

THE DUMMITT-PALMER # 1 COAL-BED  
METHANE TEST WELL, LEE COUNTY,  
NORTH CAROLINA

NORTH CAROLINA GEOLOGICAL SURVEY  
OPEN-FILE REPORT 91-1

DIVISION OF LAND RESOURCES  
DEPARTMENT OF ENVIRONMENT, HEALTH,  
AND NATURAL RESOURCES



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**STATE OF NORTH CAROLINA  
JAMES G. MARTIN, GOVERNOR**

**DEPARTMENT OF ENVIRONMENT,  
HEALTH, AND NATURAL RESOURCES  
WILLIAM W. COBEY, JR., SECRETARY**



# **The Dummitt-Palmer # 1 Coal-bed Methane Test Well, Lee County, North Carolina**

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**Charles W. Hoffman and Richard A. Beutel**

## **ABSTRACT**

The Dummitt-Palmer # 1 well was drilled to a total depth of 953 feet in December 1981 and January 1982. The project was designed to test the methane gas content of coal beds within the Cumnock Formation of the Sanford Triassic basin. This report presents a synopsis of the project's final report and of other information contained in the North Carolina Geological Survey files. It also includes some additional information that was compiled after submission of the project's final report. The well site is located in Lee County, North Carolina, about 8 miles northwest of Sanford and was funded in part by a \$65,500 grant to Richard A. Beutel and Associates from the U. S. Department of Energy for alternative energy research. The North Carolina Energy Institute (agency no longer in existence, was within the former Department of Commerce) provided a supplemental grant of \$18,000 to attempt to complete the well as a commercial producer of coal-bed methane gas if preliminary results were satisfactory. Additional funding came from a consortium comprised of numerous members of the Brick Association of North Carolina. Two coal zones and one black shale zone were sampled and yielded gas recoveries of 12.1 cc/g, 9.6 cc/g, and 2.4 cc/g with BTU values of 986.85, 976.45, and 908.95 (as determined by James P. Ulery, U. S. Bureau of Mines, Pittsburgh Research Center). Stimulation via acid-foam frac had limited success and completion as a producing well was deemed unfeasible despite indications that about 40,000 cubic feet of good quality gas could be produced per day. The data gathered and lessons learned as part of the project may have bearing on future, similar ventures.

## **INTRODUCTION**

The Dummitt-Palmer # 1 well was drilled in December 1981 and January 1982. The main purpose of the project was to collect samples from the Deep River coal field and determine their gas content. A second purpose, if the test results warranted, was to attempt to complete the well as a commercial producer of methane gas. Richard A. Beutel and Associates of Chapel Hill operated the well and were partially funded by research grants of \$65,500 and \$18,000 from the U. S. Department of Energy (DOE grant number DE-FG44-81R410400) and from the North Carolina Energy Institute (an agency no longer in existence), respectively. Additional participants in the venture included numerous members of the Brick Association of North Carolina. Basic information on the well is given in Appendix A.

The Dummitt-Palmer test well was drilled within a major rift basin known as the Deep River Triassic basin. The Deep River basin is one of many such early Mesozoic rift basins that occur along the eastern North American continental margin from Georgia to Nova Scotia. The Deep River basin is subdivided into three distinct segments referred to as the Durham, Sanford, and Wadesboro basins (Figure 1).

More specifically, the Dummitt-Palmer test well is located within the Sanford basin, a 32-mile-long by 14-mile-wide northeast-southwest-trending half-graben structure filled predominantly with clastic sedimentary rocks of Late Triassic age. Figure 2 illustrates the location and geologic setting of the well within the Sanford Triassic basin. It was drilled about 8 miles northwest of Sanford on the Lee County side of Deep River, near the Chatham County town of Gulf.

Reinemund (1955) conducted a detailed study of the Sanford basin. His study remains the single most authoritative work on the area. He mapped several northeast-southwest-trending high-angle normal faults in the Sanford basin and estimated displacements ranging from 700 to 2,200 feet. Numerous northwest-southeast-trending cross-faults with vertical displacements ranging from a few feet to several hundred feet were also mapped.

The basin's stratigraphic section consists of three formations. From oldest to youngest these are the Pekin, Cumnock, and Sanford Formations. These units are part of the Chatham Group which is part of the Newark Supergroup. The Pekin and Sanford Formations are similar in that they consist of red to brown siltstone and claystone interbedded with sandstone and minor conglomerate. The Cumnock Formation is distinct from the other two units. It is organic-rich and consists of gray to black shale and siltstone with several thin coal interbeds. Two coal units occur in the middle of the Cumnock Formation. The lower of these is the Gulf coal, which averages two feet in thickness. The upper coal is the Cumnock coal and it averages four feet in thickness. The coal beds are separated by 40 to 60 feet of gray shale, siltstone, and sandstone.

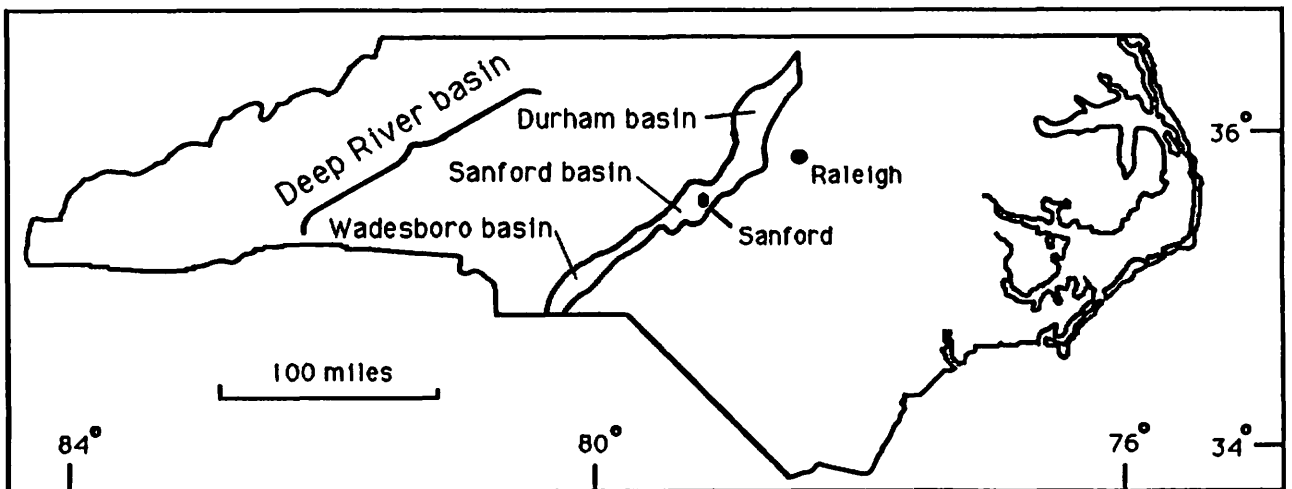


Figure 1. Location and segments of the Deep River basin within North Carolina.

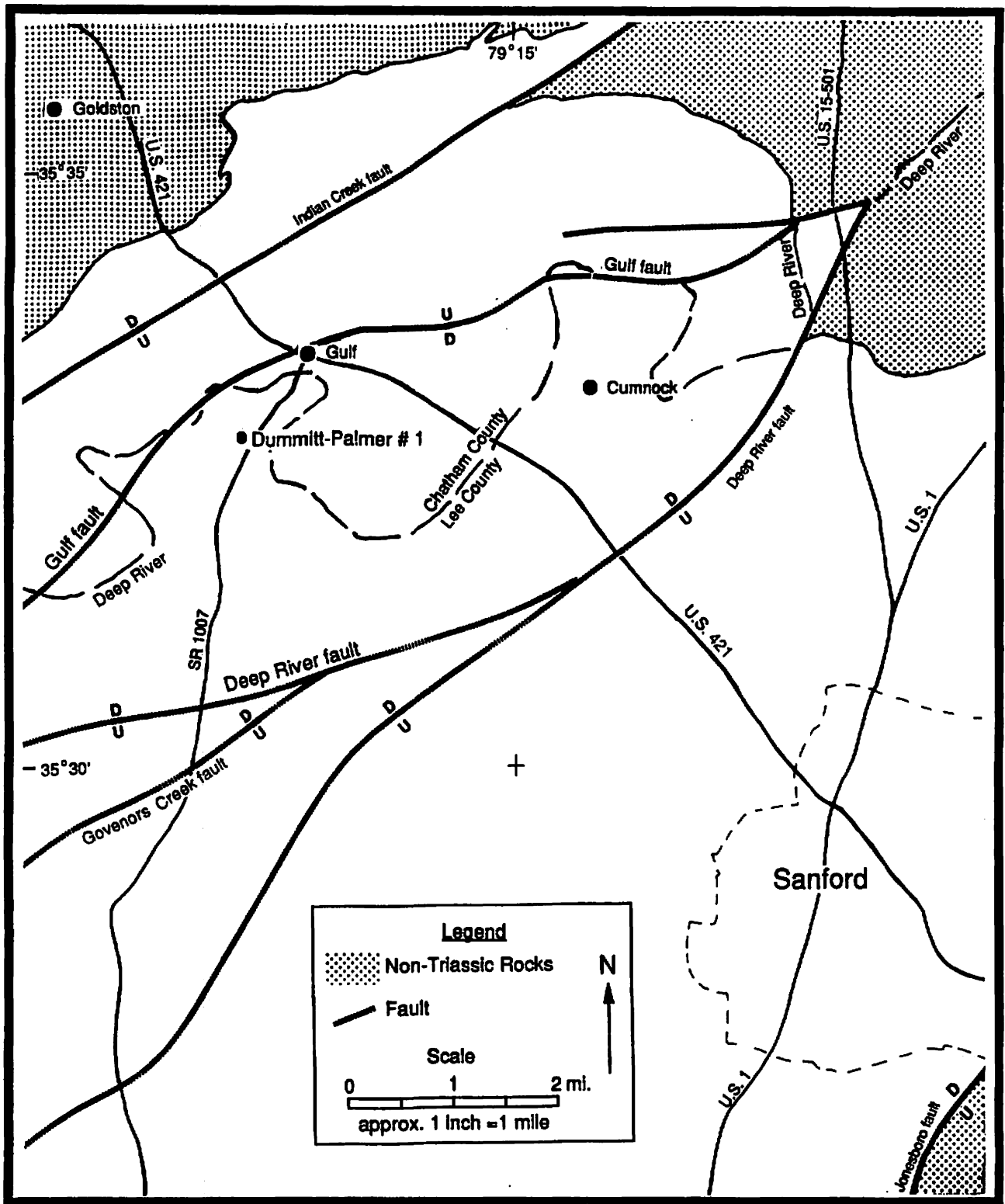


Figure 2. Map showing location of the Dummitt-Palmer #1 coal-bed methane test well in the middle portion of the Sanford Triassic basin. Geology is generalized from Reinemund (1955).

The Cumnock Formation is thickest and the coal beds are best developed in the north central portion of the Sanford basin, northwest of the Deep River fault. Maximum thickness of the Cumnock Formation, near the town of Cumnock, is about 800 feet. This is where coal thickness is also greatest, with a maximum aggregate thickness of about 8 feet. Southeastward from this area, the Cumnock Formation thins and coarsens. The coal beds pinch out about 2 miles northwest of Sanford.

## **THE DUMMITT-PALMER #1 PROJECT**

### **DRILLING OPERATIONS**

Siting of the Dummitt-Palmer test well was based primarily on Reinemund's mapping. The goals were to test the coal in the area where it was thickest and where the drilling would be relatively shallow (less than 2,000 feet - to satisfy budget constraints). This focussed the exploration along the southeast side of the Gulf fault and led the venture to its ultimate location.

The first two attempts to drill into the Deep River coals were foiled by extensive diabase and water flows in the boreholes of approximately 100 gallons per minute. Both of these holes were abandoned at a depth of 400 feet. The rig was then located about 50 feet downdip for the next hole. This third attempt was successful and the well reached total depth of 953 feet on January 19, 1982. The well configuration consisted of 42 feet of 7-inch surface casing, 665 feet of 4-1/2-inch well casing, and 288 feet of 3-inch open hole to total depth. The 3-inch hole was continuously cored with a diamond bit that obtained nearly complete recovery.

### **GEOLOGY**

Appendix B is the lithologic log of the Dummitt-Palmer #1 drill hole. The log reflects the highly fractured nature of the section that is likely related to the well's proximity to the Gulf fault. It also reflects considerable alteration associated with diabase intrusion. A 214-foot-thick body of diabase was drilled from 362 to 584 feet. Two thin conformable stringers of diabase were drilled from 751'5" to 754'7" and from 869' to 869'4".

The top of the Cumnock is interpreted on the lithologic log at the base of the main diabase body (584 feet), but alteration caused by contact metamorphism makes the call equivocal. At a depth of about 620 feet, gray to black shales diagnostic of the Cumnock Formation occur in the section. Three thin coal beds comprise the Cumnock coal between 900' and 909'6" and another thin coal bed represents the Gulf coal at 952'2" to 952'10-1/2". The Cumnock Formation as a whole is highly carbonaceous with indications of hydrocarbons. An oil show occurred at 760 feet. Gas shows occurred from 825 to 879 feet, from 885 to 895 feet, and from 920 feet to 947 feet.

## ANALYTICAL RESULTS

During coring, Mr. James P. Ulery of the U. S. Bureau of Mines, Methane Control Section, Pittsburgh Research Center was on site and obtained three samples for laboratory analysis. These samples represent the Cumnock coal section (900'-901'6"; 903'6"-907'6"; 908'-909'6"), the Gulf coal (951'6"-952'3.5"), and black carbonaceous shale from immediately above and below the Gulf coal section (950'5"-951'6"; 952'3.5"-952'8.5"). The discrepancy in the depth of the Gulf coal reported by Mr. Ulery and the depth shown on the lithologic log of the hole is not understood for certain but is not considered significant. Geophysical logs run after drilling could more precisely identify the coal interval but they do not record this part of the section because of proximity to the bottom of the hole.

Analysis consisted of placing the field samples in pressurized containers for transport to the laboratory. A certain amount of gas, termed lost gas, is lost by escape to the atmosphere prior to sealing of the sample. This value is estimated based on the time elapsed prior to sample containment, the drilling medium, and the amount of gas given off by the sample after containment. Desorbed gas is that gas which escapes from the sample and is captured in the sample container. This is bled off and measured periodically for several months. Some additional gas, termed residual gas, still remains in the sample after desorption is complete. To measure this, 200-300 grams of the sample is crushed in a sealed ball mill and the released gas is bled off and measured directly. The total of lost gas, desorbed gas, and residual gas represents the total gas contained in the coal.

Tables 1 and 2 summarize the U. S. Bureau of Mines analytical results. The two coal sections yielded significantly higher concentrations of gas versus the shale section. Nitrogen was higher (at the expense of methane) in the shale gas and the BTU value of the shale gas was somewhat lower than the values for the coal samples. None of the samples gave an odor of sulfur. Overall, these values indicate a resource of merchantable quality. However, additional testing will be required to determine if gas of this quality is present and recoverable in sufficient quantity to make a venture economically viable.

## FOAM FRAC

Having accomplished the primary objective to recover and analyze samples of the Cumnock Formation, the secondary objective of testing the viability of gas production was undertaken. Dowell Division of Dow Chemical, U.S.A. was engaged to engineer and perform a frac treatment. The purpose of such treatment is to enlarge the drainage diameter of the drill hole by injecting sand into the formation at a high pressure. The pressure creates fractures in the formation and the sand fills those fractures and keeps them open. A 42,000 gallon foam frac treatment was selected as the most appropriate for this well. This involved injection of 25,000 pounds of 20/50 mesh sand, 200,000 cubic feet of nitrogen, and about 400 barrels (17,000 gallons) of fresh water. The nitrogen and water, along with other chemical



Table 1 Gas content of core samples from Dummitt-Palmer #1

Sample	Sample Weight (g)	Lost Gas(cc)	Desorbed Gas (cc)	Residual Gas(cc)/Crushed Samp. Wt.(g)	Total Residual Gas (cc)	Desorbable Gas (cc/g)	Residual Gas (cc/g)	Total Gas (cc/g)
Cumnock coal	1,020	294	9,185	125/460	277	9.3	0.3	9.6
Gulf coal	684	199	7,587	230/332	474	11.4	0.7	12.1
Black shale	1,484	185	3,050	115/657	260	2.2	0.2	2.4

Table 2 Gas analysis - from 20 ml samples of desorbed gas

Sample	H2	O2+Ar	N2	CO2	CH4	CO	C2H6	C3H8	C4H10	C4H12	Other	
											HC's	BTU*
Cumnock coal	ND	0.40	2.40	0.24	96.95	ND	0.024	ND	ND	ND	ND	986.85
Gulf coal	ND	0.12	3.05	0.16	96.40	ND	0.27	<2ppm	ND	ND	ND	976.45
Black shale	ND	0.28	10.85	0.17	88.40	ND	0.30	0.0003	<2ppm	ND	ND	908.95

ND = not detected

From U. S. Bureau of Mines

\* Average of 2 determinations

additives, act as a transport medium for the sand. The various additives aid in the removal of surplus fluids after treatment and enhance the movement of gas to the borehole. The "frac job" was performed in June 1982. In the test hole, fluids were added at rates of up to 50 barrels per minute and the formation fractured at about 1,000 pounds per square inch.

## DISCUSSION

Performing the frac treatment in about 290 feet of open hole proved to be a problem. Borehole pressures were insufficient to produce fluid velocities that would maintain a clean hole. Thus, fluids continuously accumulated in the borehole and had to be swabbed out. Despite this problem, overnight build up of surface pressure indicated a bottom-hole pressure of about 200 pounds per square inch.

The hole remained open for testing and experimentation until March 1984. During this period, a string of 1-1/2 inch tubing was run into the open hole. Numerous combinations of packers at various depths were used to determine where gas and water were entering the borehole. This experimentation indicated that the main penetration of the frac treatment was along the base of the thin diabase sill drilled from 751'5" to 754'7". Much of the gas and most of the water was being produced from this zone. This would suggest that gas was migrating upward through fractures in the Cumnock Formation and that the diabase acted as a trapping mechanism. A very approximate estimate of the gas produced from the well during the testing period is 40,000 cubic feet per day. It should be emphasized that the testing was not rigorous and that the results obtained are only semi-quantitative. Water flow was about 5 gallons per minute.

An alternative technique that might have resulted in a successful completion but that was not feasible within the project budget would have been to case off the bottom portion of the hole, perforate it at selected intervals, and treat these individually. This technique would have provided a fairly definitive test of gas pressures and might have permitted a better defined assessment of the resource potential.

## REFERENCE CITED

Reinemund, J. A., 1955, Geology of the Deep River coal field North Carolina: U.S. Geological Survey Professional Paper 246, 159 p.

## APPENDIX A - BASIC INFORMATION ON DUMMITT-PALMER #1 TEST WELL

API Number: 32-055-00002

County: Lee Civil Township: Pocket

Lease Holder: Gus Palmer, Jr.

North Carolina Database Well Code: LE-OT-1-82

North Carolina Drilling Permit Number: 82-01

Date: April 19, 1982

Total Depth: 953 feet

Operator: Richard A. Beutel and Associates, Chapel Hill, North Carolina

Location: Latitude: 35°32'45" N

Longitude: 79°17'45" W

Elevation: Ground Level - 234 Feet; Kelly Bushing - 236 feet

Spud: November 12, 1981; TD: January 19, 1982; Foam-frac: June 14, 1982;

Plug and Abandon: March 9, 1984

Drilling and Completion Supervision: Patterson Exploration Company, Sanford, N.C.

Drilling Tools: Mud Rotary (3-inch diamond core - 668.5 feet to 953 feet)

Geophysical Logs: Coal Lithology, SP and Resistivity, Sonic, Neutron,  
Micro-resistivity, Detailed Sonic, Seam Thickness

Logging Contractor: BPB Instruments., Incorporated, Nitro West Virginia

Shows: Oil - 760 feet Gas: 825-879 feet; 885-895 feet; 920-947 feet

## APPENDIX B DRILLERS LOG OF DUMMITT-PALMER #1 TEST WELL

Log By: James E. Jones, III and O. F. Patterson, III, Patterson Exploration Services

<u>From</u>	<u>To</u>	<u>Description and Remarks</u>
0'	42'	7" Pit Casing - No samples taken
SANFORD FORMATION		
42'	55'	Red to blue sandstone, hard
55'	80'	Shale, red to blue, soft
80'	105'	Shale, red to gray; 4 GPM water at 105'
105'	130'	Shale, red to bluish gray, soft 105-120, hard 120'-130'
130'	150'	Red sandy shale to 143'. Soft blue-gray shale at 143'-150' Carbon floating on water since 90'
150'	170'	Soft blue-gray shale to 155', red to blue, soft to medium, fine-grained sandstone to 170'; 15 GPM water at 165'
170'	190'	Red sandy shale, soft to medium
190'	210'	Red sandy shale, soft to medium
210'	230'	Red sandy shale, soft to medium
230'	250'	Red to bluish-gray sandy shale, soft to medium
250'	270'	Red to bluish-gray sandy shale, soft to medium; more water at 260'.



<u>From</u>	<u>To</u>	<u>Description and Remarks</u>
270'	290'	Red sandy shale, soft to hard
290'	310'	Red sandy shale, soft to hard
310'	330'	Red sandy shale, soft to hard
330'	350'	Red to bluish-gray sandy shale, cuts fast, burnt
350'	370'	Red sandy shale changing to blue at 360', burnt, hard
370'	584'	Diabase (geophysical log shows diabase from 362-582')

### CUMNOCK FORMATION

584'	590'	Brown shale, moderately hard
590'	600'	Brown shale, moderately hard, blue gray when dried
600'	610'	Brown shale, moderately hard, blue gray when dried, Few pieces of black shale present
610'	620'	Brown to black shale
620'	630'	Gray to black shale. Some calcite and pyrite
630'	640'	Black and gray shale, more pyrite
640'	650'	Black and gray shale, softer, no pyrite
650'	660'	Black shale
660'	668' 6"	Black shale

Begin coring 668' 6"

668' 6"	674' 10"	Black shale, burnt, hard, with some pyrite
674' 10"	675' 1"	Black shale, fractures healed with calcite. Pyrite crystals following vertical fractures
675' 1"	678' 8"	Black shale, burnt, hard, some pyrite
678' 8"	678' 11"	Nodule-like gray silty shale with pyrite around edges
678' 11"	681' 1"	Black shale, hard, burnt, some pyrite
681' 1"	678' 8"	Black shale, burnt, with abundant pyrite, slightly calc
678' 8"	683' 4-1/2"	Black shale, burnt, with pyrite on fractures, some coking of carbonaceous material, contact zone at 683' 4-1/2"
683' 4-1/2"	684' 6-1/2"	Very fine-grained diabase sill. Sill conforming to bedding at about 10°. Contacts are clear and sharp
684' 6-1/2"	686' 2"	Black shale, burnt, hard, with some pyrite. Organic material coked, slightly calcareous
686' 2"	690' 3"	Black shale, burnt, some pyrite, fractured vertically at 70° with some shearing, most fractures sealed or healed with calcite. Organic material coked
690' 3"	692' 3"	Black shale, burnt, moderately calcareous, very small pyrite, bedding dipping at 10°-14°.
692' 3"	695' 5"	Black shale, burnt, calcareous, fractured, some evidence of shearing on fractures, organic material coked, calcite on fractures

<u>From</u>	<u>To</u>	<u>Description and Remarks</u>
695' 5"	713' 8"	Black shale, burnt, few fractures sealed with calcite, core somewhat mottled with dark gray, some banding of core with fine silty layers, highly calcareous, organics coked, large and small blebs of pyrite present
713' 8"	713' 11"	Black shale, burnt, fractured with calcite on fractures, calcareous
713' 11"	720' 10"	Black shale, burnt, with long vertical fractures total length of interval at about 85°-87°, total length of core sealed and healed with calcite, shale moderately calcareous
720' 10"	727' 9"	Black shale, burnt with few fractures, calcite on fractures
727' 9"	727' 10"	Gray silty shale, limey, highly calcareous, banded
727' 10"	730'	Black shale, burnt, slightly calcareous
730'	746' 6"	Black shale, burnt, vertical high-angle fractures sealed and healed with calcite
746' 6"	746' 10"	Brecciated limestone, gray.
746' 10"	751' 5"	Black shale, burnt, fractures sealed with calcite, organic material coked
751' 5"	754' 7"	Diabase sill, bottom contact irregular with black shale and calcite-banded bedded xenolith, bottom of diabase sheared, very slightly calcareous
754' 7"	759' 11"	Black shale, burnt, fractured, with calcite on fractures, <i>Estheria</i> , fish scales, ostracodes
759' 11"	770'	Black shale, burnt lightly, organics coked in part, 759' 11"-760' 2" soft fissile shale, oily smell, horizontal and vertical fractures, some calcite on fractures, all fractures smell oily, some oil on fractures. Light oil on drilling fluid, has crude oil odor. Some large pyrite blebs 765'-766'. <i>Estheria</i> , fish scales, ostracodes
770'	783' 8"	Black shale, sheared in part, very little metamorphism visible, moderately calcareous; <i>Estheria</i> , fish scales, ostracodes
783' 8"	784' 4"	Black slate, very hard, no structure with 1/2"-thick blackshale bed 2" from top; not calcareous.
784' 4"	803' 8"	Black shale, "blotched" with light gray shale, calcite on fractures, only slightly calcareous; shale is unaltered
803' 8"	804' 2"	Dark gray to black limestone, dense, with slickensides at 45° near bottom and 15° near top, with abundant carbonaceous material on slickensides

804' 2"	858' 8"	Black shale, carbonaceous, thinly bedded in part, fissile in part; 828'- clayey black shale; 837'- clayey, fissile black shale with <i>Estheria</i> , fish scales, ostracodes; all highly fractured, sheared in part, varies from soft to hard, some calcite on fractures 848'-858'
858' 8"	869'	Massive black shale, silty, bedded light gray 858'8"-860'6"; very few fractures, shale has mottled appearance when wet
869'	869' 4"	Diabase sill
869' 4"	884' 6"	Black shale, calcareous in part, highly fractured, carbonaceous, coaly in part, well defined bedding in part
884' 6"	892' 6"	Silty sandstone with shale streak or shale with sandstone streaks, hard
892' 6"	893' 8"	Interbedded gray clayey shale, sandy shale and black shale, very soft in part, highly fractured, friable
893' 8"	898'	Black shale, coaly in part, highly carbonaceous, fractured, sheared
898'	899'	Black boney shale, (would probably burn), soft
899'	900'	Black coaly shale, highly fractured
900'	901' 6"	<u>Coal</u> , Top Bench Cumnock coal bed
901' 6"	903' 6"	Black coaly shale, highly carbonaceous
903' 6"	907' 6"	<u>Coal</u> , Main Bench, Cumnock coal bed
907' 6"	908'	Black shale, carbonaceous, slightly calcareous, heavy (siderite in part, blackband)
908'	909' 6 "	<u>Coal</u> , Lower Bench, Cumnock coal bed
909' 6"	910' 6"	Black shale, 910 ' -910 ' 4" clayey
910' 6 "	915'	Sandstone with shale streaks or shale with sand streaks
915'	917' 8"	Black shale, friable in parts
917' 8"	920'	Light-gray fire clay, soft, some shaly bedding
920'	947' 7"	Gray argillaceous silty sandstone with shale streaks, in part, rooted and burrowed 920'-940' with some clayey streaks and, in part, fractured; 934'6"-935'4" is black sandy shale with carbonaceous layers
947' 7"	948' 5"	Gray fire clay
948' 5"	949' 8"	Black shale, highly carbonaceous, sheared
949' 8"	951' 2"	Gray fire clay
951' 2"	952' 2"	Black shale, "fizzing", emitting much gas, popping, and cracking
952' 2"	952' 10-1/2"	<u>Coal</u> , Gulf coal bed, much gas emitted.
952' 10-1/2"	953' 3"	Black to gray shale. TD

Note: Gas blew from the hole when adding rods or pulling core at the intervals 825'-870', 885'-895', 920'-947', and at 952'.



