AREAS RECOMMENDED FOR

TIGHT FORMATIONS

IN

FAYETTE AND RALEIGH COUNTIES

WEST VIRGINIA

TIGHT FORMATION COMMITTEE'S REPORT

January 1981

(Tight Formation Committee, 1981)

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(Source: West Virginia Geological and Economic Survey)

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(Tight Formation Committee, 1981)

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INTRODUCTION

This initial report of the West Virginia Tight Formation Committee covers only the two-county area of Fayette and Raleigh Counties evaluated as a pilot project. Further reports evaluating potential tight formations in other counties will follow. Sandstones recommended by the Committee as qualifying as tight formations are described in the first section of the report. In the second section the various types of geological and engineering data used in making these recommendations are described. The Committee's recommendations are based on calculations of expected in-situ permeabilities, stabilized natural production rates, and oil production rates, as outlined in the Federal Energy Regulatory Commission's guidelines for tight formations. The Committee also addresses the requirement of protecting fresh water aquifers before setting forth their final recommendations in a concluding section.

(Tight Formation Committee, 1981)

GEOGRAPHICAL AND GEOLOGICAL DESCRIPTION

Geographically, areas where formations are recommended as tight all underlie Fayette and Raleigh Counties, West Virginia. These two counties, located in south-central West Virginia, are outlined in red on Figure 1.

The recommended formations were all deposited within the Mississippian delta systems in the Appalachian Basin province. Figure 2 shows the general stratigraphic column for the south-central portion of West Virginia. The recommended formations are outlined in red on the column. A geological description of each formation, in descending stratigraphic order, is listed below.

1. Ravencliff Sandstone: The Ravencliff Sandstone lies below the Princeton Sandstone and above the Maxton Sandstones (see Fig. 2). The sandstone is gray to white, fine to medium grained, well sorted, with minor amounts of carbonaceous material. Composition of the Ravencliff Sandstone is ± 80% quartz, with the remaining 20% being kaolinite (primary), calcite, illite, mixed layer clays and chlorite. The Ravencliff ranges in thickness from thin stringers in the eastern portion of the two counties to a maximum thickness of 140 feet in the central portion of the area.

2. Injun-Squaw Sandstone: The Injun-Squaw Sandstone (hereafter referred to as Injun) lies below the Big Lime-Keener (see Fig. 2), separated by a 2 to 30 foot shale break. The sandstone is gray to red, very fine grained, poorly sorted, silty and micaceous. Composition of the Injun Sandstone is ± 70% quartz, with the remaining 30% consisting of clays, feldspar and calcite. The Injun Sandstone ranges in thickness from a maximum

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of ± 20 feet in northwestern Fayette County to thin stringers to the south and east.

3. Weir Sandstone: The Weir Sandstone lies ± 200 feet below the Injun Sandstone and ± 200 feet above the Berea Sandstone (see Fig. 2). The sandstone is gray to white, very fine grained, well sorted and argillaceous. The composition of the Weir Sandstone is ± 70% quartz, with the remaining 30% being kaolinite (primary), feldspar, illite, mixed layer clays and chlorite. The Weir ranges in thickness from 50 to 80 feet in the northeastern part of the two-county area to 100 feet thick in the southern portion of the area.

4. Berea Sandstone: The Berea Sandstone lies ± 200 feet below the Weir Sandstone and is the basal sandstone of the Mississippian System. The sandstone is gray, medium to fine grained, and poorly sorted. Composition of the Berea Sandstone is ± 70% quartz, with the remaining 30% being feldspars, clays and calcite. The Berea Sandstone reaches a maximum thickness of 55 feet in the northwestern portion of Fayette County and thins to shaly sandstone stringers throughout the southern portion of the evaluated area.

(Tight Formation Committee, 1981)

GEOLOGICAL AND ENGINEERING DATA

Permeability

Average in-situ permeability throughout the Ravencliff, Injun, Weir and Berea Sandstones is expected to be less than 0.1 md. except in those Field areas outlined in red on the attached formation maps (Figs. 3, 4, 5, and 6). The method used to determine permeabilities is described below.

The method of determining permeability involved the relationship between measured core porosities and permeabilities from existing core data. All the above sandstones are consistent in that those with low porosity exhibit little or no permeability, whereas those with high porosity exhibit fair to good permeability.

Ravencliff Sandstone Permeability

Two cores were analyzed, the Appalachian Exploration & Development #1 Bell (Permit Nic 495) well located in Nicholas County, West Virginia, and the Appalachian Exploration & Development #1 Wriston (Permit Ral 460) well located in Raleigh County, West Virginia (Fig. 3). As shown in Figure 1, three additional cores are available (Permits Ral 352, Ral 478, and Fay 314), but the cored sections did not cover the productive interval, and therefore were not used in this study. Plotting permeability versus porosity for the above two wells (Exhibit Nos. I and II) shows that a porosity of 5.8% on the #1 Wriston well has less than 0.1 md. and 5.6% on the #1 Bell well has less than 0.1 md. Therefore, an average porosity of 5.7% or less is expected to be associated with a permeability of less than 0.1 md. Plots of log porosity versus core porosity for the above two wells (Exhibit Nos. III and IV) show the close agreement between the results of these two methods. Therefore, where cores do not exist, log-derived porosities can be used to determine permeability.

Please refer to the attached computer map (Fig. 3), in which an average well was selected from each field to determine permeability. Fields with an average well porosity of less than 5.7% will qualify as tight formation fields. Porosities were calculated from representative wells in interfield areas and these wells showed less than 5.7% porosity and therefore qualify as tight formation areas. Water-bearing areas exhibit greater than 5.7% porosity and therefore do not qualify as tight formation areas.

Injun Sandstone Permeability

Two cores were available, the Appalachian Exploration & Development #3 Cannelton (Permit Fay 195) well located in northwestern Fayette County, and the Consolidated Gas Vanetta Land #11456 (Permit Fay 196) well located in north-central Fayette County (Fig. 1). The above two cores showed less than 0.1 md. permeability throughout the entire producing interval (Exhibit Nos. V and VI). Therefore, the entire Injun Sandstone exhibits less than 0.1 md. in northern Fayette County, West Virginia, in both productive and non-productive areas (Fig. 4). It should be noted that all wells penetrating the Injun Sandstone in Raleigh County are non-productive because of their low permeability.

Weir Sandstone Permeability - South Area

Two cores were analyzed, the Consolidated Gas Pocahontas Land #11495 (McDowell 543) and the Consolidated Gas Pocahontas Land #11498 (McDowell 539; see Figs. 1 and 5). The core data for the McDowell 507 well were insufficient for analysis. Plotting permeability versus porosity for the above two wells (Exhibit Nos. VII and VIII) shows that a porosity of 7.2% in the #11495 (McDowell 543) well has less than 0.1 md., and 9.2% in the #11498 (McDowell

539) well has less than 0.1 md. Therefore, an average porosity of 8.2% or less is expected to be associated with a permeability below 0.1 md. Plots of log porosity versus core porosity for the above two wells (Exhibit Nos. IX and X) show the close agreement between the results of these two methods. Therefore, where cores do not exist, log-derived porosities can be used to determine permeability.

Please refer to the attached computer map (Fig. 5), in which an average well was selected from each field to determine permeability. Fields with an average well porosity of less than 8.2% will qualify as tight formation fields. Porosities were calculated from representative wells in interfield areas and these wells showed less than 8.2% porosity and therefore qualify as tight formation areas. Water-bearing areas exhibit greater than 8.2% porosity and therefore do not qualify as tight formation areas.

Weir Sandstone Permeability - North Area

Two cores were analyzed, the Appalachian Exploration & Development #3 Cannelton (Fayette 195) and Consolidated Gas Charleston National Bank #12324 (Boone 1247; see Figs. 1 and 5). Plotting permeability versus porosity for the above two wells (Exhibit Nos. XI and XII) shows a porosity of 14.4% in the #3 Cannelton (Fayette 195) well has less than 0.1 md. and 8.8% in the #12324 (Boone 1247) well has less than 0.1 md. Therefore, an average porosity of 11.6% or less is expected to be associated with a permeability below 0.1 md. Plots of log porosity versus core porosity on the above two wells (Exhibit Nos. XIII and XIV) show a close agreement between the results of these two methods. Therefore, where cores do not exist, log-derived porosities can be used to determine permeability.

Please refer to the attached computer map (Fig. 5), in which an average well was selected from each field to determine permeability. Fields with an

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average well porosity of less than 11.6% will qualify as tight formation fields. Porosities were calculated from representative wells in interfield areas and these wells showed less than 11.6% porosity and therefore qualify as tight formation areas. Water-bearing areas exhibit greater than 11.6% porosity and therefore do not qualify as tight formation areas.

Berea Sandstone Permeability

No core data are available in the Cabin Creek Channel sedimentary environment, but are available in the sheet facies to the west. However, core data are not necessary because after frac flows for an average drilling depth of 2766 feet (see Berea Appendices and Fig. 6) are less than the maximum stabilized production rates allowed under 18 C.F.R. 271.703 (c) (2) (i) (B).

Stabilized Production Rates

There are no examples of stabilized natural production against atmospheric pressure from the Ravencliff, Injun, Weir or Berea Sandstones in Fayette and Raleigh Counties, West Virginia. The absence of stabilized natural rates is due to the fact that tests conducted during drilling were either of short duration or were unrecorded. In order to obtain a stabilized flow to the atmosphere from the subject formations, it would be necessary to shut the drilling rig down for extended periods of time, a practice which is economically unfeasible. In addition, large volumes of gas would be vented to the atmosphere and wasted. The recorded natural flows (see Appendices) were generally from wells of exceptional magnitude, whereas natural flows from wells with small flows or no shows were not recorded. Therefore, natural flows as shown under Initial Gas Volumes (see Appendices) are always higher than stabilized natural flows to the atmosphere would be.

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Natural flows after perforations, but before stimulation, are not recorded by operators in West Virginia because these flows are generally too small to measure.

Oil Production Rates

Oil production before stimulation in the Ravencliff, Injun, Weir and Berea Sandstones meets the five barrels of oil per day (BOPD) maximum set by FERC. Based on the production history of all four sandstones in the recommended areas (see Appendices), no production of crude oil is expected.

Protection Of Fresh Water

Existing State and Federal Regulations will assure that development of the Ravencliff, Injun, Weir and Berea Sandstones will not adversely affect any fresh water aquifers that are, or are expected to be, used as a domestic or agricultural water supply. In West Virginia, the Oil and Gas Division of the State Department of Mines has the statutory responsibility for protecting surface and subsurface water from oil and gas production-associated activities. West Virginia Administrative Regulations (1979 Edition) Chapter 22-4 Section 15.01, 15.02, and 15.03 state as follows:

"15. Regulations Related to Code 22-4-5, 22-4-6, 22-4-7, 22-4-8, and 22-4-8a.

15.01. Casing Not Exclusive. In addition to the casing required by Code 22-4-5, 22-4-6, 22-4-7, 22-4-8, and 22-4-8a, there shall be used in each well such material and equipment and there shall be employed such additional procedures as are necessary for the purpose of separating high pressure zones from low pressure zones, the producing horizons, the water-bearing strata, and mineable coal zones for the life of the well.

15.02. Multiple Casing Through Coal Seams. (a) The coal protection string of casing required by Code 22-4-5 through 22-4-8 to be installed through the workable coal seam or seams shall be in addition to the production string of casing.

(b) The coal protection string of casing required by Code 22-4-5 shall have cement circulated in the annular space outside said casing. The volume of cement needed shall be calculated by using approved engineering methods to assure the return of the cement to the surface. In the event cement does not return to the surface, every resonable attempt will be made to fill the annular space by introducing cement from the surface.

15.03. Fresh Water Casing. The fresh water protective string of casing required by Code 22-4-8a shall extend 30 feet below the deepest fresh water horizon (being the deepest horizon which will replenish itself and from which fresh water or usable water for household, domestic, industrial, agricultural, or public use, may be economically or feasibly recovered), and shall have cement circulated in the annular space outside said casing. The volume of cement needed shall be calculated using approved engineering methods to assure the return of the cement to the surface. In the event cement does not return to the surface, every reasonable attempt will be made to fill the annular space by introducing cement from the surface. If the coal protection string of casing is cemented to the surface in accordance with prescribed procedure, this may also be considered a fresh water string for water strata above the coal."

The Oil and Gas Division is required by statute to enforce proper casing and plugging practices which will protect subsurface fresh water aquifers. Legislation also allows the West Virginia Oil and Gas Conservation Commission to adopt and enforce rules and orders which relate to the prevention of pollution in regard to drilling, producing and operating deep gas wells, and oil wells in secondary recovery projects.

CONCLUSIONS

The Tight Formation Committee of West Virginia hereby recommends that those formations in areas in Fayette and Raleigh Counties not outlined in red on Figures 3, 4, 5, and 6 meet those guidelines as set out in 18 C.F.R. 271, Subpart G (as set out in order 99, issued by FERC August 15, 1980, Docket No. RM 79-76), as it relates to Section 107 (b) of the Natural Gas Policy Act of 1978.

The recommended formations, the Ravencliff, Injun, Weir and Berea Sandstones, all fall within the Mississippian System.

In recommending the above sandstones as tight formations, the Committee has concluded that all areas on the attached maps, except those outlined in red, meet each of the Federal Energy Regulatory Commission's guidelines for tight formation designation.

The Committee has prepared the necessary information for the recommendation (see attached Figures, Exhibits and Appendices).

The estimated average in-situ permeability throughout the pay section not outlined in red in Figures 3, 4, 5, and 6 is expected to be less than 0.1 millidarcy.

The stabilized production rate, against atmospheric pressure of wells completed for production in the four (4) recommended sandstone formations in this area, without stimulation, is not expected to exceed the production rate determined in accordance with the table in 18 C.F.R. 271.703 (c) (2) (i) (b).

No well drilled into these formations can be expected to produce, without stimulation, more than five barrels of oil per day.

Existing State and Federal Regulations assure that development of these four (4) formations will not adversely affect any fresh water aquifers that are used or expected to be used as a domestic or agricultural water supply.

(Tight Formation Committee, 1981)

Respectfully submitted,

TIGHT FORMATION COMMITTEE

Floyd B. Wilcox

Floyd B. Wilcox, Chairman - Peake Operating Company

Members:
- Porter J. Brown - Columbia Gas Transmission Corporation
- Edward Rothman - Columbia Gas Transmission Corporation
- James Gehr - Allegheny Land and Mineral Company
- Douglas Patchen - WV Geological and Economic Survey
- Richard H. Martin - Consolidated Gas Supply Corporation
- John P. Walsh - Pennzoil Company
- Paul L. Gebhard - Cabot Oil and Gas
- Mary C. Behling - WV Geological and Economic Survey
- Katharine Lee Avary - WV Geological and Economic Survey
- Michael E. Hohn - WV Geological and Economic Survey

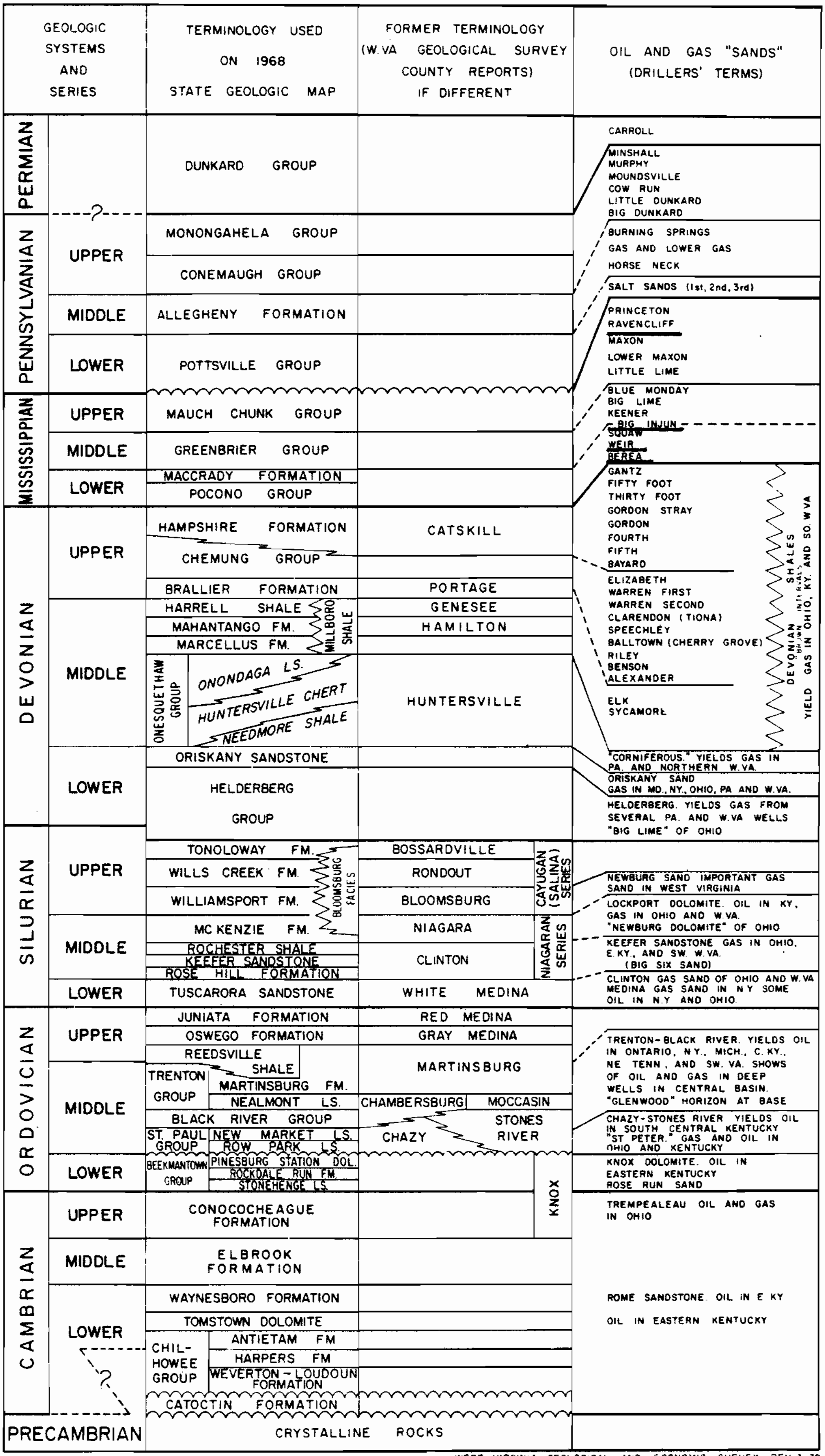
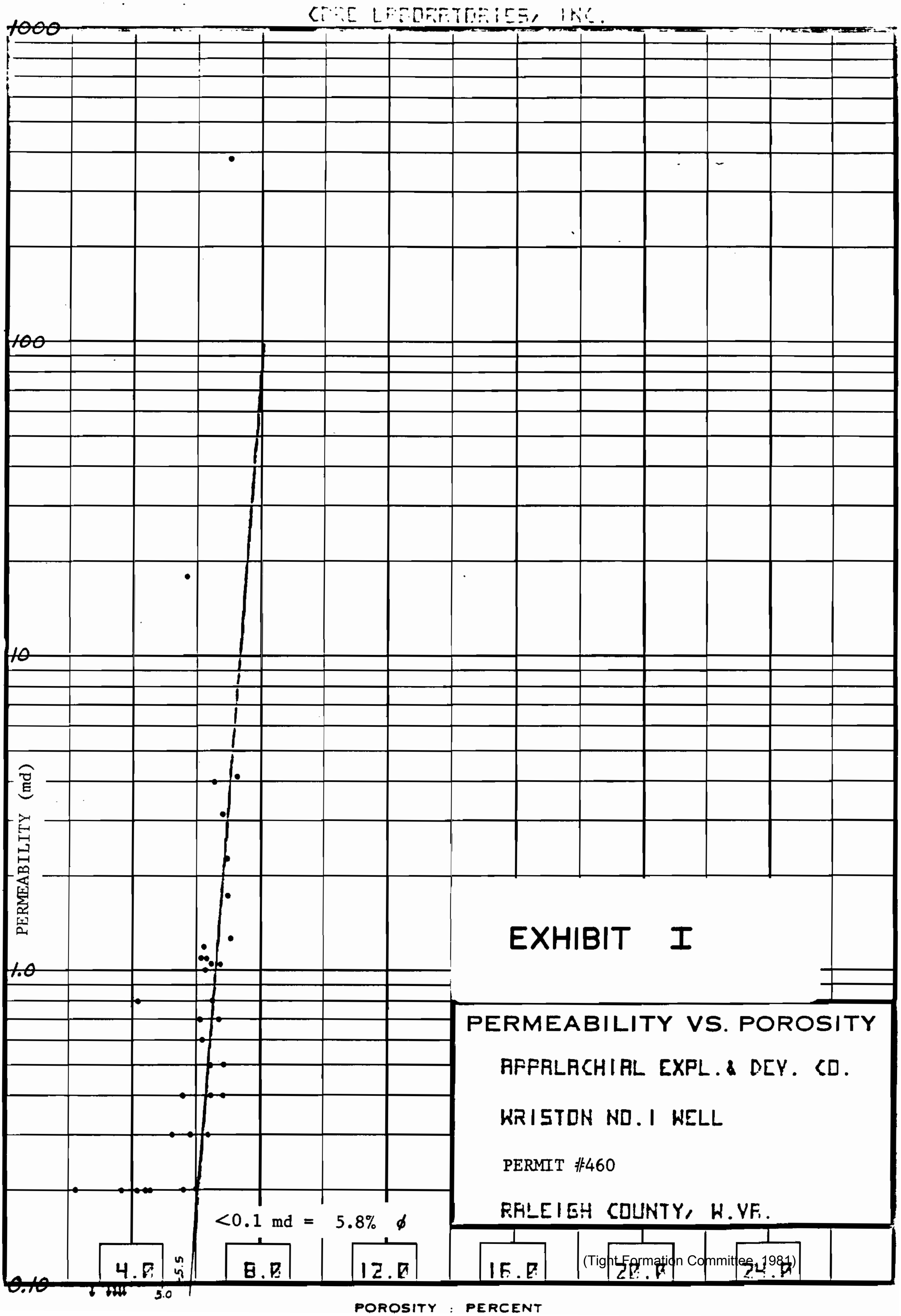
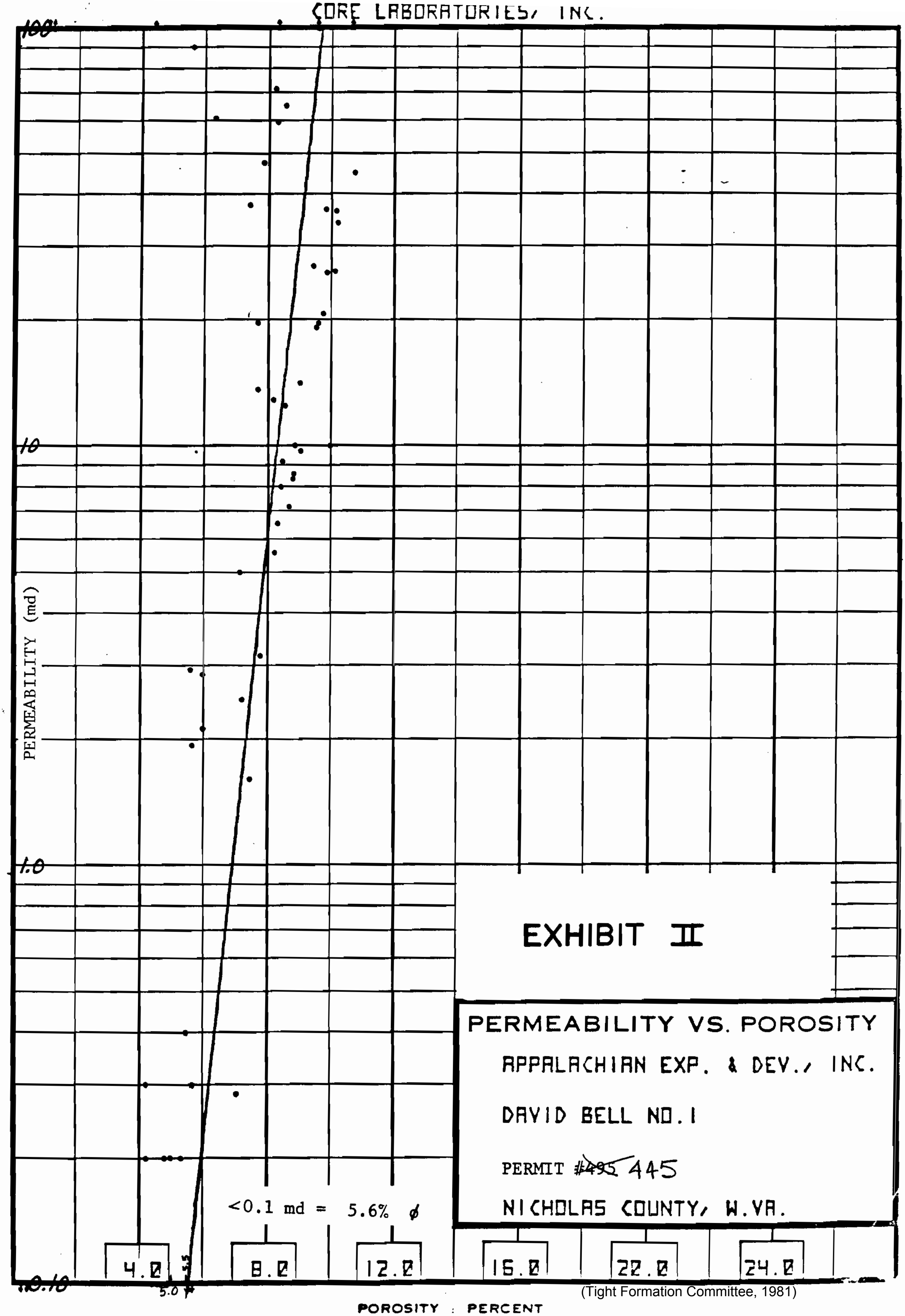


Figure 2. Generalized stratigraphic nomenclature chart, West Virginia.

(Tight Formation Committee, 1981)



(Tight Formation Committee, 1981)



(Tight Formation Committee, 1981)

EXHIBIT III
Log Porosity vs. Core Porosity
Appalachian Exploration & Development, Inc.
No. 1 Wriston Well - Permit Ral-460

Well Depth	Core Porosity	Log Porosity	Perforations
1620.0-21.0	7.1	8.9	
1621.0-22.0	7.2	8.9	
1622.0-23.0	6.2	7.1	
1623.0-24.0	6.6	7.1	
1624.0-25.0	7.0	7.7	
1625.0-26.0	3.8	7.7	1616-1632
1626.0-27.0	3.4	4.2	
1627.0-28.0	3.7	4.2	
1628.0-29.0	4.3	6.0	
1629.0-30.0	4.7	4.8	
1630.0-31.0	4.0	6.5	
1631.0-32.0	3.3	4.8	
1632.0-33.0	3.8	5.4	
1633.0-34.0	4.2	5.4	
1634.0-35.0	3.8	4.8	
1635.0-36.0	6.0	8.3	
1636.0-37.0	6.9	8.9	
1637.0-38.0	6.6	7.7	
1638.0-39.0	6.1	8.3	1642-1648
1639.0-40.0	6.4	7.7	
1640.0-41.0	6.2	7.1	
1641.0-42.0	4.2	6.0	
1642.0-43.0	2.5	4.2	
1643.0-44.0	3.2	4.2	
1644.0-45.0	3.9	6.5	
1645.0-46.0	3.8	7.1	
1646.0-47.0	4.1	6.5	
1647.0-48.0	4.0	6.0	
1648.0-49.0	4.2	6.5	
1649.0-50.0	4.1	8.3	
1650.0-51.0	4.1	8.3	
1651.0-52.0	5.5	8.3	1654-1662
1652.0-53.0	5.2	6.5	
1653.0-54.0	6.3	9.5	
1654.0-55.0	6.9	9.5	
1655.0-56.0	7.2	7.7	
1656.0-57.0	6.9	7.7	
1657.0-58.0	6.6	9.5	
1658.0-59.0	6.2	9.5	
1659.0-60.0	5.6	7.7	
1660.0-61.0	6.1	6.5	
1661.0-62.0	6.7	6.5	
1662.0-63.0	6.6	6.5	

(Tight Formation Committee, 1981)

EXHIBIT III (cont'd.)

Well Depth	Core Porosity	Log Porosity	Perforations
1663.0-64.0	5.7	6.5	
1664.0-65.0	4.5	7.7	
1665.0-66.0	3.4	7.7	
1666.0-67.0	6.5	7.7	
1667.0-68.0	6.9	8.9	
1668.0-69.0	6.4	8.9	
1669.0-70.0	6.8	8.9	
1670.0-71.0	6.3	9.5	
1671.0-72.0	6.0	9.5	
1672.0-73.0	6.4	6.5	
1673.0-74.0	5.9	3.6	
1674.0-75.0	5.6	2.4	
1675.0-76.0	3.5	2.4	
Average Porosity	6.4%*	7.0%*	

* Average log porosity reads 0.6% higher than measured core porosity

(Tight Formation Committee, 1981)

EXHIBIT IV
Log Porosity vs. Core Porosity
Appalachian Exploration & Development, Inc.
No. 1 David Bell Well - Permit Nic-445

Well Depth	Core Porosity	Log Porosity	Perforations
1134.0-35.0	10.8	11.9	
1135.0-36.0	9.8	10.1	
1136.0-37.0	6.0	8.9	1135-41
1137.0-38.0	4.5	6.0	
1138.0-39.0	5.4	7.7	
1139.0-40.0	4.8	6.5	
1140.0-41.0	5.6	6.0	
1141.0-42.0	4.9	6.5	
1142.0-43.0	5.5	6.0	
1143.0-44.0	4.9	5.4	
1144.0-45.0	5.4	5.4	
1145.0-46.0	4.4	4.2	
1146.0-47.0	4.2	4.8	
1147.0-48.0	5.2	6.5	
1148.0-49.0	7.6	6.5	
1149.0-50.0	8.9	9.5	
1150.0-51.0	8.9	9.5	
1151.0-52.0	7.5	9.5	
1152.0-53.0	5.5	6.5	
1153.0-54.0	4.7	6.5	1154-58
1154.0-55.0	5.5	5.4	
1155.0-56.0	5.2	6.0	
1156.0-57.0	7.0	7.7	
1157.0-58.0	8.6	8.9	
1158.0-59.0	9.0	10.1	
1159.0-60.0	8.6	8.3	
1160.0-61.0	9.8	10.7	
1161.0-62.0	10.1	10.7	
1162.0-63.0	10.1	10.7	
1163.0-64.0	9.8	9.5	1162-70
1164.0-65.0	6.0	7.7	
1165.0-66.0	7.1	7.1	
1166.0-67.0	8.3	8.9	
1167.0-68.0	9.6	8.9	
1168.0-69.0	10.8	8.9	
1169.0-70.0	9.7	10.7	
1170.0-71.0	9.0	10.7	
1171.0-72.0	10.1	10.7	
1172.0-73.0	9.4	10.7	
1173.0-74.0	9.5	10.7	
1174.0-75.0	9.5	10.7	
1175.0-76.0	8.2	9.5	

(Tight Formation Committee, 1981)

EXHIBIT IV (Cont'd.)

Well Depth	Core Porosity	Log Porosity	Perforations
1176.0-77.0	8.7	9.5	
1177.0-78.0	8.8	8.9	
1178.0-79.0	7.9	8.9	
1179.0-80.0	7.2	8.3	
1180.0-81.0	8.2	7.7	
1181.0-82.0	8.8	7.7	
1182.0-83.0	8.7	7.7	
1183.0-84.0	8.3	9.5	
1184.0-85.0	6.3	8.3	
1185.0-86.0	4.7	4.8	
1186.0-87.0	7.7	7.7	
1187.0-88.0	9.0	8.3	
1188.0-89.0	8.4	8.3	
1189.0-90.0	5.7	8.3	
1190.0-91.0	8.7	8.9	
1191.0-92.0	7.9	7.7	
Average Porosity	8.2 %	8.2 %	

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FINAL REPORT

EXHIBIT V

CORE LABORATORIES, INC. Petrol[illegible]

COMPANY APPALACHIAN EXPLORATION & DEV., INC. DATE ON 4/17/72 FILE NO. 521-6489
WELL CANNELTON COAL A NO. 3 DATE OFF 4/17/72 ENGRS. KUHLMAN
FIELD FORMATION ELEV. SCHLUMBERGER
COUNTY FAYETTE 195 STATE W. VA. DRLG. FLD. SALT WATER CORES TRI-CORE
LOCATION REMARKS

[illegible]

Gr. Density
1941 - 2.714
1943 - 2.741
2033 - 2.701
2043 - 2.678

Side Wall Core Analysis Data

SMP. NO.	DEPTH FEET	PERM. Md.	POR. %	% POR SAT. OIL	% POR SAT. TOTAL WATER	PROB PROD.	% OIL VOL.	% GAS VOL	°API	DESCRIPTION
CORE NO. 3- INJUN FORMATION										
1	1941 - 41.6	<0.1	4.7	0.0	36.2		0.0	3.0		SD VFG SLI SLTY MICA NO ODR NO FLU
2	1941.6- 42.0	<0.1	4.9	0.0	53.0		0.0	2.3		SD VFG SLI SLTY MICA W/SML CARB INCLS NO ODR NO FLU
3	1942.0- 43.0	<0.1	6.3	0.0	42.8		0.0	3.6		SD VFG SLI SLTY MICA W/SML CARB INCLS NO ODR NO FLU
4	1943.0- 44.0	<0.1	6.2	0.0	41.8		0.0	3.6		SD VFG SLI SLTY MICA W/SML CARB INCLS NO ODR NO FLU
CORE NO. 2- WEIR FORMATION										
5	2033.0- 34.0	0.2	16.1	0.0	32.9	GAS(*)	0.0	10.8		SD FG CLN SLI LMY MICA NO ODR FEW PIN POINT FLU
6	2034.0- 35.0	0.2	14.3	0.0	32.9	GAS(*)	0.0	9.6		SD FG CLN SLI LMY MICA NO ODR FEW PIN POINT FLU
7	2035.0- 36.0	0.3	15.9	0.0	29.6	GAS(*)	0.0	11.2		SD FG CLN SLI LMY MICA NO ODR FEW PIN POINT FLU
CORE NO. 1- WEIR FORMATION										
8	2041.0- 42.0	<0.1	6.7	0.0	31.4		0.0	4.6		SD FG CLN V SLI LMY MICA NO ODR NO FLU
9	2042.0- 43.0	<0.1	7.0	0.0	20.0		0.0	5.6		SD FG CLN V SLI LMY MICA NO ODR NO FLU
10	2043.0- 43.5	<0.1	13.5	0.0	23.0		0.0	10.4		SD FG CLN V SLI LMY MICA NO ODR NO FLU
11	2043.5- 44.0	1.7	14.3	0.0	16.1	GAS(*)	0.0	12.0		SD FG CLN V SLI LMY MICA NO ODR NO FLU

(*) LOW PERMEABILITY

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(Tight Formation Committee, 1981)

CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

EXHIBIT VI

CORE ANALYSIS RESULTS

Company CONSOLIDATED GAS SUPPLY CORP. Formation AS NOTED File CP-1-7623
Well VANETTA LAND NO. 11456 Core Type DIAMOND Date Report 7-18-72
Field Drilling Fluid AIR Analysts BOYLE
County FAYETTE State W.VIRGINIA Elev. Location

Lithological Abbreviations

SAND-SD	DOLOMITE-DOL	ANHYDRITE-ANHY	SANDY-SDY	FINE-FN	CRYSTALLINE-XLN	BROWN-BRN	FRACTURED-FRAC	SLIGHTLY-SL/
SHALE-SH	CHERT-CH	CONGLOMERATE-CONG	SHALY-SHY	MEDIUM-MED	GRAIN-GRN	GRAY-GY	LAMINATION-LAM	VERY-V/
LIME-LM	GYPSUM-GYP	FOSSILIFEROUS-FOSS	LIMY-LMY	COARSE-CSE	GRANULAR-GRNL	VUGGY-VGY	STYLOLITIC-STY	WITH-W/

SAMPLE NUMBER	DEPTH FEET	PERMEABILITY MILLIDARCYS		POROSITY PER CENT	GRAIN DENSITY	SAMPLE DESCRIPTION AND REMARKS
		PERM. MAX.	PERM. 90°			
	DEAN-STARK PLUG ANALYSIS					MISSISSIPPIAN BIG LIME
1	2093.5-94.0	<0.1		0.6	2.75	Lm, dol, stylolitic
2	94.0-95.0	<0.1		0.7	2.77	Lm, dol
3	95.0-96.0	<0.1		1.2	2.80	Lm, v/dol
4	96.0-97.0	<0.1		5.0	2.83	Dol, sl/lmy, pp vugs
5	97.0-98.0	<0.1		10.6	2.84	Dol, pp vugs
6	98.0-99.0	<0.1		11.0	2.84	Dol, pp vugs
7	99.0-00.0	<0.1		4.6	2.81	Dol, sl/lmy
8	2100.0-01.0	<0.1		5.5	2.78	Dol, sdy, silty
9	01.0-02.0	<0.1		6.6	2.82	Dol, sl/sdy, silty
10	02.0-03.0	<0.1		3.7	2.82	Dol, sl/sdy, silty
11	03.0-04.0	0.2		3.4	2.66	Sd, sl/dol, silty, congl mica
12	2104.0-04.5	<0.1		3.8	2.68	Sd, w/sh lam, silty, mica
	2104.5-2242.0					Not submitted
						POCONO INJUN
13	2242.0-43.0	<0.1		4.6	2.66	Sd, silty, mica
14	43.0-44.0	<0.1		3.6	2.68	Sd, silty, mica
15	44.0-45.0	<0.1		7.2	2.69	Sd, silty, mica
16	45.0-46.0	<0.1		7.5	2.69	Sd, silty, mica
17	46.0-47.0	<0.1		8.3	2.68	Sd, silty, mica
18	47.0-48.0	<0.1		10.0	2.70	Sd, silty, mica
19	48.0-49.0	<0.1		11.2	2.69	Sd, silty, mica
20	49.0-50.0	<0.1		10.9	2.70	Sd, silty, mica
21	50.0-51.0	<0.1		9.5	2.70	Sd, silty, mica
22	51.0-52.0	<0.1		8.7	2.68	Sd, silty, mica
23	52.0-53.0	<0.1		10.7	2.67	Sd, v/silty, mica
24	53.0-54.0	<0.1		12.8	2.70	Sd, silty, mica
25	54.0-55.0	<0.1		14.9	2.70	Sd, silty, mica
26	55.0-56.0	<0.1		14.5	2.70	Sd, silty, mica
27	56.0-57.0	<0.1		11.6	2.75	Sd, silty, mica
28	57.0-58.0	<0.1		13.6	2.71	Sd, silty, mica
29	58.0-59.0	<0.1		14.4	2.71	Sd, silty, mica
30	59.0-60.0	<0.1		13.1	2.71	Sd, silty, mica
31	60.0-61.0	<0.1		12.1	2.72	Sd, silty, mica
32	61.0-62.0	<0.1		11.6	2.71	Sd, silty, mica
33	62.0-63.0	<0.1		12.8	2.71	Sd, silty, mica
34	63.0-64.0	<0.1		12.3	2.70	Sd, silty, mica
35	2264.0-65.0	<0.1		12.2	2.72	Sd, silty, mica

(Tight Formation Committee, 1981)

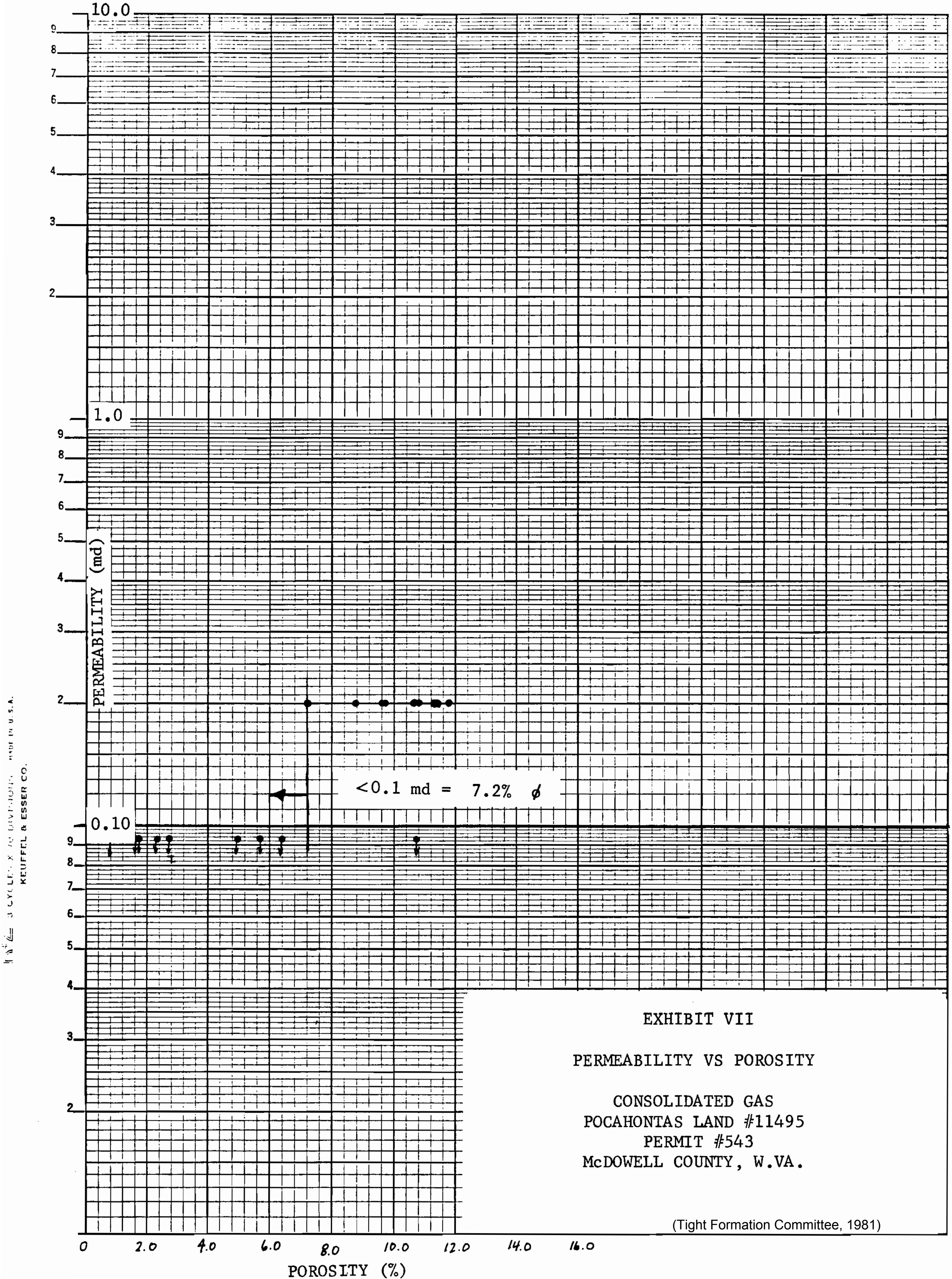

EXHIBIT VII

PERMEABILITY VS POROSITY

CONSOLIDATED GAS
POCAHONTAS LAND #11495
PERMIT #543
McDOWELL COUNTY, W.VA.

(Tight Formation Committee, 1981)

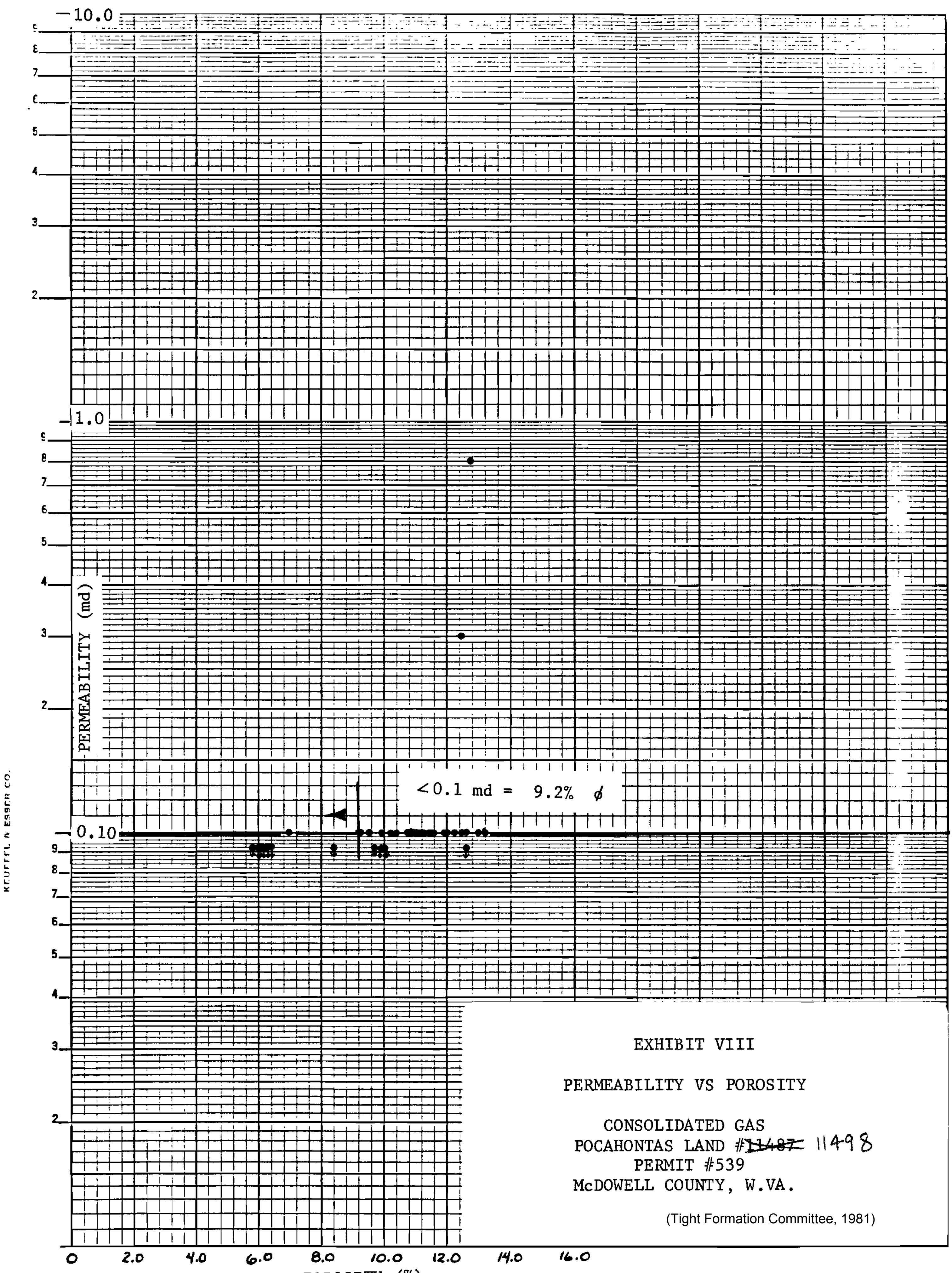

EXHIBIT VIII

PERMEABILITY VS POROSITY

CONSOLIDATED GAS
POCAHONTAS LAND #~~11487~~ 11498
PERMIT #539
McDOWELL COUNTY, W.VA.

(Tight Formation Committee, 1981)

EXHIBIT IX

Log Porosity vs. Core Porosity
Consolidated Gas Supply Corporation
Pocahontas Land No. 11495 - Permit McDow-543

Well Depth	Core Porosity	Log Porosity	Perforations
4540.0-41.0	11.8	10.8	
4541.0-42.0	11.4	11.2	
4542.0-43.0	11.3	11.2	
4543.0-44.0	10.6	10.8	4535-4545
4544.0-45.0	10.8	11.0	
4545.0-46.0	10.7	11.0	
4546.0-47.0	9.6	10.2	
4547.0-48.0	8.7	10.2	
4548.0-49.0	9.7	9.8	
4549.0-50.0	7.2	9.1	
4550.0-51.0	2.7	8.0	
4551.0-52.0	6.4	7.9	
4552.0-53.0	4.9	4.6	
4557.0-58.0	1.7	1.5	
4558.0-59.0	2.3	1.5	
4559.0-60.0	5.7	1.5	
4560.0-61.0	1.7	1.5	
4561.0-62.0	1.6	1.5	
4562.0-63.4	0.8	1.5	
4563.4-64.4			
Average Porosity	6.8%*	7.1%*	

* Average log porosity reads 0.3% higher than measured cored porosity

(Tight Formation Committee, 1981)

EXHIBIT X

Log Porosity vs. Core Porosity
Consolidated Gas Supply Corporation
Pocahontas Land No. 11498 - Permit McDow-539

Well Depth	Core Porosity	Log Porosity	Perforations
4261-62	11.8	12.7	
4262-63	12.5	12.7	
4263-64	12.0	13.5	
4264-65	12.2	13.5	4252-4272
4265-66	12.6	13.9	
4266-67	12.9	13.9	
4267-68	12.4	14.0	
4268-69	12.4	14.0	
4269-70	12.2	12.9	
4270-71	10.1	11.8	
4271-72	10.3	11.1	
4272-73	10.5	11.0	
4273-74	9.5	10.9	
4274-75	10.1	10.9	
4275-76	11.1	12.0	
4276-77	10.0	10.8	
4277-78	6.5	5.9	
4278-79	6.3	5.1	
4279-80	5.9	5.1	
4280-81	6.4	5.2	
4281-82	9.0	6.6	
4282-83	11.0	11.4	
4283-84	10.9	12.2	
4284-85	10.2	12.7	
Average Porosity	9.9%*	11.0%*	

* Average log porosity reads 1.1% higher than measured core porosity

(Tight Formation Committee, 1981)

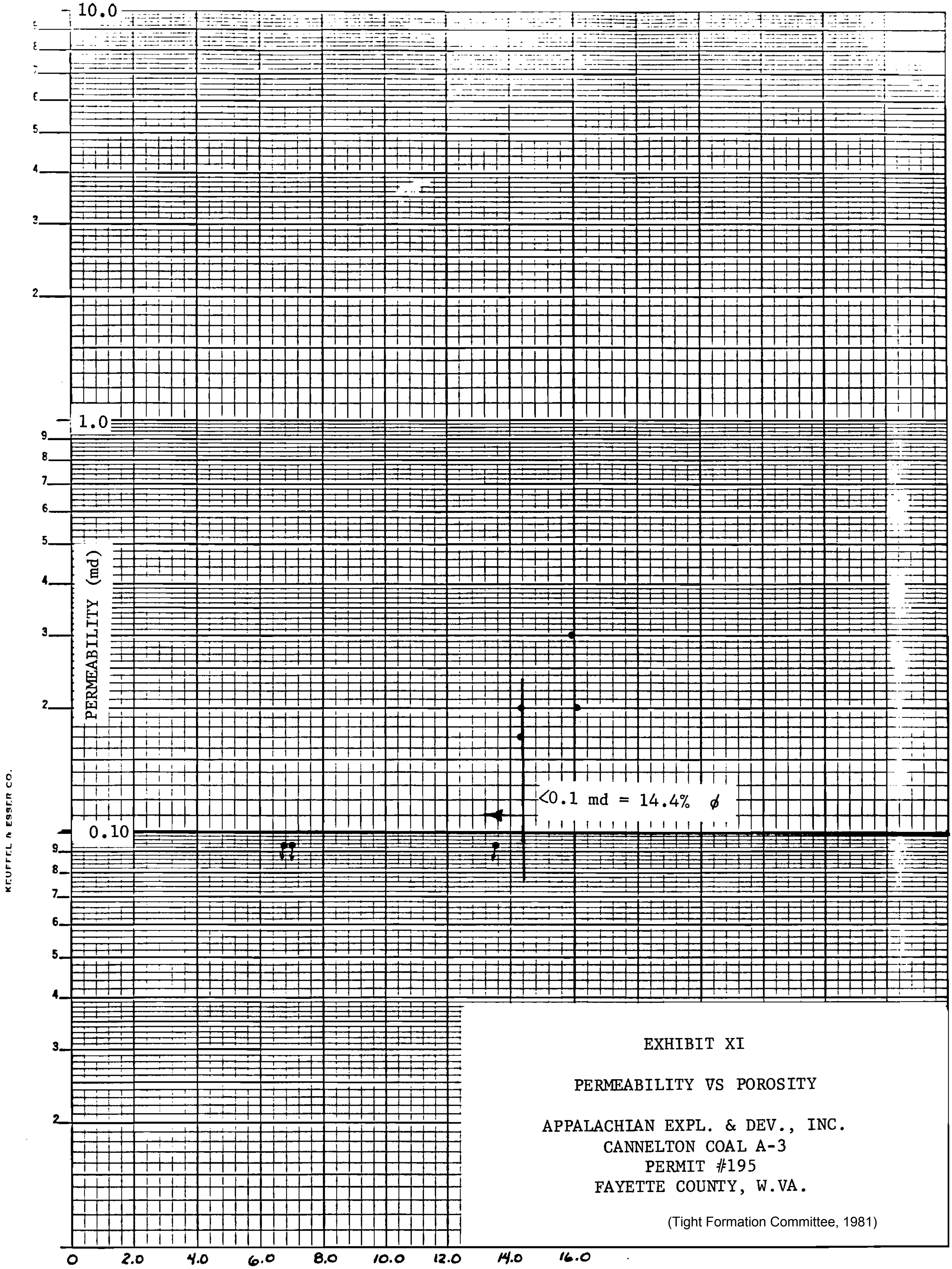

EXHIBIT XI

PERMEABILITY VS POROSITY

APPALACHIAN EXPL. & DEV., INC.
CANNELTON COAL A-3
PERMIT #195
FAYETTE COUNTY, W.VA.

(Tight Formation Committee, 1981)

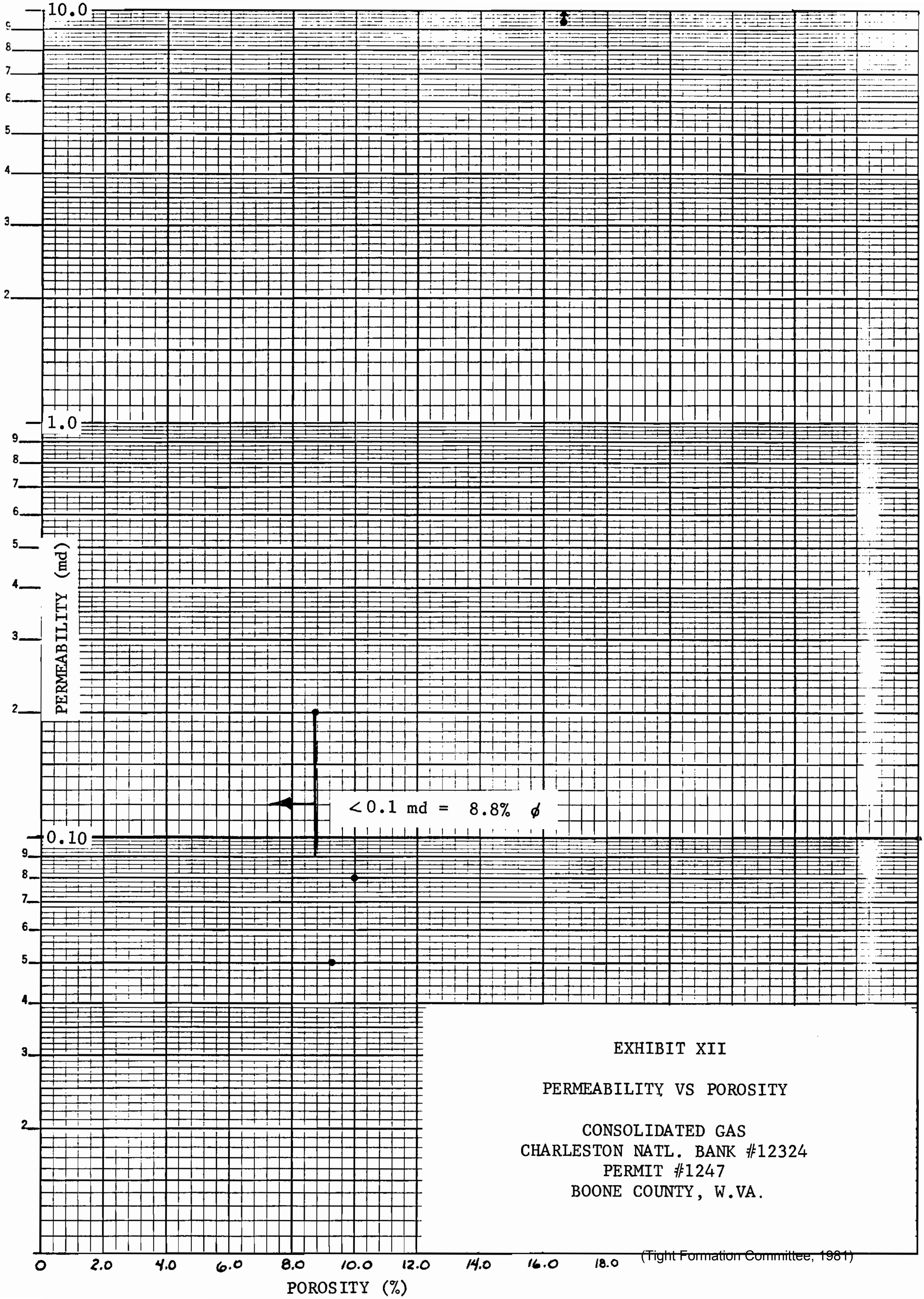

EXHIBIT XII

PERMEABILITY VS POROSITY

CONSOLIDATED GAS
CHARLESTON NATL. BANK #12324
PERMIT #1247
BOONE COUNTY, W.VA.

(Tight Formation Committee, 1981)

EXHIBIT XIII

Log Porosity vs. Core Porosity
Appalachian Exploration & Development, Inc.
Cannelton Coal A-3 Well - Permit Fay-195

Well Depth	Core Porosity	Log Porosity	Perforations
2033.0-34.0	16.1	17.5	
2034.0-35.0	14.3	18.0	2032-2046
2035.0-36.0	15.9	17.5	
2041.0-42.0	6.7	16.7	
2042.0-43.0	7.0	16.7	
2043.0-43.5	13.5	16.7	
2043.5-44.0	14.3	16.7	
Average Porosity	12.5%*	13.5%*	

* Average log porosity reads 1.0% higher than measured core porosity

(Tight Formation Committee, 1981)

EXHIBIT XIV

Log Porosity vs. Core Porosity
Consolidated Gas Supply Corporation
Charleston National Bank No. 12324 - Permit Boo-1247

Well Depth	Core Porosity	Log Porosity	Perforations
3115.0-16.0	8.7	5.7	
3116.0-17.0	10.0	8.7	3116-3120
3117.0-18.0	9.3	8.7	
3118.0-18.8	16.6	9.8	
Average Porosity	11.2% *	8.2% *	

* Average log porosity reads 3.0% lower than measured core porosity

(Tight Formation Committee, 1981)