AN OUTLINE
OF THE
METALLIC MINERALS
of ARKANSAS

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BY

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State Geologist

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OUTLINES OF ARKANSAS' MINERAL RESOURCES
BY GEORGE C. BRANNER

TABLE OF CONTENTS

Cobalt
see p 40

Metallic Minerals of Arkansas

ANTIMONY

Composition.—Antimony is a metallic element. It is usually found in nature as sulphide of antimony, or stibnite. It is also found as an impurity in other minerals, such as lead sulphide, silver, and bismuth.

Uses.—Metallic antimony is used principally in the manufacture of lead alloys, such as babbit and hard lead, solder, type metal, bullets, battery plates, Britannia metal, etc. It is also used in the manufacture of vulcanized rubber and rubber goods, enamel on metal ware, chemicals, paints, and pigments.

Occurrence.—The antimony deposits of Arkansas occur in a rather narrow belt of steeply folded Mississippian shales and sandstones (Stanley Shale) in northern Sevier County, southern Polk and northwestern Howard Counties (see accompanying map). The stibnite deposits are associated with veins of quartz which penetrate the shales and sandstones and usually have northeast-southwest trends. The ore is associated with small amounts of copper, iron, zinc, and bismuth sulphides. These were probably deposited by the circulation of underground waters which dissolved the metals from deep-seated volcanic rocks and deposited them along veins a considerable distance above. The quantity of antimony ore in Arkansas has not been definitely estimated. A considerable amount of drilling would have to take place before even a partially accurate estimate of the quantity of available ore could be made. The ore lies in lenses or pockets associated with quartzitic veins which are not continuous for any great distance. Some of the lenticular masses exceed 100 feet in vertical dimension and vary in width from three to forty feet, and vary in thickness from a feather-edge to two and one-half feet. The following are analyses of stibnite samples:

*Sample from Antimony Bluff Shaft

Stibnite	99.711
Chalcopyrite	.055
Bismuthnite	.005
Gangue	.229
Silver	None
	100.000

*Sample from Stewart Mine

Antimony	69.87
Sulphur	27.91
Iron	.02
Zinc	.01
Silica	2.69
Silver	None
	101.50

*U. S. Geological Survey Bulletin 3464, "Arkansas Antimony Deposits," by Frank L Hess.

Mar 10, '30

Lx Cx Gatlin
is with E. G. Vaughan
has installed $30, ore
machinery, at Coalgton
mine

Manganese carbonate has been mined for about two years in the Cushman district; from 150 to 200 tons of carbonate and oxide ore have been taken from the Clubhouse Mine and from Penters. The Cove Mine was discovered two years ago. High grade carbonate runs from 40% to 45% metallic manganese; low grade from 25% to 32%; average about 35%.

Braunite collected at Pfeiffer is from Davis-Hill Mine in Section 14-14N-7W. The carbonate ore is Bill Chinn property in Section 15-14N-6W.

The Coleman, Martin and Cave tracts have produced 500 tons of carbonate above 30%. The price is 27½¢ to 55¢ per unit; average 34%.

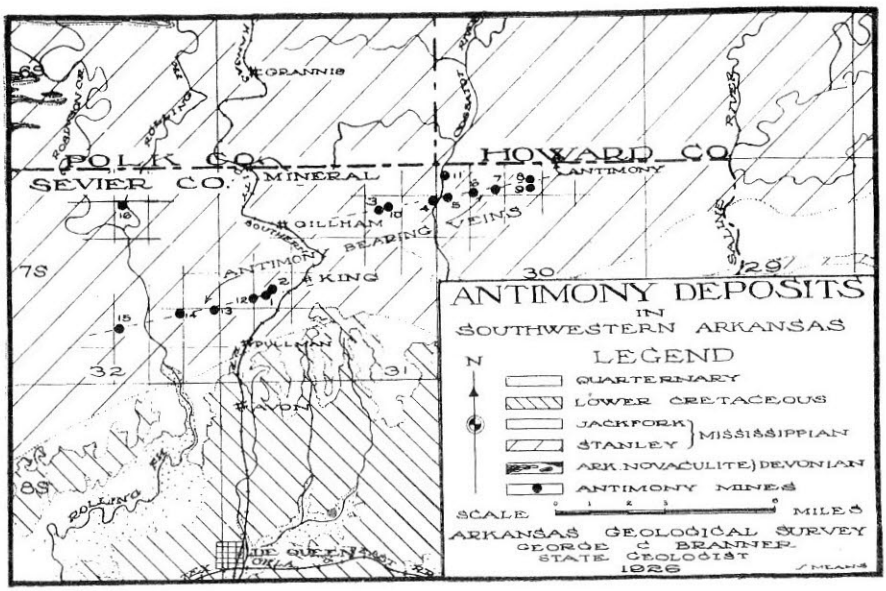
Manganese information furnished by Reed Denison and J. S. Baker, Cushman, Arkansas, October 31st.

Coleman, Martin and Cave properties in Section 2-14-8,;ledge is 3 feet to 6 feet in thickness; high grade 18 inches to 20 inches.

Worthington's carbonate ore at Pfeiffer's Switch from Walburt Mine, Section 14-6-14; low grade sold to Republic Steel & Iron, Thomas, Alabama; high grade to Sheffield & American Steel.

Pfeiffer's Quarry opened in 1903 or 1904 and closed in 1929.

Reed Denison states the total carbonate ore mined in Cushman mine district is 500 tons or over; 200 to 500 tons.

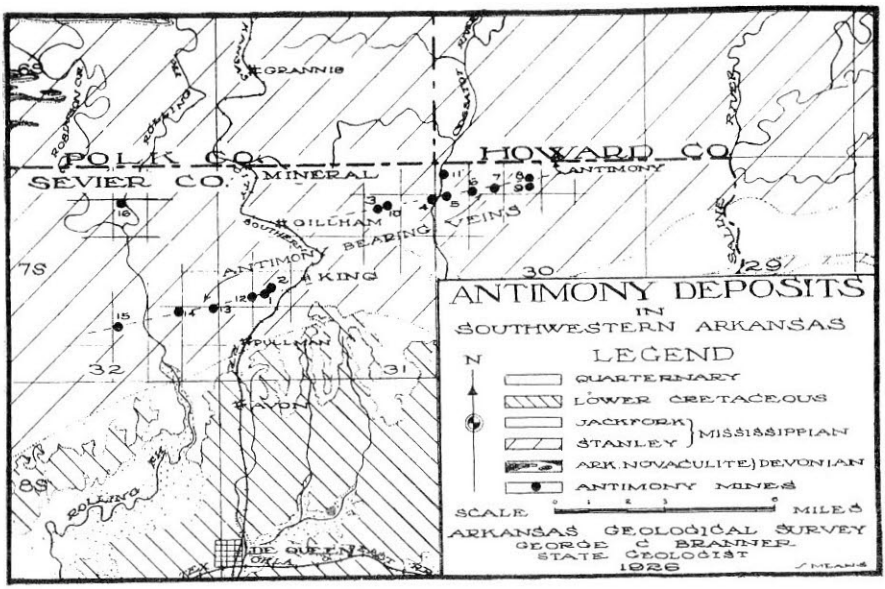


No.	Name of Mine	Depth	Probable Ore Tonnage Removed
7.	Stewart Mine	45 ft.	1,000
8.	Old May Mine	115 ft.	1,500
9.	New May Mine	73 ft.	10
10.	J. W. Jordan	75 ft.	5
11.	Blucher Bluff	Depth or tonnage not known	
12.	Brewer Mine	65 ft.	75
13.	W. J. Mittan	20 ft.	No tonnage
14.	R. A. Hankins	12 ft.	No tonnage
15.	Bellah Mine	180 ft.	Lead and Zinc; tonnage not known
16.	Davis Mine	220 ft.	Lead and zinc, 2,200 c. l.
17.	Texarkana (200 yards east of Valley mine)	60 ft	Not known

Zinc and lead concentrating mills were formerly operated at the Davis and Bellah mines, each having a capacity of about forty tons of concentrates in ten hours. Both of these mills have been dismantled. At the present time there is one mill on the Cassatot River operated by the Gillham Antimony Corporation which is now standing idle. The capacity of this mill is about forty tons in ten hours.

Producers—Gillham Antimony Corporation, E. E. Vaughan, manager, Gillham, Arkansas.

Buyers of Antimony Ore.—Rare Metals Company, Perth Amboy,



No.	Name of Mine	Depth	Probable Ore Tonnage Removed
7.	Stewart Mine	45 ft.	1,000
8.	Old May Mine	115 ft.	1,500
9.	New May Mine	73 ft.	10
10.	J. W. Jordan	75 ft.	5
11.	Blucher Bluff	Depth or tonnage not known	
12.	Brewer Mine	65 ft.	75
13.	W. J. Mittan	20 ft.	No tonnage
14.	R. A. Hankins	12 ft.	No tonnage
15.	Bellah Mine	180 ft.	Lead and Zinc; tonnage not known
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Producers—Gillham Antimony Corporation, E. E. Vaughan, manager, Gillham, Arkansas.

Buyers of Antimony Ore.—Rare Metals Company, Perth Amboy,

N. J.; Krause Chemical Company, New Brunswick, N. J.; Great Western Metal Extraction & Reduction Works, Chicago, Ill.

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2. **Santos, J. R.,** "Analysis of Native Antimony Ochre from Sevier County, Arkansas."—Chemical News Vol. 36, p. 167.

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1907

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BAUXITE

Bauxite is a mixture of minerals and is not itself a natural chemical compound. According to chemists, it is probably a mixture of hydrous aluminum oxides and iron hydroxides with hydrous aluminum silicate.

*Following is a table showing the chemical qualities of nine samples of Arkansas bauxite.

Sample No.	Silica SiO_2	Alumina Al_2O_3	Iron Fe_2O_3	Titanic Oxide TiO_2	Water H_2O	Color
1	10.13	55.59	6.08	.....	28.99	Light brown
2	11.48	57.62	1.83	.....	28.63	Gray
3	3.34	58.60	9.11	.....	28.63	Light red
4	4.89	46.44	22.15	.....	26.68	Brick red
5	5.11	55.89	19.45	.....	17.39	Black
6	33.94	44.81	1.37	2.00	17.88	Gray, surface
7	2.00	62.05	1.66	3.50	30.31	Pink
8	10.38	55.64	1.95	3.50	27.62	Surface
9	16.76	51.90	3.16	3.50	24.86	

Sample No. 1—From 1 north, 12 west, Section 24, north side of the southeast quarter. On Little Rock-Sweet Home turnpike, cut near road.

Sample No. 2—From 1 north, 12 west, Section 25, southwest corner, and Section 36, northwest corner.

Sample No. 3—From 2 south, 14 west, Sections 9 and 10; extending also from 10 into northwest of 15.

Sample No. 4—From 2 south, 14 west, Section 3, southeast of the southwest.

Sample No. 5—From 2 south, 14 west, Section 3, southeast of the southwest.

Sample No. 6—From 2 south, 14 west, Section 16, northeast corner of the southwest quarter, near Sol. Nethercut's.

Sample No. 7—From 1 south, 12 west, Section 9, northwest quarter of the northeast quarter, at the end of the Arch Street pike, and just north of the fork of the road at the point mentioned.

Sample No. 8—From 1 south, 12 west, Section 4, middle of the south side of the northwest quarter of the southwest quarter on the west side of the Arch Street pike leading south from Little Rock. Exposure in the field, a stone's throw from the road.

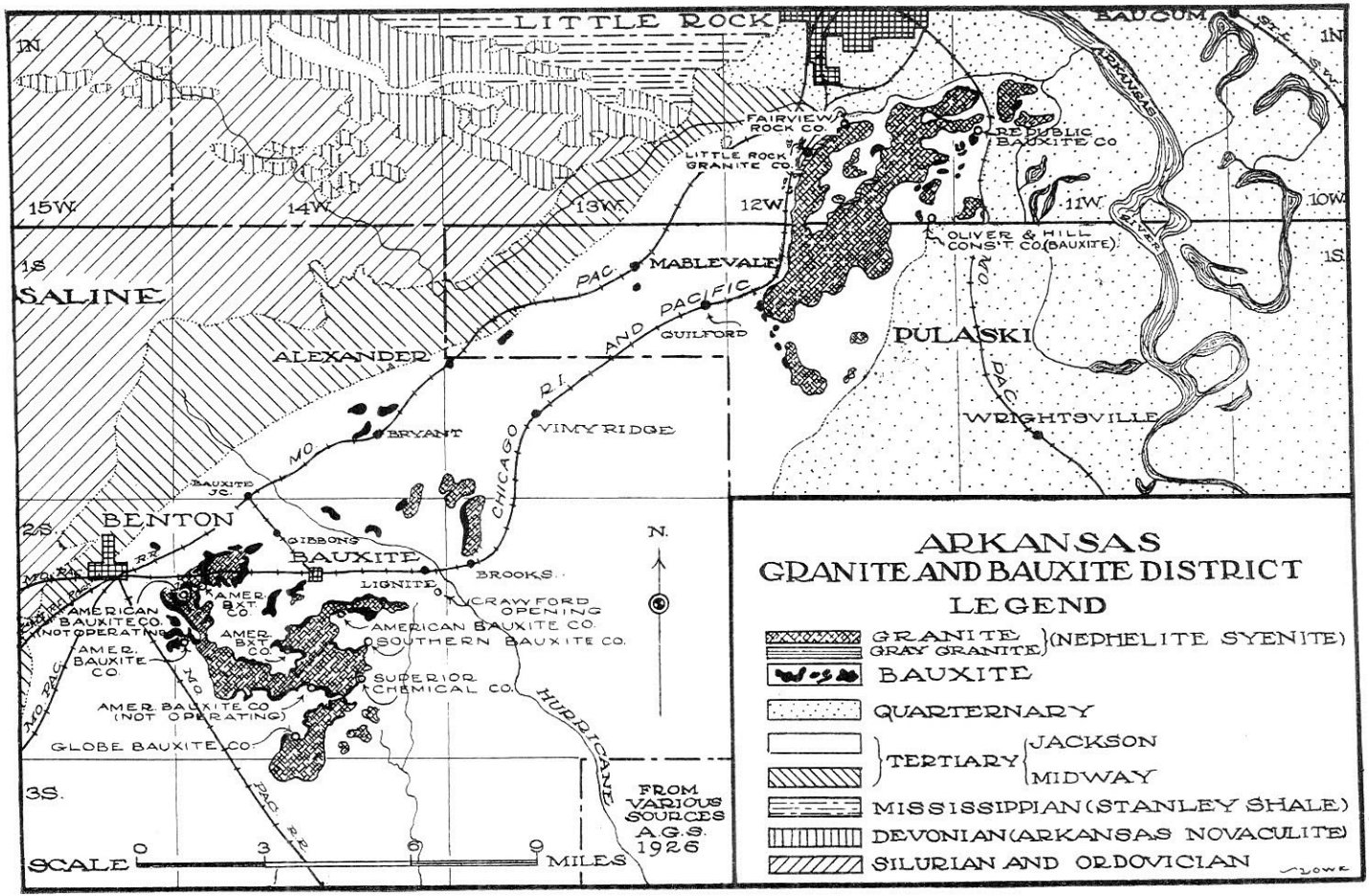
Sample No. 9—From 1 south, 12 west, Section 9, northeast quarter of the northwest quarter, west of the pike and west of small stream, about 100 feet south of bridge.

Uses of Bauxite

Bauxite is used (1) as a source of metallic aluminum, (2) in the manufacture of abrasives, (3) in the manufacture of aluminum chemicals, (4) in the manufacture of refractories, and (5) in the manufacture of aluminum cement.

Bauxite is at present the only ore used commercially as a source of metallic aluminum. It also provides the source of those abrasives

*Branner, J. C., "The Bauxite Deposits of Arkansas," Jr. of Geology Vol. V, No. 3, April-May, 1897.


LITTLE ROCK
BAUCUM
1N
1S
2S
3S
15W
14W
13W
12W
11W
10W
SALINE
PULASKI
ALEXANDER
MABLEVALE
GUILFORD
BRYANT
VIMY RIDGE
BAUXITE JC.
BENTON
GIBBONS
BAUXITE
LIGNITE
BROOKS
CRAWFORD OPENING
AMERICAN BAUXITE CO.
SOUTHERN BAUXITE CO.
SUPERIOR CHEMICAL CO.
AMER. BAUXITE CO.
AMERICAN BAUXITE CO. (NOT OPERATING)
AMER. BAUXITE CO. (NOT OPERATING)
GLOBE BAUXITE CO.
FAIRVIEW ROCK CO.
LITTLE ROCK GRANITE CO.
REPUBLIC BAUXITE CO.
OLIVER & HILL CONS'T CO. (BAUXITE)
WRIGHTSVILLE
ARKANSAS RIVER
MO. PAC.
CHICAGO R.I. AND PACIFIC
HURRICANE
N.
FROM VARIOUS SOURCES A.G.S. 1926
SCALE
0 3 6 9 MILES
ARKANSAS
GRANITE AND BAUXITE DISTRICT
LEGEND
GRANITE
GRAY GRANITE
(NEPHELITE SYENITE)
BAUXITE
QUARTERNARY
TERTIARY
JACKSON
MIDWAY
MISSISSIPPIAN (STANLEY SHALE)
DEVONIAN (ARKANSAS NOVACULITE)
SILURIAN AND ORDOVICIAN
J. DOWE

made by the dehydration of bauxite. These are synthetic products such as alundum, aloxite, exolon, and lionite. Bauxite is used in the manufacture of aluminum oxide, sulphate, chloride and floride, and the alum group known as sodium alum, potash alum, and ammonium alum. Aluminum "quick set cement" is made partially from bauxite. One brand, "Lumnite," which utilizes high grade bauxite as the principal raw material, is composed of the following:

Alumina	40%
Lime	40%
Iron oxides	15%
Silica, magnesia	not given
Loss on ignition	5%

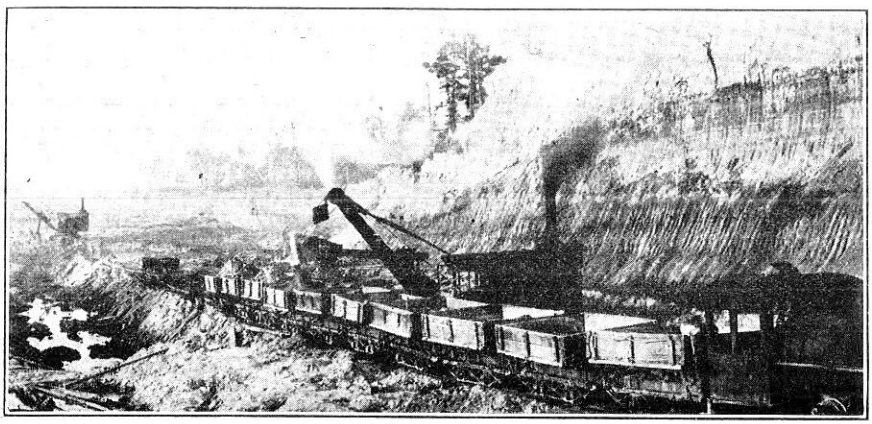
The amount of domestic bauxite sold for various purposes by producers in the United States in 1924 in long tons, according to U. S. Geological Survey figures, was as follows:

Aluminum	225,780	64.80%
Chemical	54,870	15.80%
*Abrasive	66,400	19.10%
Refractory	440	.10%
Aluminum Cement	80	.02%
Total	347,570	99.80%

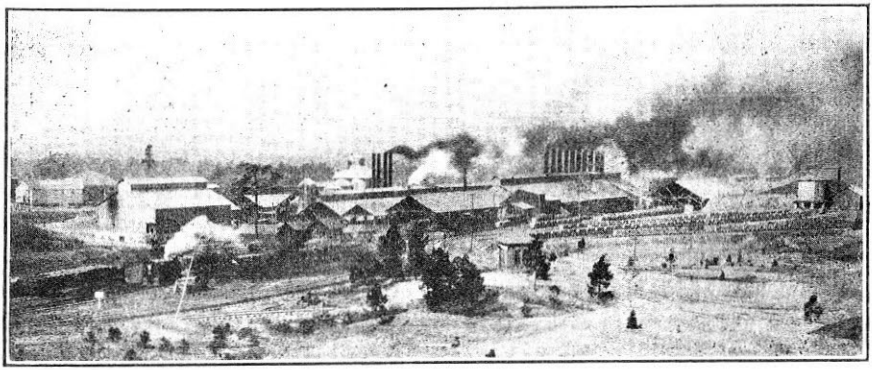
*Includes small amount of alumina used for refractories.

Geology of the Bauxite Areas

The bauxite deposits are confined to Saline and Pulaski Counties and are directly associated with the nephelite syenite or blue and gray "granite," to which they owe their origin. There are two distinct modes of occurrence: (1) Ore-bodies of irregular outline lying above or beside the syenite masses. These ores grade into kaolin and this, in turn, grades into syenite. Both the pisolitic and granitic bauxite



Mines of the American Bauxite Company, Bauxite, Arkansas



Crushing and Drying Plant of the American Bauxite Company at Bauxite, Ark.

occur here; (2) sedimentary-like beds that are occasionally interbedded with Tertiary beds of sedimentary origin that contain no ore with granitic texture.

*Mead attributes the origin of the bauxite to prolonged weathering of the syenite and the action of downward percolating waters of meteoric origin. By this action, the syenite was altered to kaolin by removal of the potassium, sodium, much of the iron, etc. The alkaline solution thus formed probably furthered the alteration of kaolin to bauxite by aiding the ground waters in the removal of the silica and other impurities, thus leaving the hydrous aluminum oxide or bauxite of commerce. This would account for the gradation found from bauxite through kaolin to syenite as well as the granitic texture that remains in some of the aluminum ore.

While this prolonged weathering was going on, erosion probably took place and some of the bauxite was removed to be deposited in the Tertiary seas thus giving rise to the ore-deposits of the second type.

†Hayes believes that the bauxite is due to the decomposition of the syenite by heated alkaline descending waters. These waters may have been derived from an arm of the Tertiary sea that was so nearly cut off from the main Mississippi embayment that its salinity was increased by evaporation. These saline waters descended to the syenite body before its complete cooling or the complete cooling of the country rock had taken place and became heated and passed over the surface of the syenite body where chemical decomposition of the syenite occurred.

As these mineral-laden waters ascended, dilution with descending water, or cooling, possibly caused a chemical precipitation of the

*Mead, Warren Judson, "Occurrence and Origin of the Bauxite of Arkansas."—Bulletin of Economic Geology, Vol. 10, pp. 28-52, 1915.

†Hayes, Chas. Willard, "The Arkansas Bauxite Deposits."—Twenty-first Annual Report of the U. S. Geological Survey, Part IIId, pp. 441-472, 1901.

hydrous aluminum oxide, but their salinity was retained sufficiently to permit the retention of silica and other mineral matter in solution. By further removal of these impurities left in solution, through the ground water agency, the first type of bauxite deposit was formed.

After this bauxite was formed, erosion with subsequent deposition in the Tertiary seas gave rise to the second type of the ore deposits.

Extent of Deposits

The areas of exposed syenite in Pulaski and Saline Counties cover approximately thirteen square miles and the associated bauxites are distributed around the edges of many of the syenite areas. The Saline County deposits were estimated to contain 50,000,000 long tons in 1900. Since that time more than 5,000,000 long tons have been removed from the Saline County area, leaving there approximately 45,000,000 tons which are available. The quantity in the Pulaski County area has not been estimated. Much of it is buried and cannot be estimated except by extensive drill tests. Bauxite has been found 170 feet below the surface in Saline County and the deposits have a maximum thickness of seventy feet with an average of between ten and fifteen feet.

Mining Methods

The bauxite ores are found in Arkansas, sometimes as outcrops but more often are buried beneath Tertiary sands and gravels. The larger portion of the bauxite is mined by stripping and open pit methods. In recent years an increasing amount of bauxite has been mined by underground methods by the American Bauxite Company, and this has been found to be economical even when the over-burden is of comparatively little thickness. At the larger mines, the bauxite is hauled from the mines in cars to the crushing plant, where it is crushed and dried or calcined in rotary kilns. A small quantity of ore is shipped without drying or crushing.

History

The Arkansas bauxite deposits were discovered by John C. Branner, State Geologist, in June, 1887, about a mile south of Fourche Bayou on the Little Rock-Pine Bluff highway. Other deposits were later discovered in Saline County. The bauxite deposits were not mined to any extent until 1899, when 5,045 long tons, valued at $18,000, were shipped. From that time to January 1, 1927, over 5,467,841 tons, valued at $30,804,620, have been taken from Saline and Pulaski Counties.

Production

Arkansas produces more bauxite than any other state. During 1925, 94 per cent of the bauxite mined in the United States came from Arkansas. The maximum production occurred in 1918, when 562,892 long tons were mined, the value of which was estimated at $3,133,880.

Directory of Bauxite Companies

American Bauxite Company, Bauxite, Ark., and Philadelphia, Pa.
Dixie Bauxite Company, Sweet Home, Ark.
Globe Bauxite Company, Joliet, Ill.
Norton Company, Bauxite, Ark.
Republic Mining & Manufacturing Company, Bauxite, Ark.
Superior Bauxite Company, Joliet, Ill.

*Production of Bauxite in Arkansas, 1899-1926
Long Tons of 2,240 Pounds

Year	Production	Value	Year	Production	Value
1899	5,045	$ 18,000	1913	169,871	$ 846,988
1900	3,445	13,300	1914	195,247	976,686
1901	867	3,700	1915	268,796	1,370,489
1902	4,645	20,500	1916	375,910	2,011,590
1903	25,713	91,500	1917	506,566	2,724,007
1904	25,748	127,500	1918	562,892	3,133,880
1905	32,956	164,780	1919	333,490	1,855,159
1906	50,267	242,876	1920	481,279	2,897,892
1907	58,942	294,710	1921	124,850	755,300
1908	33,703	168,515	1922	266,790	1,682,890
1909	101,531	534,492	1923	493,880	2,980,580
1910	110,406	547,429	1924	327,630	1,981,000
1911	122,183	606,173	1925	296,320	1,878,450
1912	117,299	577,584	1926	371,570	2,298,550
			Totals	5,467,841	$30,804,620

*U. S. Geological Survey figures.

Production of Bauxite in Arkansas from March 23, 1923, to January 1, 1928, According to the State Severance Tax Reports

Year	Production Long Tons	Value
1923 (2nd, 3rd, 4th quarters)	243,447.53	$ 480,972.09
1924	328,306.03	676,613.06
1925	295,508.52	584,200.09
1926	368,070.13	724,737.47
1927	302,776.87	604,776.79
Totals	1,538,109.08	$3,071,299.50

From Mr. Lewellyn of the Republic Mining & Manufacturing Co. Sept. 6, 1930, over telephone.

The General Bauxite Co. began business in 1895 and continued until Sept., 1905, when it was bought out by the Pittsburgh Reduction Co. This company cintinued until the name was changed in 1907 to the Aluminum Co. of America.

In 1909 the name was again changed to the American Bauxite Co. which name was retained until December 31, 1929, when the name was changed to Republic Mining and Manufacturing Co.

In the spring of 1930, the Kalbfleisch Corporation of Chattanooga bought out the Superior Chemical Co. and the Globe Bauxite Co. The Norton Co., Worcester, Mass., mined their own ore in 1917, 1918, 1919 and 1920. Their property is located in the SW NE Sec. 15, just east of Bauxite.

The American Bauxite Co. bought out the property of the Illinois Chemical Co. which was located in SE NW Sec. 16. They also bought out the E. Metznauer property which was located in NE NE sec. 15. which was operated in a small way 25 years ago.

The Tom Roland property was originally worked in a very small way by R.S.Perry, probably about 1905, when the General Bauxite Co. sold to the Pittsburgh Reduction Co. Only a few carloads at most as far as we know, were shipped. No machinery was installed.

The Berger property on the Arch St. pike was operated by the American Bauxite in 1905-1907. From 1907 to May 13, 1924, was operated by Republic Mining & Manufacturing Co.

Southern Bauxite Co. went into bankruptcy, which was settled about 2 months ago.

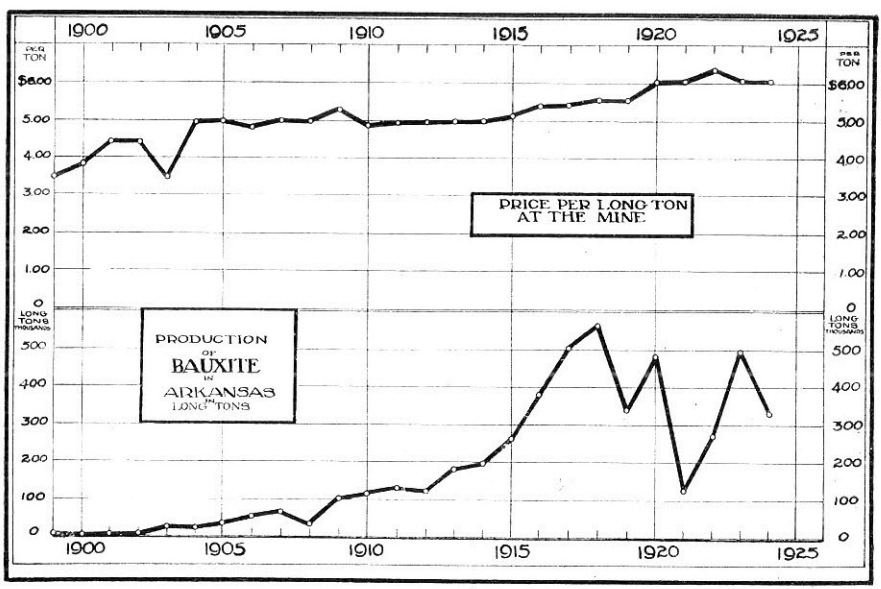
*Bauxite Production in the United States—Long Tons

Year	Arkansas	Alabama-Georgia-Tennessee	Total	Arkansas Per Cent of Total	Others Per Cent of Total
1919	333,490	43,076	376,566	89%	11%
1920	481,279	40,029	521,308	92%	8%
1921	124,850	14,700	139,550	89%	11%
1922	266,790	42,810	309,600	86%	14%
1923	493,880	28,810	522,690	94%	6%
1924	327,630	19,940	347,570	94%	6%
1925	296,320	20,220	316,540	94%	6%
1926	371,570	20,680	392,250	95%	5%
Total	2,695,809	230,265	2,926,074	92%	8%

*Consumption in the United States—Long Tons

Year	Quantity	% Mined in Arkansas
1919	364,947	94%
1920	541,946	89%
1921	161,195	77%
1922	313,639	85%
†1923	563,150	88%
†1924	472,479	69%

*U. S. Geological Survey figures.
†Estimated.



*Domestic Consumers of Bauxite

Aluminum Company of America, Pittsburgh, Pa.
Aluminum Ore Company, East St. Louis, Ill.
Atlas Cement Company, New York.
Carborundum Company, Niagara Falls, N. Y.
Charles Lennig & Company, Inc., Philadelphia, Pa.
Charles Taylor Sons Company, Cincinnati, O.
Columbus Waterworks, R. D. 5, Columbus, O.
Columbus Waterworks, Columbus, Ga.
Como Chemical Company, Kokomo, Ind.
Detroit Chemical Works, 238 Junction Ave., Detroit, Mich.
E. I. du Pont de Nemours & Company, Wilmington, Del.
Evits Creek Water Company, Cumberland, Md.
Exolon Company, 156 Sixth Ave., Cambridge, Mass.
General Abrasives Company, Niagara Falls, N. Y.
[1]General Chemical Company, 25 Broad St., New York.
General Refractories Company, Trinity Bldg., New York.
Gulf Refining Company, Pittsburgh, Pa.
Harbison-Walker Refractories Company, Pittsburgh, Pa.
Herman Chemical Corporation, Matteson, Ill.
Hudson Chemical Company, Albany, N. Y.
Internat'l Abrasive Corp., 5 Dorchester Ave., Extended, Boston, Mass.
Jarecki Chemical Company, St. Bernard Station, Cincinnati, O.
[2]Kalbfleisch Corporation, Chattanooga, Tenn.
Kansas City Water Department, Kansas City, Mo.
Laclede-Christy Clay Products Company, St. Louis, Mo.
Massillon Stone & Fire Brick Company, Massillon, O.
[3]Merrimac Chemical Company, 33 Broad St., Boston, Mass.
Metropolitan Water District of Omaha, Omaha, Neb.
Montclair Water Company, Paterson, N. J.
Montreal Waterworks, Montreal, Quebec.
Norton Company, Worcester, Mass. (also Niagara Falls, N. Y.).
[4]Pennsylvania Salt Mfg. Co., Widener Bldg., Philadelphia, Pa.
Springfield Waterworks, Springfield, Mass.
Superior Chemical Company, Joliet, Ill.
Trenton Filtration Plant, Westfield, N. J.
Welch Chemical Company, 8 East Long St., Columbus, O.

*List taken from "Marketing of Metals and Minerals," by Spurr and Wormser.

*Bauxite Elsewhere in the United States

Bauxite in commercial quantities is found in only five localities in the United States outside of Arkansas. These are (1) near Keenburg and (2) Chattanooga, Tenn.; (3) Wilkinson County, Georgia; (4) from Jacksonville, Ala., to Cartersville, Ga.; and (5) in south-

[1]Operating plants at Bay Point, Cal.; Claymont, Del.; Chicago Heights and East St Louis, Ill.; Laurel Hill, N. J., and Cleveland, Ohio. [2]Operating plants at Erie, Pa., and Chattanooga, Tenn. [3]Operating plants at Everett and Woburn, Mass. [4]Operating plants at Natrona and Philadelphia, Pa. * Data from "Economic Geology," Heinrich Ries.

western New Mexico. The Keenburg deposit is found in clays which have been derived from Paleozoic (Cambrian) shales. (2) The Chattanooga deposits are found as deposits in clays which were derived from Paleozoic (Silurian) shale. (3) The Wilkinson County, Georgia, deposits occur in beds near the contact of the Lower Cretaceous and Tertiary beds; (4) the beds from Jacksonville, Ala., to Cartersville, Ga., occur in lenses in residual clay derived from the Knox dolomite (Silurian), and (5) the southwestern New Mexico deposits were probably derived from the alteration of basic volcanic rock.

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COPPER

The only economic source of copper as yet discovered in Arkansas is the mineral chalcopyrite, or copper pyrites, which is intimately associated with galena in nearly all of the known occurrences of that mineral. There is, so far as is known, no great quantity of copper in Arkansas, although there are many places where traces of it occur in the rocks. Incrustations of azurite, the blue copper carbonate and chrysocolla, copper silicate, are common in the shales of northern and western Arkansas, but these are of no commercial importance. In some instances, vein deposits of native copper have been found.

Native copper occurs impregnating a quartz vein near Olsen switch west of Benton. An opening has been made in this vein for the purpose of mining the copper, but because of the irregular distribution of the metal in the vein, and the large amount of gangue that must be handled in recovering the metal, it is probable that this vein cannot be worked profitably at the present time.

A little metallic copper was found at the Rossin shaft, four miles east of Harrison, but not in commercial quantities. A small amount of malachite (hydrous copper carbonate) was mined at the "Tomahawk Mine" in Section 6, Township 16 north, Range 16 west, in Searcy County. Two assays of malachite from this locality gave 39.48 and 39.57 per cent of metallic copper. Small quantities of the same material were shipped from the Big Bear mine near Ferndale, Pulaski County, but the mining of these ores did not prove profitable.

A small amount of native copper has been found at Greasy Cove about 16 miles west of Caddo Gap, in Montgomery County.

Where copper minerals occur in connection with lead, zinc or other metallic ores, it is often possible to profitably save the copper as a by-product. So far as is now known there are no copper deposits in Arkansas that warrant working for copper alone.

The location of the Tomahawk mine is shown on the map of the zinc and lead district on page 55. It lies in a district in which zinc mineralization is common.

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20 m. W of L. R.
Big Bear Mining Co -
op. ~~in~~ to ~~1910~~ 1908-10
Prospecting work from 1905 to
1908.
C. J. Griffith interested
Fred Rossmer
M. ~~H.~~ N. Samson

Close to Little Maumelle
Panther Creek empties into
L. Maumelle West of mine.
Man Douglas has farm
right by it - out
Terndale road

GOLD AND SILVER

Gold

From time to time interest in gold mining is revived in the State and money is invested in gold mining ventures. Probably the greatest gold mining boom occurred between the years 1885 and 1888. The following is an extract from a letter dated August 8, 1888, from Dr. J. C. Branner, State Geologist at that time, to Governor Hughes concerning the results of the State gold and silver survey. This survey covered lands in the Ouachita Mountain district of western Arkansas:

"There has long been a popular belief that gold and silver existed in paying quantities in the State of Arkansas. During the last few years, notably since 1885, a great many people have become excited upon the subject of the occurrence of the precious metals about Hot Springs and through the country west of there. This excitement culminated in 1887-88. In some portions of the State it reached such a pitch that almost every man abandoned his usual occupation to stake off claims and turn miner. Every unfamiliar rock was regarded as a valuable ore or an "indication" of something, and these delusions have been kept alive by assayers, some of whom were, perhaps, sincere, but some of them certainly fraudulent. These same assayers and their dupes have been so successful that they induced capitalists and business men, both in and out of the State, and especially the visitors to Hot Springs, to believe in the value of the region for mining purposes to such an extent that during the last two and a half years companies have been incorporated under the laws of Arkansas with a total capital stock of more than $111,000,000 for the purpose of working the supposed gold and silver mines and ores of the State. As one investment after another has failed to pay dividends the authors of this excitement have persuaded people, whether honestly or fraudulently makes but little difference, that the ores of the region were 'peculiar' and only required some new process to get gold and silver out of them. The repeated adverse reports by competent assayers were attributed to ignorance of the character of the ores. The Lost Louisiana ore was said to contain tellurium, and the gold was said to escape from other assayers in the form of telluride of gold, and this in spite of the fact that no one was able to detect tellurium in it in the minutest quantities.

"Sufficient work has been done in this region by the Geological Survey to settle all these questions beyond dispute. Over 300 openings made in search of gold and silver have been examined and sampled by Dr. Comstock, my assistant in charge of this work, and more than 300 assays and analyses have been made of the mineral. No prejudices have been allowed to stand in the way of the most thorough investigations. To insure safety, careful examinations have been made even when there was evidently nothing to be expected from the material. The ores have been tested thoroughly and by the best

methods known to modern sciences, while the chemical work done in the Survey's laboratory has been checked by some of the best assayers in this country, notably by Dr. P. de P. Ricketts of Columbia College, New York, and by Prof. R. H. Richards of the Massachusetts Institute of Technology, Boston. * * *

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

"The results obtained by this survey and here announced do not agree with those reported by Professors Samuel Aughey, Beam, Waitz and others. Those gentlemen claim to use a special formula in their assays, a copy of which was kindly furnished the Survey. This formula had been tried on their own ores many times, but the results do not differ essentially from those obtained by the methods in use by all competent assayers. Of this formula the opinions have been sought of several of the leading American assayers. These opinions agree that while it will make an assay it has no advantage whatever over the methods ordinarily used. * * * "

According to T. B. Comstock, who made a silver and gold survey in western Arkansas in 1888 for the Arkansas Geological Survey, it is improbable that gold will be found in Arkansas in commermercial quantities, for the following reasons:

"First, the various agencies which have been at work in Arkansas have not had access to any important supplies of gold.

"Second, the processes of deposition have often acted too rapidly to accumulate the gold in workable deposits.

"Third, the auriferous deposition, if any has taken place, has been spread over such vast areas as to dilute the whole to a condition of extreme poverty.

"Fourth, there have been no special accumulations, even in cases where such must have been formed, if gold had been present in the solutions from which other metallic ores have been locally deposited.

"Fifth, at the time of the formation of the deposits in which gold is being sought, the structural conditions were unfavorable to its accumulation.

"Sixth, the proper mechanical, physical, and chemical conditions have often been present, yet gold is absent from those situations in which all of these conditions have been most favorable to its retention.

"Seventh, there is one more reason for the unfavorable opinion expressed regarding the future of the gold mining industry in Arkansas. It is the invariable absence of gold in the "float" and the

sands and gravels as well as in the large number of secondary deposits, which have resulted from decomposition and degradation of the original accumulations. In some of these, at least, the chances for deposition should be most favorable, but in none of them has gold been found in workable quantities."

Scattered through the Paleozoic sediments of the State are many local deposits of pyrite. Many of these deposits are gold-bearing. It would seem that the Paleozoic seas carried gold in small quantities which was deposited with the sediments from those waters. Since the rather uniform distribution of that time, ground water agencies have often brought about a slight concentration of the gold in the form of pyrite nodules. Many of these nodules will assay considerably over one dollar of gold per ton, but as the pyrite itself is disseminated through the rocks rather sparingly, many tons of non-metallic material have to be moved to secure the pyrite. Thus the actual recovery of gold may amount to sums varying from a portion of a cent to a few cents per ton of material mined.

Some of the shales of the Arkansas River Valley of western Arkansas have been found to contain small quantities of gold, some samples assaying as high as three dollars to the ton, although their average would be considerably less than this. Deposits of this character cannot at the present time be worked commercially.

Assays made for gold by the Manglesdorf Laboratories, Little Rock, Ark., of Pennsylvanian shales collected from the vicinity of Booneville and Magazine Mountain showed gold content equivalent to a value of $2.50 to the ton. This is equivalent to about .12 of an ounce per ton.

One hundred eighty-three samples which were believed to contain gold were assayed in 1888 by the chemist of the Arkansas Geological Survey for gold. Out of these samples, 129 contained no gold, only 51 contained traces of gold, and three contained, respectively, .08, .04 and .06 of an ounce of gold to the ton, as follows:

Sample No	Locality	County	Material	Gold Oz. Per Ton
23	Glenpatrick lodes, Patsy's Pride shaft	Garland	Siliceous sinter	.08
26	Shippey mine	Garland	Rusty quartz	.04
28	Sec. 32, Twp. 2S., R. 19W., Pleasant Run	Garland	Rusty quartz	.06

The 183 samples referred to above were taken from Pulaski, Saline, Garland, Hot Spring, Yell, Montgomery, Pike, Sevier, Polk, Scott and Logan Counties.

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Silver

(See also "Gold")

Silver occurs as native metal in veins along with bismuth, cobalt, and silver minerals. It also occurs as a secondary mineral with argentite or galena, and is contained in such minerals as freibergite, tetrahedrite, and galerite. The conditions under which silver-bearing minerals may occur in nature are more varied than those affecting the distribution of gold. There are deposits of silver-bearing ores in the northern and western parts of the State, some of which are deserving of thorough exploration. The silver that occurs in these deposits is in the nature of an accessory ingredient of some other metallic ore, usually galena.

In 1888 the chemist of the Arkansas Geological Survey assayed 181 samples which were believed to contain silver, from Pulaski, Saline, Garland, Hot Spring, Yell, Montgomery, Pike and Sevier Counties. Of this number 152 contained no silver, twelve contained traces of silver, the remaining seventeen samples were as follows:

ASSAYS OF ARKANSAS SILVER

Sample No.	Locality	County	Material	Oz. Per Ton Silver.	Remarks
4	"Fletcher diggings"	Pulaski	Manganiferous limonite	1	
5	Kellogg mine German slope	Pulaski	Galena	30 to 60	Av. assorted ore running high in lead
6	Kellogg mine	Pulaski	Freibergite	788	Selected sample
7	Kellogg mine German slope, upper west drift	Pulaski	Zinc blende	18	
8	McRae mine, Sec. 30, Tp. 1N, R. 13W	Pulaski	Shaley pyritous ore with little galena	3.5	
12	Bradfield's, Sec. 5, Tp. 1S, R. 17W	Saline	Impure limonite	1	
15	Sandcarbonate mine	Saline	Quartz	1	Crucible assay
16	Sandcarbonate mine	Saline	Quartz	1	Scorification assay
101	Silver City, Minnesota mine	Montgomery	Samples from dump showing galena and zinc blende	36	Nos. 101-105 do not represent average ore in any case. The mines were mostly filled with water and the assays given here are only rough approximations of what the ores will yield when fairly assorted. The value of the properties will depend upon the relative proportions of ore and "dead rock," at present a very uncertain element. The quartz and shale assays are from rock in place
102	Silver City, Minnesota mine	Montgomery	Quartz with spots of green and red mineral, in place	1.5	
103	Silver City, Waterloo mine	Montgomery	Zinc blende and galena from vein	23	
105	Silver City district, Montezuma mine	Montgomery	Galena, etc., from ore house	31	
107	Walnut mine	Montgomery	Galena and zinc blende	17	
109	Eureka lode	Montgomery	Galena and zinc blende	19.5	

ASSAYS OF ARKANSAS SILVER—Continued

Sample No.	Locality	County	Material	Silver, Oz. Per Ton	Remarks
110	Waterloo mine; (specimen furnished by postmaster at Silver City)	Montgomery	Specimen of rich ore, said to have come from the old "Bonanza," now worked out	346	
120	Sec. 20, Tp. 7S, R. 31W., Otto mine	Sevier	Av. samples including gangue	1.2	By fire assay yields 31% of lead and antimony
123	Davis mine, Silver Hill district	Sevier	Galena, chalcopyrite, zinc blende (specimens)	31	

Localities in Pulaski, Garland, Hot Spring, Montgomery, Pike, Howard, Sevier, Polk, Scott and Logan Counties have been fitfully and unprofitably exploited for silver at various times in the past. Some of the lead-bearing shales of the Arkansas River Valley contain from five-tenths to one ounce of silver to the ton. Up to the present time, however, no deposits large enough to be of commercial importance have been discovered.

For bibliography of "Silver" see "Bibliography of Gold and Silver."

IRON

The following is taken from the Annual Report of Arkansas Geological Survey, 1892, Vol. I, "The Iron Deposits of Arkansas," by R. A. F. Penrose, Jr.:

Composition.—"The commercial value of the iron ores of Arkansas are usually, if not always, non-Bessemer in quality, generally containing over 0.05 per cent of phosphorus; in iron they vary from less than 35 per cent to over 55 per cent; in silica they vary from rarely as low as 2 per cent to over 75 per cent, and are often much injured by an excess of this ingredient; in sulphur they range from 0.04 per cent to rarely over 1 per cent; in some localities they contain enough manganese to be classed as manganiferous iron ores; only the magnetite of Magnet Cove contains titanium in appreciable quantities.

"Most all the iron ores of Arkansas belong to the class of hydrous sesquioxides of iron, or limonite, commercially called brown hematite, or simply "brown ore." The only other ores found in the State are limited quantities of carbonate of iron or spathic ore, also known as clay-ironstone, found in the Carboniferous shales and in the Tertiary clays and sands, and still more limited quantities of magnetic ore (magnetite) occurring in a residual clay derived from the decay of crystalline rock in Magnet Cove. This last ore is the celebrated Arkansas lode stone, and has attracted more attention than any other iron deposit in the State.

Occurrence.—"Iron ore is of common occurrence throughout many parts of Arkansas, but in only a few places is it found in important quantities. The largest and most accessible deposits yet discovered are in the northeastern part of the State, especially in Lawrence and Sharp, and to a lesser extent in Fulton and Randolph Counties. Other deposits, however, of varying size and importance occur in many places in different parts of the State.

"In the descriptions of the various iron ore localities of Arkansas, the State will be divided, for the sake of convenience, into five different parts, as follows:

"1. The Iron Deposits of Northeastern Arkansas.—(Lawrence, Sharp, Fulton and Randolph Counties.)

"2. The Iron Deposits of Northwestern Arkansas.—(Carroll, Washington and Madison Counties.)

"3. The Iron Deposits of the Arkansas Valley.—(Van Buren, Conway, Pope, Yell, Johnson, Logan, Franklin, Sebastian, Scott and Crawford Counties.)

"4. The Iron Deposits of the Ouachita Mountains.—(Pulaski, the northern part of Saline, Hot Spring, Clark, Pike, Montgomery and Polk Counties.)

"5. The Iron Deposits of Southern Arkansas.—(The southern part of Saline County, Dallas, Ouachita, Nevada, Hempstead and Lafayette Counties.)

"The ores of northeastern Arkansas are associated with Lower Silurian (probably Calciferous) sandstones, cherts and limestones; the ores of northwestern Arkansas, in the central part of Carroll County, occur mostly with Lower Silurian cherts, while those of Washington and Madison Counties are mostly in Lower Carboniferous sandstones; the ores of the Arkansas Valley occur almost exclusively with rocks of Carboniferous and Lower Carboniferous ages, though some of them are much later deposits formed by the concentration, at the mouths of springs, of the iron in rocks of those ages; the ores of the Ouachita Mountains occur mostly with Lower Silurian shales and novaculites, though they also include the magnetic ore of Magnet Cove, which occurs in an area of igneous rock in the novaculite region; the ores of the southern part of the State are in a great series of sands and clays which represents the Eocene division of the Tertiary.

The Iron Mining Possibilities of Arkansas

"Conditions Necessary for Profitable Iron Mining.—The value of an iron ore deposit depends as much on its geographic position, its relation to transportation and markets, and the facilities for mining, as it does on the quality of the ore. Moreover, if furnaces are to be erected for the manufacture of pig-iron, the distance of fuel, and of limestone for fluxing purposes, are most important points to consider. In determining the value of an iron deposit, therefore, four main subjects must be taken into consideration:

"I. The quality and quantity of the ore.

"II. The facilities for mining the ore.

"III. The relations of the deposits to transportation and to markets.

"IV. The relations of the deposit to fuel and limestone.

"Conditions in Northeastern Arkansas.—In the northeastern part of the State there are some isolated deposits of fairly good brown hematite which, if they had transportation facilities and markets, might be worked at a profit. The facilities for mining the ore in this region are good. It occurs on isolated hills and ridges rising from fifty to over three hundred feet above the surrounding drainage. It forms irregularly shaped bodies from two or three to probably over twenty-five feet in thickness, and often covering several acres, generally lying in a horizontal position and usually on or near the summits of the hills. Though limited in both lateral and vertical extent, the ore that is in any one place lies near the surface and could be easily mined. The nearest means of transportation for the ore of

northeastern Arkansas is the Kansas City, Fort Scott & Memphis Railway, which is from eight to twenty miles distant from the more important deposits. The Black River flows through the northeastern part of the State and in some localities freight might be shipped down it to the White River and thence to the Mississippi. The transportation facilities, however, cannot at present be considered as good, since, unless a branch road were built, a haul by wagon of from eight to twenty miles would be necessary to reach either the railway or the river. The nearest coking coal to the iron deposits of northeastern Arkansas is that of Western Arkansas and of Oklahoma, at distances by rail varying from 225 to over 400 miles. Good hardwood, however, fit for making charcoal, is plentiful in the vicinity of the ore, and a fairly pure limestone can also be obtained in the same region.

"In consideration, therefore, of the combination of a fairly good ore with a cheap charcoal, made from the timber of the region, and with limestone in the immediate vicinity, there is a possibility of a limited iron industry in northeastern Arkansas.

"Conditions in Northwestern Arkansas.—The ores in the northwestern part of the State, aside from any questions of quality, are in too small quantities to be profitably worked.

"Conditions in the Arkansas Valley.—In the Arkansas valley the ores are too poor in quality and occur in too small quantities to be of any value as sources of iron.

"Condition in the Ouachita Mountains.—In the Ouachita Mountains the only ores yet found in large quantities are of low grade. The deposits dip steeply and would be expensive to mine. The nearest railways are from seven to, more generally, over twenty miles and often over forty miles distant. Limestone is scarce and often altogether absent in the Ouachita Mountains, and there is no coal nearer than the Arkansas Valley, with which region the Ouachita Mountains have no direct railway connection. There is, however, a large amount of timber, and with cheap charcoal fuel there is always at least a possibility of the future utilization of the better class of ores. The industry, however, would never be an important one, and could only be carried on under the most favorable conditions of transportation and markets, conditions which at present are far from being realized."

Magnetite has been found in Magnet Cove, Hot Spring County, Arkansas, and occurs there as surface float which has concentrated over a long period of time from the decomposition of masses of syenite. J. F. Williams in his report, "The Igneous Rocks of Arkansas," 1890, states concerning this mineral in Magnet Cove:

"A prospect hole was at one time opened in the lodestone bed and it was found that although pieces of ore were obtained deep

down in the decomposed syenite they were not large enough or sufficiently abundant to warrant the opening of a mine as has been proposed * * * * *. It has been found by experiment that the ore does not form a valuable grade of iron when reduced in a blast furnace."

Mr. Penrose further states:

"Conditions in Southern Arkansas.—In the southern part of the State the Tertiary brown hematites occur over considerable areas, but the ores which are of sufficiently good quality to use are so scattered that it is somewhat doubful whether enough can be found in one place to permit important mining. Large deposits of poor ore frequently occur in this region, but they are of too low grade to be of value. The better ores are mostly from eight to fifteen miles from the nearest railway transportation, which is the St. Louis, Iron Mountain & Southern Railway or the St. Louis & Southwestern Railway. Limestone would have to be brought, in most cases, from distances varying from fifty to a hundred miles. The ores are near the surface, however, and easily mined; and there is a large amount of timber fit for making charcoal in the vicinity, so that it is not impossible, in view of these advantages, that a small iron industry might, under favorable conditions, be supported on the better grades of ores of the region. The good ores are scarce, however, and under any circumstances the industry would be small.

"The commercial possibilities of the Arkansas iron region may be briefly stated as follows:

"The ores are mostly brown hematites, though small quantities of spathic and magnetic ores also occur. Most of the brown hematites, if not all, are non-Bessemer in character, the phosphorus ranging generally over 0.05 per cent; the iron ranges from 35 per cent to rarely over 55 per cent; the silica is usually, though not always high, ranging from 2 per cent to over 75 per cent; the sulphur ranges from 0.04 to over 1 per cent; there is usually a trace of manganese and sometimes enough to allow the ore to be classed as a manganiferous iron ore; none of the ores, except that of Magnet Cove, have yet been found to contain appreciable quantities of titanium. The only ores in the State that could, even under the most favorable circumstances, be worked on a commercial scale are some of those in northeastern Arkansas and a few of the deposits of the Ouachita Mountains and of southern Arkansas. Of these three regions, northeastern Arkansas is the only one which offers favorable conditions for iron mining and manufacture, and even there the industry, if established, would be limited.

"The conclusion to be drawn, therefore, is that the quality and the quantity of the Arkansas ores, the position of the deposits as

regards transportation, the distance of the markets, and the proximity of much better ores in Missouri, all point to the fact that there is, at present, no good field for an iron ore mining industry in Arkansas except possibly in the northeastern part of the State."

Production.—Two small bloomaries were operated in northern Arkansas for a short time prior to 1860. These were built to supply a local demand on account of the difficulty of transporting heavy material into the region at that time. Besides these, no iron ore has been used industrially in the State up to the present. Prospecting, however, has been done and continues.

Mr. Joe Kimzey, Magnet, Arkansas, ships orders of magnetite from ten pounds to a ton from one of the deposits in Magnet Cove.

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IRON PYRITE

For "Iron Pyrites" see "Pyrite and Marcasite," page 37.

For mine list see page 35

MANGANESE

Composition.—Manganese is a metallic element which has about the same specific gravity as iron. It is used principally as an alloy with other metals.

The manganese ores found in Arkansas are principally oxides of manganese known as psilomelane, braunite, hausmanite, pyrolusite and wad. They are classed as low-grade and high-grade ores. The low-grade or shot ore is usually classed as that containing from 10% to 35% metallic manganese and the high-grade as that containing above 35%. According to statistics from 1881-1926 inclusive, 51.6% of the Arkansas manganese ore as thus defined has been low-grade and the remainder high-grade.

Uses.—Manganese of about 20% purity together with iron is used in the manufacture of spiegeleisen, an alloy of manganese; ferromanganese, another alloy, contains from 20 to 90% manganese. Other alloys are with bronze, copper, aluminum, zinc, tin, lead, magnesium and silicon.

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

The Arkansas ores are used almost entirely in the manufacture of ferromanganese, spiegeleisen, and manganese pig ore.

The price of manganese ore depends upon the percentage of metallic manganese in it. The present price of ore (June, 1928), c. i. f. North Atlantic ports, containing a minimum of 47% manganese, is between 35 cents and 38 cents per per cent of metallic manganese per long ton, while Caucasion washed manganese (54% to 55% manganese) is from 38½ cents to 40 cents; 47% ore concentrates would, under these conditions, be worth $16.45 and $17.86 per long ton; ore containing 54% metallic manganese would be worth $20.79 and $21.60, and ore containing 55% metallic manganese would be worth $21.18 and $22.00.

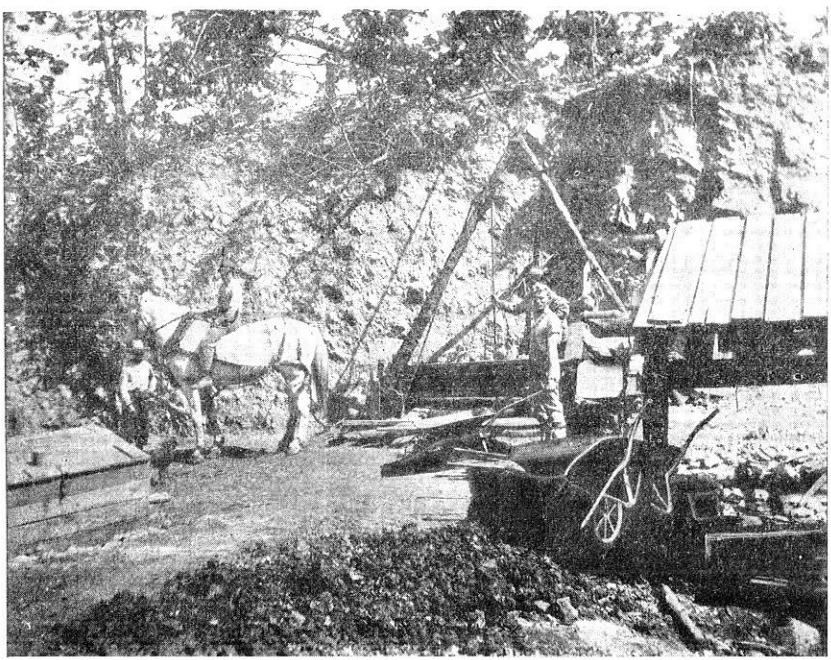
Occurrence.—Manganese is found in several localities in the State, by far the most important of which is the Batesville area of about 100 square miles, located in northwest Independence County, southeast Izard County and northeast Stone County. Other localities of less importance are in Pulaski, Saline,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

The Batesville District

In the Batesville district the manganese ores are found in irregular fragments and nodules which have been concentrated from the

Cason shale formation of Ordovician age. These lumps of ore are found in this shale and in residual clay beneath the shale. Both the clay and the manganese ore nodules are probably residual products of the decomposition of the Cason shale. The West Central Arkansas ores are found in pockets scattered through the Arkansas novaculite formations which are of Devonian age. The West Central Arkansas deposits, however, although containing large amounts of ore in the aggregate are usually not sufficiently concentrated to permit profitable mining during the present prices of manganese.

The available reserves of manganese ore in the Batesville district have been described by H. D. Miser of the U. S. Geological Sur-



Manganese Mine, Independence County

vey in a detailed report on the Batesville district in 1922 as follows:

"An estimate of the quantity of available manganese ore of all grades in this region, where mining is not preceded by systematic prospecting, is difficult to make. Of the 180 deposits examined, about half contain an estimated available reserve of 200 tons or less. Only about one-third contain about 1,000 or more tons and only a few contain more than 5,000 tons, though certain of these contain many thousand tons. A small number of prospects and mines, however, were not visited, and these and the unexplored deposits may increase considerably the reserve. The deposits of the region perhaps include

at least 250,000 tons of available ore containing 40 per cent or more manganese and 170,000 tons available ore containing less than 40 per cent manganese."

Mr. E. E. Bonewitz of the Crooks Engineering Corporation, Little Rock, Ark., estimated in November, 1927, that there were 322,000 long tons of high grade manganese ore containing 35 per cent or more metallic manganese in the Batesville district, and 322,000 long tons of low grade shot ore containing from 10 to 35 per cent metallic manganese.

Miller & Rinehart of Batesville are at the present time (June, 1928), engaged in developing a method whereby the residual manganese-bearing clays of the Batesville district can be washed and concentrated. These clays as found contain about 15 per cent manganese, and upon washing and concentration their manganese content is increased to approximately 30 per cent. If some chemical or pyrometallurgical process for beneficiating these residual clays can be economically developed, the effect of this will probably be of very great importance to the Arkansas industry. The quantity of these residual clays has never been accurately estimated. They lie in irregular pockets and are scattered over probably 100 square miles. The reserves, however, are undoubtedly very large, although it would be difficult to obtain an accurate figure of the tonnage in the Batesville district on account of the irregularity of the beds, and the fact that although the clays have been prospected for lump ore they have never been surveyed or prospected for the tonnage of the clay itself.

The West Central Arkansas District

The managanese ore in Pulaski, Saline, Garland, Hot Spring, Pike and Polk Counties is found as irregular veins and pockets which are scattered through the novaculite beds. The ores are usually found in joint cracks or occur in brecciated novaculite. The ore bodies vary from a fraction of an inch to four feet in thickness, but are usually considerably less than four feet. A portion of the ore is found near the top of the Arkansas novaculite formation, although some deposits are found near the base. On account of the hardness of the novaculite, mining is usually difficult and costly. R. A. F. Penrose* makes the following statement relative to the economic possibilities of the west central Arkansas district:

"The aggregate amount of manganese in the region is undoubtedly large, but it is distributed over an extensive area, and in almost all places it is hopelessly scattered through the rock in small nests and seams. If these nests and seams were in sufficient quantities the rock might be crushed and the ore concentrated by washing, but the pockets containing them are too small to permit the expense of machinery. It is a popular idea that the ore will increase in quantity at a depth, but there is absolutely no reason to expect this, as such

*Penrose, R. A. F., "Manganese, Its Uses, Ores and Deposits," Arkansas Geological Survey Report for 1890, Vol. I.

deposits are just as likely, and sometimes even more likely, to become poorer at a depth than they are to improve.

"From the nature of the deposit it is to be expected that the ore at a depth is, at the very best, no more plentiful than in the surface outcrops of the so-called "lodes"—that is, that it exists as a series of pockets separated by greater or less distances of barren rock. With very few exceptions the pockets of ore seen on the surface cannot be worked at a profit, and in the rare cases where a small profit might be made the amount would not be enough to pay for sinking through the barren rock that separates the pockets from each other. The intervening thickness of barren rock is much greater than the depth of any one pocket."

H. D. Miser in U. S. Geological Survey Bulletin No. 660c, "Manganese Deposits of the Caddo Gap-De Queen Quadrangle, Arkansas," makes the following statement concerning the possibilities of the region:

"Ores from a number of manganese deposits, as shown by chemical analyses, contain a sufficient high percentage of manganese (40 per cent or more) and a sufficiently small percentage of silica (8 per cent or less) for the manufacture of ferro-manganese, but most of the ores of which analyses are available exceed the phosphorus limit (0.20 per cent) for this purpose. The prices paid for medium grade ores used in the metallurgic industries the relatively stable and generally range between $8.00 and $13.50 a ton, being governed by the content of manganese, phosphorus and silica. The price has, however, steadily increased since the outbreak of the war in Europe. Manganese ores sold in 1915 for $14.40 to $22.05 a ton, and in 1916 the maximum price was $32.50. This increase in price has accordingly increased the possibility of the economic recovery of the manganese ores of the area herein described, but some deposits that might now be worked at a profit will not pay to work after the price of ore again becomes normal, which will probably be within a year after the conclusion of peace.

"The wad and other low grade oxides could be used for giving bricks a chocolate color. The pyrolusite, manganite, and psilomelane could be used to produce the spots of some varieties of speckled bricks and mixed with red-burning clay for brown bricks, and with buff-burning clay for gray bricks."

Producers of Manganese

Batesville District—Arkala Manganese Ore Co., Batesville, Ark.; Denison, Walter H., Cushman, Ark.; Miller & Rinehart, Batesville, Ark., Peterson, Lou, Batesville, Ark.; Shell & Beatty, Batesville, Ark.

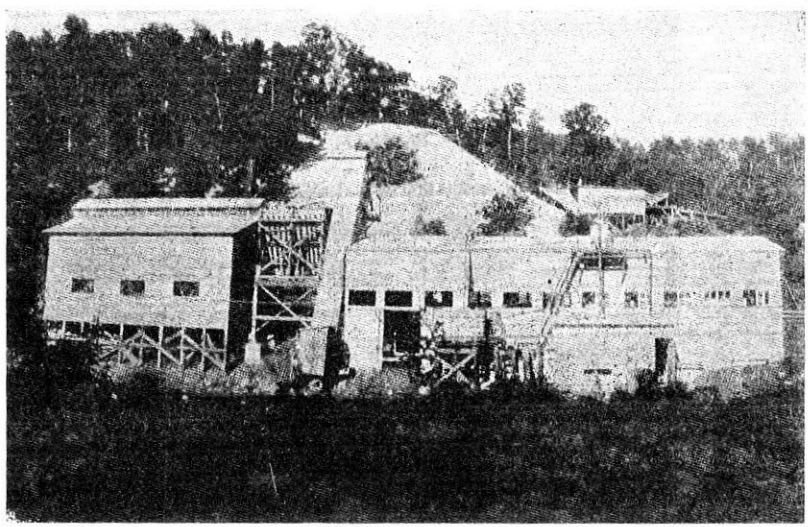
Western Arkansas District—Meyers, J. E., Mena, Ark.

Production

The manganese mines which were operating in 1927, together with their outcrop of 1925, 1926, and 1927, are, according to the State Severance Tax Report, as follows:

	Walter H. Denison, Cushman, Ark.	Shell & Beatty, Cushman, Ark.	Arkala Manganese Ore Company, Batesville, Ark.	Miller and Rinehart Batesville, Ark
First qr., 1925	747.70 tons	1,358.00 tons	.....	.....
Second qr., 1925	.....	.....	.....	.....
Third qr., 1925	779.45 tons	.....	.....	.....
Fourth qr., 1925	551.78 tons	2,939.15 tons	.....	.....
First qr., 1926	734.50 tons	742.24 tons	.....	.....
Second qr., 1926	757.10 tons	.....	.....	.....
Third qr., 1926	639.97 tons	.....	.....	.....
Fourth qr., 1926	327.20 tons	.....	299.40 tons	.....
First qr., 1927	259.99 tons	.....	1,032.40 tons	.....
Second qr., 1927	492.18 tons	.....	.....	.....
Third qr., 1927	.....	.....	1,702.33 tons	647.41 tons
Fourth qr., 1927	.....	.....	2,732.90 tons	.....
Totals	5,289.88 tons	5,039.39 tons	5,767.03 tons	647.41 tons

Grand total—16,743.71 long tons.



Miller & Rinehart's Concentrating Plant (Manganese), Batesville, Cushman District

According to available (U. S. Geological Survey) data up to 1927, approximately 195,152 long tons of manganese ore have been removed from Arkansas. Probably not more than a total of 500 tons of this has been taken from the West Central Arkansas district.

	MANGANESE ORE (35% or More Man.) Long Tons	Value	MANGANIFEROUS ORE (Less than 35% Man.) Long Tons	Value	Total Quantity	Total Value
1881	100	.....	.....	.....	100	.....
1882	175	.....	.....	.....	175	.....

	MANGANESE ORE (35% or More Man.) Long Tons	Value	MANGANIFEROUS ORE (Less than 35% Man.) Long Tons	Value	Total Quantity Long Tons	Total Value
1883	400	.....	.....	.....	400	.....
1884	800	.....	.....	.....	800	.....
1885	1,483	$ 5,932	.....	.....	1,483	$ 5,932
1886	3,316	19,258	.....	.....	3,316	19,258
1887	5,651	28,255	.....	.....	5,651	28,255
1888	4,312	38,582	.....	.....	4,312	38,582
1889	2,528	23,173	.....	.....	2,528	23,173
1890	5,339	59,861	.....	.....	5,339	59,861
1891	1,650	18,150	.....	.....	1,650	18,150
1892	6,708	64,838	.....	.....	6,708	64,838
1893	2,020	24,240	160	$ 320	2,180	24,560
1894	1,934	19,564	.....	.....	1,934	19,564
1895	2,991	20,997	.....	.....	2,991	20,997
1896	3,421	36,686	.....	.....	3,421	36,686
1897	3,240	33,708	.....	.....	3,240	33,708
1898	2,662	26,035	.....	.....	2,662	26,035
1899	356	3,781	.....	.....	356	3,781
1900	145	1,530	.....	.....	145	1,530
1901	91	657	.....	.....	91	657
1902	82	422	.....	.....	82	422
1903	.....	.....	.....	.....	.....	.....
1904	.....	.....	600	1,200	600	1,200
1905	.....	.....	3,321	6,642	3,321	6,642
1906	62	290	8,900	24,800	8,962	25,090
1907	.....	.....	4,133	8,266	4,133	8,266
1908	.....	.....	4,066	9,149	4,066	9,149
1909	.....	.....	3,325	5,819	3,325	5,819
1910	500	5,000	5,030	9,700	5,530	14,700
1911	.....	.....	2,177	4,354	2,177	4,354
1912	.....	.....	1,332	2,997	1,332	2,997
1913	.....	.....	9,650	19,250	9,650	19,250
1914	.....	.....	1,970	3,940	1,970	3,940
1915	588	10,013	3,355	11,864	3,943	21,877
1916	6,318	180,722	3,682	22,665	10,000	203,387
1917	10,140	448,511	9,100	83,227	19,240	531,738
1918	7,731	354,235	9,173	93,525	16,904	447,760
1919	.....	.....	.....	.....	.....	.....
1920	3,445	93,077	4,550	39,227	7,995	132,304
1921	728	16,360	278	3,683	1,006	20,043
1922	2,264	42,197	.....	.....	2,264	42,197
1923	3,768	73,507	4,773	20,047	8,541	93,554
1924	3,400	60,350	7,991	37,170	11,391	97,520
1925	3,517	79,335	5,076	23,140	8,593	102,475
1926	2,450	64,010	8,195	47,428	10,645	111,438
Totals	94,315	$1,853,276	100,837	$478,413	195,152	$2,331,689

Consumers of Batesville Manganese

1. American Steel Foundries, McCormick Bldg., Chicago, Ill.
2. Central Iron & Coal Company, Holt, Ala.
3. Miami Metals Company, Tower Bldg., Chicago, Ill.
4. Mississippi Valley Iron Company, 6500 Broadway, St. Louis, Mo.
5. Sligo Furnace Co., 915 Olive Street, St. Louis, Mo.
6. Southern Manganese Corporation, Anniston, Ala.
7. Sloss-Sheffield Steel & Iron Company, Birmingham, Ala.
8. Tennessee Coal, Iron & Railroad Company, Birmingham, Ala.
9. Woodward Iron Company, Birmingham, Ala.

Manganese Mines Listed by Map Numbers (Page 28)

BATESVILLE DISTRICT

1. Matlock mine
2. Story mine
3. Ball mine (Nw Nw Sec. 3-5W-14N)
4. Shlieper mine
5. Ozark mine
6. Searcy mine
7. Matheny mine
8. Bales mine
9. Mayer mine
10. Silberstein mine
11. J. A. Reves mine
12. Henley mine
13. G. A. Wilson mine
14. Martha Thompson mine
15. Walbert mine
16. Adler mine
17. W. A. Chinn mine
18. Burge mine
19. Rutherford mine
20. Cason mine
21. W. L. Greenfield
22. Allen mine
23. Roberts mine
24. Button mine
25. W. W. Allen mine
26. Shaw mine
27. Denison mine
28. Marshall mine
29. R. T. Patterson
30. Perrin mine
31. Wildcat mine
32. Hunt Hollow mine
33. McGee mine
34. A. G. Gray mine
35. W. T. Gray mine
36. Hawkins mine
37. Chappel Hill mine
38. Adler-Southard mine
39. Roach mine
40. Montgomery mine
41. Montgomery Hill mine
42. Sis Clark mine
43. Galloway mine
44. Barnett mine
45. Reed mine
46. Brooks mine
47. Shell mine
48. Kimmer mine
49. Roseborough mine
50. Rowe Field mine
51. Blue Ridge mine
52. Southern mine
53. Grubb Cut mine
54. Rogers mine
55. Polk-Southard mine
56. Wren mine
57. Turner mine
58. Lassiter mine
59. Mount Etna mine
60. Wolford mine
61. Sterrett mine
62. Page mine
63. Club House mine
64. Meeker mine
65. W. C. Collie mine
66. George mine
67. S. W. Weaver mine
68. Martin No. 1 mine
69. Martin No. 2 mine
70. Kimbrough mine
71. McBride mine
72. Harvey mine
73. T. M. Tate
74. Hankin's Hallow mine
75. Salt Peter Hill mine
76. Edwards mine
77. Cutter mine
78. Adler Hollow mine
79. Izard mine
80. Pugh mine
81. Verna mine
82. Skelton mine
83. Pittman mine
84. Cummins Hollow mine
85. Johnson Hill mine
86. United Phosphate & Chemical Company's mine
87. Shaft Hill mine
88. Sand Field mine

89. Manganese Field mine
90. Ruminer Rough mine
91. Barksdale mine
92. Earl Collie mine
93. L. J. Weaver mine
94. Cave Hill mine
95. McConnell mine
96. Klondike mine
97. W. A. King mine

CADDO GAP AND DE QUEEN QUADRANGLE

1. Arkansas Development Company's mine
2. North Mountain mine
3. Still mine
4. Fagan mine
5. Nelson mine

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PYRITE AND MARCASITE

Composition—Pyrite (iron pyrites or fool's gold) is mineral sulphide of iron (46.6% iron). It is characterized by a brassy yellow color and metallic lustre and when found in crystals is usualy in the form of cubes the faces of which are striated. Marcasite is chemically the same as pyrite but is known as white iron pyrite on account of its lighter color. Crystals are usually tabular.

Uses—Pyrite and marcasite are mined both for the gold and silver which is sometimes found with them and for the sulphur which they contain. Sulphur dioxide obtained by roasting the ore is commonly used in the manufacture of sulphuric acid. Metallic iron is recovered from the roasted ore as a by-product. The value of pyrite concentrates c. i. f., U. S. ports guaranteed 48% sulphur, was worth from 13 cents to 14 cents per per cent of sulphur per long ton on April 7, 1928. 48% ore concentrates would under these conditions be worth between $6.24 and $6.72 per long ton. The iron obtained from the roasting is usually worth less than $1.50 per long ton.

Occurrence—Pyrite is principally found in small quantities associated with the vein minerals of western and northern Arkansas. There are four deposits which are well known. These are:

1. The Wikel mine near Sour Rock Spring in the SW NW of Sec. 2-3S-20W, Garland County, about three miles west of Hot Springs near the Mt. Ida road. Vein pyrite is exposed there in a siliceous shale.

2. Marcasite was encountered in the shaft put down near the railroad station at Caddo Gap, Montgomery County. The main body of pyrite was encountered at a depth of about 40 feet. Some tons of the material were removed in 1915 and 1916 by Carl Shua although none was shipped. The main vein is reported as being about 10 inches thick.

3. The Towry Lode is located near Hatton in the SE Sec. 2-5S-32W, Polk County. Vein pyrite is exposed there.

4. A shallow dug well near Leola, Grant County, in the SW NW Sec. 24-6S-15W reported 27 feet of pyrite-bearing sand between 33 and 60 feet. Quantities of surface pyrite nodules have been found near Leola.

5. A deposit has been reported about one-fourth mile east of Yellville station on the Missouri Pacific Railroad, Marion County.

6. A vein of pyrite about 75 feet wide in feldspathic rock is exposed in the bed of Cove Creek, Magnet Cove. This is located in the northeast quarter of section 17, township 3 south, range 17 west, south of J. M. Henry's house. It was prospected to a small extent from 1893-1895.

None of the above deposits have ever been developed commercially.

RUTILE AND BROOKITE

Composition—Rutile (Titanium dioxide) contains 60% titanium with iron usually present. It is red, brownish red to black in color and gives a pale brown streak. It is found as grains and crystals, as needle-like inclusions or in a massive form. Crystals are tetragonal and usually prismatic in habit. Brookite is chemically the same as rutile and is physically much the same except that its crystals belong to the orthorhombic system.

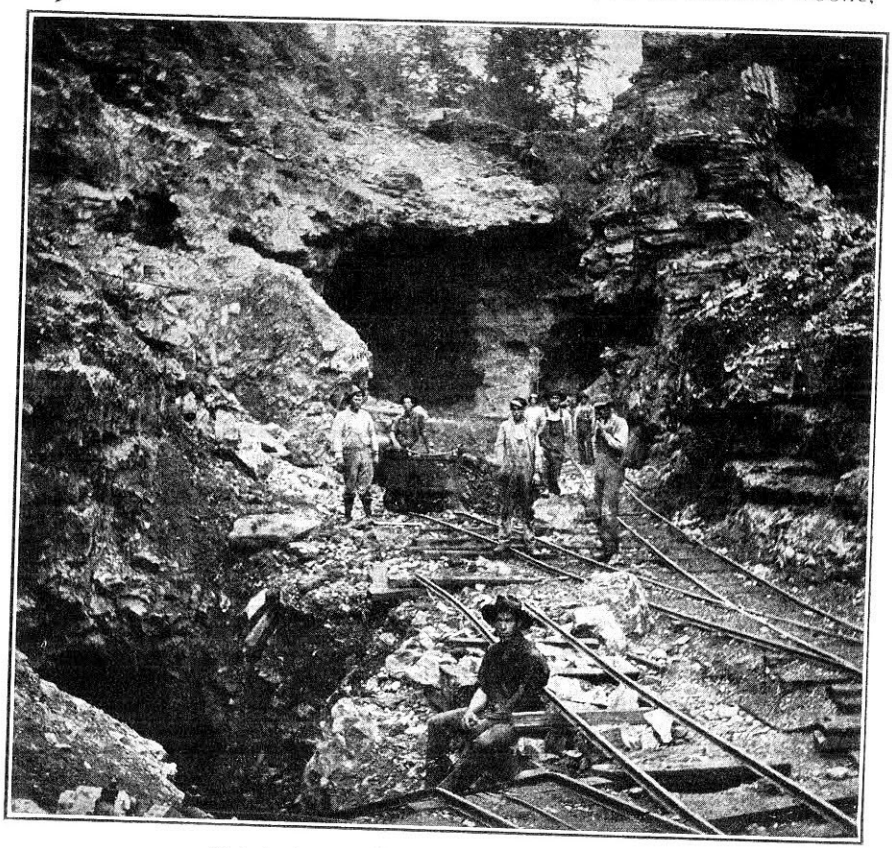
Uses—Rutile is used in the manufacture of ferrotitanium and other alloys; as a constituent part of electrodes for arc-lights; as a mordant in the dyeing industry; in glass manufacture; in the ceramic trade for glazes; in enamels; and for titanium chemicals.

Occurrence—Rutile and brookite occur in Arkansas in Magnet Cove, Hot Spring County in Sec. 17-3S-17W. Ore which has been shipped contained from 68 to 70% titanium oxide. The ore is hand picked, is found in sizes from one-fourth of an inch to six inches in diameter and is associated with quartz and feldspar. The quantity of available rutile and brookite in Magnet Cove has been variously estimated. J. W. Kimzey, Magnet, Arkansas, estimates that there is a total of 100,000 tons of mineable ore.

Production—Approximately 12 tons of ore have been shipped from Magnet Cove by Joe W. Kimzey and W. J. Kimzey, Magnet, Arkansas. The principal portion of this was shipped prior to 1905. There have been no shipments since 1910.

ZINC AND LEAD

There are two regions in Arkansas where zinc and lead ores occur. These are: (1) The mineral belt of west-central Arkansas extending through and in the vicinity of Pulaski, Saline, Garland, Hot Spring, Montgomery, Polk, Howard, Pike and Sevier Counties, and (2) the north Arkansas district which at present includes Boone,



McIntosh Zinc Mine, Rush Creek District

Marion, Newton and Searcy Counties; and to a lesser extent, parts of Baxter, Stone, Independence, Sharp and Lawrence, and adjacent counties.

The West-Central Arkansas District

History and Occurrence—*Zinc and lead mines were worked in the early 60's at Petty, six miles west of Gillham. The mines were worked by the Confederate Government principally for lead. There

*"The Zinc and Lead Deposits of Southwest Arkansas," by William B. Phillips.—The Engineering and Mining Journal, April 6, 1901, pp. 431-432.

were three lead furnaces in operation, the galena being roughly separated from the gangue and from the zinc blende by hand-sorting and jigging. The early operators apparently mined between 1,000 and 1,500 tons of ore.

Again, beginning in 1899, the North American Ore & Metal Company reopened and operated the same mines in Sevier County for several years. During the first two years 1,140 tons of ore were removed, the ore being a mixture of zinc blende, galena, chalcopyrite, and a little pyrite, with wellemite and smithsonite sparingly present. An analysis of a sample representing about 5,000 pounds showed the concentrates to contain 82 per cent lead. One shipment of 57,000 pounds to Joplin showed 55.16 per cent zinc and iron 3.91 per cent as the average of four separate analyses.

The Kellogg mine, located in Section 30, Township 3 north, Range 11 west, Pulaski County, which has been worked intermittently since about 1840, had an estimated yield up to December, 1926, of seventy short tons of lead and silver concentrates valued at about $6,000.00, and forty short tons of zinc concentrates valued at about $1,000.00. As approximately $225,000.00 has been invested and spent on the mine during the years it was worked, a considerable loss has been entailed. There are 8,000 feet of shafts, tunnels and raises in the mine, the main shaft having a present depth of 1,125 feet.

According to T. B. Comstock, Assistant State Geologist, who made a study of the minerals in the west-central Arkansas district in 1888, the lead and zinc situation of west-central Arkansas is as follows:

"The lead and zinc ores occurring in the mineral belt in portions of Pulaski, Saline, Garland, Montgomery, Polk, Pike, Howard and Sevier Counties are so closely associated with silver that it is unnecessary to consider them separately. Wherever there has been a discovery of the 'gray copper' silver-bearing minerals in more than filmy deposits, galena has always been found, and sphalerite or zinc blende is an almost invariable accompaniment in the same or neighboring ore bodies."

The districts in west-central Arkansas which at one time were thought to contain commercial lead and zinc ores, were the Kellogg area in Pulaski County and the tract southwest of the Ouachita River lying between Broken Rock and Blue Mountain axes in Montgomery, Howard and Sevier Counties, and crossing the southeastern portion of Polk County.

Galena is probably the only mineral which occurs in commercial quantities in this region, at least so far as is known. Although none of the lead mines are being worked today, it does not seem impossible that lead deposits may be discovered in this area which will merit development. The Housley mine, located near Point Cedar, Hot Spring County, has produced a small amount of high grade lead ore and as yet has been little developed.

The only ore of zinc that has been mined in west-central Arkan-

MISSOURI PACIFIC RAILROAD COMPANY

Land Department
319 Union Station

Phillips,
Commissioner

Little Rock, Ark.

August 1, 1932

Dr. George C. Branner,
State Capitol Bldg.,
Little Rock, Ark.

Dear Dr. Branner:-

Referring to my conversation with you this afternoon, I have to advise that I find in my notes taken some time ago from the "Independent Balance published at Batesville, Ark., on June 26, 1857, a copy of which you will find in the files of Mr. Dallis T. Herndon of the Arkansas History Commssion, a letter from Mr. William L. Faber, Superintendent of the Independence Zinc Mines, on Mill Creek about 8 miles from Smithville, on the road to Batesville, which says it is the first company to produce metalic zinc on the American continent. I think possibly you will wish to take a copy of the news item and letter.

Referring to the discovery of cobalt in Arkansas, I have to say I find from our tract book records that Sec. 11, in Twp. 2 S., R. 18 W., 640 acres, was sold under contract on July 12, 1887, to the St. Louis Cobalt Mining Company, whose address at that time was Hot Springs, Arkansas, which contract was later forfeited for nonpayment, and the land subsequently on April 4, 1911, sold to the Malvern Lumber Company.

This is not very near the "Rabbit Foot Mine", in Sec. 3, in Twp. 1 S., of R. 15 W., as I thought. (See Gold and Silver Report, pages 32,34, 245 and 248).

Very truly yours,

(Signed) D. L. Phillips
Land Commissioner

sas is sphalerite, or zinc sulphide. There is also a little calamine or zinc silicate, some zinc carbonate or smithsonite being found with the sulphide ores, but usually not in any quantity.

Other than the zinc and lead products of the Kellogg mines, Pulaski County, the Silver Hill, Sevier County, and the Silver City mines, Montgomery County, a small amount of zinc has been found in Polk County in the Davis and Bellah mines. Both of these mines were equipped with mills having a capacity of forty tons of concentrates in ten hours. The Davis mine is reported to have shipped 2,250 tons of concentrates. No production figures are available for the Bellah mine.

Another probable district is the area north of the base line upon the Saline River drainage, particularly in the basin of the north fork of that stream.

*North Arkansas Area

History and Occurrence—Lead ore was used by early explorers in northern Arkansas for the making of bullets. The occurrence of lead has been mentioned by writers as early as 1818. In 1834 Featherstonhaugh mentioned that a mine was in operation on Strawberry River, and ore was smelted at Lead Hill, northern Boone County, between 1850 and 1860. The industry revived about 1870, but the cost of transportation was so great at that time that the operations were abandoned.

A zinc smelter was erected at Calamine, Sharp County, in 1857 and operated until the Civil War. Smelting was resumed during 1871 and 1872. Prospecting began about 1886 and in 1899 a larger number of prospectors were busy in north Arkansas. The greatest development of zinc and lead mining in the history of the State occurred during 1917-1918, when the price of lead and zinc rose to a very high figure and stimulated mining as never before. After the war, the prices dropped and mining practically ceased. At the present time (January, 1928), there are three mines in operation. The depletion of the Missouri, Kansas and Oklahoma reserves will probably result in a progressive development of the Arkansas fields.

The lead and zinc area of northern Arkansas has never been specifically defined. It includes principally Marion, Boone, Newton and Searcy Counties, and to a lesser extent Baxter, Stone, Izard, Independence, Sharp and Lawrence Counties, and covers an area of possibly 1,600 square miles. The distribution of the mines and prospects in the first four counties is shown on the accompanying map. This area lies in the Ozark Plateau region of Arkansas or, more specifically, partly on the Springfield Plateau and partly on the Salem Plateau. The region is principally a limestone and a dolomite area, which has been dissected by the irregular water courses and presents a rough and broken topography. The rocks lying as they

*Historical data according to G. I. Adams, U. S. Geological Survey Professional Paper No. 24.

*Generalized Section of Rocks Exposed in the Eureka Springs and Harrison Quadranges, Arkansas

System	Series	Formation	Thickness (feet)	Character of Rocks
Carboniferous	Pennsylvanian	Winslow formation	500±	Black clay shale containing sandy plates and interbedded flaggysandstone Massive gray cross bedded sandstone with white quartz pebbles
		Bloyd shale	0-176	Black clay shale
		Kessler limestone member	(0-10)	Brown and gray limestone, in part conglomerate
		Brentwood limestone member	(0-30)	Compact gray fossiliferous limestone
		Hale formation	80-300	Black clay shale containing sandy plates and some sandstones; brown cross-bedded calcareous sandstones; and sandy ferruginous limestone at top
	Mississippian	Pitkin limestone	0-100	Massive gray fossiliferous limestone
		Wedington sandstone member	(0-70)	Black clay shale
			(0-15)	Fine-grained gray laminated sandstone, in part calcareous
		Fayetteville shale	10-400	Black carbonaceous fissile clay shale containing limestone and clay-ironstone concretions
		Batesville sandstone	0-100	Gray to brown calcareous even-bedded sandstone
		Hindsville limestone member	(0-50)	Gray fossiliferous oolitic limestone and thin sandstone beds; chert-pebble conglomerate at base
		Boone limestone	250-400	Gray fossiliferous crystalline limestone containing considerable gray fossiliferous chert
		St. Joe limestone member	(10-60)	Gray to pinkish crystalline fossiliferous coarse textured limestone
	Upper Devonian	Chattanooga shale	0-50	Black fissile clay shale
		Sylamore sandstone member	(0-10)	White to brown sandstone, in part pebbly and phosphatic.
	Middle Devonian	Cliffy limestone	0-2±	Gray compact sandy limestone.
Upper Ordovician		Cason shale	0-21	Platy gray calcareous shale
		Fernvale limestone	0-5±	Gray crystalline fossiliferous limestone

†The Silurian System is represented by the Brassfield limestone which occurs in a few places in the lead and zinc district of Arkansas. According to H. G. Miser's statement in "Outlines of Arkansas Geology," by J. G. Ferguson, 1920, these are "between Duff and Tomahawk, Searcy county, where it (the Brassfield limestone) is several feet thick. * * * * It is a granular, light gray, fossiliferous limestone and contains a small amount of glauconite."

*Generalized Section—(Continued)

Ordovician Lower Ordovician	*Jasper limestone	0-50	Compact bluish-gray limestone and saccharoidal sandstone
	Joachim limestone	0-95	Dark-drab compact sandy magnesian limestone, calcareous sandstone, and a little white friable sandstone
	St. Peter sandstone	0-150	Massive cross-bedded and laminated saccharoidal sandstone
	Everton limestone	0-115	Compact dove-colored limestone interbedded with friable white sandstone
	King's River sandstone member	(0-40)	White friable sandstone in massive beds
	Sneed's limestone lentil	(0-50)	Massive dark colored sandy magnesian limestone
	Powell limestone	0-200	Light-gray to greenish-gray magnesian limestone with limestone conglomerate locally at base
	Cotter dolomite	500+	Gray dolomite containing some chert and interbedded with a little saccharoidal sandstone and green shale

*Taken from U. S. Geological Survey Geologic Folio No. 202, "Eureka Springs-Harrison Folio."

†According to the United States Geological Survey, Eureka Springs-Harrison Folio, the Jasper limestone "overlies the Joachim and, judging by its fossils, is almost certainly older than the Plattin." The normal position of the Plattin limestone would therefore be above the Jasper and Joachim limestones when all three of these formations are present.

According to H. G. Miser's statement in "Outlines of Arkansas Geology," by J. G. Ferguson, 1920, "the Plattin limestone, 0 to 240 feet thick, is exposed over large areas which comprise parts of Sharp, Independence, Izard, Stone and Searcy counties, and is thickest in the counties to the east. It is a massive, even-bedded, dove-colored or grayish blue limestone which is comparatively free from fossils, and it breaks with a conchoidal fracture * * * * *"

do on the southern flank of the Ozark Uplift, usually have a nearly horizontal position or have a slight regional slope to the south.

The surface formations in the southern portion of the zinc and lead area of north Arkansas include the Winslow formation and extends through the older formations, including the Cotter dolomite (see table). It is noticeable that the younger formations have, however, been progressively worn away as one passes north to the Ozark Uplift, where one finds only the Cotter dolomite.

Practically all of the zinc and lead ores occur either in the Boone, Everton or in the Cotter formations. Of these three, the Cotter contains the greater concentrations of ore, and the deposits in it are more widely distributed than those in either the Everton or the Boone. The principal ore deposits in the Everton formation occur in the Rush district in southern Marion County. The principal ore deposits in the Boone formation occur in the southwest portion of the field.

The ores may be classed according to their method of occurrence, as follows:

1. Bedded deposits which, for the most part, were deposited with the rocks in which they occur.
2. Vein deposits of later age than the rocks in which they occur. These may be classed as:
   a. Fault or fracture deposits.
   b. Deposits associated with brecciated rock masses which have formed along underground water courses.
3. Alteration products, principally carbonate and silicate zinc ores.

Bedded Deposits.—The bedded deposits of zinc ores are found as disseminated ores associated with chert or dolomite. As a rule, this type of deposit is richer in the trough of the synclines than elsewhere. These deposits are usually fairly closely confined to some specific bed which may sometimes be traced for miles and usually are remarkably even in thickness and richness. It is probable that the vein deposits were derived from these disseminated bedded ores. The bedded ores as a rule are found in localities where ground waters are not active or where the bedded ore is contained in rock which is only slightly permeable by water.

Bedded deposits are not infrequently exposed along the sides of deeply eroded valleys. Examples of mines in bedded zinc ores are Marble City mine, McIntosh mine, Little Rock mine, Lion Hill mines, Virginia mine, and Roberts mine. These deposits, although of great extent, do not ordinarily run more than 6 per cent zinc ore concentrates and have furnished very little of the total ore produced. By drill holes and shafts it has frequently been found that there are two and sometimes three strata, all containing bedded zinc ores. These, however, are often separated vertically by intervals of from eighty to one hundred feet.

Vein Deposits.—The vein deposits include both fault deposits and those filling brecciated beds which have been permeated by underground waters of meteoric origin. These waters penetrated the earth, dissolving limestones and dolomites, and in some cases formed caverns which caved in and have been filled with irregular rock fragments and created brecciated mineralized masses. The faults in the lead and zinc area frequently break the entire series of rocks exposed. They are normal, reversed, and lateral faults and extend

from comparatively short distances to many miles. The fractured zones vary from a closed seam to several hundred feet. The mineralized portion of these fractures are very probably derived from the bedded ore deposits and occur either above, below, or opposite the mineralized fracture. The fracture zones are usually filled with mineralized silicious breccia which often appear on the surface as a ledge. Practically all of the zinc and lead mined in north Arkansas has been taken from the fissures and brecciated deposits.

Some of the known faults with which fractured lead and zinc deposits are associated are as follows:

1. Rush Creek fault, follows Rush Creek on parts of its course. Throw, 350 feet.

2. Tomahawk, Sections 7 and 8, Township 16 north, Range 16 west.

3. Pilot Mountain, northeast of St. Joe.

4. St. Joe fault, north of and parallel to Mill Creek. Displacement, 250 to 300 feet.

5. Mill Creek fault, south of Mill Creek and nearly parallel to the St. Joe fault, approximately twenty-two miles in length.

6. St. Joe monocline, in Mill Creek valley, north of St. Joe.

7. Hurricane fault, follows a portion of Hurricane branch and Davis Creek.

8. A series of three faults extend from near Jasper in a northeasterly direction to the north-central portion of Township 16 north, Range 20 west.

Alteration products.—The alteration products of the region offer nothing new or unusual. They consist chiefly of smithsonite and calamine, but the so-called "tallow clay," described below, is worthy of mention in this connection. Where lead ores prevail there is usually more or less anglesite, cerussite and pyromorphite.

*Description of Ores

Sphalerite—Composition of Ores.—The excellent character of the sphalerite of north Arkansas is worthy of attention. The accompanying analyses show the composition of specimens of clean zinc-blende, taken at random. Attention is directed to the low iron and high zinc contents. Out of a large number of analyses of sphalerite, the largest amount of iron (Fe_2O_3) found was 0.67 per cent.

*J. C. Branner, "The Zinc and Lead Deposits of North Arkansas."—Tr. American Institute of Mining and Met. Engineers, Tr. 31 pp. 572-603 (1902).

Analyses of Sphalerite from North Arkansas Showing Iron Contents

Mines	Zinc Zn	Sulphur S	Silica SiO_2	Iron Fe_2O_3	Magnesia MgO
Yankee Boy	65.88%	31.77%	0.10%	0.62%	0.14%
Hiawatha	66.27%	32.53%	0.21%	0.39%	trace
Governor Eagle	64.48%	32.16%	1.88%	0.26%	0.00%
Panther Creek	65.88%	32.30%	0.00%	0.49%	trace
Prince Frederick	65.68%	33.33%	0.09%	0.15%	0.03%
Hunt, Malloy and Blevins	58.68%	20.36%	0.10%	0.20%	0.10%+
St. Joe	65.73%	32.92%	0.11%	0.15%	0.08%
Bear Hill	66.46%	32.30%	0.25%	0.15%	0.20%+

During the 17 year period, 1907 to 1923, inclusive, 18.6% of the zinc ore concentrates mined in Arkansas has been sphalerite (U. S. G. S., see page 53).

Smithsonite.—Analyses of the smithsonite show it to be of excellent quality. Those given below, however, having been made from hand specimens for the purpose of ascertaining the composition of certain types, must not be accepted as representative of carload lots. Owing to the large amount of foreign material held mechanically in all lumps of smithsonite, analyses of carload lots would necessarily run lower in zinc than do these particular specimens.

Analyses of Smithsonite

	Morning Star Mine	Legal Tender Mine
Zinc Oxide, ZnO	64.31%	62.20%
Carbon Dioxide, CO_2	34.93%	33.86%
Water, H_2O	0.58%	2.30%
Silica, SiO_2	0.10%	0.02%
Magnesia, MgO	0.03%	0.18%
Lime, CaO	0.90%	1.25%
Iron, Alumina, Fe_2O_3, Al_2O_3	0.12%	0.21%
Cadmium, Cd	trace	trace

The zinc oxide in the analysis of the specimen from the Morning Star mine is equivalent to 51.60 per cent of the metallic zinc; that of the specimen from the Legal Tender is equivalent to 49.91 per cent.

Calamine.—Calamine is much less abundant in Arkansas than either sphalerite or smithsonite. The most abundant deposits now known are in the Sugar Orchard district. The Almy mine has been the most remarkable producer of calamine in the State.

During the seventeen year period from 1907 to 1923, inclusive, 81.4% of the concentrated zinc ore mined in Arkansas was zinc silicate and carbonate taken together (U. S. G. S., page 53).

Turkey Fat.—The yellow mineral popularly known in the mines as "turkey fat" is smithsonite, colored with a little cadmium oxide. This kind of smithsonite occurs at several of the mines, but is most abundant, perhaps, at the Morning Star, on Rush Creek. The composition of a typical sample is shown by the following analyses:

Analyses of "Turkey Fat," a Yellow Variety of Smithsonite

Zinc Oxide, ZnO	63.84%	61.20%
Carbon Dioxide, CO_2	34.60%	.....
Water, H_2O	1.09%	.....
Silica, SiO_2	0.25%	.....
Magnesia, MgO	0.07%	.....
Lime, CaO	0.70%	.....
Cadmium Oxide, CdO	0.30%	0.82%
Iron, Fe_2O_3, and Alumina, Al_2O_3	0.42%	trace

Smithsonite sometimes occurs as a red, yellow, or brown "sand." In such cases the so-called sand grains are small individual crystals of smithsonite. Sometimes these particles are loosely held together, sometimes compactly cemented.

The early zinc mines of Arkansas were mines of smithsonite, and the ore was found in the surface clays and soils along and near the outcrops of deposits of zinc blende. Although there is hardly a zinc prospect in north Arkansas which has not yielded some smithsonite, there is but little search now for smithsonite alone. It is highly probable, however, that when the search for the zinc ores of north Arkansas has been properly systematized, large bodies of zinc carbonate will be discovered. These are most likely to be in regions of deep rock decay.

Tallow Clay.—What is commonly known in the zinc mines as "tallow clay" or "buck fat" is not a definite mineral, but a mixture, probably of common clay and the mineral calamine. At present this material is not looked upon as an ore of zinc, simply because no satisfactory process of smelting it has been devised.

Tallow clay has a peculiar "feel," by which it is commonly recognized. It may be either red, yellow or brown in color. It occurs in pockets and seams in the rocks in nearly all of the zinc mines of north Arkansas. In some of the mines it is found in great abundance. The following analyses show the composition of typical Arkansas tallow clays:

Analyses of Arkansas Tallow Clays

	Buffalo Mine	Big Elephant Mine	Post Boy Mine	Coon Hollow Mine	Kansas Mine	Markle Mine
Silica, SiO_2	51.03%	45.10%	40.91%	37.04%	41.67%	36.65%
Alumina, Al_2O_3	16.98%	16.52%	9.33%	8.85%	8.47%	10.05%
Zinc Oxide, ZnO	14.10%	13.97%	34.79%	37.76%	35.88%	37.54%
Ferric Oxide Fe_2O_3	5.98%	5.65%	2.25%	1.68%	2.35%	2.86%
Ferrous Oxide, FeO	0.69%	3.16%	0.52%	0.42%	0.33%	0.53%
Lime, CaO	1.16%	2.70%	3.42%	3.58%	1.36%	2.20%
Magnesia, MgO	1.34%	1.58%	0.48%	0.77%	0.51%	1.62%
Potash, K_2O	0.44%	1.15%	.....	0.27%	0.57%	0.35%
Soda, Na_2O	0.00%	0.62%	0.42%	0.56%	0.07%	0.40%
Water, H_2O	8.88%	10.89%	9.02%	8.76%	8.28%	8.92%

Several other forms of zinc-hydrozincite, zincite, aurichalcite, and goslarite—are found in the zinc regions, but they occur too sparingly to have any importance as ores of zinc. Besides these, there are probably still other zinc minerals here, which have not as yet been identified.

Sharp and Lawrence Counties

Some of the lead and zinc mines in Sharp and Lawrence Counties, Arkansas, were examined in November, 1926, by H. D. Miser of the U. S. Geological Survey. An extract from the press notice issued by the Department of the Interior concerning this examination follows:

"Mr. Miser found that mining has not formed a continuous industry in the region since 1857, although there has been a small production of both lead and zinc ore and concentrates from fourteen or more widely scattered mines. The total output of ore has probably not exceeded a few thousand tons. The zinc ore included zinc blende and carbonate, and the lead ore, which came from two mines only, consisted of galena. The total number of mines and prospects, new and old, is about thirty, two-thirds of which are in Lawrence County and the rest in Sharp County.

"The ore-bearing rocks are of early Ordovician age—that is, of about the same age as most of the ore-bearing rocks in Baxter, Marion and other counties farther west in Arkansas. They are much younger than the Cambrian lead-bearing dolomites in southeastern Missouri, but much older than the Carboniferous rocks that carry the highly productive ores in the Joplin region.

"The ore minerals consist of the sulphides sphalerite (zinc blende) and galena (lead sulphide) and of zinc carbonate (smith-

sonite). The zinc blende has the typical brown color of rosin. Zinc silicate (calamine) and lead carbonate (cerusite) were not observed, and if they are present the quantity must be small. Most of the mines yield zinc carbonate in small masses in the residual clay and in the surficial parts of the dolomite, where the carbonate forms incrustations on the dolomite and occurs as veinlets in it. The sulphide minerals occur mainly in parts of the dolomite that have been brecciated —that is, broken into small angular fragments—though they are likewise found in joints and fractures in the dolomite. Much of the ore-bearing brecciated dolomite occurs in beds, but most of the ore bodies examined by Mr. Miser were in brecciated rock that is not confined to any particular bed but occupies zones that cut across the bedding.

"The sulphide ores occur in large part above the permanent ground water level of the region, but some have been found at a depth of 250 feet or more below it.

"The ore body studied by Mr. Miser at the bottom of the Campbell Zinc Company's No. 1 shaft, eight feet square and 275 feet deep, three-fourths of a mile south of Black Rock, is especially interesting for the reason that it occurs largely in a brecciated conglomerate consisting of dolomite and limestone pebbles in an earthy matrix, about 250 feet below the surface of Black River, which flows near by. The blende-bearing part of the conglomerate, which is estimated to average about 7½ per cent of metallic zinc, was revealed on the east and south sides of the shaft, where it ranges in thickness from fourteen inches to four feet. The ore-bearing conglomerate occurs at the base of a thick bed of dolomite and rests upon light-gray limestone. The contact between the limestone and the dolomite is irregular, showing a difference of altitude in the shaft of four and one-half feet.

"Since the shaft was examined by Mr. Miser six drill holes, the deepest 340 feet deep, have been sunk at distances of forty to 150 feet southeast, south, west and northwest of the shaft. These holes, which were bored to determine the extent of the ore body explored by the shaft, indicate the existence of bodies of zinc blende at two levels. That at the lower level corresponds to the bedded ore body in the shaft and is reported to have been found in four of the recent drill holes at depths nearly the same as in the shaft. The ore-bearing zone thus lies in a nearly horizontal position and was found, according to report, to range in thickness from five to seventeen feet. The effects of underground solution in the deeper zone are shown by softening of the matrix of the conglomerate in places and by the occurrence of open ground with dolomite crystals in the shaft and also in some of the drill holes.

"The upper ore-bearing zone, as shown by the recent drill records, lies northwest, west and southwest of the shaft. It is reported as being present in all drill holes in these directions and to range in thickness from two to fifty-eight and one-half feet. It dips

toward the west, as indicated by the depths at which its top was reached in the different drill holes. These depths range from sixty-four to 155 feet below the altitude of the mouth of the shaft, showing an inclined ore body not parallel to the lower one nor to the bedding of the rocks.

"Although the past output of this field has been small, the size and the number of ore bodies revealed by the recent drill holes and by earlier work justifies systematic drilling for workable ore bodies at the more promising localities. The most serious handicap to local development is the great distance of many of the deposits from railroads and the poor condition of nearly all of the highways."

Reserves and Future Development

The following quotation relative to the quantity of ore in north Arkansas field is taken from the Arkansas Geological Survey Report, "The Lead and Zinc Region of North Arkansas," by J. C. Branner:

"There can be no question about the existence of large bodies of excellent ore. There are, besides these richer deposits, many large bodies of low grade ores. Some of these are, of course, too poor to be worked economically under ordinary conditions, while others, if worked upon a large scale, will yield good returns.

"So far as the extent of the ore deposits is concerned it is safe to say that it is so great that it is unknown. The prospecting that has been done has not uncovered the hundredth part of the ore bodies. The bedded deposits have had their outcrops uncovered only here and there. A few pieces of the many fissures have been located, and these have been examined at but few points. The synclinal accumulations and the brecciated deposits are unknown, save where they have been hit upon almost or quite by accident.

"Some of the mines will be so high on the hills that there will never be much difficulty about draining them, but others will be in synclinal troughs and subterranean water courses where there will be much water to contend with."

The quantity of ore in the North Arkansas zinc and lead field is undoubtedly very great. It has been estimated that in the Rush Creek district a total of only thirty acres of deposits have been worked and that about 40,000 tons have been taken out of that area alone. Charles LeVasseur of Yellville estimates that a total of 20,000,000 tons of ore are available in this area alone.

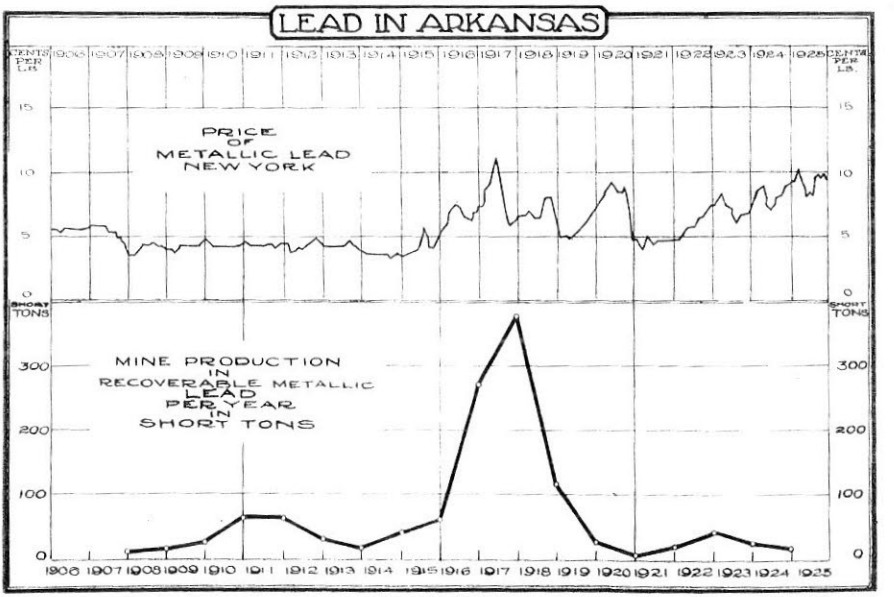
According to J. H. Hand of Yellville, Ark., the average cost of producing a ton of milled zinc carbonate was $24.00, and sulphide $35.00, f. o. b. cars, under war time conditions.

During 1917 seventy-three producing mines were operating in the Arkansas field and their cessation after the war was due to the fall in prices.

K. L. Koelker, a mining engineer, has estimated the production of the Oklahoma and Kansas fields to be as follows:

	Tons of Zinc Concentrates	
	Production Per Week	Production Per Year
1926	14,800	769,600
1927	13,000	676,000
1928	10,000	520,000
1929	8,500	442,000
1930	7,500	390,000
1931	5,500	286,000
1932	5,000	260,000

These figures assume that the production of the two state fields will be reduced to approximately one-third of their present output by 1932. If this depletion occurs as estimated, it will mean an increasing need for the development of the north Arkansas region. The building of good roads through the lead and zinc country will prove an asset in increasing the marketability of the ores. The development of hydro-electric power on the White River may also add much to the value of the Arkansas field by making possible the employment of the electrolytic process for treating lead and zinc concentrates.

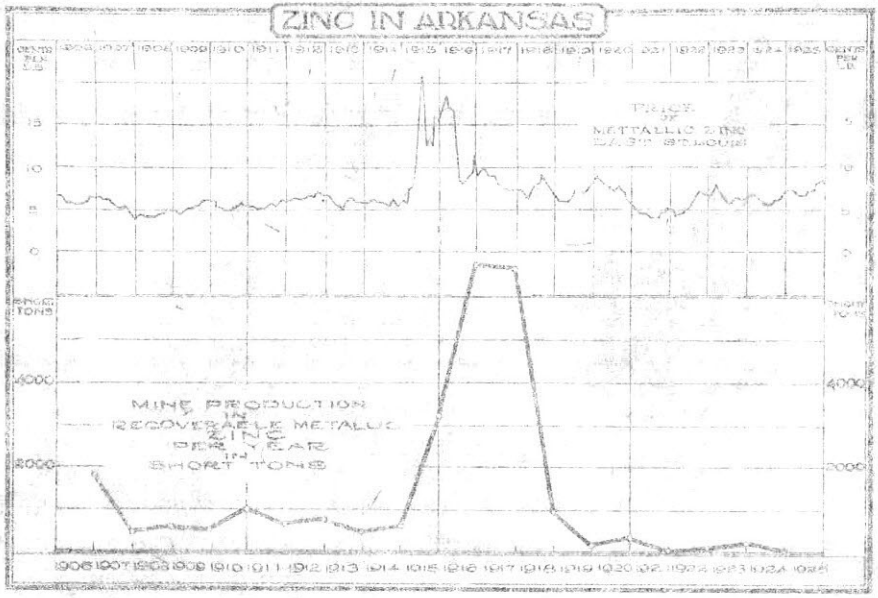


TENOR OF LEAD AND ZINC ORE CONCENTRATES PRODUCED IN ARKANSAS DURING 1908-23

The following table shows the tenor of lead and zinc ore and concentrates produced in Arkansas during the years 1908-1923, according to the U. S. Geological Survey:

	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
Total crude ore, short tons	16,550	12,800	35,060	24,925	32,755	13,000	20,000	110,000	249,000	203,600	37,000	5,800	9,800			
Total concentrates in crude ore—	8.9	8.0	5.9													
Lead, per cent	.1	.2	.2	.3	.1	.17	.26	.07	.13	.23	.42	.60	.11			
Zinc, per cent	8.8	7.8	5.7	6.4	5.7	9.80	9.40	7.76	7.35	8.82	6.62	8.80	9.36			
Metal content of crude ore—	4.4	4.7	3.4													
Lead, per cent	.1	.2	.2	.2	.1	.14	.20	.06	.11	.19	.32	.49	.08			
Zinc, per cent	4.3	4.5	3.2	3.2	2.7	4.39	3.90	3.25	3.04	3.70	2.86	3.71	3.73			
Av. lead content, galena concentrates, %	83.0	80.0	78.8	80.0	79.5	78.30	78.90	79.80	80.20	80.50	77.40	80.00	80.00	77.70	78.20	78.10
Av. zinc content, sphalerite concent.*, %	60.1	60.3	58.1	50.2	49.0	48.00	44.70	59.60	57.10	58.40	59.00					
Av. zinc cont., silicate and carbonate* %	42.8	39.8	39.1	39.1	38.0	40.60	40.00	40.60	39.90	40.50	40.60	42.00	39.90	40.00	36.00	37.80
Average value per ton																
Galena concentrates	$54.72	$60.00	$46.43	$54.01	$55.90	$51.24	$46.31	$62.80	$82.88	$100.41	$87.70	$68.57	$75.50	$55.93	$72.73	$79.97
Sphalerite concentrates	35.41	37.89	39.92	28.73	39.63	28.48	26.12	68.21	67.50	63.13	53.07					
Zinc silicate and carbonate	22.86	27.91	20.63	23.16	24.31	22.13	22.04	51.49	56.61	38.15	31.69	35.63	31.54	13.81	16.16	22.34

*Includes some mixed carbonate and sphalerite



Production of Zinc and Lead in Arkansas, According to U. S. Geol. Surv. Figures

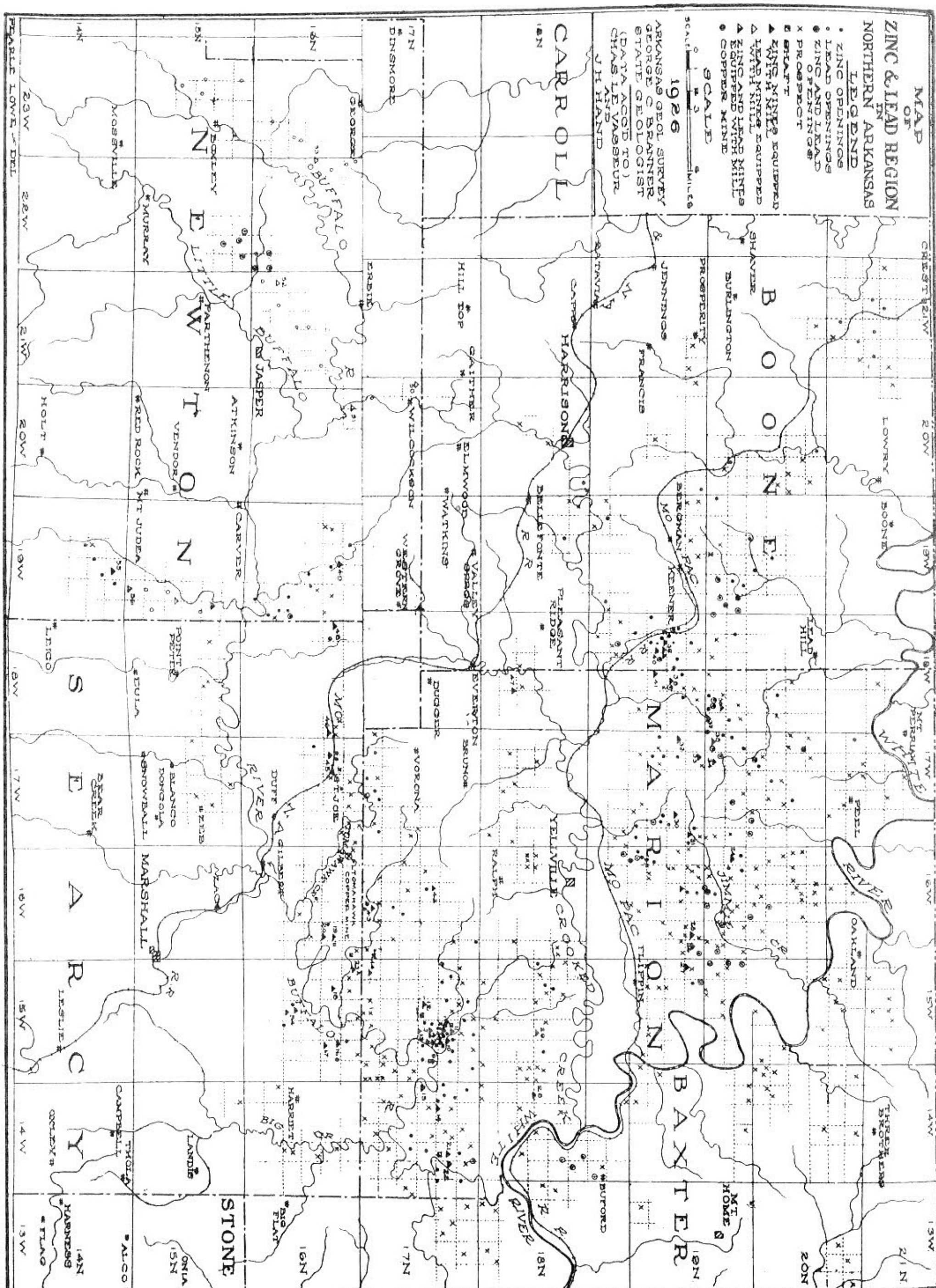
Year	ORES						METAL CONTENT			
	Lead Concentrates (Galena)		ZINC CONCENTRATES				Lead		Zinc	
			Sphalerite		Silicate and Carbonate					
	Short Tons	Value	Short Tons	Value	Short Tons	Value	Short Tons	Value	Short Tons	Value
1906		$		$		$		$	1,301	$ 219,732
1907	10	300	528	15,233	693	16,210	12	1,272	474	56,932
1908	18	985	536	18,270	903	21,469	15	1,260	605	56,870
1909	30	1,800	836	23,948	98	2,736	24	2,064	510	55,080
1910	80	3,714	1,857	74,136	123	4,641	63	5,544	994	107,352
1911	80	4,521	1,107	40,425	183	4,239	64	5,760	661	75,696
1912	39	2,180	1,419	56,275	462	11,531	31	2,790	748	103,224
1913	23	1,179	594	16,916	680	15,050	18	1,584	478	52,536
1914	52	2,408	743	13,406	1,145	25,187	41	3,198	608	52,016
1915	70	4,961	606	41,341	7,925	405,079	63	5,922	3,209	795,832
1916	339	28,097	1,670	112,726	16,609	940,224	272	27,536	6,815	1,826,420
1917	474	47,593	916	57,824	17,053	650,585	382	35,704	6,651	1,364,964
1918	155	13,594	310	16,460	2,156	68,333	120	17,040	951	173,082
1919	35	2,400			510	18,170	28	2,968	189	27,594
1920	10	755			917	28,325	3	1,280	329	53,298
1921	27	1,510			42	580	21	1,890	15	1,500
1922	55	4,000			425	6,870	42	4,620	134	15,276
1923	32	2,559			444	9,919	25	3,500	148	20,128
1924							20	3,200	4	520
1925							58	10,092	42	6,536
Totals	1,543	$122,856	11,472	$502,910	50,407	$2,231,936	1,307	$177,224	23,609	$5,074,578

NOTE—The total tonnage of zinc concentrates produced in Arkansas in 1917 according to the foregoing table of the U. S. Geological Survey is 17,969, and the lead tonnage 474. The figures of J. H. Hand of Yellville, for the same year are 21,876 and 582 tons, respectively (see page 58).

Key to Accompanying Map

The numbers on the following list of zinc and lead mines correspond to the numbers on the accompanying map.

1. Morning Star
2. Ben Carney
3. Capps
4. McIntosh
5. White Eagle
6. Edith
7. Yellow Rose
8. Red Cloud
9. Silver Hollow
10. Philadelphia
11. Beulah
12. Mattie M.
13. Big Bell
14. Dixie Girl
15. Omera.
16. Churchill
17. Evening Star
18. Jack Pot
19. Maumee
20. North Star
21. Bonanza
22. Fox Den
23. Silver Run
24. Onwata
25. Monkey Hill
26. Eric Ozark
27. North Star
28. Lion Hill
29. Reynolds
30. Bear Hill
31. Beattie
32. Governor Eagle
33. Nakomis
34. Pilot Jack
35. Markle
36. Iola
37. Broome County
38. Tarkiln
39. Jack Pot Mines (3)
40. Frisco
41. Coker Hollow
42. Philips
43. Sure Pop
44. Voegle
45. Excelsior
46. Iowa
47. Potts
48. Big Hurricane
49. Spears
50. Marble City
51. Canton
52. Panther
53. Baker
54. Consolidated Zinc Co.
55. Confederate
56. Old Grandby


MAP OF ZINC & LEAD REGION IN NORTHERN ARKANSAS
LEGEND
ZINC OPENINGS
LEAD OPENINGS
ZINC AND LEAD OPENINGS
PROSPECT
SHAFT
ZINC MINES EQUIPPED WITH MILL
LEAD MINES EQUIPPED WITH MILL
ZINC AND LEAD MINES EQUIPPED WITH MILL
COPPER MINE
SCALE
1926
ARKANSAS GEOL SURVEY
GEORGE C BRANNER
STATE GEOLOGIST
(DATA ACCD TO) CHAS LE VASSEUR AND J H HAND
CARROLL
BOONE
MARION
BAXTER
NEWTON
SEARCY
STONE
HARRISON
JASPER
YELLVILLE
MARSHALL
MT HOME

REPORT OF ORE PRODUCTION, ARKANSAS FIELD, FOR YEAR 1917

By J. H. Hand, Special Agent, State Bureau of Mines, Yellville, Arkansas

Marion County Shipments Zinc Concentrates

Name of Shipper	No. Pounds
J. C. Shepherd Mining Company	8,372,000
Morning Star Mining Company	3,415,000
Yellow Rose Mining Company	1,820,000
Edith Mining Company	1,485,000
Kennedy Mining Company	330,000
Fox Den Mining Company	300,000
Bonanza Mining Company	270,000
Omeara Mining Company	240,000
Onwata Mining Company	180,000
Silver Hollow Mining Company	180,000
Seawell Brothers	180,000
Crooked Creek Mining Company	123,000
North Star Mining Company	120,000
Pyatt Mining Company	120,000
Arkansas & S. C. Mining Company	70,000
J. B. Rowden	70,000
W. N. North	60,000
Broome County Mining Company	60,000
Monkey Hill Mining Company	60,000
Bank of Yellville	60,000
Beaty Mining Company	60,000
Bear Hill Mining Company	60,000
Paradise & Worth	60,000
W. O. Headey	50,000
Miscellaneous Shipments	480,000
Total 9,087½ short tons, or	18,175,000

Searcy County Shipments Zinc Concentrates

Name of Shipper	No. Pounds
J. C. Shepherd Mining Company	8,800,000
Howard Mining Company	1,210,000
Lucky Dog Mining Company	1,104,000
N. W. Redwine Mining Company	560,000
Jack Pot Mining Company	130,000
Wallace Mining Company	120,000
Churchill-Evening Star	80,000
Madden Mining Company	60,000
Lost Mountain Mining Company	50,000
Total 6,217 short tons, or	12,434,000

Boone County Shipments Zinc Concentrates

Name of Shipper	No. Pounds
Gloria Mining Company	1,376,000
L. L. Brown	1,347,000
E. Q. Boone	839,000
Markle & McCurry	772,000
D. G. & B. Mining Company	670,000
J. P. Harvey	438,000
Clear Creek Mining Company	350,000
Harrison Mining Company	290,000
Cantrell & French	214,000
Era Mining Company	197,000
Saylors & Lewis	167,000
Doolin & Lawhorn	150,000
Marlin & Osenbaum	140,000
Jackson Mining Company	140,000
Estes Zinc Company	130,000
Zara Mining Company	128,000
Barham Brothers	110,000
Polk Kendall	70,000
G. W. Capps	70,000
Madison Mining Company	70,000
L. T. Westrich	60,000
Arkansas Mining Company	60,000
J. E. Potts	60,000
W. J. Horsley	58,000
Alberta Mining Company	50,000
Madison Mining Company	48,000
C. E. Morris	33,000
Total 3,863 short tons, or	7,726,000

Newton County Shipments Zinc Concentrates

Name of Shipper	No. Pounds
North Slope Mining Company	1,745,000
Victor Primrose	890,000
Cook & McCoy	490,000
Eleventh Hour Mining Company	460,000
Bald Hill Mining Company	410,000
H. G. Moss	280,000
Hamilton & White	228,000
Van Sicklen	214,000
E. R. Springer	160,000
W. E. Luke	120,000
W. N. North	100,000
L. E. Lake	60,000
Hamilton & Young	60,000
Miscellaneous	1,510,000
Total 2,708½ short tons, or	5,417,000

Shipments Lead Concentrates

Name of Shipper	No. Pounds
Ike Kilgore	412,000
Minicus & Villines	140,000
Hamilton & Young	218,000
L. E. Lake	150,000
Bald Hill Mining Company	50,000
North Slope Mining Company	50,000
L. L. Brown	10,000
A. J. Wassell	4,000
Miscellaneous	130,000
Total 582 short tons, or	1,164,000

SUMMARY OF SHIPMENTS

Zinc Concentrates

Marion County shipments	18,175,000
Searcy County shipments	12,434,000
Boone County shipments	7,726,000
Newton County shipments	5,417,000
Total zinc shipments 21,876 short tons, or	43,752,000

Lead Concentrates

Total lead shipments 582 short tons, or	1,164,000
Total zinc and lead shipments 22,458 short tons, or	44,916,000

Zinc Producers

Morning Star Mining Company, Rush, Marion County, Ark.
Mattie May Mining Company, Yellville, Ark.
Silver Run Mining Company, Mull, Marion County, Ark.

Buyers of Zinc and Lead Ore

Athletic Mining & Smelting Co., Fort Smith, Ark.
Bartlesville Zinc Co., Bartlesville, Okla. (plant.)
Main office, New York City.
Eagle-Picher Lead Co., Henrietta, Okla. (plant.)
Main office, Chicago, Ill.
Edgar Zinc Co., Cherryvale, Kansas. (plant.)
Main office, St. Louis, Mo.
Grasselli Chemical Co., Cleveland, Ohio.
Illinois Zinc Co., Peru, Ill. (plant.)
Main office, Chicago, Ill.
Matthiessen & Hegeler Zinc Co., LaSalle, Ill.
Mineral Point Zinc Co., DePue, Ill. (plant.)
Main office, Chicago, Ill.
National Zinc Co., Bartlesville, Okla. (plant.)
Main office, New York City.
Quinton Spelter Co., Quinton, Okla.
U. S. Zinc Co., Henrietta, Okla. (plant.)
Main office, New York City.
U. S. Zinc Co., Amarillo, Texas. (plant.)
Main office, New York City.

United States
Department of the Interior
Geological Survey

Washington

Dec. 30

Dear Mr. Branner:

Mr. Shiras knew none of the details on the Ponca City diggings but put me in touch with a Mr. Marvin Wagner of Harrison who in turn gave me two references to whom I have written, In Ponca City; the Brewer Lead Mining Co. and a Mr. Ava Hedges. Mr. Wagner said that as far as he knew there were five or six little workings over there that are worked sporadically, depending amoung other things, on the weather, and whether the lead they are following is yielding anything or not. If I can get any information from them I will pass it on to you, and if not, will write you at the end of the week.

Sincerely,

E. J. McKnight.

United States
Department of the Interior
Geological Survey

Jan. 4,

Dear Mr. Branner:

Letter from Mr. Ava Hedges reports "3 producing mines now in operation", one that he operated in 1928 having produced about $7,000 "free lead" and about the same amount of mill ore. He does not know very much about the other two. In spite of the fact that I asked for the name of mine, name of company, owner and location, he gave none of these in detail. Apparently he is the operator of the mine, which is worked on a lease, the land belonging to somebody else (Mr. Wagner of Harrison said he thot all the land belonged to Brewer and Baker). Hedges also gave me the following references:

Brewer Lead & Zinc Co. (which I have written)
Ponca Lead and Zinc Mining Co.)all
North Arkansas Lead and Zinc Mng Co.)apparently
Ponca Ore Milling Co.)at Ponca.

Will write the other three and let you know results.

Sincerely,
Edwing T. McKnight.

United States
Department of the Interior
Geological Survey

Jan. 14

Dear Mr. Branner:

I hav to date heard nothing from the other mining companies that I wrote at Ponca, but my letters have not been returned. I wrote to all of the companies that I gave in my two letters to you.

One more bit of information that I don't believe I mentioned in my other letters: Mr. Wagner (Marvin) of the First National Bank Bldg., Harrison, said, if I got him correctly, that Hedges was the main miner that was producing.

Under separate cover I am sending the "Outline of Met. Min. of Ark." which I should have sent long ago.

Sincerely,

Edwin T. McKnight.

Bibliography of Zinc and Lead

1889

1. Anonymous, "Zinc Mining in Arkansas."—Engineering and Mining Journal, May 11, 1889. Obtainable from McGraw-Hill Publishing Company, 10th Avenue at 36th Street, New York, N. Y.

1892

2. Branner, J. C., "The Zinc and Lead Region of North Arkansas."—Annual Report of the Arkansas Geological Survey for 1892, Vol. 5. Obtainable from Arkansas Geological Survey, State Capitol Building, Little Rock, Ark.

1893

3. Winslow, Arthur, "Notes on the Lead and Zinc Deposits of the Mississippi Valley", and "The Origin of Ores."—Journal of Geology, Vol. I, pp. 612-619.

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4. Jenny, Walter P., "The Lead and Zinc Deposits of the Mississippi Valley."—American Institute of Mining Engineers Journal, Tr. 22, pp. 171-225. Obtainable from American Institute of Mining Engineers, 29 W. 39th Street, New York City.
5. Mason, Frank Lewis, "Discussion of W. P. Jenny's Paper on Lead and Zinc."—American Institute of Mining Engineers, Tr. 221, pp. 636-646. Obtainable from American Institute of Mining Engineers, 29 West 39th Street, New York City.

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6. Phillips, William B., "The Zinc and Lead Deposits of Southwest Arkansas."—Engineering and Mining Journal, Vol. 71, pp. 431-432. Obtainable from McGraw-Hill Book Company, 10th Avenue at 36th Street, New York City.
7. Phillips, William B., "Removal of Iron from Zinc Blende."—Engineering and Mining Journal, Vol. 72, pp. 710-711. Obtainable from McGraw-Hill Book Company, 10th Avenue at 36th Street, New York City.
8. Bain, H. F., Van Hise, C. R., and Adams, G. I., "Preliminary Report on the Lead and Zinc Deposits of the Ozark Region."—Twenty-second Annual Report of the U. S. Geological Survey, Part II, pp. 33-60. Now out of print, but may be consulted in public or scientific libraries.

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9. Branner, J. C., "The Zinc and Lead Deposits of North Arkansas."—American Institute of Mining Engineers, Tr. 31, pp. 572-603. Obtainable from American Institute of Mining Engineers, 29 W. 39th Street, New York City.
10. Van Hise, C. R., and Bain, H. F., "Lead and Zinc Deposits of the Mississippi Valley, United States."—Institute of Mining Engineers, Tr. 23, pp. 376-434. Obtainable from Institute of Mining Engineers, 29 W. 39th Street, New York City.
11. Keyes, Charles R., "Diverse Origin and Diverse Times of the Formation of the Lead and Zinc of the Mississippi Valley."—Institute of Mining Engineers, Tr. 31, pp. 603-611. Obtainable from American Institute of Mining Engineers, 29 W. 39th Street, New York City.

1904

12. Adams, Geo. I., Purdue, A. H., Burchard, E. F., "Zinc and Lead Deposits of Northern Arkansas," U. S. Geological Survey, Professional Paper No. 24. Now out of print, but may be consulted in public and scientific libraries.

1909

13. Keyes, Chas. R., "Ozark Lead and Zinc Deposits—Genesis, Localization, and Migration."—American Institute of Mining Engineers, Tr. 26, pp. 119-166. Obtainable from American Institute of Mining Engineers, 29 West 39th Street, New York City.

AVAILABLE REPORTS OF ARKANSAS GEOLOGICAL SURVEYS

The following reports of the Arkansas Geological Survey are available for distribution and may be obtained upon receipt of indicated postage (see table, following page). Orders may be addressed to Arkansas Geological Survey, 447 State Capitol Building, Little Rock, Arkansas.

Annual Report for 1890

Vol. IV—"Marbles," by T. C. Hopkins, pp. xxiv, 443; illustrated; atlas of six maps.

Annual Report for 1891

Vol. I—"Mineral Waters," by J. C. Branner, pp. viii, 144; one map.

Vol. II—Miscellaneous Reports: "Benton County," by F. W. Simonds and T. C. Hopkins; "Elevations," by J. C. Branner; "River Observations," by J. C. Branner; "Magnetic Observations," by J. C. Branner; "Mollusca," by F. A. Sampson; "Myriapoda," by Chas. H. Bollman; "Fishes," by Seth E. Meek; "Dallas County," by C. E. Siebenthal; "Bibliography of the Geology of Arkansas," by J. C. Branner, pp. xii, 349; illustrated; two maps.

Annual Report for 1892

Vol. II—"Tertiary" by Gilbert D. Harris, pp. xiv, 207; illustrated; one map.

Report of 1909

"The Slates of Arkansas," by A. H. Purdue, with a bibliography of the Geology of Arkansas by John C. Branner, pp. xii, 164; illustrated; two maps.

Report of 1910

"Coal Mining in Arkansas," by A. A. Steele. Parts I and II in one volume; illustrated; two maps. Part I, pp. xxviii, 383 with "Glossary of Coal Mining Terms"; Part II, pp. 389-632.

Publication of 1927

"Outlines of Arkansas' Mineral Resources," By George C. Branner, pp. 352; illustrated; one chart; one map.

REPORTS OF THE BUREAU OF MINES, MANUFACTURES AND AGRICULTURE

The following reports issued by the Bureau of Mines, Manufactures and Agriculture contain reference to the mineral resources and industries in the State, and requests for copies should be addressed to Commissioner W. N. Wilkes, State Capitol Building, Little Rock, Ark.:

"Mineral Fertilizers," by Dr. N. F. Drake, 1924.
"Industrial Arkansas," by J. G. Ferguson, 1924.
"Minerals of Arkansas," by W. N. Wilkes, 1925.
"Outlines of Arkansas' Mineral Resources," by George C. Branner, 1927.

U. S. Department of Interior
Geological Survey

Jan. 18

Dear Mr. Branner:

Letter from S.R.Manning, Metuchen, New Jersey, of the Brewer Lead Mining Co. states that the Brewer Lead Mining Co. having had 10 tons of free ore on top since Oct. 1 and about the same amount of mill dirt, which they are at present unable to work from lack of water, is going to be inactive for next three months. This ore mentioned is at R. Brewer property. In closing, states, "We took the property that Mr. Hedges worked for a year as he had th lease". Am writing Hedges to find if this property is the same as the one from which he said he took $7000 free ore in 1928. They appear to be the same property.

Very truly yours,

Edwin T. McKnight.

mentioned in a previous letter. I wrote to al the companies mentioned in my previous letters and apparently all the letters found their way into the hands of Hedges and Manning. I have not heard from the North Ark. Lead and Zinc Co

Respectfully,

Edwin T.McKnight.

United States
Department of the Interior
Geological Survey

Jan. 27

Dear Mr. Branner:

Another letter from Ava Hedges states that the mine now being operated by Manning (Brew Lead Co) is the one from which he made 4 shipments of "free lead" in 1928. In a previous letter he said that "one mine that he had been operating on a small scale in 1928 had produced about $7000 of free lead". These are therefore evidnetly the same mine.

He further states that he now owns the property of the Ponca Lead and Zinc Mining Co (referred to in previous letter) and is also operating the ore mill at Ponca and will soon have a car of Pb to ship. Evidently the mill belongs to the Ponca Ore Milling Co. also mentioned in a previous letter. I wrote to al the companies mentioned in my previous letters and apparently all the letters found their way into the hands of Hedges and Manning. I have not heard from the North Ark. Lead and Zinc Co

Respectfully,

Edwin T. McKnight.

POSTAGE RATES ON PUBLICATIONS OF ARKANSAS GEOLOGICAL SURVEY

Any of the following reports will be mailed to persons interested, so long as copies are available, on receipt of postage, which may be computed by the following table:

PUBLICATION	ZONES FROM LITTLE ROCK								
	Local	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth
Report for 1890: Vol. IV—Marbles and Atlas	.08	.09	.09	.12	.17	.22	.27	.33	.38
Report for 1891: Vol. I—Mineral Waters	.07	.07	.07	.08	.09	.10	.11	.13	.14
Report for 1891: Vol. II—Miscellaneous	.08	.08	.08	.10	.13	.16	.19	.23	.27
Report for 1892: Vol. II—Tertiary	.08	.08	.08	.10	.13	.16	.19	.23	.27
Report of 1909: Slates of Arkansas	.08	.08	.08	.10	.13	.16	.19	.23	.27
Report of 1910: Coal Mining in Arkansas	.08	.09	.09	.12	.17	.22	.27	.33	.38
"Outline of Arkansas' Mineral Resources"	Sent postage free								

AVAILABLE BASE MAPS OF ARKANSAS

1. U. S. Geological Survey Base Map, size 35x40 inches; scale 1:500,000, or 8 miles to the inch. Obtainable from U. S. Geological Survey, Washington, D. C. Done in black and white only. Price, 25c each, or in orders of over $3.00, price 15c each.

2. U. S. Geological Survey Base Map; size 16x18½ inches; scale 1:1,000,000, of 16 miles to the inch. Obtainable from U. S. Geological Survey, Washington, D. C. Done in black and white. Price, 5c each; or in orders over $3.00 price 3c each.

3. Rand-McNally Vest Pocket Edition Map, size 28x21 inches; scale 13 miles to the inch. Price, 35c. Obtainable from Rand-McNally & Company, 536 South Clark Street, Chicago, Ill.

4. Rand-McNally Wall Map, size 40x28 inches. Price $3.50. Obtainable from Rand-McNally & Company, 536 South Clark Street, Chicago, Ill.

5. Arkansas State Base Map, in colors, by W. N. Wilkes, Commisioner of Mines, Manufactures and Agriculture; scale 10¾ miles to the inch; size 28¾x26 inches. Obtainable from Bureau of Mines, Manufactures and Agriculture, State Capitol Building, Little Rock, Ark., upon request.

6. Geologic Map of Arkansas, by J. C. Branner. Size 10¾x12 inches; scale 24 miles to the inch; in colors. Obtainable from the Arkansas State Geological Survey, State Capitol Building, Little Rock, Ark., upon request.

7. Base map of Arkansas showing counties, railroads, etc., 40½x48 inches, published by the National Map Company, Indianapolis, Ind.

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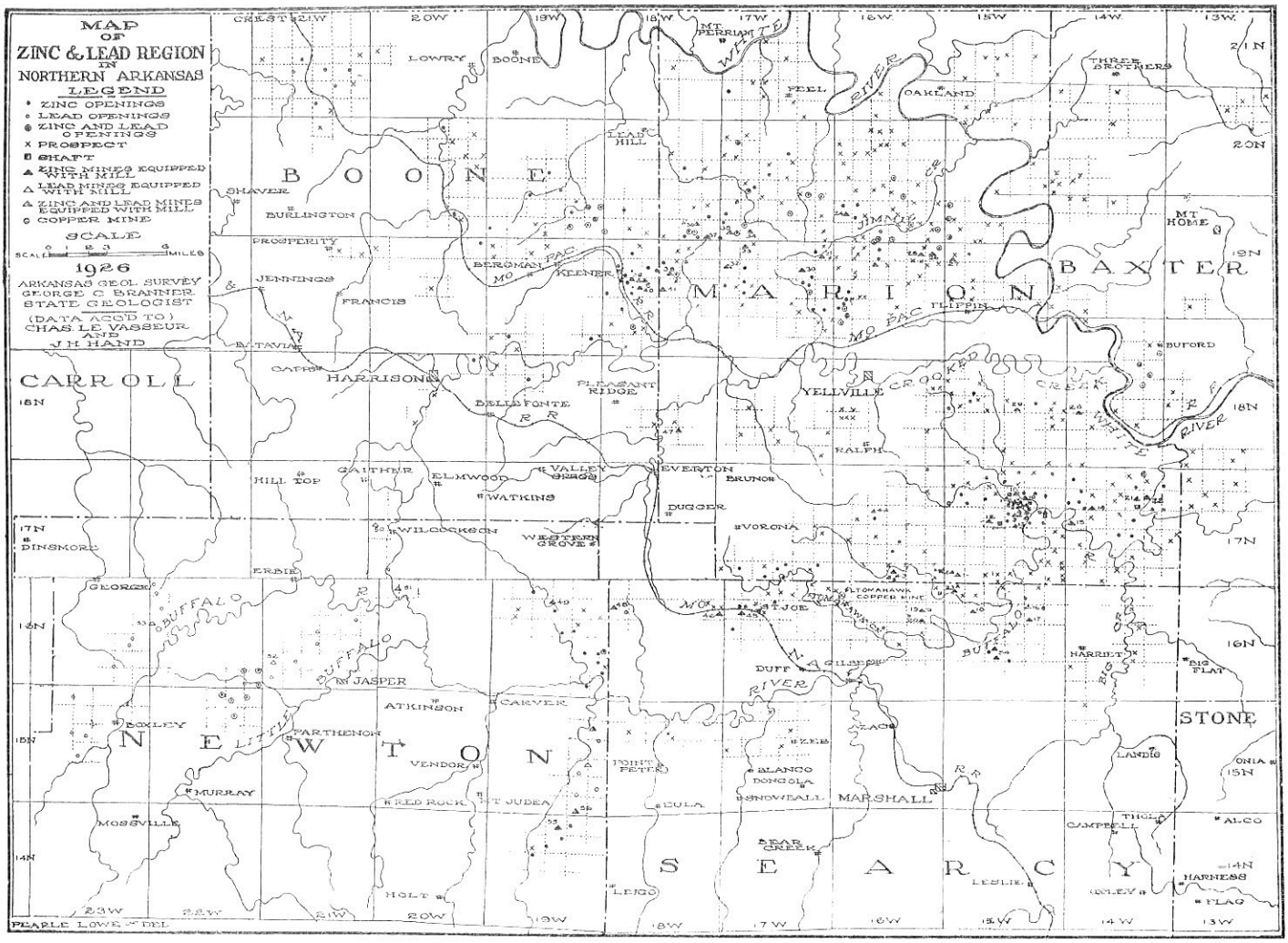
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MT. HOME
BUFFALO RIVER
WHITE RIVER
MO. PAC. R.R.
LOWRY
BOONE
MT. PERRIN
FEEL
OAKLAND
THREE BROTHERS
LEAD HILL
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KEENER
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FLIPPIN
BUFORD
CROOKED CREEK
RALPH
PLEASANT RIDGE
BELLEFONTE
HILL TOP
GAITHER
ELMWOOD
VALLEY SPRINGS
WATKINS
EVERTON
BRUNO
DUGGER
VORONA
WESTERN GROVE
WILCOCKSON
DINSMORE
ERBIE
GEORGES
ST. JOE
ALTOMAHAWK COPPER MINE
DUFF
HARRIET
BIG FLAT
JASPER
ATKINSON
CARVER
BOXLEY
PARTHENON
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MURRAY
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ZACH
ZEEB
LANDIS
ONIA
THOLA
CAMPBELL
ALCO
BEAR CREEK
LEGO
LESLIE
HARNESS
FLAG
HOLT
PEARLE
LOWE
DEL
CREST
21W
20W
19W
18W
17W
16W
15W
14W
13W
21N
20N
19N
18N
17N
16N
15N
14N
23W
22W

Key to Accompanying Map

The numbers on the following list of zinc and lead mines correspond to the numbers on the accompanying map.

1. Morning Star
2. Ben Carney
3. Capps
4. McIntosh
5. White Eagle
6. Edith
7. Yellow Rose
8. Red Cloud
9. Silver Hollow
10. Philadelphia
11. Beulah
12. Mattie M.
13. Big Bell
14. Dixie Girl
15. Omera
16. Churchill
17. Evening Star
18. Jack Pot
19. Maumee
20. North Star
21. Bonanza
22. Fox Den
23. Silver Run
24. Onwata
25. Monkey Hill
26. Eric Ozark
27. North Star
28. Lion Hill
29. Reynolds
30. Bear Hill
31. Beattie
32. Governor Eagle
33. Nakomis
34. Pilot Jack
35. Markle
36. Iola
37. Broome County
38. Tarkiln
39. Jack Pot Mines (3)
40. Frisco
41. Coker Hollow
42. Phillips
43. Sure Pop
44. Voegle
45. Excelsior
46. Iowa
47. Potts
48. Big Hurricane
49. Spears
50. Marble City
51. Canton
52. Panther
53. Baker
54. Consolidated Zinc Co.
55. Confederate
56. Old Grandby