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COAL IN THE DARDANELLE RESERVOIR AREA, YELL, POPE, LOGAN, JOHNSON, AND FRANKLIN COUNTIES, ARKANSAS

By Boyd R. Haley

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

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The U. S. Geological Survey is releasing in open files the following reports. Copies are available for consultation in the U. S. Geological Survey Library, 1033 GSA Bldg., Washington, D. C., and in other offices as listed:

1. Geologic map of the Mount Harvard quadrangle, Gunnison and Chaffee Counties, Colorado, by M. R. Brock and Fred Barker. 1 map and cross-section, scale 1:62,500. Bldg. 25, Federal Center, Denver, Colo. 80225; 15426 Federal Bldg., Denver, Colo. 80202; 345 Middlefield Rd., Menlo Park, Calif. 94025.

2. Instrument installations for the study of coal mine bumps at Sunnyside, Utah, by John O. Maberry. 12 p., 5 figs. 8102 Federal Office Bldg., Salt Lake City, Utah, 84111; Bldg. 25, Federal Center, Denver, Colo. 80225; 345 Middlefield Rd., Menlo Park, Calif. 94025.

3. Coal in the Dardanelle Reservoir area, Yell, Pope, Logan, Johnson, and Franklin Counties, Arkansas, by Boyd R. Haley. 12 p., 5 charts, 6 figs., 1 table.

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Correction of title; and announcement of additional depositories:

On Oct. 15, 1966, the open-filing of a report was announced. Originally, it had been entitled "Recovery of rare earths as a byproduct of phosphate fertilizer production: a study in economic geochemistry," by Z. S. Altschuler, Sol Berman, and Frank Cuttitta. This title is hereby corrected to "Rare earths in phosphorites--geochemistry and potential recovery."

Two additional depositories are announced for this report: 8102 Federal Office Bldg., Salt Lake City, Utah 84111; and South 157 Howard St., Spokane, Washington 94111.

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Coal in the Dardanelle Reservoir area,

Yell, Pope, Logan, Johnson, and Franklin Counties,

Arkansas

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By Boyd R. Haley

INTRODUCTION

Purpose and area of report

This report is a summary of the geology and related information pertaining to coal in the Dardanelle reservoir area, Yell, Pope, Logan, Johnson, and Franklin Counties, Arkansas. It was compiled in 1956 by the U.S. Geological Survey at the request of the Commanding Officer of the Little Rock District of the Corps of Engineers, U.S. Army.

The report describes the coal in the area represented by Charts 17 through 21 of the Arkansas River chart series prepared by the Corps of Engineers, U.S. Army. The area represented by these charts extends along the Arkansas River from about eight miles west of Ozark to about one mile east of Dardanelle. This area is identified in this report as the Dardanelle reservoir area.

Source of information

The information pertaining to the coal in the Dardanelle reservoir area was compiled from the work sheets of a completed, but as yet (1956) unpublished report of the Geological Survey, titled "Coal resources of Arkansas", 1/ supplemented by a small amount of additional data collected since completion of that report.

1/ Haley, B.R., 1960, Coal resources of Arkansas, 1954: U.S. Geol. Survey Bull. 1072-P, p.795-831.

The basic data were taken largely from reports of the U.S. Geological Survey, the Arkansas Geological and Conservation Commission, and the U.S. Bureau of Mines, and from well logs, reports by local residents, field observations by the author, and mine maps in the files of county clerks. A selected bibliography of published source material is included in this report.

Limitations and usefulness of this report

This report is based on a limited amount of detailed information regarding the thickness, rank, and quality of the coal, amount of overburden, and the geology of the Dardanelle reservoir area. The coal and the overburden thickness lines shown on Charts 17 through 21 are in part inferred or projected to show the author's estimate of the thickness trends. Thus, they are subject to subsequent revision and correction. Nevertheless, these projected thicknesses should give the report maximum utility and value for planning. In the event of litigation requiring precise details for all parts of an area, a more definitive report based on surface trenching and core drilling may be necessary.

In general, the Dardanelle reservoir will have an adverse effect upon (1) mining methods and percentage of recovery, and (2) mining expenses (machinery, supplies, and labor costs); it will have a favorable effect upon proximity and cost of transportation. Few, if any, of the detailed legal, economic, geologic, and mining engineering data necessary to determine the absolute effect of the reservoir flooding upon the future of the coal mining industry in the Dardanelle reservoir area are available. However, this report will serve as a basis for planning investigations to determine these factors.

METHODS OF CLASSIFYING DATA

Thickness of coal

The coal thickness lines shown on Charts 17 through 21 of this report were drawn at four-inch thickness intervals on the basis of known coal thicknesses. These lines are thought to represent the thickness of mineable coal because all known partings of rock more than three-eighths of an inch thick and benches of coal normally left in mining were excluded from the recorded coal bed thicknesses.

Thickness of overburden

The overburden thickness lines shown on Charts 17 through 21 of this report were drawn at 100-foot thickness intervals on the basis of recorded and computed depths of the coal.

Rank of coal

The dry mineral-matter-free fixed-carbon (dry Mm-free F.C.) content of the coal in the Dardanelle reservoir area ranges from about 83 percent in the western part to about 90 percent in the eastern part. Therefore the coal ranges in rank from low-volatile bituminous coal (78 to 86 percent dry Mm-free F.C.) to semianthracite (86 to 92 percent dry Mm-free F.C.). The amount of low-volatile bituminous coal is very small, and no attempt has been made in this discussion to separate it from the semianthracite.

The fixed-carbon content of the coal was calculated to the dry mineral-matter-free basis in accordance with standard specifications established by the American Society for Testing Materials. The following approximation formula was used:

$$\text{Dry Mm-free F.C.} = \frac{\text{F.C.}}{100-(M + 1.1A + 0.1S)} \times 100$$

where: Mm = mineral matter, F.C. = percentage of ~~ash,~~ fixed carbon, M = percentage of moisture, A = percentage of ash, and S = percentage of sulfur.

A list of the sample analyses used in determining the rank of the coal in and near the Dardanelle reservoir area is appended to this report.

GENERAL GEOLOGY

Stratigraphy

The rocks in the Dardanelle reservoir area are of Pennsylvanian age and have been divided into four formations, from oldest to youngest, the Atoka formation, Hartshorne sandstone, McAlester formation, and Savanna formation (Hendricks and others, 1936).

Atoka formation. - Only the uppermost part of the Atoka formation totaling about 300 feet in thickness is exposed in the Dardanelle reservoir area. This part of the formation consists of shale and siltstone and a minor amount of sandstone. It is not coal-bearing.

Hartshorne sandstone. - The Hartshorne sandstone, which unconformably overlies the Atoka formation, is composed of a single bed of sandstone or clayey sandstone, or several sandstone beds intercalated with thin beds of shale. Thin stringers of coal are present locally in the shale. The thickness of the formation ranges from about 10 to about 70 feet.

McAlester formation. - The McAlester formation conformably overlies the Hartshorne sandstone and consists of sandstone, siltstone, shale, and two known coal beds. It is about 650 feet thick in the reservoir area. The

Lower Hartshorne coal bed is near the base of the McAlester formation, and the other coal bed is from 20 to 40 feet above.

Savanna formation. - The Savanna formation, which overlies the McAlester formation -- probably unconformably, has been eroded from most of the Dardanelle reservoir area, but approximately 500 feet of the lower part of the formation is present in a syncline southeast of Morrisons Bluff (Chart 19). In this syncline, the lower part of the Savanna formation consists of shale, siltstone, sandstone, and two thin coal beds that are near the base of the formation. The lower bed may be equivalent to the Charleston coal bed in the western part of the Arkansas coal field. The other bed is from 10 to 25 feet above the Charleston(?) coal bed. Each of these coal beds is thought to be less than 8 inches thick throughout the reservoir area.

Structure

The rocks in the Dardanelle reservoir area have been folded into asymmetrical anticlines and synclines and are cut locally by normal and reverse faults. The rocks dip less than 35 degrees throughout the area. The maximum amplitude of folding is difficult to determine but is in excess of 1,100 feet on the Lower Hartshorne coal bed in the area of Chart 19.

Prairie View fault and Big Danger fault are normal faults that have relative displacements ranging from a few feet to more than 300 feet. Their surface traces are shown on Chart 18 and 19 respectively.

The Hartman fault (Chart 19), a reverse fault, has a displacement of more than 300 feet near its western end where it has been cut by a northward-trending unnamed normal fault. The surface and subsurface traces of the Hartman fault and the associated normal fault are shown on Chart 19. The subsurface traces of both are drawn on the Lower Hartshorne coal bed. The unnamed fault and the Coal Hill fault may be branches of a larger normal fault trending northward beyond the north boundary of Chart 19.

COAL

General description

The Lower Hartshorne coal bed is the only bed of commercial importance in the Dardanelle reservoir area. Three coal beds are present in the rocks overlying the Lower Hartshorne coal bed. These are: (1) a thin coal bed that is 20 to 40 feet above the Lower Hartshorne coal bed, (2) the Charleston(?) coal bed, and (3) a thin coal bed that is 10 to 25 feet above the Charleston(?) coal bed.

Lower Hartshorne coal bed

The thickness of the Lower Hartshorne coal bed is known to range from 6 to 63 inches in the Dardanelle reservoir area. It is present in an area of about 320 square miles within the boundaries of Charts 17 through 21, and it extends from the surface to a depth of more than 1,100 feet. The details of the known and estimated extent, depth, and thickness of the Lower Hartshorne coal bed are shown on Charts 17 through 21. The Lower Hartshorne coal bed in the Dardanelle reservoir area has a sulfur content ranging from 0.6 percent to 4.5 percent and averaging 2.2 percent. It has an ash content ranging from 3.2 percent to 16.2 percent and averaging 8.6 percent. A small amount of the Lower Hartshorne coal in the western part of the area has a dry mineral-matter-free fixed-carbon content of less than 86 percent, as calculated from the coal sample analyses data appended to this report, and is thus classified as low-volatile bituminous coal.

Reserves

With the data presented on Charts 17 to 21, inclusive, it is possible to calculate the inferred coal reserves in any part or all of the area covered by the charts. Because the coal areas are mostly synclinal, or basin shaped, the coal that could be endangered by filling of the reservoir is more closely related to the shape of the basins than to the actual area to be inundated. At the same time those coal areas nearest outcrops that pass below the reservoir are in greatest danger of being flooded. Thus the tonnage of coal subject to flooding will necessarily be based on consideration of many local engineering and mining factors that are beyond the scope of this report.

The 320-square-mile area underlain by Lower Hartshorne coal bed in the area shown on Charts 17 through 21 is about 25 percent of the total area in which the Lower Hartshorne coal bed is present in Arkansas. In this report the Lower Hartshorne coal bed is assumed to be thicker than 14 inches throughout an area of about 200 square miles of the Dardanelle reservoir area. If the coal has an average thickness of 2 feet and weighs 2,000 tons per acre-foot, the area contained more than 500,000,000 tons of coal prior to the start of mining in the early 1800's. The exact amount of coal produced in the mapped area since the start of mining is unknown, but 30,000,000 tons is a maximum total. Assuming that an equal amount was lost in mining, about 440,000,000 tons of coal in a bed more than 14 inches thick remains in the Dardanelle reservoir area.

COAL MINING

Past and present coal mining

Coal has been mined in the Dardanelle reservoir area for more than 100 years, most of it from underground mines north and south of Russellville (Chart 17) and east and south of Ozark (Charts 21, 20, and 19). The total amount of coal produced from these mines is unknown, but during fiscal year 1956 approximately 66,000 tons of coal was produced from the mines in the Dardanelle reservoir area. This tonnage represents about 10 percent of the amount of coal produced in Arkansas during the same period (Berry, 1956). Coal has been produced from strip mines in the area, but during fiscal year 1956 all the coal was produced from underground mines.

The maximum depth of the active mining in the area is not known, but some mining has occurred at depths greater than 400 feet. Present underground mining is performed by longwall, and by room and pillar methods. Most of the mines use mining machines and chain conveyors or scows.

Coal mining factors

The amount of coal mined in the Dardanelle reservoir area, as in every coal mining area, is or will be influenced by the following factors: (1) rank, (2) quality, (3) thickness, (4) depth, (5) mining methods and percentage of recovery, (6) mining expenses (machinery, supplies, and labor costs), (7) proximity and cost of transportation, (8) demand, and (9) mine operator's remuneration, which is dependent to a great extent on the demand for the coal. In general, all these factors must be favorable if coal mining is to flourish in any given area.

Effects of reservoir flooding on coal mining

The effects of the reservoir flooding upon the local coal mining industry and upon future coal mining regulations may be summed up as follows:

Adverse effects

Mining methods will be less efficient, and a smaller percentage of the coal will be recovered. Some of the reasons for these adverse effects are: (a) The coal in Arkansas is mined by the room and pillar method with the roof being supported by the pillars, or by the more efficient longwall method with the unsupported roof collapsing behind the area of active mining. The longwall method cannot be used under the reservoir because a collapse of the roof would result in flooding the mines. The room and pillar method will be used with the dimensions of the pillars being larger than normal to insure adequate roof support. (b) Where the outcrop is to be flooded, a block of coal must be left between the reservoir and the mining operations. The width of this block of coal will be dependent upon the thickness of the coal, the permeability of the rocks above the coal, and the continuity and extent of the joint systems and bedding planes in these rocks and in the coal. (c) Coal cannot be mined within a minimum distance of a fault plane or fault zone with a surface trace underneath the reservoir; this distance is dependent upon the thickness and depth of the coal, the permeability of the overlying rocks, and the permeability of the rocks along a fault or fault zone. The permeability of the rocks along a fault or fault zone is difficult to determine, and probably differs considerably in different localities, but in the Clarksville gas field (5 miles north of

Jamestown, Chart 19), the permeability near the faults or fault zones must be very low because the gas does not escape to the surface along or through them. (d) Additional coal will be left in barrier pillars between individual underground mining operations. These barrier pillars, which will be more closely spaced than normal, are needed to localize flooding in the mined areas in the event of a collapsed roof. (e) Mining expenses will be increased because of the extra hazard of flooding represented by the reservoir. The increase in mining expenses will be due to the need for more and larger pumping and ventilating equipment, more timbering, lagging, and brattice supplies, and possibly higher pay scale.

Favorable effects

The reservoir will provide easily accessible low-cost transportation for the mined coal, providing the Arkansas River is made navigable.

Future of coal mining

After the Dardanelle reservoir is flooded, coal can be mined in many parts of the area by adopting mining regulations and techniques developed during the mining of coal under the Susquehanna River in the Northern anthracite field of Pennsylvania and under the ocean off the coast of Wales.

Much of the coal mined in the Dardanelle reservoir area is used by the metallurgical industries, which furnish a rather constant market for the coal. In all probability, the demand for coal by the metallurgical industries will be great enough to insure a market for coal mined in the Dardanelle area even though the coal may cost more per ton.

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TABLE 1: ANALYSES (IN PERCENT) OF COAL FROM THE LOWER HARTSHORNE COAL BED IN AND NEAR THE DARDANELLE RESERVOIR AREA, YELL, POPE, LOGAN, JOHNSON AND FRANKLIN COUNTIES, ARKANSAS

Mine Operator	Approximate location	Remarks	Sample			Proximate			Ultimate		Heat value (Btu)	Source of data 3/
			Laboratory number	Kind 1/	Condition 2/	Moisture	Volatile matter	Fixed carbon	Ash	Sulfur		
POPE COUNTY												
Bernice mine	Sec. 20, T. 7 N., R. 20 W.		18,755	M	1	2.8	11.9	75.2	10.1	2.2	13,360	A
					2		12.2	77.4	10.4	2.2	13,740	
					3		13.7	86.3		2.5	15,330	
McAlester Fuel Co. (Bernice No. 3)	Sec. 20, T. 7 N., R. 20 W.		A99410	M	1	2.5	11.3	77.4	8.8	1.7	13,660	B
			A99411	M	1	2.9	10.7	77.7	8.7	1.8	13,580	B
			A99412	M	1	2.6	10.7	77.6	9.1	2.2	13,610	B
			A99413	M	1	2.7	10.9	77.6	8.8	2.0	13,600	B
		Composite of A99410-12			2		11.2	79.7	9.1	2.0	13,980	B
					3		12.4	87.6		2.2	15,380	
JOHNSON COUNTY												
Sterling Coal Co.	Sec. 17, T. 9 N., R. 23 W.		A99386	M	1	3.1	10.3	79.5	7.1	1.5	13,910	B
			A99387	M	1	2.3	10.9	78.2	8.6	2.0	13,690	B
			A99388	M	1	2.3	10.3	80.6	6.8	1.5	14,080	B
			A99389	M	1	2.6	10.6	79.3	7.5	1.7	13,880	B
		Composite of A99386-88			2		10.8	81.5	7.7	1.8	14,240	
					3		11.7	88.3		1.9	15,430	
Clark and McWilliams Coal Co.	Sec. 18 T. 9 N., R. 24 W.		A99390	M	1	2.6	11.4	78.1	7.9	1.7	13,790	B
			A99391	M	1	2.5	10.6	79.8	7.1	2.0	13,990	B
			A99392	M	1	2.5	11.3	79.1	7.1	1.9	13,930	B
			A99393	M	1	2.5	10.9	79.2	7.4	1.9	13,930	B
		Composite of A99390-92			2		11.2	81.2	7.6	1.9	14,290	
					3		12.1	87.9		2.1	15,470	

1/ M: Mine samples
2/ 1: Sample as received; 2: dried at 105°C.; 3: moisture and ash free
3/ A: Fieldner, A.C., Cooper, H.M., and Osgood, J.N., 1928, Analyses of Arkansas coal: U.S. Bur. Mines Tech. Paper 416
B: Hendricks, T.A., and Parks, Bryan, 1937, Geology and mineral resources of the western part of the Arkansas coal field: U.S. Geol. Survey Bull. 847-E
C: U.S. Bureau of Mines, Pittsburgh, Pennsylvania

TABLE 1: ANALYSES (IN PERCENT) OF COAL FROM THE LOWER HARTSHORNE COAL BED IN AND NEAR THE DARDANELLE RESERVOIR AREA, YELL, POPE, LOGAN, JOHNSON AND FRANKLIN COUNTIES, ARKANSAS

Mine Operator	Approximate location	Remarks	Sample			Proximate			Ultimate		Heat value (Btu)	Source of data 3/
			Laboratory number	Kind 1/	Condition 2/	Moisture	Volatile matter	Fixed carbon	Ash	Sulfur		
LOGAN COUNTY												
New Deal Coal Co.	Sec. 26, T. 8 N., R. 24 W.		A99831	M	1	7.0	11.3	75.0	6.7	1.4	13,310	B
			A99832	M	1	4.9	10.8	78.2	6.1	2.0	13,680	B
			A99825	M	1	4.1	10.7	80.5	4.7	1.1	14,120	B
		Composite of A99831-32 & 99825	A99834	M	1	5.4	10.5	78.1	6.0	1.4	13,690	B
					2		11.1	82.6	6.3	1.5	14,470	
					3		11.8	88.2		1.6	15,440	
K. and S. Coal Co.	Sec. 26, T. 8 N., R. 24 W.			M	1	3.5	12.2	76.6	7.7	1.4	13,750	C
					2		12.7	79.3	8.0	1.4	14,240	
					3		13.8	86.2		1.6	15,480	
				M	1	3.8	12.8	75.1	8.3	1.1	13,540	C
					2		13.3	78.1	8.6	1.1	14,080	
					3		14.5	85.5		1.2	15,410	
FRANKLIN COUNTY												
Quality Coal Co.	Sec. 18, T. 9 N., R. 26 W.		A99367	M	1	2.4	15.7	76.3	5.6	0.7	14,370	B
			A99368	M	1	3.3	13.6	80.3	2.8	0.7	14,710	B
			A99369	M	1	3.4	14.3	78.6	3.7	0.7	14,500	B
		Composite of A99367-69	A99370	M	1	3.1	14.6	78.2	4.1	0.7	14,540	B
					2		15.0	80.7	4.3	0.8	15,000	
					3		15.7	84.3		0.8	15,660	

1/ M: Mine samples

2/ 1: Sample as received; 2: dried at 105°C.; 3: moisture and ash free

3/ A: Fieldner, A.C., Cooper, H.M., and Osgood, J.N., 1928, Analyses of Arkansas coal: U.S. Bur. Mines Tech. Paper 416

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Pocket contains 11 items