RI 8459

Bureau of Mines Report of Investigations/1980

Three Coal Mine Gob Degasification Studies Using Surface Boreholes and a Bleeder System

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UNITED STATES DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
Lindsay D. Norman, Acting Director

This publication has been cataloged as follows:

Maksimovic, S D

Three coal mine gob degasification studies using surface boreholes and a bleeder system.

(Report of investigations ; 8459)
Supt. of Docs. no.: I 28.23:8459.

1. Coal mines and mining—Safety measures. 2. Mine gases. 3. Mine ventilation. I. Kissell, Fred N., joint author. II. Title. III. Series.

TN23.U43 [TN295] 622s [622'.8] 80-607066

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THREE COAL MINE GOB DEGASIFICATION STUDIES USING SURFACE BOREHOLES AND A BLEEDER SYSTEM

by

S. D. Maksimovic[1] and Fred N. Kissell[2]

ABSTRACT

The use of vertical surface degasification boreholes with bleeder systems and the use of a timbered bleeder system to degasify gob areas were studied by the Bureau of Mines. This report describes three gob degasification studies conducted in the Pittsburgh coalbed.

One study was conducted to determine the number of panels degasified with one large borehole. The study showed that the borehole provided degasification for three panels.

Another study was conducted during the retreat of a 35-acre panel with a single-entry and a two-entry bleeder system and a large surface borehole. A major portion of methane emitted from the panel was carried away by the borehole, leaving the bleeder entries relatively free of methane.

The last study was made to determine the effectiveness of a timbered bleeder system. The bleeder entries successfully degasified the gob area when enough entries were available and adequate pressure was available to force the air through roof falls.

INTRODUCTION

The proper ventilation of coal mine gobs is becoming more difficult as deeper coalbeds are mined and restrictions on permitted methane levels become more stringent. The Bureau of Mines is conducting research into new ways of reducing methane in gobs, and most of this effort centers on the use of boreholes and better bleeders for gob degasification (1-3).[3] One of the most important aspects of gob ventilation is the need to vent safely that portion of gas that flows into active workings when the barometric pressure falls.

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

This report details results from three gob degasification studies conducted by the Bureau, two of which involved the use of a borehole, and the third the use of a heavily timbered bleeder entry. It illustrates the manner in which three different mines, all in the Pittsburgh coalbed, handled their gob degasification problems.

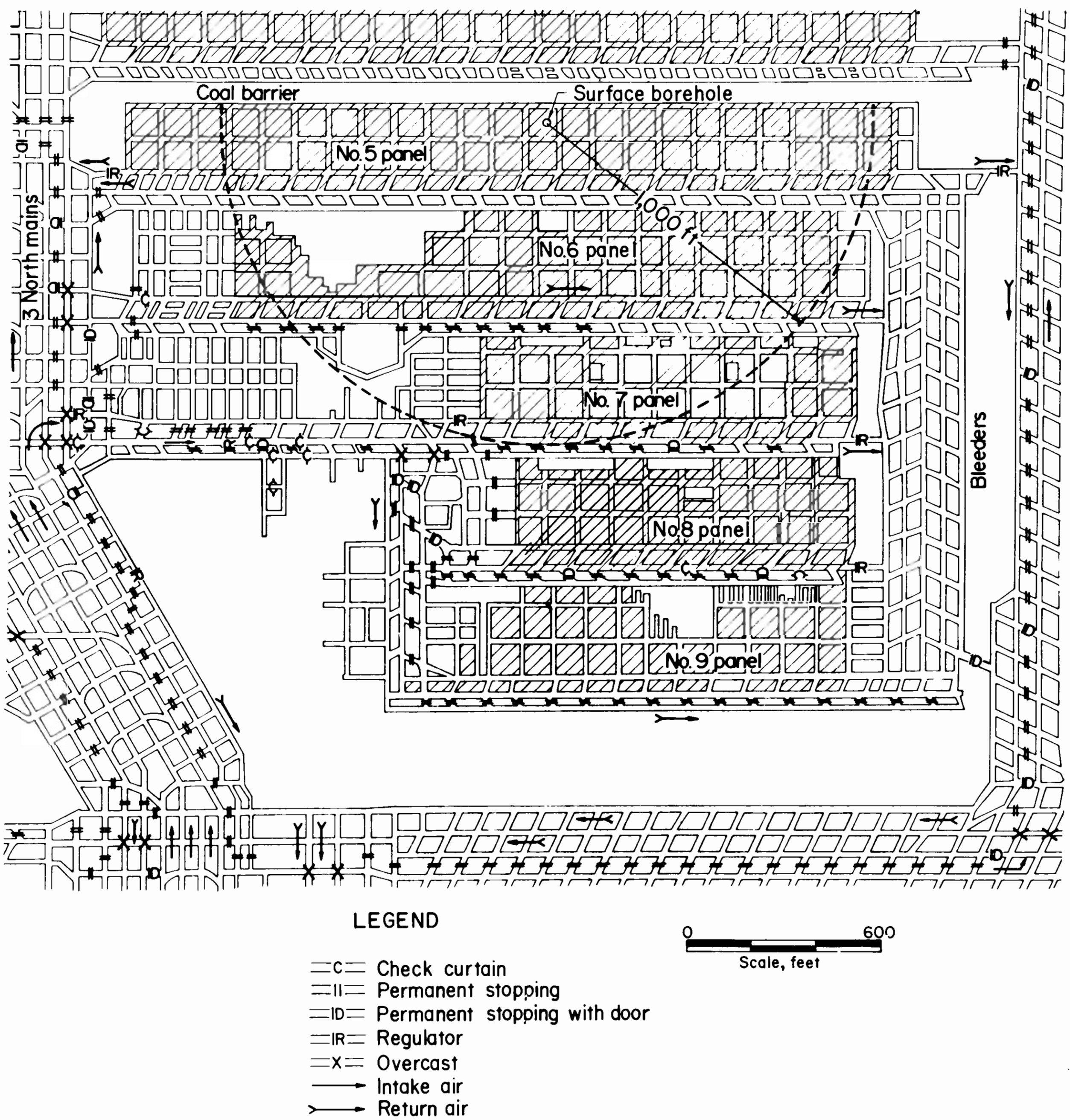

FIGURE 1. - Map of the first study area.

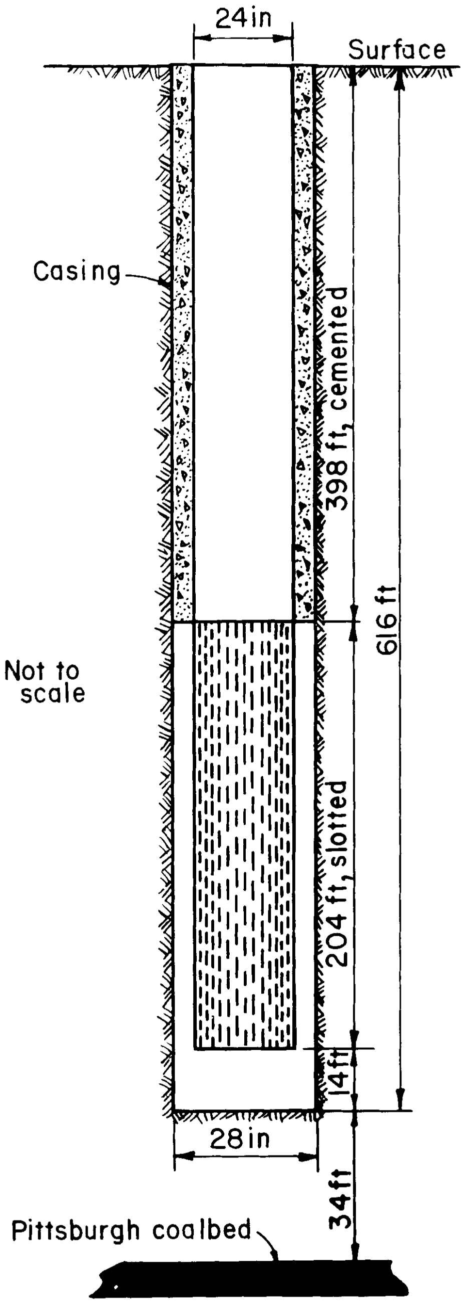

FIGURE 2. - Detail of borehole completion.

FIRST STUDY: DEGASIFICATION OF PILLARED PANELS THROUGH A SURFACE BOREHOLE

In this instance, the borehole was drilled before mining into the center of a panel so as to drain methane from the gob after the panel was retreat mined. The coal mine is located in Monongalia County, W. Va., and the study area consisted of panels 5-9, right off 3 North Mains (fig. 1). Each panel was developed, then pillared and retreated before starting to develop the next panel.

The surface degasification borehole was located in panel 5, adjacent to a coal barrier (fig. 1). It was drilled ahead of the approaching pillar line to a depth of 616 ft, 34 ft above the Pittsburgh coalbed. It was 28 inches in diameter[4] and was cased with 24-inch-OD casing to a depth of 602 ft. The casing interval between 398 and 602 ft in depth was slotted, with the remaining unslotted casing cemented from 398 ft to the surface (fig. 2).

Underground methane flow was measured during periodic ventilation surveys using the difference in methane concentrations between intake and return airflows. During retreat mining, the volume of the intake air varied from 22,000 to 40,000 ft^3/min. Roughly half of this air was conducted across the gob to the bleeder entries and the surface borehole.

The borehole was intersected by the pillar line in March 1972. However, for the first 7 weeks, the methane concentration in the hole did not build up enough to provide a natural draft. Since no exhaust fan was installed on the surface, the hole would not produce. By May, the methane concentration had risen sufficiently to provide a natural draft, and the initial production was 300 ft^3/min, which was 60 pct of the total methane flow from panel 5 (fig. 3). When panel 5 was completed, the borehole flow dropped together with the underground flow. As panel 6 was pillared, borehole flow increased to 200 ft^3/min, and

[4]Ordinarily such a large-diameter hole would not be drilled, but it was a test hole for a mine rescue project.

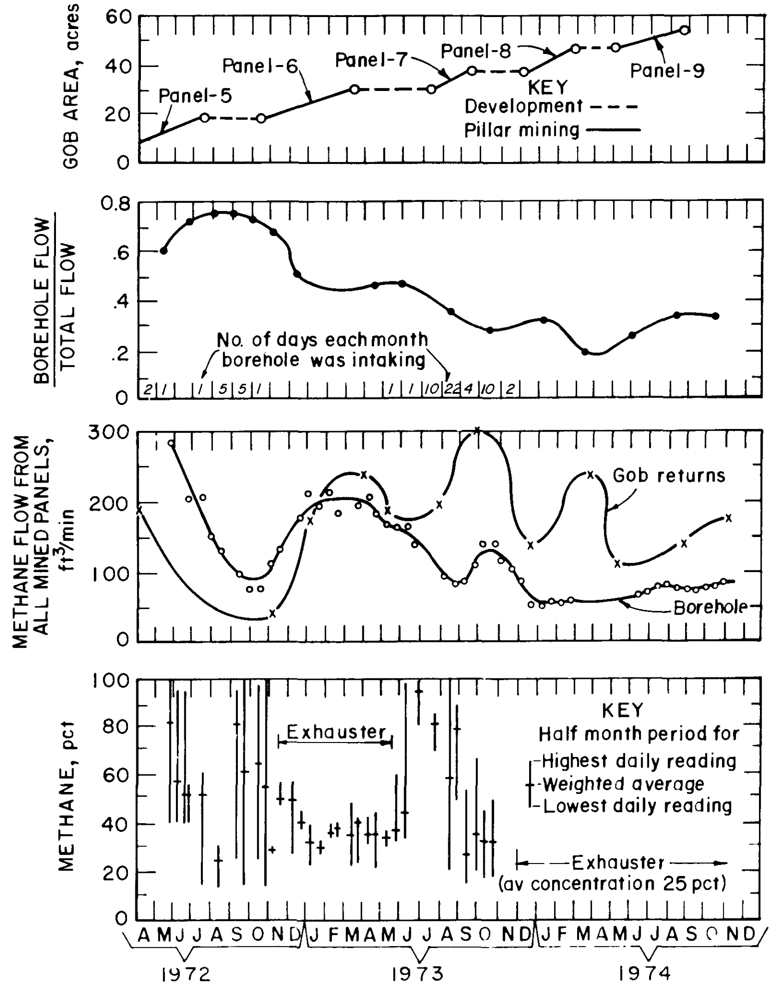

FIGURE 3. - Borehole methane concentration, methane flow from borehole and all mined panels, borehole flow versus total flow, and gob area in acres.

during the life of this panel, roughly 50 pct of the total methane released from panels 5 and 6 combined emerged through the borehole (fig. 3).

Borehole effectiveness dropped considerably during the pillar mining of panel 7, producing only 30 pct of the total from all three panels. However, there is evidence that about one-third of the gas from panel 7 was flowing to the borehole. As panel 7 was mined, the borehole flow increased about 50 ft^3/min, whereas the total flow (borehole and return) increased about 140 ft^3/min. There was no increase in borehole flow as panel 8 was pillared, indicating that no measurable gas from panel 8 gob was flowing to the borehole.

During all of this time, the methane concentration in the borehole effluent varied widely. For the first few months as panel 5 was pillar mined, it averaged over 50 pct but fluctuated considerably on a day-to-day basis (fig. 3). After panel 5 was completed, the concentration occasionally dipped into the 20-pct range, with the hole losing its natural draft and beginning to intake. When pillar mining of panel 6 started, an exhauster fan was installed on the surface, but its effect was to lower the effluent concentration[5]. It was removed 6 months later (fig. 3). The mining of panel 7 resulted in some higher concentrations for a short period, with the hole also frequently intaking. After panel 7, the exhauster was reconnected, and the effluent concentration averaged about 25 pct.

[5] Previous experience with degasification boreholes indicates that the larger hole or the exhauster fan does not necessarily increase the quantity of methane flow from the gob area. In some cases, these only increase the total effluent flow at a lower methane concentration.

Analysis

The surface borehole provided degasification for three panels: panel 5, in which it was drilled, and two adjacent ones to the south, panels 6 and 7. The coal barrier to the north of the borehole probably prevented any substantial gas flow from that direction.

From figure 1, it appears that the borehole provided degasification up to a radius of roughly 1,000 ft. This is somewhat higher than expected, for in longwall panels where multiple holes are used, the spacing varies between 1,000 and 1,500 ft for holes in the same panel, which is equivalent to a degasification radius of 500 to 750 ft.

Since the airflow through the gob to the bleeder entries averaged about 12,000 ft^3/min, the safe limit for methane flow to the bleeders was 240 ft^3/min of methane (12,000 × 2 pct). The actual gob emission was often twice this, indicating that if the borehole were not present, the air quantity through the gob to the bleeders would have to be doubled. This would have not been a simple task.

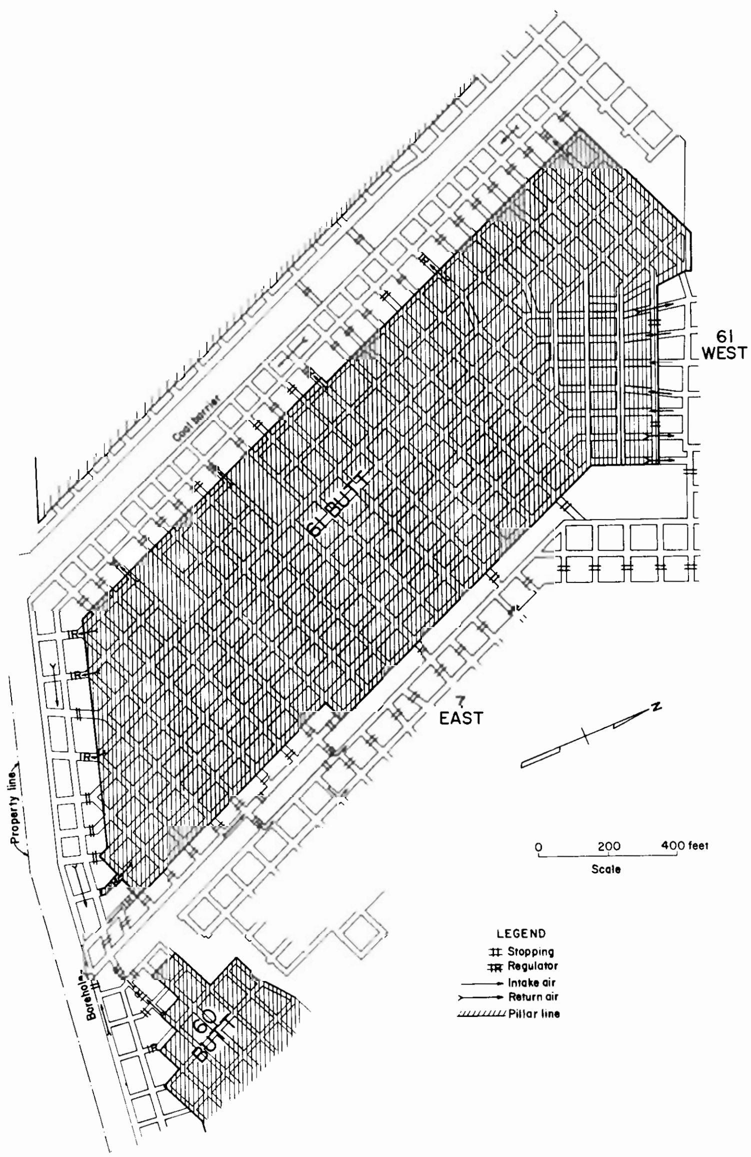

FIGURE 4. - Map of the second study area.

SECOND STUDY: BLEEDER ENTRY VENTILATION THROUGH A SURFACE BOREHOLE

A large-diameter borehole was drilled to the intersection of bleeder entries located at the back end of a large panel. The purpose of the hole was to serve as a ventilation supplement to the conventional bleeder system. The back end of the panel was adjacent to a property line and was difficult to ventilate.

The panel, denoted 61 Butt, was located in a coal mine in Washington County, Pa. It was bounded on the sides by 7 East entries and a coal barrier. At the back was a property line. Access was from 61 West entries located on the north side (fig. 4).

Ventilation was provided with intake and return airways to 61 West entries. The side and back were provided with bleeder entries, with the bleeder air passing to the borehole and 7 East entries.

The borehole was drilled 640 ft deep, 28 inches in diameter, and cased with 24-inch casing. Two exhausters located on the surface served to move an average of 9,000 ft^3/min up the borehole.

Retreat mining of 61 Butt started in October 1972 and was completed in November 1973. During this period, the Bureau of Mines made periodic ventilation surveys to measure the methane emission and determine what fraction was exiting to 61 West returns, 7 East entries, or the borehole. The ventilation picture was complicated somewhat by the introduction of methane from the adjacent 60 Butt (fig. 4). However, in the survey, it was possible to distinguish the methane amounts contributed by 60 Butt and 61 Butt, respectively.

The results of these surveys are shown in table 1. Methane emerging from the front of the panel passed to 61 West returns, and from the side and rear to 7 East and the borehole. Generally, the borehole carried most of the load at the sides and rear, leaving 7 East free of large amounts of methane. This indicates that the borehole worked well. However, the major question to be resolved is whether 7 East could have handled the methane load without the borehole. Table 2 gives methane concentrations that would have been found in 7 East had the borehole not been present. Three different airflows were used: the actual measured airflow from table 1, an assumed airflow of 5,000 ft^3/min, and an assumed airflow of 10,000 ft^3/min. A glance at table 2 shows that if the borehole had not been present, an airflow of 10,000 ft^3/min or more would have been consistently required in 7 East to maintain safe methane levels.

TABLE 1. - Methane emission survey from 61 West returns, 7 East entries, and borehole, ft^3/min

Date of survey	Front of Panel		Sides and rear of panel					Methane from 7 East and borehole
	61 West Returns		7 East		Borehole			
	Air (thousands)	Methane	Air (thousands)	Methane	Air (thousands)	Methane from 61 Butt	Methane from 60 Butt	
10-02-72	42	55	12	25	0	0	0	25
11-02-72	51	32	2.5	26	6.8	85	0	111
11-21-72	44	30	1.9	18	6.5	52	0	70
12-06-72	37	49	1.7	17	7.2	65	0	82
12-20-72	45	63	2.2	18	8.5	106	0	124
01-11-73	52	36	1.6	22	8.6	121	4	147
02-06-73	53	18	1.7	14	10	95	31	140
02-22-73	52	53	9.4	160	11	0	134	294
03-15-73	48	10	3.6	69	10	73	149	291
04-12-73	44	22	0	0	10	141	25	166
05-17-73	42	23	8.5	89	11	185	17	291
08-09-73	39	19	11	74	10	128	8	210
10-30-73	7.1	0	8.2	66	11	207	8	281

TABLE 2. - Concentrations[1] in 7 East if borehole were inoperative, pct

Date of survey	Using measured airflow in 7 East	Assuming airflow of 5,000 ft^3/min in 7 East	Assuming airflow of 10,000 ft^3/min in 7 East
10-02-72	0.2	0.5	0.25
11-02-72	4.41	2.2	1.1
11-21-72	3.6	1.4	0.7
12-06-72	4.8	1.6	0.8
12-20-72	5.6	2.5	1.2
01-11-73	9.2	2.9	1.4
02-06-73	8.2	2.8	1.4
02-22-73	3.1	5.9	2.9
03-15-73	8.3	5.8	2.9
04-12-73	0	3.3	1.6
05-17-73	3.4	5.8	2.9
08-09-73	1.9	4.2	2.1
10-30-73	3.4	5.6	2.8

[1]Calculated by F. N. Kissell.

Analysis

A major fraction of the methane emitted from 61 Butt was carried away by the borehole, leaving 7 East relatively free of methane. Without the borehole, 7 East could not have safely handled the methane without major changes in the ventilation plan.

THIRD STUDY: BLEEDER SYSTEM FOR LONGWALL GOB VENTILATION

A more common approach to gob ventilation is to depend entirely on the bleeder system, without the use of supplementary boreholes. If not badly blocked by falls, such a system is capable of safely carrying a considerable amount of methane.

One effective conventional bleeder system is located in a mine in the Pittsburgh coalbed in Monongalia County, W. Va. It illustrates what volumes of methane can be handled without the use of supplementary boreholes.

The area (fig. 5) included four adjacent longwall panels that were mined in sequence. Each was circumscribed by three panel entries on the side, South Bleeders at the back, and 2 South Mains. Daily production ranged from 1,000 to 4,000 tons of coal. Intake air totaling 40,000 to 90,000 ft^3/min was conducted from 2 South Mains through the panel entries and to the South Bleeders. The South Bleeders carried an additional 20,000 to 40,000 ft^3/min to 1 Left Gob on the other side.

In the South Bleeders, entry 3 was timbered down the center of most of its length with closely spaced cribs. Most of the time, entries 3 and 4 served as bleeders for the longwall panels, with entries 1 and 2 serving as intakes for 1 Left Gob. A typical air volume in entries 3 and 4 totaled 65,000 ft^3/min.

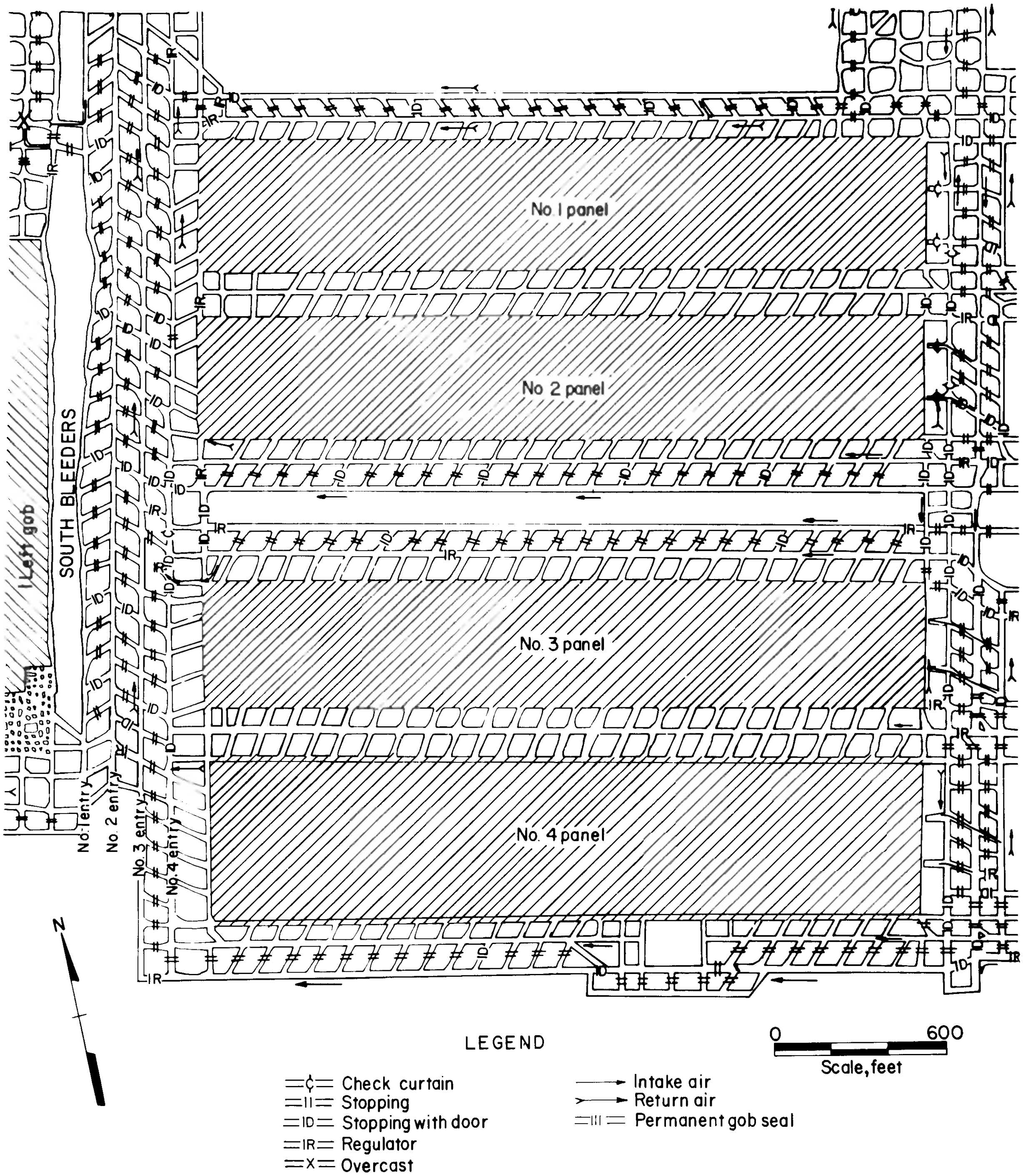

FIGURE 5. - Map of the third study area.

As panel 3 was mined, the pressure drop over the length of the bleeder was about 2 inches water gage. This pressure drop, which was twice that normally to be expected, was due to the constricting effect of roof falls.

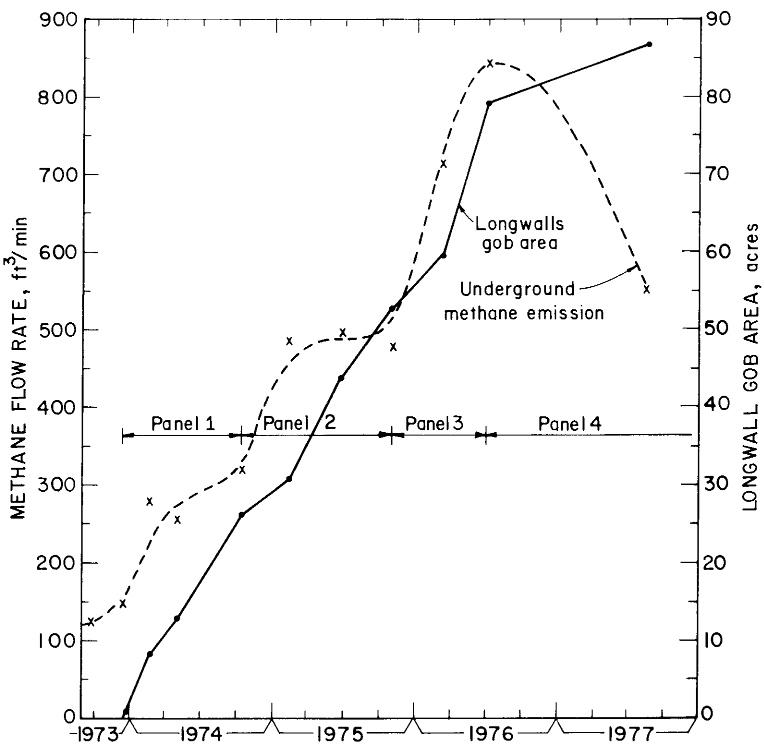

FIGURE 6. - Methane flow rate and longwalls gob area.

As panel 4 was mined, all of the South Bleeder entries were converted to returns, allowing a boost in the air to 95,000 ft^3/min. The methane flow rate from the entire four panel area (fig. 6) increased steadily over a 3-year period to 850 ft^3/min and then declined, the decline due to slow mining of panel 4.

Analysis

Conventional bleeder entries can safely carry away considerable amounts of methane, provided enough entries are available and enough pressure is available to force the air through roof falls. Because of heavy timbering, entry 3 did not provide the completely unobstructed ventilation aircourse that was hoped for; however, it was still possible to move 65,000 ft^3/min through entries 3 and 4 with a pressure loss of 2 inches water gage in the bleeder. The underground emission peaked at about 850 ft^3/min of methane, which was much more gas than was measured in the two studies where boreholes were used. The bleeder system effectively handled this larger gas emission, although four bleeder entries were required.

In practice, it is not often easy to drain methane adequately using this type of bleeder, because of the difficulties involved with maintaining the necessary air pressure differentials.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1980-603-102/78

INT.-BU.OF MINES,PGH.,PA. 24730