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METHANE CONTROL PROGRAM

USE OF VERTICAL BOREHOLES FOR ASSISTING VENTILATION OF LONGWALL GOB AREAS

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ABSTRACT

An experimental degasification program using a vertical borehole and vacuum pump to drain gas from the gob area of a longwall panel was successful at Bethlehem Mines Corporation, Cambria Division, No. 33 coal mine. Sixty-one million cubic feet of methane has been exhausted during a 9-month period. Daily production time in the panel increased as a result of lower methane levels in the returns. Removal of large quantities of methane in this way and the exclusion of it from the ventilating system will provide reduced cost in mine ventilation and provide a safer environment for the mine.

INTRODUCTION

A comprehensive methane control research program is being conducted by the Bureau of Mines to establish the geological structural controls that govern the migration and retention of methane in coalbeds; determine the physical properties of methane and of the coal and other strata with which methane is associated; devise methods by which methane may be removed from, or controlled in, coalbeds prior to and during coal extraction; develop mechanical equipment and instrumentation needed to control methane; and conduct field trials of the methane control techniques developed. This is one of a series of reports on specific aspects of the program.

Cooperative studies, conducted either as part of a formal agreement or informally arranged by letter, offer opportunities for expediting investigation that would be unduly delayed or prohibitively costly if done independently. This work is typical of those cooperative investigations where benefits accrue to industry immediately.

An experiment in degasifying a longwall coal mining panel and the gob area resulting therefrom was implemented at the Bethlehem Mines Corporation, Cambria Division, No. 33 mine in Cambria County, Pa. The prime objectives were to reduce gas emissions from gob areas resulting from longwall mining, and to gain knowledge of the nature of gas transmission and emission

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characteristics in the Kittanning coals and related rock strata. As the longwall system became more perfected and shift tonnage continued to increase, it became apparent that mining would have to be limited to two 8-hour shifts because the third shift would be used to ventilate the area to keep the gas content in the returns at a safe concentration. As the longwall approached the vertical borehole it was necessary, on occasion, to stop mining during a shift to ventilate and reduce the gas to a proper level in the returns.

GEOLOGY

The Cambria 32 and 33 mines, mining Lower Kittanning (B) coal, sit on the crest and down the east limb of the Ebensburg anticline into the Wilmore syncline to the east. The structures have a general northeast-southwest trend and substantial concentrations of methane are encountered in mining.

The Allegheny Formation of the Pennsylvanian Age, which forms the immediate overlying strata, consists of carbonaceous shales, argillaceous carbonaceous sandstones, coals, and some thin argillaceous limestones. It is known that methane is usually present in the Upper Freeport (E), Lower Freeport (D), Upper Kittanning (C'), and Middle Kittanning (C) coalbeds and in the contiguous carbonaceous shales and sandstones.

Slow emission of methane from the two vertical drill holes and the nature of samples collected and studied during drilling of the holes indicate formations of very low permeability and high porosity. A great number of shales with up to 1,000 feet of overburden have an average measured porosity of approximately 30 percent. Shales are known to have porosities ranging from 24 to 38 percent.

In the course of longwall mining fracturing over the face greatly increased the permeability of the rock strata, providing an easy escapeway for the methane in the overburden into the ventilation returns of the mine.

PROCEDURE

Vertical Borehole Completion

The drainage hole was drilled 594 feet deep through the B coal with an 8-3/4-inch-diameter rotary air drill. It was reamed to 12 inches in diameter 567 feet deep. Eight-inch casing with the bottom 48 feet slot-perforated was cemented into the hole, leaving 29 feet of uncased hole and the 48 feet of ungrouted slotted casing. The hole was located 675 feet in advance of the face (figs. 1 and 2).

The 77 feet of ungrouted hole provided free drainage of methane from the exposed formations in the borehole, and from fractures intercepted by the borehole when the overburden was collapsed. Because of the low permeability of the unfractured formation, a natural flow of only 400 cubic feet of gas per day (cfd) was measured on completion of the hole.

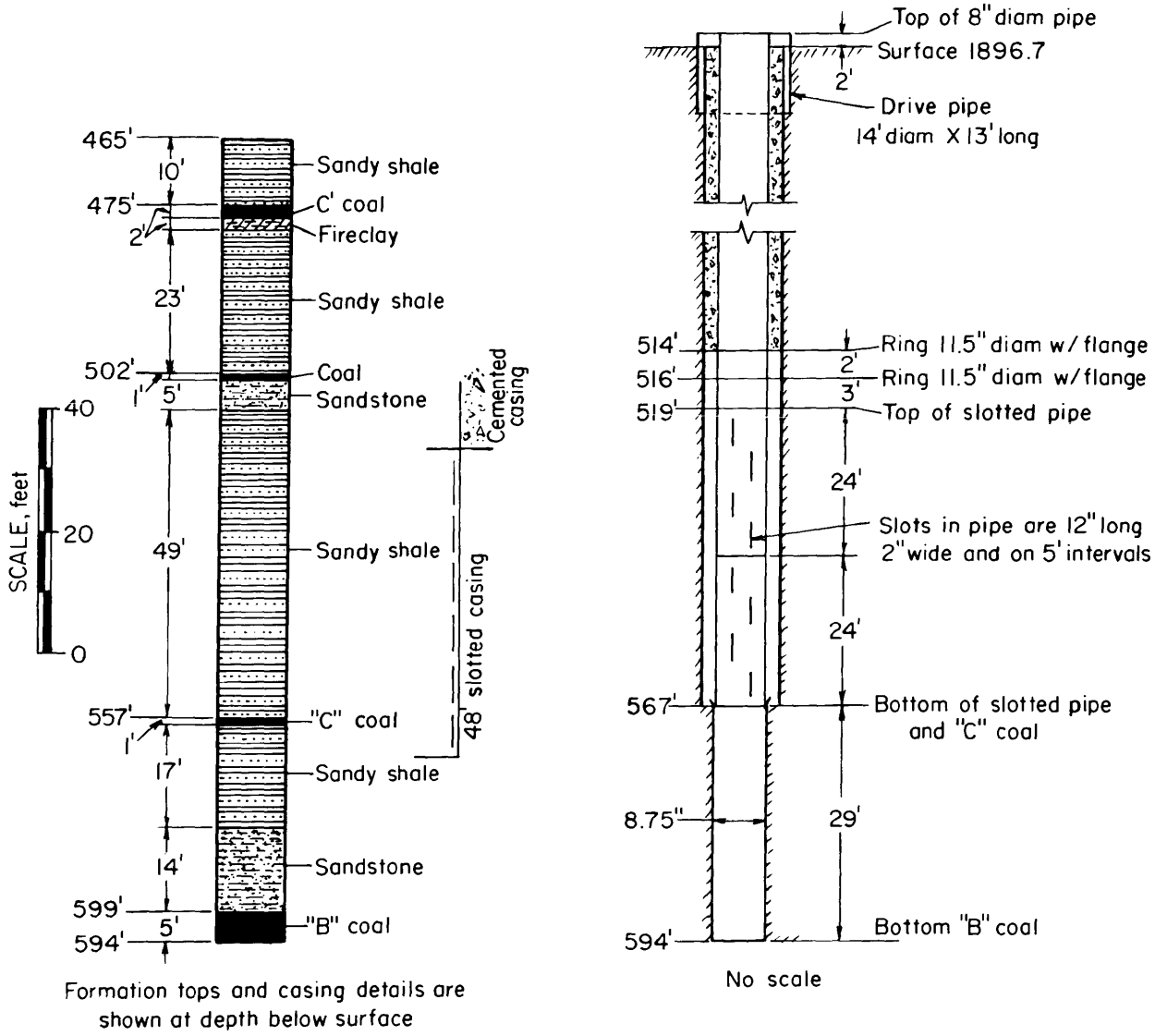

FIGURE 1. - Ventilation Borehole Completion Plan, Experimental Hole Drilled in 2 Left D West Section, Mine 33, Cambria Division, Bethlehem Mines Corporation.

During the drilling of a nearby borehole, gas was observed bleeding from the cuttings while drilling the carbonaceous shales and sandstones overlying the coalbed. Gas was encountered in the borehole from the Lower Freeport (D) coalbed down through the B coalbed.

Monitoring Gas Production

An explosion-proof vacuum pump with a capacity of 170 cubic feet per minute (cfm) was installed on the borehole. Pumping was intermittent with negligible methane flow, until the longwall face intersected this drainage hole, and then a sustained flow was established. Flame arrestors and protective check valves were installed for safety. The borehole was monitored regularly

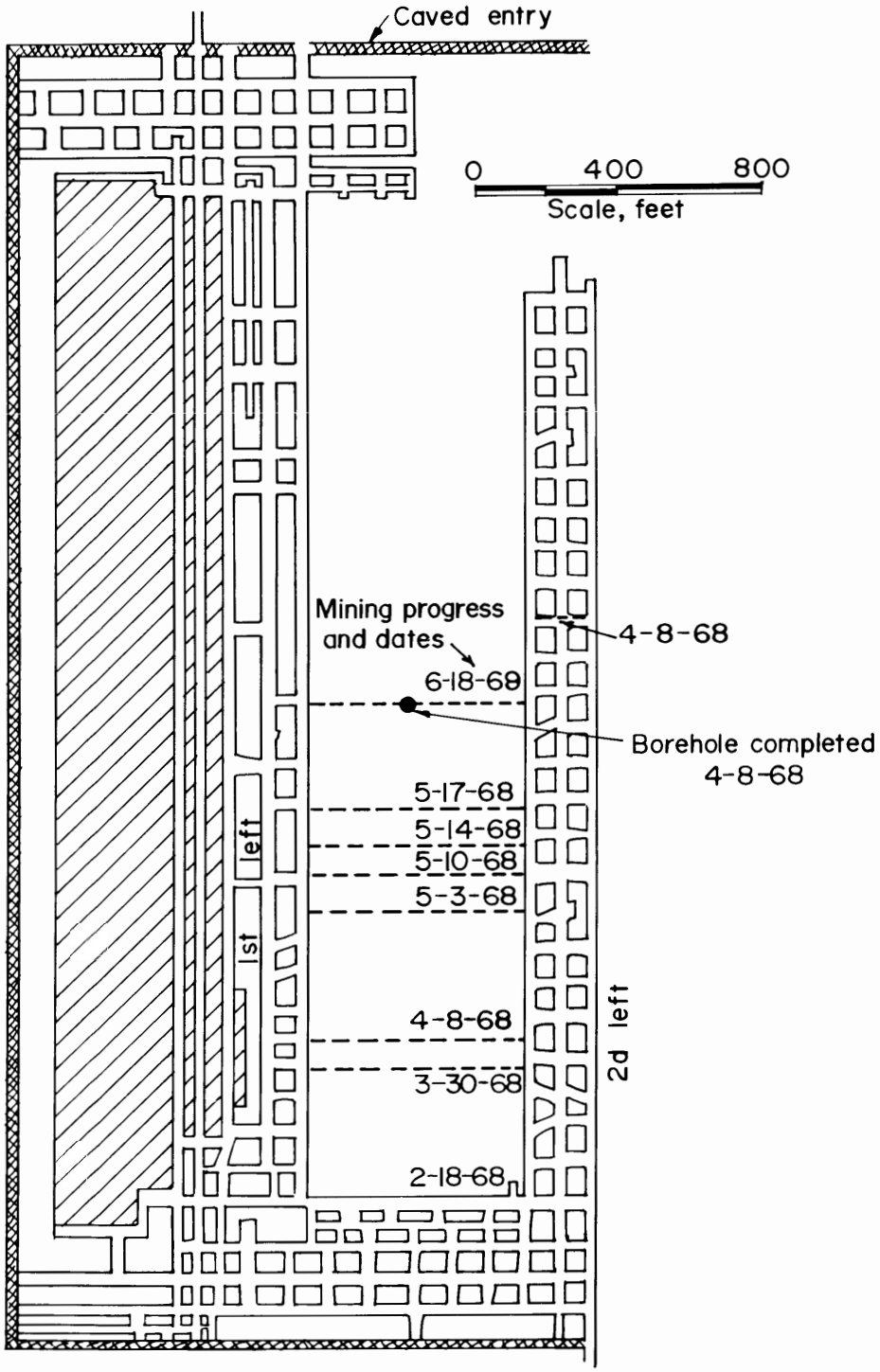

FIGURE 2. - Location of Ventilation Borehole in Longwall Panel and Progress Mining.

with a Riken[2] gas detector and a flowmeter for gas production records. The pumping rate would be adjusted to keep the gas concentration in the exhaust well above the explosion range.

Although the exhaust averaged 89.5 percent methane, 172,000 cfd of methane was evacuated from the hole during the first month (table 1).

During a 3-day pump shutdown, the borehole developed a natural flow of 215,000 cfd of methane, indicating that the low-volume pump was actually inhibiting the flow.

A larger vacuum pump, 700 cfm, was installed and an average methane production of 335,000 cfd was evacuated during the next 4 months. The exhaust averaged 34 percent methane.

[2]Reference to specific brands is made for identification only and does not imply endorsement by the Bureau of Mines.

TABLE 1. - Gas production from the vertical drainage borehole

Date		Pump	Cubic feet of methane, total production	Methane in exhaust, percent	Cubic feet of methane, average daily production	Natural flow	Cubic feet of methane, total production	Methane, percent	Cubic feet of methane, average daily production	Comments
From	To									
Apr. 18, 1968	June 18, 1968	170 cfm vacuum pump.	5,137	80 to 100	-	-	-	-	-	Intermittent pumping. Hole pumped to 24-inch mercury vacuum.
June 18, 1968	July 20, 1968	170 cfm vacuum pump.	5,000,000	89.5	172,000	-	-	-	-	Pumping 24 hours per day with sustained flow.
July 20, 1968	July 23, 1968	-	-	-	-	Open hole, 8-inch casing.	640,000	89	215,000	Installing larger vacuum pump.
July 23, 1968	Nov. 6, 1968	700 cfm vacuum pump.	36,000,000	34	335,000	-	-	-	-	Pumping 24 hours per day.
Nov. 7, 1968	Nov. 14, 1968	-	-	-	-	Open hole, 8-inch casing.	1,000,000	61	140,000	Installing blower.
Nov. 14, 1968	Dec. 26, 1968	1,100 cfm blower.	14,000,000	24	320,000	-	-	-	-	Pumping 24 hours per day. Longwall panel was completed Nov. 23, 1968. Longwall panel gob area continuous high gas emission.
Dec. 26, 1968	Dec. 30, 1968	-	-	-	-	-	-	-	-	Drainage hole shut-in.
Dec. 30, 1968	Feb. 25, 1969	1,100 cfm	400,000	28	-	Open hole, 8-inch casing.	2,000,000	61.5	57,000 (24-hour basis)	Intermittent pumping and natural flow with some shut-in periods.
Feb. 25, 1969	Mar. 13, 1969	1,100 cfm	1,000,000	34	-	-	-	-	-	Intermittent pumping.
Mar. 13, 1969	Mar. 17, 1969	1,100 cfm	1,000,000	30	220,000	-	-	-	-	Pumping 24 hours per day.

A 5-horsepower, 1,100-cfm blower was installed on the borehole. This blower has evacuated 220,000 to 320,000 cfd of methane. The exhaust was 24 to 30 percent methane.

The borehole during its 9-month production period has exhausted 61 million cubic feet of methane from the gob area of the completed longwall panel, thus eliminating from the ventilation returns that amount of methane.

EVALUATION

Drainage of the gob through vertical boreholes has resulted in a substantial reduction in methane content of the ventilation air. Monitoring of the returns off the longwall panel showed a reduction of approximately 1 percent methane in the main air returns ventilating the panel.

This reduction has made possible a mining period to be three 8-hour shifts per day. The longer mining period could increase production by several hundred tons through longer use of high-cost, rapid mining equipment.

An additional 35 to 40 million cubic feet of air would be necessary to dilute the volume of methane exhausted each day through one vertical borehole. The use of the vertical borehole yields savings on fan power costs and, if enough holes are utilized, the need for large additional ventilation shafts will be reduced substantially.

The vertical borehole has proved so beneficial that six additional holes are being drilled for use in draining methane from the gob areas of all active longwall panels. A second vertical borehole, which was completed with an additional 30 feet of overburden, has been exposed to open flow. A more powerful blower at the hole has produced, during 2 months of service, an average daily production of 1 million cubic feet of methane. The exhaust averaged 88 percent methane.

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