8-33-41W

CONVENTIONAL CORE ANALYSIS
& GEOLOGICAL ANALYSIS

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

1151 BRITTMORE ROAD ▪ HOUSTON, TEXAS 77043 ▪ (713) 932-7183 ▪ FAX (713) 932-0520

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& GEOLOGICAL ANALYSIS

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Natural Core Gamma Radiation
Specific Permeability To Gas (Steady-State Method)
Porosity And Grain Density (Boyle's Law Method)
Bulk Density
Lithological Descriptions
Mineralogical Analysis By X-ray Diffraction
Core Photographs

RESERVOIRS INC.

RESERVOIRS, INC.

1151 BRITTMORE ROAD HOUSTON, TEXAS 77043

GEOLOGICAL ANALYSIS • CLASTICS/CARBONATES
SINGLE WELL/FIELD/REGIONAL STUDIES
WELL COMPLETION/STIMULATION STUDIES
ROUTINE AND SPECIAL CORE ANALYSIS

(713) 932-7183 FAX (713) 932-0520

January 29, 1996

Mr. Warren Winters
Anadarko Petroleum Corporation
17001 Northchase Drive
Houston, TX 77060

Dear Mr. Winters:

On September 6, 1995, Reservoirs, Inc., provided Anadarko Petroleum Corporation with a proposal for wellsite services, conventional core analysis and geological analysis to be performed on well core material anticipated to be recovered from the following well:

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas

Approximately ninety-six (96) feet of full diameter core material was recovered from the well. On October 20 and 21, 1995, two (2) well cores were retrieved and packaged by personnel from Reservoirs, Inc., on location at the wellsite in Morton County, Kansas, and transported to Houston, Texas, for analysis. The core material was obtained from the following cored intervals:

Core 1	1,950.0 - 1,996.5 ft.
Core 2	2,010.0 - 2,059.7 ft.

Each segment was removed from the preservation material, oriented, marked with respect to depth and the natural core gamma radiation measured. Conventional core analysis was then immediately initiated by obtaining horizontally oriented core plug samples. A total of forty-seven (47) core plug samples were obtained.

Initially, six sandstone samples were analyzed which had been drilled with liquid nitrogen and subsequently temperature and humidity oven dried. These samples are designated by the symbol "#" in Tables 1 and 2 of the report. These samples were immediately geologically analyzed, using a combination of X-ray diffraction analysis and thin section petrographic scanning to determine the presence/absence of halite; the samples were handled with techniques designed to ensure salt preservation. X-ray diffraction data revealed only minor to trace amounts of halite in several samples (Table 4).

Thin section evaluation revealed only trace amounts of halite. The small amounts of halite were thought to have precipitated from formation water after coring procedures were completed. That is, based on the available data, the halite is judged to be a contaminant, rather than a naturally occurring cement. The remaining forty-one (41) core plug samples were then analyzed.

Preliminary test results for Cores 1 and 2 were electronically transmitted to Mr. Winters of Anadarko Petroleum Corporation in Houston on October 26, 1995 by Mr. Steve Root of Reservoirs, Inc. via facsimile.

On October 26, 1995, two whole core segments were sent to Reservoirs, Inc.'s, laboratory in Midland, Texas, for analysis. Mr. Winters selected one sample from Core No. 1 at a depth interval of 1,983.3 - 1,983.7 ft. and one sample from Core No. 2 at a depth interval of 2,045.8 - 2,046.4 ft. The two full diameter samples were not cleaned but analyzed in their native state. The test results for these two samples are presented in Table 3.

This report presents the conventional core analysis in both tabular and graphical formats together with the core gamma log. A section entitled "Laboratory Procedures", which describes the methods used to obtain the test results is also included in the report. The core gamma log, which includes the conventional core analysis and the natural gamma radiation of the core is presented at the back of this report. The full diameter well core has subsequently been cut longitudinally into two (2) portions (1/3 slab: 2/3 slab), which have been packaged in cardboard slab boxes and photographed in color to provide a permanent record of the stratigraphic interval (Figure 13).

The conventional core analysis test results are presented in Tables 1, 2 and 3 and in Figures 1 through 12, which present the relationships of permeability - porosity, permeability - grain density, grain density - porosity and bulk density - porosity. Examination of the test results indicates the specific permeabilities to gas ranged for <0.001 md to 1.45 md and the porosities ranged from 0.4 to 19.0 percent of the bulk volume. The grain densities and the bulk densities obtained from the samples ranged from 2.46 g/cc to 2.95 g/cc and from 2.18 g/cc to 2.94 g/cc, respectively.

It has been a pleasure to be of service to you and Anadarko Petroleum Corporation with this project, and Reservoirs, Inc., looks forward to working together with you on future projects. If you should have any questions pertaining to the test results, the procedures used to obtain the test results or if Reservoirs, Inc., can be of any further service, please do not hesitate to contact Mr. Lawrence Bruno (Manager, General Geological Projects) at (713) 935-4239 or me at (713) 932-9670.

Sincerely,

Paul Delacoe

Paul Delacoe
Manager
Special Core Analysis
RESERVOIRS, INC.

PD:jm

LABORATORY PROCEDURES

Natural Core Gamma Radiation Log

The full-diameter well core was passed over a gamma radiation detection unit which was shielded from the natural background radiation. The relative magnitude of the radiation was recorded as a function of depth for comparison with the downhole logs. The gamma radiation log is presented at 1:240 scale equivalent to the wireline logs. (Five inches of recorded log is equivalent to one hundred feet of measured gamma response.)

Sample Preparation

Six horizontally oriented core plug samples, one inch (1") in diameter were prepared from the full diameter well core. Each sample was obtained using a diamond core drill and liquid nitrogen as the core drill coolant and lubricant. The samples were trimmed to form right cylinders using a diamond rimmed sawblade. Each sample was marked with an identification number and immediately dried in a temperature and humidity controlled oven for forty eight hours (48 hrs.). The samples were then placed in a desiccator containing silica-gel and allowed to cool to room temperature prior to the basic rock properties determination.

The remaining forty-one horizontally oriented core plug samples, one and one-half inches in diameter were obtained using a diamond core drill and brine as the core drill coolant and lubricant. The samples were trimmed to form right cylinders using a diamond rimmed sawblade. Each sample was marked with an identification number and immediately extracted using methanol as the solvent to remove any residual salts present from the samples. The samples were then dried in a temperature controlled oven and subsequently placed in a desiccator containing silica-gel to cool to room temperature prior to determination of the basic rock properties.

Basic Rock Properties

The **bulk volume** of each core plug sample was determined by mercury immersion (Archimedes' principle) and confirmed by measuring the length and diameter of each core plug sample with calipers and calculating the bulk volume.

The **porosity** and grain density of each core plug sample was determined using the Boyle's law method and helium as the gaseous phase. The core plug sample was placed in a matrix cup (sealed chamber) of known volume. Another chamber of known volume containing helium at a preselected pressure was connected to the matrix cup. The helium expanded into the matrix cup, and an equilibrium pressure was recorded. Using Boyle's law, the grain volume of the core plug sample being tested can be determined. The grain volume subtracted from the bulk volume of the core plug sample results in the pore volume of the core plug sample. Porosity is the pore volume expressed as a percent of the bulk volume.

The **grain density** is the weight of the core material per unit volume of the core material (grain volume). The weight of the core material is determined by weighing the clean and dry core plug sample on a pan-balance at ambient conditions. The grain volume is obtained from the Boyle's law calculation.

The **specific permeability to gas** was determined by placing each core plug sample in a Hassler-type core holder. A confining pressure of 400 psig was applied to the system to prevent bypassing of the gas around the core plug sample. Nitrogen gas was injected into each core plug sample at a constant pressure until a constant flow rate of gas through the core plug sample was attained (steady-state conditions). The specific permeability to gas was calculated using the Darcy equation.

Table 1

BASIC ROCK PROPERTIES

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

Core No.1
Depth Interval: 1950.0 - 1996.5 ft.

Sample	Depth (ft.)	Porosity (%BV)	Permeability to gas (md)	Grain Density (g/cc)	Bulk Density (g/cc)	Lithological Description
H 171	1957.4	5.6	0.005	2.72	2.57	Sst buff vf gr vwl consol sltly
H 261	1957.8	8.4	0.137	2.70	2.47	Sst buff vf gr vwl consol slty thn gry sh lams
H 172	1958.3	12.2	0.053	2.71	2.38	Sst buff-lt gry vf gr vwl consol thn gry sh lams
H 262	1959.2	4.5	0.017	2.71	2.59	Sst buff vf gr vwl consol gry sh incl
H 173	1959.7	2.8	0.011	2.74	2.66	Sst buff vf gr vwl consol slty
H 257#	1960.0	3.1	0.027	2.73	2.65	Sst buff vf gr vwl consol slty
H 174	1960.5	4.2	0.006	2.74	2.62	Sst buff vf gr vwl consol slty
H 175	1962.6	14.1	3.19*	2.72	2.34	Sst lt gry-gry vf gr vwl consol slty thn gry sh lams
H 258#	1963.4	11.1	0.185	2.71	2.41	Sst mott lt gry-rd brn vf gr vslty anhy incl
H 176	1963.6	12.3	0.140	2.75	2.41	Sst mott lt gry-rd brn vf gr vslty red slt lam lge anhy incl
H 177	1964.4	15.7	0.308*	2.72	2.29	Sst lt gry-red brn vf gr vwl consol vslty rd slt & gry sh lam
H 178	1965.1	16.5	**	2.71	2.26	mott Sst & Sltst vf gr vwl consol vslty varg
H 179	1966.7	10.9	0.261*	2.74	2.44	Sst lt brn vf gr vwl consol slty thn gry sh lam anhy incl
H 259#	1966.8	14.6	1.45	2.68	2.29	Sst lt gry vf gr wl consol vslty thn gry sh lams
H 180	1967.3	6.8	0.018	2.73	2.54	Sst buff vf gr vwl consol slty
H 181	1968.3	6.2	0.007	2.74	2.57	Sst buff vf gr vwl consol slty
H 182	1969.5	8.3	0.132	2.70	2.48	Sst buff vf gr vwl consol slty
H 183	1975.7	15.9	**	2.72	2.29	Sst mott gry-brn vf gr vslty lge sh strks
H 184	1981.4	15.7	0.789*	2.70	2.28	Sst lt gry vf gr vwl consol vslty thn gry sh lams
H 185	1982.2	14.3	**	2.71	2.32	Sst lt gry vf gr vwl consol vslty thn gry sh lams
H 186	1986.5	4.1	0.002	2.73	2.62	Sst lt brn vf-f gr vwl consol arg
H 260#	1986.7	5.0	0.061	2.72	2.58	Sst lt gry vf gr vwl consol slty
H 187	1987.4	17.7	**	2.73	2.25	Sst mott lt gry-lt brn-rd brn vf gr vslty 30% rd sh gry sh lams
H 188	1988.3	15.7	**	2.69	2.27	Sst lt brn vf gr vslty thn gry sh strks thk rd sh strks

Table 1 (continued)

BASIC ROCK PROPERTIES

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

Core No.1
Depth Interval: 1950.0 - 1996.5 ft.

Sample	Depth (ft.)	Porosity (%BV)	Permeability to gas (md)	Grain Density (g/cc)	Bulk Density (g/cc)	Lithological Description
H 189	1989.1	8.4	5.33*	2.70	2.47	Sst lt brn vf gr vwl consol slty thn gry sh lams
H 190	1990.2	18.7	**	2.75	2.24	Sst lt gry vf gr vwl consol vslty varg anhy incl
H 191	1992.4	19.0	**	2.73	2.21	Sst lt gry vf gr vwl consol vslty varg gry sh strks
H 192	1993.7	12.9	0.220*	2.69	2.34	Sst lt gry vf gr vwl consol Slty arg thn gry sh lams
H 193	1995.7	0.5	0.003	2.95	2.94	Anhy gry dns rd sh incl

# Denotes 1" diameter sample.

* Denotes sample contains fracture, permeability to gas may be anomalously high.

** Denotes broken and/or non-cylindrical sample. Permeability to gas indeterminable.

Figure 1

PERMEABILITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

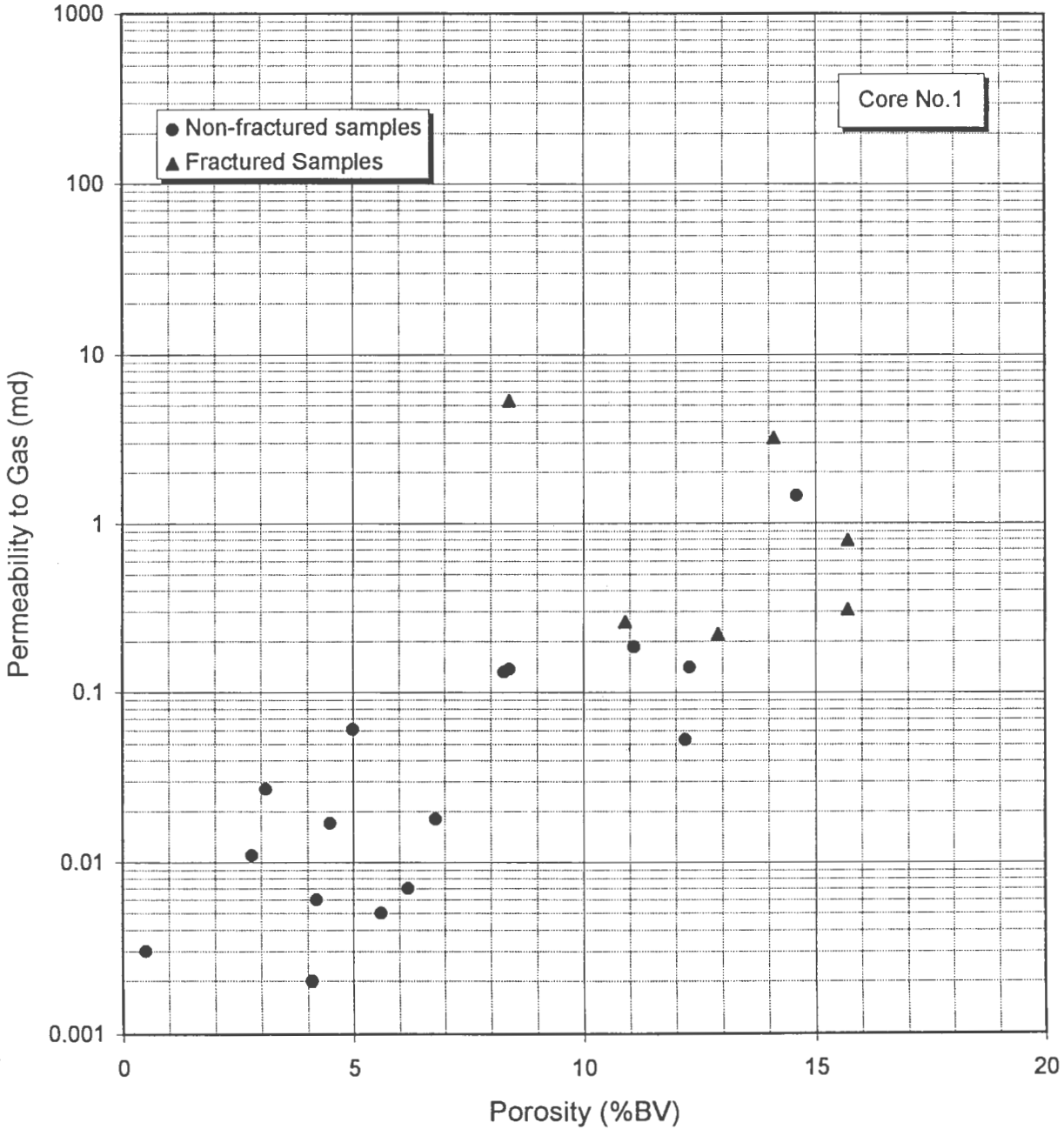


Figure 2

PERMEABILITY - GRAIN DENSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

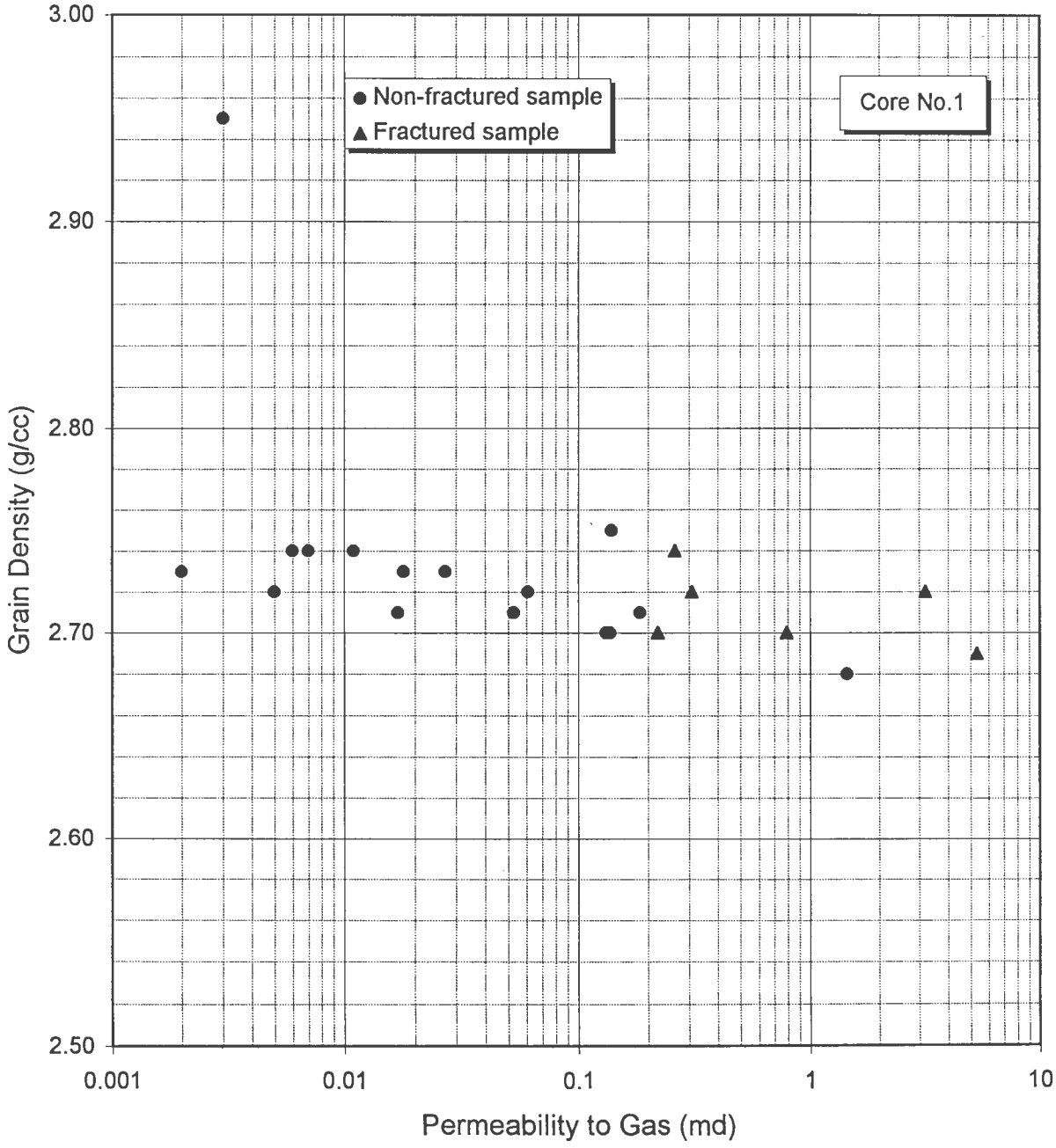


Figure 3

GRAIN DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

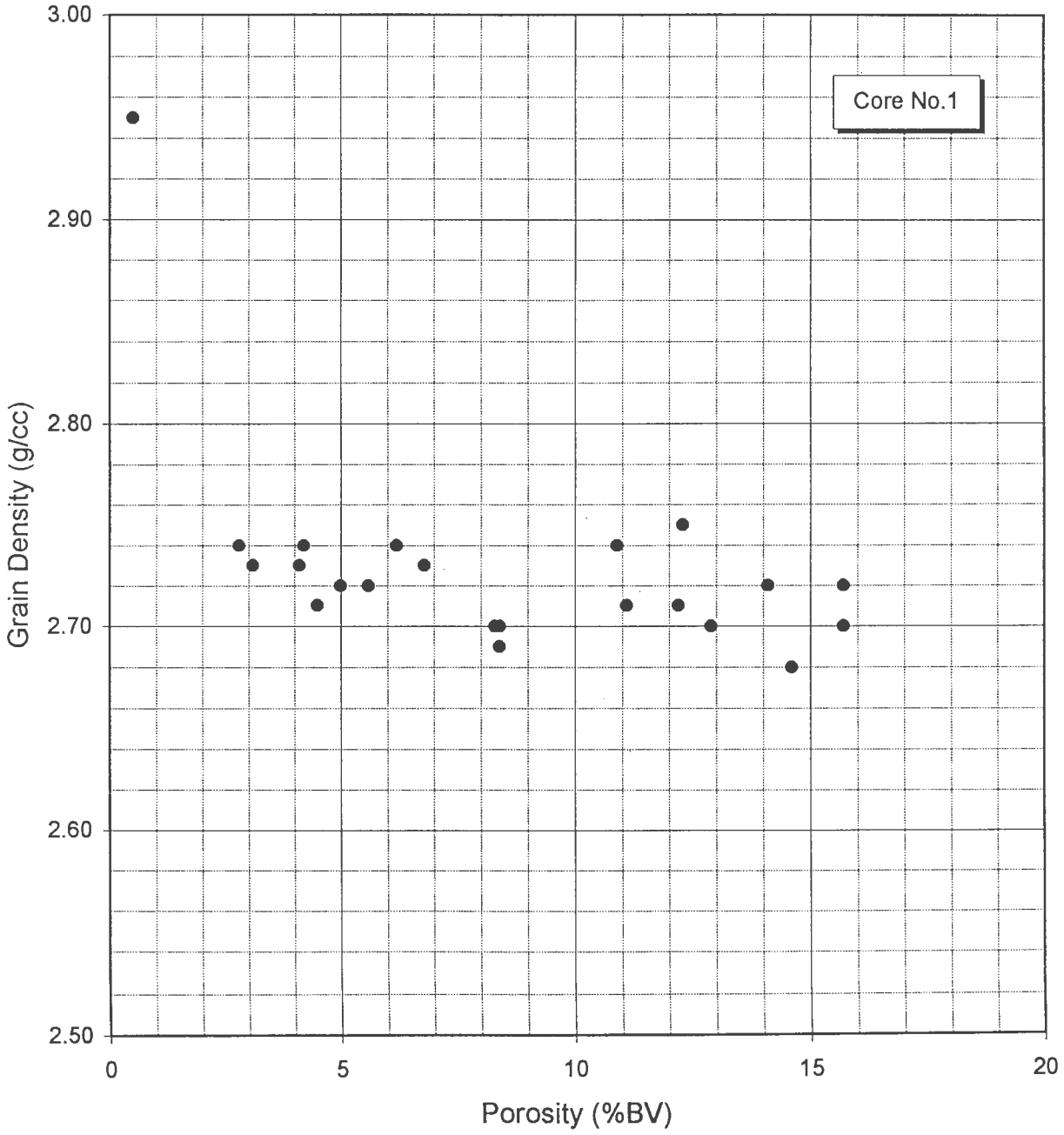


Figure 4

BULK DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

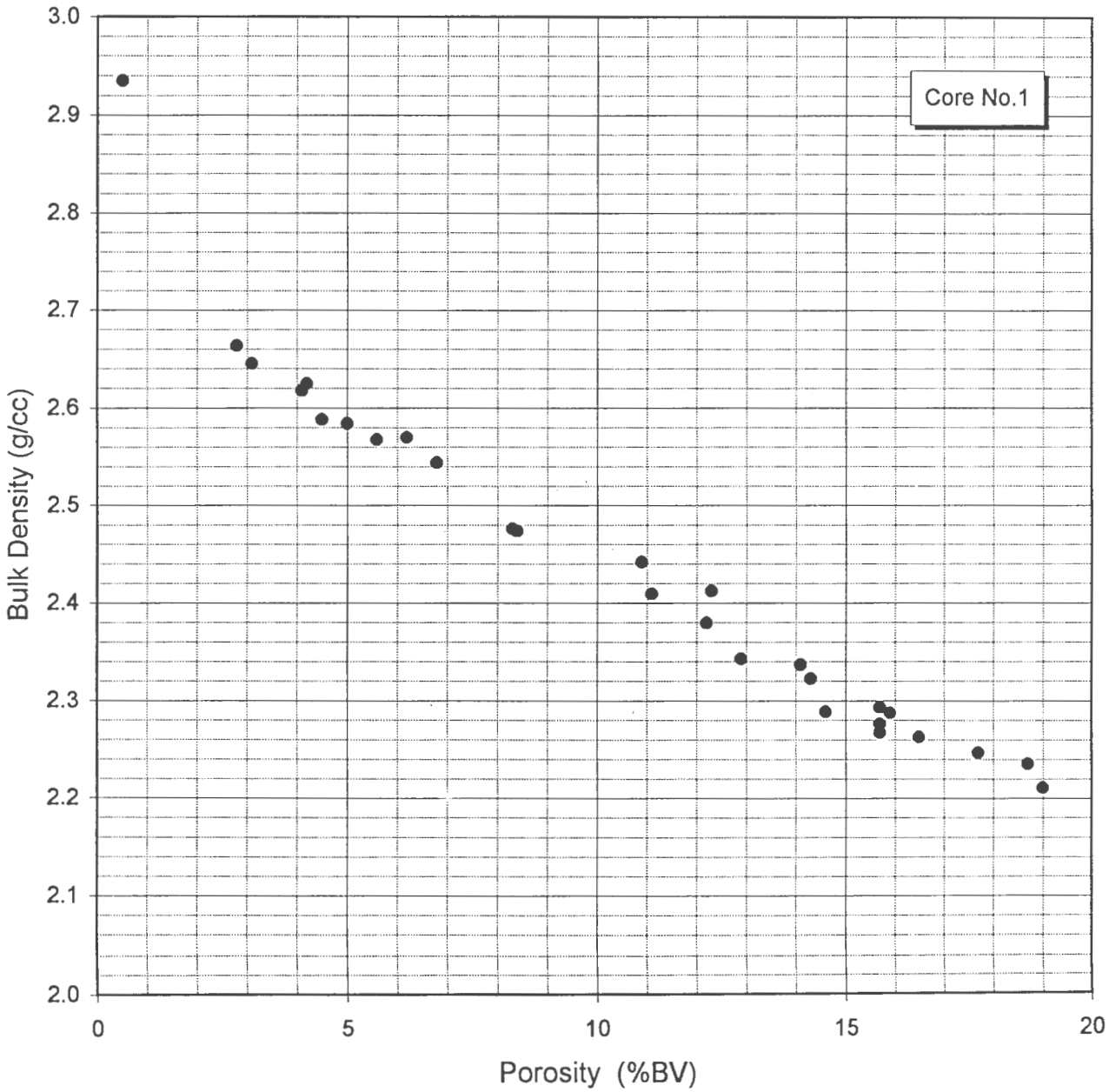


Table 2

BASIC ROCK PROPERTIES

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

Core No.2
Depth Interval: 2010.0 - 2059.7 ft.

Sample	Depth (ft.)	Porosity (%BV)	Permeability to gas (md)	Grain Density (g/cc)	Bulk Density (g/cc)	Lithological Description
H 194	2012.7	8.0	0.505	2.80	2.58	Sltst rd brn vwl consol sli sdy arg abd anhy incl
H 195	2020.3	13.5	**	2.74	2.37	Sst lt gry-rd brn vf gr vlty arg gry sh lams rd sh strks
H 196	2031.7	18.5	**	2.67	2.18	Sltst lt gry wl consol sdy arg
H 197	2032.3	15.4	**	2.72	2.30	Sltst lt gry wl consol sdy arg lge anhy incl
H 255#	2035.4	9.4	0.098	2.71	2.46	Sst lt gry vf gr vwl consol slty anhy
H 198	2035.7	6.2	< 0.001	2.73	2.56	Sst lt brn vf-f gr vwl consol anhy incl
H 199	2036.1	5.0	0.003	2.74	2.60	Sst lt brn vf-f gr vwl consol
H 256#	2040.2	15.9	0.198	2.68	2.25	Sst lt gry vf gr vwl consol slty
H 200	2040.7	2.8	0.002	2.85	2.77	Sst lt gry vf gr vwl consol abd anhy
H 201	2041.4	14.8	0.044	2.71	2.31	Sltst buff vwl consol sli sdy cln
H 202	2043.6	17.1	0.331	2.68	2.22	Sltst buff vwl consol sli sdy cln
H 203	2047.7	15.0	0.051	2.70	2.30	Sltst buff vwl consol sdy tr anhy incl
H 204	2048.7	14.3	0.038	2.71	2.32	Sst lt gry vf gr vwl consol slty thn gry sh strks
H 205	2049.1	13.4	0.307*	2.71	2.35	Sst lt gry vf gr vslty varg abd rd sltst
H 206	2050.2	14.1	0.111	2.70	2.32	Sst lt gry vf gr vslty arg thn gry sh strks
H 207	2056.7	12.0	0.018	2.69	2.37	Sst lt gry vf-f gr vwl consol sli arg
H 208	2057.5	10.0	0.126	2.70	2.43	Sst lt gry vf gr vwl consol thn gry sh lams
H 209	2058.4	14.0	**	2.74	2.36	Sst mott gry-brn vf-f gr vslty varg sh cl strks anhy

# Denotes 1" diameter sample.
* Denotes sample contains fracture, permeability to gas may be anomalously high.
** Denotes broken and/or non-cylindrical sample. Permeability to gas indeterminable.

Figure 5

PERMEABILITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

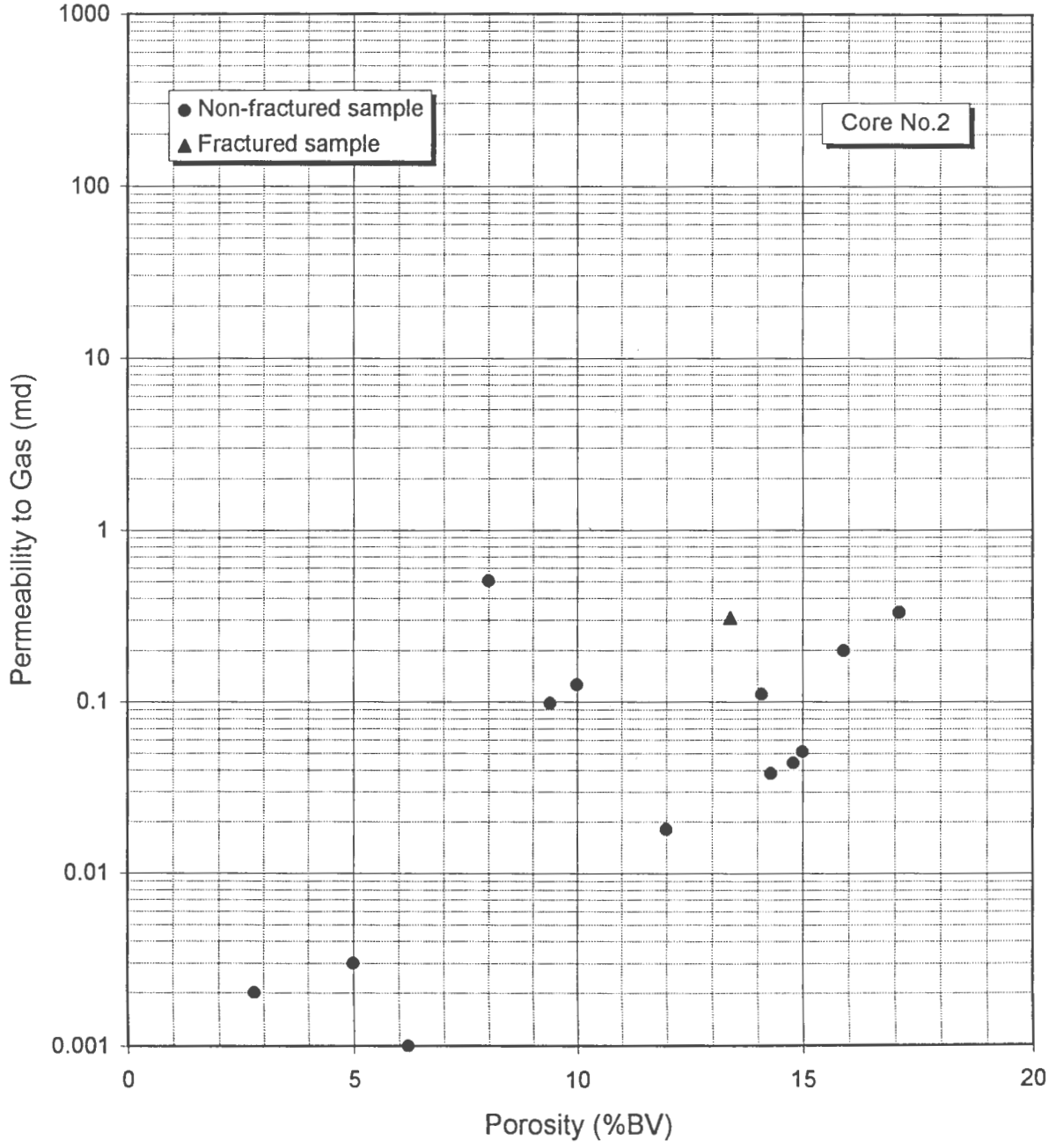


Figure 6

PERMEABILITY - GRAIN DENSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

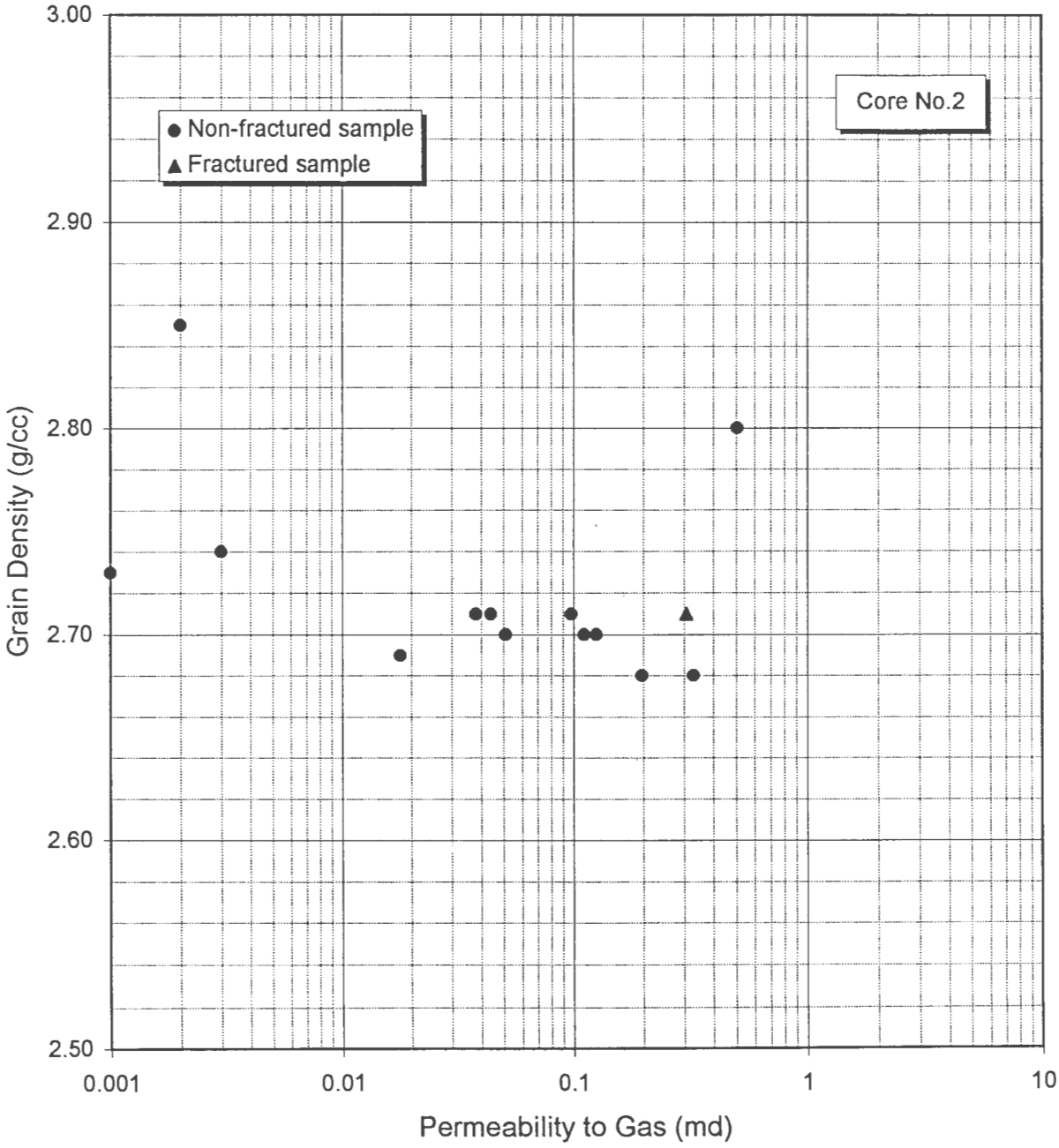


Figure 7

GRAIN DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

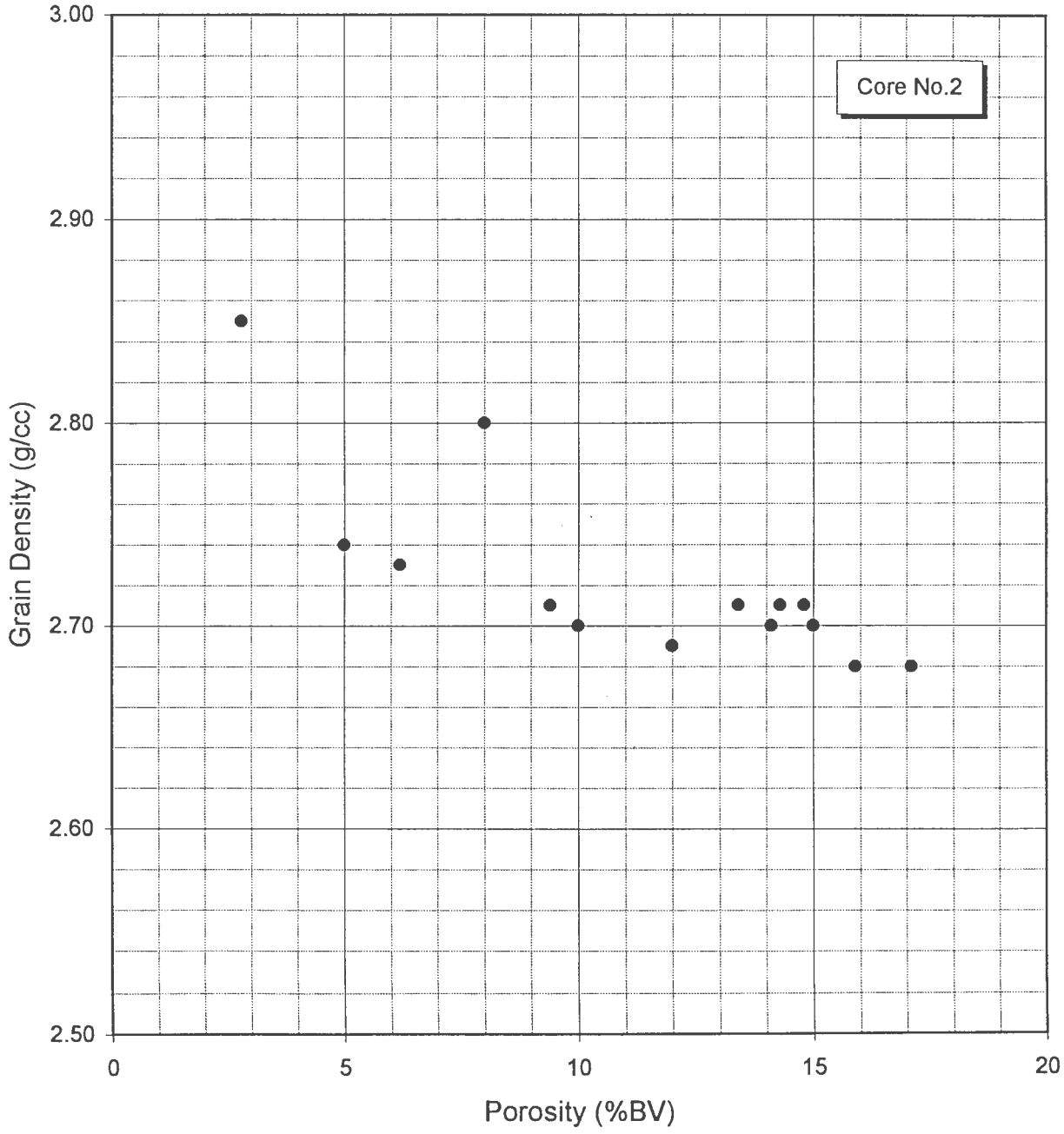


Figure 8

BULK DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

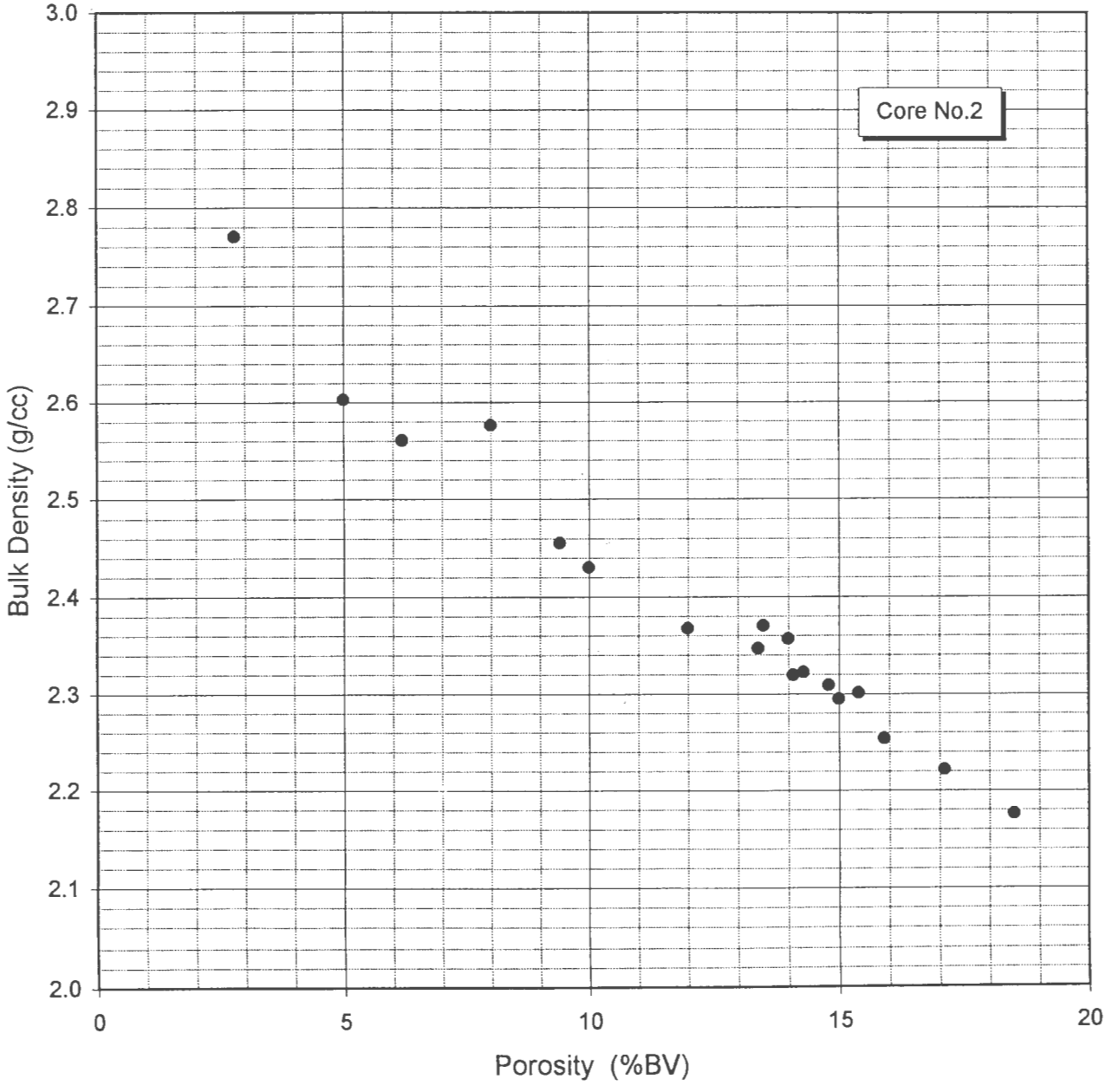


Figure 9

PERMEABILITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

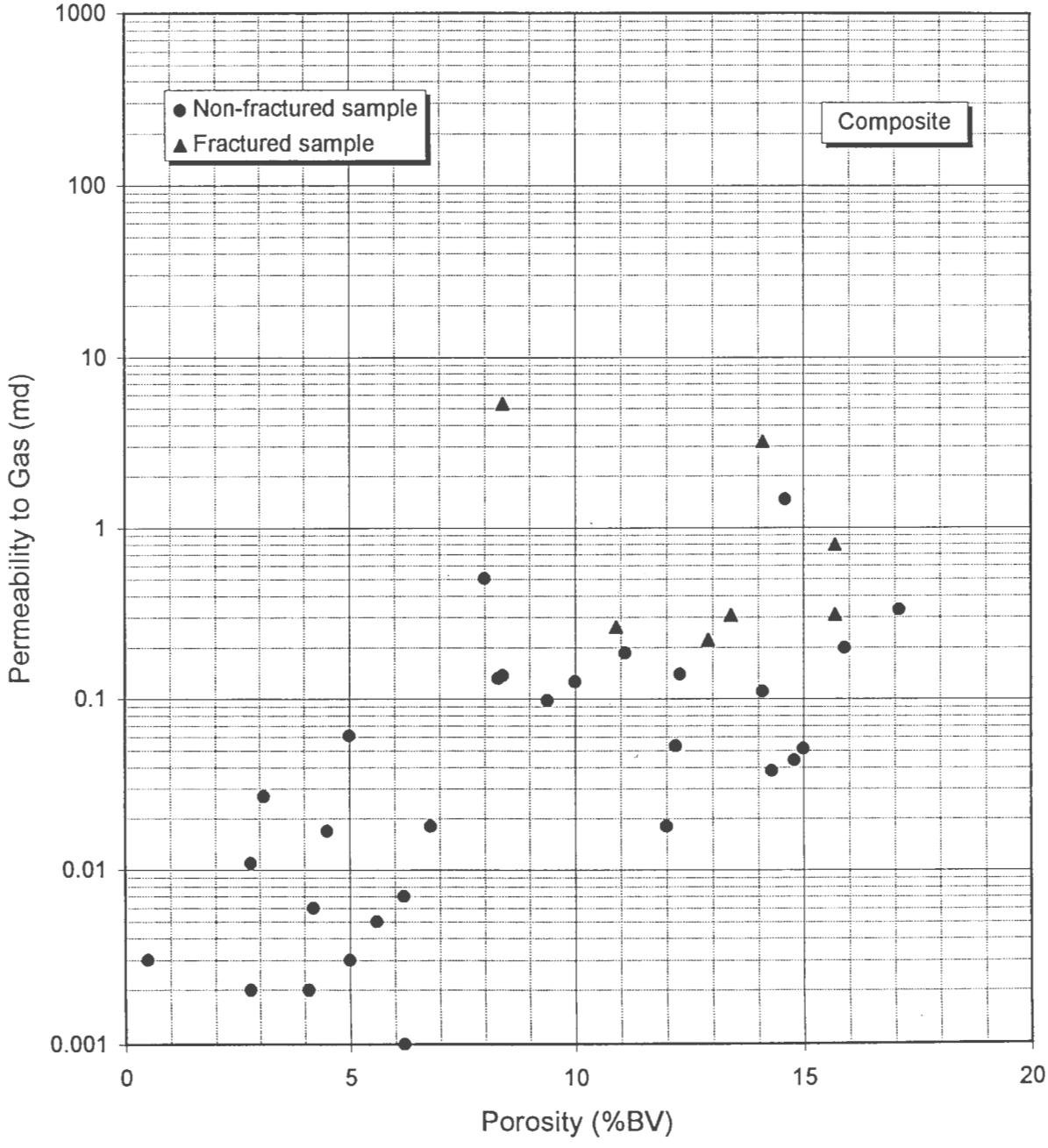


Figure 10

PERMEABILITY - GRAIN DENSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

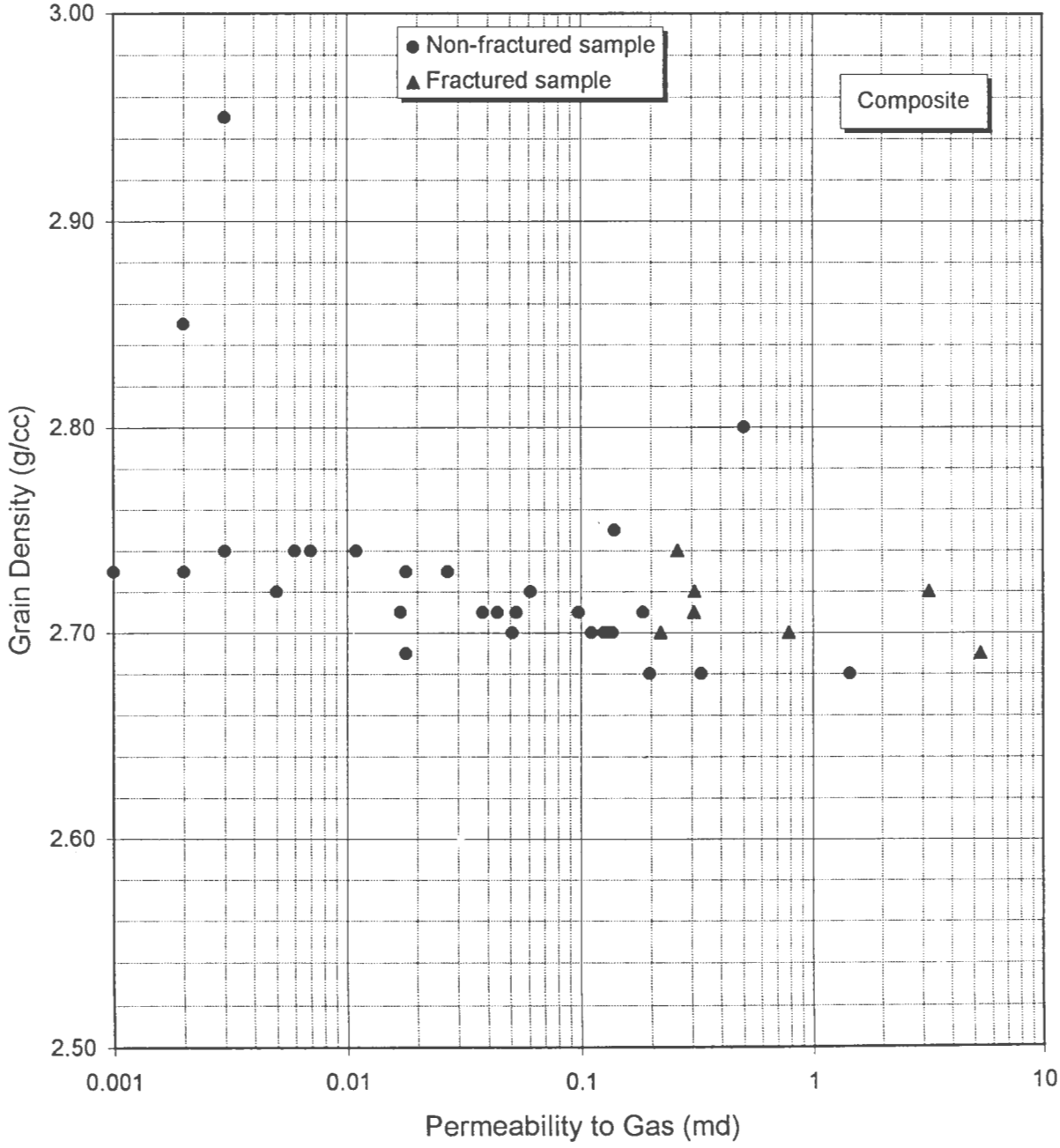


Figure 11

GRAIN DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

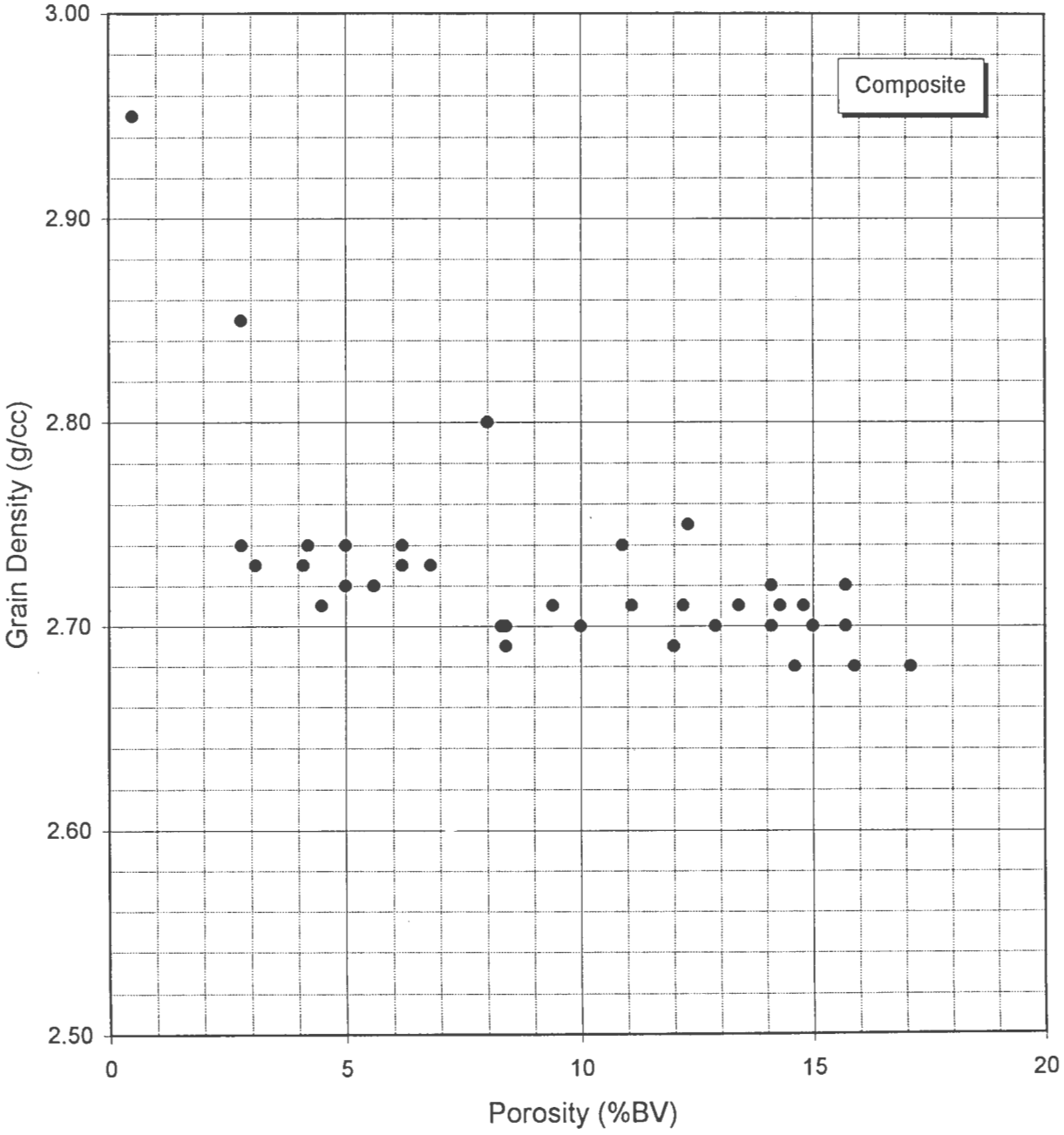


Figure 12

BULK DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

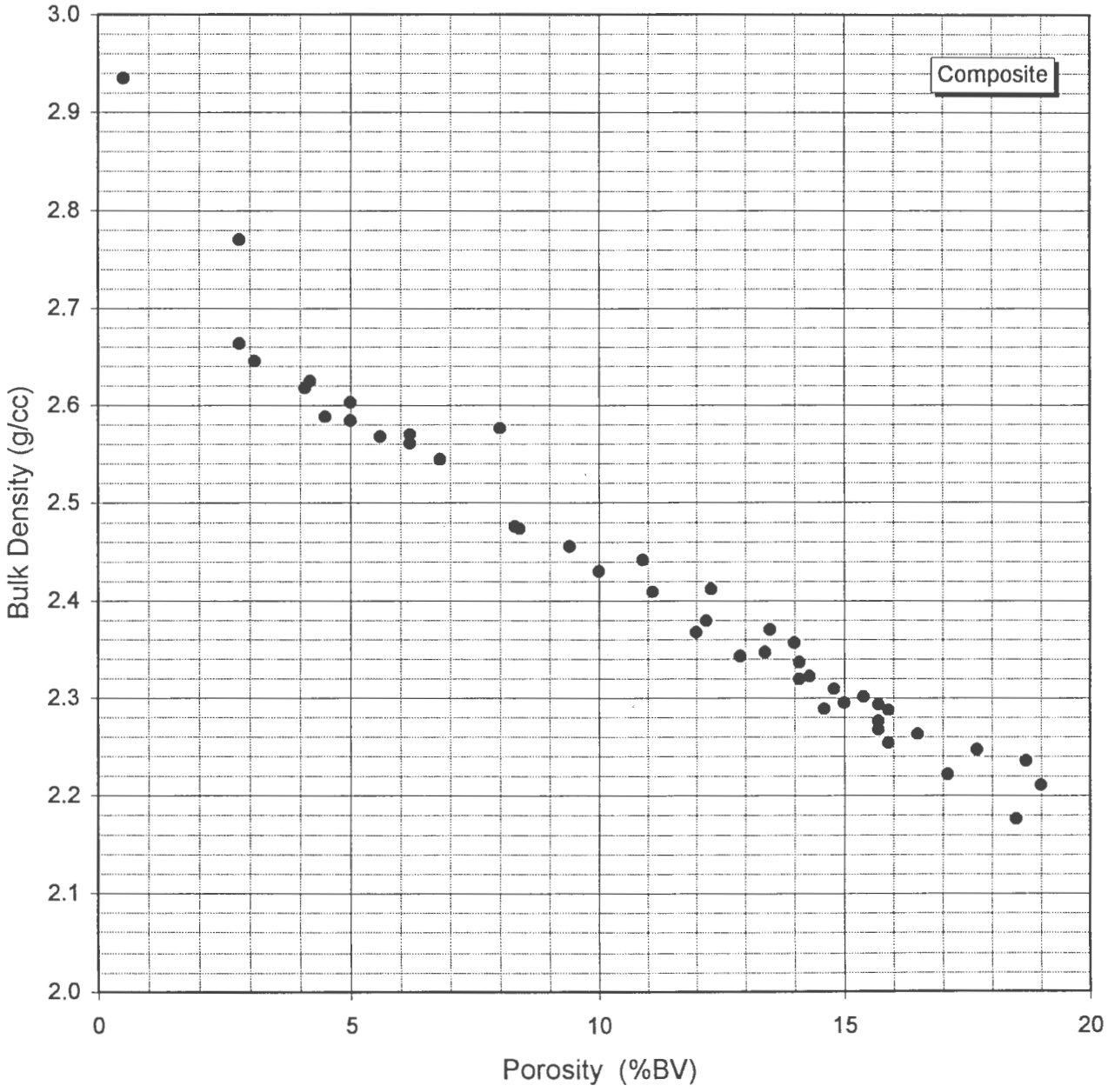


Table 3

FULL DIAMETER CORE ANALYSIS *

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

Sample	Depth (ft)	Permeability (md) Kmax	K90	Kvert	Porosity (%BV)	Grain Density (g/cc)	Saturation (%PV) Water	Oil	Lithological Description
1	1983.3 - 1983.7	0.07	0.06	0.01	1.0	2.46	N/A	N/A	Sh rd brn wl consol slty sli sdy
2	2045.8 - 2046.4	0.02	0.01	0.03	0.4	2.51	N/A	N/A	Sltst rd brn wl consol vsdy arg

* Denotes analysis performed on native state sample.

TABLE 4

MINERALOGICAL ANALYSIS BY X-RAY DIFFRACTION

ANADARKO PETROLEUM CORPORATION ARNOLD C-1 WELL
MORTON COUNTY, KANSAS

Mineralogy of Whole Rock Sample

Relative Abundance in Percent

Depth (ft)	Qtz	Ksp	Plag	Dol	Anh	Gyp	Hal	Clay	Total	Gd
1960.	56	4	5	1	26	1	0	7	100	2.72
1963.4	53	0	8	8	16	0	1	14	100	2.70
1966.8	57	0	7	7	12	0	2	15	100	2.69
1986.7	63	0	8	0	21	0	0	8	100	2.71
2035.4	59	0	8	1	23	0	0	9	100	2.71
2040.2	67	0	9	6	5	0	1	12	100	2.67
Min	53	0	5	0	5	0	0	7		2.67
Max	67	4	9	8	26	1	2	15		2.72
Avg	59	1	8	4	17	0	1	11		2.70

Clay Mineralogy of the < 5 micron size fraction

Relative Abundance in Percent

Depth (ft)	I/S	Chl	Ill	Total	I/S Comp
1960.	66	13	21	100	91
1963.4	10	23	67	100	90
1966.8	18	20	62	100	88
1986.7	47	20	33	100	92
2035.4	10	34	56	100	87
2040.2	14	21	65	100	86
Min	10	13	21		86
Max	66	34	67		92
Avg	28	22	51		89

KEY:

Qtz = quartz
Ksp = K-feldspar
Plag = plagioclase
Dol = dolomite
Anh = anhydrite
Gyp = gypsum
Hal = halite
Clay = total clay
Gd = calculated grain density

I/S = mixed-layer illite/smectite
Chl = chlorite
Ill = illite
I/S comp = percent illite layers in I/S

FIGURE 13

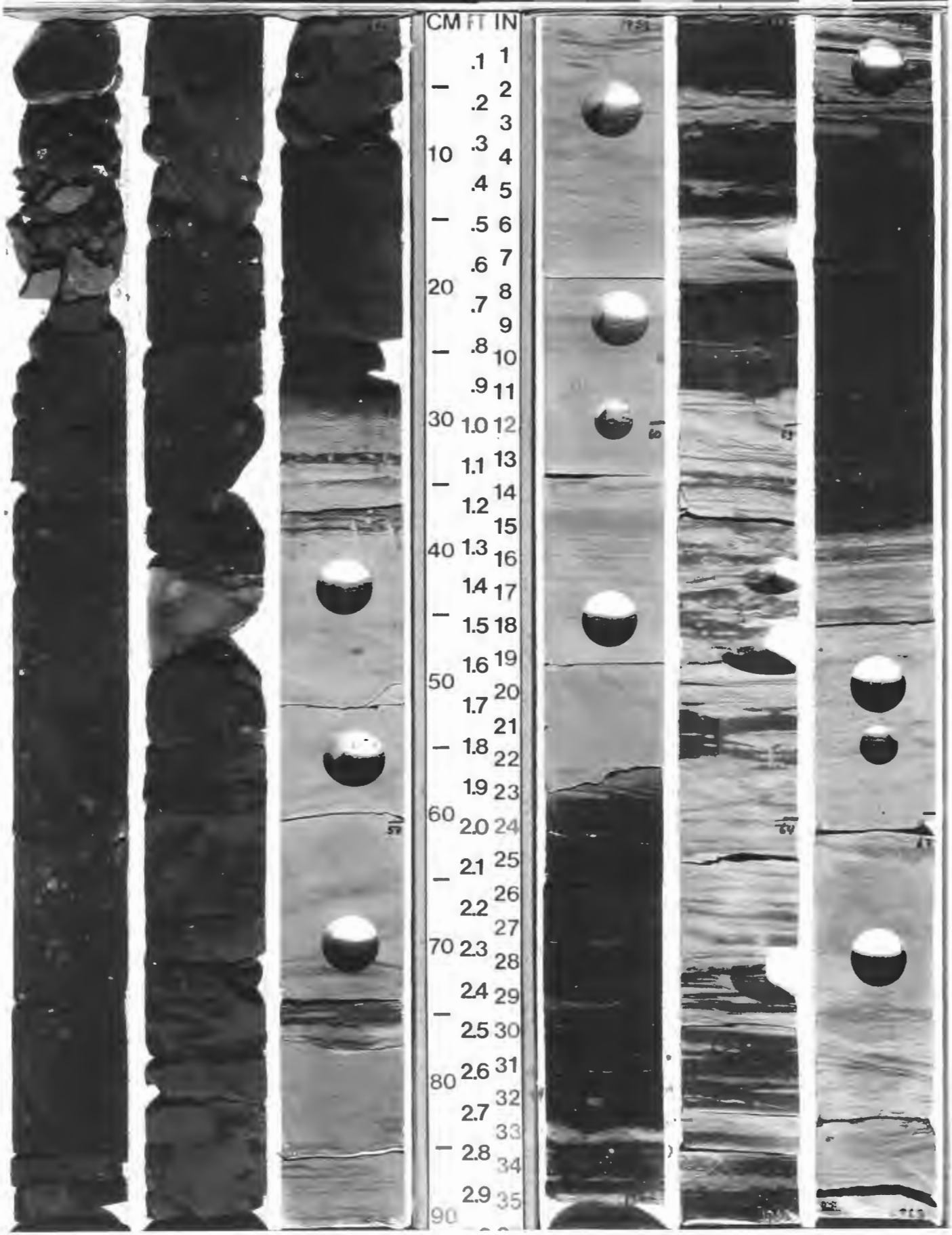
CORE PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION ARNOLD C-1 WELL

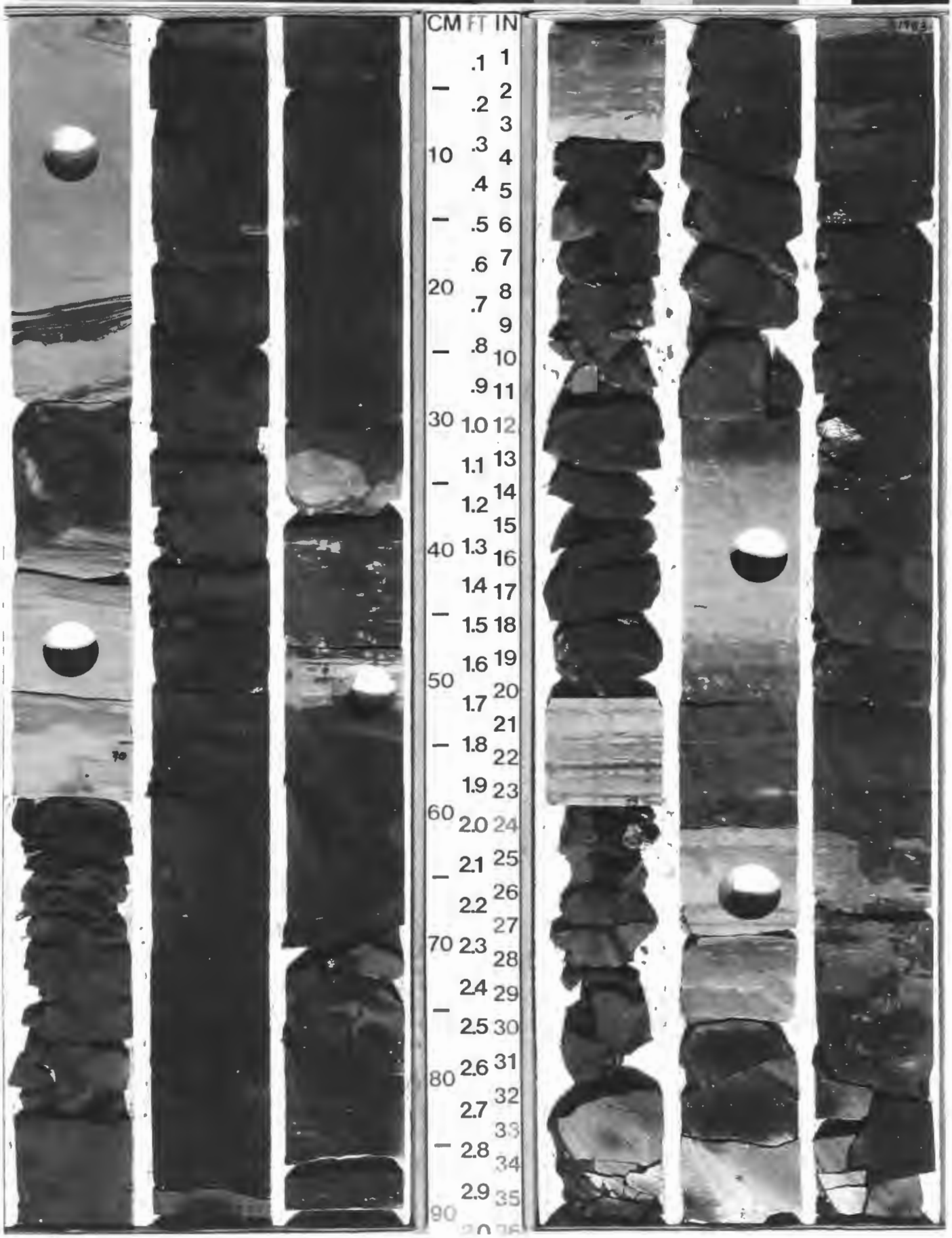
HUGOTON FIELD

MORTON COUNTY, KANSAS

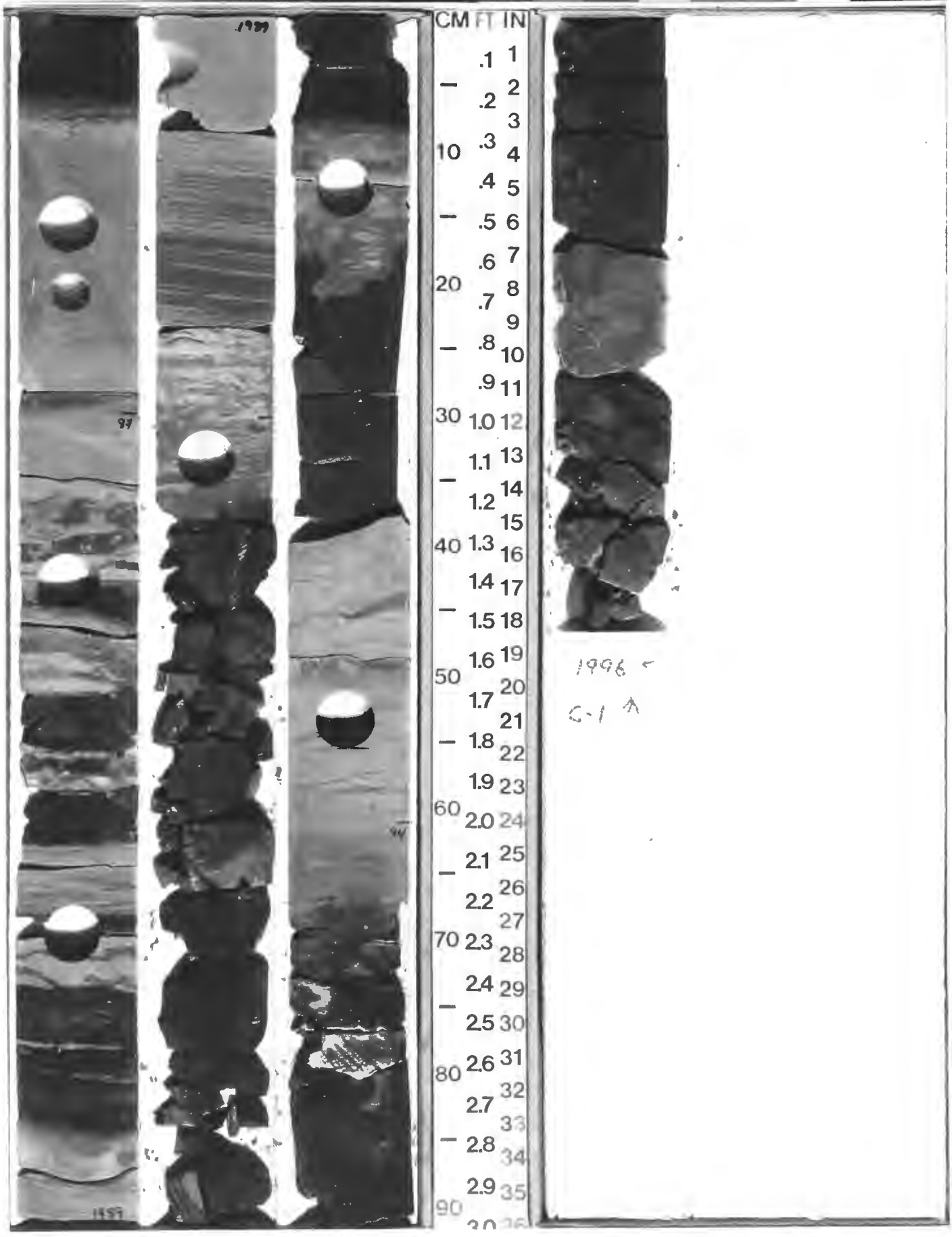
ANADARKO PETROLEUM CORPORATION
ARNOLD C-1
MORTON COUNTY, KANSAS
1950.0 - 1968.0



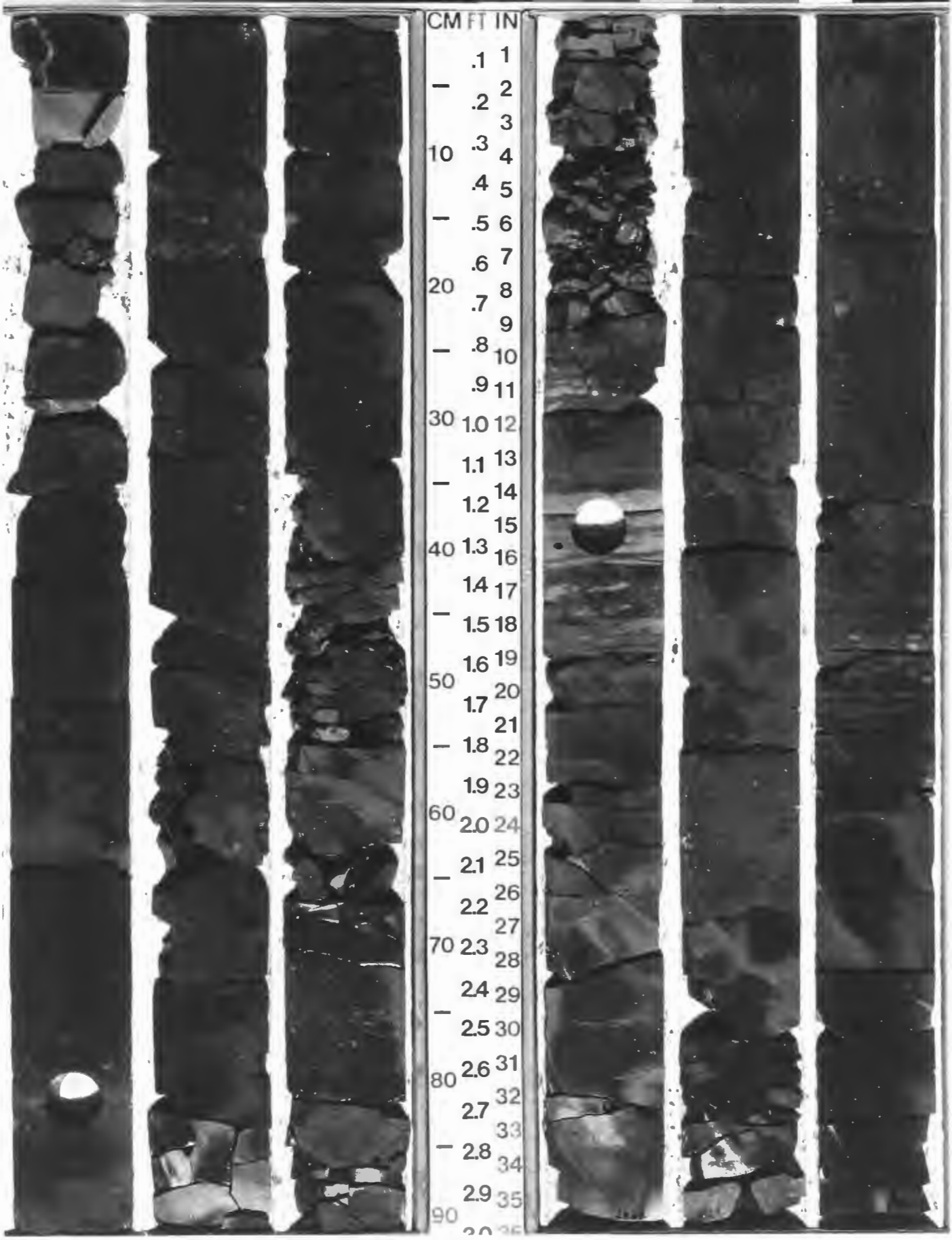
ANADARKO PETROLEUM CORPORATION
ARNOLD C-1
MORTON COUNTY, KANSAS
1968.0 - 1986.0



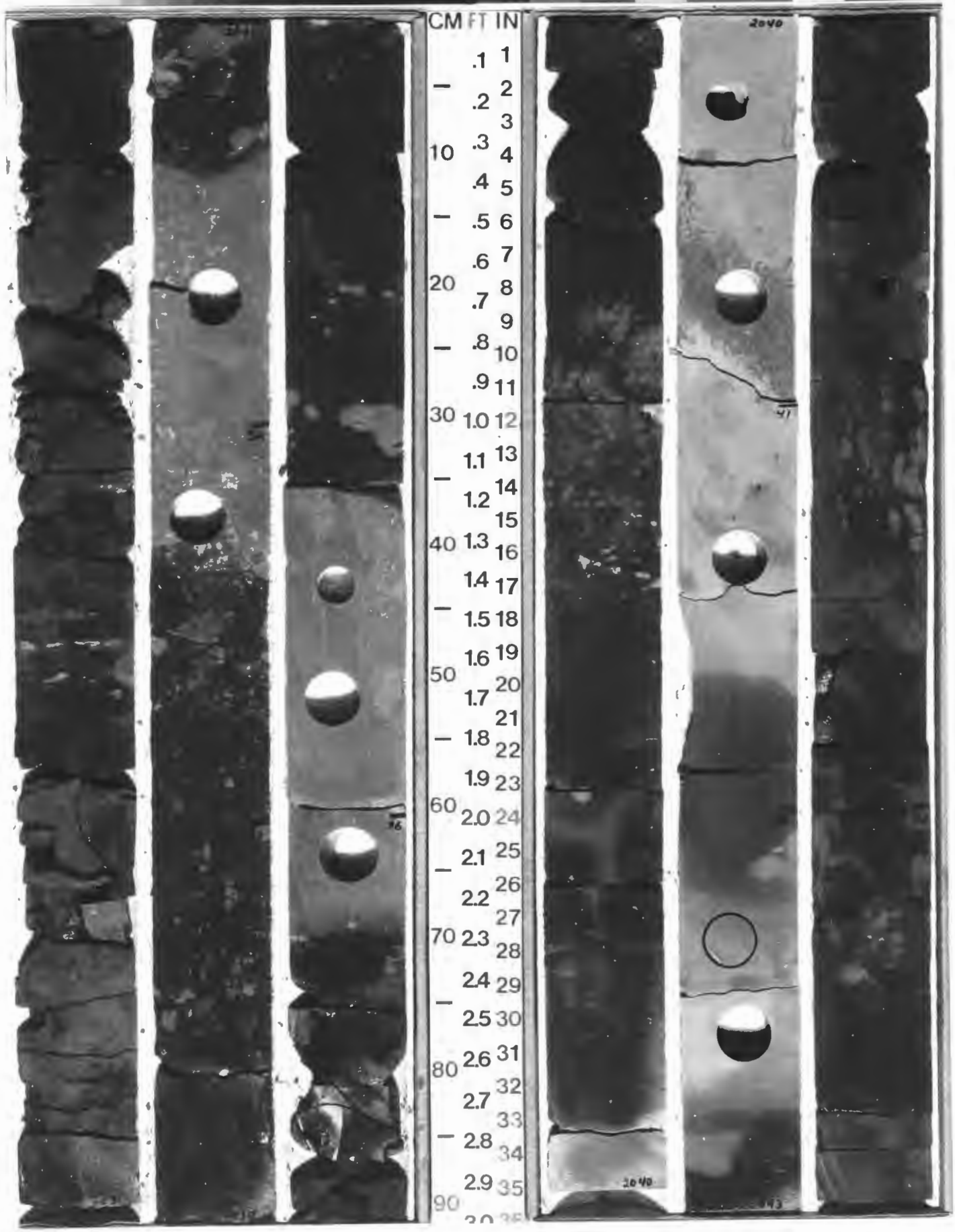
ANADARKO PETROLEUM CORPORATION
ARNOLD C-1
MORTON COUNTY, KANSAS
1986.0 - 1996.5



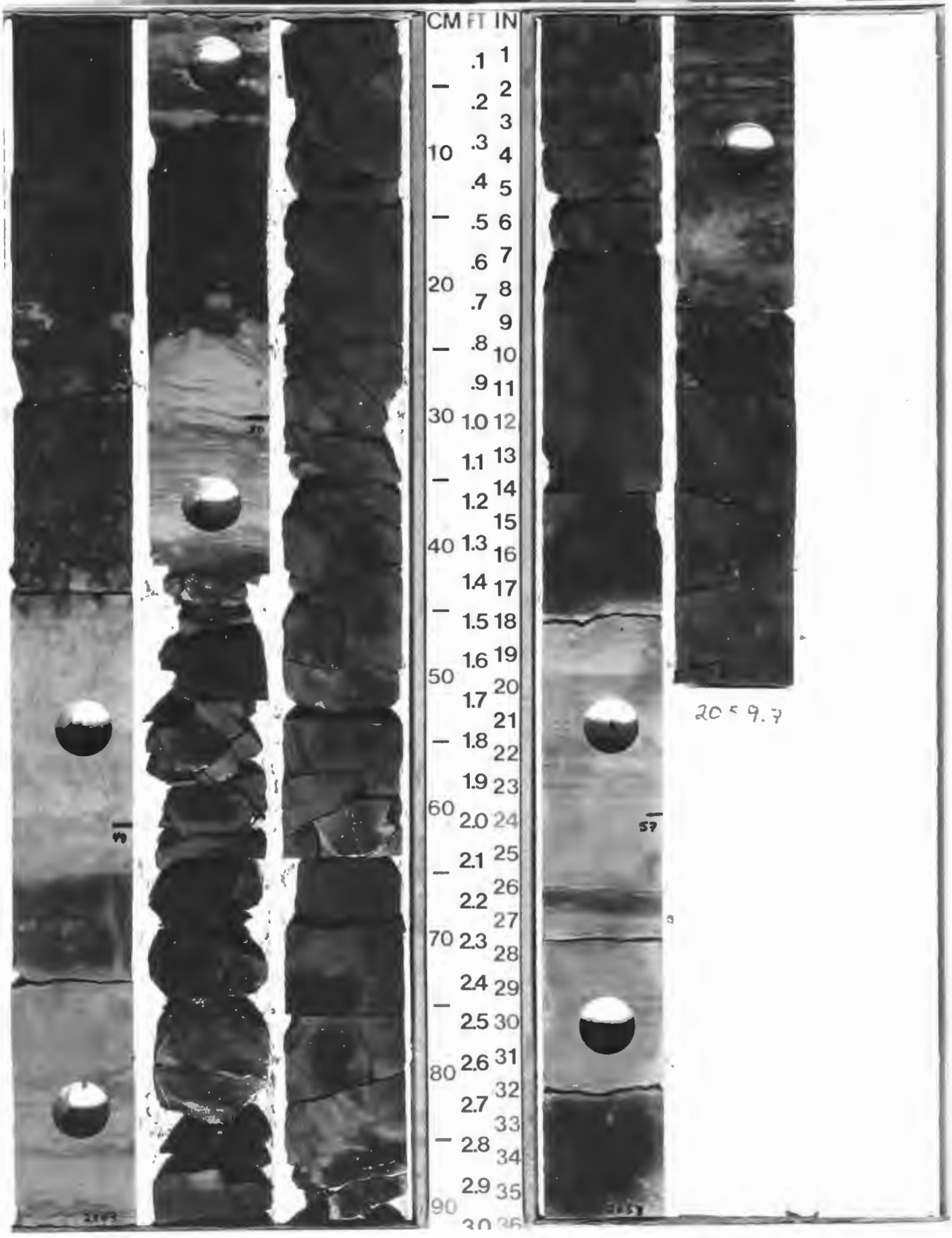
ANADARKO PETROLEUM CORPORATION
ARNOLD C-1
MORTON COUNTY, KANSAS
2010.0 - 2028.0



ANADARKO PETROLEUM CORPORATION
ARNOLD C-1
MORTON COUNTY, KANSAS
2028.0 - 2046.0



ANADARKO PETROLEUM CORPORATION
ARNOLD C-1
MORTON COUNTY, KANSAS
2046.0 - 2059.7



TOTAL GAMMA LOG

Anadarko Petroleum Corporation
Arnold C-1 Well
Morton County, Kansas
SRS 2068/RSH 3266

Scale 1:240