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Geology and Gas Content of Coalbeds in Vicinity of Bureau of Mines, Bruceton, Pa.

UNITED STATES DEPARTMENT OF THE INTERIOR

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By C. H. Elder and M. C. Irani

UNITED STATES DEPARTMENT OF THE INTERIOR
Cecil D. Andrus, Secretary

BUREAU OF MINES

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GEOLOGY AND GAS CONTENT OF COALBEDS IN VICINITY OF BUREAU OF MINES, BRUCETON, PA.

by

C. H. Elder[1] and M. C. Irani[2]

ABSTRACT

Two degasification test boreholes were drilled to depths of 1,238 and 1,212 feet on Bureau of Mines property at Bruceton, Pa., as part of the Bureau's long-range coal degasification program. The holes provided detailed geologic information and geologic sections, which were correlated with regional stratigraphic cross sections prepared by the Pennsylvania Geological Survey. Gas content determinations and coal analyses were made on the Upper Freeport, Middle Kittanning, Clarion, Brookville, and Mercer coalbeds; gas content of the coalbeds ranged from 53 to 165 cubic feet per ton. Formation pressure and gas flow tests were conducted on selected coalbed intervals in borehole 1; formation pressures ranged from 292 to 473 psig. The middle Kittanning coalbed was hydraulically stimulated using very heavy gelled water, but gas production remained low because gel residue and formation water inhibited the flow of gas. Gas contents in the Clarion, Upper Brookville, and Mercer coalbeds were anomalously low owing to the proximity of porous sandstones which act as reservoirs for gas migrating from coalbeds.

INTRODUCTION

The present study was conducted as a part of the Bureau of Mines comprehensive long-range coal degasification program. The objective was to develop specific information on physical properties of coalbeds relative to gas content and to apply and evaluate a stimulation technique for increased gas drainage. For such experimental work the most convenient site was at the Bruceton Station of the Bureau of Mines near Pittsburgh, Pa.; the program also provided an opportunity to develop detailed geologic information and correlation of the coalbeds present in the Bruceton area.

Early geologic studies and maps of the area do not give detailed stratigraphic information for coalbeds below the Pittsburgh coalbed in the immediate vicinity of Bruceton (7).[3] Studies at the outcrop areas of several of the coalbeds show they are discontinuous in Allegheny County (5, 7). Coalbed

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[1]Geologist.
[2]Supervisory mining engineer.
Both authors are with the Pittsburgh Mining and Safety Research Center, Bureau of Mines, Pittsburgh, Pa.
[3]Underlined numbers in parentheses refer to items in the list of references preceding the appendix.

formation pressures had never been measured, and the presence of gas in the coalbeds had never been recorded. There have been no earlier attempts to produce gas from coalbeds in the vicinity of Bruceton, Pa.

Two boreholes were drilled to depths of 1,238 and 1,212 feet on Bureau of Mines property at Bruceton, Pa. Sedimentary rock strata encountered in the boreholes are described later in the report and correlated to the stratigraphic sequence established in unpublished regional cross sections constructed by W. R. Wagner, of the Pennsylvania Geological Survey (7). Correlations are shown on a cross section constructed from selected geophysical logs of wells 6 to 17-1/2 miles distant from the two test boreholes. Drill stem tests were conducted to evaluate formation pressures and gas flows from the coalbeds. Each coalbed was analyzed for gas content. The Kittanning coalbed was hydraulically stimulated using very heavy gelled water in an attempt to increase gas flow for degasification.

The two test holes will provide sites for future research in stimulation techniques using different fluids to achieve formation fracture, such as nitrogen-generated foam or new water gelling agents, which will provide better water recovery potential. The cored holes can be used to test new logging techniques or other types of remote-sensing equipment for formation evaluation.

Lithologic data collected during drilling, coring, and testing provide a geologic section for regional stratigraphic correlation and assist in making more accurate interpretations of

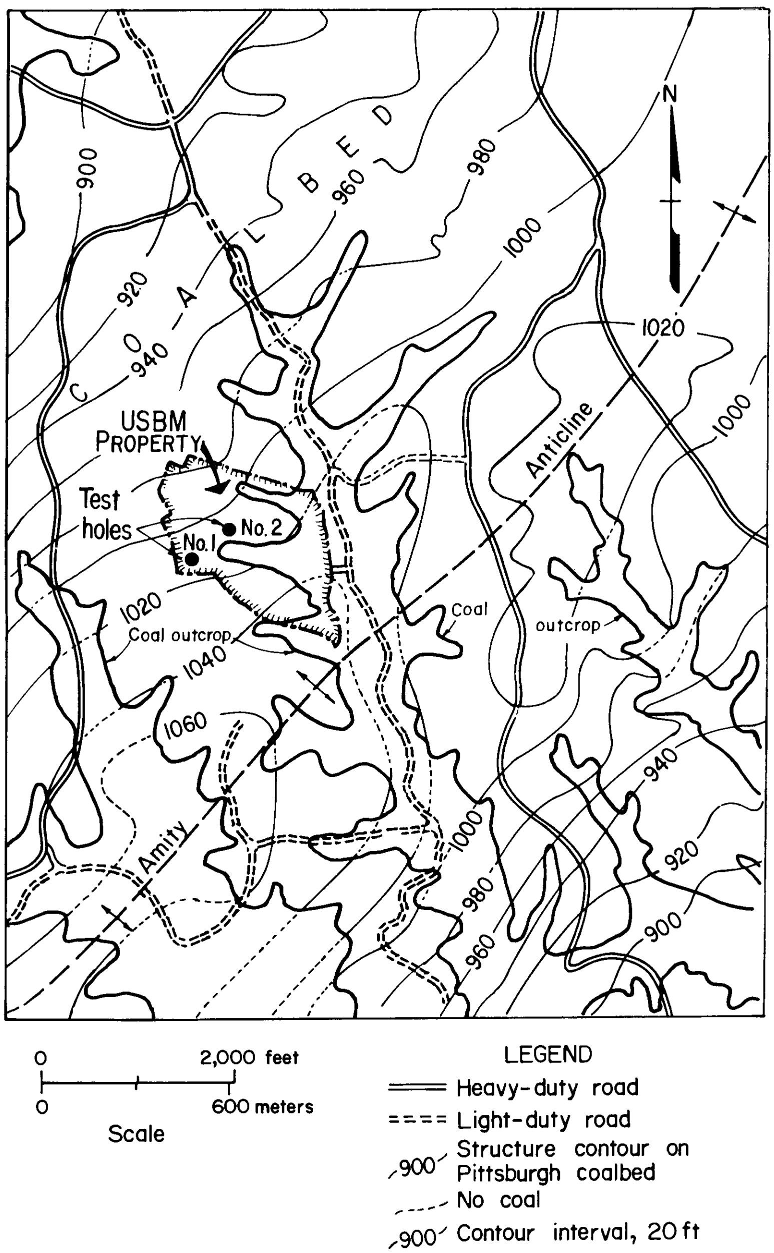

FIGURE 1. - Geologic structure map of Bureau of Mines Bruceton Station area.

the regional geology and assessment of mineral resources in the Allegheny County area.

GEOLOGY

Structure

The area at Bruceton where the two boreholes were drilled (figs. 1-2) is folded into gentle anticlines and synclines with a general northeast-southwest

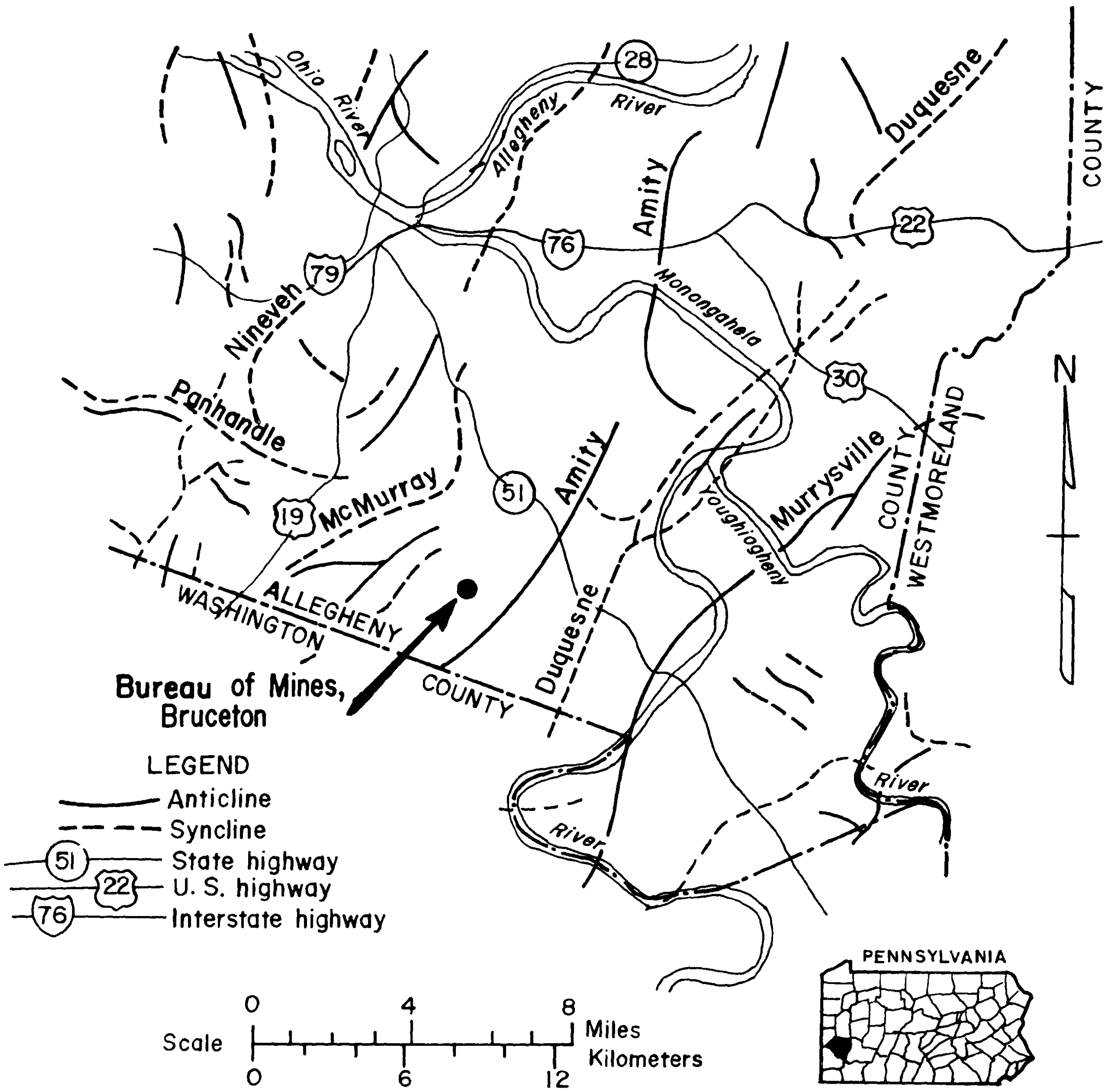

FIGURE 2. - Structural axes of a portion of Allegheny County.

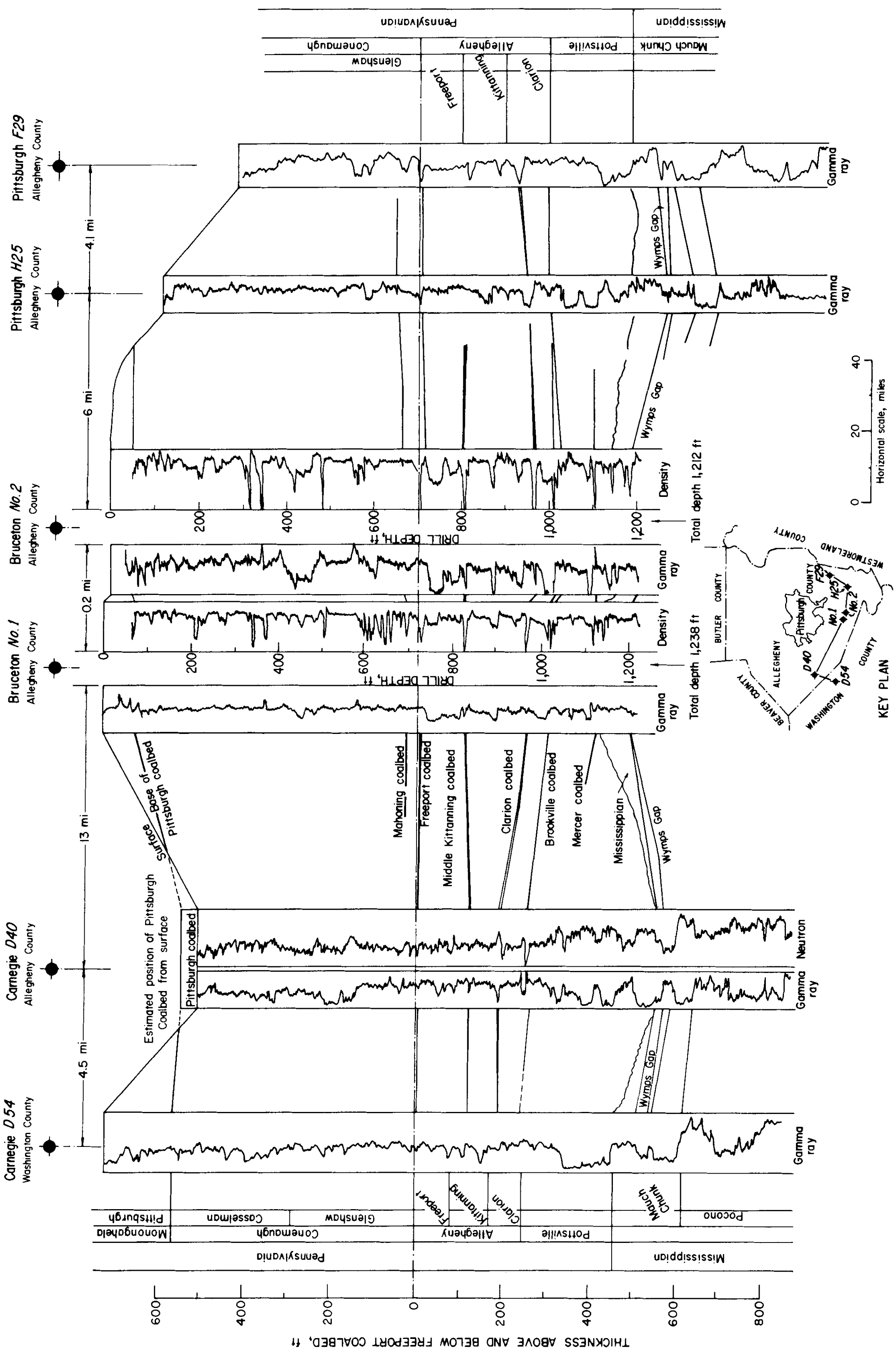

FIGURE 3. - Geologic stratigraphic cross section.

trend. The major structures in the vicinity of the boreholes are the McMurray syncline, Amity anticline, and Duquesne syncline (7). The McMurray syncline is a broad gentle fold which appears in the Glassport 7-1/2-minute quadrangle northwest of Bruceton and trends N 10° E to Pittsburgh, Pa., where it swings to the northeast. The Amity anticline trends N 30° E, its axis passing just east of Bruceton through Homestead, Pa. The test boreholes were drilled on the west limb of this anticline. The Duquesne syncline is a broad structure lying southeast of, and parallel to, the Amity anticline and west of the Monongahela River. It is complicated by several minor folds.

Stratigraphy

The stratigraphic section penetrated by the test boreholes consists, in descending order, of the Monongahela, Conemaugh, Allegheny, and Pottsville Groups of the Pennsylvanian System, and the Mauch Chunk Formation of the Mississippian System (fig. 3) (5, 7).

PENNSYLVANIAN SYSTEM

Monongahela Group

The Pittsburgh Formation, the basal member of the Monongahela Group, crops out of the rolling hills in the vicinity of the test boreholes. The interval of the Pittsburgh Formation penetrated by the boreholes consists of interbedded sandy shales and sandstones. The Pittsburgh coalbed, the basal member of the formation, has been mined out in the area of the drill sites. The Pittsburgh Formation is 75 and 47 feet thick in boreholes 1 and 2, respectively.

Conemaugh Group

The Conemaugh Group is divided into the Casselman and Glenshaw Formations in descending order. The Conemaugh Group consists of a series of interbedded shales, red and green shales and claystones, thin limestones, thick sandstone members, and local very thin coalbeds. The Conemaugh Group is 653 and 657 feet thick in boreholes 1 and 2, respectively.

The upper portion of the Casselman Formation crops out in the valley bottoms at Bruceton. The Pittsburgh Limestone Member in the upper portion of the Casselman Formation consists of several thin limestones interbedded with calcareous shales and calcareous sandstones. Five limestones 4 to 6 feet in thickness occur in the 125-foot interval immediately below the Pittsburgh coalbed.

The Clarksburg Limestone Member occurs at a depth of 280 feet in borehole 1. The limestone is 4 feet thick and is underlain by gray, calcareous shale and clay in borehole 1. It is absent in borehole 2.

The Duquesne Limestone Member, a freshwater limestone encountered at a depth of 340 feet in borehole 1, is 8 feet thick at this location. In borehole 2, the limestone is 4 feet thick and very shaley.

The Ames Limestone Member marks the top of the Glenshaw Formation. This 6-to 8-foot-thick fossiliferous marine limestone, penetrated at a depth of 420 feet in borehole 1, is absent in borehole 2. The interval between the Pittsburgh coalbed and the Ames Limestone commonly ranges from 265 to 350 feet thick; in borehole 1 the interval is 346 feet.

The Saltsburg Sandstone Member underlies the Ames Limestone as two separate units in borehole 1. The top unit, 38 feet thick, is shaley at the top and coarsens downward from a fine-grained sand to a coarse-grained sand. The two units are separated by a dark-gray-to-black shale approximately 4 feet thick. The bottom unit is 34 feet thick and consists of fine-grained sand with some thin shale stringers at the top.

The Pittsburgh red beds, commonly present below the Ames Limestone, are not present in the drill site area. The lower part of the Glenshaw Formation consists of interbedded shales, thin limestones, and sandstones.

The Mahoning coalbed is the first coal encountered below the Pittsburgh coalbed and is generally not minable in this area. At depths of 702 and 680 feet in boreholes 1 and 2, respectively, the Mahoning coalbed is 9 inches thick.

Allegheny Group

The Allegheny Group is subdivided into three formations: Freeport, Kittanning, and Clarion, in descending order. Although the lithologies in the Allegheny Group vary considerably, sandstone is the dominant lithotype in boreholes 1 and 2.

The Upper Freeport coalbed marks the top of the Freeport Formation. It was encountered at depths of 728 and 704 feet in boreholes 1 and 2, respectively. The Upper Freeport consists of an upper bench of 2 feet of coal separated from a lower 4-foot bench by 3 feet of gray-to-black shale. Analysis of the Upper Freeport coal cores showed a high ash content, indicating a high inert-mineral-matter content. The Pennsylvania Geological Survey reports the Upper Freeport coalbed in Allegheny County commonly ranges from 24 to 72 inches in thickness and locally may be dirty, thin, irregular, or entirely absent (8). The coalbed is underlain by 10 feet of dark-gray shale. The remaining portion of the Freeport Formation is white, medium-to-coarse sandstone.

The Kittanning-Clarion Formation boundary could not be determined in the section penetrated by the test boreholes owing to the absence of the Lower Kittanning coalbed. The top of the Kittanning-Clarion Formation is marked by the Johnstown Limestone Member, encountered at 800 and 764 feet in boreholes 1 and 2, respectively. The remaining section of the Kittanning-Clarion Formation consists of interbedded sandstones and shales. The Middle Kittanning coalbed occurs at drill depths of 834 and 808 feet in boreholes 1 and 2, respectively. It is 3 to 4-1/2 feet thick. A section of interbedded sandstones and shales, equivalent to the Lower Worthington and Lower Kittanning Sandstone Members, underlies the Middle Kittanning coalbed. The Lower

Kittanning coalbed, when present, separates these sandstone members and marks the top of the Clarion Formation. The Clarion coalbed was penetrated at drill depths of 980 feet in borehole 1 and 966 feet in borehole 2, and was 1 and 3 feet thick, respectively. The Clarion coalbed and associated shale overlie the Clarion Sandstone Member of the Clarion Formation. The sandstone is 38 feet thick, white to gray, fine grained, and argillaceous. The base of the sandstone is conglomeratic in borehole 2.

The Brookville coalbed marks the base of the Clarion Formation and the Allegheny Group. The Brookville coalbed is divided into two benches at both drill sites; both benches are 1 foot thick. The two benches are separated in borehole 1 by 6 feet of gray coarse-grained sandstone, which changes laterally to dark-gray-to-black carbonaceous shale in borehole 2. The bottom bench of the Brookville coal has a high inert-mineral content. Cross sections by the Pennsylvania Geological Survey also indicate that this coalbed is probably discontinuous in the greater Pittsburgh area (7).

Pottsville Group

The Pottsville Group consists predominately of interbedded sandstones, shales, and some discontinuous coalbeds. The Homewood Sandstone, at the top of the Pottsville Group, is poorly developed in this area. It consists of interbedded sandstones and sandy shales. Farther to the south and southeast in southwestern Pennsylvania and northern West Virginia, the Homewood is a thick, cross-bedded sandstone.

Only one of several Mercer coalbeds is present at the drill sites. A 1-foot coalbed was penetrated at the 1,135- and 1,103-foot drill depths in boreholes 1 and 2, respectively. A 14-foot sandstone overlying the Mercer coal contained gas, which flowed during a drill stem test.

The Connoquenessing Sandstone in the lower Pottsville Group is very poorly developed or absent over the crest of the Amity anticline at this location. Thick Connoquenessing Sandstone is present in the synclines east and west of the drill site and Amity anticline axis.

MISSISSIPPIAN SYSTEM

Mauch Chunk Formation

The Mauch Chunk Formation of the Mississippian System is unconformably overlain by the Pottsville Group of the Pennsylvanian System. The Mauch Chunk Formation ranges from 0 to 300 feet thick regionally. It was encountered at 1,150 feet in borehole 1 and at 1,136 feet in borehole 2. Eighty-eight and 76 feet of Mauch Chunk Formation was penetrated in boreholes 1 and 2, respectively. The formation is characterized by varicolored red, green, and gray shales interbedded with some thin argillaceous sandstones and limestones. The test holes terminated after penetrating 14 feet into the Wymps Gap Limestone Member of the Mauch Chunk Formation (3). The Wymps Gap Member is a tan-to-brown fine crystalline limestone.

FORMATION TESTING

Mud Analysis Well Log

The mud analysis well log is a formation evaluation tool using gas detection equipment during drilling to locate and evaluate gas-bearing strata. Formation gases are circulated to the surface by the drilling medium. They are collected in a trap placed in the flow line and analyzed by a hot-wire detecting device.

Drill cuttings are collected during drilling, and a complete lithological description is made with the aid of a binocular microscope. The formation sample description is made with the aid of a binocular microscope. The formation sample descriptions and drill penetration rates for selected intervals are correlated to drill depth. These data are continuously plotted on a log (figs. 4-5). Additional engineering and test data such as cored intervals, drill stem pressure test intervals, and drill bit records also are recorded.

Geophysical Log

Gamma ray logs (figs. 6-7) were used to correlate the strata with other holes which had been drilled nearby for exploration and production of gas and oil. The gamma ray logging tool measures natural gamma radiation emanation from the various rock types encountered in the borehole. A caliper logging tool was used to measure the variation in diameter from the bottom to the top of the drilled holes.

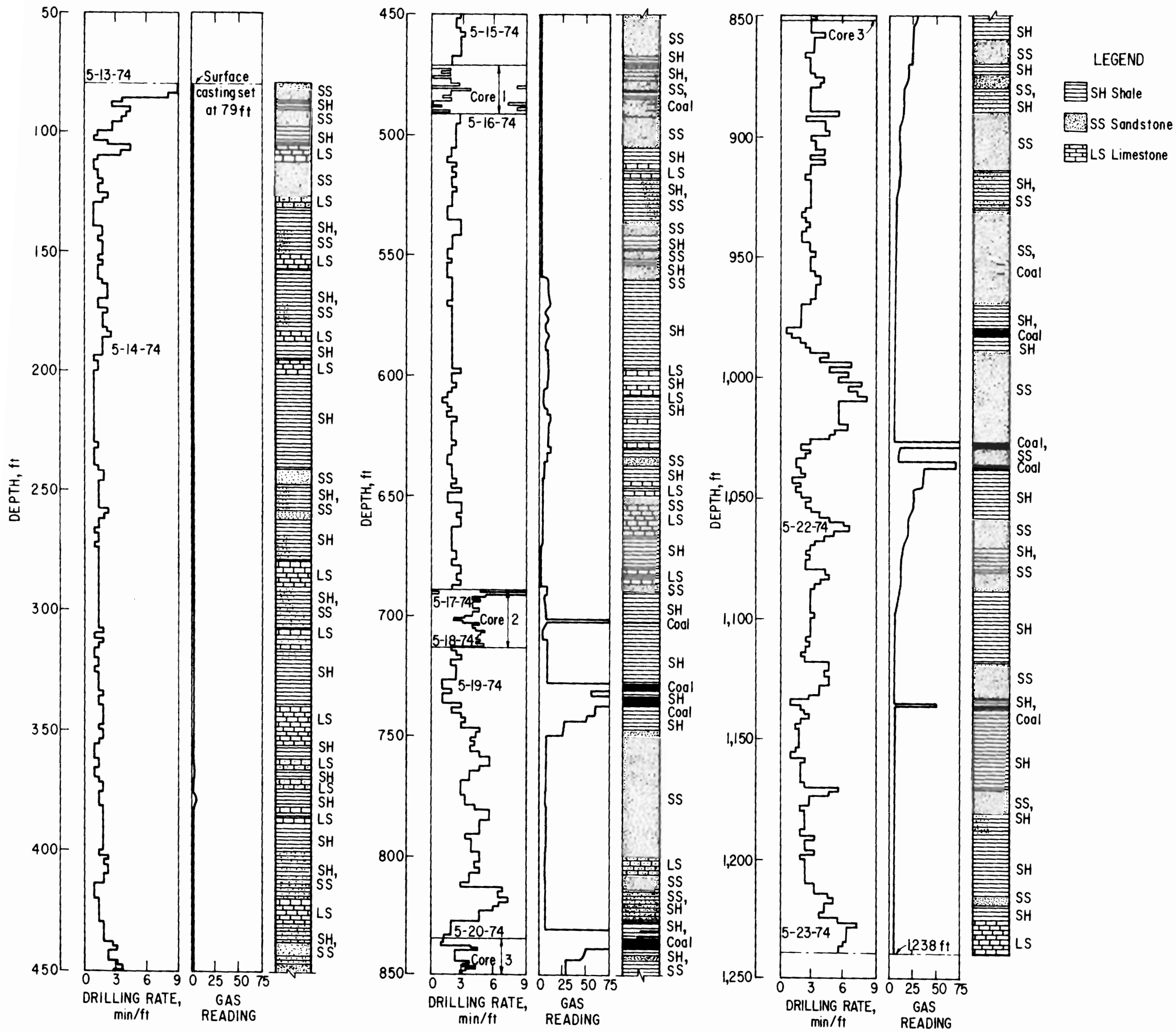

FIGURE 4. - Mud log of borehole 1.

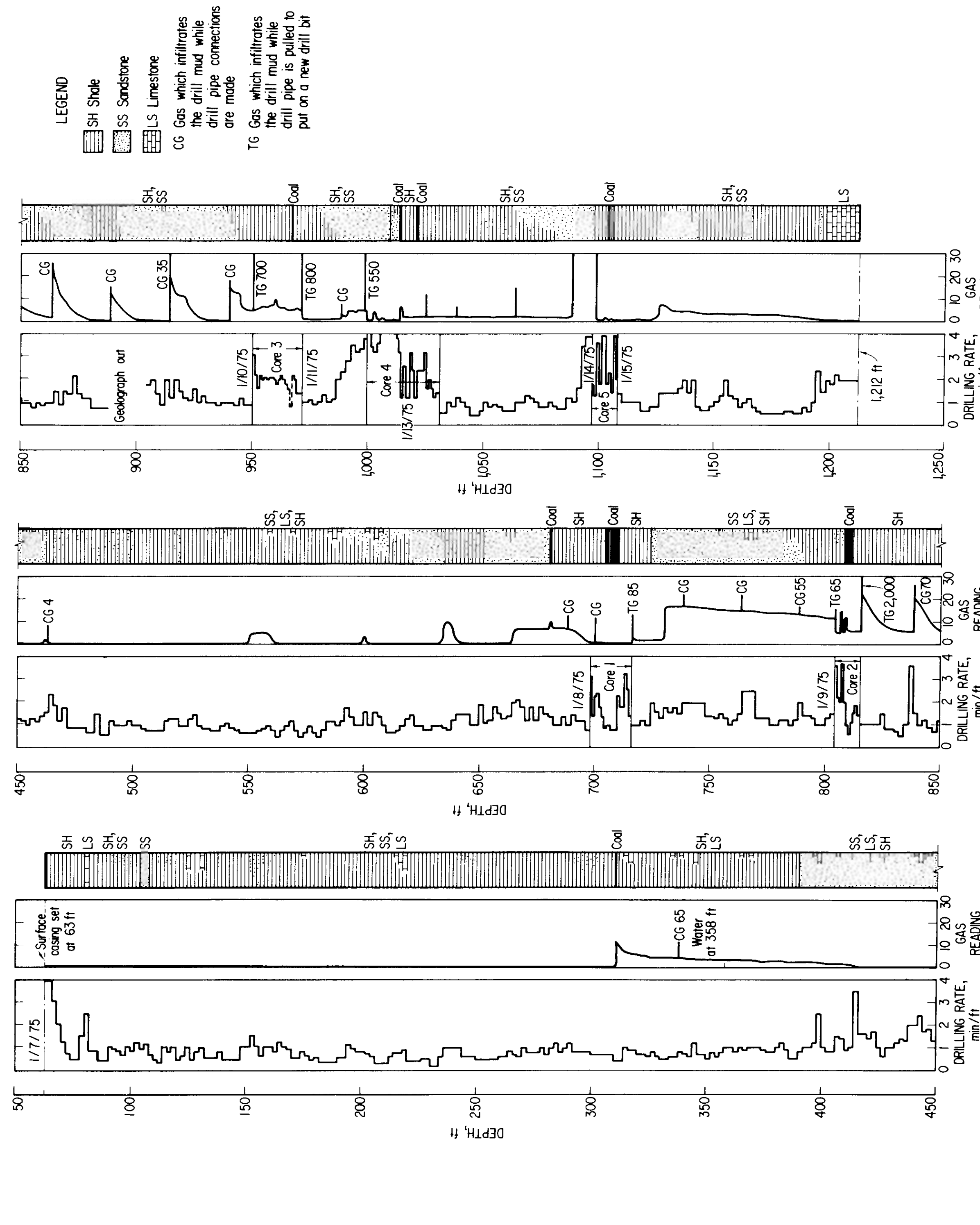

FIGURE 5. - Mud log of borehole 2.

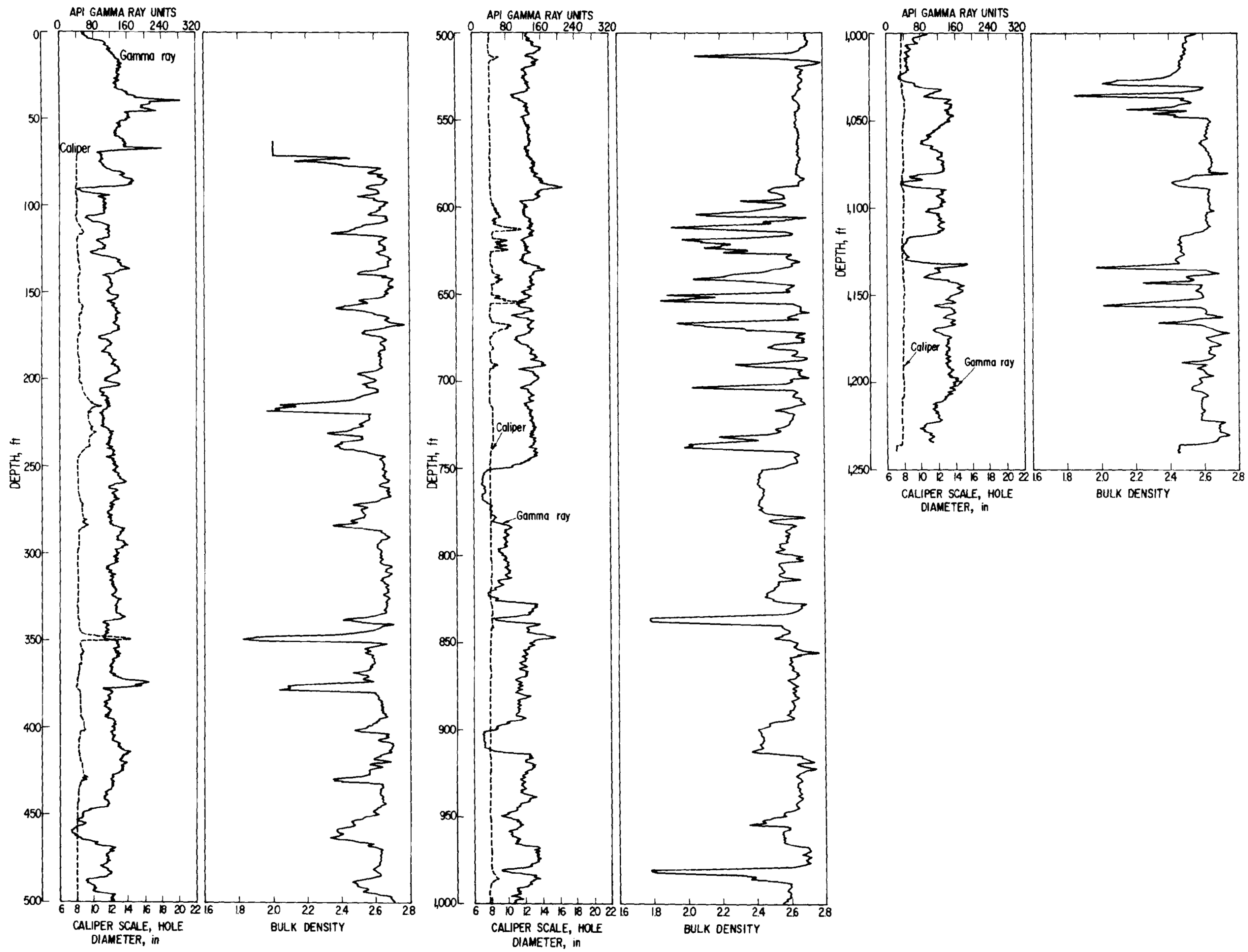

FIGURE 6. - Gamma ray-density caliper log of borehole 1.

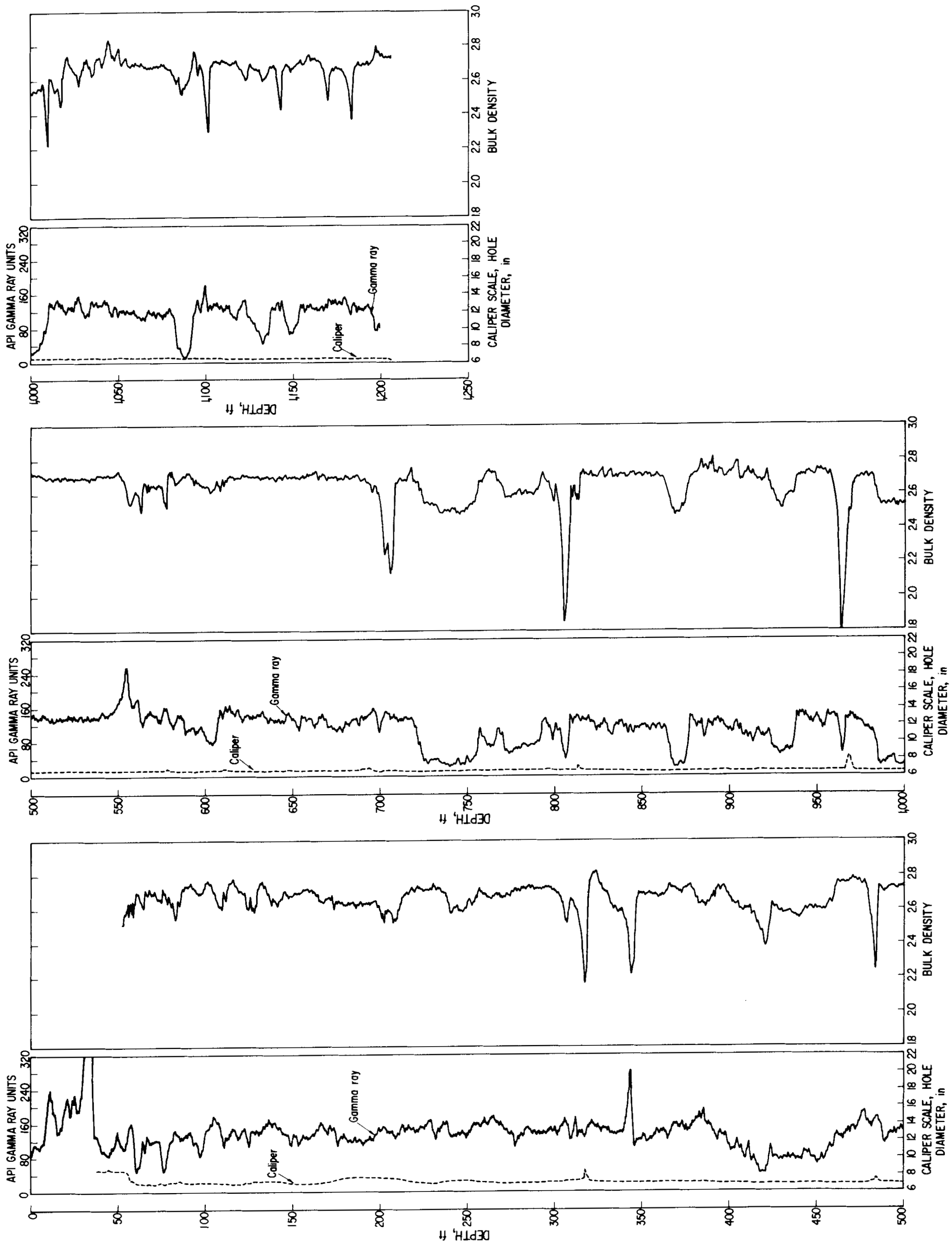

FIGURE 7. - Gamma ray-density caliper log of borehole 2.

FORMATION PRESSURES

Formation pressures were measured by a drill stem test (DST) in which a set of formation packers, special valves, and pressure-recording gages are introduced into the borehole on the end of a string of drill pipe (4). The formation packers are set to isolate a selected portion of the borehole and thereby allow fluids in the isolated zone to enter the drill pipe during flow periods. Formation pressures are measured in the isolated zone during shut-in periods. The valves allow for timed shut-in and flow periods. Five drill stem tests were conducted to determine pressures in four coalbeds encountered in borehole 1 (figs. 8-12). Formation pressures and gas and water recovery data are shown in table 1.

TABLE 1. - Drill stem shut-in pressure tests, borehole 1

No.	Test interval, feet	Coalbed	Coalbed interval, feet	Formation pressure, psig	Water in drill-pipe,[1] feet	Gas,[2] ft^3/day
DST 1	1,048-1,238	Mercer......	1,135-1,136	361	315	5,890
DST 2	1,128-1,238	...do.......	1,135-1,136	473	280	2,000
DST 3	970- 992	Clarion.....	980- 983	319	310	800
DST 4	819- 847	Middle Kittanning.	834- 838.5	293	310	([3])
DST 5	726- 747	Freeport....	728- 730 (upper) 733- 737 (lower)	292	300	([3])

[1]Water recovery was measured in feet of water in the drill string when test tools were removed from borehole.

[2]Gas flows were measured at the surface with an orifice meter during the first flow period of test.

[3]No gas to surface.

NOTES.--Gas flows in tests 1 and 2 are attributed to a 14-foot-thick sandstone overlying the 1-foot-thick Mercer coalbed. Pressure in Mercer coalbed is assumed to be equivalent to pressure recorded because of close proximity of sandstone to the coalbed. Pressure curves and reduced flow in test 2 indicate a depleting reservoir of limited volume.

Gas flow in test 4: 10 feet of water frothed with gas.

Gas flow in test 5: 40 feet of water frothed with gas.

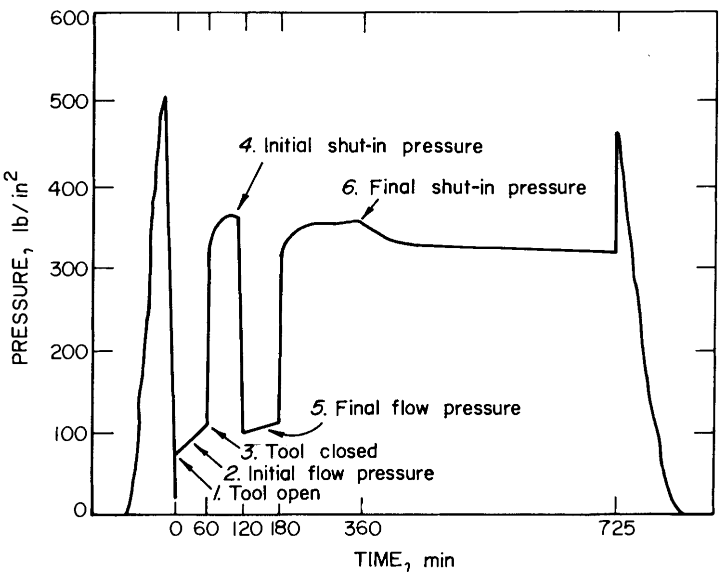

FIGURE 8. - Pressure chart, drill stem test 1, Mercer coalbed interval.

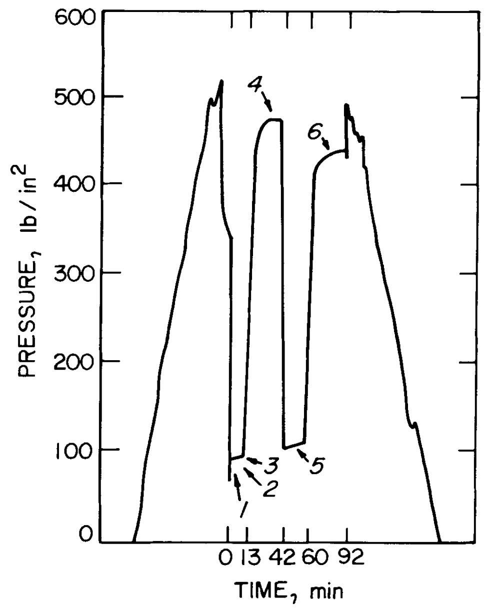

FIGURE 9. - Pressure chart, drill stem test 2, Mercer coalbed interval. Italicized numbers are explained in figure 8.

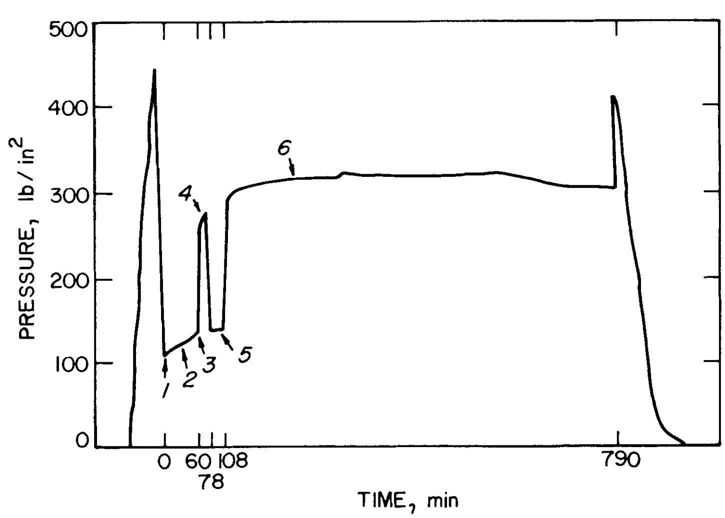

FIGURE 10. - Pressure chart, drill stem test 3, Clarion coalbed. Italicized numbers are explained in figure 8.

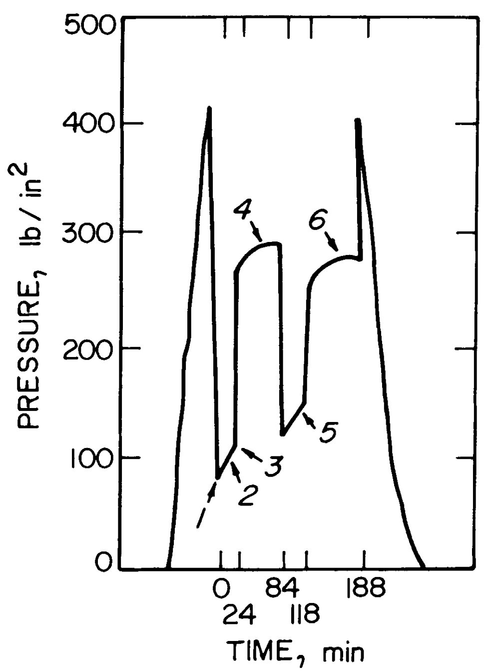

FIGURE 11. - Pressure chart, drill stem test 4, Middle Kittanning coalbed. Italicized numbers are explained in figure 8.

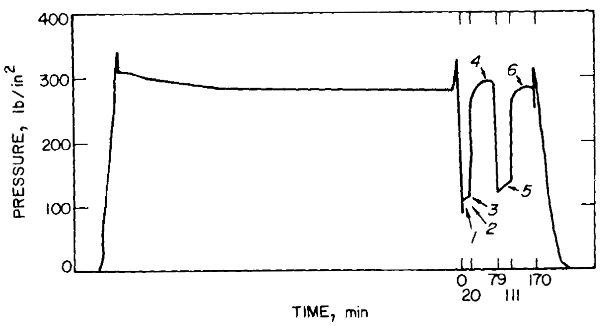

FIGURE 12. - Pressure chart, drill stem test 5, Freeport coalbed. Italicized numbers are explained in figure 8.

The Brookville coalbed was not tested. Formation pressures for all the coalbeds were plotted versus depth and compared with hydrostatic pressures (fig. 13). All formation pressures were less than hydrostatic, indicating that there are no abnormally high pressures in the coalbed. The formation pressures in the coalbeds appear to be controlled by the local piezometric water level in each coalbed (6, p. 819).

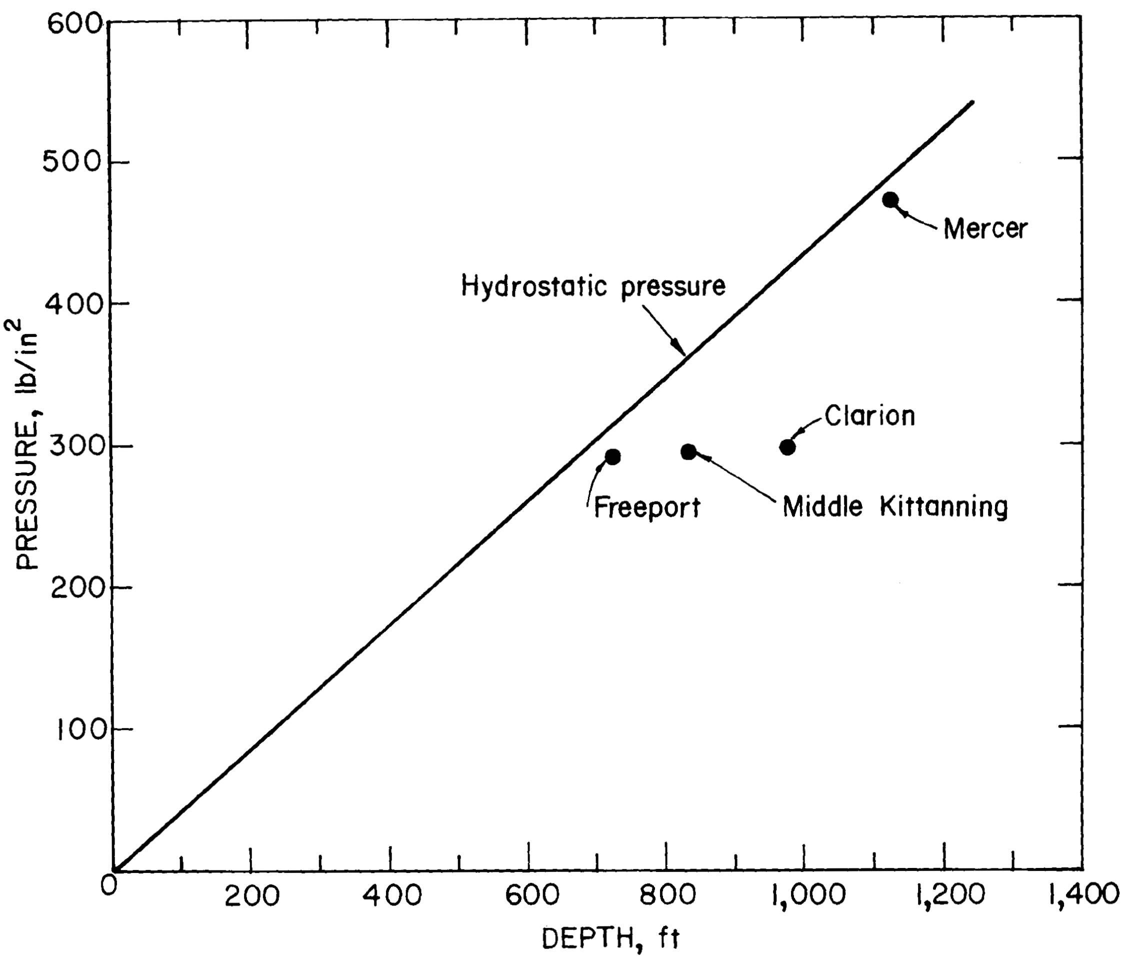

FIGURE 13. - Plot of coalbed pressures versus depth.

GAS CONTENT OF COALBEDS

During drilling of boreholes 1 and 2, coalbed cores were taken when possible, for analysis by the Bureau of Mines direct method of determining mining coalbed gas content (5). When core drilling was done using air as a drilling medium, desorption of gas was plotted versus square root of time to graphically determine gas loss between coring and insertion into sample container. The coal samples were allowed to desorb to completion at atmospheric pressure. Results are summarized in table 2. Proximate analyses were made of the core samples of coals to determine the approximate amount of inert mineral matter present, which can be roughly equated to ash percentage. The inert mineral matter does not adsorb gases (appendix). Gas concentrations for the coals on an ash-free basis were calculated for comparative purposes to show relation of gas concentration to depth and determine geological factors which could cause anomalous low gas concentrations in some coalbeds.

TABLE 2. - Gas content of coalbeds

Coalbed	Sample, grams	Released gas, cm^3 (STP)	Gas concentration		Coalbed thick-ness, feet	Gas concen-tration (ash-free basis), cm^3/g (STP)	Ash,[1] pct
			Cm^3/g (STP)	Ft^3/ton			
Freeport:							
Upper bench....	3,195	1,516	0.4	15	2	1.3	[2]63.8
Lower bench....	3,143	5,940	1.8	61	4	4.0	[2]53.2
Middle Kittanning	2,336	12,071	5.1	165	4-1/2	5.9	12.4
Clarion..........	1,855	5,505	2.9	95	3	3.9	24.5
Brookville.......	2,000	5,730	2.8	92	1	3.2	11.2
	2,520	6,504	2.5	83	1	6.2	58.1
Mercer...........	1,888	3,110	1.6	53	1	2.2	26.6

[1]Percent ash from proximate analysis of coalbed (appendix).
[2]The Pennsylvania Geological Survey reports the Upper Freeport coalbed is variable in composition and may locally be "dirty" (8).

Based on thickness, the Freeport, Middle Kittanning, and Clarion are the more important coalbeds for gas production in the study area. Differences in the gas content of the coalbeds may be due to the depth, physical differences in the coals, and sedimentary environmental histories of the individual beds (1).

In the Freeport, Middle Kittanning, and lower bench of the Brookville beds, where shale roof and floor inhibit gas migration from the coal, the gas content increases with depth (table 2). The Clarion, upper bench of the Brookville, and Mercer coals have anomalously low gas contents. These coals have porous gas-laden sandstone roof rock, or gas-laden sandstone in close proximity. Gas from these coals may have migrated into the sandstone, depleting gas concentration in the coalbeds.

The mineral content of coalbeds reduces their adsorptive capacity. The greater the mineral matter content, the lower the gas content per unit weight of coal at standard temperature and pressure (STP).

GAS AND WATER ANALYSES

Samples of gas and water were taken from the two boreholes and analyzed (tables 3 and 4). The gases from the coals in borehole 1 and from the Middle Kittanning coalbed in borehole 2 are similar in composition to gases from other Pennsylvanian coalbeds. Typically, coalbed gas is high in methane and has only trace amounts of higher hydrocarbon gases. One gas sample obtained from the Middle Kittanning coalbed soon after stimulation treatment had an anomalously high hydrogen and CO_2 content, which may be due to chemical reactions in the acid in the gelled water used during the stimulation treatment.

TABLE 3. - Gas sample analyses, percent

Coalbed	H_2	CH_4	C_2H_6	C_3H_8	C_4H_{10}	C_5H_{12}	O_2	N_2	CO_2	CO
Kittanning, borehole 2[1]...	2.3	84.4	0.25	0.07	0.018	0.0035	1.4	6.2	5.3	ND
Composite, borehole 1[2]....	.35	95.8	1.8	.32	.044	.0035	.2	1.5	.004	ND
Kittanning[3]..............	ND	80.1	.1	.04	.006	.0012	3.7	14.9	1.2	ND

ND--Not detected.

[1]High hydrogen and carbon dioxide percentages in this sample are attributed to chemical reactions of the acidic hydraulic stimulation fluid in the borehole. The sample was taken soon after stimulation treatment (sample date, March 14, 1975).

[2]This is a composite gas sample from all coalbeds in borehole 1 because all coal intervals were perforated to allow for gas flow.

[3]There was some air contamination during sampling (sample date, July 7, 1976).

TABLE 4. - Water sample analyses

	Composite from borehole 1	Kittanning coalbed, borehole 2
pH........................	10	6
Alkalinity............ppm..	93	415
Dissolved solids......ppm..	43,140	62,700
Sulfate as SO_4........ppm..	119	115
Calcium as $CaCO_3$......ppm..	6,318	2,300
Magnesium as $CaCO_3$....ppm..	692	9,200
Iron.................ppm..	0	30
Potassium.............ppm..	8.3	0
Sodium................ppm..	12,800	20,000
Chloride..............ppm..	25,200	36,000

Water samples from the coalbeds showed a high concentration of dissolved solids and salts.

HYDRAULIC STIMULATION

Hydraulic stimulation is a process used to increase fluid flow from a formation. Stimulation is achieved by inducing or extending a vertical parting in a selected section of a formation or coalbed by applying hydraulic pressure with controlled injection of gelled water or other fluids (2).

The Kittanning coalbed in borehole 2 was hydraulically stimulated on January 21, 1975, using 30,000 gallons of water premixed with 1,800 pounds of My-T-Gel[4] and 20,000 pounds of 10- to 20-mesh sand as a propping agent. The initial fracture was induced in the coalbed with 4,000 gallons of water containing 60 pounds of WG-6 gel. Following this, the sand-laden My-T-Gel fracturing fluid was injected to extend and prop the fracture. The treatment was completed by flushing the sand-laden fluid from the casing.

The coalbed fractured at 2,400 psig (fig. 14). The average treating pressure throughout the job was 1,500 psig at an average injection rate of 13.2 bbl/min. During the treatment 20,000 pounds of 10- to 20-mesh sand proppant was used. A chemical breaker was mixed with the gel to break the high viscosity of the fluid for recovery and cleanup of the borehole. The instant close-in pressure after treatment was 800 psig; the pressure declined to 700 psig in 10 minutes.

Since treatment, gas and water emissions from borehole 2 have been very low (350 to 1,350 ft^3/day and 2 to 3 bbl/day water). This is attributed to formation blockage by formation water in very small pores, coal fines, and gel residue. The breakdown of the gel depends partially upon heat and pressure.

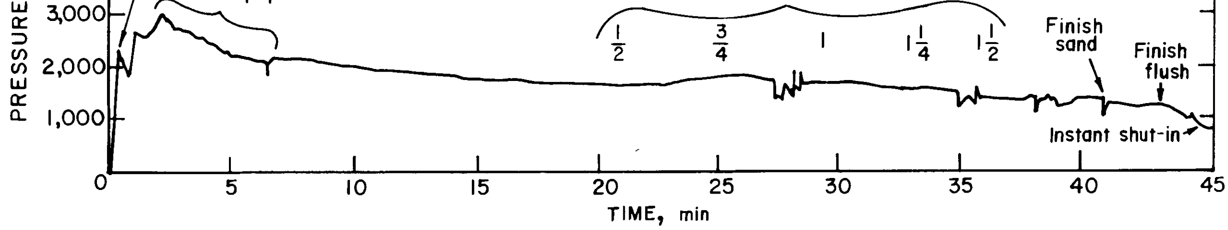

FIGURE 14. - Hydraulic stimulation pressure and flow charts.

[4]Reference to specific products does not constitute endorsement by the Bureau of Mines.

The fact that treatment was done in January during very cold weather with cold water in a low-pressure formation suggests that the gel that was squeezed into very small pores did not break down easily, and that the pressure was too low to move the gel or gel residue from the low-permeable paths.

SUMMARY

There are five coalbeds below the Pittsburgh coalbed in the Bruceton Station area. Two of these coals, the Upper Freeport and Middle Kittanning, are more than 3 feet thick and are at minable depths. During the Bureau's studies the coalbed formation gas pressures were less than hydrostatic for the depth of the coalbeds.

The gas content of the coalbeds ranged from 15 to 165 ft^3/ton--the Kittanning coalbed having the highest. The gas content of the coalbeds is affected by its mineral content, which reduces its adsorption capacity. Migration of gas to porous sandstones in close proximity to some of the coalbeds (Clarion, Brookville, and Mercer) may also be a cause of the lower gas content observed in these coals.

Hydraulic stimulation with very heavy gelled fluid was not effective in increasing gas flow for degasification. Production rates of water were very low, indicating blockage by gel residue and fine coal particles, and water production averaged only 2 to 3 bbl/day. Gas production fluctuated from 350 to 1,350 ft^3/day during extended production intervals; such fluctuations usually result from changes in water production due to pump stoppage.

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APPENDIX.--ULTIMATE AND PROXIMATE COAL ANALYSES

	As received	Moisture free	Moisture and ash free
MIDDLE KITTANNING BED			
Proximate analysis, percent:			
Moisture	1.1	NAp	NAp
Volatile matter	36.5	36.9	42.2
Fixed carbon	50.0	50.6	57.8
Ash	12.4	12.5	NAp
Ultimate analysis, percent:			
Hydrogen	4.9	4.8	5.5
Carbon	70.7	71.5	81.7
Nitrogen	1.1	1.1	1.3
Sulfur	7.3	7.4	8.5
Oxygen (indirect)	3.6	2.6	3.0
Ash	12.4	12.5	NAp
Heating value.....Btu/lb..	-	-	15,092
CLARION BED			
Proximate analysis, percent:			
Moisture	1.3	NAp	NAp
Volatile matter	29.8	30.2	40.2
Fixed carbon	44.4	44.9	59.8
Ash	24.5	24.9	NAp
Ultimate analysis, percent:			
Hydrogen	4.3	4.2	5.6
Carbon	61.5	62.3	82.9
Nitrogen	1.0	1.0	1.4
Sulfur	2.5	2.5	3.3
Oxygen (indirect)	6.2	5.1	6.8
Ash	24.5	24.9	NAp
Heating value.....Btu/lb..	-	-	14,838
FREEPORT BED--UPPER BENCH			
Proximate analysis, percent:			
Moisture	1.7	NAp	NAp
Volatile matter	17.6	17.9	51.1
Fixed carbon	16.9	17.2	48.9
Ash	63.8	64.9	NAp
Ultimate analysis, percent:			
Hydrogen	2.5	2.3	6.6
Carbon	25.2	25.6	72.9
Nitrogen	.5	.5	1.4
Sulfur	1.9	2.0	5.6
Oxygen (indirect)	6.2	4.8	13.6
Ash	63.8	64.9	NAp
Heating value.....Btu/lb..	-	-	12,620
FREEPORT BED--LOWER BENCH			
Proximate analysis, percent:			
Moisture	1.6	NAp	NAp
Volatile matter	20.7	21.1	46.0
Fixed carbon	24.5	24.8	54.0
Ash	53.2	54.1	NAp

NAp--Not applicable.

	As received	Moisture free	Moisture and ash free
FREEPORT BED--LOWER BENCH--Continued			
Ultimate analysis, percent:			
Hydrogen	2.9	2.9	5.9
Carbon	34.9	35.5	77.4
Nitrogen	.6	.6	1.3
Sulfur	1.7	1.7	3.8
Oxygen (indirect)	6.7	5.3	11.6
Ash	53.2	54.1	NAp
Heating value...Btu/lb..	-	-	13,632
BROOKVILLE BED--UPPER BENCH			
Proximate analysis, percent:			
Moisture	1.1	NAp	NAp
Volatile matter	38.7	39.1	44.1
Fixed carbon	49.0	49.6	55.9
Ash	11.2	11.3	NAp
Ultimate analysis, percent:			
Hydrogen	5.2	5.2	5.8
Carbon	73.8	74.6	84.1
Nitrogen	1.1	1.1	1.3
Sulfur	2.7	2.7	3.0
Oxygen (indirect)	6.0	5.1	5.7
Ash	11.2	11.3	NAp
Heating value...Btu/lb..	-	-	15,391
BROOKVILLE BED--LOWER BENCH			
Proximate analysis, percent:			
Moisture	1.3	NAp	NAp
Volatile matter	20.2	20.5	49.7
Fixed carbon	20.4	20.7	50.3
Ash	58.1	58.8	NAp
Ultimate analysis, percent:			
Hydrogen	2.6	2.5	6.1
Carbon	30.3	30.7	74.6
Nitrogen	.4	.4	1.0
Sulfur	1.0	1.0	2.5
Oxygen (indirect)	7.5	6.5	15.7
Ash	58.1	58.8	NAp
Heating value...Btu/lb..	-	-	13,140
MERCER BED			
Proximate analysis, percent:			
Moisture	1.5	NAp	NAp
Volatile matter	31.9	32.4	44.4
Fixed carbon	40.0	40.6	55.6
Ash	26.6	27.0	NAp
Ultimate analysis, percent:			
Hydrogen	4.1	4.0	5.5
Carbon	56.2	57.0	78.0
Nitrogen	.9	.9	1.2
Sulfur	11.0	11.2	15.3
Oxygen (indirect)	1.3	.0	.0
Ash	26.6	27.0	NAp
Heating value...Btu/lb..	-	-	14,831

NAp--Not applicable.

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