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**Methane Emissions From Four
Working Places in the Beckley Mine,
Raleigh County, W. Va.**



UNITED STATES DEPARTMENT OF THE INTERIOR

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BUREAU OF MINES

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METHANE EMISSIONS FROM FOUR WORKING PLACES IN THE BECKLEY MINE, RALEIGH COUNTY, W. VA.

by

P. W. Jeran,¹ D. H. Lawhead,² and M. C. Irani³

ABSTRACT

The Beckley mine is one of five new mines in a heretofore unmined portion of the Beckley coalbed. The remoteness of these new mines from prior mining and their greater overburden preclude applying methane emission experience obtained in the old mines. Four sections of the Beckley mine were monitored. The data gathered show that variations in methane emission cannot be explained by variations in coal production. Although overburdens varied by as much as 30 pct, no correlation with methane emissions could be determined. The rib emissions increase with increased length of rib from a section advancing into virgin coal and do not decline over a prolonged idle period (32 days) whereas some decline has been measured for a section not mining into virgin coal. The indication is that degasification prior to mining will reduce the hazard of methane emissions in this area of the Beckley coalbed.

INTRODUCTION

Methane air explosions are a major hazard in underground coal mining. The Bureau of Mines has developed two instruments that give continuous and accurate data on the emission of methane into coal mines. One, an exhaust fan methanometer (2),⁴ monitors total emissions from the mine. The other, an in-mine methane analyzer system (1), allows subdivision of the total variations seen at the exhaust fan into the component parts contributed by the individual sections of the mine.

The first multiple section installation of the methane analyzer system was at the new Beckley mine operating in the Beckley coalbed near Glen Daniel, Raleigh County, W. Va. The mine property is in an area of the Beckley coalbed

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⁴Underlined numbers in parentheses refer to the list of references at the end of this report.

remote from prior mining. Four other mines in this area of the coalbed are in various stages of planning and development.

The remoteness from prior mining does not permit the extrapolation of methane emission data from the old mines to these new mines. The primary purpose of this investigation was to study the effects of various parameters on methane emissions during mining.

Monitoring began September 12, 1974, and was continued until December 27, 1974, when an icefall in the main shaft severed the data cable connecting surface and underground components of the instrumentation system.

The geology of the Beckley coalbed was described by Popp and McCulloch (5). Past mining in the Beckley coalbed shows that it varies in thickness. Popp and McCulloch show the coalbed to range from less than 36 to 108 inches within the Beckley mine property. In these workings the coalbed is about 7 feet thick.

The Beckley coalbed dips to the northwest and has two major folds, the Pineville anticline and syncline (fig. 1), neither of which are present in the Beckley mine property. Overburden above the Beckley coalbed ranges from 200 to over 2,200 feet, but at the Beckley mine the average overburden thickness is 830 feet (5).

The face cleat in the Beckley mine is oriented about 15° counter-clockwise from a major rock joint striking N 25° W. The butt cleat oriented N 50° E lies between the two strongest or most often measured rock joints. The cleat, although well developed, is not closely related to the jointing of the rocks overlying the coalbed.

Little geologic variation was observed in the Beckley mine. The roof rock is gray sandy shale between 30 to 40 feet thick. The floor rock is dark shale. A contour map of the base of the Beckley coalbed within the mine (fig. 2) shows that the coal dips to the northwest, in general agreement with the regional structure of the coalbed. No variations in the coal cleat orientation were observed within the mine workings.

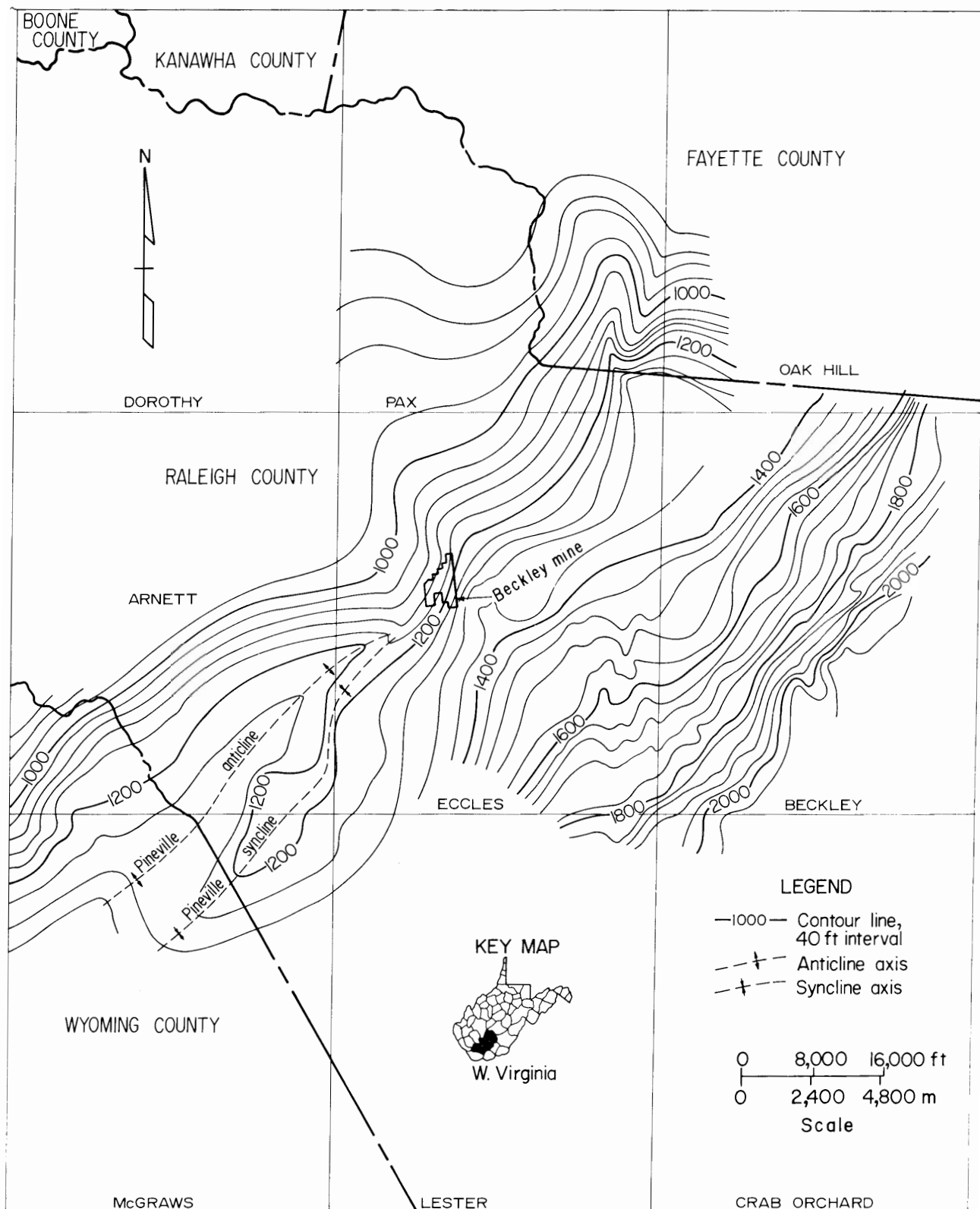


FIGURE 1. - Structure of Beckley coalbed.

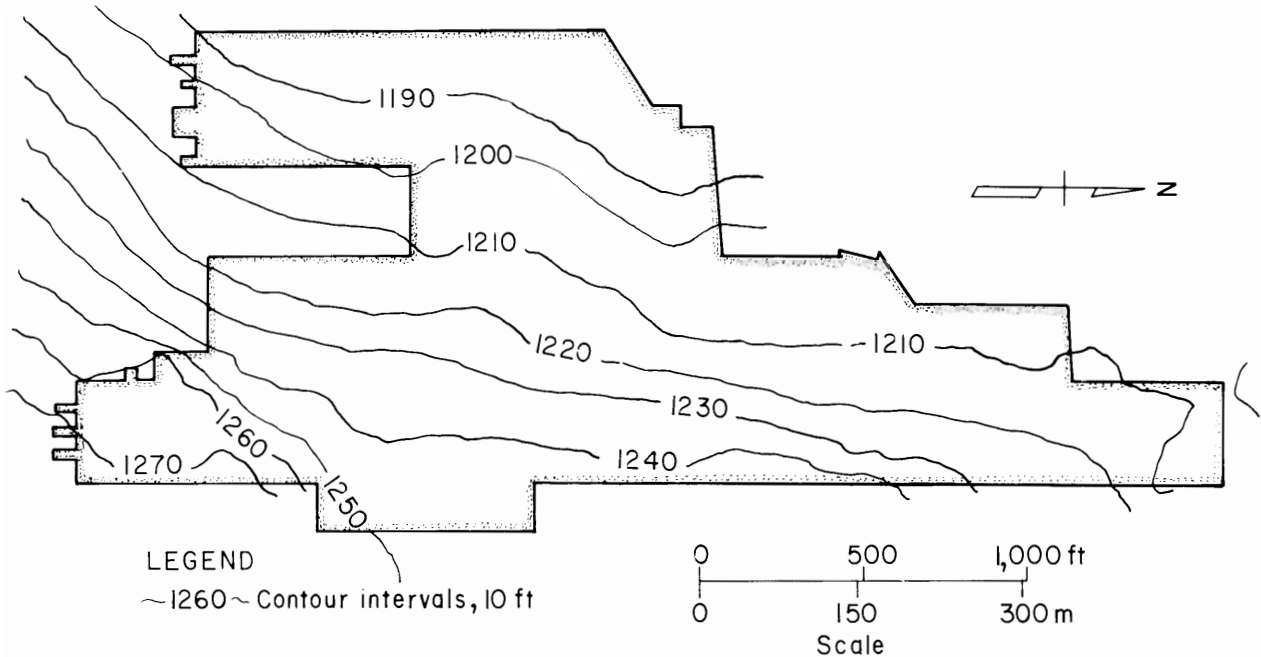


FIGURE 2. - Structure of base of Beckley coalbed at the Beckley mine.

INSTRUMENTATION

The methane analyzer system (1) installed in the Beckley mine has a capacity for 31 methane sensors because of the size of the data transmission cable. The system continuously records the volume percent of methane in the air passing each sensor with an accuracy of ± 0.04 on a scale of 0 to 2 vol-pct.

The receiving units and recorders at the surface were connected to the sensors through the main data cable containing 31 pairs of wire. The cable ran down the elevator shaft to an underground electrical room where the power supply boxes were installed. From these boxes, four-conductor cables were strung to each sensor.

A standby battery power source at the surface receiving station insures continuous methane recordings in case of a power failure on the surface. Up to 3 hours of electrical power can be supplied to the receiving units and recorders in this way. Also, each sensor contains a standby battery.

The four sections monitored were the North mains, Northwest mains, South mains, and the South right mains (fig. 3). The Southwest mains was not monitored because changes were being made in ventilation to this area.

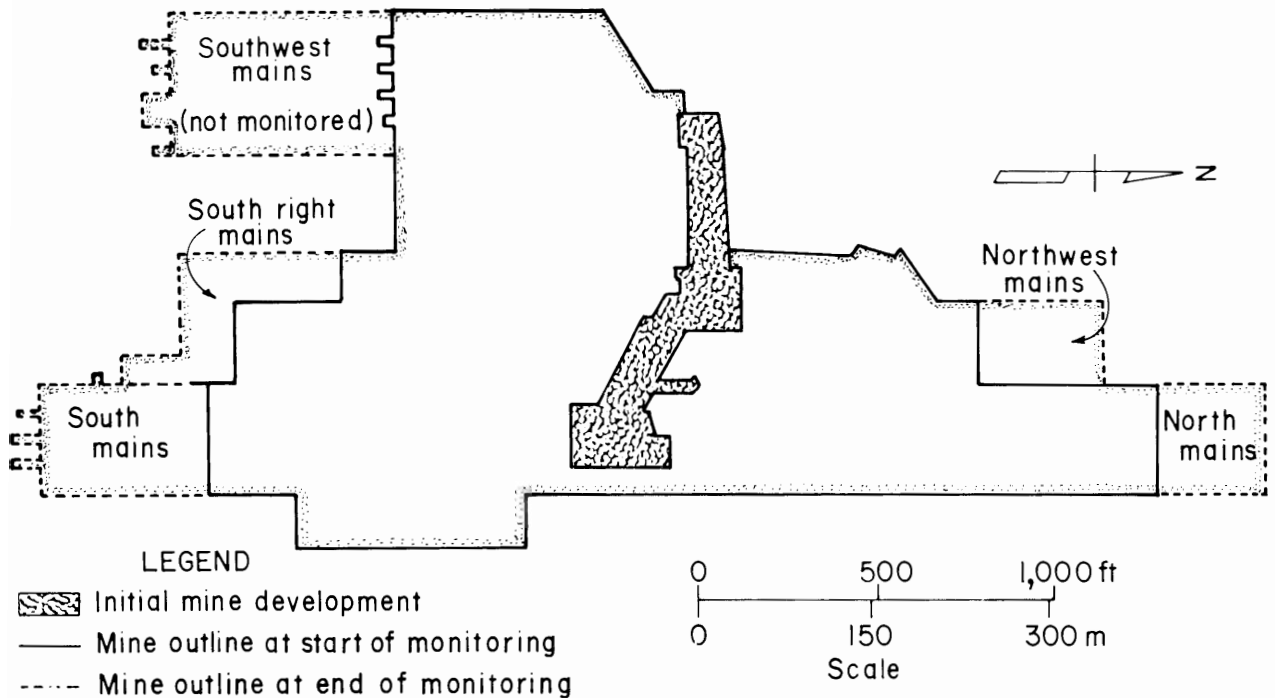


FIGURE 3. - Mine outline.

Sensors were installed at each of the regulators controlling airflow from the individual sections. The volume of air passing each regulator is regularly measured by mine personnel. The ventilation and daily coal production data from each section were supplied by the mining company.

METHANE EMISSIONS AND COAL PRODUCTION

Figures 4-7 are plots of the daily methane emissions and coal production from each section. The breaks in the coal production represent periods of idle time. The dashed line is a 32-day strike.

These graphs show the wide range of daily coal production and give the general trend of methane emissions during the monitoring. Only the South mains (fig. 6) shows a definite upward trend in methane emission. Table 1 summarizes the range and average values of daily coal production and daily methane emission. These data show that while the north sections had the same range of daily coal production as the south sections, the north sections were not as productive of either coal or methane.

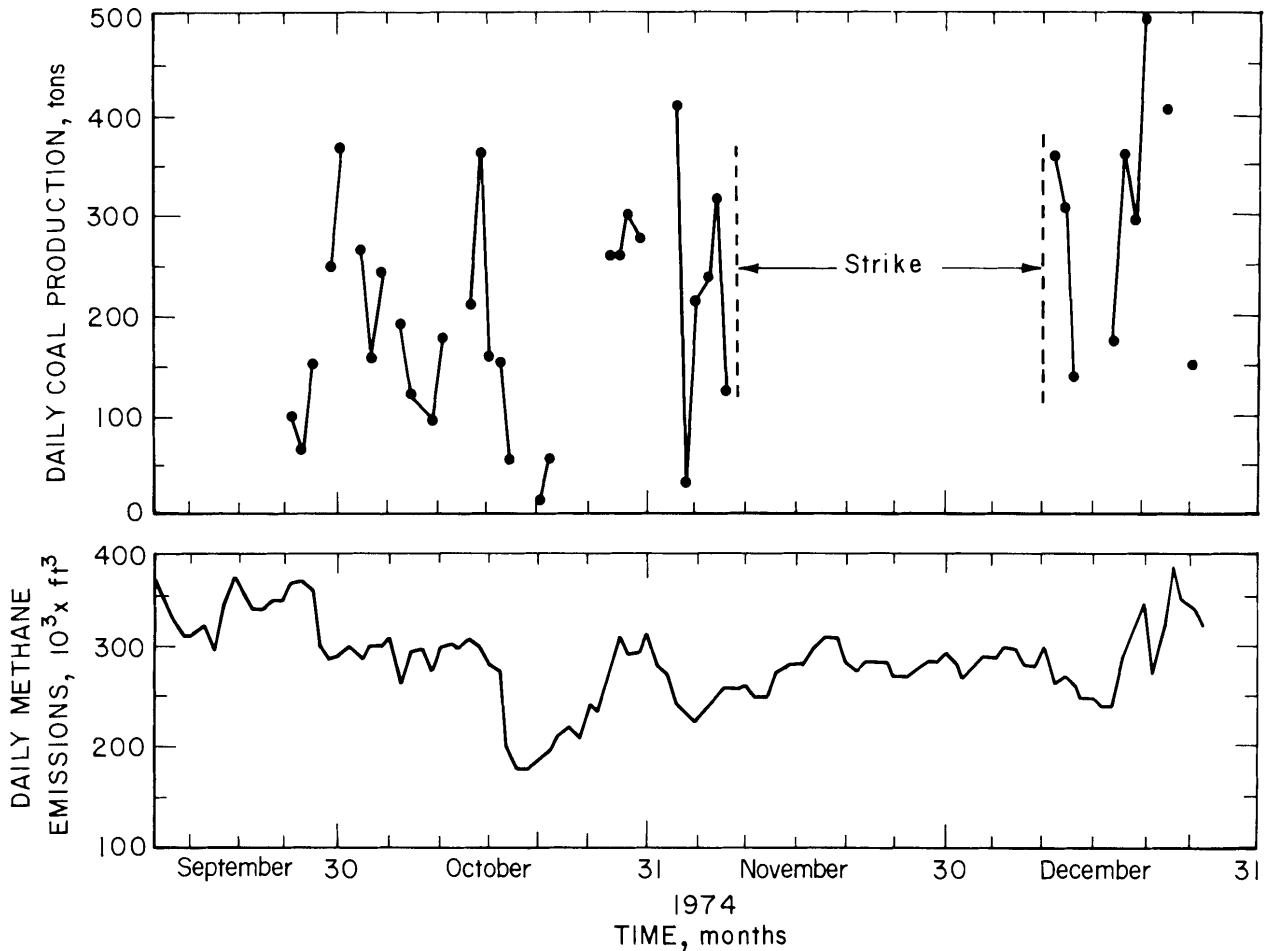
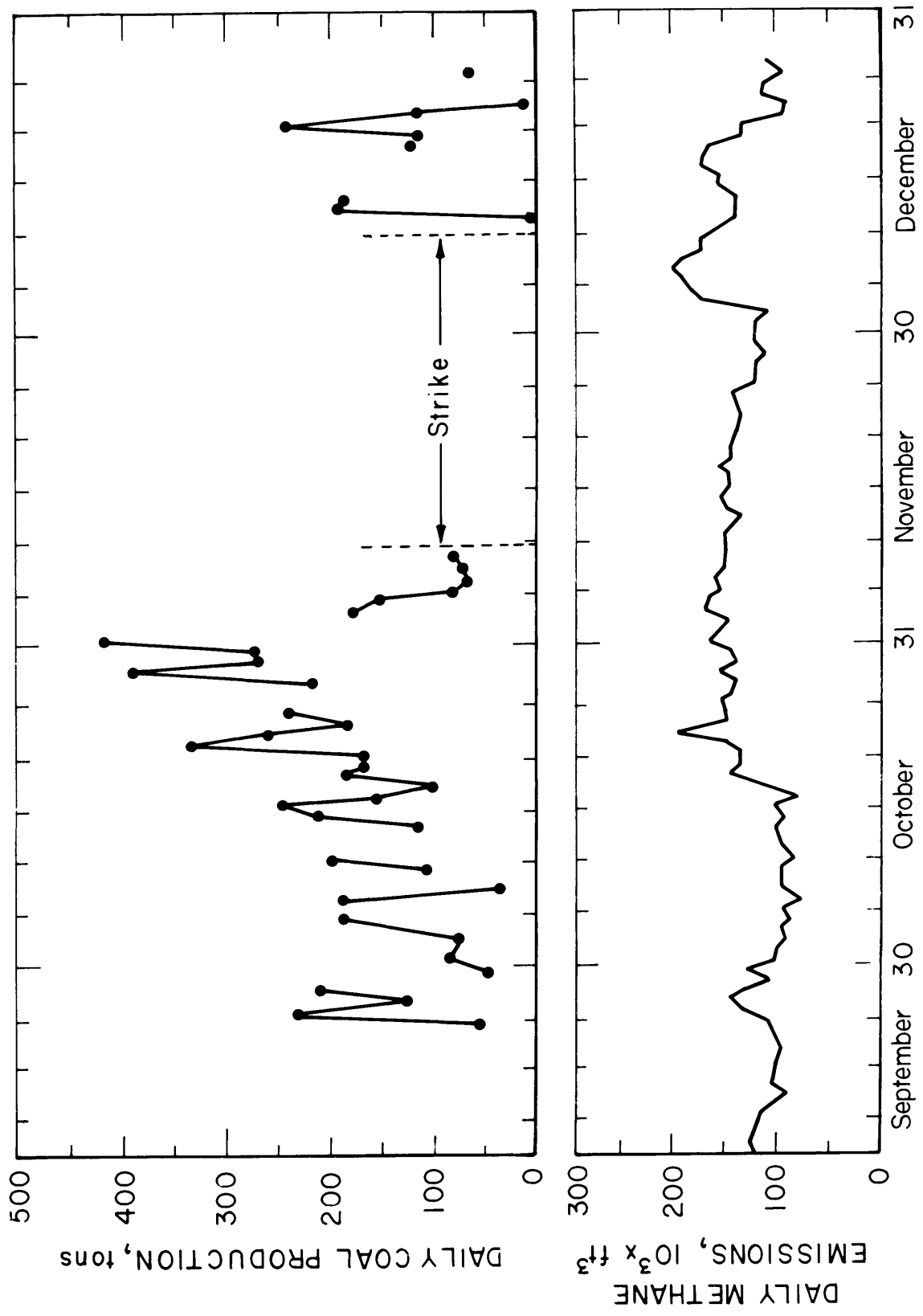


FIGURE 4. - Daily methane emissions and coal production from North mains.

TABLE 1. - Range of daily coal production and daily methane emissions

Section	Days monitored	No. of production, days	Range of coal production, tons	Range of methane emissions, ft^3
North.....	107	43	60 to 500 ¹ 282	180,000 to 380,000 ¹ 289,000
Northwest.....	107	47	50 to 400 ¹ 224	80,000 to 200,000 ¹ 135,000
South.....	107	55	50 to 500 ¹ 361	180,000 to 450,000 ¹ 304,000
South right.....	86	41	50 to 500 ¹ 356	120,000 to 250,000 ¹ 158,000

¹ Daily average.



1974
TIME, months

FIGURE 5. - Daily methane emissions and coal production from Northwest mains.

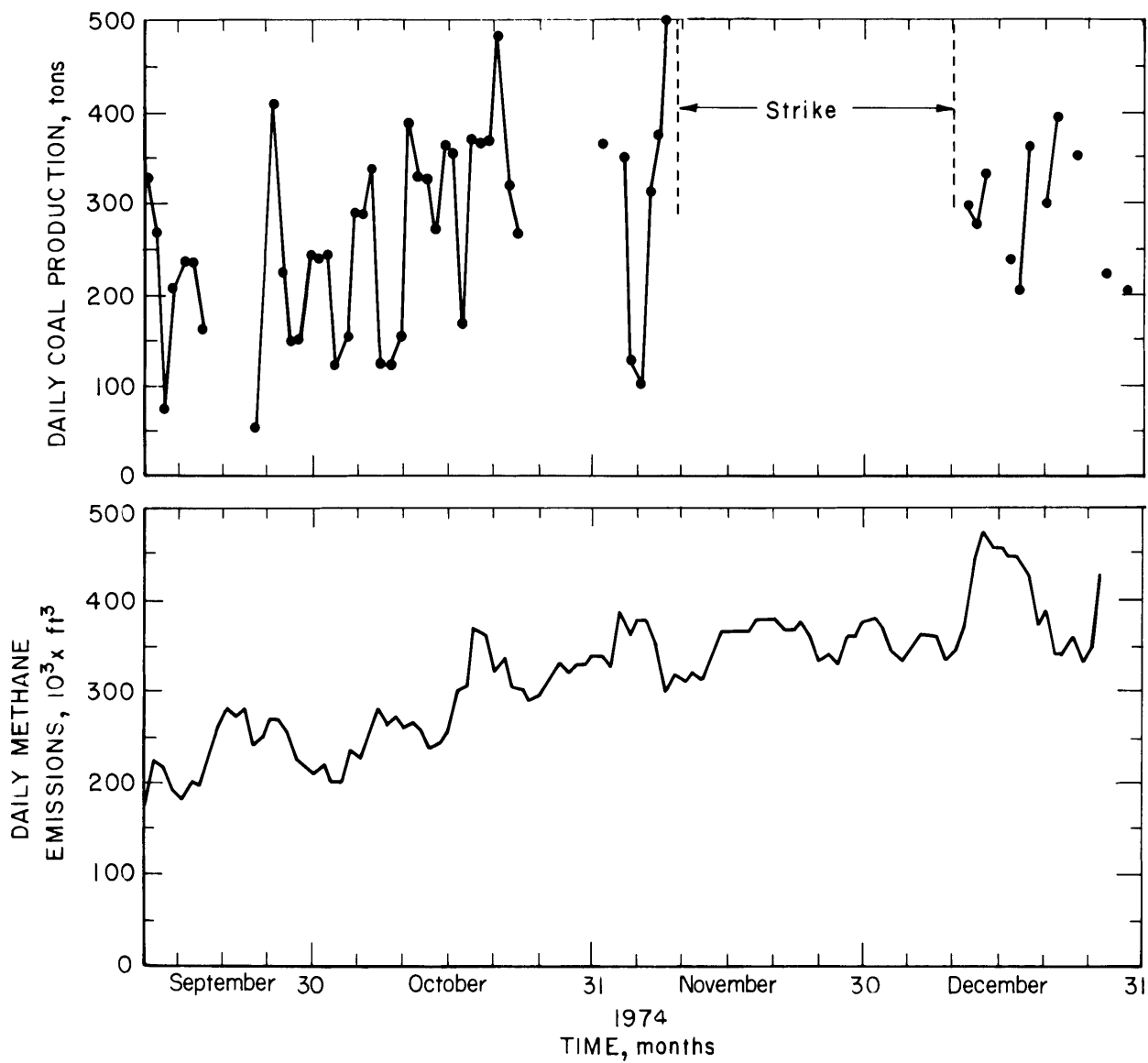


FIGURE 6. - Daily methane emissions and coal production from South mains.

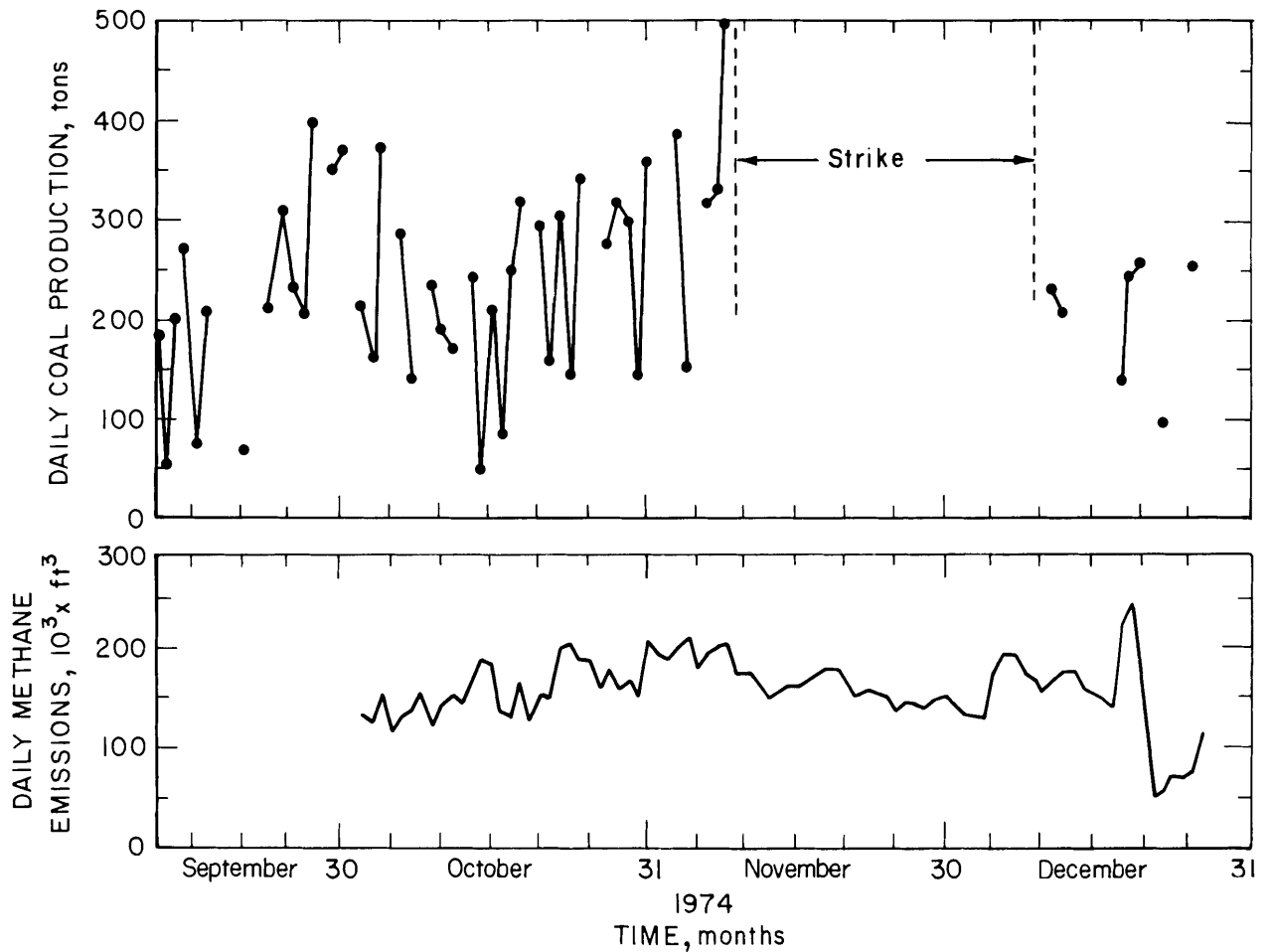


FIGURE 7. - Daily methane emissions and coal production from South right mains.

The South mains section had the highest average coal production and also the highest methane emissions. Its companion section, South right mains, had almost as high an average daily coal production but only about half the emissions. This same relationship exists between the North and Northwest mains. Comparison of the monthly totals of coal production and methane emissions for each section monitored (table 2) shows no correlation between volume of methane emitted and tons of coal produced within each section. Furthermore the plots of the daily methane emissions and daily coal production show no correlation between daily high coal production and high methane emission.

TABLE 2. - Summary of monthly methane emission and coal production

Section	Total coal for month, tons	Total methane for month, ft ³	Total coal, October to December, tons	Total methane, October to December, ft ³
North:				
September.....	564	6.49×10 ⁶		
October.....	6,776	8.37×10 ⁶		
November.....	1,696	8.32×10 ⁶		
December.....	3,092	7.75×10 ⁶	11,564	24.44×10 ⁶
Northwest:				
September.....	750	2.13×10 ⁶		
October.....	7,717	3.65×10 ⁶		
November.....	1,034	4.35×10 ⁶		
December.....	1,014	4.39×10 ⁶	9,765	12.39×10 ⁶
South:				
September.....	2,661	4.53×10 ⁶		
October.....	11,802	8.85×10 ⁶		
November.....	2,214	10.60×10 ⁶		
December.....	3,162	10.30×10 ⁶	17,178	29.75×10 ⁶
South right:				
September.....	(¹)			
October.....	10,536	4.52×10 ⁶		
November.....	2,201	5.17×10 ⁶		
December.....	2,028	3.92×10 ⁶	14,765	13.6×10 ⁶

¹No data.

METHANE EMISSIONS AND OVERBURDEN

Except for North mains, all sections increased their average daily methane emission during the monitoring (table 3). During this time the overburden (fig. 8) above the face increased for all except Northwest mains. The two south sections show an increase of methane emission with increased overburden while the two north sections contradict this. Therefore, no conclusions from these data can be drawn regarding the effect of overburden on methane emissions in this area.

TABLE 3. - Summary of methane emissions and overburden thicknesses

Section	Average daily emissions, ft ³		Average overburden over face, ft	
	Beginning	Ending	Beginning	Ending
South mains.....	200,000	400,000	650	850
North mains.....	350,000	350,000	650	700
Northwest mains.....	100,000	150,000	650	625
South right mains.....	150,000	200,000	750	850

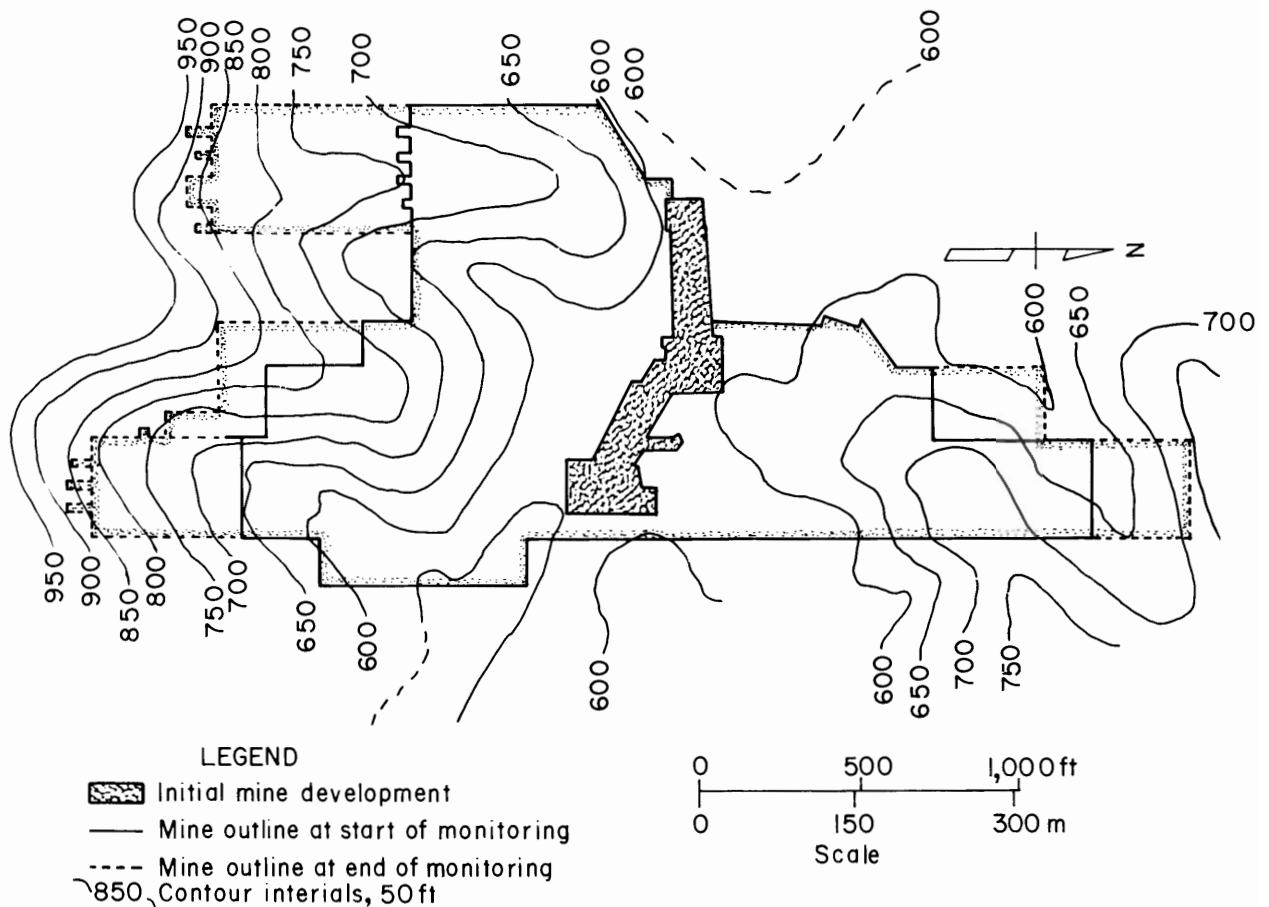


FIGURE 8. - Overburden over Beckley mine development,

METHANE EMISSIONS AND VIRGIN RIBS

At the beginning of the monitoring the North mains had advanced about 1,250 feet beyond the initial development and the South mains had advanced about 1,000 feet. At the end of the monitoring period the North mains had advanced to 1,550 feet and the South mains had advanced to 1,600 feet. The limited advance (300 feet) of the North mains was due to roof control problems. The 250-foot difference in advance into virgin coal at the beginning of monitoring is reflected in a 150,000-ft³/d difference in daily methane emissions. At the end of monitoring the 50-foot difference in advance is reflected in a 50,000-ft³/d difference in emissions. This shows that the section furthest advanced into virgin coal has the highest emissions in both cases.

The virgin rib lengths of each section at the beginning and end of monitoring are summarized in table 4. Tables 3 and 4 show that the South mains doubled average daily emissions after a 690-foot increase in rib length while the North mains showed no increase in methane emissions with a 320-foot increase in rib length. The South mains had fairly regular production and steady advance and the methane emissions rose accordingly. The North mains, with sporadic production and irregular advance, showed no increase in daily methane emissions. This indicates that a steadily advancing section in the Beckley coalbed will exhibit increasing methane emissions.

TABLE 4. - Virgin rib lengths, feet

Section	Start of monitoring	End of monitoring	Increase
North mains.....	2,060	2,380	320
Northwest mains.....	970	1,290	320
South mains.....	2,230	2,920	690
South right mains.....	880	1,200	320

The South right mains and Northwest mains both showed increased methane emissions of 50,000 ft³/d with virgin rib increases of 320 feet. Comparing the South right mains and Northwest mains, almost equal initial rib lengths, increases in rib lengths, and increases in daily methane emissions are noted. Throughout the study interval the South right mains had 50,000 ft³/d more daily methane emission than the Northwest mains. The 50,000-ft³/d difference in methane emissions between these sections is attributed to the relative distances behind their adjacent sections. The Northwest mains, 500 feet behind North mains, mined into a more degasified area of the Beckley coalbed than did the South right mains, which started only 100 feet behind the South mains.

The four sections monitored can be grouped into two sets of 10 entries, one driving north, and the other south. Each of these consists of two 5-entry sections in which one section is advancing into virgin coal and the other is following between 100 and 500 feet behind. Krickovic, Findlay, and Merritts (4) found that comparing two working places in the Pittsburgh coalbed, one adjacent to old workings, produced 32 ft³/min less methane for twice as much coal as one mining into virgin coal. In the Beckley coalbed the data show that the following section, mining coal partially degasified by the advance section, has about half the emissions of the advancing section.

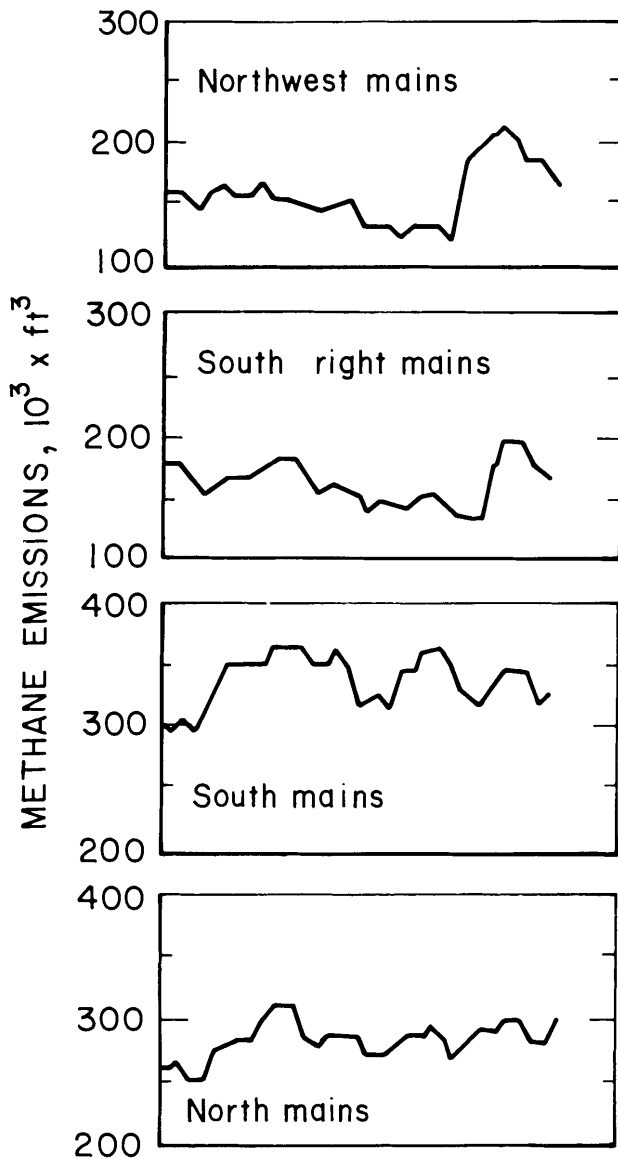


FIGURE 9. - Daily methane emissions from monitored sections during strike.

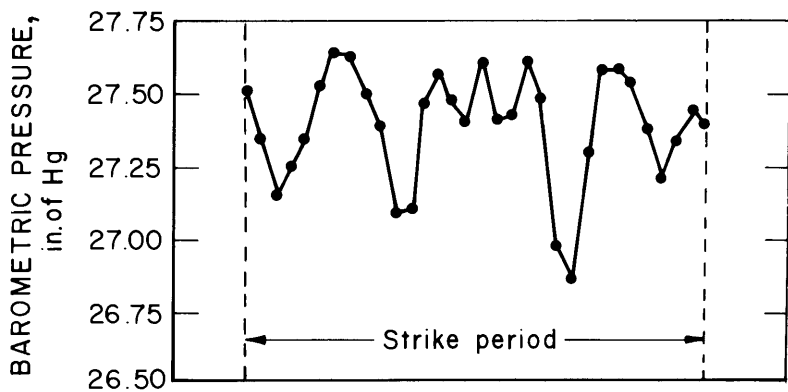
are not explained by the daily barometric pressure variations (fig. 10); the largest barometric change of 0.7 inch mercury (November 30 through December 4) had no effect on methane emission from any section. The variations in daily methane emissions observed during idle time remain unexplained.

METHANE EMISSIONS DURING 32-DAY STRIKE

A 32-day strike took place at the Beckley mine during the 107-day monitoring period. Methane emission was monitored continually for all four sections during this idle time (fig. 9). The graphs show that the North mains and the South mains, both driving into virgin coal, had no decline in emissions during the strike. The Northwest mains and the Southwest mains driving parallel to, but behind the North and South mains, had lower gas emissions with a slight decline except for a slight peak at the end. This indicates that methane emissions from the ribs will be long lasting and that advance degasification can effectively control emissions into the return airways. The slight decline in the following sections indicates that rib emissions do decline but data are insufficient to estimate the rate of decay.

Jeran (3) reported that in the Pittsburgh coalbed the methane emissions from an advancing section can be explained by the length of virgin rib. The data gathered during this monitoring, while not sufficient to demonstrate the excellent correlation previously observed, show that in the Beckley coalbed methane emissions increase with increased length of virgin rib.

During the 32-day strike, the daily methane emissions were not constant or regular. These variations



METHANE LAYERING IN BECKLEY MINE

During the monitoring period, an experiment was set up to determine if methane emitted from an active section was layering in the return airway. The South mains were chosen for this experiment because mining was fairly rapid and gas emissions were increasing steadily. Three methane sensors were placed in the center of the left return

FIGURE 10. - Daily barometric pressures from weather station at Beckley, W. Va.

airway, approximately 140 feet from the active face. One sensor was 15 inches below the roof, another 15 inches above the floor, and the third midway between, 3 feet from the floor.

Recordings taken from the sensors for 30 days while the section was advancing show that the methane was well mixed in the return air by the time it reached the sensors. At no time during the experiment did the methane concentration exceed 0.35 pct methane (fig. 11).

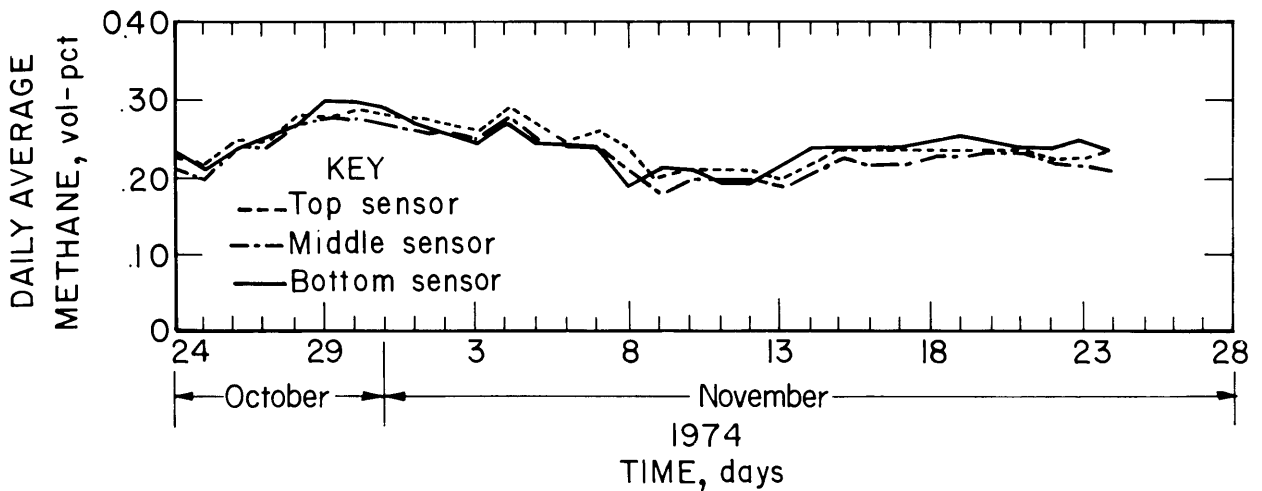


FIGURE 11. - Daily methane emissions from three sensors in layering experiment.

CONCLUSIONS

The 107-day monitoring of the four sections in the Beckley mine showed that the coal production rate cannot be used as a parameter to explain methane emission; that sections advancing steadily into the virgin Beckley coalbed will have increasing methane emissions; that the driving of a section into virgin coal partially degasifies the coal resulting in lower emissions from a following parallel section; and that rib emissions from the Beckley coalbed are slow to decline and not affected by normal barometric pressure variations (0.7 inch of mercury).

RECOMMENDATIONS

This study is the first long-period monitoring of methane emissions from the Beckley coalbed in a heretofore unmined area. Based upon the data gathered, it is recommended that companies planning new mining in this area seriously consider some technique of degasification of the coalbed in advance of mining to decrease and control the level of methane emission into mine workings.

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