY
GEORGE C. BRANNER STATE GEOLOGIST
SCALE OF MILES
CONTOUR INTERVAL 250 FEET
1940



PERIOD	FORMATION	MEMBER	THICKNESS IN FEET	CHARACTER OF ROCKS
PENNSYLVANIAN	Atoka		500±	Massive, coarse-grained sandstone at base. Black shales and micaceous sandstones inter-bedded with massive sandstones Madison and Washington Counties
	Unconformity			
	Bloyd	Kessler limestone member	0-270	Dark brown to black clay shale. Brown to brownish-red limestone, locally conglomeratic
		Baldwin coal member		
		Brentwood limestone member		Gray, fossiliferous limestone and shale Madison and Washington Counties.
	Hale		0-275	Carbonaceous shale and flaggy sandstone; brown calcareous sandstone and sandy ferruginous limestone Carroll, Madison, and Washington Counties.
	Unconformity			
MISSISSIPPIAN	Pitkin		40	Massive, gray, fossiliferous limestone. Madison and Washington Counties.
	Unconformity			
	Fayetteville	Wedington sandstone member	200-250	Black and gray, carbonaceous, fissile clay shales. Medium to fine-grained, gray to brown, cross-bedded sandstone, in part calcareous. Carroll, Benton, Madison, and Washington Counties
		"Mayes" limestone member	(0-40)	Blue-gray, fine-grained, fossiliferous limestone
	Batesville		0-60	Gray to brown, even-bedded sandstone; somewhat calcareous in places Carroll, Benton, Madison, and Washington Counties.
		Hindsville limestone member		Chert conglomerate, with gray oolitic limestone
	Unconformity			
	Boone		325	Gray, crystalline, fossiliferous limestone, gray to red, fossiliferous chert, several oolitic horizons Carrol, Benton, Madison, and Washington Counties.
		St Joe limestone member	(20-50)	Non-cherty "marble
	Unconformity			
DEVONIAN	Chattanooga		10-75	Black, carbonaceous, fissile clay shale. Carroll, Benton, Madison, and Washington Counties.
	Sylamore		2-5	Light brown to white, phosphatic sandstone in part conglomertic Carroll, Benton, Madison, and Washington Counties.
	Unconformity			
	Clifty		2-4	Gray, compact, sandy limestone. Benton County.
	Unconformity			
ORDOVICIAN	St. Peter		0-175	White, quartzitic, friable, cross-bedded, granular, massive sandstone Carroll and Madison Counties
	Unconformity			
	Everton		0-100±	Gray, compact limestone. Carroll, Benton, and Madison Counties
		Kings River sandstone member	(0-40)	Heavy-bedded, white, friable sandstone.
	Unconformity			
	Powell		0-200	Gray, magnesian limestone, and local limestone conglomerate at base Carroll, Benton, and Madison Counties. Local minor chert nodules.
	Unconformity			
	Cotter		500±	Gray dolomite, chert, friable sandstone, and green shales. Benton, Carroll, and Madison Counties.

M.C.Q.

sized, translucent quartz grains, which are commonly poorly cemented. The rock is massive, friable, and porous, particularly where it is weathered. The formation ranges in thickness from a feather edge to over 175 feet, becoming thicker toward the southeast. The sandstone is exposed in Madison and Carroll counties along Kings River and Osage Creek.

Devonian

Clifty limestone. The Clifty limestone is known to crop out only along the east fork of Little Clifty Creek, in the southeastern part of Benton County, where the formation is from 2 to 4 feet thick. The lower part of the limestone is gray, compact, and cross-bedded, and contains a large amount of quartz sand. The upper part is light-blue, dense, and breaks with a conchoidal (glasslike) fracture. It also is sandy, but less so than the lower part.

Upper Devonian (?)

Sylamore sandstone. The Sylamore sandstone is generally 2 to 5 feet thick, but its thickness varies greatly within short distances. It is typically very porous, and is so friable that a fragment of it falls into loose sand when struck with a hammer. The color is dominantly light, though dark spots are present.

Chattanooga shale. This shale is black, dense, and clayey and contains bright yellow pyrite locally. The shale breaks into thin plates and slabs when struck with a hammer. Freshly broken fragments give off the odor of petroleum, and with intense heat an oily substance can be distilled from the shale. The thickness varies from a few inches to 70 feet, and averages about 25 to 30 feet. The upper limit of the outcrops of the Chattanooga formation is marked by numerous small springs, which are formed by underground water seeping out along the top of the impervious shale.

The Chattanooga shale and the Sylamore sandstone crop out in Washington, Benton, Carroll, and Madison counties. The total area of outcrop is small, and is limited to narrow bands along the rivers.

Mississippian

Boone formation. This formation is composed of limestone, chert, and cherty limestone. The lower part of the formation is chert-free, and is known as the St. Joe member of the Boone formation. The limestone of the St. Joe member is usually gray and coarse-grained, and takes a fine polish. The thickness ranges from 20 to over 50 feet, and averages 30 feet. Building blocks of convenient size can be removed because of even beds and joints. Chert and cherty limestone beds form the upper 325 feet of the Boone formation. The chert is commonly light-gray when fresh, and becomes stained by yellowish-brown iron oxide after exposure. Tripoli is often found associated with the cherty beds. The limestones are light-gray, coarsely-crystalline, and generally fossiliferous. The Boone formation is the surface rock in approximately one-third of the entire area, and almost all of Benton County.

Batesville formation. The Batesville formation is composed mostly of sandstone, but limestone with a prominent basal chert conglomerate (the Hindsville limestone member) is present at the base. The sandstone is coarse-grained, brown, and well-cemented. The total thickness varies from a few feet to 60 feet, and the individual beds vary from a few inches to 10 feet. The thin beds furnish excellent slabs for stonework. The Batesville formation covers about 30 square miles in eastern Carroll County, and is present in narrow bands along the large rivers in western Carroll County. In northern Madison and Washington counties and in Benton County, the Batesville formation is found in small isolated patches. The Hindsville limestone member is not present everywhere the sandstone occurs.

Fayetteville formation. This formation is generally gray or black, fissile (thinly bedded), carbonaceous shale, with a prominent sandstone (Wedington member) near the top of the formation,and a fossiliferous limestone ("Mayes" member) near the base. The formation averages 200 to 250 feet in thickness, and the Wedington sandstone member averages about 40 feet of that total. Thin and flaggy layers of the sandstone furnish good blocks for stonework. The most extensive outcrops of the Fayetteville formation are in central Washington and Madison counties and southwestern Carroll County. Isolated patches and narrow bands occur in northern Washington and Madison counties and in southern Benton County.

Pitkin limestone. This limestone is thickly bedded, bluish-gray, and compact. Locally some of the limestone beds are distinctly cross-bedded. The limestone contains many fossils of the genus Archimedes (screw-like fossils) and was once known as the "Archimedes limestone." The formation is ordinarily about 50 feet thick. Outcrops of the Pitkin limestone commonly form steep cliffs through central Washington and Madison counties.

Pennsylvanian

Hale formation. The Hale formation was named for outcrops on Hale Mountain in the southwestern part of Washington County. The base of the formation is a limestone conglomerate made of fragments and worn fossils from the underlying Pitkin limestone. Sandstone, shale, and limestone layers comprise the remainder of the formation. The sandstones are generally hard, gray, and ripple-marked. Some soft, calcareous, cross-bedded layers are present. The formation has an average thickness of about 130 feet. The Hale formation is present in central Washington and Madison counties and in southwestern Carroll County.

Bloyd formation. This formation was named for Bloyd Mountain, Washington County. The formation is composed mostly of thin, black, fissile, carbonaceous, clay shale. Sandstone occurs locally in the lower beds. Besides the shale and sandstone are the Brentwood and Kessler limestone members and the Baldwin coal member. The coal occurs between the two limestone members, and is from 2 to 22 inches thick. The Brentwood limestone lies near the base of the Bloyd formation. It consists of 9 to 40 feet of gray, fine-grained, impure limestone. The limestone contains many fossil Pentremites ("fossil acorns") for which it was once called the "Pentremital limestone." The Kessler limestone is a compact,gray to brown, fossiliferous, locally conglomeratic, limestone from 10 to 30 feet thick. It occurs within 60 feet of the top of the Bloyd formation. Total thickness of the formation varies from a feather edge to 270 feet. It is thickest in Washington County. Madison and Washington counties include extensive outcrops of the Bloyd formation. The coal is not present in all of the outcrops.

Atoka formation. (Winslow formation). The base of the Atoka formation (also called the Millstone grit formation) consists of a massive, coarse-grained, commonly cross-bedded sandstone as much as 100 feet thick. Above the basal sandstone, particularly in the southwestern part of the area, black shale and thinly bedded micaceous sandstone are interbedded with massive sandstone. The top of the Atoka formation has been eroded, and at no place in the area is the full thickness present.

Pleistocene and Recent

The chert and limestone gravels and the alluvial rocks formed by the streams are the only Pleistocene deposits in the area. The thickness of these deposits is usually only a few feet.

STRUCTURE

General Statement

The rocks of the Ozark Plateau were deposited in an essentially horizontal position, and they have undergone no great deformation (folding or faulting) since their deposition. The Arkansas Ozarks are the southern and southwestern part of the dome formed by the uplift of the St. Francis Mountains in southeastern Missouri. Consequently,the prevailing dip of the rock strata in northern Arkansas is toward the south or southwest. The inclination of the beds is slight, commonly between one and two degrees, particularly near the northern border of the state. Minor folds are common. Vertical displacements of 50 to 300 feet have occurred along faults or breaks. (See geologic map, pl. I.) The folds, faults, and related structures commonly have an important bearing on the distribution of metallic minerals, such as lead, zinc, and pyrite.

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

SUMMARY OF THE ECONOMIC MINERALS

A small amount of iron ore was mined in Carroll County between 1850 and 1860. The ore was smelted at the Beach Iron Works in central Carroll County to supply local requirements for iron ware. The iron deposits are of no economic value today.

Lead and zinc have been known to occur in Washington and Benton counties for many years.The proximity to the highly productive Tri-State district has led to the assumption that deposits of considerable magnitude might be found in these counties. Prospecting and testing have not justified the assumption, and no lead or zinc deposits of commercial value are known.

The only important mineral production from Washington, Benton, Carroll, and Madison counties has been of non-metallic substances. The production of non-metallics from this area will probably become more important in the future than it has been in the past

Limestone, dolomite, and tripoli have contributed most to the mineral values produced up to the present time. (See table 1.) Good deposits of silica sand are available for development, but none has been produced from these counties to date.

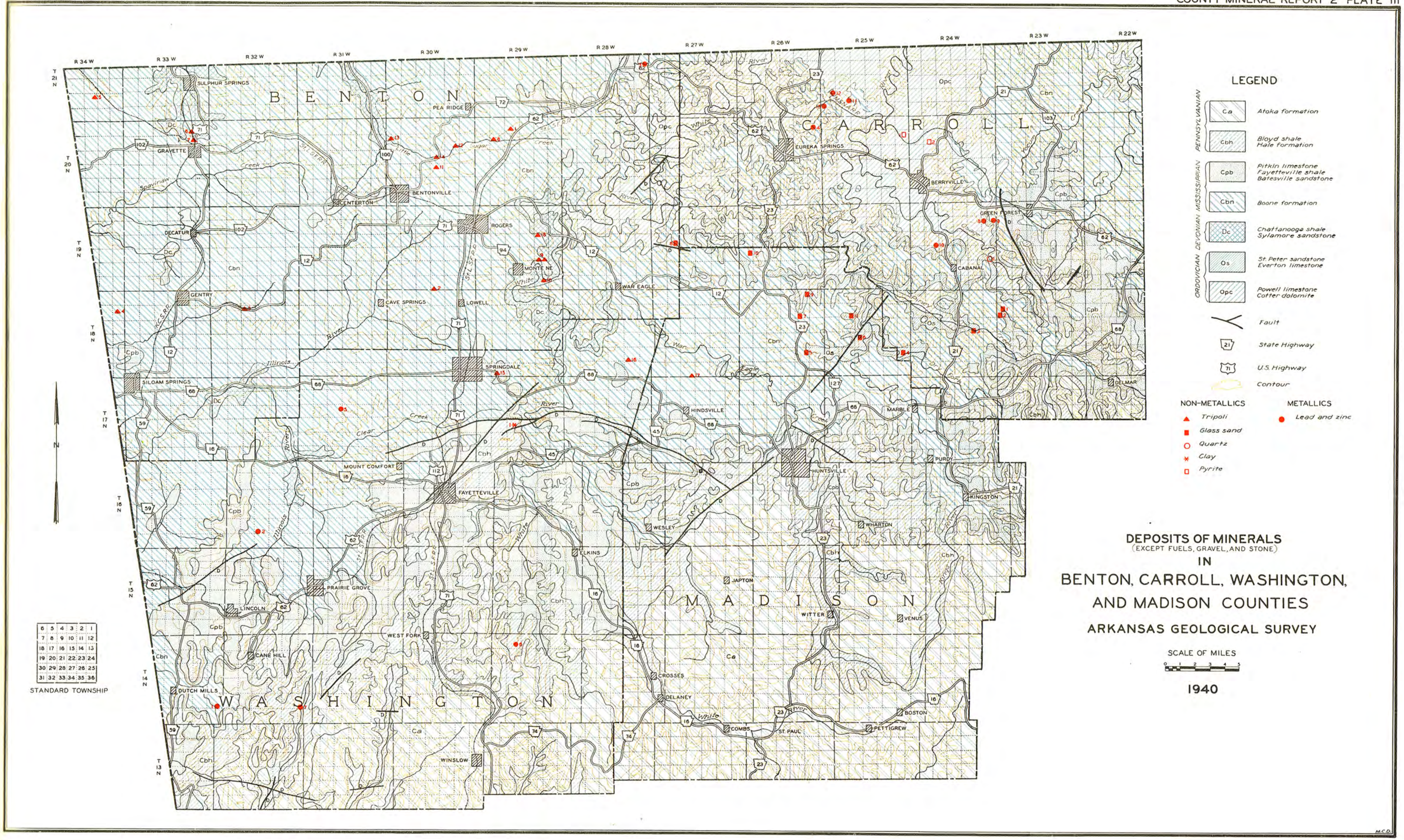
Gravel has been a source of revenue, but it is probably of only local importance, inasmuch as it is used mainly on county, state, and federal roads, none being exported from the counties. Building stone is also of value locally. No records of production for sale are available for building stone.

There are several deposits of pyrite in Carroll County. The most promising of these has been examined and drilled. This deposit appears to be of questionable commercial value at present prices.

The fuel minerals, coal and gas are of minor local importance.

Table 1. Production statistics for Benton, Carroll, Madison, and Washington counties[1]

Year	Gravel		Stone[2]		Tripoli		Coal		Total
	Cu.yds.	Value	Sh.tons	Value	Sh.tons	Value	Sh.tons	Value	value
1923	-	$ -	4,334	$ 7,324	--	$ -	-	$ -	$ 7,324
1924	-	-	6,330	9,558	-	-	-	-	9,558
1925	-	-	9,502	12,770	-	-	-	-	12,770
1926	-	-	7,237	11,941	-	-	-	-	11,941
1927	-	-	6,052	9,199	-	-	-	-	9,199


DEPOSITS OF MINERALS
(EXCEPT FUELS, GRAVEL, AND STONE)
IN
BENTON, CARROLL, WASHINGTON, AND MADISON COUNTIES
ARKANSAS GEOLOGICAL SURVEY
SCALE OF MILES
1940
LEGEND
PENNSYLVANIAN
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Os St. Peter sandstone Everton limestone
Opc Powell limestone Cotter dolomite
Fault
State Highway
U.S. Highway
Contour
NON-METALLICS
Tripoli
Glass sand
Quartz
Clay
Pyrite
METALLICS
Lead and zinc
STANDARD TOWNSHIP
BENTON
CARROLL
WASHINGTON
MADISON
BENTONVILLE
ROGERS
SPRINGDALE
FAYETTEVILLE
EUREKA SPRINGS
BERRYVILLE
HUNTSVILLE
SILOAM SPRINGS
M.C.D.

Table 1. Production statistics for Benton, Carroll, Madison, and Washington counties (cont.)

Year	Gravel		Stone2/		Tripoli		Coal		Total
	Cu.yds.	Value	Sh.tons	Value	Sh.tons	Value	Sh.tons	Value	value
1928	-	$ -	7,720	$11,117	-	$ -	-	$ -	$ 11,117
1929	-	-	7,312	10,383	300	2,928	-	-	13,311
1930	18,581	15,329	5,459	7,097	5,455	104,791	-	-	127,217
1931	15,580	17,950	4,910	7,316	1,429	27,451	-	-	52,717
1932	-	-	4,608	6,214	1,135	24,085	-	-	30,299
1933	66,449	46,847	3,448	4,310	809	14,505	1,074	2,857	68,519
1934	-	-	4,032	4,153	1,972	21,810	248	522	26,485
1935	-	-	5,173	5,328	2,079	22,994	112	235	28,557
1936	-	-	6,961	7,170	3,230	50,149	-	-	57,319
1937	-	-	21,595	27,041	4,186	60,697	-	-	87,738
1938	-	-	33,5843/	40,704	2,750	35,365	-	-	76,069
1939	-	-	33,066	42,216	955	14,411	-	-	56,627
	100,610	$80,126	171,318	$223,841	24,300	$379,186	1,434	$3,614	$686,767

1/ Based from state severance tax reports.
2/ Several thousand tons of stone have been produced from Carroll County on which there are no figures available.
3/ Includes additional tonnage for the years 1934-1937 by audit adjustment.

METALLIC MINERALS

Iron

Composition and properties. Iron is found in Benton, Carroll, Madison, and Washington counties chiefly as pyrite (iron sulphide),as limonite (yellow or brown hydrous iron oxides), and hematite (red iron oxide). Pyrite is used in the manufacture of sulphuric acid and is discussed on page 16. Limonite and hematite are ores of iron.

Occurrence. Deposits of hematite and limonite in the vicinity of Berryville in Carroll County, as well as in many places in Benton, Madison, and Washington counties, have been known for many years. These deposits were described by Penrose1/ as follows:

> "The iron ores of Carroll County occur as pockets in chert ***. The pockets are extremely small, however, and the ore deposits often consist simply of parts of the chert bed cut by a network of thin seams and bunches of ore ***. The iron ores of Washington and Madison counties occur simply as thin seams, at most a few inches thick, cutting the sandstone in various directions."

The deposits are too small and too low grade to be of commercial value as a source of iron ore.

Production. The Beach Iron Works in central Carroll County, using local ore, was operated on a small scale for a short period between 1850 and 1860 to supply local requirements for iron ware.

1/ Penrose, R. A. F., Jr., The iron deposits of Arkansas: Arkansas Geol. Survey Ann. Rept. for 1892, vol. I, pp. 39-43, 1892.

Lead and Zinc

Composition and properties. Lead is found in Washington and Benton counties, chiefly in the form of galena (lead sulphide), which contains 86.4 per cent lead. Cerussite (lead carbonate) is present locally as a thin powdery coating on the galena, or as white crystals associated with the galena. Cerussite contains 77.5 per cent lead.

Sphalerite (zinc sulphide) and smithsonite (zinc carbonate)are the only zinc minerals that have been found in appreciable amounts in these counties. Sphalerite contains 67 per cent zinc and smithsonite contains 52 per cent zinc.

Uses. Lead is a constituent of certain paints. It is also used in storage batteries, lead pipe, sheet lead, and shot, and has a wide variety of other uses.

Zinc is used principally in galvanizing, brass manufacture, rolled zinc (employed for many purposes), and die casting.

Prices. The average value of galena concentrates produced in southwestern Missouri was $40.00 (average lead content of 73.7 per cent) in 1935; $50.53 (average lead content of 77 per cent) in 1936; $66.00 (average lead content of 79 per cent) in 1937; and $50.79 (average lead content of 77 per cent) in 1938. In 1939 the price paid for lead concentrates at Joplin, Missouri, ranged from an average of $52.95 for the week ending on February 25, to an average of $65.51 for the week ending September 16.

The average value of sphalerite concentrates produced in southwestern Missouri was $28.57 (average zinc content of 59.4 per cent) in 1935; $32.20 (average zinc content of 61.1 per cent) in 1936; $43.30 (average zinc content of 60.7 per cent) in 1937; and $30.26 (average zinc content of 58.5 per cent) in 1938. In 1939 the price paid for sphalerite concentrates at Joplin, Missouri, ranged from an average of $28.96 for the week ending February 25, to an average of $42.03 for the week ending September 30.

Occurrence. Lead and zinc minerals have long been known to occur in the Boone formation in Washington, Benton, and Carroll counties. The most important of the known deposits of lead and zinc in these counties are described below. The number of each deposit corresponds to a location number on plate III.

Number 1. The Morrow Prospect(lead-zinc deposit no. 1 on pl. III) is on the bank of Fly Creek about 800 feet below the town of Morrow in Washington County. It is in the SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 25, T. 14 N., R. 33 W. The ore is in interbedded chert and limestone of the Boone formation. An opening, about 200 feet long, 40 to 50 feet wide, and about 30 feet deep, the bottom of which is below the level of the creek, is partly filled with water. Approximately 100 feet north of the open pit there is a 50-foot shaft. The ore minerals are galena and sphalerite in about equal proportions. They occur in scattered pockets and small cracks in the chert and, to a lesser extent, in the limestone. The ore in the shaft seems to have been of lower grade than that in the open pit. In referring to the Morrow Prospect, McKnight2/ says:

> "The first work on this prospect is said to have been done somewhere around 1880,or perhaps as much as 5 years later than that, but serious development began in 1908. The property was worked to some extent during the period of high prices in the early years of the World War. In spite of the fact that a mill was erected to handle the ore,the output has been small, estimated at about 50 tons, half galena and half jack."

2/ McKnight, E. T., Zinc and lead deposits of northern Arkansas: U. S. Geol. Survey Bull. 853, pp. 154-155, 1935.

Number 2. The Burr Prospect (lead-zinc deposit no. 2 on pl. III) is on the R. F. Ezell property about one mile northeast of Rhea's Mill in the NE$\frac{1}{4}$ SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 28, T. 16 N., R. 32 W., Washington County. The Arkansas Mining and Milling Company sank 5 test shafts, reported to be 70 feet to 115 feet deep, in an area of about 500 feet in diameter. There are no outcrops in the immediate vicinity of the shafts, but the material on the dumps indicate that the ore occurs as galena crystals in Boone chert. Some ore is reported to have come from the clay overlying the chert. In describing the Burr Prospect, McKnight[3] says:

> "The total production amounted to only 5 or 6 tons, made somewhere around 1905. The prospect is of low grade."

Number 3. The Roller Prospect is on the A. W. Roller property in the SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 13, T. 21 N., R. 28 W., Benton County. There is a vertical shaft 50 feet or more deep sunk in limestone and chert of the Boone formation. Sphalerite and a little galena is reported to occupy a vertical crevice. A small amount of sphalerite is present in the wallrock away from the crevice.

Number 4. Galena occurs on the W. D. Weaver farm in the NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 1, T. 20 N., R. 26 W., Carroll County. The galena was found in an excavation made in opening a spring in the Boone formation. Cracks in the limestone are lined with galena crystals, and some cubes of galena are present in the spring and in a stream as much as 100 feet away.

Other localities from which galena is reported are given in the following table and are shown on plate III.

Table 2. Occurrences of galena

Reference no. plate III	Quarter	Sec.	Twp.	Rge.	Remarks
5	NE	16	17N	31W	Prospect hole
6	NW SE	5	14N	29W	Lead in gray limestone
7	SW SW	25	14N	32W	-
8	NW NW	12	19N	24W	-
9	NE	12	19N	24W	-
10	SE SE	17	19N	24W	Galena cubes on chert
11	SE SE	29	21N	25W	Prospect hole
12	NE	30	21N	25W	-
13	NW	31	21N	25W	-

Economic importance. The known deposits are too low grade and too small to be profitably worked at present prices.

Production. It is estimated that approximately 55 tons of lead and zinc concentrates have been produced up to the present time. The Morrow workings are responsible for 50 tons of this total.

NON-METALLIC MINERALS AND ROCKS

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 classifica-

[3] Op.cit., p. 154.

tions according to their utility.

Uses. Clay is used principally in the manufacture of brick, tile, terra cotta, pottery, stoneware, and refractories. There are, however, many other important uses.

Prices. The prices paid for raw clay vary greatly, depending on quality and utility. In general, only the high-grade clays used in the manufacture of fine pottery, the paper industry, etc., can be economically transported. Most clay product plants are located at or close to the deposit from which the raw clay is mined. Table 3 gives the average selling price of kaolin (highest grade clay) and of stoneware.

Table 3. Average values per short ton of various kinds of clays sold in the United States1/

Year	Kaolin	Fire clay and stoneware clay
1930-1934 (av.)	$6.44	$2.59
1935	7.19	2.64
1936	7.10	2.48
1937	7.31	2.58
1938	7.97	2.78

1/ Tyler, Paul M., and Metcalf, R. W., Clays: Minerals Yearbook, Review of 1938, p. 1219, 1939.

Occurrence. Residual clays are common throughout the limestone area of Washington, Madison, Benton, and Carroll counties. Residual clays formed by the rotting of shale, especially the Fayetteville and Bloyd shales are not uncommon. However, no large deposits of these clays are known.

A sedimentary clay bed averaging about 4 feet in thickness, and covering an estimated area of about 100 acres, crops out in the Alex Allen farm approximately 5 miles southeast of Springdale in sec. 21, T. 17 N., R. 29 W. (See clay deposit no. 1, pl. III.) The clay bed is believed to be of uniform thickness, and is overlain by 12 to 14 inches of coal. (See section on coal, p. 44.) The coal is overlain by 20 feet of sandstone and shale. It is estimated that there are approximately 6,000 cubic yards or 8,500 short tons of recoverable clay per acre in this deposit.

The unfired and fired properties of a sample of this clay are summarized in tables 4 and 5. The physical and fired properties of the sample indicate the clay probably could be used for the manufacture of face brick. This clay also appears to be suitable for the manufacture of low-grade stoneware and low-fired flower pots.

Production. According to Simonds4/, bricks have been made at two places in Washington County. The production was small. No production of clay or clay products has been reported in recent years.

4/ Simonds, F. W., The geology of Washington County: Arkansas Geol. Survey Ann. Rept. for 1888, vol. IV, p. 121, 1891.

Table 4. Summary of unfired properties of clay

Color: dark-gray to black, iron-stained
Workability: works well
Drying shrinkage: (volume, 8.3 per cent
(linear, 2.85 per cent

Modulus of rupture: 71 lbs. per sq. in.
Drying behavior: regular drying, no cracks

Texture: shaly, some sand
Water of plasticity: 20.8 per cent
Time of slaking: 7 minutes

Screen analysis		
Retained on screen	Percentage	Character of residue
No. 30	6.70	Abundance of clay nodules.
No. 60	23.90	Clay nodules.
No. 100	9.00	Clay nodules; small amount of milky quartz fragments.
No. 150	5.17	Clay nodules and pyrite particles; trace of quartz fragments.
No. 200	3.63	Quartz grains; trace of clay nodules.
No. 250	0.86	Quartz grains; trace of clay nodules.

Table 5. Summary of fired properties of clay

Cone	Temperature degree Fahrenheit	Percentage porosity	Percentage absorption	Apparent specific gravity	Bulk specific gravity	Percentage volume shrinkage	Percentage linear shrinkage	Modulus of rupture lbs./sq.in.	Color
03	1,976	25.8	13.9	2.49	1.85	3.6	1.20	1,117	Tan-pink.
01	2,030	22.2	11.3	2.52	1.96	7.9	2.71	1,642	Creamy tan.
2	2,075	21.9	11.3	2.49	1.94	8.0	2.74	1,331	Buff.
4	2,129	18.2	8.8	2.47	2.04	11.5	3.99	2,897	Buff, iron spots.
6	2,174	8.2	4.0	2.26	2.08	14.2	4.98	3,626	Buff.
8	2,237	3.9	1.9	2.06	2.06	13.2	4.61	2,870	Brown-black, over fired

Steel hardness at cone 01.
Overburning temperature, cone 8.
Best apparent burning range, cone 01 to 6.

Glass Sand

Composition and properties. The chemical requirements of a good glass sand are high silica content (99 per cent or more), and a minimum of harmful impurities, particularly iron, magnesia, and clay. The most important physical property of a desirable glass sand is grain size, which should be fairly uniform. An ideal range in size is between 30 mesh and 120 mesh, but many sands that exceed these limits are highly successful. The shape of the individual grains appears to be of small importance. For a comprehensive study of the sands of this area, the reader is referred to a report by Giles and Bonewits[5] on the St. Peter and older Ordovician sandstones of northern Arkansas.

Uses. In the manufacture of glass, sand is the principal raw material. The highest grades of glass require the greatest chemical purity in the raw sand used. Bottle glass, window glass, etc., are less exacting in their chemical requirements. The St. Peter and Kings River sandstones are, in most occurrences, suitable for ordinary glass manufacture, and treatment (washing and screening) will bring many within the limits required by the manufactures of quality glass products. Screening or grading of some sort is probably necessary to bring the sand to within limits of grain size required by manufactures, though locally a sandstone may be suitable for specific markets without grading to size and blending of products.

Other uses to which the St. Peter and Kings River sandstones are adaptable are building and paving sand, molding sand, engine (friction) sand, grinding and polishing sand, and filter sand.

Prices. Table 6, taken from data in Minerals Yearbook, Review of 1938, p. 1164, gives production and average prices of the most important commercial uses of sand.

Table 6. Sand sold or used by producers in the United States

King of sand	1937			1938		
	Short tons	Value		Short tons	Value	
		Total	Av. per sh. ton		Total	Av. per sh. ton
Glass	2,799,230	$4,746,629	$1.70	2,109,462	$3,601,734	$1.71
Molding	4,953,873	5,239,435	1.06	2,319,902	2,651,779	1.14
Building	26,050,459	14,809,078	0.57	22,939,683	12,888,823	0.56
Paving	17,395,013	9,487,817	0.55	16,755,634	9,388,865	0.56
Grinding and polishing	1,067,178	1,440,736	1.35	502,328	745,805	1.50
Fire or furnace	258,287	268,355	1.04	108,093	124,343	1.15
Engine	1,802,869	1,092,171	0.61	1,378,450	786,639	0.57
Filter	99,383	182,414	1.84	93,711	137,283	1.46

Occurrence. The St. Peter sandstone crops out in Carroll and Madison counties, and the Kings River sandstone crops out in Benton, Carroll, and Madison counties. In this area, the St. Peter sandstone ranges in thickness from 10 feet to 100 feet. The Kings River sandstone varies in thickness from 2 to 40 feet. Several locations of sandstone of potential commercial value are indicated on plate III. Tables 7, 8, and 9 give some physical and chemical properties of several sandstones. The numbers of the samples on the tables correspond to the index number on plate III. The samples are probably fairly representative of the formation at each place. It should be remembered, however, that these analyses are intended to show the general character of the sand only.

5/ Giles, A. W., and Bonewits, E. E., St. Peter and older Ordovician sandstones of northern Arkansas: Arkansas Geol. Survey Bull. 4, 1930.

Table 7. Results of screen tests of sands[1]

No.	Location	Horizon	Weight of sample grams	Percentage (by weight) left on screen of meshes specified								
				On 28	On 35	On 48	On 65	On 100	On 150	On 200	Pan	Total
1	10 mi. SE of Berryville, Carroll County	Middle of St. Peter formation	100	0.38	3.58	8.78	25.76	42.34	15.92	2.76	0.30	99.82
2	Same as 1	5 ft. above base of St. Peter formation	90	4.15	14.82	22.22	24.75	26.77	5.69	0.44	0.22	99.06
3	At Metalton on Piney Creek, Carroll County	Near top of St. Peter formation	100	3.02	23.80	12.59	13.92	34.58	8.30	1.47	0.63	98.31
4	Tarkiln Hollow, near Wolfpen, Carroll County	25 ft. below top of St. Peter formation	50	-	15.04	19.44	22.20	28.24	11.88	1.64	-	98.44
5	East of Forum, on Pine Creek, Madison County	5 ft. below top of St. Peter formation	50	4.92	27.64	39.00	17.10	9.30	1.70	0.30	-	99.96
6	NE of Forum, Kings River, Madison County	5 ft. above base of St. Peter formation	150	5.36	15.86	39.69	21.86	12.46	3.20	0.68	0.81	99.92
7	Rockhouse Hollow, Madison County	5 ft. below top of St. Peter formation	150	2.46	18.64	34.70	24.66	17.52	1.73	0.40	0.12	100.23
7A	Same as 7	5 ft. above base of St. Peter formation	50	-	14.68	21.80	29.00	30.44	3.24	0.22	-	99.38
8	Little Clifty Creek, east Benton County	Near top of Kings River formation	50	-	9.00	26.60	30.80	29.40	3.24	0.60	-	99.64
8A	Same as 8	Same as 8	50	-	11.50	27.44	28.20	25.20	5.14	0.84	-	98.32

1/ Giles, A. W., St. Peter and older Ordovician sandstones of northern Arkansas: Arkansas Geol. Survey Bull. 4, pp. 71 and 146, 1930.

Table 8. Chemical analyses of sands[1/]

No.	Location	Ignition loss	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	Total	Color
1	10 mi SE of Berryville, Carroll County	0.24	99.16	0.07	0.11	0.03	-	99.61	Cream
5	East of Forum in Pine Creek, Madison County	0.16	99.38	0.13	0.15	0.12	-	99.94	White
8&8A	Little Clifty Creek, East Benton County	0.24	99.24	0.11	0.19	-	-	99.78	White

1/ Giles, A. W., St. Peter and Older Ordovician Sandstones of Northern Arkansas: Arkansas Geol. Survey Bull. 4, pp. 71 and 146, 1930.

Table 9. Chemical analyses of St. Peter sandstone

No.	Location				SiO_2	Fe_2O_3	Al_2O_3	$CaCO_3$	MgO	Alkali	Total
	Quarter	S.	T.	R.							
9	NE	2	18N	26W	99.50	0.12	-	0.35	-	-	99.97
10	NE	19	19N	26W	99.64	0.04	-	0.34	-	-	100.02

<u>Production</u>. No high-grade sand from the St. Peter or Kings River sandstones has been produced from this area. The mining of sandstones at Everton in Boone County and at Guion in Izard County has been successful for several years.

Pyrite

Composition and properties. Pyrite (iron sulphide) is brass-yellow in color. It is harder than calcite and softer than quartz. When pyrite is roasted it oxidizes and sulphur dioxide and trioxide gases are evolved.

Uses. Pyrite is used in the manufacture of sulphuric acid. This acid is employed principally in the manufacture of phosphate fertilizers, explosives, and in refining crude oil.

Prices. Table 10 gives the value and production of pyrite in the United States for the years 1934 to 1938, inclusive.

Table 10. Pyrite (ores and concentrates) produced in the United States, 1934-1938[1]

Year	Production		Value	
	Gross weight (long tons)	Sulphur content (per cent)	Total	Average per long ton
1934	432,524	38.8	$1,216,363	$2.81
1935	514,192	39.5	1,583,074	3.08
1936	547,236	39.6	1,666,194	3.04
1937	584,166	39.7	1,777,787	3.04
1938	555,629	39.4	1,685,766	3.03

1/ Ridgeway, R. H., and Mitchell, A. W., Sulphur and Pyrites: Minerals Yearbook, Review of 1938, p. 1250, 1939.

Occurrence. Pyrite deposits of apparent substantial size have been found in Carroll County on the Newman farm, about 3 miles north and one-half mile west of Berryville, in the N½ NW¼ NE¼, sec. 12, T. 20 N., R. 25 W., and on the J. W. Van Hook farm in SE¼ SW¼ sec. 8, T. 20 N., R. 24 W. The Van Hook pyrite exposure (pyrite deposit no. 2, pl. III) is 1 1/8 mile southeast from the Newman deposit. Pyrite was encountered in wells dug in sec. 7, T. 20 N., R. 24 W., between the Newman farm and the Van Hook farm.

The largest known pyrite deposit in the area is on the Newman farm. (Pyrite deposit no. 1, pl. III), where mixed limonite and pyrite is exposed along the bed of a creek for about 100 feet and limonite is exposed over a wider area on the hill slope south of the creek. The pyrite occurs in the Cotter dolomite. The dolomite in the mineralized area is highly fractured. The major fractures strike N. 80° E., but there are numerous minor fractures striking in various directions.

This deposit was drilled in 1937 and 1938 by the Manda Industrial Company. The following map (pl. IV), sections (pls. V and VI), summary of drill holes (table 11), and tonnage estimate (table 12) are taken from a report by S. J. Burris, Jr., on the results of the drilling. In estimating the tonnage, Burris says:

> "For the purpose of estimating the tonnage of developed pyrite, the deposit has been split up into different zones and blocks. *** (See pls. V and VI) ***. While there is still some pyrite mineralization below zone 'C' it is too low in tenor to be of interest.
>
> "The following tabulations (see table 12) sum up the total developed tonnage of pyrite corresponding to the different zones and blocks of ground as shown on the attached maps." (See pls. V and VI.)

Table 11. Summary of analyses of Berryville pyrite deposit

Drill hole	Footage	Average analyses Sulphur (S)	Average analyses Iron (Fe)
1	0 to 300	Not analyzed	
2	1 to 70	38.40	38.50
	70 to 115	15.13	14.51
	115 to 150	24.27	23.20
	150 to 190	13.10	12.94
3	15 to 25	4.67	6.50
	25 to 30	25.81	25.40
	30 to 50	16.30	15.75
4	50 to 75	4.11	5.40
5	27 to 55	37.23	38.70
	55 to 66	32.93	31.40
	66 to 81	20.13	19.87
	81 to 101	10.46	11.00
	101 to 121	16.00	16.50
	121 to 256	5.38	6.47
6	30 to 45	23.55	22.55
	45 to 65	8.94	9.05
7	35 to 50	30.00	32.93
	50 to 55	43.94	43.00
	55 to 70	25.46	26.33
	70 to 86	9.36	10.83
	86 to 95	22.57	22.30
	95 to 115	11.89	12.47
	115 to 120	24.10	23.80
	120 to 150	8.75	9.61
	150 to 290	3.85	5.07
8	0 to 50	27.67	28.43
	50 to 75	24.24	23.45
	75 to 100	15.29	15.86
	100 to 180	4.30	5.42
9	45 to 50	8.54	8.30
	50 to 70	2.62	3.72
	70 to 95	6.69	6.79
10	0 to 25	2.25	3.16
	25 to 50	17.51	16.46
	50 to 60	5.50	5.85
10 cont.	60 to 70	12.62	11.95
	70 to 100	3.64	4.33
11	20 to 65	1.64	2.70
	65 to 70	9.27	9.00
	70 to 80	2.72	3.65
12	0 to 55	4.42	5.75
	55 to 75	14.00	14.60
	75 to 100	5.64	7.48
	100 to 180	6.20	-
13	0 to 116	Not analyzed	
14	30 to 55	22.80	-
	55 to 90	15.30	-
	90 to 155	26.40	-
	155 to 180	7.60	-
15	40 to 55	10.88	-
	55 to 90	27.43	-
	90 to 95	12.31	-
	95 to 100	28.16	-
	100 to 180	11.00	-
16	0 to 120	Not analyzed	
17	40 to 60	11.53	-
	70 to 75	22.16	-
	75 to 90	7.19	-
	90 to 95	21.82	-
	95 to 115	6.91	-
	145 to 150	7.81	-
18	0 to 94	Not analyzed	
19	18 to 85	33.06	-
	85 to 140	12.57	-
	140 to 145	20.10	-
	145 to 160	13.15	-
	160 to 175	5.73	-
20	25 to 35	23.55	-
	35 to 50	11.48	-

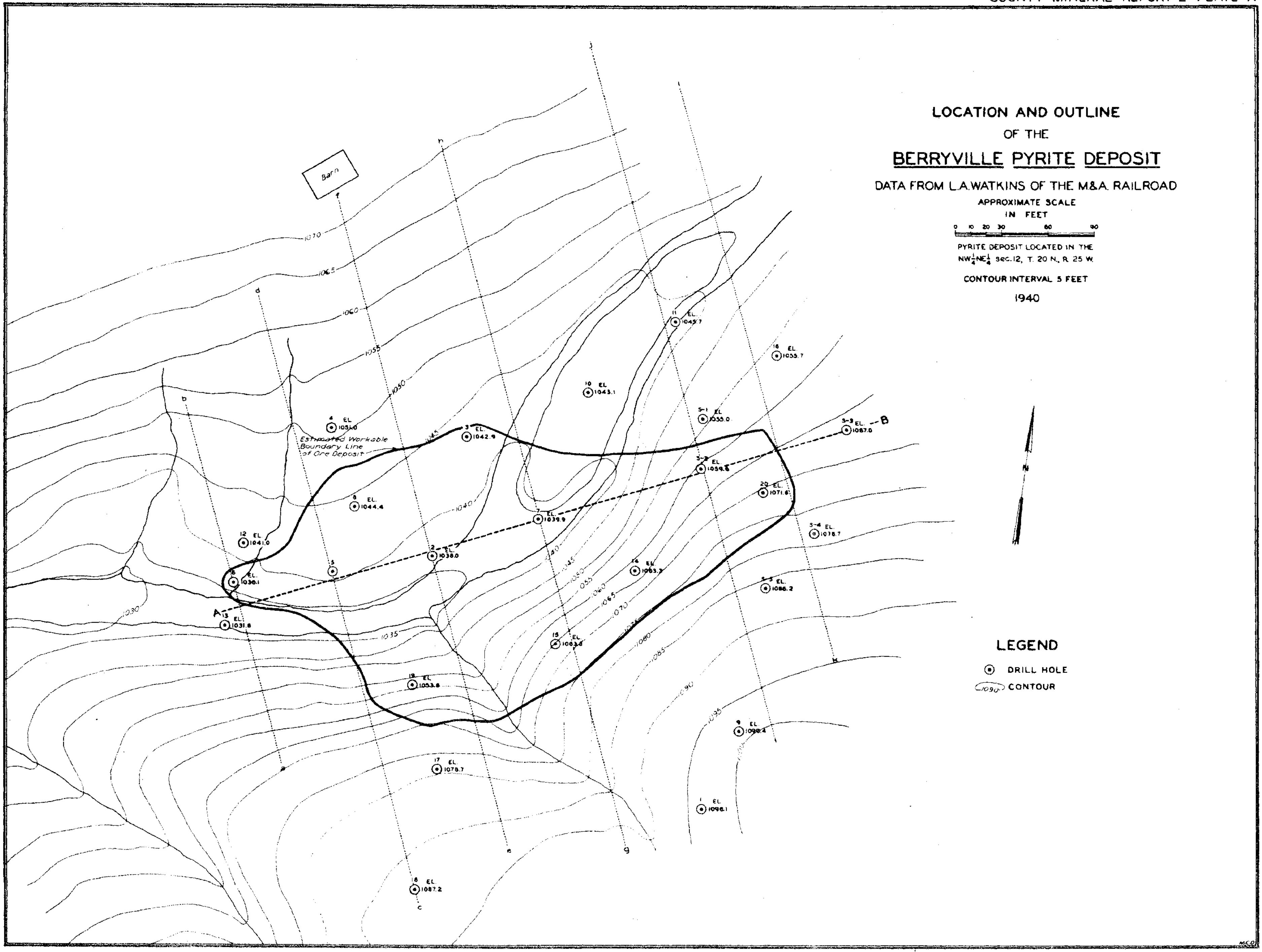
Table 11. Summary of analyses of Berryville pyrite deposit (cont.)

Drill hole	Footage	Average analyses Sulphur (S)	Average analyses Iron (Fe)	Drill hole	Footage	Average analyses Sulphur (S)	Average analyses Iron (Fe)
20	115 to 120	5.17	-	S-2	5 to 20	3.62	6.00
cont.	120 to 125	27.78	-		20 to 55	27.15	26.82
	125 to 130	9.42	-		55 to 80	6.53	8.56
	130 to 145	20.44	-		80 to 190	31.43	-
	145 to 155	5.85	-				
	155 to 175	13.17	-				
	185 to 195	16.75	-	S-3	0 to 145	Not analyzed	
	195 to 205	5.35	-				
				S-4	40 to 45	3.80	-
S-1	0 to 45	2.78	3.79		45 to 100	13.90	-
	45 to 50	17.05	17.00		100 to 105	6.00	-
	50 to 55	3.05	4.30				
	55 to 60	26.65	25.40				
	60 to 95	3.98	5.07	S-5	0 to 100	Not analyzed	
	95 to 125	6.09	7.50				
	125 to 200	18.41	18.80				
	200 to 240	5.49	6.43				

Table 12. Summary of developed tonnage of pyrite

Zone	Block	Overburden cu.yds.	Crude ore Volume cu.ft.	Crude ore Per cent sulphur	Crude ore Cu.ft. per ton	Crude ore Long tons	Long tons pyrite 42% sulphur
"A"1/	1-A	1,620	106,898	23.55	8.8	12,148	6,811
	2-A	6,300	532,712	30.81	8.0	66,589	48,850
	3-A	10,300	658,245	32.40	7.9	83,322	64,275
	4-A	17,450	522,069	28.80	8.3	62,900	48,130
	5-A	10,000	159,521	27.50	8.4	18,990	12,433
	6-A	1,330	17,328	23.55	8.9	19,470	10,917
		47,000				263,419	191,416
"B"2/	1-B	-	66,726	8.94	10.7	6,230	1,326
	2-B	-	380,359	13.34	10.0	38,036	12,080
	3-B	-	429,730	13.75	9.9	43,407	14,211
	4-B	-	312,403	10.00	10.5	29,753	7,084
	5-B	-	127,617	6.53	11.1	11,497	1,787
	6-B	-	14,640	11.48	10.2	1,435	392
						130,358	36,880
"C"3/	1-C	-	-	-	-	-	-
	2-C	-	58,426	19.40	9.2	6,350	2,933
	3-C	-	116,340	22.82	8.8	13,220	7,178
	4-C	-	281,089	24.25	8.7	32,309	18,652
	5-C	-	294,240	31.43	8.0	36,780	27,522
	6-C	-	-	-	-	-	-
						88,659	56,285

1/ 47,000 cu. yds. of overburden is equivalent to 105,750 tons. Ratio of overburden to crude ore, 0.40:1. Ratio of crude ore to pyrite, 1.38:1.
2/ Ratio of crude ore to pyrite, 3.51:1.
3/ Ratio of crude ore to pyrite, 1.58:1.

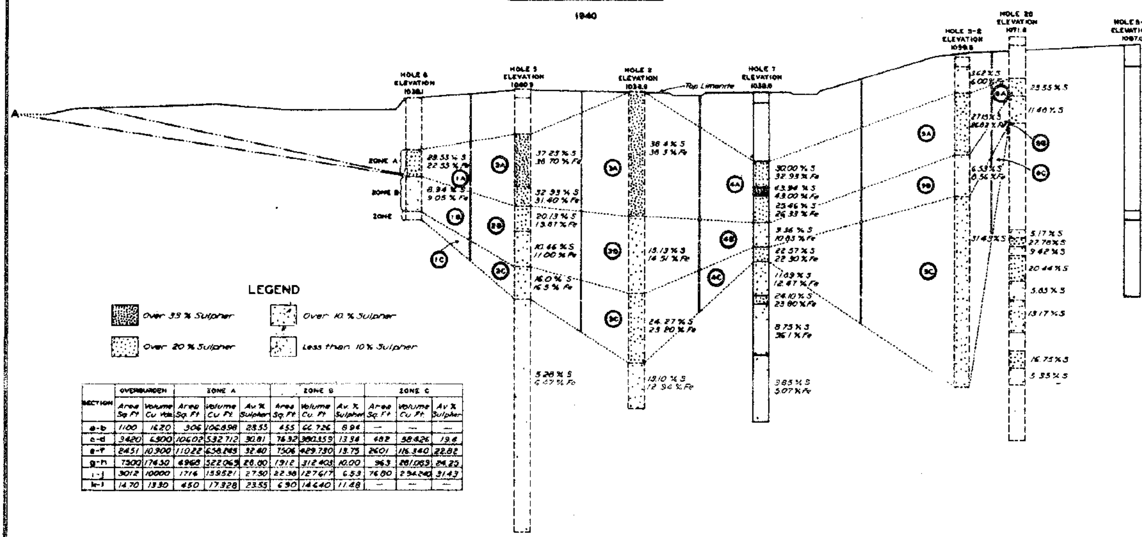

LOCATION AND OUTLINE
OF THE
BERRYVILLE PYRITE DEPOSIT
DATA FROM L.A.WATKINS OF THE M&A. RAILROAD
APPROXIMATE SCALE
IN FEET
0 10 20 30 60 90
PYRITE DEPOSIT LOCATED IN THE
NW¼NE¼ sec.12, T. 20 N., R. 25 W.
CONTOUR INTERVAL 5 FEET
1940
LEGEND
DRILL HOLE
CONTOUR
N
Barn
Estimated Workable Boundary Line of Ore Deposit
A
B
1070
1065
1060
1055
1050
1045
1040
1035
1030
1090
1095
4 EL. 1051.0
3 EL. 1042.9
8 EL. 1044.4
12 EL. 1041.0
2 EL. 1038.0
7 EL. 1039.9
10 EL. 1043.1
11 EL. 1045.7
16 EL. 1055.7
5-1 EL. 1055.0
5-2 EL. 1059.6
5-3 EL. 1087.0
20 EL. 1071.6
5-4 EL. 1078.7
5-5 EL. 1086.2
14 EL. 1063.3
15 EL. 1063.6
13 EL. 1031.6
19 EL. 1053.6
17 EL. 1078.7
18 EL. 1087.2
9 EL. 1098.4
1 EL. 1098.1

SECTION A-B
IN THE
BERRYVILLE PYRITE DEPOSIT

DATA FROM L.A. WATKINS OF THE M.&A. RAILROAD

APPROXIMATE SCALE
IN FEET

1940



LEGEND

Over 33 % Sulpher — Over 10 % Sulpher

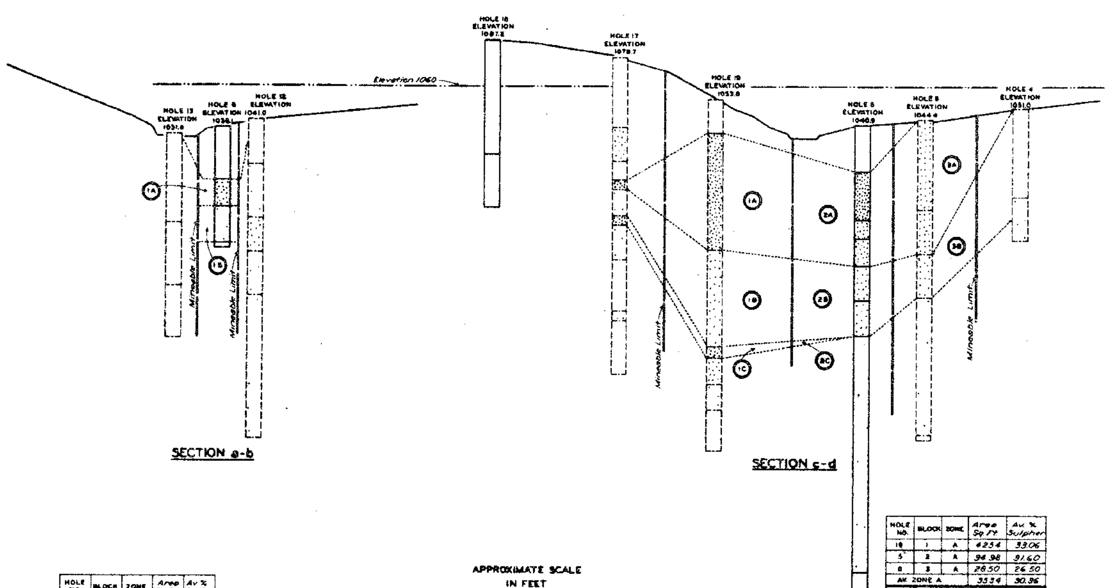
Over 20 % Sulpher — Less than 10 % Sulpher

SECTION	OVERBURDEN		ZONE A			ZONE B			ZONE C		
	Area Sq. Ft.	Volume Cu. Yds.	Area Sq. Ft.	Volume Cu. Ft.	Av. % Sulpher	Area Sq. Ft.	Volume Cu. Ft.	Av. % Sulpher	Area Sq. Ft.	Volume Cu. Ft.	Av. % Sulpher
a-b	1100	1620	306	106.898	23.55	455	66.726	8.94	—	—	—
c-d	3420	6300	10602	532.712	30.81	7632	380.359	13.94	482	58.426	19.4
e-f	2451	10.900	11022	638.285	32.40	7506	429.730	13.75	2601	116.340	22.82
g-h	7500	17630	4968	522.065	26.00	1912	312.403	10.00	963	281.063	24.25
i-j	3012	10000	1714	159.521	27.50	22.38	127.617	6.53	7680	294.240	31.43
k-l	14.70	1330	450	17.328	23.55	690	14.640	11.48	—	—	—

SECTIONS ACROSS THE
BERRYVILLE PYRITE DEPOSIT

DATA FROM L.A. WATKINS OF THE M.&A. RAILROAD

1940



HOLE NO.	BLOCK	ZONE	Area Sq. Ft.	Av. % Sq. Ft.
6	1	A	306	23.55
6	1	B	455	8.94

APPROXIMATE SCALE
IN FEET

LEGEND

Over 33 % Sulpher — Over 10 % Sulpher

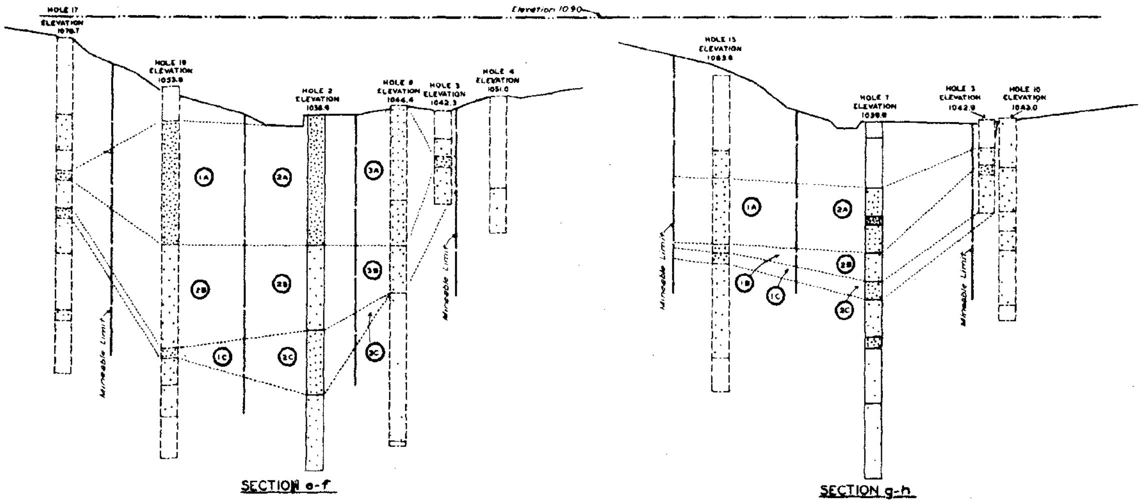
Over 20 % Sulpher — Less than 10 % Sulpher

HOLE NO.	BLOCK	ZONE	Area Sq. Ft.	Av. % Sulpher
19	1	A	4254	33.06
5	2	A	94.98	31.60
8	3	A	26.50	26.50
AV. ZONE A			3534	30.96
19	1	B	34.92	12.57
3	2	B	2586	13.23
8	3	B	1554	15.29
AV. ZONE B			2544	13.69
18	1	C	400	20.10
8	2	C	82	16.00
AV. ZONE C			241	18.05

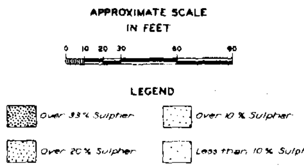
SECTIONS ACROSS THE BERRYVILLE PYRITE DEPOSIT

DATA FROM L.A. WATKINS OF THE M.& A. RAILROAD

1940



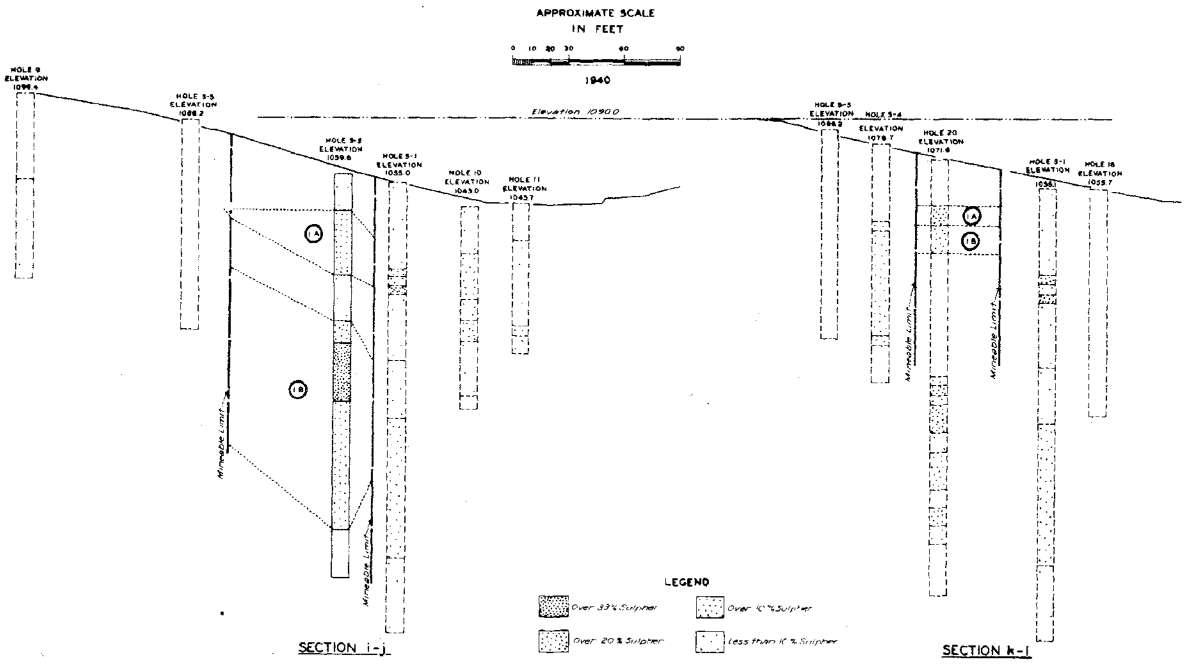
HOLE NO.	BLOCK	ZONE	Area Sq. Ft.	Av % Sulpher
19	1	A	4236	33.06
2	2	A	4200	38.40
8	3	A	2586	26.50
AV. ZONE A			3674	32.65
19	1	B	3438	12.57
2	2	B	2748	14.51
8	3	B	1320	15.29
AV. ZONE B			2502	14.12
19	1	C	702	20.10
2	2	C	1710	24.27
8	3	C	189	19.78
AV. ZONE C			864	21.38



HOLE NO.	BLOCK	ZONE	Area Sq. Ft.	Av % Sulpher
15	1	A	2334	27.43
7	2	A	1512	30.00
AV. ZONE A			1923	28.71
15	1	B	400	12.31
7	2	B	1512	9.36
AV. ZONE B			956	10.83
15	1	C	291	28.16
7	2	C	672	22.57
AV. ZONE C			481	25.06

SECTIONS ACROSS THE BERRYVILLE PYRITE DEPOSIT

DATA FROM L.A. WATKINS OF THE M.& A. RAILROAD



HOLE NO.	BLOCK	ZONE	Area Sq. Ft.	Av % Sulpher
29	1	A	1716	275
29	1	B	7680	3143

HOLE NO.	BLOCK	ZONE	Area Sq. Ft.	Av % Sulpher
20	1	A	450	23.55
20	1	B	690	11.48

Economic importance. There are at present no plants equipped to burn pyrite within economic shipping distance of the Berryville area. The factors bearing on the possible commercial development of pyrite in this area make a complex problem. It appears possible that, if a local use for sulphuric acid could be found, such as the manufacture of acid phosphate from north Arkansas phosphate rock, a small acid plant might be operated profitably. Cheap electric power in the north Arkansas area might also affect the value of the pyrite deposits.

Production. No production of pyrite has been reported in Arkansas. United States production for the years 1934 to 1938 is shown in table 10.

Quartz

An unusual deposit of quartz occurs on Crystal Mountain in Carroll County. This quartz is located in the S½, sec. 24, T. 19 N., R. 24 W., approximately 7½ miles southeast of Berryville on the property of R. L. Brawley. (See quartz deposit no. 1, pl. III.)

The deposit lies on the top of a high plateau, the flanks of which are steep and composed of large irregular broken blocks of chert. The quartz occurs as a crust on the chert boulders. The size of the individual crystals varies from pyramids of quartz less than one sixteenth of an inch, to some over two inches in diameter. The color of the quartz ranges from colorless to shades of yellow, pink, blue, and lavender.

Mr. Brawley, the owner, states that he has sold the crystal aggregates for ornamental purposes such as rock gardens, for building decorations, fire places, etc. The average price was $12.50 per ton. Specimens of unusual beauty have been sold for as much as $15.00 each.

Boulders which carry quartz encrustations cover an area of approximately 3 acres, and are found in the clays to a depth of 30 feet. It was stated by Mr. Brawley that no ledge rock was encountered at that depth.

Tripoli

Composition and properties. The term "tripoli" is loosely used to include many fine-grained substances, consisting principally of silica used for abrasive purposes, but here the word "tripoli" designates a light, porous rock, high in silica, which has an even fine-grained texture. Most of the grains are under one hundredth of a millimeter in diameter, and are probably chalcedony (a form of quartz).

Five samples of tripoli were analyzed by the Mineral Survey Laboratory. The composition of these samples is shown in table 13.

Table 13. Analyses of tripoli from Benton County

Constituents	Deposit No. 2	Deposit No. 3	Deposit No. 6	Deposit No. 8	SW SW sec. 14-20N-31W
Insoluble	70.94	99.30	99.50	99.48	98.60
Iron (Fe_2O_3)	0.16	0.23	0.23	0.22	Trace
Alumina (Al_2O_3)	0.70	1.27	1.17	0.02	2.10
Calcium carbonate ($CaCO_3$)	27.31	0.00	0.00	0.00	0.00
Calcium oxide (CaO)	15.30	0.00	0.00	0.00	0.00
Carbon dioxide (CO_2)	12.01	0.00	0.00	0.00	0.00
Moisture	0.12	0.00	0.00	0.00	0.00
Magnesium carbonate ($MgCO_3$)	0.00	0.00	0.00	0.00	0.00
Magnesium oxide (MgO)	0.00	0.00	0.00	0.00	0.00

Uses. Of the tripoli sold or used by producers in 1938 in the United States, 36.5 per cent of the tonnage and 42.2 per cent of the value was used for abrasives: 25.2 per cent of the tonnage and 24.0 per cent of the value was used as filler: 9.8 per cent of the tonnage and 3.8 per cent of the value was used as concrete admixture; and 28.5 per cent of the tonnage and 30.0 per cent of the value was used for miscellaneous purposes, including filter block, foundry facing, and other unspecified uses.

The tripoli from Arkansas appears to be best adapted for use as filler, but is also employed as concrete admixture and for other uses. In recent years the Arkansas product, having the trade name "Opalite," has found a large potential market as a constituent of drilling muds used in oil well drilling.

Prices. In 1937 the finished products of Arkansas tripoli were reported to be priced from $8.00 to over $22.50 per short ton, f.o.b. mill. The average yearly prices per short ton of tripoli in the United States, according to the U. S. Bureau of Mines, are shown on table 14.

Occurrence. The tripoli found in the Benton, Carroll, Madison, and Washington county area occurs in the Boone formation and is thought to be an alteration product of the chert. The largest deposits of tripoli in this area are in Benton County, two deposits are known in Washington County, and one deposit has been reported from Madison County. No tripoli is known to occur in Carroll County.

The most important of the known tripoli deposits are described below. The number of each deposit corresponds to a location number on plate III.

The Corona Products, Inc., quarry (no. 18 on pl. III) is located in secs. 11 and 14, T. 19 N., R. 29 W., approximately 3½ miles east of Rogers and about half a mile west of State Highway 12. The tripoli is pure white and contains 98 per cent or more silica. The tripoli bed is nearly horizontal. It averages 30 feet in thickness and has an areal extent of about 60 acres.

Early mining was done underground, using the room and pillar method. Six rooms, an average of 50 feet by 100 feet by 30 feet in height, were excavated. The underground mining was abandoned in favor of quarrying when some trouble with caving ground was anticipated. Plate VII shows some of the rooms that have been broken into with the quarry. All of the tripoli now being produced is quarried. The quarry is roughly circular in shape, with dimensions of about 125 feet by 175 feet and with an average depth of 15 feet. An average of about 2 feet of overburden is stripped from the surface. Drilling is done with power drills and light charges of powder are used for blasting. A small Insley power shovel loads the broken tripoli into trucks and the material is taken to the company plant at Rogers where it is prepared for market. (See pl. VII.) The Corona Products plant has a daily capacity of 60 tons. The tripoli is wet ground in a pebble lined tube mill and water classified. It is then dried and air classified. Several classes of product are made, all of which will screen 99.5 per cent through 325 mesh.

The Corona Products, Inc., has reported a production of 23,300 short tons with a value of $379,230.92 for the years 1929 to 1939 inclusive.

Number 1. Tripoli is exposed in a road cut on the west side of U. S. Hwy. 62 in the NW¼ SW¼ sec. 4, T. 20 N., R. 29 W. The cut is 200 feet south of a bridge over a dry branch, approximately 5 miles north of Rogers. The exposure is at the base of a small hill, approximately 100 feet in height. The tripoli is snow white, fine-grained, hard, and the exposed material has not become earthy. The tripoli is 5 feet thick and is exposed for a length of 50 feet along the cut. The hill in which the tripoli bed is present has an area of at least 5 acres. The deposit is easily accessible for truck haulage.

Number 2. Tripoli is exposed in the bed of the middle fork of Osage Creek in the center of the SW$\frac{1}{4}$ sec. 34, T. 19 N., R. 30 W., approximately 2$\frac{1}{2}$ miles from the town of Cave Springs. The tripoli forms the bed of the creek for a distance of 100 yards, and also is exposed on the west bank of this creek. The exposure ranges from 4 to 5 feet in thickness. There is a high percentage of limestone fragments in this tripoli. (See analysis, table 13.) Transportation facilities to the deposit are poor.

Number 3. A deposit crops out along a W.P.A. road from Highfill to Gentry, 3 miles from Gentry, in the NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 9, T. 18 N., R. 32 W. It is situated on the west side, and near the base of a very steep hill. The hill at this point forms a right angle at its base;one prong of the ridge runs north, while the other prong forms a ridge running east. The top of the hill is a small flat plateau which stands at an elevation of approximately 100 feet above the valley. The outcrops of tripoli were traced from the point of the hill on its west slope for a distance of 300 yards, with an exposed face measuring 30 feet in height. Tripoli in this exposure appears to be free of limestone and chert impurities; it is soft, coarse-grained, and light in weight. (See analysis, table 13.) The deposit is near a good W.P.A. road and only 3 miles from rail transportation. It could be easily mined by underground methods. .

Number 4. Tripoli is found along a county road one mile south of the village of Bloomfield, in the SE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 12, T. 18 N., R. 34 W. The tripoli is found in loose boulders which are scattered along the road cut, and flat pieces which cover over 2 acres of the surface on the east and west sides of the road. No excavation has been made to determine the thickness of the beds. The boulders of tripoli are coarse-grained and earthy. They are stained red and yellow in places, due to the presence of iron oxides. There has been no development of this deposit.

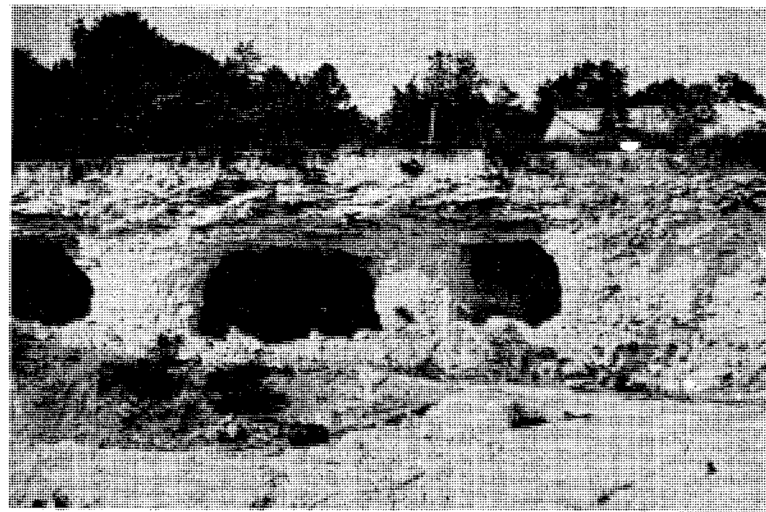
Number 5. Tripoli in the NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 27, T. 21 N., R. 34 W., is approximately 3 miles south of the town of Southwest City, Missouri, and a half mile from a branch line of the St. Louis & San Francisco Railway. The tripoli crops out about two-thirds of the distance around a dome-shaped hill, approximately 40 feet below its top, and it has an exposed face 25 feet high at the outcrop. The deposit covers approximately 5 acres at the surface. The tripoli is snow white, light in weight, and free from limestone and chert impurities. It is of a good grade. The deposit could be mined by underground methods.

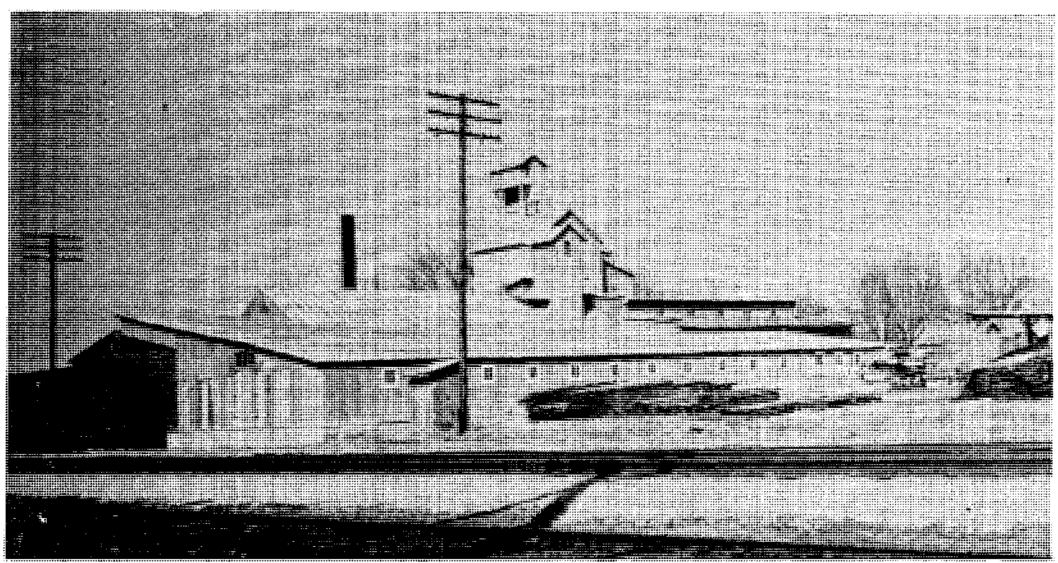
Number 6. A deposit is one mile north of Gravette, on U. S. Hwy. 71, in the NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 2, T. 20 N., R. 33 W. A low dome-shaped hill is cut through its center by the highway. The hill is roughly circular in shape and has an area of approximately 2$\frac{1}{2}$ acres. The tripoli bed averages 12 feet in thickness. (See analysis, table 13.) The location of the deposit on the highway near the tracks of the Kansas City Southern Railway is ideal for transportation facilities.

Number 7. Tripoli is found one-half mile north of Gravette, at the Cobb Tourist Camp on U. S. Hwy. 71. Tripoli crops out here in several places along both sides of a ridge, approximately 50 feet down the slopes. The tripoli is stained yellow in places, but few limestone and chert impurities are present. The deposit is adaptable to mining either by stripping or by underground methods. Some of this tripoli was used as a building stone in the construction of nearby camp buildings. The Kansas City Southern Railway tracks are adjacent to the deposit.

Number 8. A tripoli deposit is located in the NW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 8, T. 20 N., R. 29 W., on a south flowing branch of Sugar Creek, 150 yards from the confluence of the branch and Sugar Creek. It is 1$\frac{1}{2}$ miles from U. S. Hwy. 62 at Bestwater. It has an outcrop 100 yards long and a thickness of approximately 4 feet above the stream bed. The tripoli is capped by limestone. Chert inclusions near the contact make the exposed tripoli low in grade. Immediately east of this exposure, white tripoli of good quality is exposed on the county road at the base of a hill. (See analysis, table 13.) The thickness here is as much as 25 feet, and the tripoli is exposed for a length of 100 feet along the hillside. It is possible that a fair tonnage of good tripoli could be

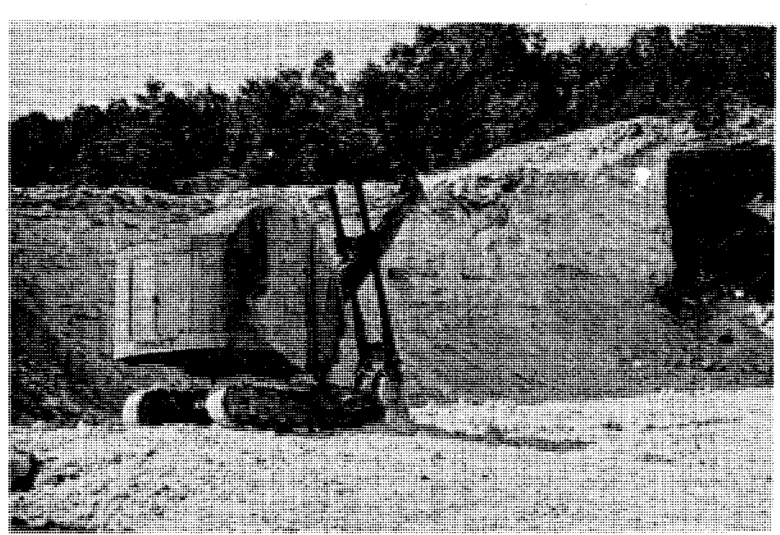
View of Silica Products, Inc., Quarry showing abandoned underground workings





View of Silica Products, Inc., Plant at Rogers, Benton County

View of Silica Products, Inc., Quarry



developed here.

Number 9. A deposit in the SE$\frac{1}{4}$ SW$\frac{1}{4}$ and the SW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 23, T. 19 N., R. 29 W., is known as the Starck Prospect. Outcrops occur for a distance of 250 yards along State Highway 94, and are traceable over a hillside which covers an area of 20 acres. Twenty-one feet of white tripoli is exposed in a cistern at the Starck home, and the bottom of the cistern is in tripoli. The deposit is adjacent to a good gravel road approximately 6 miles from railway transportation at Rogers.

Number 10. Tripoli is present on both sides of a cut along the abandoned Kansas City & Memphis Railroad in the SW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 35, T. 19 N., R. 29 W. Tripoli is exposed from the top to the bottom of the 28-foot cut for a distance of 350 feet, and it covers about 9 acres. The tripoli is somewhat iron-stained and contains hard chert inclusions.

Number 11. Tripoli is located along State Highway 72, 3$\frac{1}{2}$ miles northeast of Bentonville in the NE$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 22, T. 20 N., R. 30 W. Nine feet of tripoli is exposed for a distance of 300 feet. An area of 9 acres is believed to be underlain by tripoli which appears to be of good quality. The location is favorable for highway transportation. The deposit could be mined by open pit methods.

Number 12. A deposit known locally as the Sugar Creek Prospect No. 1., is located on the north bank of Little Sugar Creek, near State Highway 72 in the SE$\frac{1}{4}$ sec. 11, T. 20 N., R. 30 W. Twelve feet of tripoli is exposed for a quarter mile along a county road. The tripoli contains impurities of limestone and chert.

Number 13. A deposit, known locally as the Little Sugar Creek Prospect No. 2, is probably an extension of deposit Number 12. It is located in the NW$\frac{1}{4}$ sec. 7, T. 20 N., R. 30 W. The characteristics and thickness of the tripoli in the deposit are similar to those of tripoli in deposit Number 12.

Number 14. Tripoli is located on State Highway 72, about 3$\frac{1}{2}$ miles from Bentonville in the center of sec. 15, T. 20 N., R. 30 W. The tripoli covers approximately 2 acres and is about 12 feet thick. The quality of the tripoli is good. This deposit is not adaptable to open pit mining but could be mined by the room-and-pillar method.

The tripoli deposits investigated in Washington County are not as large nor of as good quality as those studied in Benton County. The two occurrences in Washington County that appear to have the most promise are:

NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 32. T. 18 N., R. 29 W. (See tripoli deposit no. 15, pl. III.)
SW$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 26, T. 18 N., R. 28 W. (See tripoli deposit no. 16, pl. III.)

Number 17. The only location of tripoli reported from Madison County is approximately 2 miles north of the town of Hindsville in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 33, T. 18 N., R. 27 W. (See pl. III.) This deposit is located on the bank of a shallow creek approximately one mile from its confluence with War Eagle Creek. The tripoli is exposed in a discontinuous bed which occurs between strata of limestone and chert of the Boone formation. The tripoli is impure, is stained yellow to brown, and is not suitable for commercial use. The deposit is about 20 miles from railway transportation.

Economic importance. The average annual production of tripoli in the United States for the years 1934 to 1938 inclusive was 26,703 short tons as reported by the U. S. Bureau of Mines[6]. There is probably somewhat more tripoli exported from the United States than is imported, and, therefore, the domestic production is slightly greater than the domestic consumption.

6/ Johnson, Bertrand L., and Schauble, M., Abrasive Materials: U. S. Bureau of Mines Minerals Yearbook, Review of 1938, p. 1227, 1939.

Figure 4 shows graphically the production of tripoli from Benton County for the years 1934 to 1938 and the percentage relationship between Benton County production and the total United States production. It is apparent that, although the tonnage produced varies widely from year to year, Benton County tripoli has maintained a steady position in relationship to total production.

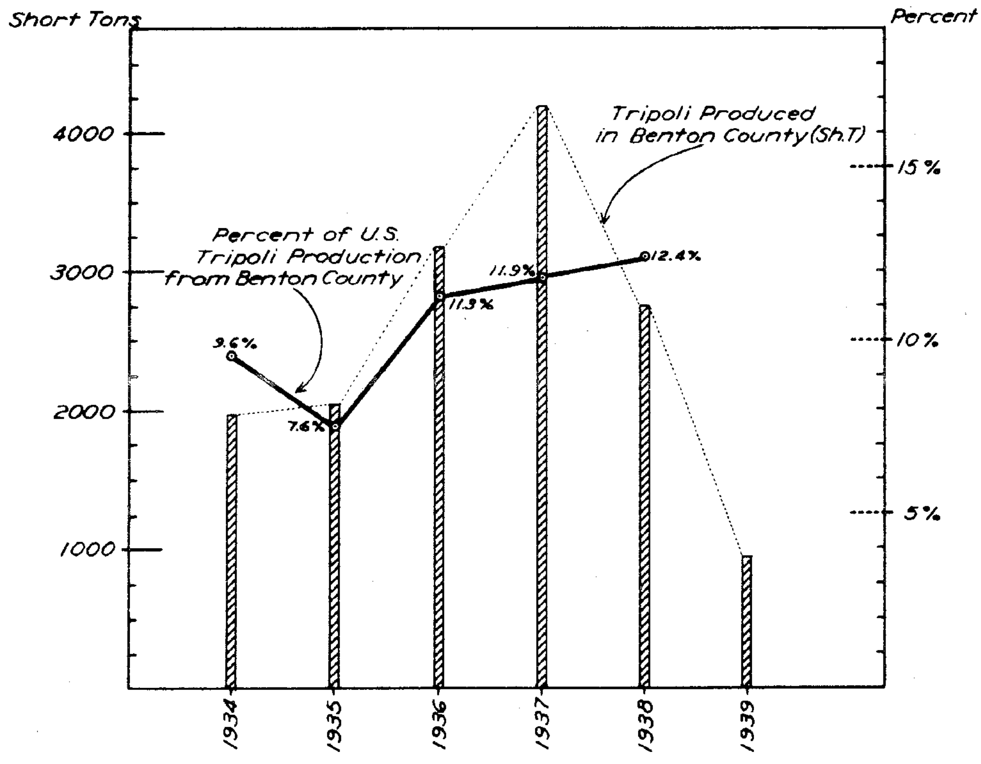


Figure 4. Tonnage of tripoli produced in Benton County and percentage relationship to United States production, 1934-1938

The production of tripoli is limited by the needs of consumers, and these needs may be gauged by the records of past production. New markets for tripoli may be developed and present markets may be extended in the future, but it is unlikely that these factors would cause a sharp increase in demand.

The developed deposits in northern Arkansas have large reserves of raw tripoli, and present plant (mill) capacity is more than adequate to supply the present demands for the product. There are undeveloped deposits of tripoli in North Arkansas that appear to be of good quality, of sufficient size, and well located for exploitation. The commercial development of these deposits is a complex problem.

Production. All of the production of tripoli in northwest Arkansas has come from Benton County. The total production is shown in table 14.

Table 14. Production and value of tripoli produced in Benton County1/

Year	Production short tons	Value	Average price per short ton
1929	300	2,928.00	$ 9.76
1930	5,455	104,790.55	19.21
1931	1,429	27,451.09	19.21
1932	1,135	24,084.70	21.22

Table 14. Production and value of tripoli produced in Benton County (cont.)

Year	Production short tons	Value	Average price per short ton
1933	809	14,505.37	17.93
1934	1,972	21,810.32	11.06
1935	2,079	22,993.74	11.06
1936	3,230	50,194.20	15.54
1937	4,186	60,697.00	14.50
1938	2,750	35,365.00	12.86
1939	955	14,410.95	15.09
	24,300	379,230.92	15.61

1/ Based on state severance tax reports.

BUILDING STONE

Composition and properties. The principal desirable properties of a building stone are: relatively high strength (hardness and toughness), low percentage of absorption (absence of pores and minute fractures), good workability (ease of cutting and dressing), resistance to chemical weathering, and beauty (attractive color and texture). Physical and chemical tests may be made to determine the adaptability of rocks to particular uses, but the best test of a building stone is observation of the stone in use over a period of years.

A survey was made of 358 stone structures in Benton, Carroll, Madison, and Washington counties. Approximately 55 per cent of all of the stone used in the structures surveyed is field stone gathered near the site of the structures. The field stone is derived principally from the Atoka sandstone, the Wedington sandstone, the Boone formation, and the Hale sandstone. Most of the field stone is used as found or is rough cut.

About 45 per cent of the stone has come from quarries. Approximately 17 per cent of the stone has been quarried from the Boone formation (including the St. Joe limestone), and about the same percentage of stone has been quarried from lower Ordovician magnesian limestones (nearly all is Cotter dolomite). Less than 2 per cent of the quarried stone is Hale sandstone, about 1.3 per cent is Atoka sandstone, and less than 1 per cent is Wedington sandstone. About 7.5 per cent of the quarried stone was not identified as to formation. The major part of this unidentified stone is probably Boone limestone, Pitkin limestone, Brentwood limestone, and Wedington sandstone. (See table 16.)

The structures surveyed were constructed between 1820 and 1939 and more than half were built since 1930. Less than 3 per cent of the structures were reported to be in poor condition for which inferior mortar is partly responsible. The oldest structure, a stone house between Fayetteville and Greenland in Washington County, was constructed in 1820 of Wedington sandstone. The stone is reported to be in good condition, but the mortar is crumbling and cracking.

Uses. Of the structures surveyed there were 110 residences, 61 stores, 25 garages and filling stations, 24 schools, 22 business and office buildings, 19 cabins, 16 churches, 14 hotels and apartment houses, 13 public buildings, 8 farm buildings, 7 factories, 4 warehouses, 3 hospitals, and 2 railroad stations. There were also 23 retaining walls, 5 dams, and 2 bridge abutments. Approximately 55 per cent of the stone was used in dams, retaining walls, and bridge abutments. The major part of the stone used in this class of structure was rough field stone. About 45 per cent of the stone was used for the several kinds of buildings listed above. Most of the stone used in this class of structure was cut or rough cut quarried stone.

Occurrence. Stone suitable for building purposes is widely and abundantly distributed over the four-county area. Field stone is present over most of the area. The Boone limestone, the St. Joe limestone, the Cotter dolomite, the Wedington sandstone, the Atoka sandstone, and the Pitkin limestone are good quarry stones and of these formations, one at least is available in every township. Locations and brief descriptions of several quarries are given on table 15.

Production. It is estimated that there are 3,752,244 cubic feet of stone in the 358 structures surveyed. Approximately 3,725,510 cubic feet of stone came from Benton Carroll, Madison and Washington counties. About 26,734 cubic feet of stone was imported from other states and other counties of Arkansas. (See table 16.)

Dolomite

Composition and properties. Chemically pure dolomite consists of 45.65 per cent magnesium carbonate, and 54.35 per cent calcium carbonate. Dolomite rock commonly contains more or less silica, iron, excess lime, or other elements. Physically, dolomite rock resembles limestone with which it is easily confused. It is slightly harder than limestone, and will not effervesce with cold dilute hydrochloric acid. (Limestone effervesces freely.)

Uses. Dolomite may be used as road material, building stone, and structural stone. It is used to correct acidity and as a source of magnesium in soils, in glass manufacture, and in the manufacture of insulating material (such as rock wool). Dead-burned dolomite is used as a refractory in furnace bottoms.

Prices. The prices paid for dolomite depend upon the use for which it is employed. Crushed dolomite usually sells for about the same as crushed limestone and sandstone. The price of crushed rock f.o.b. plant ranges from about 50 cents to $2.00 per short ton.

Occurrence. The only surface occurrences of dolomite of possible economic importance in this area are located in Carroll and Benton counties. The dolomite is part of the Cotter formation. The deposits described below are numbered to correspond to the location numbers on plate VIII.

Number 1. A symmetrical ridge of dolomite parallels the east bank of the White River in sec. 20, T. 21 N., R. 26 W. This ridge supports the east side of the Missouri and Arkansas Railway bridge, which crosses the White River near Beaver Station. The dolomite forms a steep bluff which rises approximately 100 feet above normal water level. The dolomite is fine-grained, light-gray, and hard. Occasional lenticular nodules of chert are present between the beds. Very thin beds of sandstone are locally present. On exposed surfaces, the dolomite beds are vertically jointed and cubical blocks weather out from the formation.

Number 2. A cut and tunnel of the Missouri and Arkansas Railway in the NW¼ NW¼, sec. 31, T. 21 N., R. 25 W., has exposed a thickness of 20 feet to 40 feet or more of dolomite. The dolomite appears to be of good quality with only minor chert and thin sandy beds. A large tonnage of material has been indicated by the railroad cut, and conditions here seem to be favorable for low quarrying costs.

Number 3. The only reported production of dolomite has come from two quarries near Sulphur Springs in Benton County. Both are operated by the Independence Gravel Company, whose main office is located in Joplin, Missouri. The Chalybeate Quarry is located on U. S. Hwy. 71 at Chalybeate Creek in sec. 15, T. 21 N., R. 33 W. This quarry is about 400 feet south of the Missouri-Arkansas line. It is approximately 400 feet in diameter, and is excavated to a depth of 21 feet. The top 7 feet consists of red clay and gravel overburden, which is stripped with a steam shovel. Two beds of dolomite are mined, the upper bed, about five feet thick, contains a small percentage of impurities, principally chert and iron oxide. The material from this bed is ground

Table 15. Stone deposits in Benton, Carroll, Madison, and Washington counties

Map no.	Location	S.	T.	R.	Formation or rock type	Type of opening and size	Use	Remarks
	Benton County							
1		14	21N	33W	Boone limestone	-	Building stone	-
2		23	21N	33W	Boone limestone	-	Building stone	Many buildings in Benton County have been built of this stone
3		24	21N	33W	Boone limestone	-	Building stone	-
4		33	21N	33W	-	-	Building stone	-
5	NW NW	25	21N	29W	Boone limestone	Quarry 500x100x50 ft.	Structural stone and burned lime	-
6		22	21N	28W	Boone limestone	-	Building stone	-
7		24	21N	28W	Limestone	Quarry 300x100x11 ft.	Building stone	-
8		27	21N	28W	Wedington sandstone	-	Building stone	-
9	$N\frac{1}{2}$ SE	29	21N	28W	Boone limestone	Quarry and underground	Road material and agricultural lime	Large deposit of good grade limestone, relatively free from chert and other impurities
10	NW NE	32	21N	28W	Boone limestone	New quarry	Building stone	Stone is thin bedded and slabs are cut for veneer
11		20	21N	27W	Limestone	Quarry 300x75x10 ft.	Building stone	-
12		9	20N	31W	Limestone	Quarry 150x150x13 ft.	Building stone	-
13	SW NW	21	20N	31W	Limestone	Quarry 400x400x30 ft.	Building stone	-
14		36	20N	31W	Boone limestone	Quarry 400x200x9 ft.	Building stone	-
15		28	20N	30W	Boone limestone	Quarry 250x75x6 ft.	Building stone	-
16	SE SW	9	20N	29W	Boone limestone	Quarry 200x50x40 ft.	Road material and agricultural lime	-

Table 15. Stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Formation or rock type	Type of opening and size	Use	Remarks
17		12	19N	33W	Limestone	Quarry 400x75x10 ft.	Building stone	-
18		7	19N	32W	Boone limestone	-	Building stone	-
19	SW	8	19N	32W	Boone limestone	Quarry 300x100x50 ft.	Structural stone (crushed)	-
20		28	19N	31W	Boone limestone	-	-	For chemical analysis, see table 18
21		19	19N	30W	Boone limestone	-	-	For chemical analysis, see table 18
22		29	19N	29W	Boone limestone	-	-	For chemical analysis, see table 18
23		10	18N	33W	Boone limestone	Quarry 500x50x6	Building stone	-
24		30	18N	33W	Boone limestone	-	Building stone	-
25		32	18N	33W	Boone limestone	-	Building stone	-
26		12	17N	33W	Boone limestone	-	Building stone and agricultural lime	-
27		32	17N	33W	Boone limestone	-	Building stone	-
	Carroll County							
28	SW SW	22	21N	27W	Limestone	Quarry 300x90x6 ft.	-	-
29	NW SE	8	21N	26W	Limestone	Quarry 250x50x15 ft.	-	-
30	SW	21	21N	26W	Cotter (?)	-	Building stone	Stone used in Palace Hotel, Eureka Springs
31		33	21N	26W	Cotter (?)	Quarry	Building stone	Stone used in Baptist and Presbyterian churches, Eureka Springs
32		35	21N	26W	Cotter (?)	Quarry	Building stone	Known as Spangler Quarry
33		36	21N	26W	Limestone	Quarry 400x100x6 ft.	-	-
34	SE	35	21N	24W	-	-	-	For chemical analysis, see table 18

Table 15. Stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location				Formation or rock type	Type of opening and size	Use	Remarks
		S.	T.	R.				
35		20	21N	22W	-	-	-	For chemical analysis, see table 18
36		10	20N	26W	Boone (?)	-	Building stone	-
37		15	20N	26W	Boone (and St. Joe) limestones	-	Building stone	Stone used in City Auditorium, Eureka Springs
38		16	20N	26W	Boone limestone	-	Building stone	-
39		11	20N	25W	Cotter (?)	-	Building stone	-
40	SW NE	18	20N	25W	Limestone	Quarry 250x200x9 ft.	Building stone	-
41	S½	18	20N	25W	Limestone	-	Building stone	-
42		29	20N	24W	Cotter (?)	-	Building stone	Stone used in Methodist Church, Berryville
43		30	20N	24W	Cotter (?)	-	Building stone	-
44	SE NE	34	20N	24W	Limestone	-	Road surfacing	-
45		35	20N	24W	Limestone	-	Building stone	-
46	SE NE	36	20N	24W	Boone limestone	Quarry	Agricultural lime and road material	-
47	NE SW	36	20N	24W	Boone limestone	Quarry 150x25x18 ft.	Chiefly agricultural lime	For chemical analysis, see table 18
48	NE SW	5	20N	23W	Boone (St. Joe) limestone	Quarry 200x200x15 ft.	-	-
49		9	20N	22W	Boone limestone	-	-	For chemical analysis, see table 18
50		29	20N	22W	Boone limestone	-	-	For chemical analysis, see table 18
51		31	20N	22W	Boone limestone	-	-	For chemical analysis, see table 18

Table 15. Stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location				Formation or rock type	Type of opening and size	Use	Remarks
		S.	T.	R.				
52		14	19N	26W	Boone limestone	-	-	For chemical analysis, see table 18
53	SW	12	19N	23W	Limestone	Quarry 400x100x15 ft.	-	-
54	NE	12	19N	23W	Limestone	-	-	-
55		32	18N	24W	Boone limestone	-	-	For chemical analysis, see table 18
	Madison County							
56		23	19N	26W	Boone limestone	-	-	For chemical analysis, see table 18
57		17	18N	26W	Boone limestone	-	-	For chemical analysis, see table 18
58		1	17N	27W	Boone limestone	-	-	For chemical analysis, see table 18
59		18	17N	27W	Boone limestone	-	-	For chemical analysis, see table 18
60		21	17N	27W	-	-	Building stone	-
61		1	17N	26W	Boone limestone	-	-	For chemical analysis, see table 18
62		14	17N	26W	Boone limestone	-	-	For chemical analysis, see table 18
63		17	17N	26W	Boone limestone	-	-	For chemical analysis, see table 18
64		19	17N	26W	-	-	Building stone	-
65	NW NE	22	17N	26W	Boone limestone	-	Agricultural lime	-
66		25	17N	26W	Boone limestone	-	-	For chemical analysis, see table 18
67	SW SW	28	17N	26W	Hindsville (?)	-	Agricultural lime and road material	Average thickness 15 ft.
68	SE SE	29	17N	26W	Boone Hindsville (?)	-	-	For chemical analysis, see table 18
69		30	17N	26W	-	-	Building stone	-

Table 15. Stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Formation or rock type	Type of opening and size	Use	Remarks
70		34	17N	26W	Brentwood limestone	Quarry	Agricultural lime and structural stone	Hard, blue-gray, pure limestone. Quarry located about 1/2 mile north of Huntsville Courthouse
71	NW NW	30	17N	25W	Boone limestone	Quarry	Agricultural lime (local)	-
72	SW NW	30	17N	25W	Boone (?)	Quarry	Agricultural lime	-
73		5	16N	26W	-	-	Building stone	Stone used in State Vocational School, Huntsville
74		8	16N	26W	-	-	Building stone	Stone used in old courthouse, Huntsville
75		11	16N	26W	-	-	Building stone	Stone used in grade school, Huntsville
76		18	16N	24W	Boone (?)	-	-	For chemical analysis, see table 18
77		20	16N	24W	Boone limestone	-	-	For chemical analysis, see table 18
78		11	14N	28W	Limestone	-	Building stone	-
79	SE NE	31	14N	27W	Limestone	-	Building stone	-
80		4	13N	26W	-	-	Building stone	Stone used in school at St. Paul
	Washington County							
81		25	18N	31W	Boone limestone	-	Agricultural lime and structural stone	-
82		21	17N	30W	Boone limestone	Quarry	Limestone for burning and agricultural lime	Two natural gas-fired kilns; normal daily output said to be between 25 and 50 tons of burned lime. For chemical analysis, see table 18
83		1	17N	29W	Boone limestone	-	Agricultural lime	-

Table 15. Stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location				Formation or rock type	Type of opening and size	Use	Remarks
		S.	T.	R.				
84		5	17N	29W	Wedington (?)	-	Building stone	-
85		32	17N	29W	Brentwood limestone	-	-	For chemical analysis, see table 18
86		21	17N	28W	Boone limestone	-	-	For chemical analysis, see table 18
87		32	17N	28W	Boone limestone	-	-	For chemical analysis, see table 18
88	NW	7	16N	30W	Batesville sandstone	-	Building stone	Stone used in Fayetteville jail
89		4	15N	31W	Boone limestone	-	-	For chemical analysis, see table 18
90		28	15N	30W	Pitkin limestone	-	-	For chemical analysis, see table 18
91	SW SW	29	15N	30W	Wedington sandstone	-	Building stone	Stone used in school at West Fork
92		32	15N	30W	Pitkin limestone	-	-	For chemical analysis, see table 18
93		4	14N	33W	Boone (?)	-	Building stone	-
94		7	14N	32W	Pitkin limestone	Quarry	Agricultural lime and road material	-
95		4	14N	30W	Pitkin limestone	-	Agricultural lime and crushed lime	-
96		5	14N	30W	Pitkin limestone	-	-	For chemical analysis, see table 18

Table 16. Kinds of building stone in use in Benton, Carroll, Madison, and Washington counties (cu. ft.)

County	Field stone1/	Quarried stone								Total
		Boone lime-stone2/	Lower Ordovician limestone2/	Limestone, formation not known4/	Atoka sand-stone	Hale sand-stone	Wedington sandstone	Sandstone, formation not known5/	Unspe-cified 6/	
Benton	56,439	94,103	-	27,519	-	-	2,618	1,792	-	182,471
Carroll	20,835	536,064	638,378	8,064	-	-	-	-	-	1,203,341
Madison	43,460	7,515	-	-	33,940	-	-	38,457	139,563	262,935
Washington	1,954,020	-	-	-	12,930	59,840	11,093	38,880	-	2,076,763
	2,074,754	637,682	638,378	35,583	46,870	59,840	13,711	79,129	139,563	3,725,510
Stone from other counties in Arkansas	-	-	-	-	-	-	-	-	1,214	1,214
Stone from other states	-	-	-	-	-	-	-	-	25,520	25,520
	2,074,754	637,682	638,378	35,583	46,870	59,840	13,711	79,129	166,297	3,752,244

1/ Includes stone from Atoka sandstone, Wedington sandstone, Boone formation, and Hale sandstone.
2/ Includes the St. Joe limestone.
3/ Probably nearly all from the Cotter dolomite.
4/ Probably mostly Boone limestone.
5/ Probably mostly Wedington sandstone.
6/ Probably mostly Boone limestone, Pitkin limestone, and Brentwood limestone.

to pass a 60 mesh screen, and is sold as a fertilizer ingredient. The lower bed, about 9 feet thick, is nearly pure dolomite. It is fine-grained and hard. Material from this bed is sold to the glass industry.

The other quarry is located on Butler Creek, a short distance from the Chalybeate Quarry in the same section. The quarrying is accomplished by cutting down the face of a hill. Material from this operation is crushed to between 10 and 20 mesh, and is sold for soil sweetener through the Federal Soil Conservation Department. The impure product is crushed and sized for use as road material.

Production. Quarries in Benton County report 51,350 short tons of crushed dolomite, valued at $69,321.68, for the years 1937 to 1939, inclusive. The production for these years, from state severance tax reports, is:

Table 17. Production and value of crushed dolomite in Benton County1/

Year	Production short tons	Value	Average unit price
1937	15,382	$20,765.98	1.35
1938	13,435	18,135.58	1.35
1939	22,533	30,419.02	1.35
	51,350	69,321.68	

1/ Based on state severance tax reports.

Limestone

Composition and properties. Pure limestone consists of 100 per cent calcium carbonate, but it is seldom that the rock is found in the pure state. The term "limestone" may designate a rock which varies from nearly pure carbonate of lime to a rock which is high in clay, magnesia, or siliceous impurities. Marked variations in composition may at times be found even in a single quarry, while in other cases a limestone formation may show remarkable uniformity of composition over a wide area. Limestones may be massive or thin-bedded, porous or compact, coarse or fine-grained, or composed of fragmental material. They may have almost any color. The chief impurities in the limestones found in northwest Arkansas are silica, clay minerals, iron, and magnesium.

Table 18 gives the analyses and locations of a variety of limestone samples taken in the four counties covered by this report.

Uses. Limestones are used chiefly as building stones, road material, limestone for burning, agricultural lime, and in the manufacture of Portland cement. The limestones found in this area are used for all of these purposes except in the manufacture of Portland cement.

Prices. The price of limestone is relative to the purity of the deposit, use of the stone, location, and degree of preparation. Price for limestone f.o.b. plant ranges from less than 50 cents to $4.00 or more per short ton.

Occurrence. The limestone used for burning and for agricultural lime is quarried chiefly from the Boone formation in these counties, although some has been obtained from the Pitkin limestone. The St. Joe limestone, often referred to as a marble, is the basal member of the Boone formation and is widely used as a building stone. The Brentwood limestone of the Bloyd formation is used to some extent as a rough building stone. Thirty limestone analyses are given in table 18. Additional limestone occurrences are described in table 15 (p. 26).

Table 18. Locations and analyses of limestone

Map no.	County	Location				Formation or member	Silica (SiO_2) or insoluble	Alumina (Al_2O_3)	Magnesium carbonate ($MgCO_3$)	Calcium oxide (CaO)	Magnesium oxide (MgO)	Organic matter	Carbon dioxide (CO_2)	Water (H_2O)	Calcium carbonate ($CaCO_3$)
			S.	T.	R.										
20	Benton		28	19N	31W	Boone	0.26	2.58	0.26	55.18	0.12	-	43.36	-	98.54
21	Benton		19	19N	30W	Boone	0.56	0.02	-	55.63	-	-	43.68	0.21	99.31
22	Benton		29	19N	29W	Boone	0.62	2.76	0.30	54.82	0.23	-	43.08	-	97.90
34	Carroll	SE	35	21N	24W	Boone	4.56	0.96	0.09	53.72	0.04	-	42.18	-	95.90
35	Carroll		20	21N	22W	Boone (?)	4.98	4.28	0.26	49.80	0.12	-	39.29	-	88.95
47	Carroll	NE SW	36	20N	24W	Boone	0.93	0.30	-	42.90	-	-	54.60	0.03	97.50
49	Carroll		9	20N	22W	Boone	4.42	5.18	2.19	48.34	1.05	-	39.04	-	86.24
50	Carroll		29	20N	22W	Boone	0.52	6.46	-	52.98	-	-	41.67	-	94.65
51	Carroll		31	20N	22W	Boone	2.16	1.84	1.93	53.49	0.94	-	-	-	95.51
52	Carroll		14	19N	26W	Boone	3.76	2.50	0.53	51.18	0.25	-	40.53	-	91.43
55	Carroll		32	18N	24W	Boone	5.40	1.70	28.30	35.35	13.58	-	-	-	63.50
56	Madison		23	19N	26W	Boone	0.06	0.48	-	55.50	-	-	43.54	-	99.04
57	Madison		17	18N	26W	Boone	2.34	0.72	0.11	54.05	0.24	-	42.48	-	96.53
58	Madison		1	17N	27W	Boone	0.94	0.70	0.17	55.10	0.084	-	43.30	-	98.40
59	Madison		18	17N	27W	Boone	1.46	0.76	-	55.90	-	-	43.91	-	99.81
61	Madison		1	17N	26W	Boone	0.48	0.82	-	55.05	-	-	43.25	Trace	98.30
62	Madison		14	17N	26W	Boone	2.34	1.96	0.18	53.34	0.086	-	41.91	0.11	95.25
63	Madison		17	17N	26W	Boone	0.38	0.66	-	55.25	-	-	42.40	0.08	98.65
66	Madison		25	17N	26W	Boone	-	-	-	54.90	-	-	42.18	-	97.72
68	Madison	SE SE	29	17N	26W	Boone	0.24	0.32	-	55.38	-	-	43.48	0.02	98.87
76	Madison		18	16N	24W	Boone	3.10	2.32	0.89	52.04	0.43	-	41.30	-	92.88
77	Madison		20	16N	24W	Boone	0.44	0.46	0.55	55.24	0.26	-	43.63	-	98.58
82	Washington		21	17N	30W	Boone	0.71	1.51	0.33	54.60	0.15	-	-	-	97.48
85	Washington		32	17N	29W	Brentwood	7.45	24.12	-	37.52	-	-	29.48	0.77	67.00
86	Washington		21	17N	28W	Boone	2.70	2.44	-	49.73	-	3.75	39.07	0.56	88.80
87	Washington		32	17N	28W	Boone	1.26	1.12	-	53.20	-	-	34.10	0.04	97.30
89	Washington		4	15N	31W	Boone	0.95	0.66	0.30	54.92	0.14	-	-	-	98.08
90	Washington		28	15N	30W	Pitkin	1.76	1.62	2.34	52.37	1.11	-	-	-	93.52
92	Washington		32	15N	30W	Pitkin	1.90	0.89	0.27	54.58	0.13	-	-	-	97.32
96	Washington		5	14N	30W	Pitkin	0.22	0.64	0.39	55.44	0.18	-	-	-	99.00

Field men for the State Mineral Survey took samples of limestones from the Bloyd formation to be analyzed to determine their suitability for use in manufacturing cement. The limestone samples were taken from the Brentwood member of the Bloyd formation. The samples were taken along 12 cross sections (numbered A-B 1 to A-B 12) over an area covering 20 square miles in T. 14 N., R's. 29 and 30 W. (See fig. 5.) The area lies along U. S. Hwy. 71, and the St. Louis and San Francisco Railway, between the towns of West Fork and Brentwood in Washington County. Between 5 and 10 samples were taken along each cross section. The samples from each cross section were pulverized, mixed thoroughly, and analyzed as composites. The results of the chemical analyses are given in table 19.

The results of the sampling, though inconclusive, indicate that limestones suitable for Portland cement can be obtained in this area.

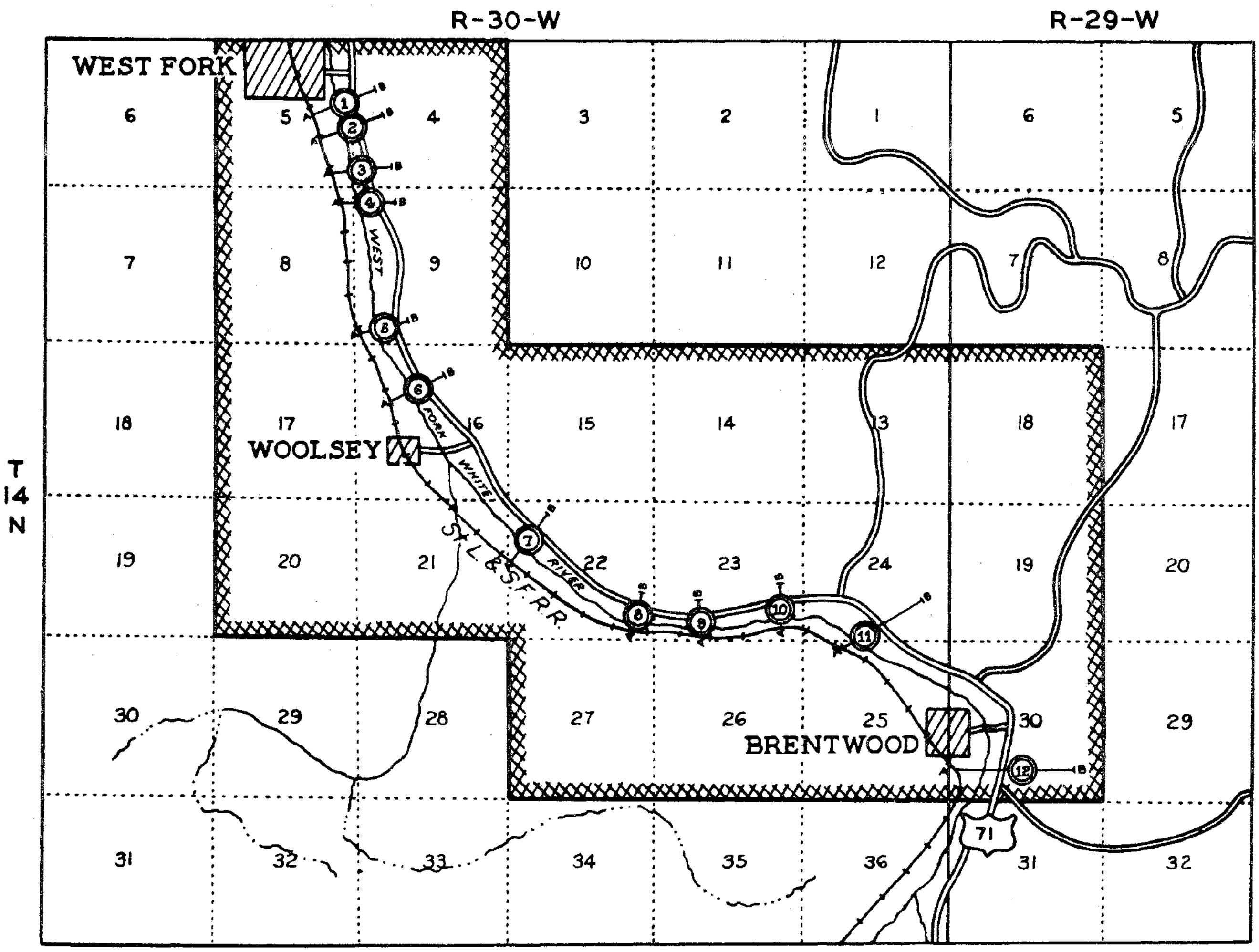


Figure 5. Map showing location of limestone samples

Economic importance. Limestone is one of the most important non-metallic deposits in northwest Arkansas. These deposits are widespread over the counties, and the large reserves of highly pure limestone are of sufficient quantity and will probably become of greater commercial importance in the future.

Production. Table 20 gives the production of limestone from this area for the years 1923 to 1939 inclusive. Most of this stone was used as agricultural lime.

Table 19. Chemical analyses of composite limestone samples

	Cross sections											
	A-B 1	A-B 2	A-B 3	A-B 4	A-B 5	A-B 6	A-B 7	A-B 8	A-B 9	A-B 10	A-B 11	A-B 12
Calcium carbonate ($CaCO_3$)	94.49	89.01	89.24	92.00	80.52	88.00	78.30	78.44	72.76	72.76	47.10	81.40
Magnesium carbonate ($MgCO_3$)	0.84	1.05	0.63	1.27	2.45	1.61	3.03	3.15	10.70	11.40	2.11	1.65
Silica (SiO_2) and insolubles	1.60	2.28	1.32	3.22	13.38	6.35	12.26	13.48	14.12	11.68	41.20	10.01
Iron oxide (Fe_2O_3)	0.36	0.19	0.28	0.45	1.18	1.68	1.04	2.50	1.62	1.63	1.62	3.79
Alumina (Al_2O_3)	1.30	3.81	3.32	0.55	0.40	0.67	2.94	0.50	0.18	3.37	3.78	1.65
Calcium oxide (CaO)	52.94	49.88	50.73	51.52	45.09	49.31	43.85	43.93	40.65	40.65	26.37	45.48
Magnesium oxide (MgO)	0.40	0.50	0.30	0.60	1.17	0.77	1.45	1.51	5.02	5.35	0.99	0.77
Carbon dioxide (CO_2)	40.60	45.72	42.00	40.48	35.43	38.70	34.45	34.49	33.46	33.10	21.78	29.20
Water (H_2O)	0.02	0.00	0.00	0.16	0.08	0.10	0.04	0.20	0.14	0.00	0.30	0.00

Table 20. Production of limestone[1]

Year	Production short tons	Value	Average unit price
1923[2]	4,334	$7,324.46	$1.69
1924	6,330	9,558.30	1.51
1925	9,502	12,769.46	1.34
1926	7,237	11,941.05	1.65
1927	6,052	9,199.04	1.52
1928	7,720	11,116.80	1.44
1929	7,312	10,383.04	1.42
1930	5,459	7,096.70	1.30
1931	4,910	7,315.90	1.49
1932	4,603	6,214.05	1.35
1933	3,448	4,310.00	1.25
1934	4,032	4,152.96	1.03
1935	5,173	5,328.19	1.03
1936	6,961	7,169.83	1.03
1937	6,213	6,275.13	1.01
1938	20,149[3]	22,566.88[3]	1.12
1939	10,533	11,796.96	1.12
	119,968	$154,518.74	1.29

1/ Based on state severance tax reports.
2/ Covers period from April 1 to December 31, 1923.
3/ Includes additional tonnage by audit adjustment for years 1934-1937, inclusive.

Marble

Properties. Any limestone that will take a polish and is suitable for ornamental purposes is considered to be a marble. The St. Joe member of the Boone formation is the only rock in these four counties which is so classified. The St. Joe marble is flesh to chocolate-colored, fine-grained, highly crystalline, and generally fossiliferous. The crushing strength varies between 8,989 pounds and 17,835 pounds per square inch; the absorption ratio varies from 1:296 to 1:400; and the specific gravity varies between 2.686 and 2.715. The stone weighs between 169.69 pounds to 177.88 pounds per cubic foot.

Onyx marble or Mexican onyx are popular names for a banded variety of crystalline lime carbonate which often occurs as a cave deposit.

Uses. The St. Joe marble is subject to all the uses of other limestones besides being used for ornamental and decorative purposes. The onyx marble is used in making pen stocks, paper weights, ash trays, and other small articles that are sold for curios.

Occurrence. The St. Joe marble is distributed over a wide area in Benton, Washington, Madison, and Carroll counties. (See pl. II.) It is found at the base of the Boone formation. Throughout the greater part of the area the St. Joe is from 25 to 50 feet thick and is in layers from a few inches to 10 feet thick.

Some caves in the limestones and dolomites near Eureka Springs in Carroll County contain onyx marble. One of these caves is on the east side of the railway, one mile north of the depot. Another is near Gaskin's Switch, four miles from Eureka Springs. A few slabs of onyx marble have been taken from Dirsts' Cave in sec. 14, T. 20 N., R. 17 W.

Road Materials

Properties. 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 chert, with some clay and fine calcite as "binder," are commonly used in the Ozark Plateaus Region. Crushed limestone also is used.

Occurrence. Washington, Benton, Carroll, and Madison counties are well supplied with road materials that can be used for both road foundations and surfaces. (See table 21.)

Alluvial gravel deposits, in stream and river beds and residual fragmental deposits formed by weathering of cherty limestone in place, are abundant in the Ozark plateaus Region. These deposits are widely distributed and long hauls are not necessary for road building. Some of these deposits have been opened and the gravel used on federal, state, and county roads. The location of certain of these gravel deposits is shown on plate VIII and described on table 21.

Sufficient gravel or fragmental stone is obtained for road construction in Boone County, northern Washington County,and western Carroll County by grading the right-of-way to form a road bed. In localities in which the chert fragments are too large for road material,the large pieces are broken with hammers while the grading is being done.

An abundance of alluvial gravel occurs along the creeks and rivers in Madison County. Generally the alluvial gravel is easily accessible to transportation because the roads and highways are commonly built parallel to and near the streams.

Screen analyses were made of gravels from 15 deposits; three in Washington County, four in Benton County, four in Carroll County, and three in Madison County. These analyses are shown in table 22.

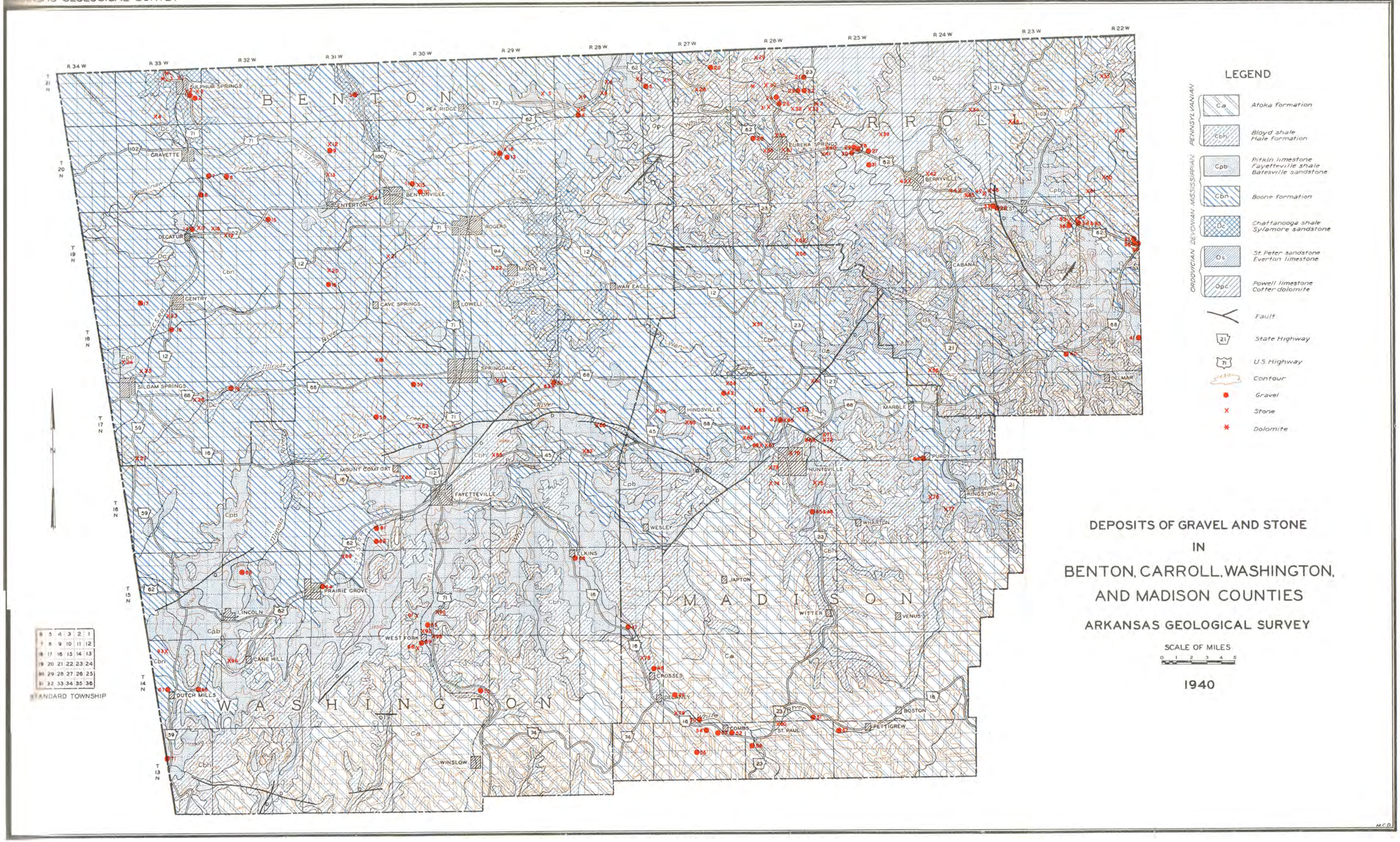

DEPOSITS OF GRAVEL AND STONE
IN
BENTON, CARROLL, WASHINGTON,
AND MADISON COUNTIES
ARKANSAS GEOLOGICAL SURVEY
SCALE OF MILES
1940
LEGEND
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
ORDOVICIAN
Ca Atoka formation
Cbh Bloyd shale Hale formation
Cpb Pitkin limestone Fayetteville shale Batesville sandstone
Cbn Boone formation
Dc Chattanooga shale Sylamore sandstone
Os St. Peter sandstone Everton limestone
Opc Powell limestone Cotter dolomite
Fault
State Highway
U.S. Highway
Contour
Gravel
Stone
Dolomite
BENTON
CARROLL
WASHINGTON
MADISON
STANDARD TOWNSHIP
SULPHUR SPRINGS
GRAVETTE
DECATUR
GENTRY
SILOAM SPRINGS
CENTERTON
BENTONVILLE
ROGERS
PEA RIDGE
CAVE SPRINGS
LOWELL
MONTE NE
WAR EAGLE
SPRINGDALE
HINDSVILLE
EUREKA SPRINGS
BERRYVILLE
GREEN FOREST
CABANAL
DELMAR
MARBLE
HUNTSVILLE
PURDY
KINGSTON
WHARTON
FAYETTEVILLE
MOUNT COMFORT
WESLEY
ELKINS
JAPTON
WITTER
VENUS
PRAIRIE GROVE
LINCOLN
CANE HILL
WEST FORK
DUTCH MILLS
WINSLOW
CROSSES
DELANEY
COMBS
ST. PAUL
PETTIGREW
BOSTON
R 34 W
R 33 W
R 32 W
R 31 W
R 30 W
R 29 W
R 28 W
R 27 W
R 26 W
R 25 W
R 24 W
R 23 W
R 22 W

Table 21. Gravel and fragmental stone deposits in Benton, Carroll, Madison, and Washington counties

Map no.	Location	S.	T.	R.	Components	Size of components	Approximate size of deposit or opening	Estimated cu. yds.	Remarks
	Benton County								
1	SW SW	24	21N	33W	-	-	-	-	Gravel
2	NE NW	25	21N	33W	-	-	-	-	Gravel
3	NE NW	26	21N	31W	Angular chert and a small amount shale	83.6% passing 2" mesh	Estimated 20 acres, with 4 ft. above water level	290,000	Alluvial gravel. Excavated area covers 1/4 acre. This gravel used to patch and resurface State Hwy. 100.
4	S½	32	21N	28W	Chert, clay, gravel	-	Pit 150x130x4 ft.	-	-
5	SW	18	21N	27W	Chert, gravel	-	Pit 300x100x4 ft.	-	-
6	SE	25	20N	33W	Chert, clay	-	Pit 300x300x4.5 ft.	-	-
7		19	20N	32W	Chert	-	Pit 300x100x6 ft.	-	-
8		20	20N	32W	Gravel	-	-	-	-
9	W½ SE	9	20N	31W	Chert, clay	-	Pit 750x300x6 ft.	-	-
10	SE	28	20N	30W	Chert, clay	-	Pit 350x150x4 ft.	-	-
11		28	20N	30W	Chert, clay	-	Pit 250x250x4.5 ft.	-	-
12	NW NW	16	20N	29W	Chert, clay	-	Pit 650x200x5 ft.	-	-
13	Cen	16	20N	29W	Chert, clay	82.3% passing 2" mesh	Estimated 40 acres average 20 ft.	3,800,000	Gravel crops out in and on both sides of an intermittent stream. Used as base for black topping U. S. Hwy. 62.
14	W½ NW	12	19N	33W	Chert, clay	-	Pits (200x160x5 ft. (300x60x6 ft.	-	-
15	SW	2	19N	32W	Chert, clay	81.7% massing 2" mesh	Estimated 5 acres, average 10 ft. thick	75,000	Used on State Hwy. 102 between Decatur and Centerton

Table 21. Gravel and fragmental stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Components	Size of components	Approximate size of deposit or opening	Estimated cu. yds.	Remarks
16	Cen	33	19N	31W	Chert	92.9% passing 2" mesh	Estimated 7 acres, with 6 ft. above water	65,000	Alluvial gravel in west fork of Osage Creek. There are other similar deposits along Osage Creek
17		5	18N	33W	Chert, clay	-	Pit 200x200x4 ft.	-	-
18		15	18N	33W	Shattered chert	-	Estimated 20 acres, average 18 ft. thick	575,000	Material is coarse and requires crushing. Used as base for black-topping State Hwy. 59.
19	SE NW	5	17N	32W	Chert	-	-	-	-
	Carroll County								
20		14	21N	27W	85% chert, 10% limestone, 5% fines	88.8% passing 2" mesh	-	-	Alluvial gravel in bars along Butler Creek. Has been used as railroad ballast and on W.P.A. roads
21	NW	24	21N	26W	Chert, clay	100% passing 2" mesh 95% passing $1\frac{1}{2}$" mesh	Estimated 10 acres, average 15 ft. thick	140,000	Gravel from opening 100x25x15 ft. used on local W.P.A. roads Reported excellent clay gravel because of uniformity of size
22	$W\frac{1}{2}$ NW	25	21N	26W	Chert	-	Pit 150x150x5 ft.	-	Alluvial gravel
23	$E\frac{1}{2}$ NE	26	21N	26W	Chert	-	Pit 150x150x5 ft.	-	Alluvial gravel
24	$N\frac{1}{2}$ SW	27	21N	26W	Chert, clay	-	Pit 300x300x3 ft.	-	Alluvial gravel
25	NW	34	21N	26W	90% chert, 10% limestone	85.8% passing $1\frac{1}{2}$" mesh	Pit 400x100x4 ft.	-	Alluvial gravel. Has been used on State. Hwy. 23, and as filler between back and face walls of Leatherwood Dam
26	$N\frac{1}{2}$	8	20N	26W	Chert, sandstone	-	Pit 600x150x5 ft.	-	Alluvial gravel
27		15	20N	25W	Chert	-	-	-	Alluvial gravel

Table 21. Gravel and fragmental stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Components	Size of components	Approximate size of deposit or opening	Estimated cu. yds.	Remarks
28		16	20N	25W	Chert, clay	-	Pit 500x200x4 ft.	-	River gravel
29		16	20N	25W	Chert	-	Pit 400x200x4 ft.	-	River gravel
30	Cen	16	20N	25W	About 50% sandstone and about 50% chert	82.5% passing 2" mesh	Pit 750x150x6 ft.	-	Used on Pettigrew-Golden road, base for black-topping U. S. Hwy. 62, and for aggregate in concrete in Kings River bridge
31	N½	22	20N	25W	Chert	-	Pit 800x200x4 ft.	-	Alluvial gravel
32	SE NW	6	19N	23W	Chert	-	Pit 300x300x5 ft.	-	Bank gravel
33	SE NW	6	19N	23W	Chert, clay	-	Pit 1000x800x12 ft.	-	Alluvial gravel
34	SE SE	12	19N	23W	Chert, sandstone	-	Pit 210x210x4 ft.	-	River gravel
35	SE	12	19N	23W	Chert, clay	-	Pit 340x130x4 ft.	-	Alluvial gravel
36	SW NW	12	19N	23W	Chert, Clay	-	Pit 250x150x2 ft.	-	River gravel
37	SW SE	15	19N	22W	Chert, clay	-	-	-	Alluvial gravel
38	NW NE	22	19N	22W	-	-	-	-	-
39	N½ NE	22	19N	22W	Chert	-	Pit 300x150x9 ft.	-	River gravel
40	SE	26	18N	23W	80% sandstone, 20% chert	83.4% passing 2" mesh	Estimated 60 acres, with 4 ft. above water level	290,000	Alluvial gravel of Osage and Kenner creeks. Several other bars below Kenner might be easily worked.
41	SE	22	18N	22W	Chert	-	-	-	Alluvial gravel
	Madison County								
42	NW	12	17N	27W	-	-	Pit 500x75x3 ft.	-	River gravel
43	NW	22	17N	26W	Sandstone with minor chert and limestone	93.4% passing 2" mesh	-	-	Has been screened and used in construction of State Hwy. 68

Table 21. Gravel and fragmental stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Components	Size of components	Approximate size of deposit or opening	Estimated cu. yds.	Remarks
44	SW	32	17N	24W	-	-	Pit 300x100x3 ft.	-	River gravel
45		23	16N	26W	Soft sandstone	75% passing 2" mesh	Pit 1300x300x3 ft.	-	Alluvial gravel. Used on State Hwy. 23.
46		23	16N	26W	Soft sandstone	-	Estimated 5 acres, 3 ft. above water level	75,000	Alluvial gravel, downstream from No. 45.
47		34	15N	28W	Sand, gravel	-	-	-	-
48		13	14N	28W	-	-	Pit 600x75x4 ft.	-	River gravel
49	NE	30	14N	27W	-	-	Pit 600x75x5 ft.	-	River gravel
50	NE SE	33	14N	27W	-	-	-	-	River gravel
51	SW	35	14N	26W	-	-	Pit 250x200x2 ft.	-	River gravel
52	SW	1	13N	27W	-	-	-	-	River gravel
53		2	13N	27W	-	-	Pit 1500x300x6 ft.	-	River gravel
54		3	13N	27W	-	-	Pit 1500x300x6 ft.	-	River gravel
55	NE	16	13N	27W	Soft sandstone and 10% limestone	90% passing 2" mesh	Estimated 20 acres, 5 ft. above water level	550,000	Alluvial gravel. Used in construction of State Hwy. 16
56		7	13N	26W	-	-	-	-	River gravel
57		6	13N	25W	-	-	Pit 600x75x4 ft.	-	River gravel
	Washington County								
58	SW SE	13	17N	31W	Clay, gravel	-	-	-	-
59	SW NW	4	17N	30W	Chert, clay	-	Pit 800x200x5 ft.	-	-

Table 21. Gravel and fragmental stone deposits in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location				Components	Size of components	Approximate size of deposit or opening	Estimated cu. yds.	Remarks
		S.	T.	R.					
60	SW NE	1	17N	29W	Chert, clay	87.5% passing 2" mesh	Estimated $1\frac{1}{2}$ acres, average 11 ft. thick	30,000	Some gravel has been crushed for black-topping State Hwy. 68, and for surfacing W.P.A. roads.
61		26	16N	31W	Chert, clay	-	Pit 300x100x7 ft.	-	-
62		35	16N	31W	Chert, sand, clay	65% passing 2" mesh	Estimated 5 acres, average 12 ft. thick	95,000	Approximately 1 acre has been removed. Used in construction of State Hwy. 62.
63		8	15N	32W	Chert, clay, gravel	-	Pit 200x150x5 ft.	-	-
64		18	15N	31W	Chert, clay, gravel	-	Pit 210x210x3 ft.	-	-
65		32	15N	30W	Gravel	-	-	-	-
66		1	15N	29W	Gravel	-	-	-	-
67		21	14N	33W	-	-	Pit 300x100x2.5 ft.	-	River gravel.
68		23	14N	33W	-	-	Pit 250x100x4.5 ft.	-	River gravel.
69		5	14N	30W	Chert, sandstone	80.6% passing 2" mesh	Pit 900x90x3 ft.	-	Alluvial gravel. Now used for shoulders along U. S. Hwy. 71. If properly sized, would be suitable for coarse concrete aggregate.
70		24	14N	30W	Clay, gravel	-	-	-	-
71		16	13N	33W	-	-	Pit 100x100x3 ft.	-	River gravel.

Table 22. Screen analyses of gravel

Map no.	Screen size: 2 in. Per cent retained	2 in. Per cent passed	1½ in. Per cent retained	1½ in. Per cent passed	1 in. Per cent retained	1 in. Per cent passed	3/4 in. Per cent retained	3/4 in. Per cent passed	5/8 in. Per cent retained	5/8 in. Per cent passed	1/2 in. Per cent retained	1/2 in. Per cent passed	3/8 in. Per cent retained	3/8 in. Per cent passed	No. 4 Per cent retained	No. 4 Per cent passed
3	16.4	83.6	10.0	73.6	5.0	68.6	27.0	41.6	-	-	13.4	28.2	11.5	16.7	6.4	10.3
13	17.7	82.3	10.7	71.6	10.0	61.6	16.0	45.6	-	-	6.4	39.2	3.5	35.7	4.3	31.4
15	18.3	81.7	10.0	71.7	3.3	68.4	13.3	55.1	-	-	6.0	49.1	15.9	34.2	17.5	16.7
16	7.1	92.9	2.1	90.8	9.0	81.8	13.4	68.4	-	-	19.0	49.4	13.4	36.0	20.7	15.3
20	11.2	88.8	13.7	75.1	3.7	71.4	5.6	65.8	-	-	20.0	45.8	5.6	40.2	21.8	18.4
21	0.0	100.0	5.0	95.0	4.1	90.9	6.6	84.3	-	-	13.3	71.0	30.0	41.0	17.5	23.5
30	17.5	82.5	1.3	81.2	9.0	72.2	14.4	57.8	-	-	10.0	47.8	6.8	41.0	20.0	21.0
40	16.6	83.4	20.0	63.4	15.8	47.6	14.1	33.5	-	-	7.5	26.0	10.0	16.0	7.5	8.5
43	6.6	93.4	16.6	76.8	13.3	63.5	7.5	56.0	-	-	15.8	40.2	2.5	37.7	20.8	16.9
45	25.0	75.0	8.3	66.7	25.0	41.7	17.5	24.2	-	-	9.1	15.1	10.0	5.1	2.5	2.6
55	9.1	90.9	10.0	80.9	32.5	48.4	18.3	30.1	-	-	10.9	19.2	10.0	9.2	5.3	3.9
60	12.5	87.5	12.5	75.0	17.5	57.5	8.7	48.8	-	-	7.5	41.3	16.2	25.1	15.0	10.0
62	35.0	65.0	5.8	59.2	4.2	55.0	10.9	44.1	10.0	34.1	2.5	31.6	8.3	23.3	15.8	7.5
65	19.4	80.6	8.5	72.1	6.3	65.8	11.2	54.6	7.5	47.1	6.9	40.2	11.9	28.3	15.0	13.3

FUEL MINERALS

Coal

Composition and properties. The coal in Washington County is similar to the coal farther to the south in the Arkansas Valley. It is of low-volatile bituminous rank. The volatile (or gaseous) constituents range from 12 per cent to about 20 per cent. The percentage of fixed carbon ranges from about 67 per cent to 80 per cent. The coal is friable (breaks up into fine particles) and must be handled carefully.

Uses. The market for the coal is local. The coal is used for heating and for blacksmithing.

Prices. Blacksmithing coal, in very small quantities, brought $6.00 per ton, delivered in Springdale, and the run-of-mine coal brought $4,50 per ton, f.o.b. Springdale. Blacksmithing coal, sold in 100-pound lots, brought $3.00 to $4.00 per ton in Prairie Grove. The prices quoted above were those for December, 1939.

Occurrence. Coal occurs in many localities in Washington County, and has been dug at intervals in several places. The coal bed is thin, having a maximum thickness of 22 inches. The lower portion of the bed (from 2 to 4 inches) is soft, and crumbles into small fragments. From 7 to 10 inches of the coal bed forms a continuous layer. All the coal known to be present in this area occurs in the Bloyd shale between the Brentwood limestone member (below the coal) and the Kessler limestone member (above the coal.) The coal bed is from 15 to 20 feet above the Brentwood limestone.

Coal deposits Number 1 and Number 2 appear to be the most promising in Washington County. The number used in referring to each deposit corresponds to the location number on plate IX.

Number 1. A coal seam is on the Alex Allen farm, approximately 5 miles southeast of Springdale, in sec. 21, T. 17 N., R. 29 W. (See pl. IX.) The coal occurs in a nearly horizontal seam which is capped by beds of sandstone. The sandstone is 20 feet thick at this place, and is overlain by 15 feet of overburden. The coal bed is from 12 to 14 inches thick. It is underlain by 48 inches of gray clay. (See section on clay, p. 10.) It is estimated that the surface area of coal in this locality covers 100 acres, with an average bed thickness of 12 inches. The quality of the coal appears to be uniform in all the openings examined.

Number 2. A coal bed on the Van Over farm crops out at Stephenson Mountain, about 3 miles southeast of Prairie Grove, in sec. 33, T. 15 N., R. 31 W. (See pl. IX.) The coal bed dips slightly to the east, and is overlain by 35 feet of sandstone and shale. The coal seam varies in thickness from 14 inches on the western exposure to 22 inches on the eastern exposure. The coal is present in the hills adjacent to Stephenson Mountain, and in the hills at the Hubbard settlement, a gross area of approximately 200 acres. Clay underlies much of the coal in this district.

The locations of some of the coal occurrences in Washington County are listed in table 23, and are shown on plate IX.

Table 23. Locations of coal deposits in Washington County

No.	Quarter	Sec.	Twp.	Rge.
1	NW NW	21	17N	29W
2	NE NE	33	15N	31W
3	NE NE	12	13N	31W
4	SE SW	19	13N	31W
5	SW NW	24	13N	31W

Table 23. Locations of coal deposits in Washington County (cont.)

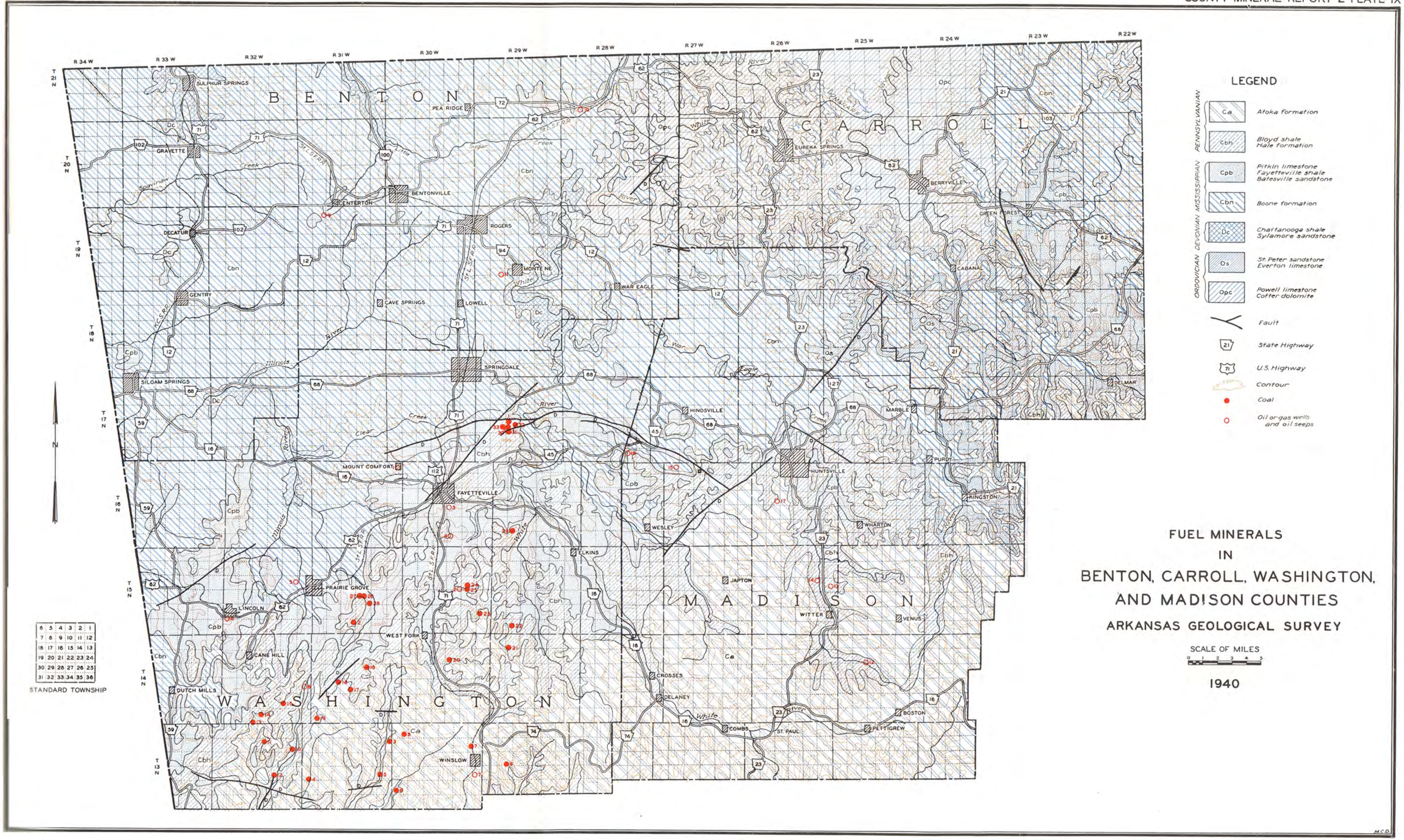
No.	Quarter	Sec.	Twp.	Rge.
6	NE SW	30	13N	30W
7	SW NW	12	13N	30W
8	NW SE	6	13N	30W
9	SE SW	17	13N	29W
10	SW	12	13N	32W
11	NE NW	10	13N	32W
12	NW SW	23	13N	32W
13	SW SW	33	14N	32W
14	SW NE	33	14N	32W
15	NW SW	26	14N	32W
16	NW NE	15	14N	31W
17	NE SE	21	14N	31W
18	NE NE	20	14N	31W
19	NE SW	31	14N	31W
20	NE SW	10	14N	30W
21	SW SW	5	14N	29W
22	SE NW	32	15N	29W
23	NW SW	25	15N	30W
24	NE SW	14	15N	30W
25	SE SW	14	15N	30W
26	SW NW	22	15N	31W
27	SE NW	22	15N	31W
28	SE SE	22	15N	31W
29	SE SW	29	16N	29W
30	SW NW	21	17N	29W
31	NW SW	21	17N	29W
32	SW NE	21	17N	29W
33	$E\frac{1}{2}$	20	17N	29W

Economic importance. The coal deposits in Washington County are of local importance only. The quantity of coal present is too small to supply large markets. The quantity available is sufficient, however, so that substantially more coal could be produced if there were a greater local demand.

Production. The production of coal in Washington County has been small. State severance tax reports give the production as follows:

Table 24. Production of coal in Washington County

Year	Production short tons	Value
1923-1932	None reported	
1933	1,074	$2,856.84
1934	248	521.72
1935	112	235.20


FUEL MINERALS
IN
BENTON, CARROLL, WASHINGTON, AND MADISON COUNTIES
ARKANSAS GEOLOGICAL SURVEY
SCALE OF MILES
1940
LEGEND
PENNSYLVANIAN
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DEVONIAN
ORDOVICIAN
Ca Atoka formation
Cbh Bloyd shale Hale formation
Cpb Pitkin limestone Fayetteville shale Batesville sandstone
Cbn Boone formation
Dc Chattanooga shale Sylamore sandstone
Os St. Peter sandstone Everton limestone
Opc Powell limestone Cotter dolomite
Fault
State Highway
U.S. Highway
Contour
Coal
Oil or gas wells and oil seeps
STANDARD TOWNSHIP
B E N T O N
C A R R O L L
W A S H I N G T O N
M A D I S O N
SULPHUR SPRINGS
GRAVETTE
PEA RIDGE
BENTONVILLE
CENTERTON
ROGERS
DECATUR
MONTE NE
GENTRY
CAVE SPRINGS
LOWELL
WAR EAGLE
SILOAM SPRINGS
SPRINGDALE
EUREKA SPRINGS
BERRYVILLE
GREEN FOREST
CABANAL
DELMAR
MARBLE
HINDSVILLE
HUNTSVILLE
PURDY
KINGSTON
WHARTON
WESLEY
MOUNT COMFORT
FAYETTEVILLE
ELKINS
PRAIRIE GROVE
LINCOLN
WEST FORK
CANE HILL
DUTCH MILLS
WINSLOW
JAPTON
WITTER
VENUS
CROSSES
DELANEY
COMBS
ST. PAUL
PETTIGREW
BOSTON
R 34 W
R 33 W
R 32 W
R 31 W
R 30 W
R 29 W
R 28 W
R 27 W
R 26 W
R 25 W
R 24 W
R 23 W
R 22 W
T 21 N
T 20 N
T 19 N
T 18 N
T 17 N
T 16 N
T 15 N
T 14 N
T 13 N
M.C.D.

Table 25. Producers of coal in Washington County

Name	Address	Year operated
Eaton, J. A.	Fayetteville	1933
Eaton, L. F.	Fayetteville	1933
Edwards, W. S.	Fayetteville	1934-34
Gray, W. E.	Fayetteville	1933
Little, John L.	Baldwin	1933-34
Stanberry, J. R.	Fayetteville	1933-34-35
Van Over & Johnson	Prairie Grove	1933-34
Allen Bros. Coal Co.	Springdale	1933-40
Spring, C. A.	Farmington	1934
Napier, G. C.	Cave Hill	1935
Turner, M. B.	Winslow	1935

Oil and Gas

Occurrence. Surface structures, oil seeps, and "shows" of oil in water wells in northwest Arkansas, have led to exploration and wildcatting for oil and gas. Several test wells have had indications of oil and gas. Table 26 gives the location of two oil seeps and 15 test wells drilled in Washington, Benton, and Madison counties. The formations or members of formations considered to be the most favorable for gas or oil accumulation in this area are the Sylamore sandstone, the Hale sandstone, the Wedington sandstone, the St. Peter sandstone, the Kings River sandstone, the Everton sandstone, and the Boone limestone.

Table 26. Oil seeps and test wells in Washington, Benton, and Madison counties

Map no.	Quarter	Sec.	T.	R.	County	Remarks
1	Mount Comfort				Washington	Small yield of gas reported
2	SE	15	15N	30W	Washington	Small amount of oil reported
3	South of Fayetteville city limits				Washington	Small yield of gas reported
4	NW	34	16N	30W	Washington	Shows of oil and gas reported
5	NW SE NE	14	15N	32W	Washington	Reported to have produced some gas
6	SW SW	30	15N	32W	Washington	Shows of oil and gas reported
7		24	13N	30W	Washington	Show of oil and gas reported
8		24	14N	32W	Washington	Oil seep reported
9	NE SE	5	19N	31W	Benton	Gas reported
10	SE NW	32	21N	28W	Benton	Small gas production reported
11	SW SE	29	19N	29W	Benton	Dry hole
12	SE SE SE	8	14N	25W	Madison	Gas reported
13		13	15N	26W	Madison	Shows of gas and oil reported
14	NW NW NE	14	15N	26W	Madison	Shows of gas and oil reported
15	NE SE NE	6	16N	27W	Madison	Show of gas and oil reported
16	NW SE NW	35	17N	28W	Madison	Shows of gas reported
17	NE SE	17	16N	26W	Madison	Oil seep - Hale formation

Economic importance. There appears to be good possibilities for the accumulation of small quantities of gas in favorable structures in Washington, Benton, and Madison counties, but the chances of finding oil in commercial quantities in this area do not appear to be good. The possibilities are poor for gas or oil accumulations in commercial quantities in Carroll County.

Springs

There are many springs in Benton, Carroll, Madison, and Washington counties. Table 27 lists most of the larger springs and gives the approximate flow of water during a 24-hour period. The springs described in table 27 are located on plate X, the number on the map corresponding to the reference number in the table.

Table 27. List of springs in Benton, Carroll, Madison, and Washington counties1/

Map no.	Location	S.	T.	R.	Est. 24-hour yield (gals.)	Owner and address
	Carroll County					
1	NW SE	17	19N	23W	1,200	L. Wolfe, Osage
2	NE NW	3	19N	25W	1,000	W. Fanning, Berryville
3	SW SE	1	20N	27W	11,520	Wm. Stilley, Eureka Springs
4	SE NE	1	20N	27W	7,200	Dave Starr, Eureka Springs
5	SE SE	2	20N	27W	2,450	Dave Starr, Eureka Springs
6	NW NE	3	20N	27W	4,175	Jessie Parker, Busch
7	SW NW	10	20N	27W	7,200	V. R. McManus, Eureka Springs
8	SE NW	10	20N	27W	1,440	M. Redwine, Sacremento, California
9	NE NW	11	20N	27W	2,160	Ira Dean, Eureka Springs
10	SW SE	12	20N	27W	2,880	J. Herndon, Eureka Springs
11	NW NE	13	20N	27W	1,440	B. Scates, Eureka Springs
12	NE NW	14	20N	27W	1,440	Floyd Slaine, Eureka Springs
13	SW SW	21	20N	27W	1,630	W. H. Roller, Eureka Springs
14	NW SE	21	20N	27W	2,020	A. P. McAlester, Eureka Springs
15	SW SW	23	20N	27W	10,800	Fred Eames, Mundell
16	SE SE	25	20N	27W	21,600	C. Johnson, Eureka Springs
17	NW NW	26	20N	27W	5,040	S. Higginbotham, Mundell
18	NW SE	28	20N	27W	1,585	S. Amous, Mundell
19	NW NW	36	20N	27W	1,870	Mary David, Eureka Springs
20	NE NW	30	21N	22W	1,000	D. C. Candill, Oakgrove
21	NE NW	14	21N	27W	1,730	E. H. Boyer, Eureka Springs
22	NE SE	16	21N	27W	2,880	J. W. Lawson, Busch
23	SE SE	22	21N	27W	1,870	G. W. Dye, Busch
24	NW NW	28	21N	27W	1,295	L. Crentzberg, Eureka Springs
25	SW SW	33	21N	27W	1,585	E. Gunnels, Busch
26	SW SW	36	21N	27W	1,440	Marvin David, Eureka Springs
27	SW NE	36	21N	27W	2,450	Phillips University, Enid, Okla.
	Benton County					
28	SW NE	1	17N	33W	2,000	Charley Owen, Siloam
29	NW SE	1	17N	33W	144,000	Charley Owen,
30	NE SE	3	17N	33W	7,200	Frank Watts, Rt. #4, Gentry
31	NW SE	1	18N	28W	53,800	O. V, Samuels, War Eagle
32	SW NW	12	18N	28W	79,200	G. C. Sharp, Rt. #2, Springdale
33	NE SE	12	18N	28W	5,090	C. J. Broderick, Best
34	NW NE	4	18N	29W	18,720	C. H. Cloyd, Rt. #2, Lowell
35	NE SW	23	18N	30W	1,008,000	City of Springdale, Springdale
36	SW SW	23	18N	30W	600,000	City of Springdale, Springdale
37	NE SE	1	18N	31W	750,000	Mrs. Julia Young, Tulsa, Okla.

Table 27. List of springs in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Est. 24-hour yield (gals.)	Owner and address
38	NW SE	19	18N	31W	1,440	J. H. Elliott, Springtown
39	SE SW	19	18N	31W	2,000	Unknown
40	NE SW	22	18N	31W	3,000	Burk Henisho, Elm Springs
41	NE SE	22	18N	31W	8,000	Coly Oneal, Elm Springs
42	SW SW	5	18N	32W	10,080,000	J. C. Davidson, Springstown
43	SE NE	15	18N	33W	3,000	Forest Maddox
44	NE NW	15	18N	33W	3,000	Sam Gratell, Rt. #2, Gentry
45	SW NW	15	18N	33W	1,000	E. L. Moore, Rt. #2, Gentry
46	SE SW	35	18N	33W	576,000	Siloam Springs, Siloam Springs
47	SW SW	36	18N	34W	1,500	John E. Brown Schools, Siloam Spgs.
48	NE SE	24	19N	28W	34,560	John Pullen, Rogers
49	NW NW	16	19N	29W	40,320	E. H. Fischer, Rogers
50	NW SE	22	19N	29W	67,680	J. E. Felker, Rogers
51	NW NE	29	19N	31W	416,000	C. V. Rice, Bentonville
52	NW NW	34	19N	31W	79,200	J. E. Kirkes, Bentonville
53	NW NE	34	19N	31W	21,600	Unknown
54	SE SW	36	19N	31W	12,000	W. D. Rozar, Cave Springs
55	SW SW	17	20N	27W	34,560	Earmie Douglas, Garfield
56	NE NE	9	20N	28W	113,760	W. L. Moon, Rt. #1, Garfield
57	SE NW	21	20N	28W	25,280	W. E. Smiley, Star Rt., Garfield
58	SW SE	4	20N	29W	148,020	Charles Hutcheson, Rogers
59	SW SE	5	20N	29W	630,000	George Miser, Rogers
60	NE NW	9	20N	29W	14,480	Miss Jane Wardlow, Rt. #4, Rogers
61	NW SW	15	20N	29W	223,200	Cleda Miller, Avoca
62	NW NE	17	20N	29W	34,560	C. E. Pfrimmer, Avoca
63	SE SW	19	20N	29W	132,930	Dr. R. W. Russell, Rt. #6, Rogers
64	SE NW	29	20N	29W	108,000	Crest Bowman, Rogers
65	SW NW	34	20N	29W	630,000 plus	Mrs. Claude Woods, Wichita Falls, Texas
66	NE SE	34	20N	29W	630,000 plus	Percy Farley, Rogers
67	NW NW	2	20N	30W	67,680	H. F. Price, Rt. #4, Bentonville
68	SW SE	6	20N	30W	630,000 plus	Martha Blevins, Rt. #4, Bentonville
69	NW SE	7	20N	30W	630,000 plus	Ford Estate, Bentonville
70	SW NE	7	20N	30W	115,200	Claudia A. Summers, Tulsa, Okla.
71	SE NE	29	20N	30W	1,800	Dr. W. A. Pickens, Bentonville
72	NW NE	34	20N	30W	67,680	H. M. Bush, Rt. #5, Rogers
73	NE SW	18	20N	32W	17,280	J. E. Ketcheraid, Gravette
74	SE SW	1	20N	33W	5,000	N. C. Brun, Des Moines, Iowa
75	NW NW	24	20N	34W	1,000	A. Walley, Montrose, Mo.
76	SW SW	10	21N	28W	108,000	Floyd Gregory, Bakersville, Calif.
77	NE SW	23	21N	28W	79,200	Keen Roller, Seligman, Mo.
78	NW NE	22	21N	31W	23,040	Port Thompson, Bentonville
79	SE NE	29	21N	31W	36,000	J. O. Sheppard, Rt. #1, Hiwasse
80	NE SE	21	21N	31W	36,000	O. H. Keer, Rt. #2, Hiwasse
81	SE SE	33	21N	31W	250,000	L. R. McNeeley, Rt. #3, Bentonville
82	SW NW	34	21N	31W	2,230	Lewis Mertshey, Rt. #4, Bentonville
83	SE SE	27	21N	32W	31,680	D. B. Figgins, Sulphur Springs
84	NE NW	34	21N	33W	2,230	D. M. Greer
	Washington County					
85	NE SE	5	13N	28W	4,320	Miss Cloud, Sunset
86	SE NW	6	13N	28W	4,320	Bob Miller, Sunset
87	NE NE	8	13N	29W	7,200	J. W. McKenzie, Winslow
88	NW NE	23	13N	29W	36,000	Mr. Gambles, Winslow

Table 27. List of springs in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Est. 24-hour yield (gals.)	Owner and address
89	NE NE	25	13N	29W	7,200	Bill Lopper, Sunset
90	NW SE	29	13N	29W	11,520	F. C. Meadows, Winslow
91	NW SE	29	13N	29W	4,320	Alec Sorencen, Winslow
92	SE SW	2	13N	31W	31,680	John Taylor, West Fork
93	SE SE	2	13N	31W	7,200	Mrs. Rose, Strickler
94	NW SW	4	13N	31W	1,200	J. E. Bance, Rt. #1, West Fork
95	SW NE	26	13N	31W	7,200	State of Arkansas
96	SE NW	18	13N	32W	1,000	W. F. Cole, Evansville
97	NE NE	33	13N	32W	4,320	Unknown
98	SW SW	1	13N	33W	14,400	Lee Wright, Cane Hill
99	NW NW	2	13N	33W	4,800	Smuck Heirs, Evansville
100	SE SE	2	13N	33W	3,600	Lee Wright, Cane Hill
101	NE NE	11	13N	33W	28,800	Milton Brown, Evansville
102	SW NW	11	13N	33W	21,600	H. A. Eckhardt, Evansville
103	NW SW	11	13N	33W	21,600	L. W. Baker, Evansville
104	SE NE	13	13N	33W	21,600	R. J. Cox, Evansville
105	SE NW	13	13N	33W	21,600	R. J. Cox, Evansville
106	NE SE	22	13N	33W	28,800	A. H. Reed, Evansville
107	NE SW	22	13N	33W	36,000	W. A. Wilson, Evansville
108	SW SW	22	13N	33W	36,000	Sherman Cartwright, Evansville
109	SE NE	23	13N	33W	14,400	George Barker, Rt. #1, Evansville
110	SE NE	23	13N	33W	21,600	Bevely Bowlin, Evansville
111	SE NE	23	13N	33W	14,400	George Barker, Evansville
112	NE NW	23	13N	33W	14,400	Jim Winsted, Evansville
113	NW NW	6	14N	28W	1,000	Blaine du Bell, Durham
114	NE SW	21	14N	28W	2,000	J. C. Nichols, Hazel Valley
115	NW NW	31	14N	28W	36,000	Berl Skelton, Hazel Valley
116	SE NE	31	14N	28W	36,000	W. L. Evans, Hazel Valley
117	NE NE	33	14N	28W	72,000	Fred Baker, Hazel Valley
118	NE NE	2	14N	29W	1,000	F. W. Luttwerm, Sturgis, Mich.
119	NE NE	15	14N	29W	7,200	F. A. Stout, Hazel Valley
120	NW NW	20	14N	29W	2,000	George Hoover, Brentwood
121	SW NE	2	14N	31W	7,200	C. O. Carney, West Fork
122	SW SW	4	14N	32W	1,000	W. B. Campbell, Cane Hill
123	SE NE	4	14N	32W	2,500	W. R. Land, Cane Hill
124	NW NE	4	14N	32W	1,250	R. B. Moore, Fayetteville
125	SE SE	5	14N	32W	24,000	J. H. Pyatt, Cane Hill
126	NE NW	5	14N	32W	14,400	H. W. Henson, Lincoln
127	SE SE	5	14N	32W	3,000	N. C. Meals, Cane Hill
128	NE SW	8	14N	32W	1,200	H. W. McClellan, Cane Hill
129	SE NE	8	14N	32W	7,200	R. P. Paterson, Cane Hill
130	NE NW	9	14N	32W	4,200	W. H. Ludle, Cane Hill
131	NW SW	9	14N	32W	1,200	Unknown
132	NE SE	10	14N	32W	1,000	Wm. Williams, Rt. #1, Prairie Grove
133	SW SE	11	14N	32W	1,000	J. J. Phillips, Prairie Grove
134	SW NE	11	14N	32W	2,000	Gene Rollins, Unknown
135	NE SE	13	14N	32W	4,320	Nannie Stanley, Rt. #1, Prairie Grove
136	NW NW	14	14N	32W	4,320	E. W. Spencer, Prairie Grove
137	NW SE	17	14N	32W	43,200	H. E. Richmond, Clyde
138	SW NW	17	14N	32W	7,200	S. W. Yates, Clyde
139	SE NE	17	14N	32W	1,440	
140	NE NE	20	14N	32W	28,800	A. F. Cox, Cane Hill
141	SE SE	21	14N	32W	1,800	A. R. Reed, Prairie Grove

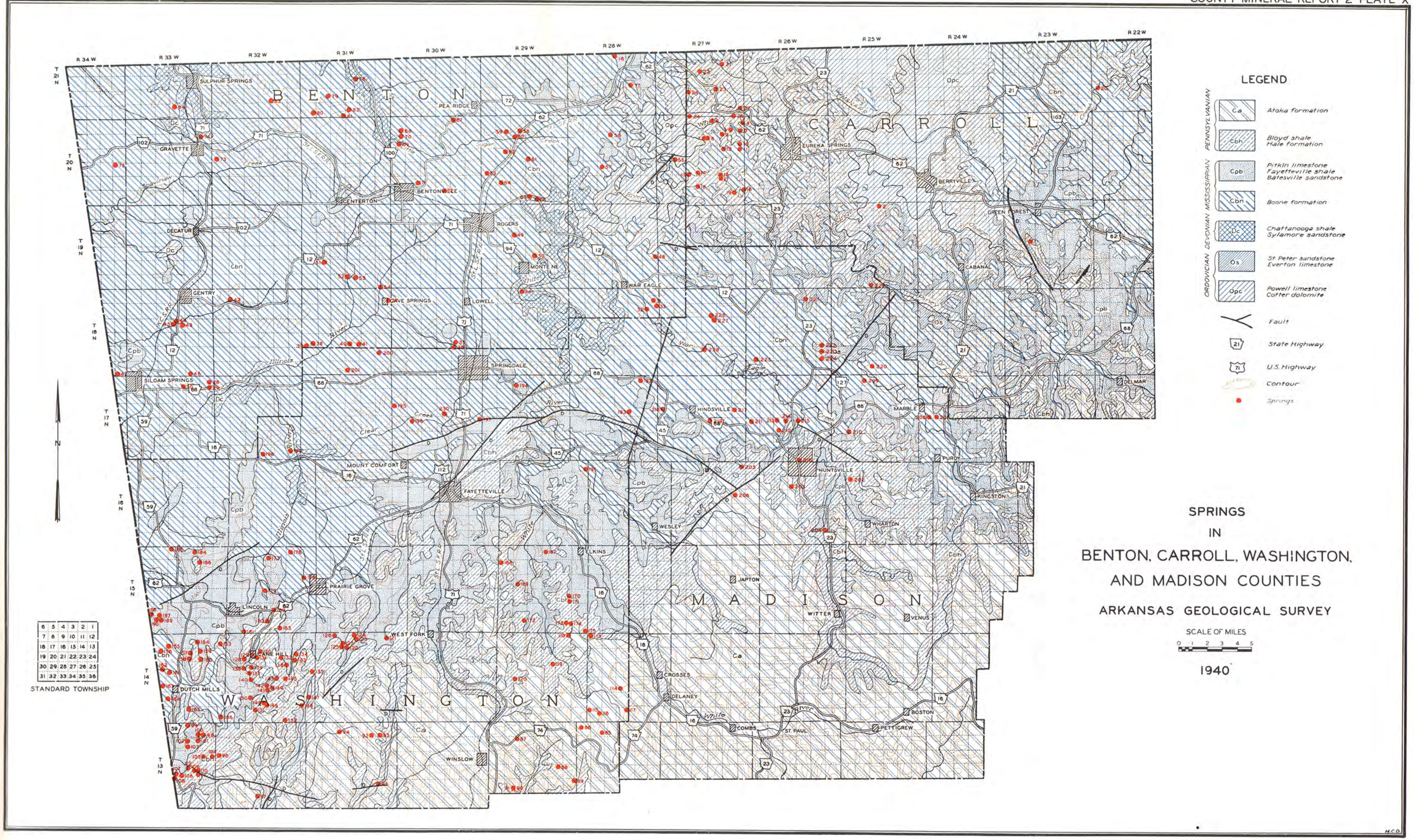
Table 27. List of springs in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Est. 24-hour yield (gals.)	Owner and address
142	NE SE	21	14N	32W	1,800	Emma King, Unknown
143	NE NW	22	14N	32W	1,200	Tommy Taylor, Prairie Grove
144	NW SW	22	14N	32W	1,800	Delta Jordan, Prairie Grove
145	NW NW	23	14N	32W	1,000	W. M. Remington, Prairie Grove
146	SW SW	25	14N	32W	36,000	T. W. Brewster, Rt. #1, Prairie Grove
147	SW NE	25	14N	32W	28,800	G. L. Montgomery, Prairie Grove
148	SW SE	28	14N	32W	21,600	Jim Reece, Lincoln
149	SE SE	28	14N	32W	36,000	Spurrier, Prairie Grove
150	SE NE	29	14N	32W	7,200	Frank Webber, Cane Hill
151	NW NW	33	14N	32W	1,440	Unknown
152	SW SW	35	14N	32W	4,320	C. W. Chambers, Prairie Grove
153	NW SE	1	14N	32W	2,400	Mrs. Bush, Fayetteville
154	NW SW	2	14N	33W	1,000	Pette Bros., Lincoln
155	SW SW	4	14N	33W	21,600	Otis Williams, Rt. #2, Lincoln
156	NW NE	8	14N	33W	1,500	Government Reserve
157	SW NE	10	14N	33W	7,200	C. C. Ryker, Rt. #2, Lincoln
158	SW SE	10	14N	33W	7,200	Z. W. Lofton, Lincoln
159	NE NW	11	14N	33W	4,320	M. S. Padgett, Lincoln
160	SE SW	11	14N	33W	7,200	Evert Thomas, Lincoln
161	NE SW	16	14N	33W	2,800	H. McCarty, Rt. #2, Lincoln
162	SE NE	17	14N	33W	2,500	W. C. Choate, Lincoln
163	NE SE	20	14N	33W	11,520	State of Arkansas
164	SE NW	28	14N	33W	240,000	Cane Hill Canning Co., Cane Hill
165	NW NE	34	14N	33W	14,400	Mrs. Ray, Morrow
166	NE SE	36	14N	33W	11,520	Owen Reed, Rt. #1, Cane Hill
167	SW NW	3	15N	29W	14,400	Anna E. Martin, Rt. #5, Fayetteville
168	NW NW	7	15N	29W	3,000	C. E. Denney, Fayetteville
169	NE SW	17	15N	29W	5,000	R. S. James, Rt. #5, Fayetteville
170	SE NE	23	15N	29W	6,000	W. J. Harris, Rt. #1, Elkins
171	SE SE	23	15N	29W	4,800	J. S. Clark, Rt. #1, Elkins
172	NE NE	32	15N	29W	1,200	J. D. Eagle, Fayetteville
173	SW NE	35	15N	29W	7,200	Tom Smith, Carter
174	SE NE	35	15N	29W	60,000	W. B. Netherland, Hix
175	SE SE	36	15N	29W	1,000	H. E. Eaton, Durham
176	SE NW	2	15N	29W	1,000	Neal Carim, Prairie Grove
177	SE SE	4	15N	32W	14,400	A. J. Wilson, Prairie Grove
178	NW NW	13	15N	32W	4,000	Nora Rollins, Prairie Grove
179	NW NE	21	15N	32W	7,200	Unknown
180	NW SW	27	15N	32W	1,000	Robert Parks, Salisaw, Okla.
181	SW SW	32	15N	32W	79,200	I. A. Tull, Norma, Okla.
182	NE NE	33	15N	32W	1,000	J. P. Harris, Prairie Grove
183	NW SE	34	15N	32W	8,640	W. A. Delap, Rt. #1, Lincoln
184	SE NE	3	15N	33W	1,000	J. C. Mensch, Rt. #1, Lincoln
185	NW NW	4	15N	33W	28,800	Fred Stennant, Summers
186	NW NW	11	15N	33W	61,920	R. G. Beal, Lincoln
187	SE SW	29	15N	33W	2,000	W. V. Bibb, Rt. #2, Lincoln
188	SE SE	30	15N	33W	1,000	C. L. Carter, Wichita
189	NE NW	32	15N	33W	1,000	J. T. Smith, Lincoln
190	NE NW	33	15N	33W	19,200	R. H. Gibson, Summers
191	SE SE	1	16N	29W	31,680	Fred Kleine, Goshen
192	NW NE	2	17N	28W	27,360	L. A. Sanders, Spring Valley
193	NE SE	15	17N	28W	27,360	Bruce Morris, Mayfield
194	NW SW	4	17N	29W	31,680	Jones Heirs, Rt. #2, Springdale

Table 27. List of springs in Benton, Carroll, Madison, and Washington counties (cont.)

Map no.	Location	S.	T.	R.	Est. 24-hour yield (gals.)	Owner and address
195	NW NW	18	17N	30W	528,480	Ed Farrish, Rt. #4, Springdale
196	SE NW	20	17N	30W	40,320	A. J. Greathouse, Rt. #4, Springdale
197	NE NE	24	17N	30W	27,360	Jack Wilkerson, Johnson
198	NE SW	34	17N	32W	40,320	Wedington Park Reserve
199	SE NW	36	17N	32W	148,320	Earl Darling, Fayetteville
200	SE NW	25	18N	31W	630,000 plus	Steele Bros., Elm Springs
201	NW SW	34	18N	31W	630,000 plus	Roy Arthurs, Elm Springs
	Madison County					
202	NE NW	7	16N	25W	3,000	H. A. Griggs, Rt. #2, Huntsville
203	NW SW	9	16N	26W	18,720	L. W. Minor, Huntsville
204	NW SE	26	16N	26W	57,600	Wilburn Boman, Huntsville
205	SW NE	2	16N	27W	108,000	Mr. Linemore, Rogers
206	SW NW	14	16N	27W	62,020	John Hillis, Huntsville
207	SW SW	17	17N	24W	108,000	M. L. Harvey, Marble
208	SW SE	18	17N	24W	53,280	John Kane, Marble
209	SW NW	4	17N	25W	89,280	W. R. Goucher, Alabama
210	SW SW	20	17N	25W	46,080	John Berry, Huntsville
211	NE NW	19	17N	26W	630,000 plus	Hobbs Tie & Lbr., Gayetteville
212	NE SW	21	17N	26W	53,280	Clara Harrington, Huntsville
213	NW NW	21	17N	26W	27,360	J. C. Smith, Huntsville
214	NE NE	21	17N	26W	27,360	Elmer Warren, Huntsville
215	NW NE	22	17N	26W	18,720	Frank Simpson, Huntsville
216	SE SE	34	17N	26W	4,100	I. M. Coger, Huntsville
217	SW NW	13	17N	27W	108,000	P. G. Hawkins, Hindsville
218	SE NW	18	17N	27W	18,720	I. K. Vaughan, Whitener
219	NW NE	22	17N	27W	24,480	W. E. Starns, Hindsville
220	SW NE	33	18N	25W	53,280	Lem Kindell, Berryville
221	NE SW	2	18N	26W	27,360	Melvin Graham, Clifty
222	SE SW	24	18N	26W	24,480	Jim McElroy, Fayetteville
223	SE NW	25	18N	26W	18,720	May Lawman, Los Angeles, Calif.
224	NE SW	25	18N	26W	79,200	May Lawman, Los Angeles, Calif.
225	SW SE	30	18N	26W	18,720	E. L. Calico, Clifty
226	SW SE	10	18N	27W	27,360	Mrs. J. B. Todd, Clifty
227	NE NE	15	18N	27W	53,280	Charley Samuels, Clifty
228	NW NW	27	18N	27W	27,360	E. Guthrie, Hindsville
229	NW SE	33	19N	25W	27,360	Sam Doss, Rock House
230	SE SW	15	17N	30W		Brumfield's Fish Hatchery, Johnson, Washington County

1/ Springs nos. 1 to 27, inclusive, have not been weired. Most of the springs nos. 28 to 230 have been weired.


SPRINGS
IN
BENTON, CARROLL, WASHINGTON,
AND MADISON COUNTIES
ARKANSAS GEOLOGICAL SURVEY
SCALE OF MILES
0 1 2 3 4 5
1940
LEGEND
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
ORDOVICIAN
Ca Atoka formation
Cbh Bloyd shale Hale formation
Cpb Pitkin limestone Fayetteville shale Batesville sandstone
Cbn Boone formation
Dc Chattanooga shale Sylamore sandstone
Os St. Peter sandstone Everton limestone
Opc Powell limestone Cotter dolomite
Fault
State Highway
U.S. Highway
Contour
Springs
BENTON
CARROLL
WASHINGTON
MADISON
R 34 W
R 33 W
R 32 W
R 31 W
R 30 W
R 29 W
R 28 W
R 27 W
R 26 W
R 25 W
R 24 W
R 23 W
R 22 W
SULPHUR SPRINGS
PEA RIDGE
GRAVETTE
CENTERTON
BENTONVILLE
ROGERS
DECATUR
MONTE NE
GENTRY
CAVE SPRINGS
LOWELL
WAR EAGLE
SILOAM SPRINGS
SPRINGDALE
HINDSVILLE
EUREKA SPRINGS
BERRYVILLE
GREEN FOREST
CABANAL
MARBLE
DELMAR
PURDY
HUNTSVILLE
KINGSTON
WHARTON
MOUNT COMFORT
FAYETTEVILLE
WESLEY
ELKINS
PRAIRIE GROVE
LINCOLN
JAPTON
WITTER
VENUS
CANE HILL
WEST FORK
DUTCH MILLS
CROSSES
DELANEY
BOSTON
COMBS
ST. PAUL
PETTIGREW
WINSLOW
STANDARD TOWNSHIP
6 5 4 3 2 1
7 8 9 10 11 12
18 17 16 15 14 13
19 20 21 22 23 24
30 29 28 27 26 25
31 32 33 34 35 36
M.C.D.

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