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Methane Gas Content of the Mary Lee Group of Coalbeds, Jefferson, Tuscaloosa, and Walker Counties, Ala.

UNITED STATES DEPARTMENT OF THE INTERIOR

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METHANE GAS CONTENT OF THE MARY LEE GROUP OF COALBEDS, JEFFERSON, TUSCALOOSA, AND WALKER COUNTIES, ALA.

by

W. P. Diamond,[1] G. W. Murrie,[1] and C. M. McCulloch[1]

ABSTRACT

It is estimated that more than 1 trillion cubic feet of methane is contained within the coals of the Mary Lee group in Jefferson, eastern Tuscaloosa, and southern Walker Counties, Ala. Most of this methane will be encountered by mining. Coals of the Mary Lee group are presently being mined at depths exceeding 1,000 feet and will in the near future be mined at even greater depths, where the problem of methane gas affecting the mining operations will be acute. It is calculated that approximately 90 pct of the methane is at depths greater than 1,000 feet, and over half of the gas is contained within only 12 pct of the study area which is under more than 1,500 feet of overburden. Degasification in advance of mining will increase mine safety, reduce ventilation expenditures, increase productivity, provide an additional energy source, and make it possible to mine parts of deep coalbeds that probably could not otherwise be mined.

INTRODUCTION

The Mary Lee group contains the greatest coal reserves in the Warrior basin, Ala. (1).[2] These coals have been extensively mined in the shallower portion of the basin and are now being mined under deeper overburden. Desorption of methane from coal cores taken at various depths within the basin (4) indicated that high concentrations of gas were to be expected in coals of the Mary Lee group. The high gas emission rates anticipated for mines to be operating in the deeper parts of the Warrior basin prompted this study to estimate the methane gas content of the Mary Lee group, delineate areas of high gas concentration, and encourage degasification in advance of mining.

The area selected for investigation is that part of the Warrior basin located in Jefferson, eastern Tuscaloosa, and southern Walker Counties of north-central Alabama (fig. 1). This area contains all abandoned and operating mines in the Mary Lee group, as well as those proposed for the near future.

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[1] Geologist.

[2] Underlined numbers in parentheses refer to the list of references at the end of this report.

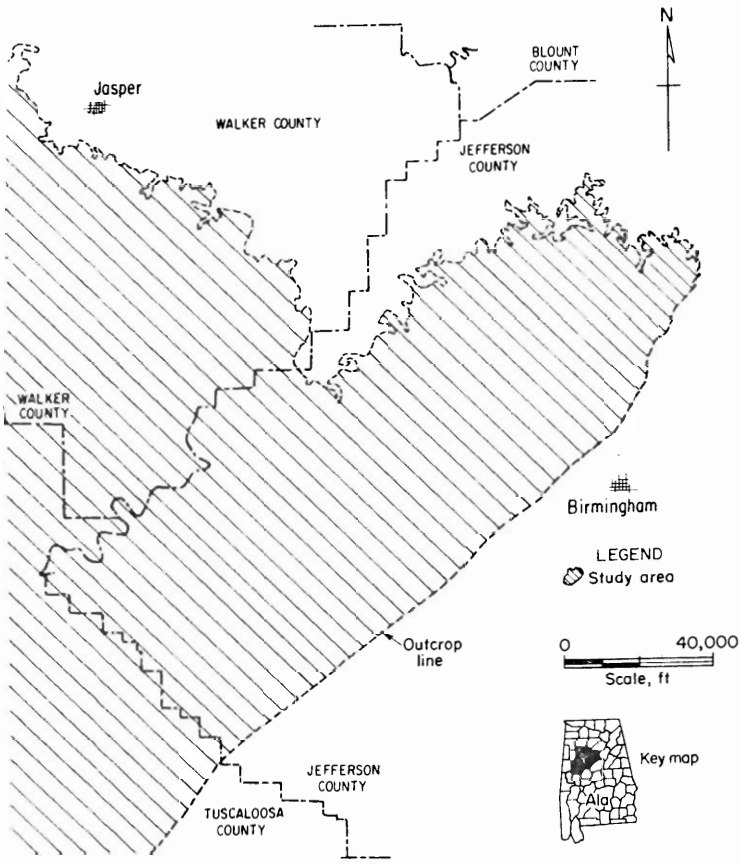

FIGURE 1. - Study area.

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GEOLOGY

Nomenclature

The Mary Lee group is comprised of five coals which, in ascending order, are the Ream, Jagger, Blue Creek, Mary Lee, and New Castle. The most persistent and economically important member of this group is the Mary Lee coal. It is composed of two predominant benches which split and coalesce in the northern part of the Warrior basin and are often mined as one bench. As the Mary Lee dips southwest into the basin, the bottom bench thickens, the interval between the two main benches increases, and the bottom bench becomes the minable bed. The distance between these two main benches ranges from less than 1 foot in the shallow parts of the basin to more than 9 feet in the deeper portion of the basin where, in places, the bottom bench has been named the Blue Creek coal.

Structure and Overburden

The Warrior basin dips to the southwest, and its major structures, the Warrior and Coalburg synclines and Sequatchie anticline, trend northeast to southwest (fig. 2). The major fault trends are nearly perpendicular to the structural axes and are generally oriented northwest to southeast. Thrust faults are present along and parallel to the southeastern flank of the basin.

The overburden thickness trend follows the regional southwestern structural dip and ranges from 0 feet at outcrop to greater than 2,300 feet at the southern limit of the study area (fig. 3). The most rapid transition in overburden thickness, from 0 to 1,500 feet in approximately 1/2 mile, occurs in an east to west direction across the southeastern flank of the Warrior basin. The distribution of the various overburden intervals is given in table 1.

TABLE 1. - Overburden distribution

Overburden thickness, ft	Area, mi^2	Area, pct
0- 500	282	34
500-1,000	277	33
1,000-1,500	174	21
1,500-2,000	79	9
2,000-2,500	27	3
Total	839	100

Coal Thickness

Two isopachs of the original coalbed were constructed for use in calculating methane gas volumes. The publication of these isopachs has been withheld owing to the confidentiality of the data. The Mary Lee coal isopach included the two predominant benches of coal that are of greatest interest to the mining industry, commonly known as the Mary Lee in the north and the Mary Lee and/or Blue Creek in the south. The total coal isopach included the coal of the first isopach and the New Castle, plus the Blue Creek coalbed where data is complete. The total coal isopach represented a conservative estimate of coal present in the Mary Lee group because most core holes were not drilled deep enough to intercept the lower members of the group.

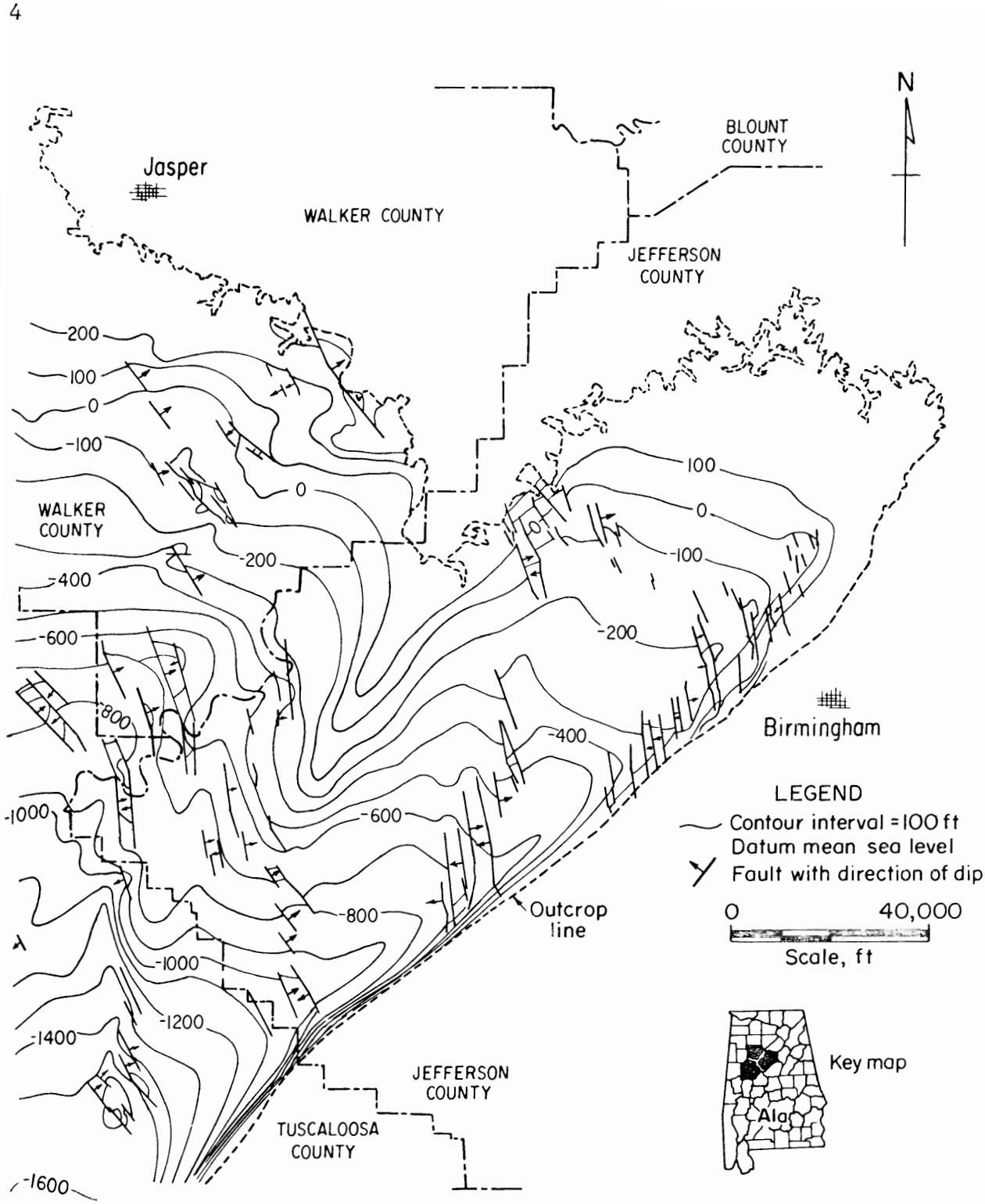

FIGURE 2. - Structure map.

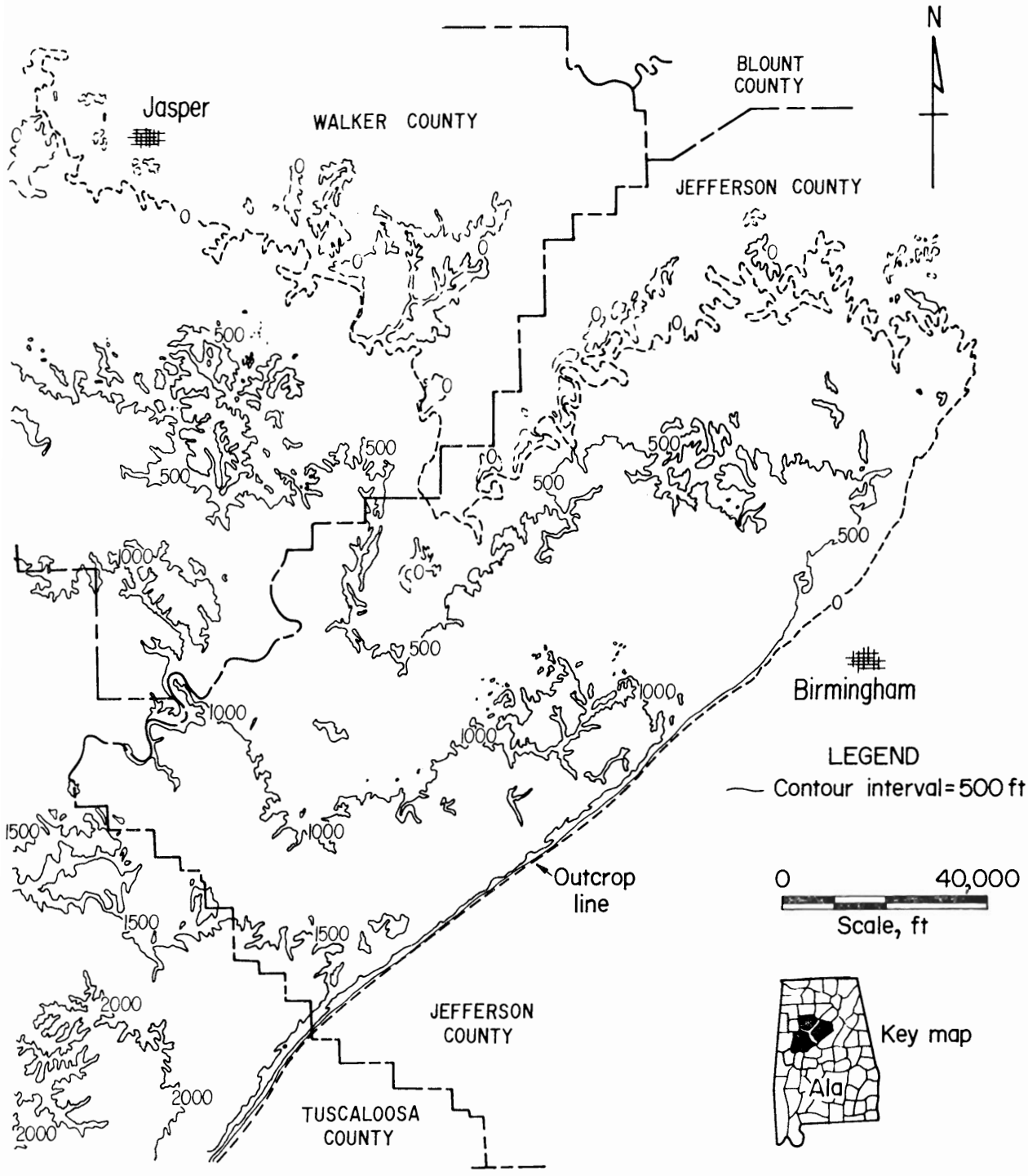

FIGURE 3. - Overburden map.

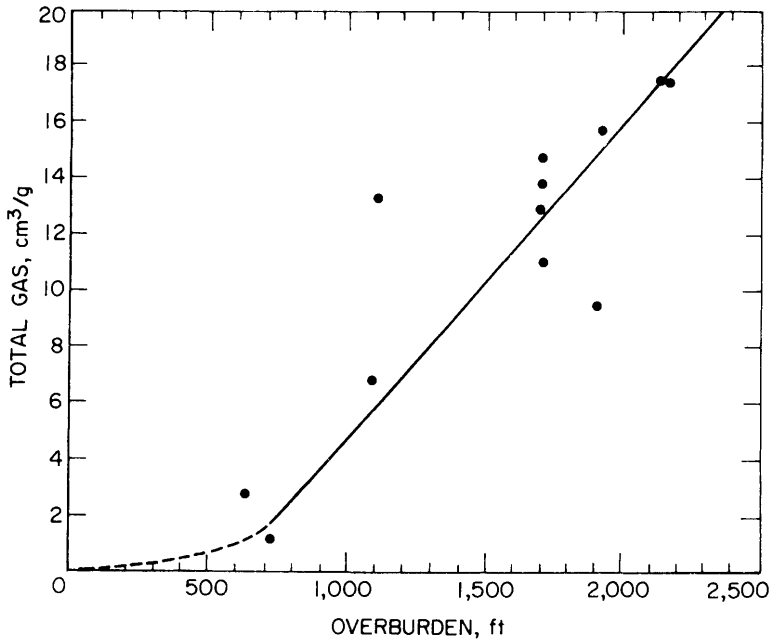

FIGURE 4. - Depth of coalbed versus gas content.

METHANE GAS CONTENT

Method of Calculation

Coal samples were obtained from seven core holes ranging in depth from 600 to 2,200 feet. The methane content of a unit weight of coal was determined for the 12 samples by the direct method (3-4). A graph for estimation of gas content was constructed (fig. 4) by plotting the measured gas content versus depth for each sample and fitting a line to the points using least squares statistical analysis. The overburden isopach was overlaid on the coal isopachs to determine the amount of coal contained under each overburden interval. The methane content for each overburden interval was obtained by multiplying the volume of coal under an interval by the estimated methane content of the median depth of each interval.

Results

The methane gas content of the Mary Lee group, within the study area, is estimated to be approximately 1 trillion cubic feet. Approximately 700 billion cubic feet of methane is contained within the Mary Lee coalbed alone. Table 2 lists the gas potentials of the Mary Lee and the Mary Lee group for each overburden interval.

TABLE 2. - Methane potentials

Overburden, ft	Average methane content		Methane potential, ft^3	
	Cm^3/g	Ft^3/ton	Mary Lee	Mary Lee group
0- 500.....	0.25	7.5	0.09×10^{11}	0.13×10^{11}
500-1,000.....	2.00	64.0	$.90 \times 10^{11}$	1.15×10^{11}
1,000-1,500.....	7.50	240.0	2.65×10^{11}	3.76×10^{11}
1,500-2,000.....	13.10	419.0	2.30×10^{11}	3.54×10^{11}
2,000-2,500.....	18.60	595.2	1.23×10^{11}	1.96×10^{11}
Total.....	-	-	7.17×10^{11}	10.54×10^{11}

DISCUSSION

It is estimated that nearly 70 pct of the 1 trillion cubic feet of methane present in the Mary Lee group is contained within that portion likely to be encountered by mining operations. Based on the amount of coal known to have been previously removed, primarily from shallow (less than 500 feet) depths, and the expected low gas content of that coal, 98 pct of the calculated methane content probably remains. The calculated methane content is probably conservative because only the gas in the coal has been calculated and no assessment of that which may be contained in the roof and floor rocks has been included.

Mining operations are gradually progressing to greater depths in the Mary Lee group, with mines now operating in excess of 1,000 feet. The data derived from coal samples obtained from various depths, as plotted on the graph (fig. 4), indicate an increase in gas content with increasing depth. Table 3 indicates approximately 90 pct of the total methane content exists at depths greater than 1,000 feet. The Mary Lee group is at depths of greater than 1,500 in less than 12 pct of the study area, yet more than half of the methane is estimated to be within that portion.

TABLE 3. - Methane distribution

Overburden, ft	Methane potential, pct	
	Mary Lee	Mary Lee group
0- 500	1	1
500-1,000	13	10
1,000-1,500	37	36
1,500-2,000	32	34
2,000-2,500	17	19

The present study does not include the total extent of the Mary Lee group in the deeper part of the Warrior basin, owing to the lack of data. However, it should be noted that the methane potential of the Mary Lee group in the deeper part of the Warrior basin is enormous. Every additional square mile of coal 6 feet thick, at a depth of 2,000 feet, would contribute another 3.3 billion cubic feet of gas to the 1-trillion-cubic-foot total.

Experimental methods to remove methane in advance of mining have been conducted in the Mary Lee coalbed. Production from degasification boreholes at a depth of approximately 1,000 feet in Jefferson County, Ala., sustained a flow rate of 70,000 ft^3/day after hydraulic stimulation (2). The gas production averaged 93 pct methane, with H_2 and CO_2 making up the greatest part of the remaining 7 pct. The British thermal unit value of the gas ranged from 970 to 990.

CONCLUSION AND RECOMMENDATIONS

The Mary Lee coal group of the Warrior basin, Ala., contains substantial quantities of methane, estimated to be in excess of 1 trillion cubic feet. Most of this methane will be encountered in mining operations, with the

greatest concentration being in the deeper portions of the basin. Bureau of Mines research (2) has shown that degasification in advance of mining is feasible in the Mary Lee coalbed and can produce commercial quantities of pipeline-quality methane. It is recommended that degasification in advance of mining be considered as part of a complete mine development plan for areas having greater than 1,000 feet of overburden.

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