**RI** 8195

Bureau of Mines Report of Investigations/1976

# Longwall Gob Degasification With Surface Ventilation Boreholes Above the Lower Kittanning Coalbed

UNITED STATES DEPARTMENT OF THE INTERIOR

Report of Investigations 8195

# Longwall Gob Degasification With Surface Ventilation Boreholes Above the Lower Kittanning Coalbed

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March 3, 1849

UNITED STATES DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe, Secretary
BUREAU OF MINES
Thomas V. Falkie, Director

This publication has been cataloged as follows:

Moore, T D

Longwall gob degasification with surface ventilation boreholes above the Lower Kittanning coalbed / by T. D. Moore, Jr., Maurice Deul, and Fred N. Kissell. [Washington] : Bureau of Mines, 1976.

13 p. : ill., diagrs. ; 26 cm. (Report of investigations • Bureau of Mines ; 8195)

Bibliography: p. 13.

1. Mine ventilation. 2. Methane. I. Deul, Maurice, joint author. II. Kissell, Fred N., joint author. III. Title. IV. United States. Bureau of Mines. V. Series: United States. Bureau of Mines. Report of investigations • Bureau of Mines ; 8195.

TN23.U7 no. 8195 622.06173

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## ILLUSTRATIONS

# LONGWALL GOB DEGASIFICATION WITH SURFACE VENTILATION BOREHOLES ABOVE THE LOWER KITTANNING COALBED

by

T. D. Moore, Jr.,[1] Maurice Deul,[2] and Fred N. Kissell[3]

## ABSTRACT

Methane emission from two surface gob-degasification boreholes was measured by the Bureau of Mines. The investigation took place during mining of a 3,200-foot longwall panel in the Lower Kittanning coalbed in central Pennsylvania. The first hole was 500 feet from the start of mining, and the second hole was 2,200 feet. The first hole went on natural draft as soon as the longwall face passed it. This caused the methane flow in the return entries to drop 75 pct. In the 6 months required to complete the panel, the two holes emitted 69 MMcf of methane in varying percentages of concentration in air. In 3 years, the holes emitted a total of 150 MMcf of methane.

## INTRODUCTION

Methane is contained under pressure within the micropores and fractures of coalbeds and in the adjacent strata. It is released into the mine atmosphere during working of the bed and must be removed either in advance of or during mining to prevent the formation of explosive gas-air mixtures (1, 4-5, 7-8).[4] The removal of methane by conventional ventilation is particularly difficult in longwall mining of gassy coalbeds. As mining progresses in a longwall, the overburden continually fractures, and the immediate roof caves directly behind the roof support units. Thus, the gob is always near the coal face, and any methane-bearing material in the overburden adds to the methane released from the coal during mining.

Air losses at the longwall face also create problems. A considerable amount of air can escape into the gob as it is coursed along the face, making ventilation of the face zone at the return end of the face especially difficult. To supply sufficient air, a considerable flow rate must be maintained at the intake end.

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[2] Supervisory geologist.

[3] Physical research scientist.

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

In most coal mines, the methane dilution requirements of the Federal Coal Mine Health and Safety Act of 1969 can generally be met by providing bleeder entries with adequate pressure differentials across the gob. However, where emissions of gob methane are unusually high, the bleeder system must be supplemented with one or more surface gob-degasification boreholes drilled prior to mining (6). Some earlier work on the subject of degasification has been reported by Ferguson (2-3).

This Bureau of Mines report details results from two such boreholes drilled over a mine located in the Lower Kittanning coalbed in Cambria County, Pa., where gob-degasification holes must be used on a regular basis.

## DESCRIPTION OF STUDY AREA

### Mining Plan

The block of coal to be mined by a retreat longwall system was bounded on each side by a set of panel entries (7 Left and 8 Left) and on the ends by D West and E West mains (fig. 1). The block was 570 feet wide, 3,200 feet long, and 58 inches thick. The three entries of 7 Left and 8 Left panels were mined on 80-foot centers, with cross entries on 100-foot centers. All entries were 18 feet wide. The middle 7 Left entry was used as a trackless haulway for workers, supplies, and equipment to the longwall face, and as a return when the longwall face was retreated past the first cross entry connection to the gob.

At the start of the study on September 20, 1971, the longwall face had been retreated 360 feet and was 140 feet from the first surface borehole (borehole 20, fig. 1). At the end of the study on September 30, 1971, the face was 85 feet past this borehole.

### Stratigraphy

The overburden at the study area was 600 to 700 feet thick and consisted of carbonaceous shales, argillaceous carbonaceous sandstones, some argillaceous limestones, and a number of coalbeds. The immediate roof strata comprised 7 inches of bone and coal and 9 feet of dark, sandy shale. The immediate 4 feet of floor was fire clay with coal and shale partings.

McCulloch and Deul (5) have reported that the amount of gas emitted directly from the Lower Kittanning coal into the mine working is known to be small. During development and in preparation for installation of longwall mining equipment, methane emission rates are very low. In one methane emission study in a development section, only 23 cfm of methane was measured. In contrast, when longwall mining was being conducted, methane emission rates rose to 1,500 cfm from a single section. This additional methane mostly originates in the overburden. Four other coalbeds, Upper and Middle Kittanning and Upper and Lower Freeport, are in close proximity to the mined Lower Kittanning coal, and these are known to be gassy. The result is a much higher proportion of methane from the overburden than is common in most mines.

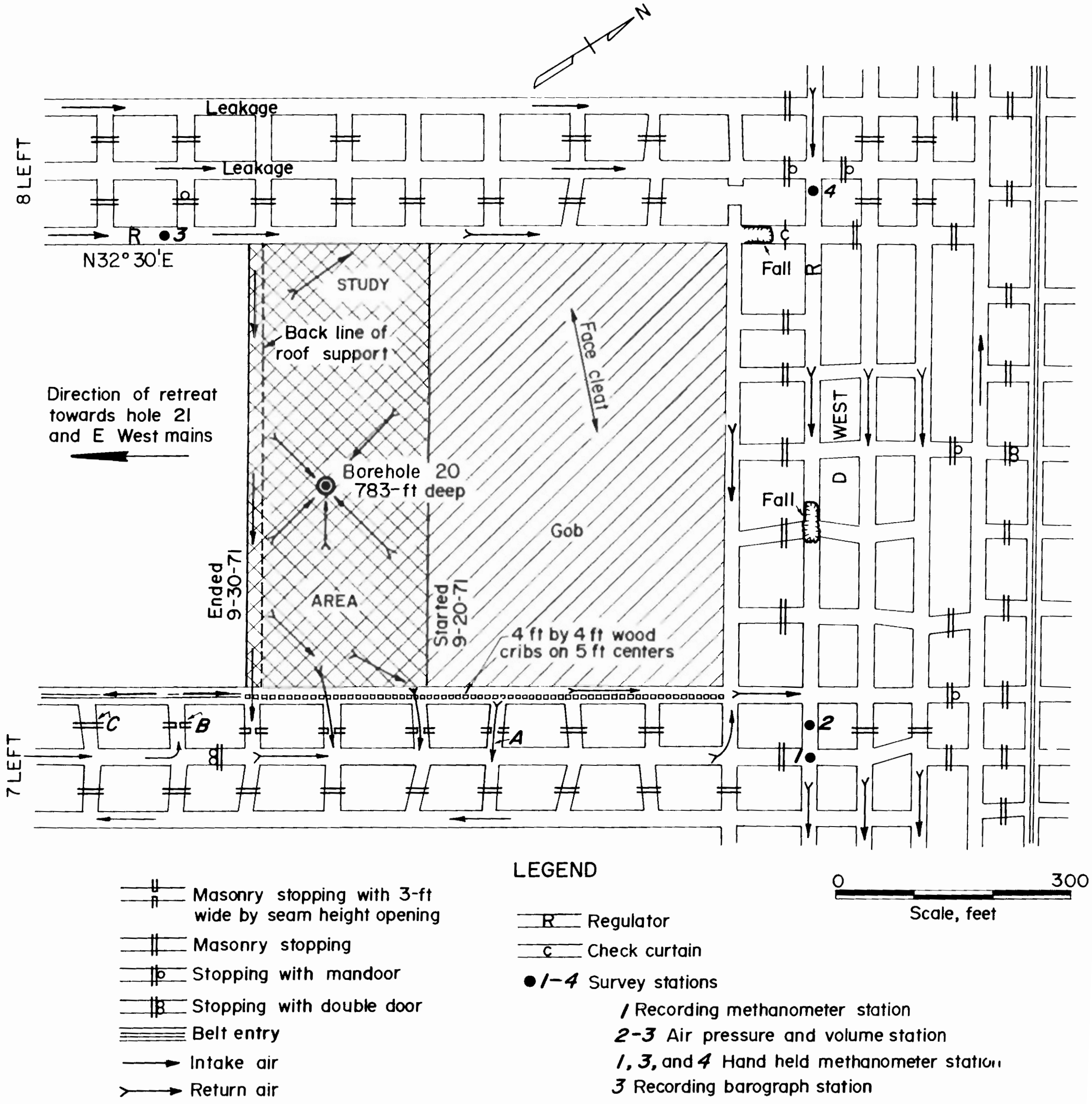

FIGURE 1. - Map of study area.

## Equipment

A double-drum bidirectional shearer was used to mine 52 inches of the 58-inch-thick coalbed. A chain conveyor received the coal along the face and discharged it at the head end onto a mother-chain conveyor in the closest 7 Left entry. From there the coal was discharged onto a rope-frame, 36-inch belt conveyor that loaded into mine cars.

The roof was supported by hydraulic self-advancing steel props. Each unit consisted of four 42-ton-capacity steel props mounted on a rigid base and topped with shielded steel beams. The units were paired to operate as an eight-prop chock, spaced on 42-inch centers across the face. Coal production ranged from 2,100 to 3,800 tpd.

### Ventilation

The flow distribution, the range of air and methane volumes, and the pressure differential across the gob are shown in figure 2. The primary air split that ventilated the section was conducted across the face from the tail end at 8 Left to the head end at 7 Left.

A regulated secondary intake of approximately 3,000 cfm was conducted in the middle entry of 7 Left to the head end. Most of the return air flowed to D West through the middle entry of 7 Left and the 7 Left edge of the gob, which was cribbed. The D West return air split joined the longwall return air in the main return entries at 7 Left and 8 Left. The maximum pressure differential between intake station 3 and return station 2 was 0.17 inch of water.

A feature of the ventilation system was a row of timber cribs at the edge of the gob that were installed one by one at the head end of the longwall face as it retreated. Their purpose was to provide a high-permeability path for the return air at the gob edge (fig. 1). This allowed ventilation air to dilute gob methane before it entered accessible areas of the mine. In this way, the methane concentrations in accessible areas near the gob could be kept low enough to meet regulations.

Airflow across the face and through the row of cribs was controlled by alternately opening and closing stoppings adjacent to the head entry (fig. 1). The closed stoppings near the gob in 7 Left confined the gob gasses and permitted bleeding through the cribbed entry. The four open stoppings in the same row allowed ventilation of the active face and the adjacent gob to the middle 7 Left entry. As the panel was retreated to cross entry B, the opening in cross entry A stopping was closed, and stopping C was opened to airflow. This procedure was followed, with the system as shown in figure 1, until the panel was mined out.

The masonry stoppings were constructed with 3- by 5-foot openings into which cement blocks could be easily fitted. The blocks were removed and replaced as needed.

## TEST PROCEDURE

### Surface Degasification Boreholes

Before longwall mining was started in the study panel, surface borehole 20 was drilled to a depth of 783 feet, which was 1 foot below the bottom of the Lower Kittanning coalbed (fig. 3). Because of the rough surface topography, borehole 20 was located 500 feet from the back edge of the gob instead of the usual 300 to 400 feet. An 8-inch-ID steel casing was installed in the

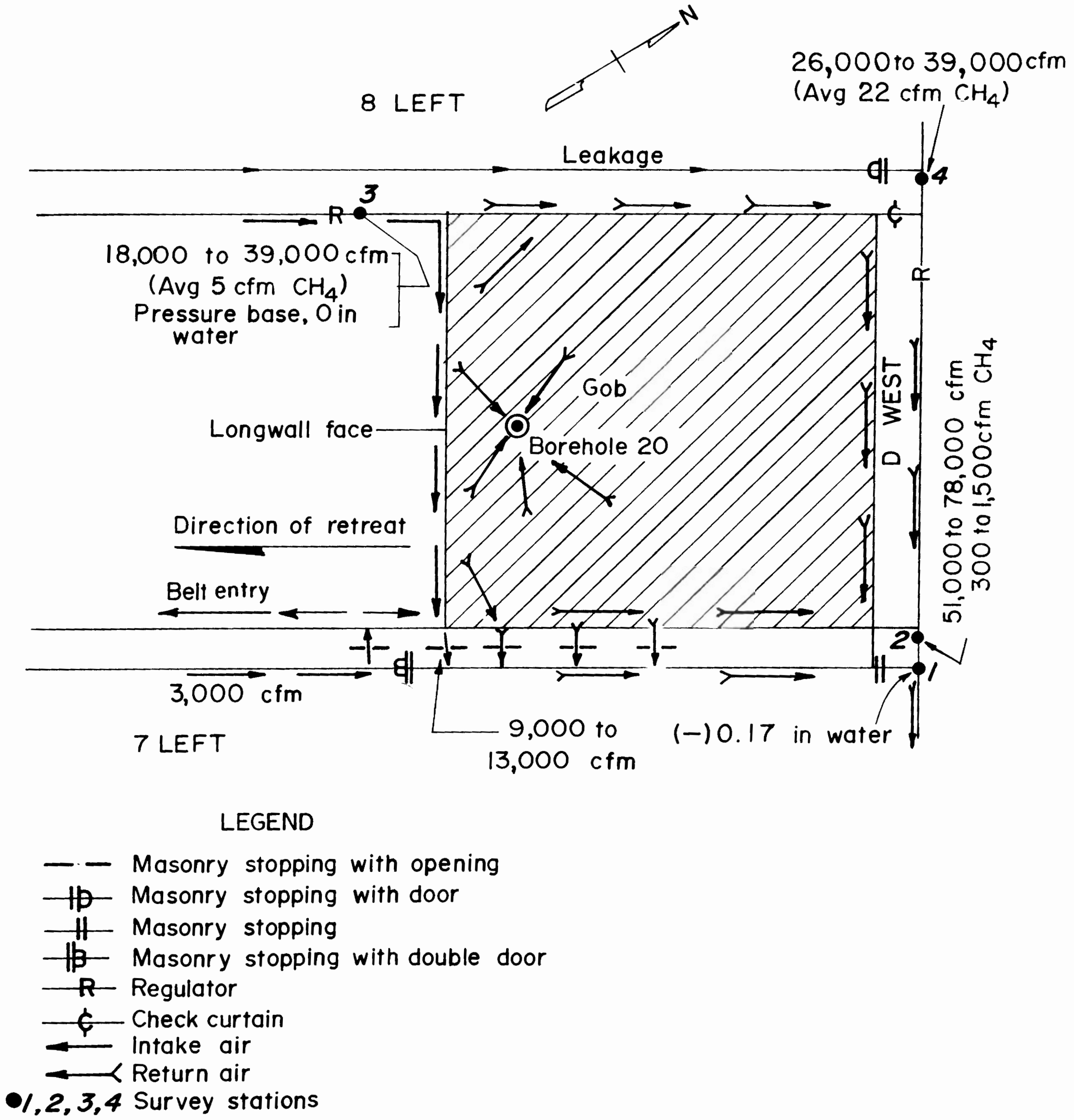

FIGURE 2. - Ventilation schematic of study area.

hole to 760 feet. The lowermost 119 feet of the casing was ungrouted in the lower portion of the hole and served to prevent hole collapse as the mine roof was caved. It was slotted to provide easy access to gas emerging from all levels within the 119-foot interval. Most of the gob methane entering the mine probably originated in this region. Both the Middle and Upper Kittanning coalbeds, located 25 and 100 feet above the mined Lower Kittanning coal, were

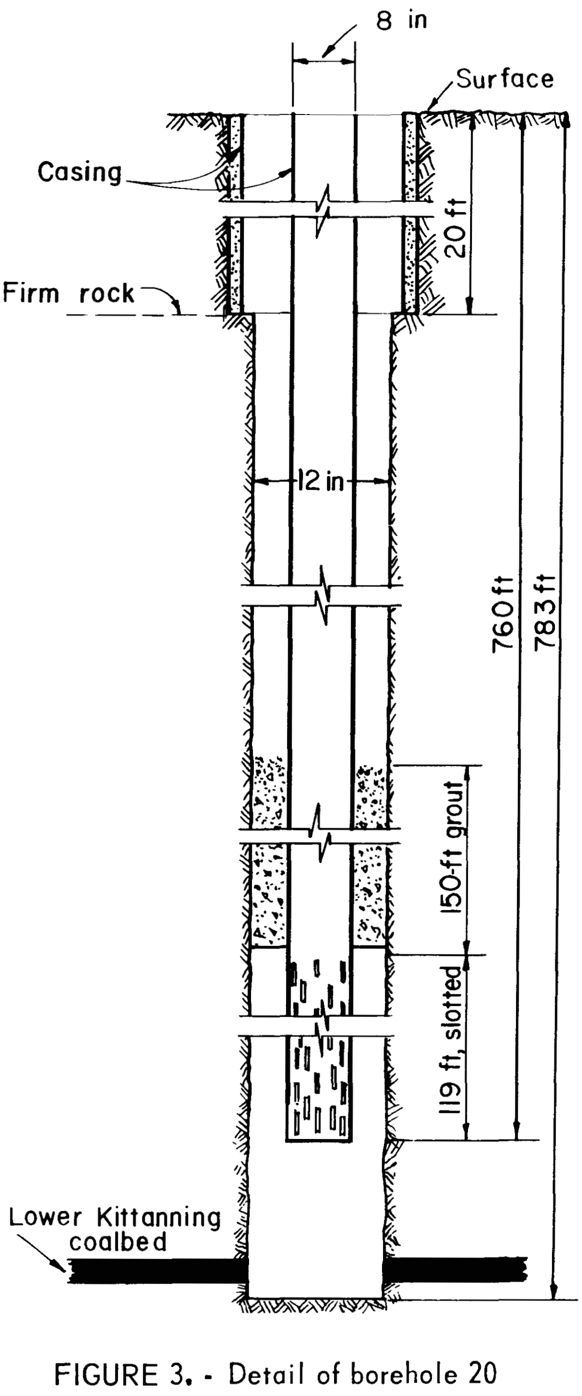

FIGURE 3. - Detail of borehole 20 completion.

here. One object in the borehole completion procedure was to try to locate the top of this open portion as high as possible in order to bleed off methane from the highest possible point in the cavity created by caving in the mine. However, at the same time, it was necessary to stay below water bearing strata.

Above the open portion, 150 feet of the hole were grouted to maintain the position of the casing and protect against intrusion of water. Still higher, the upper portion of the casing was not grouted. This was to avoid the casing breakage that can occur when the mine roof is caved and the strata around the borehole subsides. The standpipe of the hole was equipped with a check valve to prevent airflow from the surface to the mine. Surface borehole 21 (565 feet deep) was drilled 1,700 feet from hole 20 and completed in a similar manner.

## Underground Monitoring

A recording methanometer installed at station 1 continuously measured the total methane from the longwall section and from D West development (fig. 2). At stations 2 and 3, ventilation pressures were measured with an altimeter, and air velocities were measured with an anemometer. A recording microbarograph located at station 3 during each monitoring shift recorded barometric changes and underground pressure changes caused by interferences to normal airflows. Handheld methanometer readings were taken at 15-min intervals at stations 1 and 3, and methanometer and anemometer readings were taken occasionally at station 4 in D West. The accuracy of the methanometers was checked by laboratory analysis of bottle samples. All monitoring was performed on the day shift (8 a.m. to 4 p.m.) for 5 days prior to mining under borehole 20 and for 3 days after the hole was intersected and had become productive.

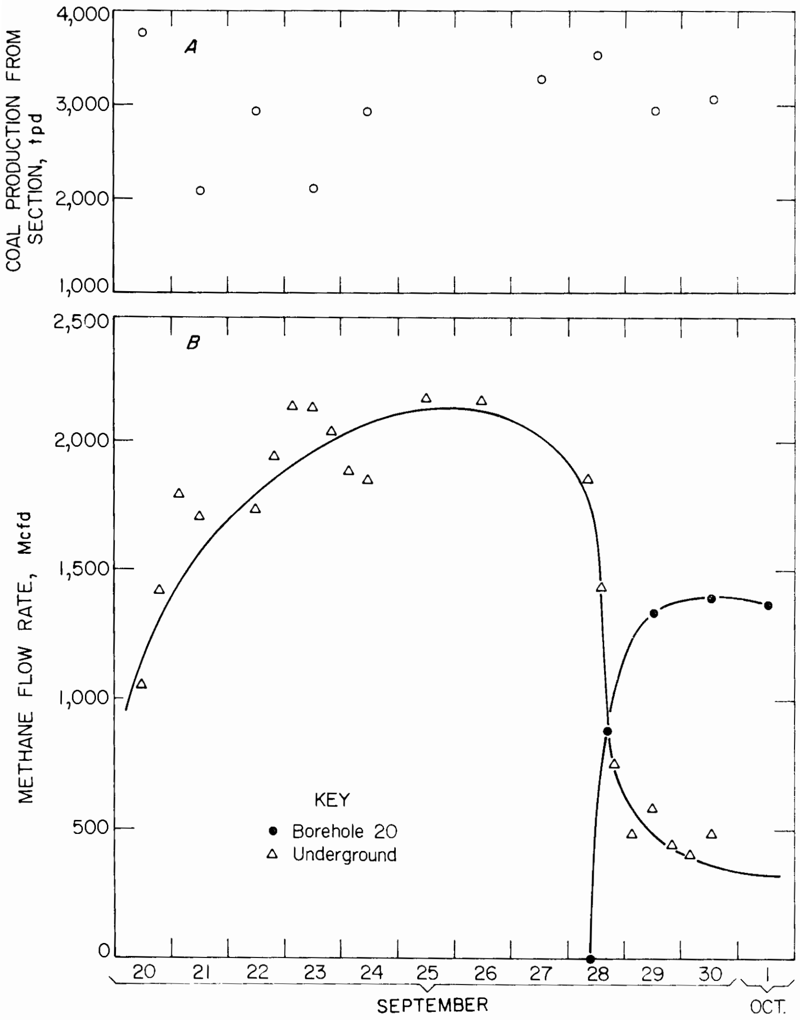

FIGURE 4. - Borehole effectiveness. *A*, Coal production from section; *B*, methane flow from section and methane flow from borehole 20.

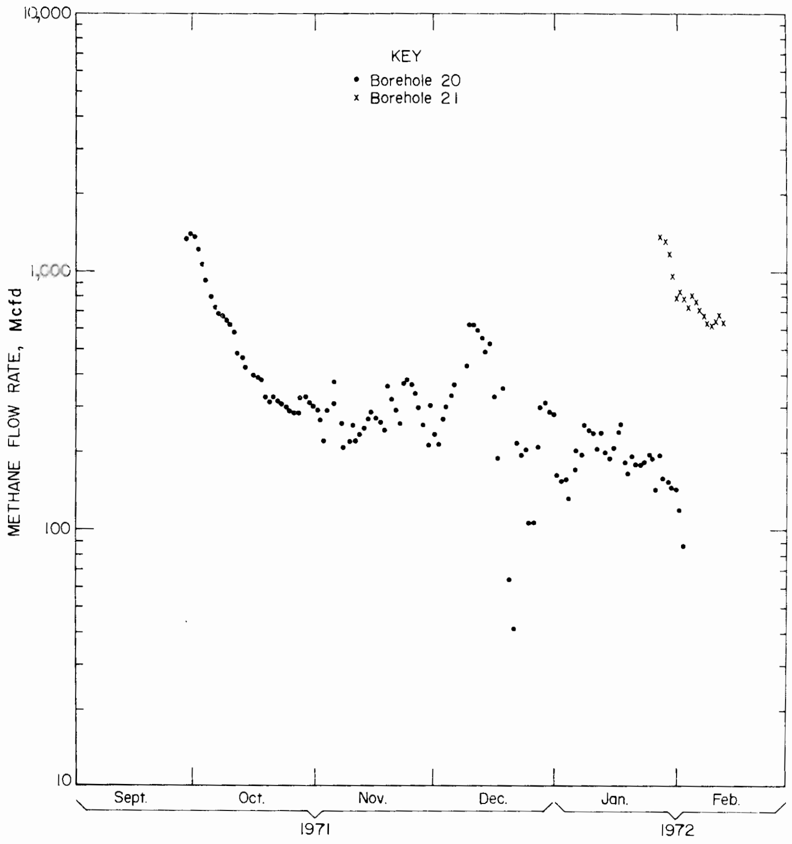

FIGURE 5. - Methane flow from boreholes 20 and 21.

## RESULTS

A surface borehole becomes useful only after mining passes the hole. Until that time, all the methane must be handled by the mine ventilation system. On September 28, borehole 20 was uncapped after the longwall face had reached it (fig. 4), and underground methane flow from the longwall section dropped 75 pct. Underground monitoring could not be continued beyond September 30 because a strike began on October 1. However, surface monitoring of the borehole continued (figs. 5-6).

During October and November, flow from the borehole was by natural draft alone. Methane flow started at about 1,400 Mcfd and drifted down to about 300 Mcfd over a 5-month period. The methane level in the effluent drifted from an initial 100 pct to about 45 pct.

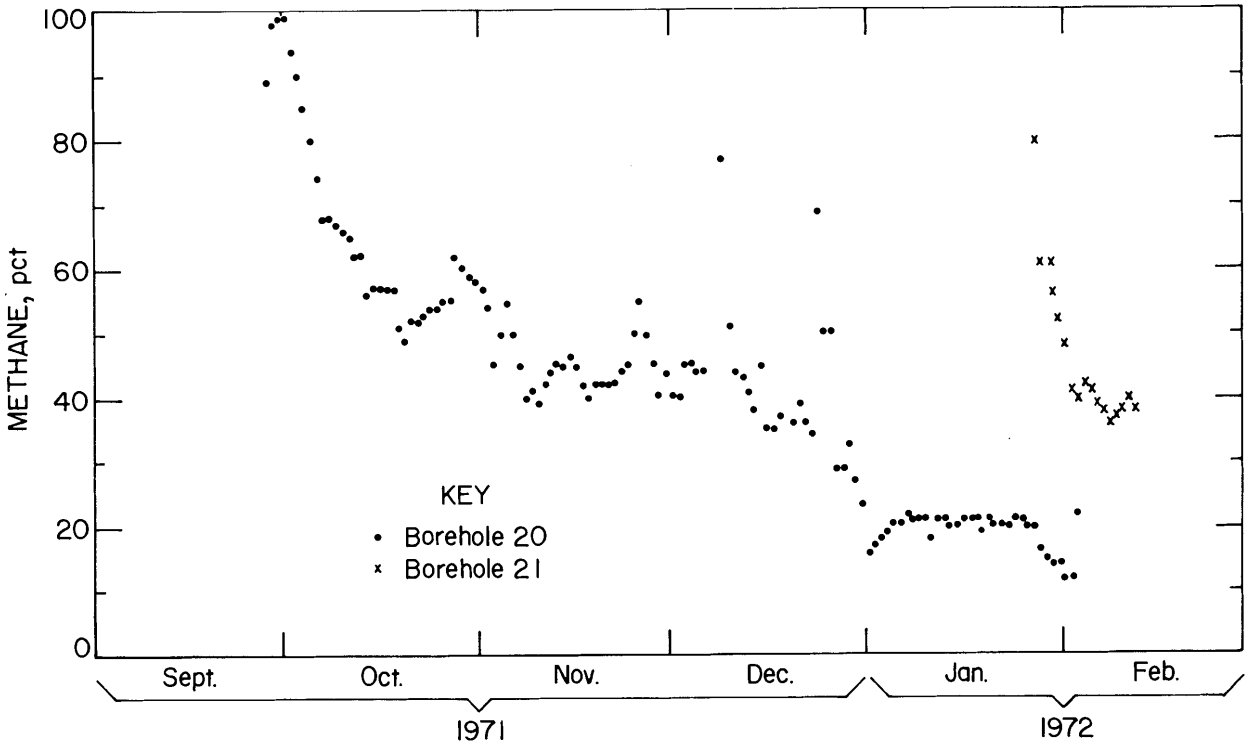

FIGURE 6. - Effluent methane concentrations–boreholes 20 and 21.

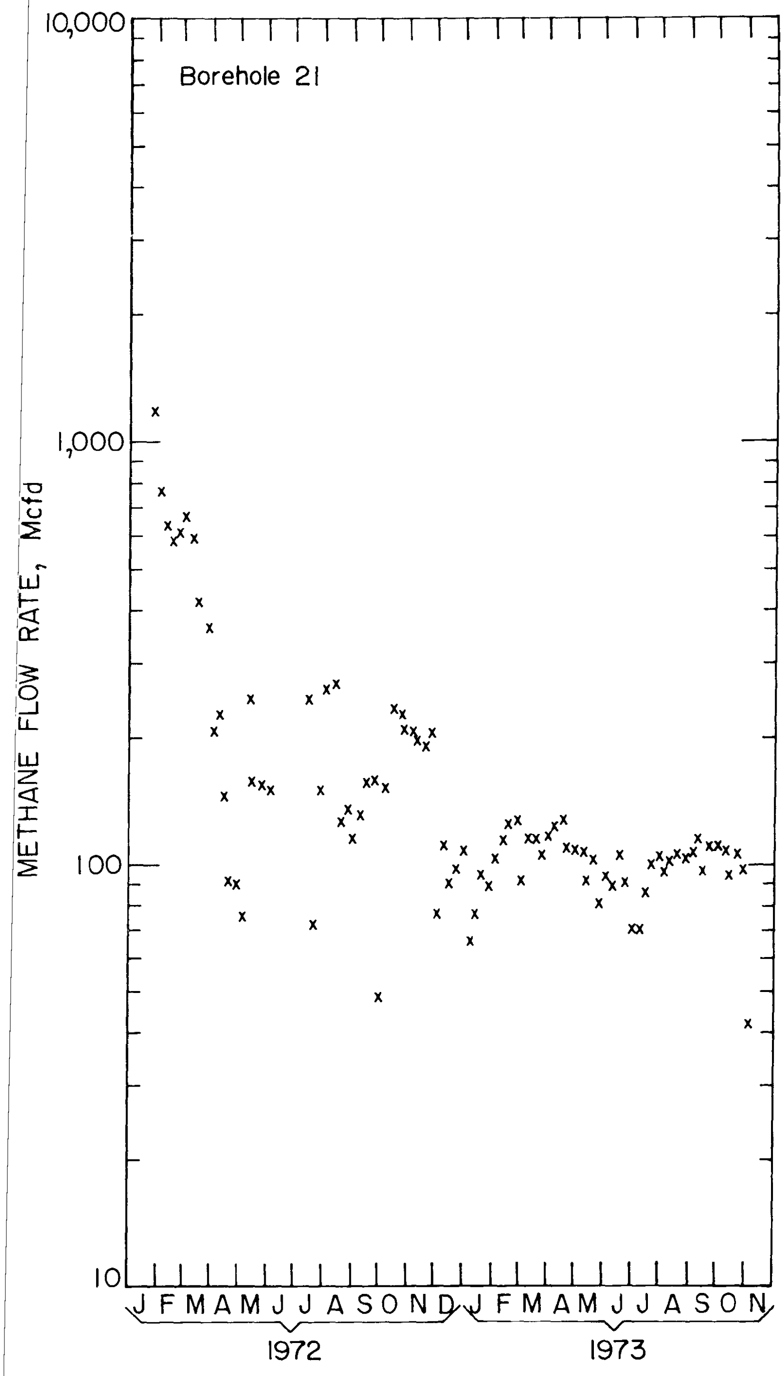

FIGURE 7. - Methane flow from borehole 21.

At the end of November, the strike ended. Mining of the longwall face resumed and, at the same time, an exhauster[5] was connected to the borehole at the surface. This combined action raised the borehole flow for a week, but it soon returned to earlier levels (fig. 5). The methane concentration in the borehole effluent continued to drift downward (fig. 6). Borehole 20 valve was closed at the end of January when the effluent concentration dropped below 25 pct methane. Periodic testing during February and March still indicated low methane concentrations in the effluent, so this hole was permanently sealed.

At the end of January, the longwall face intersected the second borehole (borehole 21), which was then uncapped. The flow from this hole was initially 1,000 Mcfd at 80 pct methane, but it soon began to drift downward (fig. 5-6).

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[5] The exhauster was a centrifugal blower, and the vacuum was generally between 17 and 35 inches of water.

Mining of the panel was completed in March 1972, only 5 weeks after the hole (borehole 21) had been put into service. Nevertheless, the borehole continued to emit methane for the next 2 years. Flow and concentrations during 1972 and 1973 are shown in figures 7 and 8. The hole was equipped with an exhauster for the entire period. In 1972, methane flow dropped to 200 Mcfd, and the effluent concentration was about 35 pct; in 1973, the flow dropped and the concentration rose.

Cumulative methane amounts for both boreholes are given in figures 9 and 10. While in service, borehole 20 yielded 40 MMcf methane; up to December 1973, borehole 21 yielded 110 MMcf methane. In 1974, borehole 21 declined substantially, and by July 1974, the flow was only 32 Mcfd.

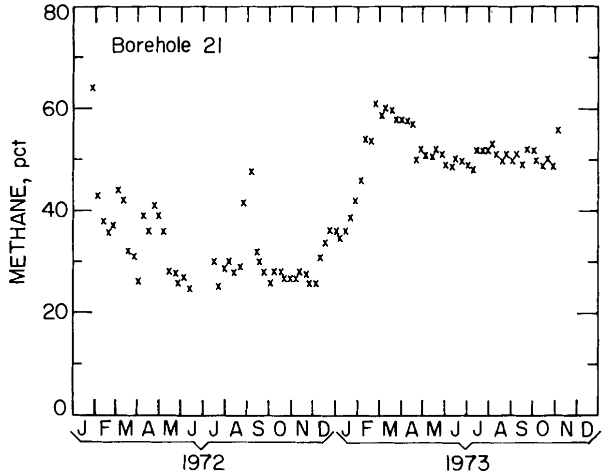

FIGURE 8. - Effluent methane concentrations—borehole 21.

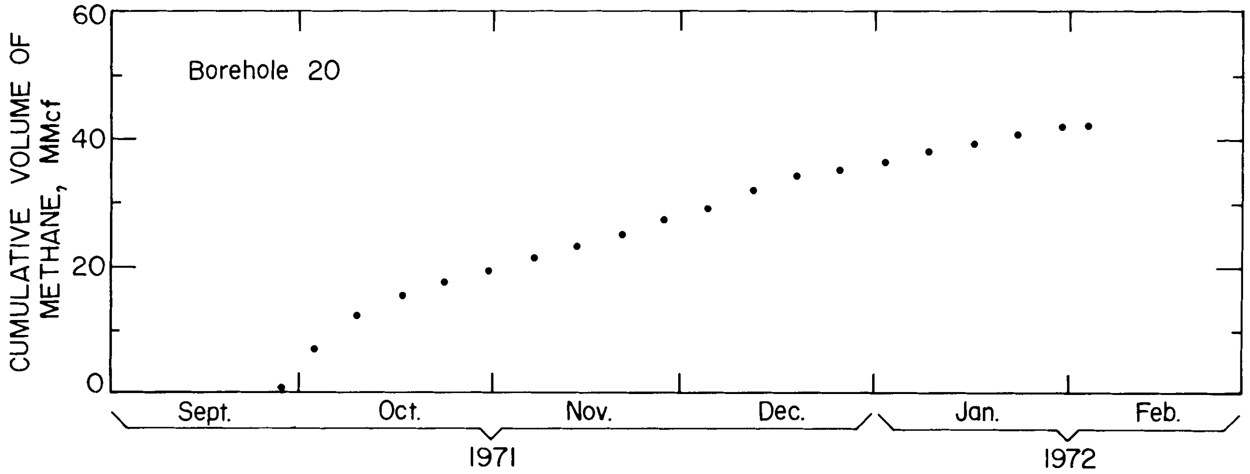

FIGURE 9. - Cumulative volume of methane from borehole 20.

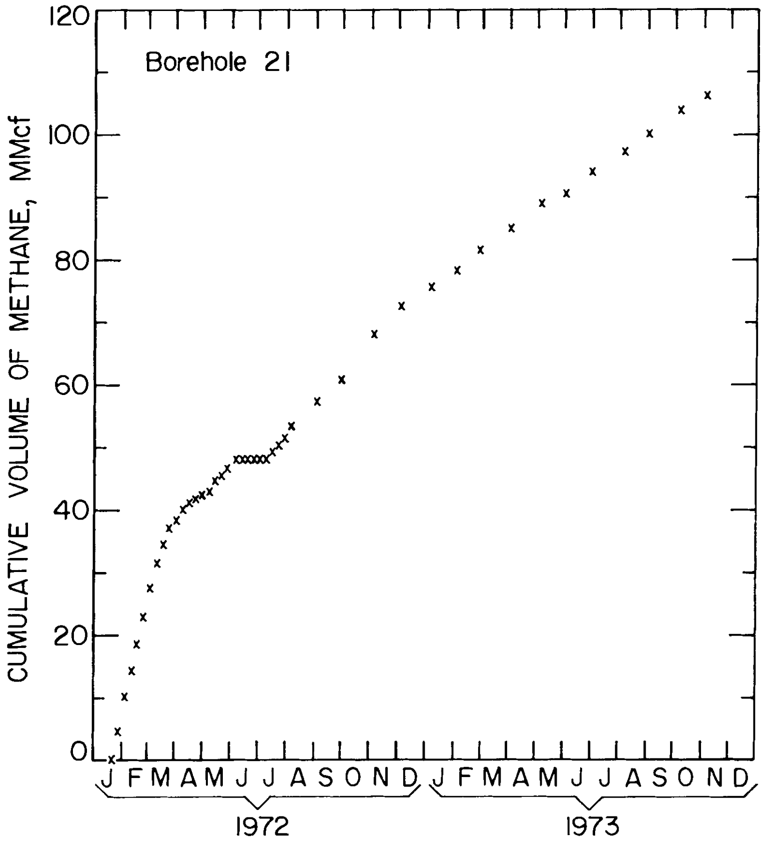

FIGURE 10. - Cumulative volume of methane from borehole 21.

## ANALYSIS

The effectiveness of surface boreholes in draining off methane that otherwise would have to be removed by the ventilation air is evident in figure 4, where uncapping borehole 20 produced an immediate 75 pct decrease in the underground methane flow from the section. Methane levels were too high to allow us to shut off a hole temperarily as an experiment to see what increase in underground flow would result; however, when borehole 20 was finally shut down, the section had to be idled for 5 shifts due to high methane levels in the returns. These levels occurred notwithstanding the fact that borehole 21 was already producing 1 MMcfd (fig. 5).

Had the surface boreholes not been in operation, the ventilation air would have had to be boosted from the 20-30 Mcfm shown in figure 2 to as much as 75 Mcfm across the face. Under those conditions, allowing for the normal overhang and the considerable obstruction created by the self-advancing hydraulic jacks, the face conveyor, and the coal-shearing machinery, the air velocities at times across part of the face would exceed 2,000 fpm. This would be intolerable for the workers and would disperse excessive amounts of coal dust.

The company usually locates the first surface gob-degasification borehole about 300 to 400 feet from the start of longwall retreat. However, because of the terrain, hole 20 could not be located closer than 500 feet. This delayed the time until hole 20 became productive and resulted in some very high underground methane flows between September 21 and 27 (fig. 4), but subsequently the methane control system functioned successfully.

In general, both holes started with high methane flows and high methane percentages in the effluent; within a few weeks, both flow and concentration declined substantially. Large fluctuations in flow and concentration took place on a week-to-week or even day-to-day basis.

## CONCLUSIONS

Gob degasification through surface boreholes permits high-production mining of the Lower Kittanning coalbed. Without the surface drainage described here, an additional 150 MMcf of methane would have had to be diluted and carried out of just one section of the mine by the underground ventilation system. This would have necessitated increasing airflows to unreasonably high levels.

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