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CONVENTIONAL CORE ANALYSIS

Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
~~Greenwood Field~~
Morton County, Kansas
SRS 1654/RSB 2744

Natural Core Gamma Radiation Log

Specific Permeability to Gas (Steady-State Method)

Porosity and Grain Density (Boyle's Law Method)

Fluid Saturations (Dean-Stark Method)

Lithological Description of the Core Plug Samples



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

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December 30, 1992

Mr. Kirk Malinowsky
Anadarko Petroleum Corporation
17001 Northchase Drive
Houston, Texas 77060

Dear Mr. Malinowsky,

On December 2, 1992, Mr. Steve Root of Reservoirs, Inc. arrived at Elkhart, Kansas to retrieve, preserve and ship the full-diameter well core from the Snyder "A" No. 3 Well, Greenwood Field, Morton County, Kansas. On December 4, 1992 the well core was transported in a van to Amarillo, Texas and shipped by air to Houston, Texas.

The core segments were removed from the preservation material, placed on a table and oriented according to the depth. The natural core gamma radiation was determined as a function of depth.

Sixty-six (66) horizontally oriented core plug samples were drilled from the well core, trimmed and placed into individual Dean-Stark apparatus. Toluene was used to distill the water from the core plug samples and methanol was used to remove any salt present in the core plug samples. No oil saturation was apparent in any of the core plug samples. The gas saturations ranged from 13.8 to 59.3 percent of the pore volume. (Table 1)

The specific permeability to gas, porosity and grain density was determined for each of the clean and dry core plug samples. These results are presented in Table 1 with the fluid saturations and the lithological descriptions of the core plug samples, the specific permeabilities to gas ranged from less than 0.002 to 236 md with most of the core plug samples having permeabilities to gas less than 1 md. The porosities ranged from 2.6 to 22.4 percent of the bulk volume.

Figure 1 presents the porosity-specific permeability to gas relationship and Figure 2 presents the porosity-grain density relationship. A core-graph has been prepared for your use which presents graphically the core gamma-radiation log, permeabilities to gas, porosities and the fluid saturations. A transparency has been enclosed which can be used to compare these test results with the well logs.

A section entitled "Laboratory Procedures" has been included which describes the methods and techniques used to obtain the test results. I will be happy to answer any questions that you may have regarding these test results or the methods used to obtain them. My telephone number is (713) 932-6619 or contact Mr. Paul Delacoe (713)932-9670.

One unbound copy of the report has been included for your use; however, if you would like additional copies of the bound report please let me know how many copies you need. There is no charge for the extra copies.

Thank you for selecting Reservoirs, Inc. to perform these analyses for you and Anadarko Petroleum Corporation. We are looking forward to being of service to you in the future.

Sincerely,

A handwritten signature in cursive script that reads "Duane L. Archer".

Duane L. Archer
Vice President
Special Core Analysis

LABORATORY PROCEDURES

Introduction:

Sixty (60) feet of full-diameter well core was retrieved from the Snyder "A" No. 3 Well, Greenwood Field, Morton County, Kansas on December 4, 1992. Mr. Steve Root was the Geologist from Reservoirs, Inc. that was at the well site. He preserved the core material and transported it to Amarillo, Texas where he shipped the core by air to Houston, Texas. The core material arrived in Houston on December 5, 1992.

Natural Core Gamma-Ray Log:

The full-diameter well core was removed from the shipping boxes and preservation material. Each core segment was placed on a table and oriented according to the depth. The entire well core was placed on the moving belt assembly of the core-gamma apparatus. The natural gamma radiation of the well core was measured as a function of depth. Thus, the core gamma-log can be compared to the down-hole gamma radiation logs.

Sample Preparation:

Sixty-six (66) horizontally oriented core plug samples (one-inch in diameter) were drilled from the well core using water as the lubricant and bit coolant. The core plug samples were trimmed with water to form right cylinders. Each sample was placed in separate Dean-Stark apparatuses for distillation and extraction.

Dean-Stark Distillation/Extraction:

Each core plug sample was placed in the Dean-Stark apparatus after the toluene had been pre-boiled to remove any absorbed water. The temperature in the boiling flask was increased to begin the distillation process. The vapors flow upward around the core plug sample and into the condenser. The condensed liquid flows over the core plug sample and returns to the boiling flask. Toluene boils at a temperature higher than water. Thus, the water in the core

plug sample was distilled and the vapors flow upward into the condenser. The condensed water was trapped in a graduated receiving tube and the water volumes were read to the nearest 0.01 ml. When no further production of water was evident, the toluene was replaced with methanol to remove any salts present in the core plug sample.

After thoroughly cleaning the core plug samples, they were placed in a conventional chamber and dried at 160°F. The core plug samples were allowed to cool to room temperature in a desiccator containing silica-gel.

The fluid saturations were determined from the gravimetric measurements obtained before and after cleaning of the samples and the volumes of water produced during the Dean-Stark extractions. The water saturations were determined by expressing the volume of water produced as a percentage of the pore volume. No oil saturations were determined; thus, the gas saturations were calculated by subtracting the water saturations from 100 percent.

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 the 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 chamber (matrix cup) 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 and applying a confining pressure of 400 psig to the system to prevent bypassing of the gas around the core plug sample. Nitrogen gas was injected into the 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.

CONVENTIONAL CORE ANALYSIS

**Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Greenwood Field
Morton County, Kansas
SRS 1654/RSR 2744**

*mudstone
micro φ?*

Sample	Depth (ft.)	Permeability To Gas (md)	Porosity (%BV)	Density (g/cc)	Saturation(%PV)		Description/Comments
					Water	Gas	
U 255	2139.3	6.22	15.7	2.79	61.9	38.1	SD GRY-RD SLT SLTY SLI LMY LAMS NO FLU NO CUT
U 256	2139.8	236	18.0	2.78	49.0	51.0	SD GRY-RD SLT SLTY LMY LAMS NO FLU NO CUT
U 257	2140.3	205	22.4	2.80	40.7	59.3	MDST LT-GRY DOL LMY FT FLU NO CUT
U 258	2140.7	0.348	22.0	2.78	41.9	58.1	MDST LT-GRY DOL LMY FOSS NO FLU NO CUT
U 259	2141.2	0.119	17.8	2.73	54.5	45.5	SD LT-GRY RD SLT SLI LMY FOSS NO FLU NO CUT
U 260	2141.7	0.286	17.4	2.69	54.2	45.8	SD LT-GRY RD VFGR SLTY MOTT NO FLU NO CUT
U 261	2142.2	1.99	14.3	2.70	68.1	31.9	SD LT-GRY RD VFGR SLTY CLN NO FLU NO CUT
U 262	2142.8	0.724	17.3	2.71	63.9	36.1	SD GRY RD VFGR SLTY LAM NO FLU NO CUT
U 263	2143.3	1.58	17.0	2.70	71.5	28.5	SD GRY RD VFGR SLTY LAM NO FLU NO CUT
U 264	2143.7	1.38	16.8	2.71	73.7	26.4	SD GRY RD VFGR SLI SLTY LAM NO FLU NO CUT
U 265	2144.2	24.0	15.4	2.71	71.8	28.2	SD BLK VFGR SLTY NO FLU NO CUT
U 266	2144.7	6.64	18.6	2.67	62.6	37.4	SD BLK VFGR SLTY NO FLU NO CUT
U 267	2145.3	0.283	16.7	2.71	65.4	34.6	SD GRY RD VFGR SLI SLTY SLI LMY MOTT NO FLU NO CUT
U 268	2145.7	0.640	15.8	2.71	72.3	27.7	SD GRY RD VFGR SLI SLTY SLI LMY MOTT NO FLU NO CUT
U 269	2146.2	2.04	16.6	2.71	67.3	32.7	SD GRY RD VFGR SLI SLTY LMY LAM NO FLU NO CUT
U 270	2146.7	0.020	15.4	2.74	62.7	37.3	SD GRY RD VFGR SLI SLTY LMY LAM NO FLU NO CUT
U 271	2147.2	0.839	20.0	2.67	73.3	26.7	SD GRY RD VFGR SLI SLTY LMY NO FLU NO CUT
U 272	2147.8	8.52	19.7	2.67	72.4	27.6	SD LT-GRY BLK VFGR SLI SLTY PYR MOTT NO FLU NO CUT
U 273	2148.2	0.046	13.2	2.73	70.5	29.5	SD LT-GRY BLK VFGR SLI SLTY PYR MOTT NO FLU NO CUT
U 274	2148.7	11.7	20.4	2.67	73.2	26.8	SD LT-GRY BLK VFGR SLI SLTY PYR MOTT NO FLU NO CUT
U 275	2149.3	1.08	18.8	2.68	78.9	21.1	SD GRY-BLK VFGR SLI SLTY SLI SH MIC MOTT NO FLU NO CUT
U 276	2149.6	5.39	17.1	2.70	76.1	23.9	SD GRY VFGR SLI SH MIC MOTT NO FLU NO CUT
U 277	2150.3	29.4	15.3	2.71	78.5	21.5	SD GRY VFGR SLI SH MIC FOSS MOTT NO FLU NO CUT
U 278	2150.9	46.8	16.6	2.71	79.1	20.9	SD GRY VFGR SLI SH MIC NO FLU NO CUT
U 279	2151.4	0.98	15.6	2.70	76.2	23.8	SD LT-GRY VFGR SLI SLTY MIC NO FLU NO CUT
U 280	2151.9	6.87	14.1	2.71	62.0	38.0	SD LT-GRY VFGR SLI SLTY MIC PYR FOSS NO FLU NO CUT
U 281	2152.2	5.15	15.1	2.69	67.0	33.0	SD LT-GRY VFGR MIC NO FLU NO CUT
U 282	2152.7	46.6	17.5	2.68	62.9	37.1	SD LT-GRY VFGR MIC NO FLU NO CUT
U 283	2153.2	0.564	8.4	2.77	66.3	33.7	LS BLK DOL XLN FOSS NO FLU NO CUT
U 284	2153.7	0.019	5.1	2.79	74.3	25.7	LS BLK DOL XLN FOSS NO FLU NO CUT
U 285	2154.3	0.102	9.5	2.76	77.5	22.5	LS BLK DOL XLN FOSS NO FLU NO CUT
U 286	2154.8	0.073	12.2	2.73	85.2	14.8	SD GRY VFGR CALC XLN FOSS NO FLU NO CUT

LS

①

②

LS interbed

1.5' LS interbed affects density log over 4' interval

Zone	Log Depth	DPHI @ 2.71	DPHI @ 2.66	remark?
①	2132-2137	18.25	16.75	good when against core (16.75 log vs core) - core sampling unbiased
②	2137.5-2140	18.25	16.75	ave core d higher - some high d, low K samples may have microporous clay

Reservoirs

Inc.

CONVENTIONAL CORE ANALYSIS (CONTINUED)

Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Greenwood Field
Morton County, Kansas
SRS 1654/RSH 2744

Sample	Depth (ft.)	Permeability To Gas (md)	Porosity (%BV)	Density (g/cc)	Saturation(%PV)		Description/Comments
					Water	Gas	
U 287	2155.3	0.871	12.7	2.70	66.0	34.0	SD GRY VFGR LIG MIC NO FLU NO CUT
U 288	2155.8	0.921	13.6	2.72	85.5	14.5	SD GRY VFGR LIG MIC FOSS NO FLU NO CUT
U 289	2156.3	3.01	15.8	2.70	68.8	31.2	SD GRY VFGR LIG MIC FOSS NO FLU NO CUT
U 290	2156.8	0.442	14.4	2.70	80.3	19.7	SD GRY VFGR MIC NO FLU NO CUT
U 291	2157.2	0.292	15.7	2.70	83.2	16.8	SD GRY VFGR MIC NO FLU NO CUT
U 292	2157.7	0.358	15.1	2.70	80.5	19.5	SD GRY VFGR MIC NO FLU NO CUT
U 293	2158.3	6.96	18.6	2.68	62.2	37.8	SD LT-GRY VFGR W/SLT LAMS NO FLU NO CUT
U 294	2158.7	0.183	17.0	2.68	76.1	23.9	SD GRY VFGR MIC MOTT NO FLU NO CUT
U 295	2159.5	31.0	20.7	2.67	49.2	50.8	SD LT-GRY VFGR MIC THN LAMS NO FLU NO CUT
U 296	2159.8	29.7	18.1	2.70	74.7	25.3	SD GRY VFGR SLI SLTY W/SH LAMS MIC NO FLU NO CUT
U 297	2160.4	0.367	7.1	2.79	82.5	17.5	LS BLK DOL SLT LAM FOSS NO FLU NO CUT
U 298	2160.8	16.4	13.2	2.73	63.5	36.5	SD GRY VFGR SLI SLTY SLI SH FOSS NO FLU NO CUT
U 299	2161.2	<0.002	2.6	2.87	77.9	22.1	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 300	2161.7	0.014	4.0	2.87	78.4	21.6	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 301	2162.2	0.014	4.3	2.85	77.6	22.4	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 302	2162.8	0.031	6.5	2.85	64.9	35.1	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 303	2163.3	0.024	5.7	2.85	71.7	28.3	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 304	2163.7	0.040	7.0	2.83	75.4	24.6	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 305	2164.3	0.034	7.2	2.83	71.8	28.2	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 306	2164.9	0.048	9.9	2.83	74.8	25.2	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 307	2165.2	0.037	7.3	2.84	78.2	21.8	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 308	2165.7	0.070	10.0	2.85	65.3	34.7	DOL BLK XLN W/GYP LAM PYR FOSS NO FLU NO CUT
U 309	2166.3	0.033	7.5	2.84	71.4	28.6	DOL BLK XLN FOSS NO FLU NO CUT
U 310	2166.7	0.041	8.9	2.84	71.9	28.1	DOL BLK XLN FOSS NO FLU NO CUT
U 311	2167.1	0.040	9.4	2.83	82.8	17.2	DOL BLK XLN FOSS NO FLU NO CUT
U 312	2167.7	0.033	9.2	2.82	76.7	23.3	DOL BLK XLN FOSS NO FLU NO CUT
U 313	2168.2	0.040	9.7	2.83	86.2	13.8	DOL BLK XLN FOSS NO FLU NO CUT
U 314	2168.8	0.017	10.8	2.82	63.0	37.0	DOL BLK XLN FOSS NO FLU NO CUT
U 315	2169.2	0.020	5.6	2.92	71.9	28.1	DOL BLK XLN FOSS NO FLU NO CUT
U 316	2169.8	0.063	7.1	2.83	68.1	31.9	DOL BLK XLN FOSS NO FLU NO CUT
U 317	2170.2	0.028	5.0	2.83	71.1	28.9	DOL BLK XLN FOSS NO FLU NO CUT
U 318	2170.7	0.009	3.4	2.84	75.4	24.6	DOL BLK XLN FOSS NO FLU NO CUT
U 319	2171.2	0.018	12.1	2.78	72.0	28.0	MDST LT-GRY DOL SLI LMY FT GOLD FLU NO CUT
U 320	2171.8	18.8	12.7	2.73	79.9	20.1	MDST LT-GRY SLTY DOL SLI LMY FT GOLD FLU NO CUT

Reservoirs

Inc.

Figure 1

SPECIFIC PERMEABILITY TO GAS - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Greenwood Field
Morton County, Kansas
SRS 1654/RSH 2744

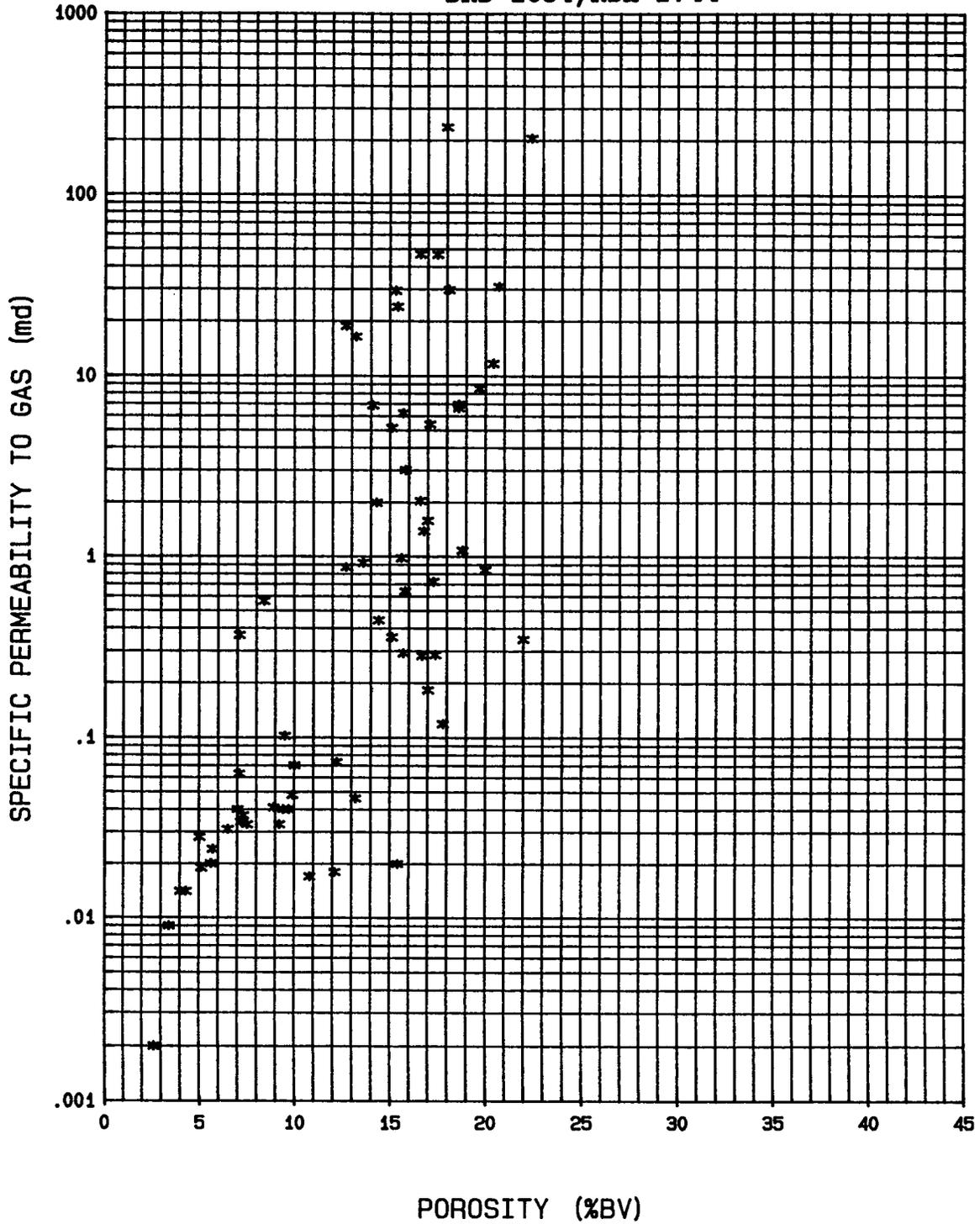
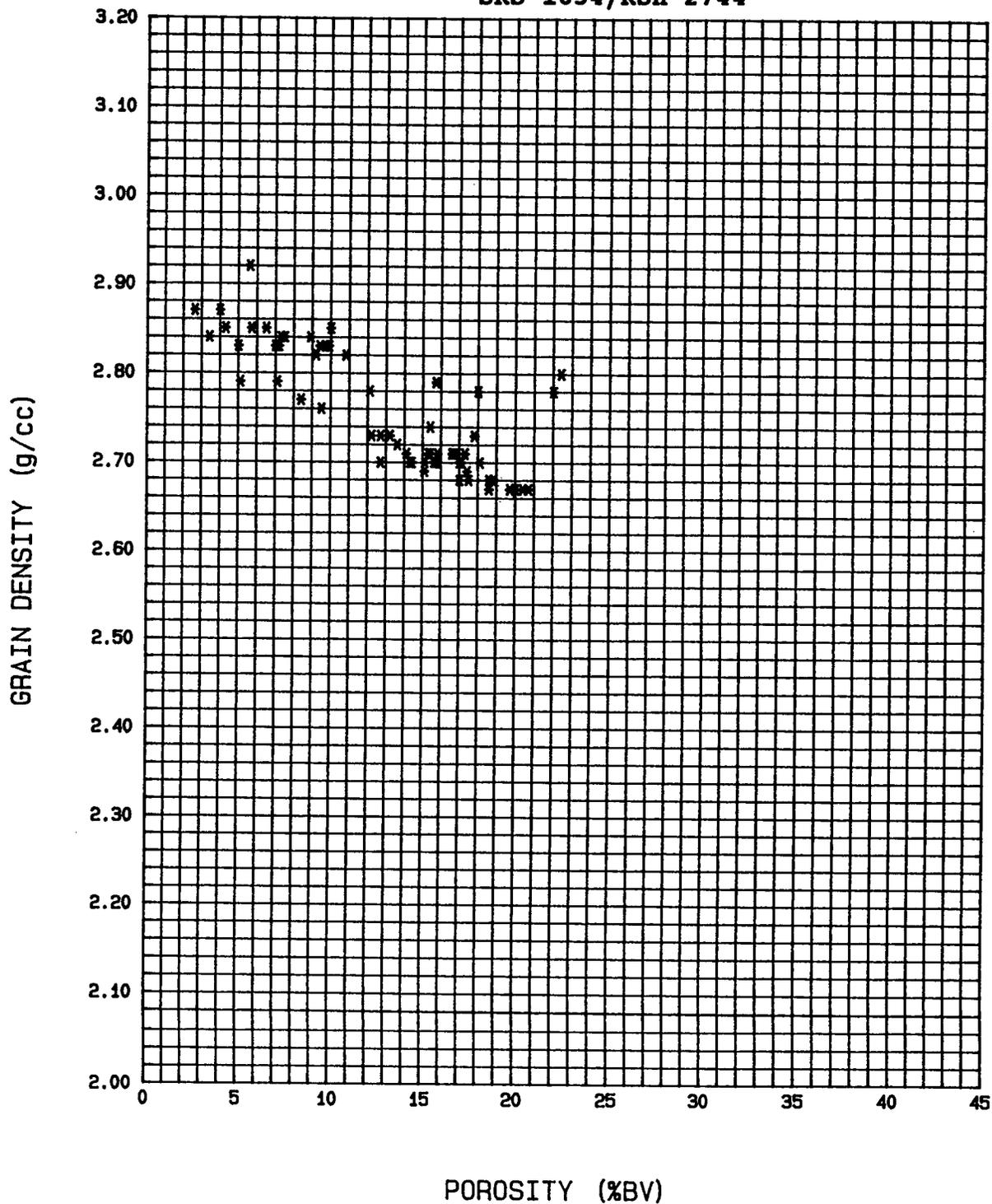


Figure 2

GRAIN DENSITY - POROSITY RELATIONSHIP

Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Greenwood Field
Morton County, Kansas
SRS 1654/RSH 2744



COMPANY ANADARKO PETROLEUM COMPANY FIELD GREENWOOD FILE SRS 1654
 WELL SNYDER "A" NO. 3 COUNTY MORTON ELEV. _____
 LOCATION _____ STATE KANSAS DATE _____

RESERVOIRS

Inc. CORE-GAMMA LOG

VERTICAL SCALE: 5" = 100'

TOTAL WATER
 PERCENT TOTAL WATER
 (—————)
 100 80 60 40 20 0

GAMMA RAY
 RADIATION INCREASE
 (—————>)

PERMEABILITY
 MILLIDARCIES
 100 10 1.0
 1.0 .10 .01 30 20 10 0

POROSITY
 PERCENT
 30 20 10 0

OIL SATURATION
 PERCENT PORE SPACE
 (-----)
 0 20 40 60 80 100

