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GEOLOGICAL EVALUATION OF CONVENTIONAL CORE FROM THE ANADARKO PETROLEUM CORPORATION SNYDER "A" NO. 3 WELL HUGOTON FIELD MORTON COUNTY, KANSAS

Prepared

for

Anadarko Petroleum Corporation

Houston, Texas

RSH 2744

GEOLOGICAL EVALUATION

OF CONVENTIONAL CORE FROM THE

ANADARKO PETROLEUM CORPORATION

SNYDER "A" NO. 3 WELL

HUGOTON FIELD

MORTON COUNTY, KANSAS

INTRODUCTION

This report, prepared for Anadarko Petroleum Corporation, presents the results and conclusions drawn from geological analysis of 59 feet (2130–2189 feet) of conventional core recovered from the Anadarko Petroleum Corporation Snyder "A" No. 3 Well, located in Hugoton Field, Morton County, Kansas.

The objectives of this study were to 1) describe the cored interval, leading to an interpretation of depositional environments, 2) provide petrographic data on the prospective reservoir rocks, and 3) evaluate the reservoir potential and pore system properties of the strata. In order to meet these objectives, the following analytical program was utilized:

-- The core was slabbed into one-third and two-third sections.

-- The slabbed core was described in detail to delineate lithologies, textural characteristics, and sedimentary structures. This description is presented in Figure 2.

-- Samples were selected for thin section analysis, scanning electron microscopy (SEM), and X-ray diffraction (XRD). These samples are:

Depth	Thin Section	SEM	XRD
2143.3 feet	*	*	*
2147.2 feet	*	*	*
2150.9 feet	*	*	*
2155.3 feet	*	--	--
2159.5 feet	*	*	*
2163.7 feet	*	--	--
2168.2 feet	*	--	--

-- Samples selected for thin section analysis were impregnated with blue-dyed epoxy to highlight pore space. The thin sections were ground to 30 microns and stained with Alizarin Red-S which aids in differentiating calcite from other carbonate minerals. Point count modal analysis (250 points) was utilized to obtain data on the relative proportions of grain types, pore-filling constituents, and pore types. Point count data are presented in Table 1. Thin section photomicrographs are presented in Figures 4 through 10.

-- SEM analysis, which was performed on freshly broken rock surfaces, was conducted to examine and document pore system properties and pore-filling constituents in these rocks. SEM photomicrographs are presented in Figures 11 through 14.

-- X-ray diffraction analysis was used to determine the mineral content of these samples. The rocks were ground to 40 microns to ensure homogeneity and analyzed through standard X-ray diffraction techniques. The "less than 5 micron" fraction of the samples were also analyzed to determine the relative proportions of clay mineral species. X-ray diffraction data are presented in Table 2.

-- The core was photographed in color, in its entirety, to provide a permanent, easily accessible record of the cored interval. The core photographs are presented in Figure 15.

Reservoir Job Number RSH 2744 was assigned to this study. Any communications regarding this report should refer to this Job Number. Three copies of this study have been forwarded to Mr. Kirk Malinowsky, at Anadarko Petroleum Corporation, Houston, Texas. Additional copies of this report may be obtained for reproduction costs. All data, interpretations, and other matters related to this study are considered highly confidential and the sole property of Anadarko Petroleum Corporation, Houston, Texas.

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GEOLOGICAL ANALYSIS

This section of the report presents the results and conclusions drawn from geological analysis of 59 feet (2130–2189 feet) of conventional core recovered from the Anadarko Petroleum Corporation Snyder "A" No. 3 Well, located in Hugoton Field, Morton County, Kansas.

Core Description and Interpretations

2170.9–2189.0 feet (18.1 feet)

Description:

The lowermost 18.1 feet of core are dominated by **brick-red, siltstone to silty claystone**. A minor amount of greenish-gray dolomitic sandstone is present at the top of this interval. The siltstone and silty claystone strata are mostly massive, although parts show distinct root mottling. A few **desiccation cracks** and anhydrite nodules can be distinguished, as well several anhydrite-filled fractures (Figure 2). The dolomitic sandstone that caps this unit also shows root mottling, and contains scattered carbonate grains including fragments of marine fossils.

Two routine core analysis measurements were made in this interval, both from the dolomitic sandstone at the top of the unit. Porosity values of 12.1% and 12.7% (average of 12.4%) were determined, with permeability values of 0.018 md and 18.8 md (average of 9.41 md) also reported. The porosity and permeability values from these two core plugs are not representative of the entire interval. Visual estimates indicated that average porosity in the siltstone/silty claystone is less than 5%, and permeability should be under 1 md. Overall, this interval of siltstone, silty claystone and sandstone is estimated to have **poor** reservoir potential.

Interpretation:

The brick-red color, desiccation cracks, anhydrite nodules and root mottling are interpreted to reflect sedimentation in a terrestrial setting such as a **coastal plain** or

flood plain environment. The sedimentary structures and depositional textures observed in this interval are commonly attributed to **paleosol** (ancient soil) horizons.

2161–2170.9 feet (9.9 feet)

Description:

Gradationally overlying the sandstone/siltstone described in the previous interval is a 9.9 foot–thick unit of dark gray, **sandy dolomite**. Depositional textures are difficult to resolve due to dolomitization, but there appears to be three (?) sequences that grade from wackestone at the base to packstone/grainstone at the top (Figure 2). Pelecypods are the main bioclastic constituent, with some echinoderms, bryozoans and coral fragments also identified (Figures 9 and 10). Peloids are also present as an allochemical constituent.

Visible pore space is uncommon in this unit due to a combination of dolomite cement (in the packstones and grainstones) and dolomitized micrite matrix (in the wackestones). Routine core analysis measurements show porosity values ranging from 2.6% to 10.8% (average of 7.1%), with permeability values ranging from 0.001 md to 0.07 md (average of 0.032 md). Very little macropore space was observed in these dolomitic strata, although some intercrystalline pores can be distinguished (Figure 9). However, throughout this dolomitic interval, most of the measured pore volume is in the form of microporosity in the matrix. Overall, these dolomitized carbonate deposits are judged to have rather **poor** reservoir potential.

Interpretation:

The "coarsening–upward" sequences (wackestone at the base to packstone/grainstone at the top) are interpreted to reflect several stacked shoaling–upward cycles. The wackestone deposits record relatively low to moderate energy conditions, while the packstone and grainstone beds record higher energy sedimentation. The textural differences, combined with the assemblage of framework grains suggests sediment accumulation in a carbonate sand **shoal** to **shoal flank** environment.

2139.1–2161.0 feet (20.9 feet)

Description:

Gradationally overlying the carbonate unit described in the previous section is a 20.9 foot–thick interval of light gray, tan and brownish–red, **very fine–grained sandstone** to **siltstone**. Average grain size in the sandstones is between 0.062 and 0.088 mm, in the range of lower very fine–grained sand. The sand grains are mostly **very well sorted** and have angular to subrounded shapes. Compaction is estimated at moderate. Point count analysis of the sandstones indicate that quartz is the dominate framework constituent, with minor to trace amounts of feldspar, chert and rock fragments. These sandstones can be classified as **subarkoses** and **quartzarenites**. Dolomite cement, anhydrite cements, authigenic clay and clay matrix are present as pore–filling constituents.

Below 2153 feet, most of the strata are bioturbated, with some partially preserved ripples and laminations noted. Above 2153 feet, thin laminations and ripple cross-stratification predominate (Figure 2). Some root structures were observed near the top of the unit.

Routine core analysis measurements from this depth interval show porosity values ranging from 5.1% to 22.4% (average of 15.9%), and permeability values ranging from 0.019 md to 236.0 md (average of 16.9 md). In general, porosity and permeability values are higher in the uppermost 14 feet of this interval (between 2139.1 and 2153 feet), than in the lower part of this interval (below 2153 feet).

Depth Range (ft)	Sedimentary Structures	Porosity (%) (Average)	Permeability (md) (Average)
2139.1–2153.0	Ripples and Lamination	22.4–13.2 (17.2)	236–0.02 (23.2)
2153.0–2161.0	Bioturbated	20.7–5.1 (13.6)	31.0–0.019 (5.70)

Bioturbation in the strata below 2153 feet appears to have reduced porosity and permeability by 1) altering the distribution of detrital matrix, and, 2) resulting in closer grain packing. Other variations in porosity and permeability in this sandstone reflect differences in dolomite cementation and the amount/distribution of matrix material. Overall, the sandstones in this interval are judged to have **fair** to **very good** reservoir potential.

Interpretation:

The sandstones in this interval are interpreted as **tidal flat** deposits. More specifically, the partially bioturbated, partially stratified sandstones below 2153 feet are interpreted as having been deposited in the *lower* intertidal zone. By comparison, the ripple cross-stratified to laminated sandstones above 2153 feet are interpreted as having accumulated in the *upper* intertidal zone. The degree of bioturbation in tidal flat deposits is frequently tied to position relative to mean sea level. That is, those tidal flat deposits that are predominately in the lower intertidal zone tend to be more extensively bioturbated. The preserved sedimentary structures, general lack of bioturbation and minor root mottling in the upper half of this unit are consistent with sedimentation in the upper intertidal zone, where subaerial exposure is more pervasive.

2130–2139.1 feet (9.1 feet)

Description:

The uppermost 9.1 feet of the core consists of **brick-red** to **reddish-gray claystone**, **silty claystone** and **argillaceous siltstone**. Parts of the unit are massive, while other parts have root mottling and/or some ripple cross-stratification. Most of the core between 2136 and 2138 feet is rubble, with some faint ripples and laminations observed.

No routine core analysis measurements were made in this depth range, but, based on visual estimates, porosity is less than 5%, and permeability is judged to be less than 1 md. The strata in this interval are interpreted to have rather **poor** reservoir potential.

Interpretation:

The brick–red to reddish–gray color and root mottling are interpreted to be indicative of sedimentation in a terrestrial setting such as a **coastal plain** or **flood plain** environment. The sedimentary structures and depositional textures observed in this interval are commonly attributed to **paleosol** (ancient soil) horizons.

Diagenesis and Pore System Properties

This section of the report provides a synthesis of petrographic observations, and identifies diagenetic alterations that have influenced pore system properties and reservoir potential. This discussion focuses on the principal reservoir facies, specifically the sandstones in the tidal flat facies between 2139.1 and 2161.0 feet.

Point count data and thin section observations indicate that primary intergranular pores account for nearly all of the measured pore volume in the "clean" sandstone samples (Figures 8 and 14). However, in the more argillaceous sandstones, a large portion of the total measured pore volume is in the form of microporosity within the matrix (Figure 12). Thus, permeability varies widely for a very narrow range of porosity values. Secondary pores are rather uncommon in most of the samples, usually occurring where feldspar grains have been leached. One notable exception is the sample from 2155.3 feet where roughly 10% of the total pore volume is in the form of secondary pores. **Dolomite cement, anhydrite cement, authigenic clay and detrital clay are the main pore–filling constituents.** In addition, minor to trace amounts of carbonate matrix, pyrite cement and quartz overgrowths were observed.

Routine core analysis measurements show porosity values in the sandstone ranging from 5.1% to 22.4% (average of 15.9%) and permeability values ranging from 0.019 md to 236.0 md (average of 16.9 md). In general, porosity and permeability values are higher in the ripple cross–stratified/laminated parts of this facies, and somewhat lower where bioturbation has disrupted the depositional fabric. The higher range of porosity and permeability values occur in the "clean" sandstones with relatively minor amounts of clay, and where dolomite cementation is less extensive.

SEM analysis and X–ray diffraction data indicate that authigenic clay minerals have precipitated around many of the framework grains. A combination of mixed–layer illite/smectite, chlorite and illite were detected (Table 2). Experience with these clay minerals suggest that they pose potential problems with formation sensitivity. The illite and mixed-layer illite/smectite may react with freshwater and undersaturated brines containing monovalent ions. Furthermore, the chlorite could make the rock sensitive to acids or completion fluids with low pH. These topics are considered further in the section entitled Engineering Discussion and Recommendations.

Depositional Model

This section provides a synthesis of the observations and interpretations drawn from analysis of the strata in the cored interval. Three lithofacies were identified in the core. These are:

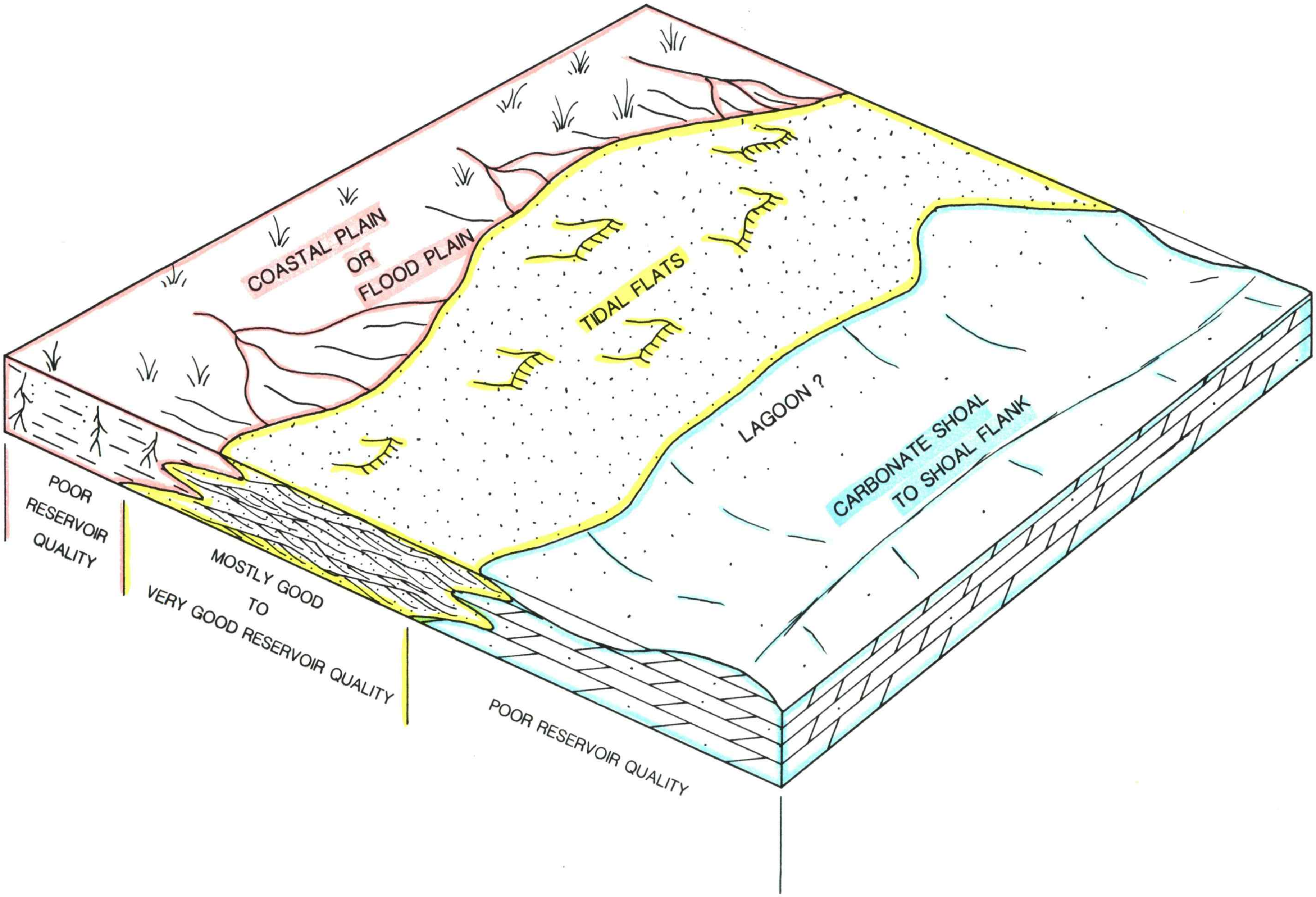
Lithofacies	% of Core	Depositional Environment	Estimated Reservoir Potential
Interbedded siltstone, silty claystone and claystone. Root mottled. Brick-red color.	46%	Coastal Plain or Flood Plain	Poor
Light gray, tan and brownish-red, very fine grain sandstone/siltstone. Ripples and laminations in upper half of unit; bioturbation more common in lower half.	**37%**	**Tidal Flat**	**Fair to very good**
Sandy, skeletal wackestone to packstone/grainstone.	17%	Shoal to Shoal Flank	Poor

The sequence of lithofacies identified in the core (Figure 2) is interpreted to reflect interfingering of three laterally adjacent depositional environments (Diagram 1). The carbonate beds are interpreted to record stacked shoaling-upward deposits that are the product of shoal flank and shoal sedimentation. The shoal and shoal flank deposits have poor reservoir potential.

The sandstones of the tidal flat facies, and are the main prospective reservoir in these strata. The generally well preserved intergranular pore space in the very fine-grained sandstones/siltstones yields reservoir rocks with a rather high porosity and permeability and **fair** to **very good** reservoir potential. Tidal flat deposits form in the intertidal zone where wave action winnows out mud matrix and deposits ripple cross-

DIAGRAM 1

IDEALIZED DEPOSITIONAL MODEL



stratified, sandstones/siltstones. Within the tidal flat facies, below 2153 feet bioturbation is more extensive. This suggests sedimentation in the lower intertidal zone. By comparison, the sandstones above 2153 feet contain ripple cross-stratification and thin laminations with only minor bioturbation. These are interpreted to reflect sedimentation in the upper intertidal zone. Tidal flat deposits generally form in a facies belt that parallels the paleocoastline. However, as these deposits prograde seaward, they can form sheet-like sandbodies. Defining the direction of depositional strike and dip can be an important tool for maximizing sand (and thus pay) thickness, while minimizing the occurrence of non-pay coastal plain/flood plain and shoal to shoal flank facies. The main objective in future wells should be to identify thick accumulations of tidal flat sandstones in structurally favorable positions. The tidal flat deposits may thin up depositional dip where they grade into terrestrial facies, and thin down dip as they grade into more seaward (carbonate-dominated?) deposits. It may be possible to define trends of maximum sandstone thickness parallel to depositional strike.

The coastal plain/flood plain deposits that occur at the top and bottom of the cored interval are the product of nearshore, terrestrial (paralic) sedimentation. The root mottling and extensive oxidation associated with this facies support this interpretation. These deposits accumulated landward of the tidal flat environment. In the lower part of the cored interval, the transition from coastal plain/flood plain to carbonate shoal to shoal flank deposits (around 2170.9 feet) is interpreted to reflect a transgressive event. By comparison, the gradational shift from tidal flat deposits to coastal plain/flood plain facies at the top of the core (around 2139.1 feet) is interpreted to record the seaward migration (progradation) of facies.

ENGINEERING DISCUSSION AND RECOMMENDATIONS

Discussion

This well was drilled with a mud listed as "Premix" with a density of 8.6 lbs/gal, viscosity of 58 sec/qt, Ph of 9.5 and fluid loss of 14 cc/30 min. The caliper log indicated gauge hole from 2130 to 2112 feet (top of available log section). The caliper log implies that this mud is not compatible with the formations. The washouts could complicate the primary cement job which, in turn may result in channelling in the borehole.

The zone of interest was cored in the log interval 2120–2179 feet. The log gross interval for stimulation purposes is 36 feet (2127–2163 feet) and the net interval is 23 feet (2127–2150 feet). The average porosity in the gross pay interval is 13%, average permeability is 11.5 md, average water saturation is 70.5% and average grain density is 2.76 gm/cc. The high water saturation may reflect water retention by the microporosity in the authigenic clays.

X–ray analysis of four samples from the interval 2143–2160 feet revealed the following components: 65% quartz, 16% feldspar, 6% dolomite, 1% pyrite, 1% anhydrite, 1% halite (contaminate) and 11% total clays. The total clay consists of 7% illite, 3% chlorite and 1% mixed–layer illite/smectite. Illite and mixed–layer illite/smectite will react with fresh water and undersaturated brines containing monovalent ions such as 2% KCl. These fluids leach potassium from illite which will allow the structure to collapse and disperse. Smectite will swell in the presence of these fluids. Chlorite will react and disperse when exposed to HCl and low pH waters. HCl–HF mixtures will react with feldspar and may form an insoluble precipitate. SEM analysis indicates that the cementing material consists of quartz overgrowths, dolomite, anhydrite and authigenic clays. HCl will also remove the dolomite which may release some of the framework grains.

Recommendations

Consider replacing the "Premix" freshwater mud with an inexpensive "old timer" such as calcium lignosulforate. The divalent calcium ion has a stabilizing effect on the authigenic clays. The apparent low reservoir pressure (less than 1000 psi) will require a low density mud and low fluid loss is required (5 cc/30 min or less) to reduce the amount of mud filtrate lost to the formation.

The primary cement slurry should be mixed for high density, low viscosity and low fluid loss. This slurry should be pumped in turbulent flow if possible. Plug flow should be used in the presence of severe washouts. A 40 bbl mud spacer will enhance the primary cement job.

Perforating underbalanced is preferable to overbalanced perforating. Large diameter perforations are more important than deep penetrating perforations.

If a clean–up treatment is desired, do not use 2% KCl, HCl or HCl–HF mixtures. The recommended treating fluid is 1% calcium chloride brine at a pH of 8.0. This fluid should be applied with the matrix technique and buoyant ball sealers.

If stimulation by fracturing is contemplated, do not used 2% KCl. A KCl substitute material may be a better choice. The average permeability implies that stimulation by fracturing will probably not be required.

SUMMARY

1) A total of 59 feet (2130–2189 feet) of conventional core from the Anadarko Petroleum Corporation Snyder "A" No. 3 Well, located in Hugoton Field, Morton County, Kansas, were analyzed.

2) Three lithofacies were delineated, each corresponding to a depositional environment:

Lithofacies	Percent of Core	Depositional Environment	Porosity (%) Average)	Permeability (md) (Average)
Interbedded siltstone, silty claystone and claystone. Root-mottled. Brick red color.	46%	Coastal Plain or Flood Plain	12.1–12.7 (12.4)*	0.018–18.8 (9.41)*
Light gray, tan and brownish-red very fine-grained sandstone to siltstone. Ripples and laminations is common in parts. Bioturbation more extensive in other areas.	**37%**	**Tidal Flat**	**5.1–22.4 (15.9)**	**0.019–236.0 (16.9)**
Sandy-skeletal wackestone to packstone/grainstone. Dolomite.	17%	Shoal to Shoal Flank	2.6–10.8 (7.1)	0.001–0.07 (0.032)

* Data from only two plugs. Not representative of entire facies. Visual estimates suggest average porosity of less than 5% and average permeability of less than 1.0 md.

3) The tidal flat deposits are the principal reservoir target. The facies consists of lower very fine-grained sandstones and siltstones. Sand grains are very well sorted, with shapes ranging from angular to subrounded. Compaction is estimated as moderate. Quartz grains are the principal framework constituent and the rocks can be classified as subarkoses and quartzarenites.

4) The sandstones in the tidal flat facies generally have well preserved, well interconnected primary intergranular pores. The exceptions to this are where detrital clay, recrystallized detrital clay and/or dolomite cementation are more extensive. Dolomite cement, anhydrite cement, detrital clay and authigenic clay are the main pore–filling constituents. In some cases, clay minerals have acted to replace macropores with ineffective microporosity.

5) The clay minerals in the sandstones, illite, mixed–layer illite/smectite, and chlorite, may pose some problems with formation sensitivity. Procedures to minimize formation damage are considered in the section entitled Engineering Discussion and Recommendations.

6) The coastal plain/flood plain and shoal to shoal flank facies have poor reservoir potential. Future well locations should attempt to maximize the thickness of tidal flat sandstones and minimize the occurrence of non–pay facies.

TABLE 1

POINT COUNT DATA

ANADARKO PETROLEUM CORPORATION SNYDER "A" NO. 3 WELL

	2,143.3'	2,147.2'	2,150.9'	2,155.3'	2,159.5'	2,163.70'	2,168.2'
Texture							
Average Grain Size	0.062 mm (Silt/L.V.F Sand)	0.060 mm (Silt)	0.060 mm (Silt)	0.073 mm (L.V.F. Sand/Silt)	0.069 mm (L.V.F. Sand/Silt)		
Sorting	Moderately Sorted	Not Applicable	Not Applicable	Well-Sorted	Well-Sorted		
Framework Constituents							
Quartz	34.4%	50.0%	35.2%	40.8%	48.4%		
Plagioclase Feldspar	4.8	4.8	4.0	3.6	4.0		
Potassium Feldspar	2.8	2.8	3.6	2.0	3.2		
Chert	0.8	1.2	0.4	0.4	-		
Argillaceous Rock Fragments	0.4	1.2	-	0.4	0.8		
Metamorphic Rock Fragments	0.4	0.4	0.4	1.2	1.2		
Mica	0.4	1.6	1.2	0.8	1.6		
Heavy Minerals	0.4	0.8	0.4	1.2	-		
Fossils	0.8	Tr	0.4	0.8	-		
Matrix						DOLOMITE - NO POINT COUNT	DOLOMITE - NO POINT COUNT
Clay	3.6%	22.8%	42.0	2.8%	1.6%		
Micrite	4.0	-	-	-	-		
Cements							
Quartz Overgrowths	1.2	0.8	0.8%	0.8	0.8%		
Dolomite	16.0	2.4	2.0	26.4	6.8		
Calcite	-	-	-	-	-		
Anhydrite	2.8	1.6	0.4	1.6	2.4		
Pyrite/Opaques	0.4	0.4	2.4	0.8	-		
Authigenic Clay	6.4	2.4	2.0	1.2	6.8		
Replacements							
Clay	-	-	0.4	-	-		
Dolomite	2.8	-	1.6	2.8	1.2		
Pore Space							
Intergranular	16.8%	6.8%	2.8%	11.2%	20.0%		
Leached Grain	0.8	Tr	-	1.2	1.2		

Tr = Trace percent

TABLE 2

MINERALOGICAL ANALYSIS BY X-RAY DIFFRACTION

ANADARKO PETROLEUM CORPORATION SNYDER "A" NO. 3 WELL
HUGOTON FIELD
MORTON COUNTY, KANSAS

Mineralogy of Whole-Rock Sample

Relative Abundance in Percent

Depth (ft)	Qtz	Ksp	Plag	Dol	Pyr	Anh	Hal	Clay	Total	Gd
2,143.30	68	4	8	11	0	2	1	6	100	2.67*
2,147.20	73	4	11	3	0	0	1	8	100	2.64*
2,150.90	59	8	11	4	0	0	1	18	100	2.64*
2,159.50	58	8	10	7	2	0	1	14	100	2.70*
Min	58	4	8	3	0	0	1	6		2.64
Max	73	8	11	11	2	2	1	17		2.70
Avg	65	6	10	6	1	1	1	11		2.66

Clay Mineralogy of the < 5 micron size fraction

Relative Abundance in Percent

Depth (ft)	I/S	Chl	Ill	Total	I/S Comp
2,143.30	0	22	78	100	NA
2,147.20	5	27	68	100	92
2,150.90	13	27	60	100	85
2,159.50	35	19	46	100	88
Min	0	19	46		85
Max	35	27	78		92
Avg	13	24	63		88

KEY:

Qtz = quartz
Ksp = K-feldspar
Plag = plagioclase
Dol = dolomite
Pyr = pyrite
Anh = anhydrite
Hal = halite
Clay = total clay
Gd = calculated grain density
* = Contains ankerite/ferroan dolomite

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

TABLE 3

CONVENTIONAL CORE ANALYSIS

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) Water	Gas	Description/Comments
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

TABLE 3 CONTINUED

CONVENTIONAL CORE ANALYSIS (CONTINUED)

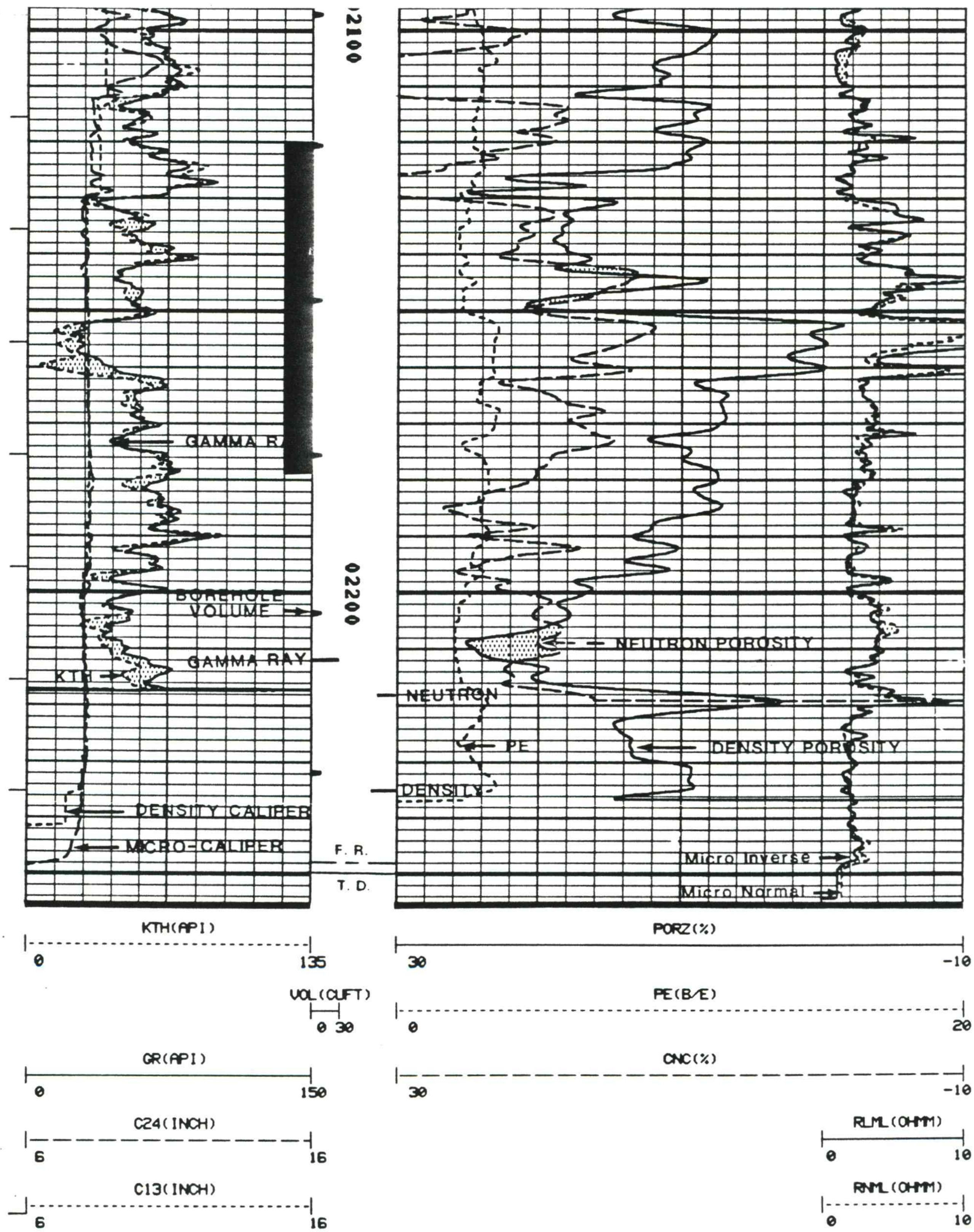
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Greenwood Field
Morton County, Kansas
SRS 1654/RSH 2744

Sample	Depth (ft.)	Permeability To Gas (md)	Porosity (%BV)	Density (g/cc)	Saturation (%PV) Water	Gas	Description/Comments
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

FIGURE 1

CORE TO LOG CORRELATION
ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3
HUGOTON FIELD
MORTON COUNTY, KANSAS

CORE DEPTH -10 FEET ≅ LOG DEPTH



CORE LEGEND

ALLOCHEMS

- Gastropods
- Pelecypods
- Rudists (undifferentiated)
- Rudists (Radiolitids)
- Rudists (Monopleurids)
- Rudists (Caprotinids)
- Rudists (Caprinids)
- Rudists (Requienids)
- Cephalopods
- Echinoderms
- Orbitolinids
- All Other Foraminifera
- Ostracods
- Coelenterates (undifferentiated)
- Undifferentiated Coral
- Solitary Coral
- Ooids
- Peloids
- Pellets
- Oncoids/Algally Encrusted Grains
- Intraclasts
- Stromatoporoids
- Bryozoans
- WT — Worm Tubes
- Calcareous Algae (undifferentiated)
- Dasyclad Algae
- Columnar Stromatolites
- Porifera

STRUCTURES

- Horizontal Bedding/ Laminations
- Planar Cross-Stratification
- Trough Cross-Stratification
- Ripples
- Soft-sediment Deformation
- Stylolites/ Microstylolites
- Anastomosing Compaction Seams
- Algal Laminations
- Open Fracture
- H — Healed Fracture
- Root Mottling
- Bioturbation

MISCELLANEOUS

- GI — Glauconite
- An — Void-Filling Anhydrite
- Su — Sulfur
- PY — Pyrite
- Nodular to Mosaic Anhydrite
- TS — Thin Section
- Wd — Wood Fragments
- CD — Carbonaceous Debris

ROCK TYPE

- Limestone
- Dolomitic Limestone
- Shale
- Siltstone
- Sandstone
- Evaporite
- Dolomite

FIGURE 2

ANADARKO PETROLEUM CORPORATION SNYDER "A" NO. 3
HUGOTON FIELD
MORTON COUNTY, TEXAS

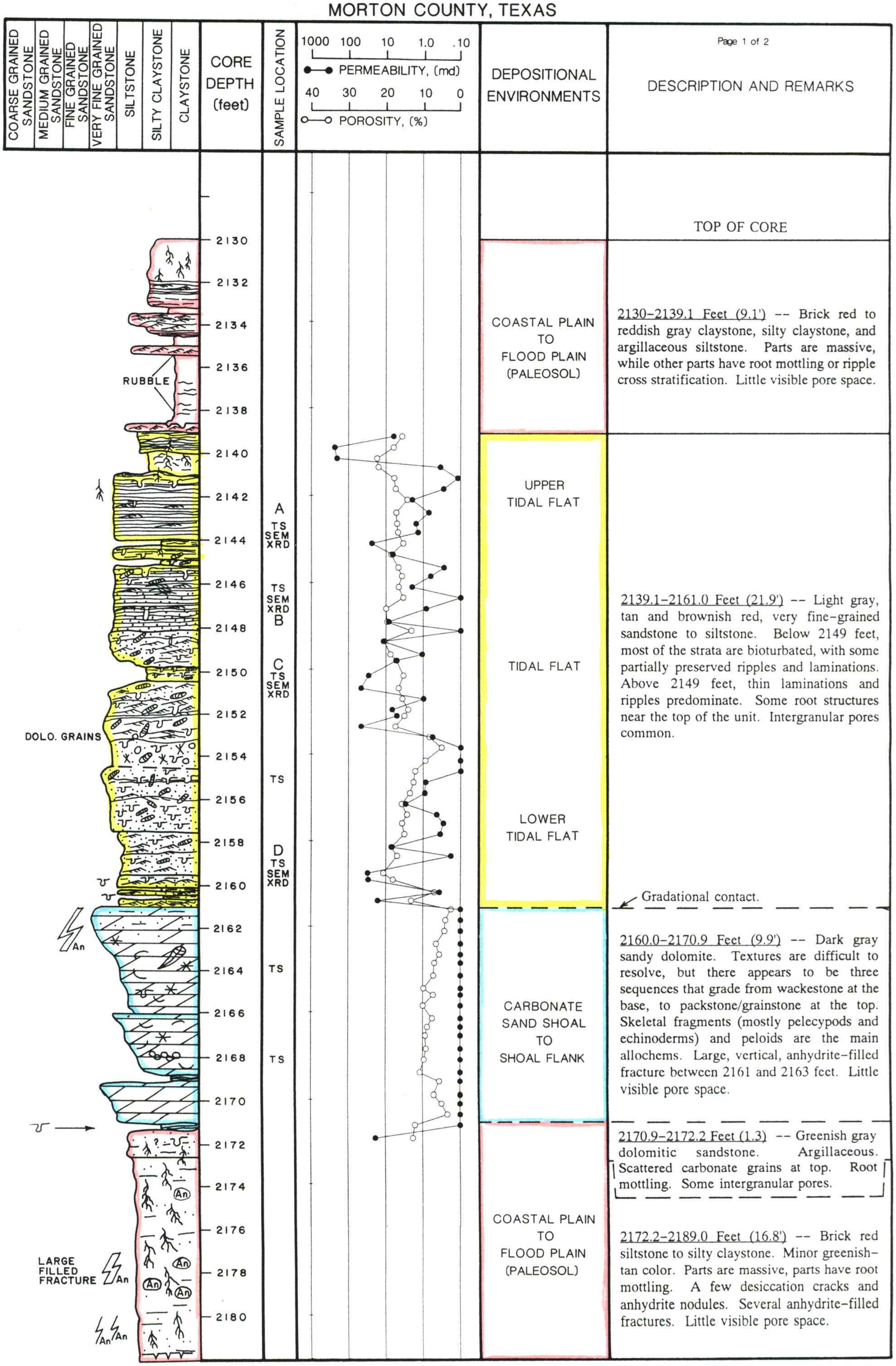


FIGURE 2 CONTINUED
SNYDER "A" NO. 3

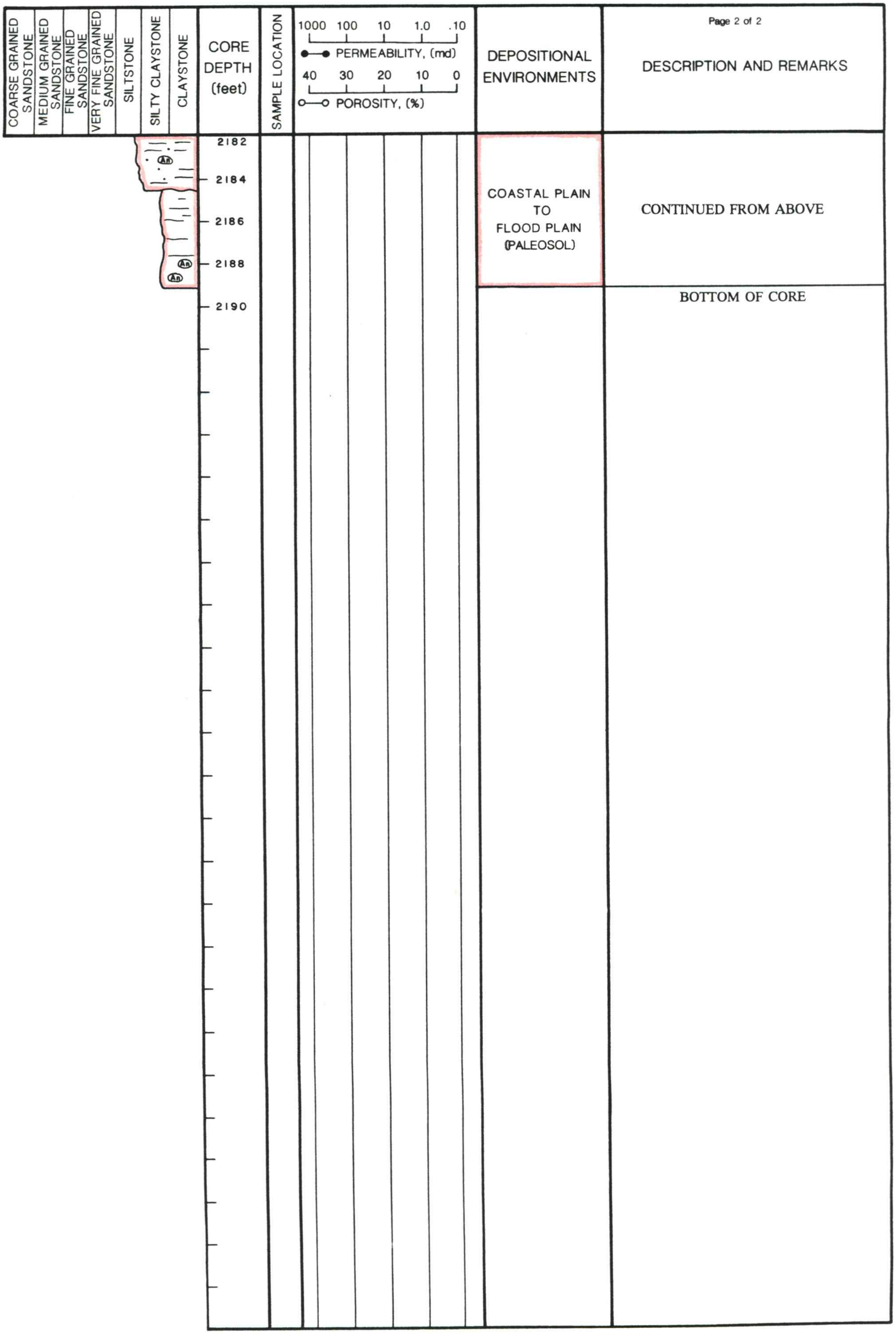


FIGURE 3

CLOSE CORE PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

A. Depth: 2143.3 feet — Depth Facies: Tidal flat

The laminations and ripples preserved in this very fine–grained sandstone are common attributes of tidal flat deposits. Routine core analysis measurements from the plug in this sample shows porosity at 17.0% and permeability at 1.58 md.

B. Depth: 2147.2 feet — Depth Facies: Tidal Flat

Compare the color in this sample to the rock shown in view A. Reddish coloration is common in the upper tidal flat deposits. Routine core analysis from the plug shown in this sample indicates porosity at 20.0% and permeability at 0.839 md. Detrital clay is common.

C. Depth: 2150.0 feet — Depth Facies: Tidal flat

This rock is from an argillaceous horizon within the tidal flat deposits. Routine core analysis measurements from the plug in this core piece show porosity at 16.6% and permeability at 46.8 md. However, the high measured permeability reflects measurement through a fractured plug, and is thought to be unrepresentative of this sample.

D. Depth: 2159.5 feet — Depth Facies: Tidal flat

Note the well preserved laminations and ripples in this very fine–grained sandstone from the tidal flat facies. Petrographic observations indicate an abundance of authigenic clay (Figure 8). Routine core analysis measurements from this sample depth show porosity at 20.7% and permeability at 31.0 md.

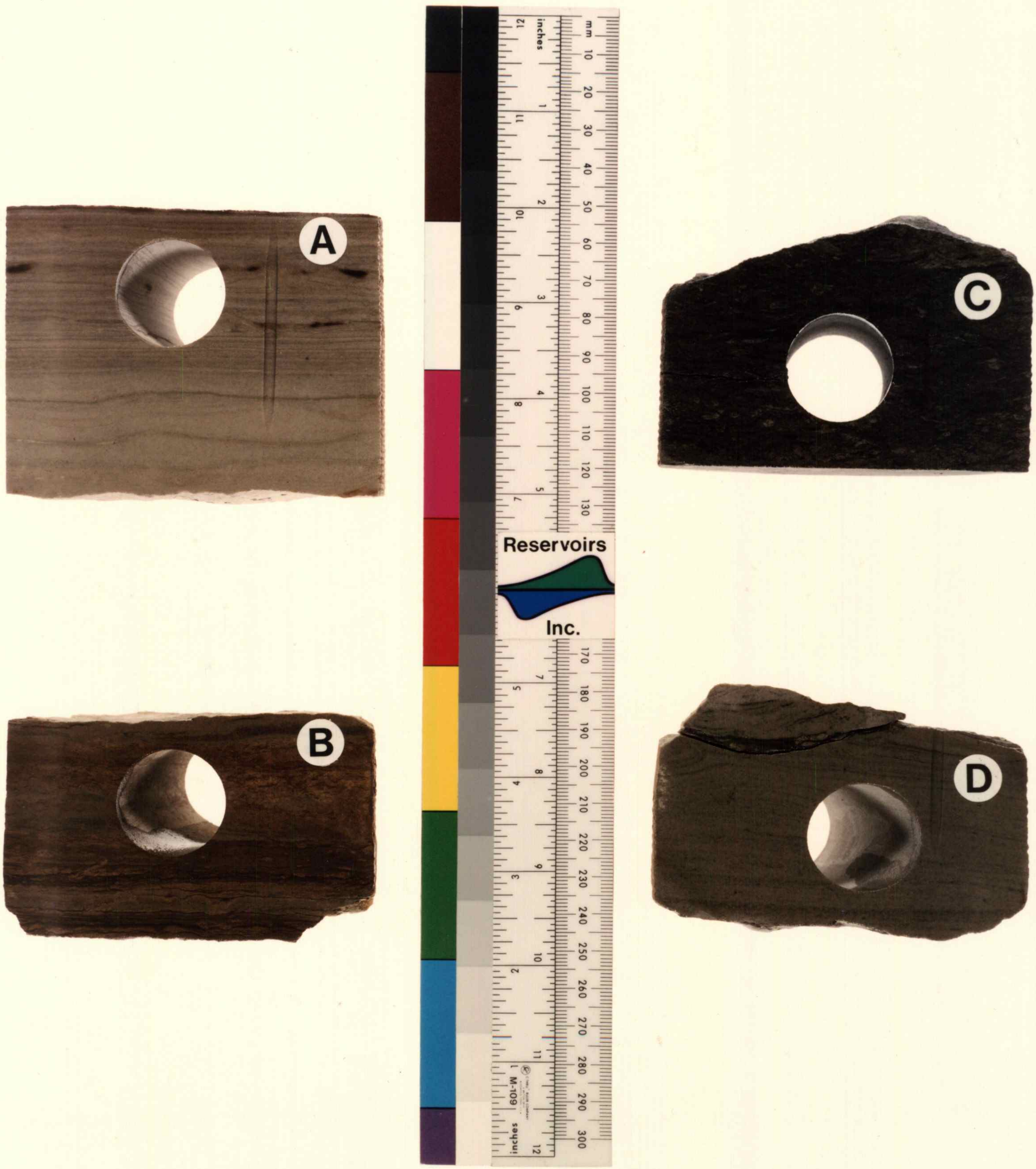

A
B
C
D
Reservoirs
Inc.

FIGURE 4

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2143.3 feet

Porosity: 17.0%
Average Grain Size: Silt/very fine sand

Permeability: 1.58 md
Sorting: Moderate

View A shows the alternating matrix-rich and "clean" laminations in this rock. The matrix contains a combination of siliciclastic and carbonate mud. View B focuses on one of the "clean" laminations, and highlights the abundance of intergranular pore space. Near the base of view B, note that matrix material has occluded some voids . Point count data indicate that dolomite cement is the main pore-filling constituent in this rock. Nearly all of the measured pore volume is in the form of primary pore space and microporosity associated with authigenic clay. Secondary pores are uncommon.

A - 32X

B - 128X

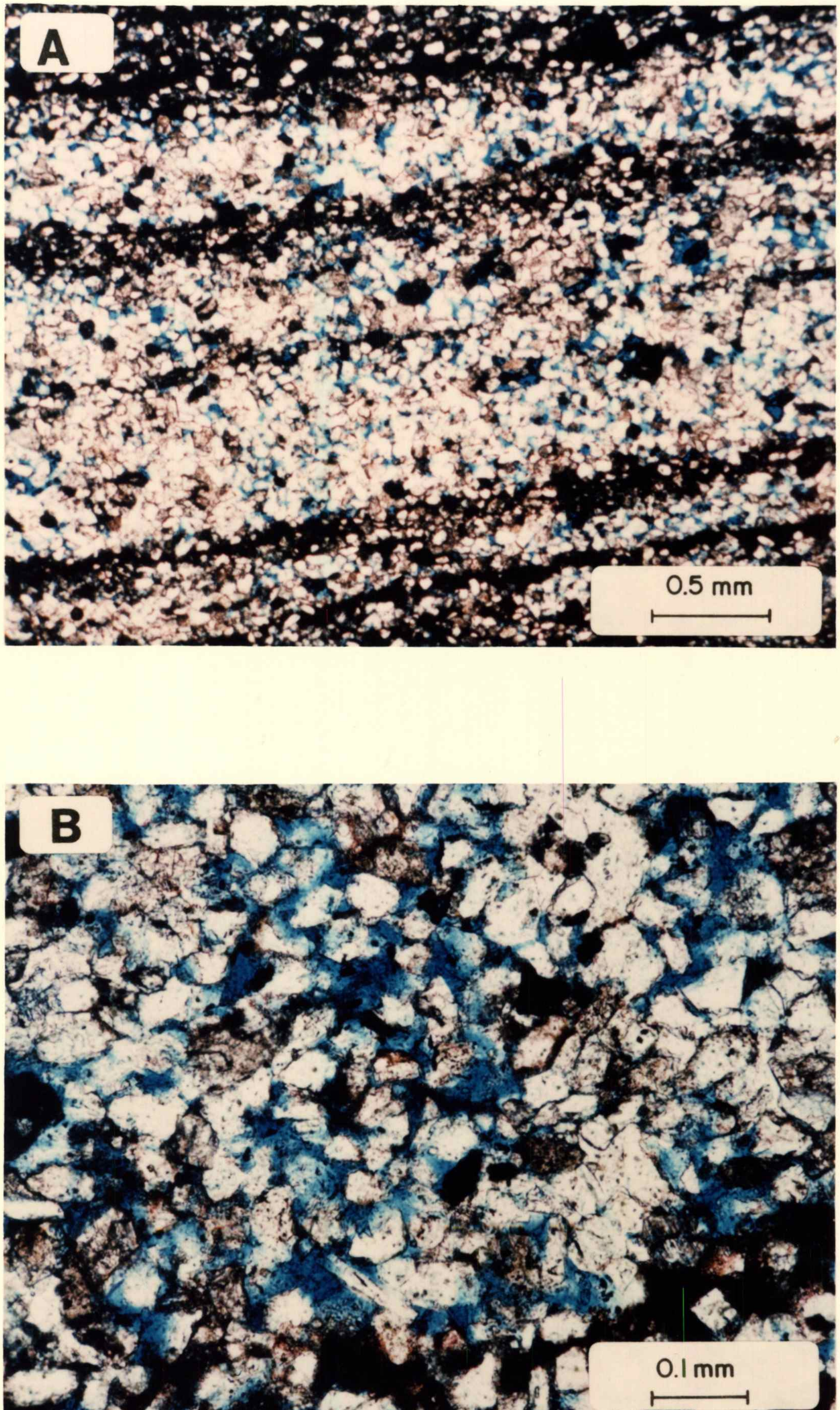

A
0.5 mm
B
0.1 mm

FIGURE 5

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2147.2 feet

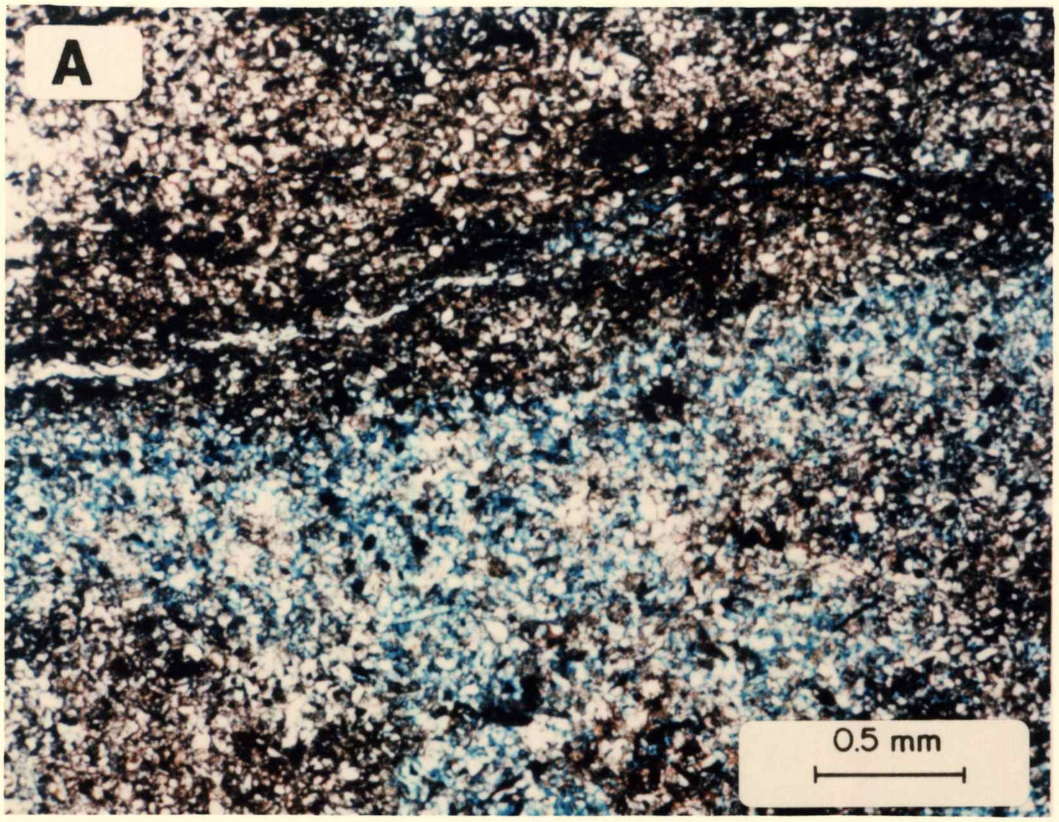
Porosity: 20.0%
Average Grain Size: Silt

Permeability: 0.839 md
Sorting: Not Applicable

Parts of this sample contain an abundance of detrital clay matrix (brown material), while other parts are relatively clean and contain intergranular pore space. The marked difference between measured (20.0%) and point count (6.8%) porosities probably reflects this heterogeneity. There may also be microporosity in the matrix. Quartz grains are the dominant framework constituent.

A – 32X

B – 128X


A
0.5 mm

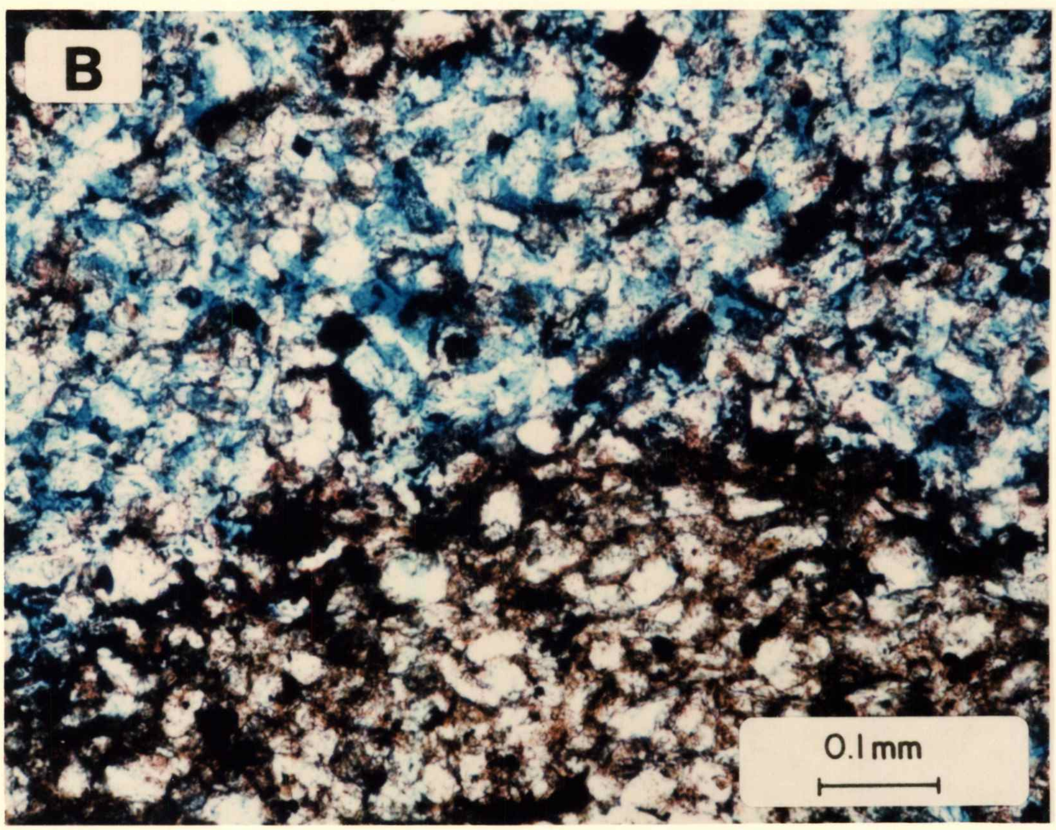

B
0.1 mm

FIGURE 6

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2150.9 feet

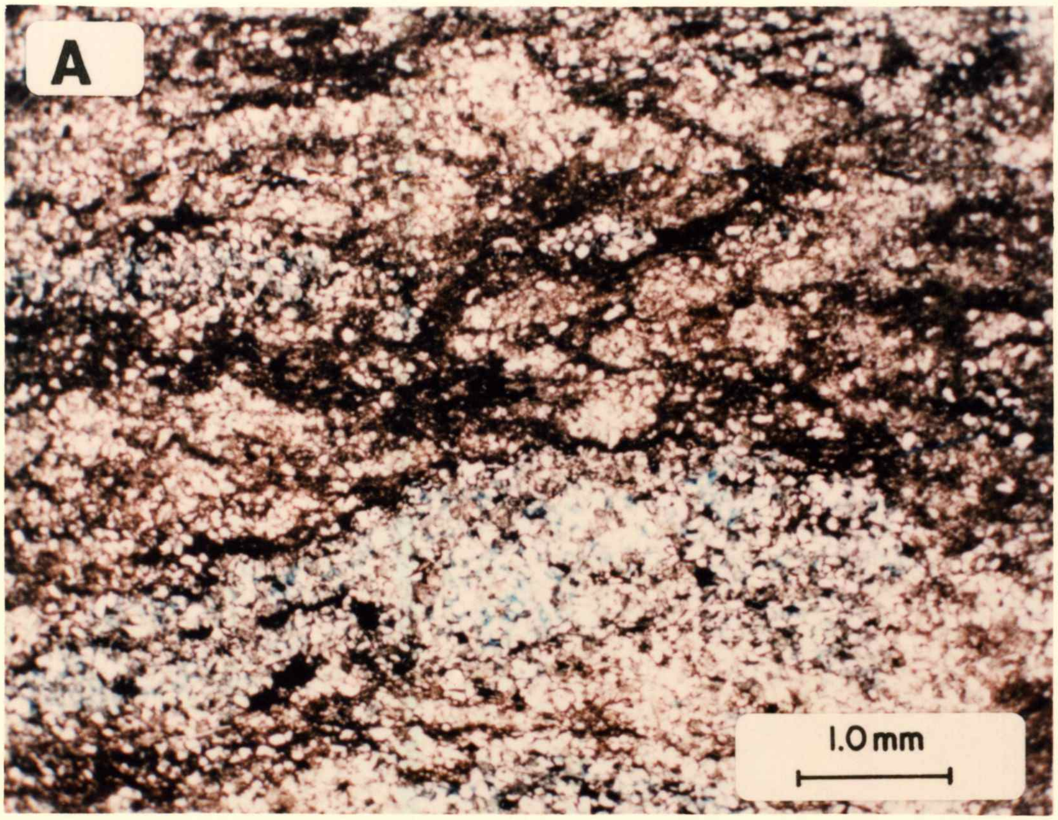
Porosity: 16.6%
Permeability: 46.8 md

Average Grain Size: Silt
Sorting: Not Applicable

There is a large discrepancy between the measured and visible pore space in this siltstone and the measured permeability is too high; the permeabililty was reported as measured through a fractured plug. Point count data indicate roughly 3% porosity, compared to the 16.6% determined through laboratory measurement. Some of this variation could reflect heterogeneous distribution of detrital clay matrix (brown material). In the part of the sample shown here, most of the intergranular areas are filled with clay matrix. In the lower half of view A, and near the center of view B, parts of the sample with preserved intergranular pore space can be identified. This sample is from a thin argillaceous bed that is not representative of the tidal flat sands.

A - 16X

B - 32X


A
1.0 mm

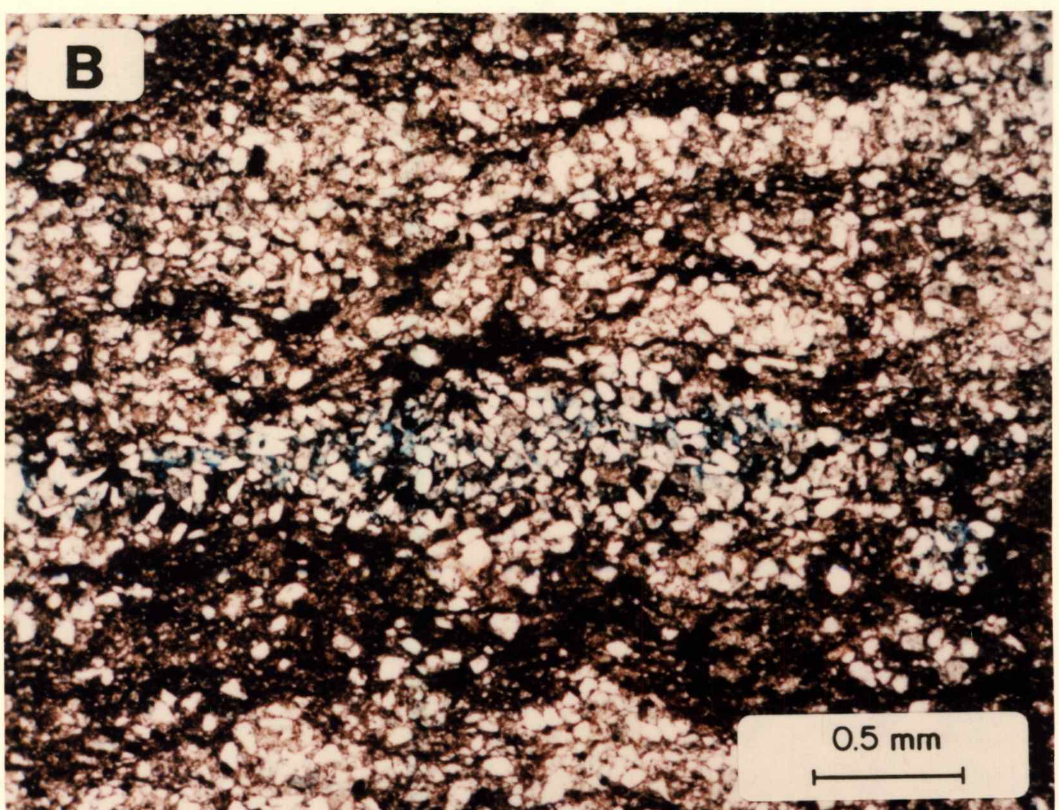

B
0.5 mm

FIGURE 7

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2155.3 feet

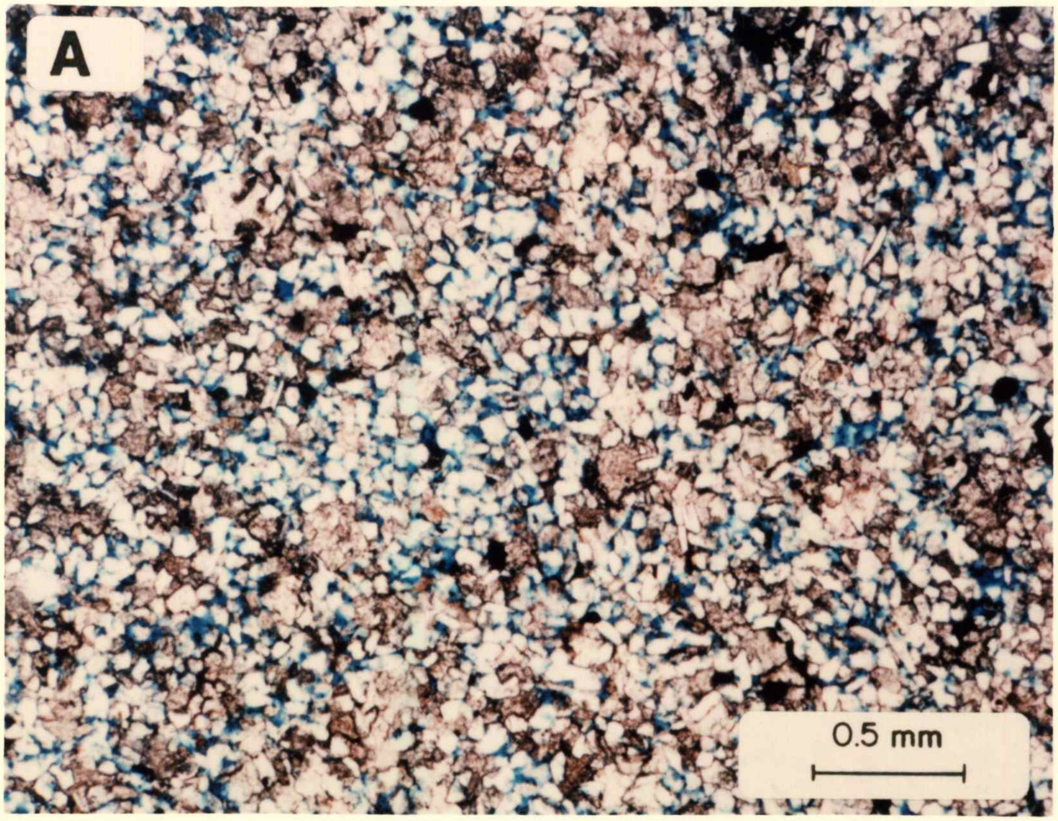
Porosity: 12.7%
Average Grain Size: Very fine sand/silt

Permeability: 0.871 md
Sorting: Well sorted

Point count data indicate that dolomite (D) cement is the principal pore-filling constituent in this rock. The dolomite crystals have a rather patchy distribution; where dolomite cement is less abundant, primary intergranular pores have been preserved. The low measured permeability probably reflects the heterogenous porosity distribution and high pore system tortuosity.

A - 32X

B - 128X


A
0.5 mm

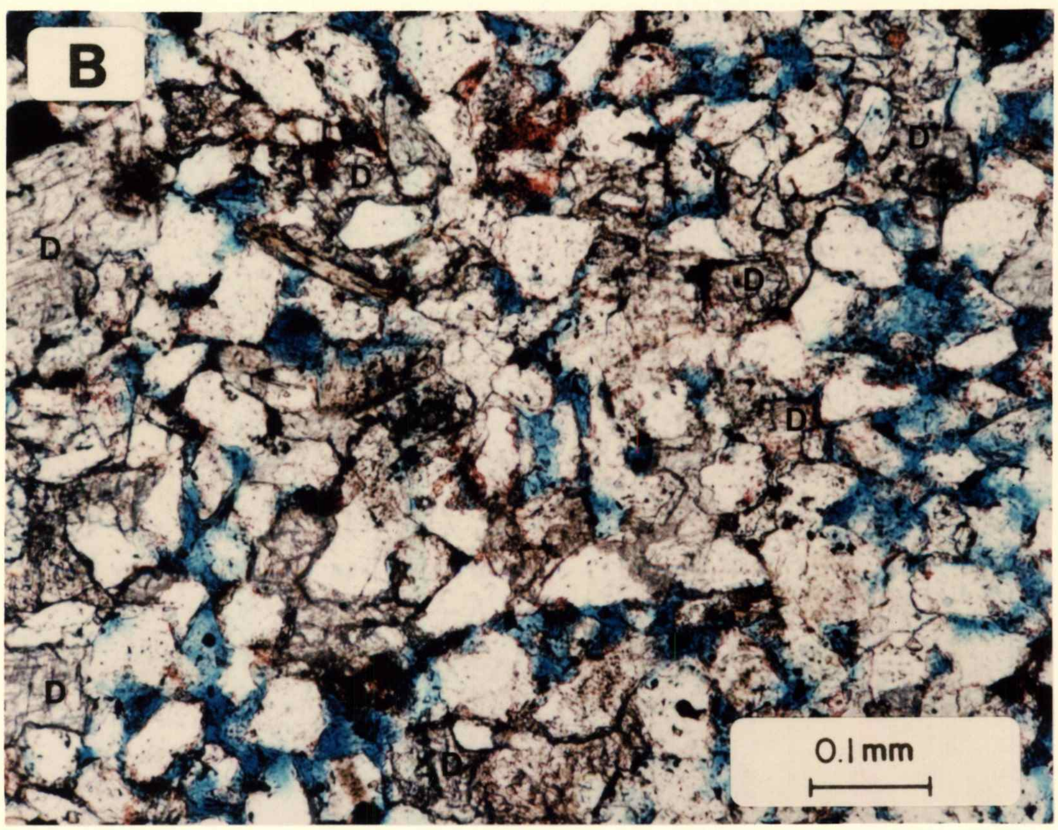

B
D
D
D
D
D
D
D
0.1mm

FIGURE 8

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2159.5 feet

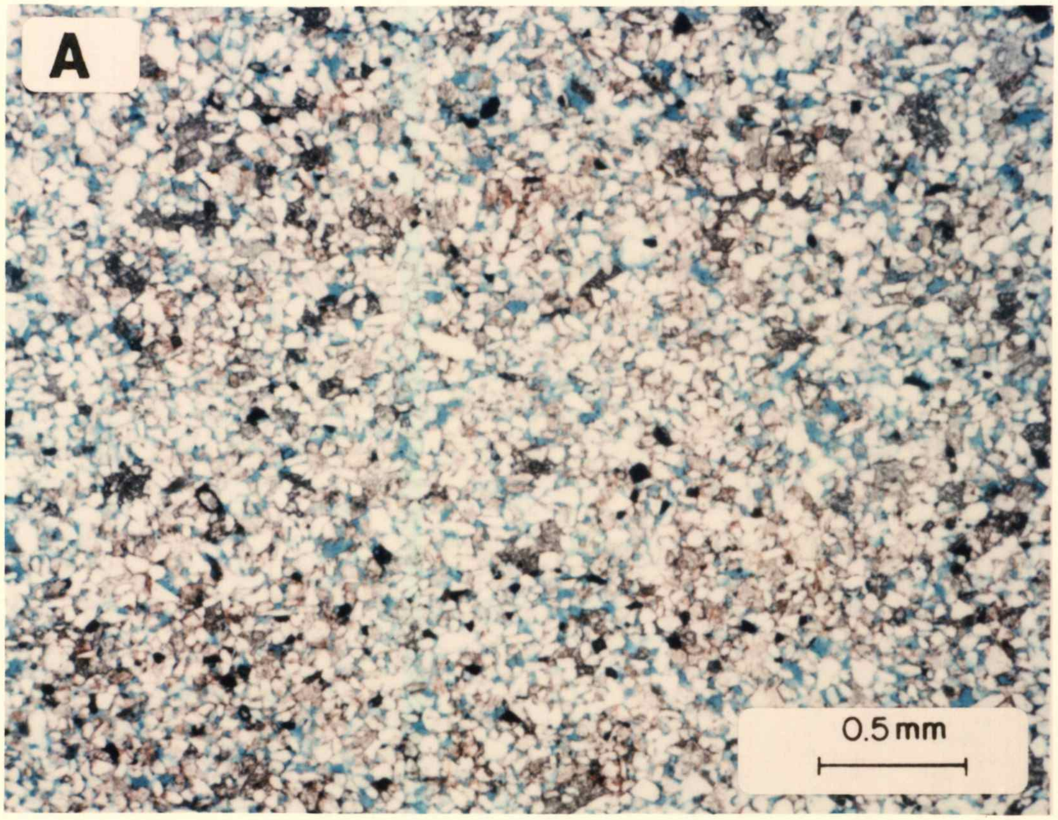
Porosity: 20.7%
Average Grain Size: Very fine sand/silt

Permeability: 31.0 md
Sorting: Well sorted

Note the abundance of primary intergranular pore space in this well sorted sandstone. Scattered crystals of dolomite (D) cement are the main pore–filling constituent. Quartz grains and subordinate amounts of feldspar and rock fragments are present. SEM analysis of this sample reveals microporosity occurs in association with authigenic clay (Figure 14).

A – 32X

B – 128X


A
0.5 mm

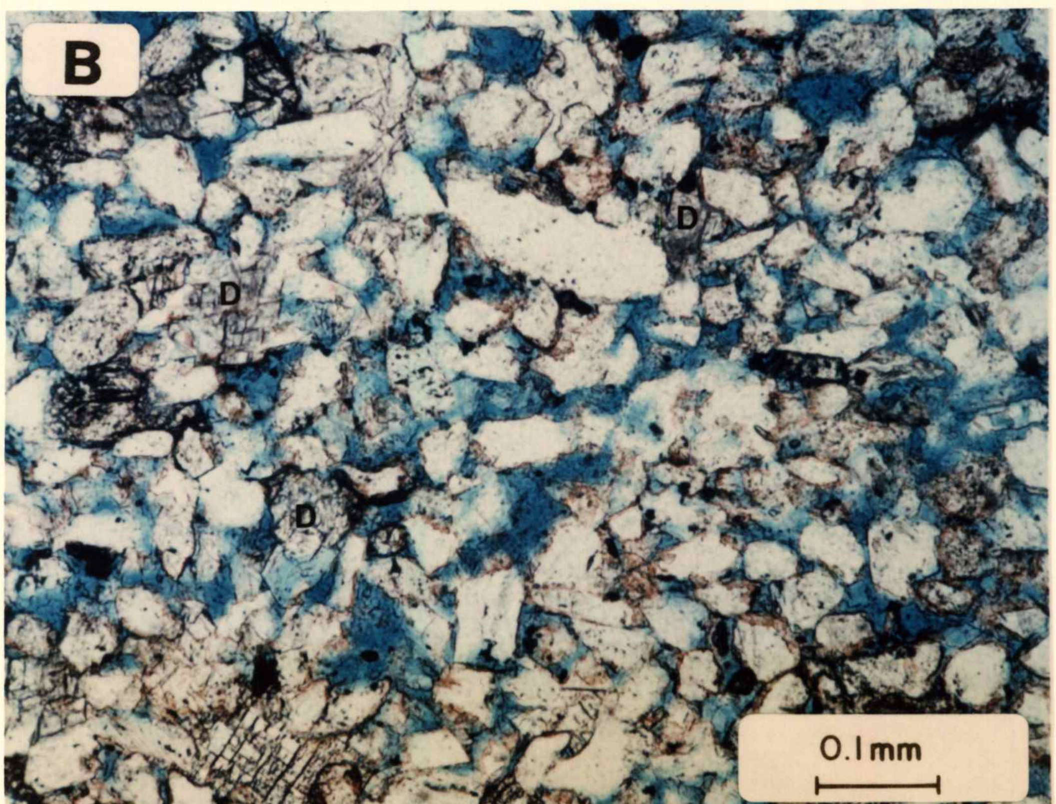

B
D
D
D
0.1mm

FIGURE 9

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2163.7 feet

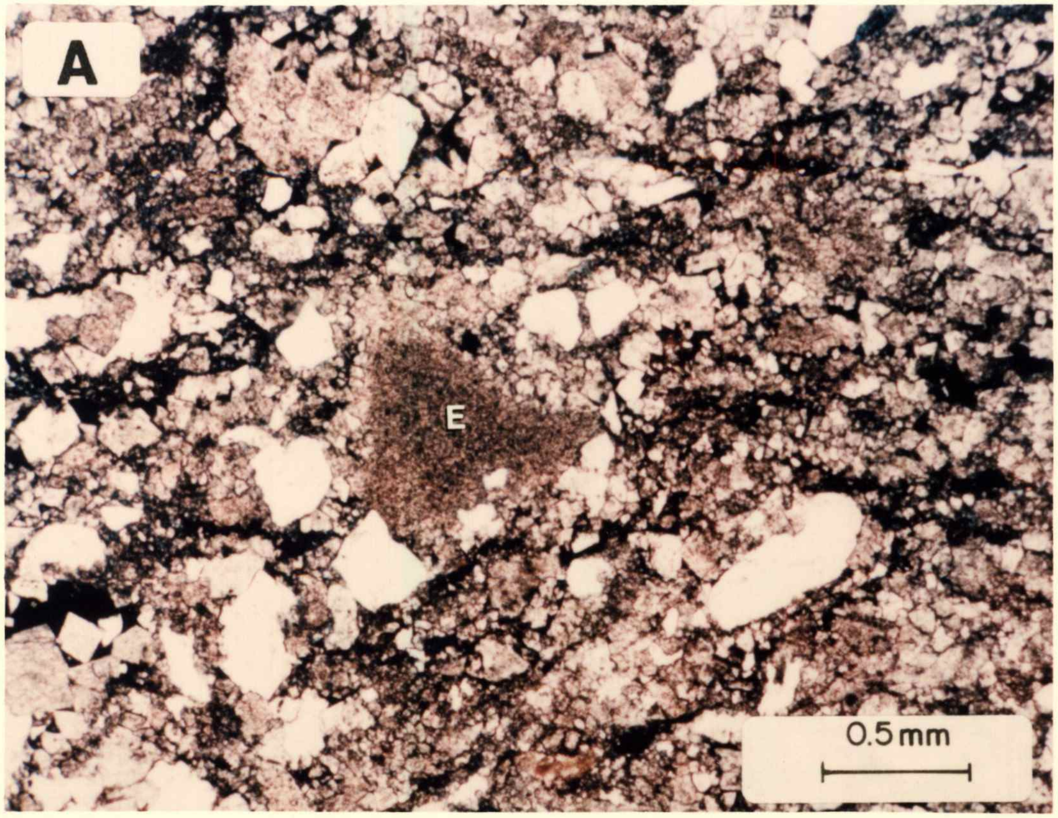
Porosity: 7.0%
Average Grain Size: Not applicable

Permeability: 0.040 md
Sorting: Not applicable

This rock is a dolomitized, sandy, skeletal packstone. In addition to the siliciclastic (white) grains, echinoderm (E) fragments and other skeletal constituents are present. Close examination of the sample reveals small intercrystalline pores (black arrows in view B). The relatively low measured permeability in this rock suggests that this network of intercrystalline pores is poorly interconnected.

A - 32X

B - 128X


A
E
0.5 mm

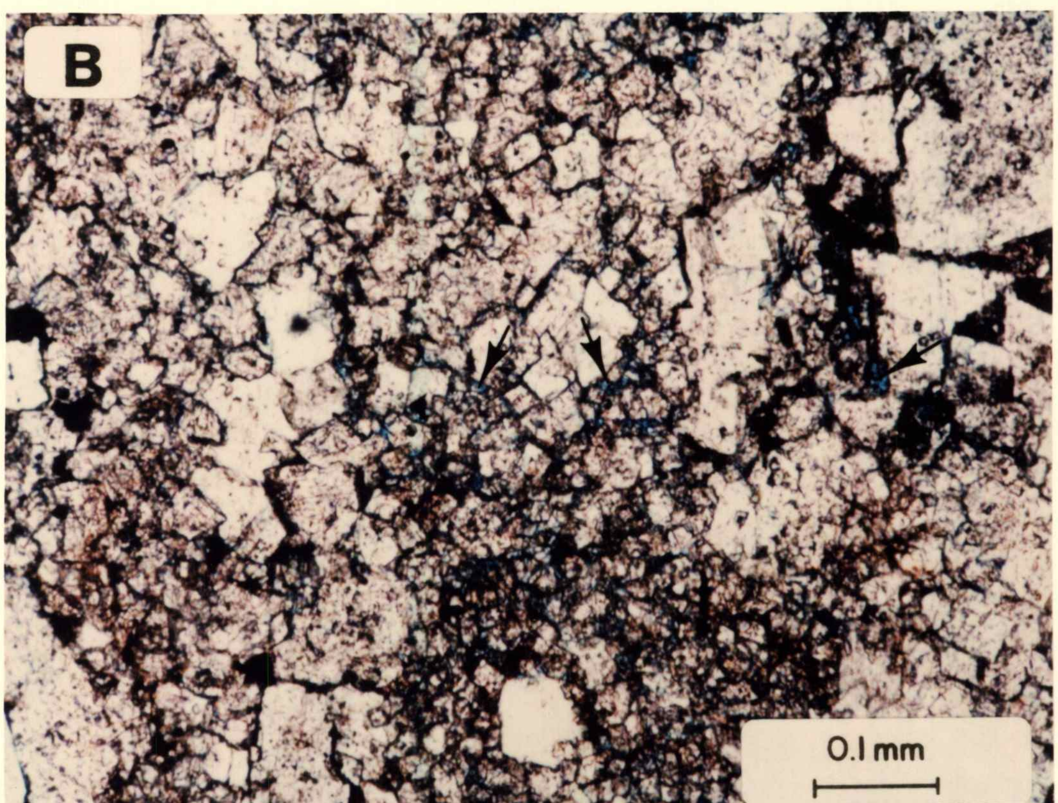

B
0.1 mm

FIGURE 10

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2168.2 feet

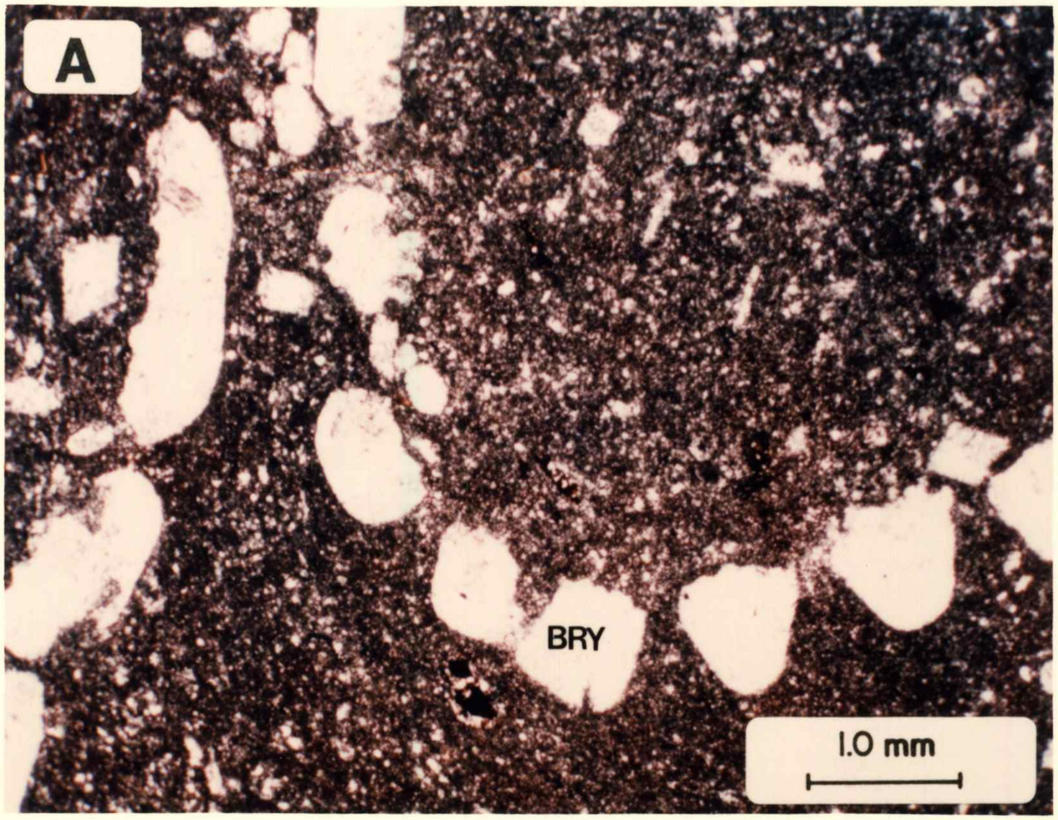
Porosity: 9.7%
Average Grain Size: Not applicable

Permeability: 0.040 md
Sorting: Not applicable

Detrital micrite (brown material) is the principal constituent in this dolomitic rock. Large fragments of replaced bryozoans (BRY) are present. Note the general lack of visible pore space within the dolomitized matrix. Most of the measured pore volume must be within microporosity in this matrix. The low permeability, compared to the measured porosity, is consistent with a pore system dominated by micropores.

A – 16X

B – 128X


A
BRY
1.0 mm

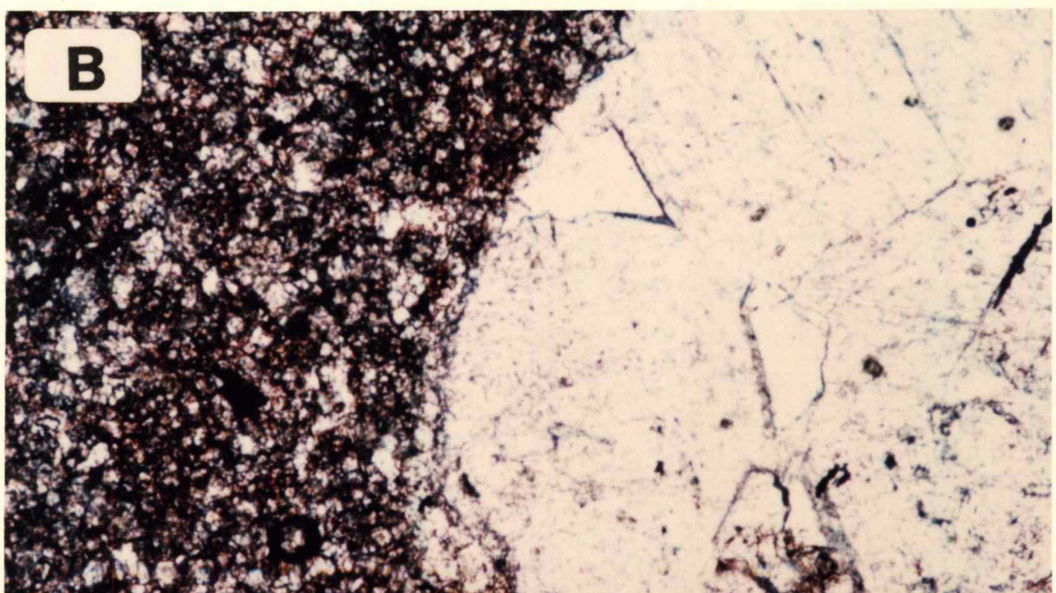

B
D
0.1 mm

FIGURE 11

SEM PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2143.3 feet

Porosity: 17.0% Permeability: 1.58 md

Dolomite (D) cement, quartz overgrowths (Qo), and authigenic clay/siltstone (arrows) are the main pore–filling constituents in this siltstone/very–fine grained sandstone. The quartz and dolomite cements have acted to occlude primary intergranular pore space, while the authigenic clay has filled voids, and replaced macropores with micropores. Some intergranular (In) pores have been preserved, and a few secondary (2) pores are also present. Based on X–ray diffraction data and SEM analysis, most of the clay within the pore system appears to be illite. A portion of the total clay content determined by XRD (6% of the bulk rock) is contained within argillaceous rock fragments and altered feldspar grains.

A – 100X, First Area

B – 500X

C – 2500X

D – 1500X, Second Area

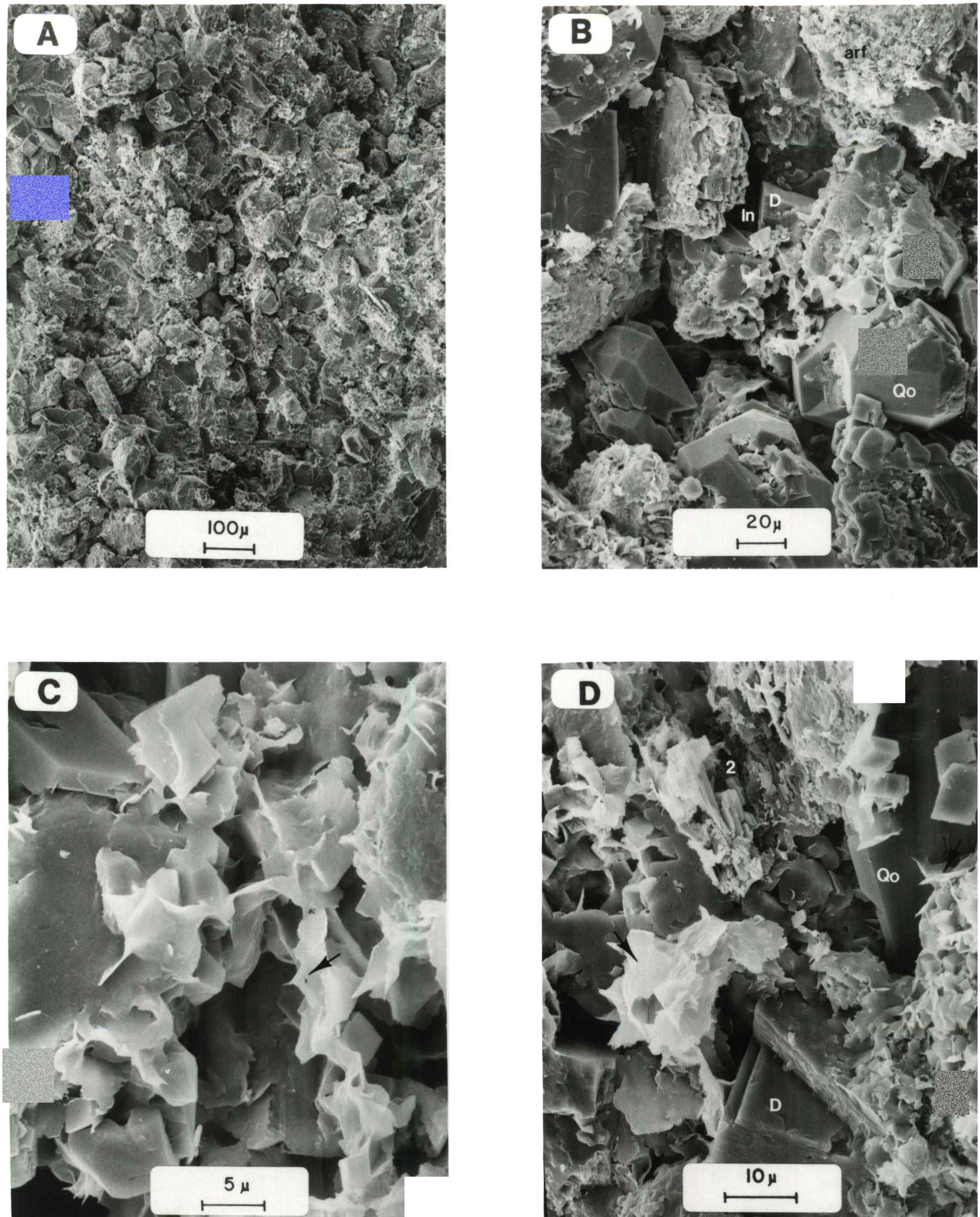

A
100μ
B
arf
In
D
Qo
20μ
C
5 μ
D
2
Qo
D
10μ

FIGURE 12

SEM PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2147.2 feet

Porosity: 14.3%

Permeability: 1.99 md

Open intergranular macropore space is relatively uncommon in this rock due to an abundance of detrital, recrystallized detrital and authigenic clay. Note how most of the interstices between framework grains are filled with microporous clay. A large portion of the measured pore volume is probably contained within this microporous clay. This pore structure is relatively inefficient, due to the very narrow pore throat apertures and small pore diameters. X–ray diffraction data indicate that illite (68%) and chlorite (27%) are the dominant clay mineral species, with a subordinate amount of mixed–layer illite/smectite (5%) also detected. This clay mineral suite could be sensitive to fresh water and undersaturated brines with monovalent ions. The chlorite might be adversely affected by acidic solutions.

A – 100X, First Area

B – 500X

C – 2500X

D – 750X, Second Area

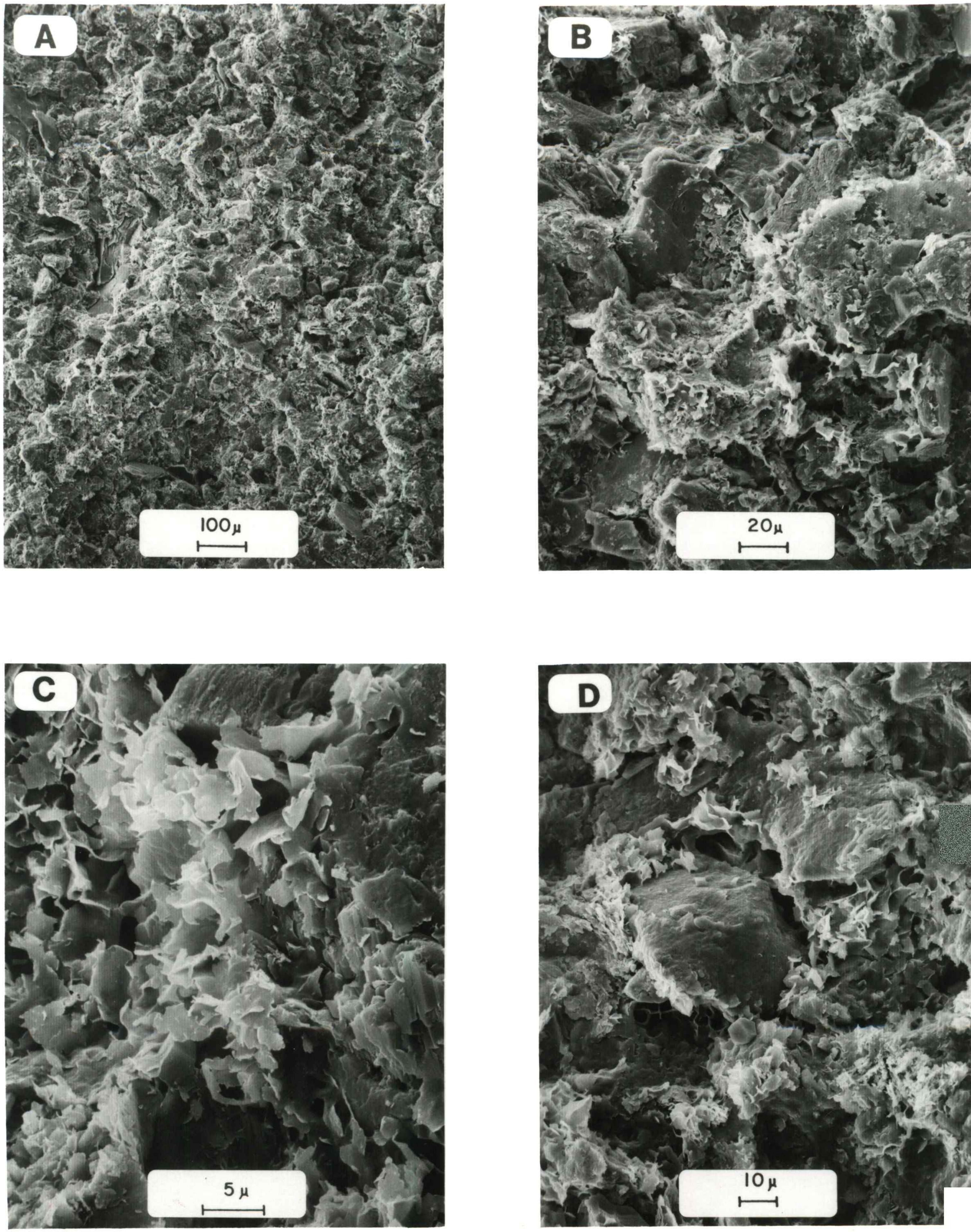

A
100µ
B
20µ
C
5µ
D
10µ

FIGURE 13

SEM PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2150.9 feet

Porosity: 16.6% Permeability: 46.8 md*

Although the measured porosity and permeability values in this sample are quite high, the SEM sample contains little visible intergranular pore space. Recrystallized detrital clay (cl) has occluded nearly all of the macropore space between the quartz (q) and feldspar grains; only minor amounts of primary pore space (center of view D) were observed. The discrepancy between the observed pore structure and the measured permeability reflects the presence of hairline fractures in the core plug.

A – 100X, First Area

B – 500X

C – 2500X

D – 500X, Second Area

* Multiple hairline fractures in core plug.

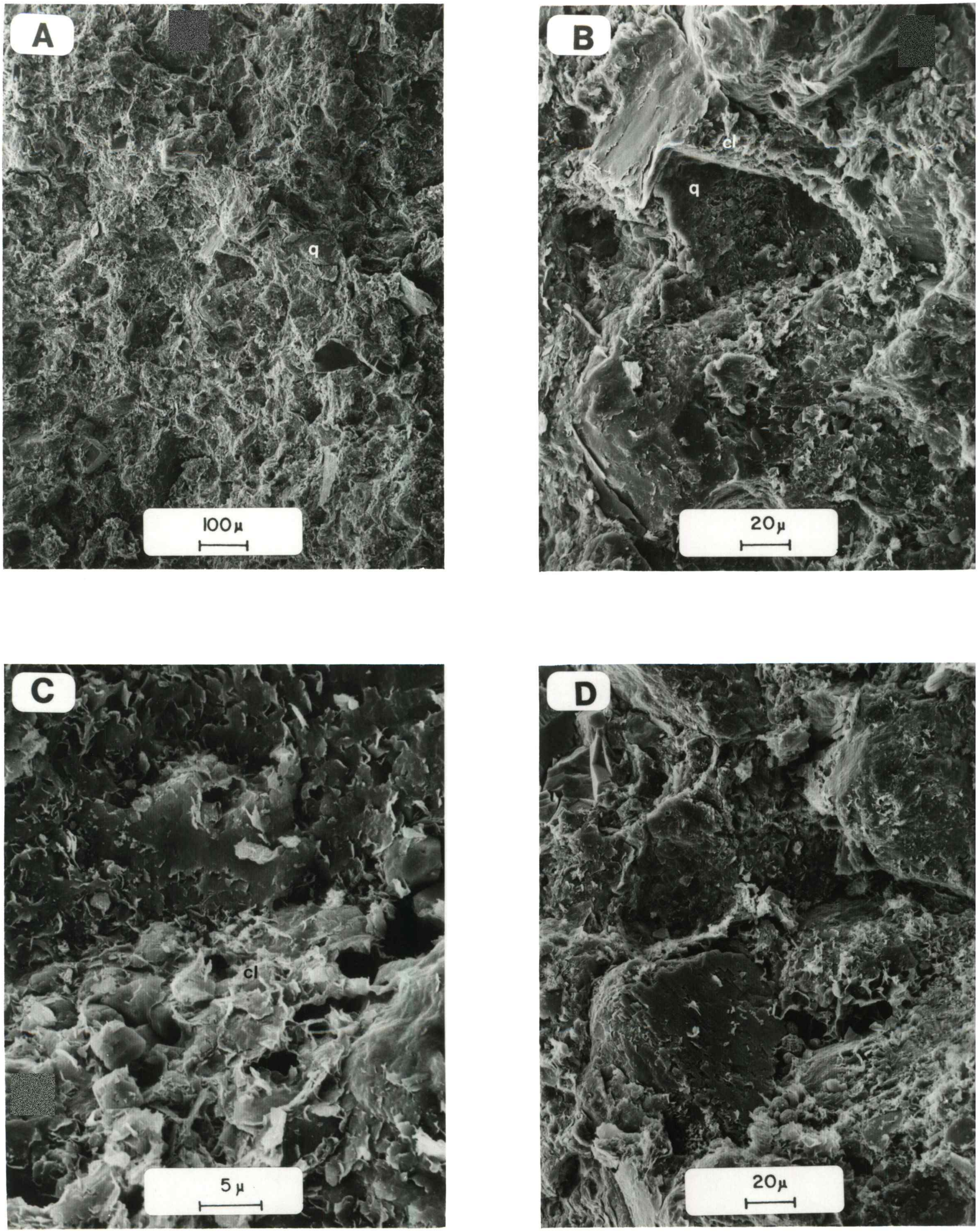

A
q
100µ
B
cl
q
20µ
C
cl
5µ
D
20µ

FIGURE 14

SEM PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION
SNYDER "A" NO. 3 WELL

Depth: 2159.5 feet

Porosity: 20.7% Permeability: 31.0 md

This very fine–grained sandstone contains an abundance of authigenic clay. The clay has infilled most of the intergranular pores, and replaced macropores with micropores. Illite and mixed–layer illite/smectite are the main pore–filling clay minerals; these could be sensitive to fresh water or undersaturated brines with monovalent ions. Some intergranular pores were only partially occluded. Chlorite was also detected by XRD; chlorite is sensitive to acidic fluids. Dolomite (D) cement plays a role in reducing pore space. In view C, note that some of the dolomite crystals are small and loosely attached. These could pose a migration of fines problem. Overall, the measured permeability seems somewhat high, compared to the observed pore structure.

A – 100X, First Area

B – 500X

C – 2500X

D – 750X, Second Area

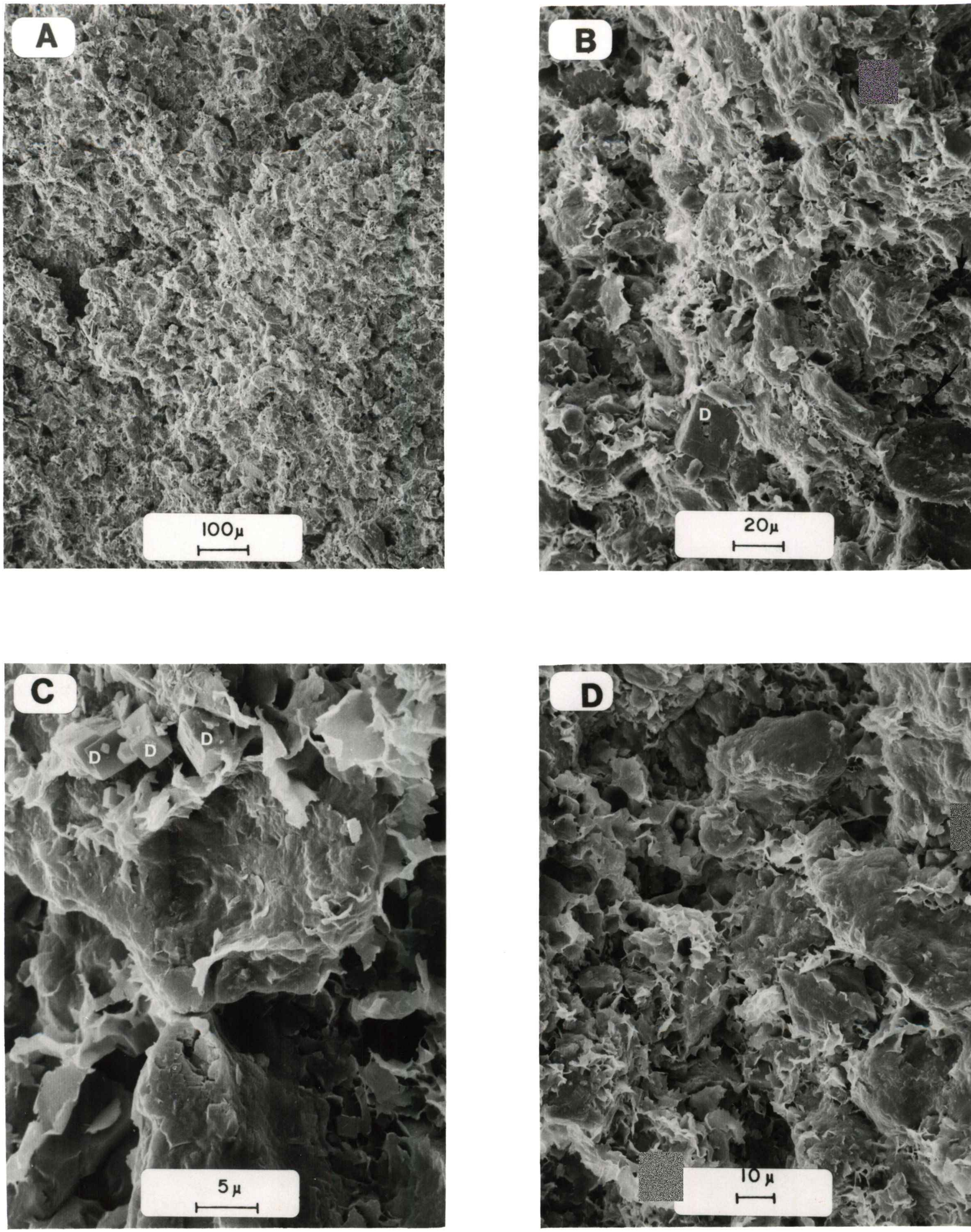

A
100μ
B
D
20μ
C
D
D
D
5μ
D
10μ

Table 10

TRAPPED GAS-FLOWING GAS
RELATIONSHIP AT 300 psig NET CONFINING PRESSURE

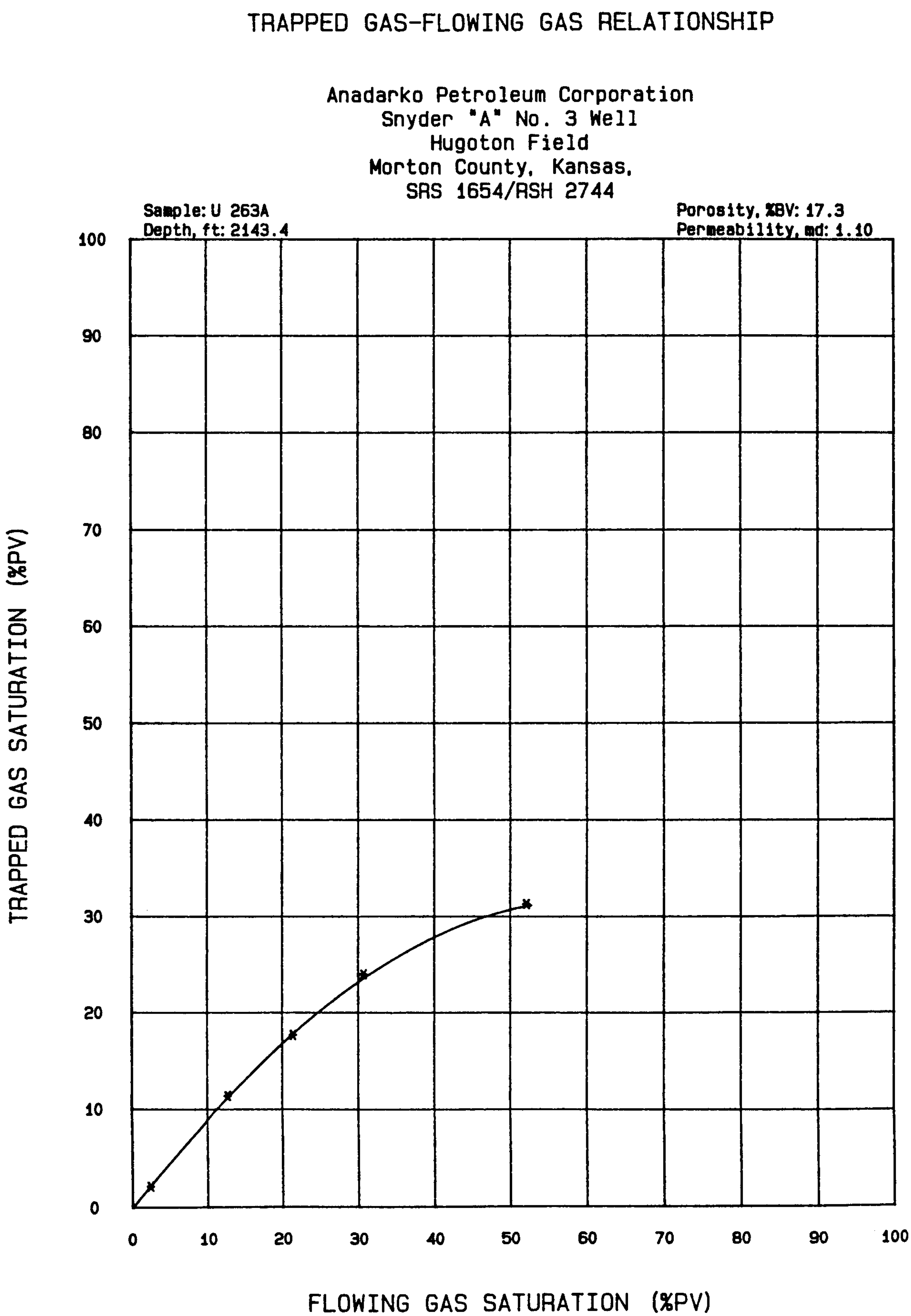
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744

Sample: U 263A
Depth, (ft.): 2143.4

Porosity, (% BV): 17.3
Perm. to Gas, (md): 1.10
Perm to Water, (md): 0.59

Flowing Gas Saturation, %PV	Trapped Gas Saturation, %PV
52.1	31.3
30.7	24.0
21.4	17.7
12.7	11.4
2.40	2.20

Figure 17



Reservoirs Inc.

Table 11

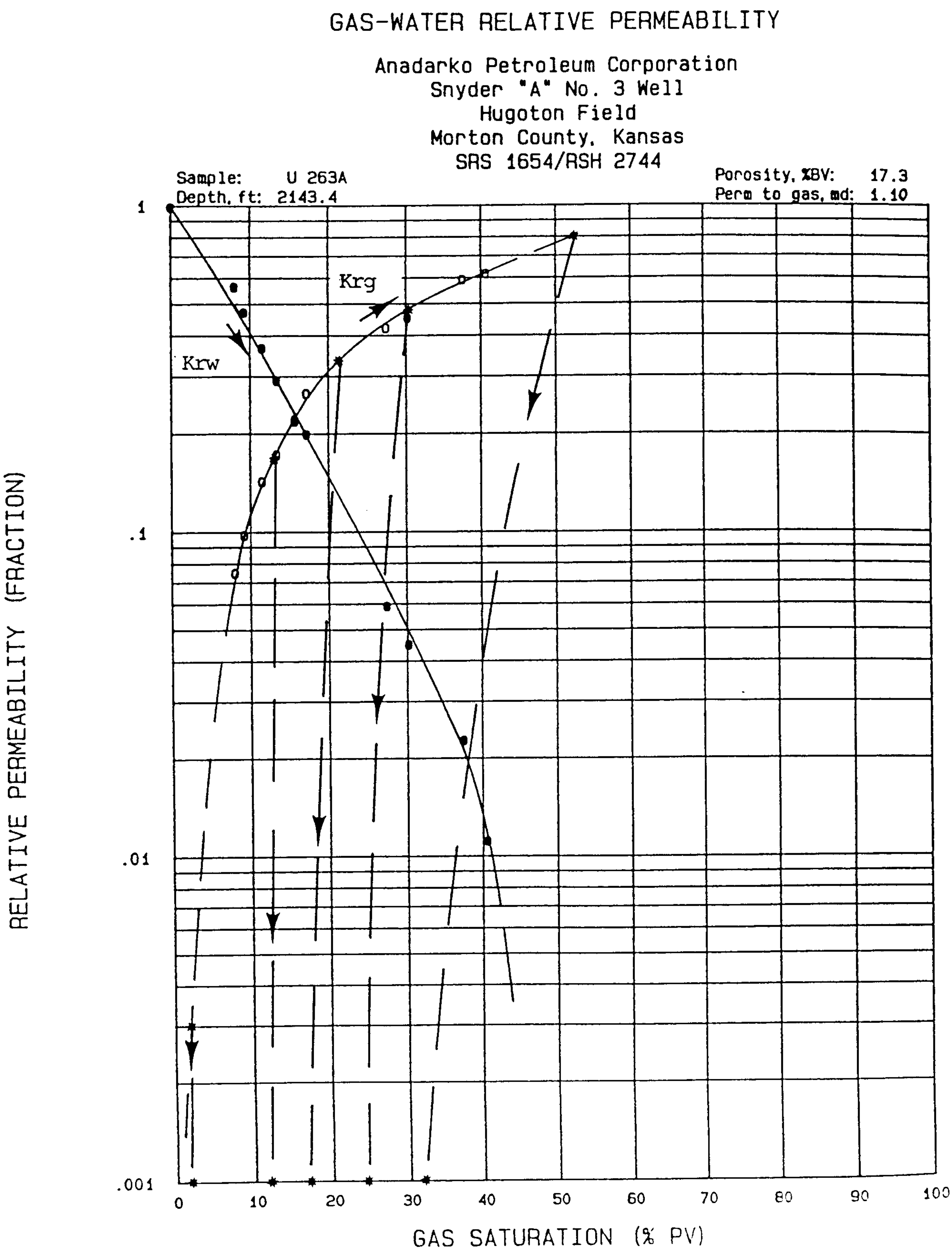
GAS-WATER RELATIVE PERMEABILITY

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

Sample:	U 263A	Porosity, (% BV):	17.3
Depth, (ft.):	2143.4	Perm. to Gas, (md):	1.10
		Perm to Water, (md):	0.59

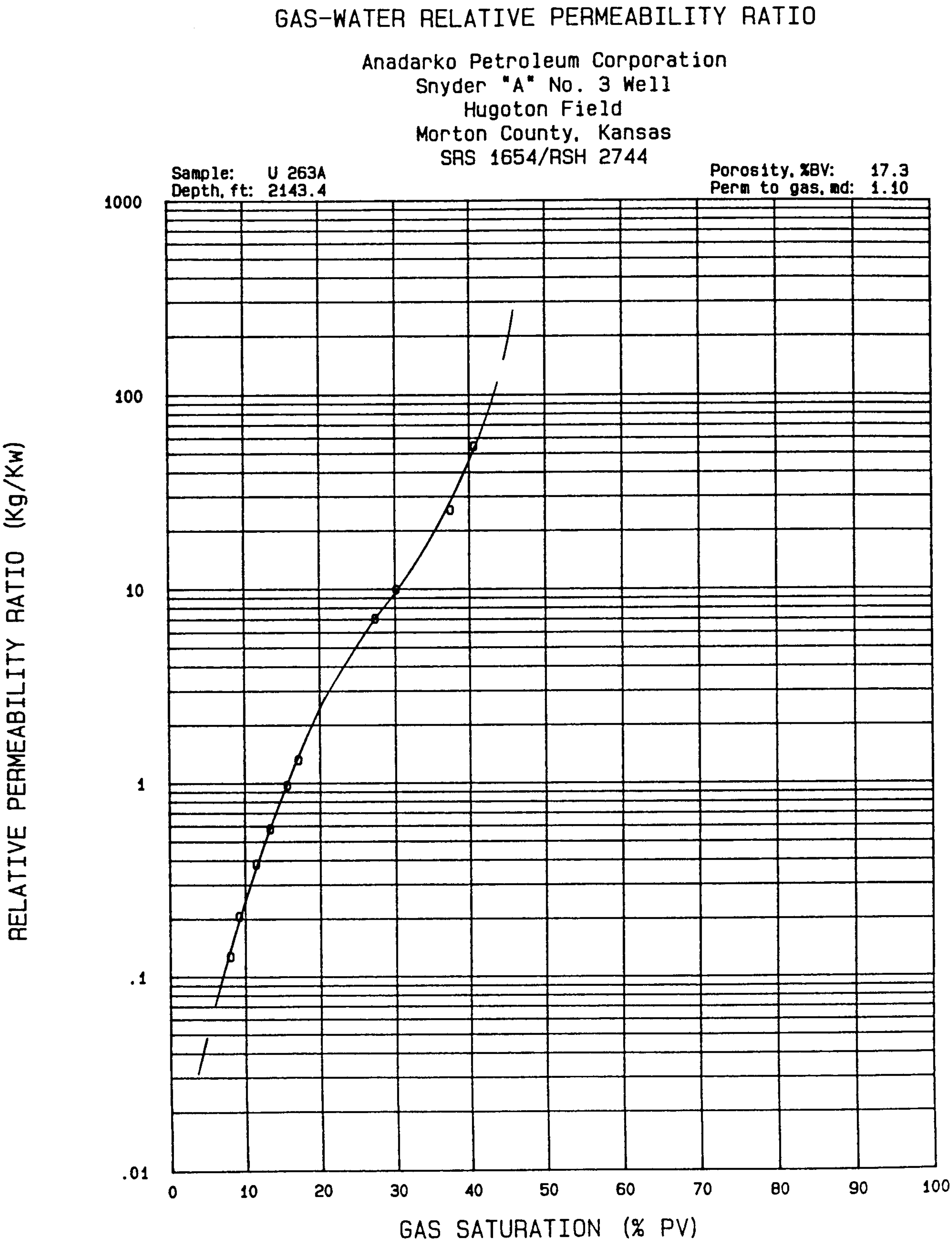
Gas Saturation (%PV)	Relative Permeability (Fraction)		Gas-Water Ratio (Kg/Kw)
	Gas(Krg)	Water(Krw)	
0.0	0.0000	1.0000	0.00
8.0	0.0756	0.5701	0.13
9.2	0.0987	0.4760	0.21
11.5	0.1440	0.3703	0.39
13.4	0.1743	0.2942	0.59
15.7	0.2204	0.2232	0.99
17.2	0.2686	0.2010	1.34
27.4	0.4255	0.0595	7.16
30.2	0.4566	0.0453	10.1
37.5	0.5972	0.0229	26.0
40.7	0.6220	0.0112	55.4

Figure 18



GAS-WATER RELATIVE PERMEABILITY
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744
Sample: U 263A
Depth, ft: 2143.4
Porosity, %BV: 17.3
Perm to gas, md: 1.10
Krg
Krw
1
.1
.01
.001
0
10
20
30
40
50
60
70
80
90
100
RELATIVE PERMEABILITY (FRACTION)
GAS SATURATION (% PV)

Figure 19



Reservoirs Inc.

Table 12

TRAPPED GAS-FLOWING GAS RELATIONSHIP AT 300 psig NET CONFINING PRESSURE

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

Sample: U 295
Depth, (ft.): 2159.5

Porosity, (% BV): 20.7
Perm. to Gas, (md): 31.0
Perm to Water, (md): 26.5

Flowing Gas Saturation, %PV	Trapped Gas Saturation, %PV
60.7	39.3
39.8	28.2
28.3	21.6
10.8	9.65
5.60	5.10

Figure 20

TRAPPED GAS-FLOWING GAS RELATIONSHIP

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

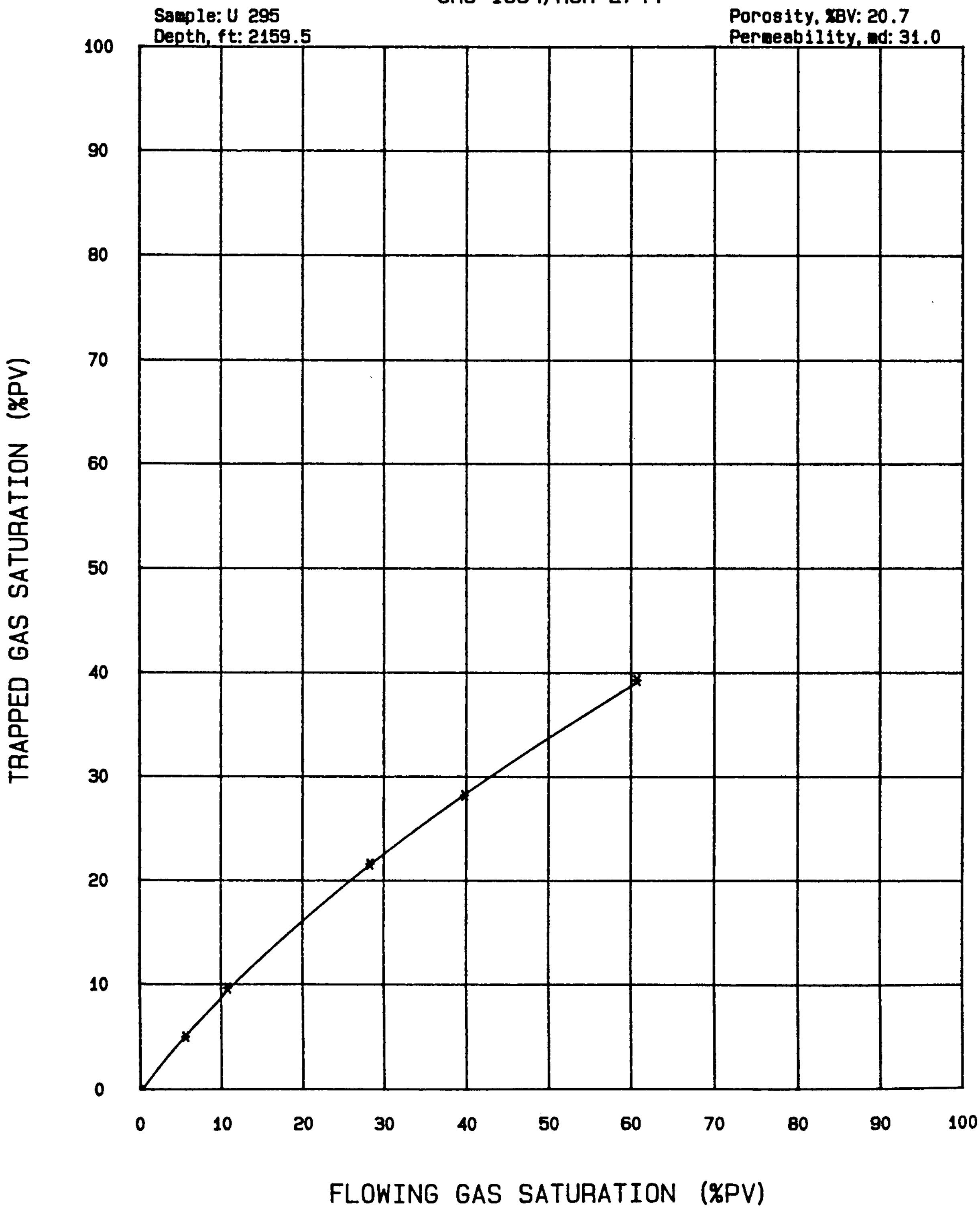


Table 13

GAS-WATER RELATIVE PERMEABILITY

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

Sample: U 295
Depth, (ft.): 2159.5

Porosity, (% BV): 20.7
Perm. to Gas, (md): 31.0
Perm to Water, (md): 26.5

Gas Saturation (%PV)	Relative Permeability (Fraction) Gas (Krg)	Relative Permeability (Fraction) Water (Krw)	Gas-Water Ratio (Kg/Kw)
0.0	0.0000	1.0000	0.00
9.5	0.0156	0.5365	0.029
11.0	0.0244	0.5075	0.048
14.5	0.0465	0.3409	0.14
16.7	0.0614	0.2887	0.21
19.4	0.0869	0.2499	0.35
23.3	0.1183	0.1781	0.66
26.1	0.1473	0.1408	1.05
27.8	0.1655	0.1207	1.37
29.1	0.1723	0.1034	1.67
31.6	0.1957	0.0820	2.39
35.6	0.2339	0.0561	4.17
38.5	0.2652	0.0377	7.02
40.6	0.3058	0.0285	10.7
43.1	0.3296	0.0212	15.6
45.5	0.3617	0.0147	24.7
46.4	0.3961	0.0136	29.1

Figure 21

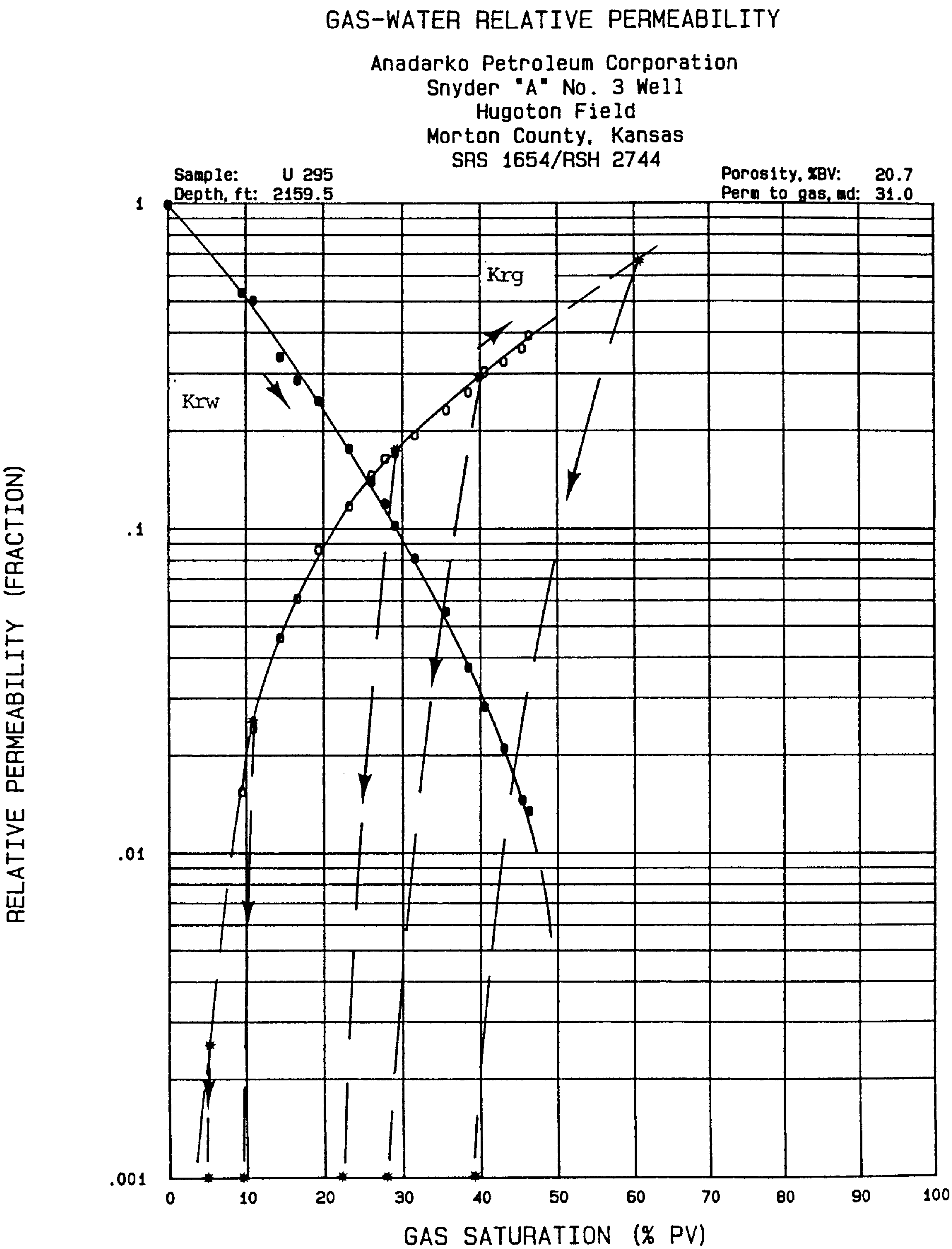

GAS-WATER RELATIVE PERMEABILITY
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744
Sample: U 295
Depth, ft: 2159.5
Porosity, %BV: 20.7
Perm to gas, md: 31.0
Krg
Krw
1
.1
.01
.001
0
10
20
30
40
50
60
70
80
90
100
RELATIVE PERMEABILITY (FRACTION)
GAS SATURATION (% PV)

Figure 22

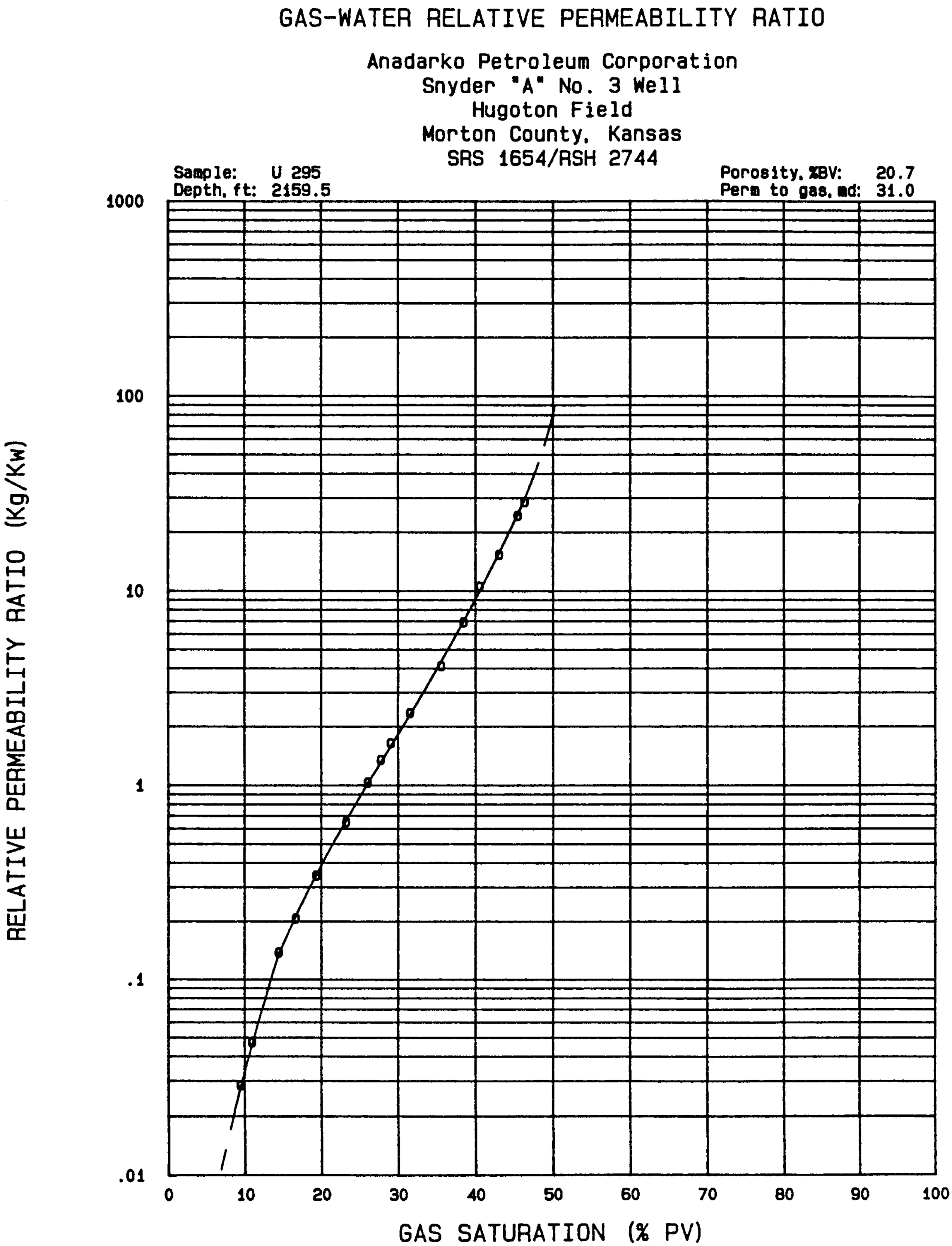

GAS-WATER RELATIVE PERMEABILITY RATIO
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744
Sample: U 295
Depth, ft: 2159.5
Porosity, %BV: 20.7
Perm to gas, md: 31.0
RELATIVE PERMEABILITY RATIO (Kg/Kw)
1000
100
10
1
.1
.01
0
10
20
30
40
50
60
70
80
90
100
GAS SATURATION (% PV)

Table 14

FORMATION RESISTIVITY FACTOR - POROSITY RELATIONSHIP

AT CONFINING PRESSURE

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

Sample	Depth (ft.)	Confining Pressure (psig)	Formation Resistivity Factor (F)	Porosity (% BV)	Cementation Exponent (m)
U 263	2143.3	300	31.76	17.0	1.95
U 271	2147.2	300	25.52	19.9	2.01
U 295	2159.5	300	20.28	20.7	1.91

Rw = 0.046 ohm-meters @ 73 degrees Fahrenheit

Figure 23

FORMATION RESISTIVITY FACTOR - POROSITY RELATIONSHIP AT CONFINING PRESSURE

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

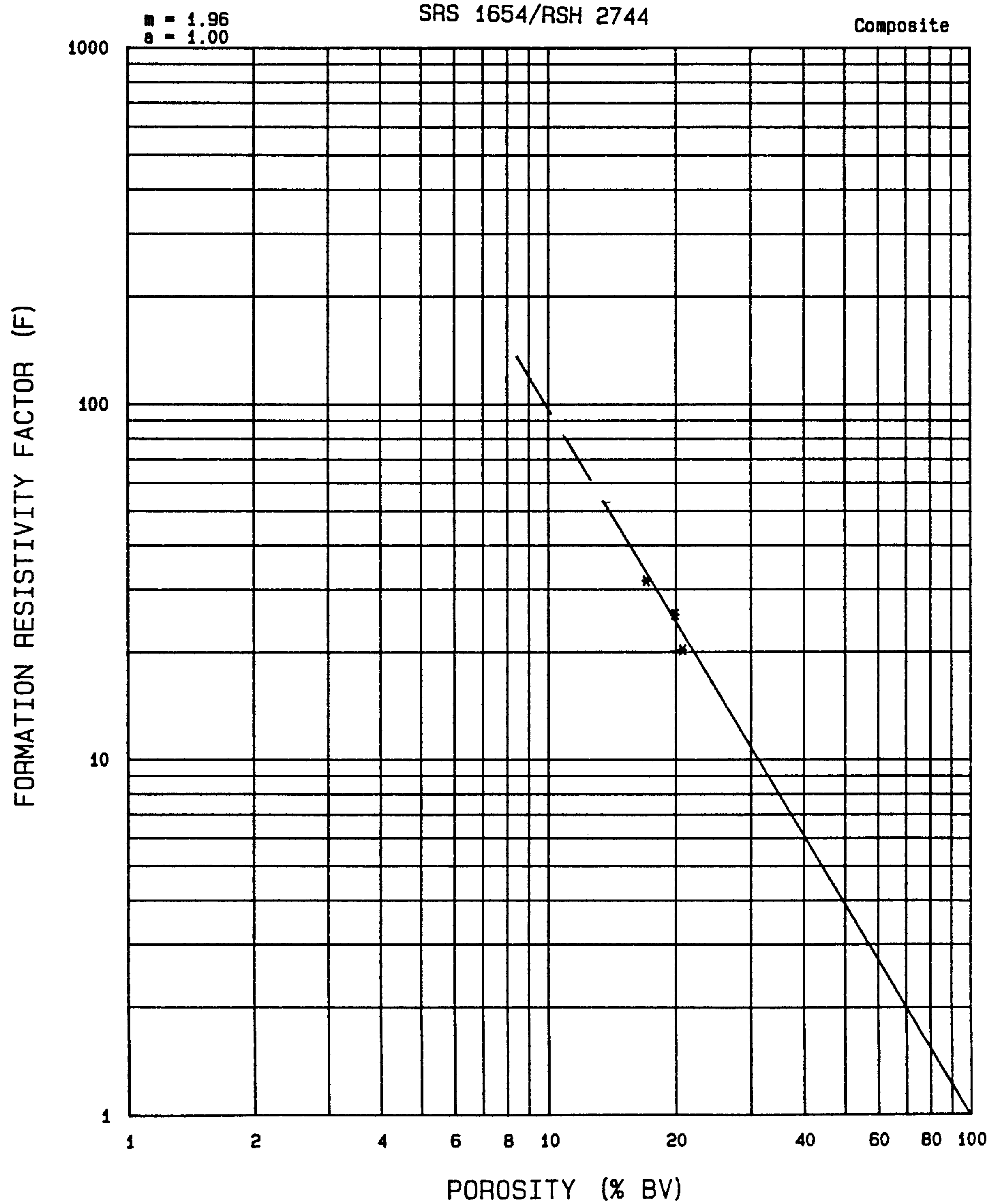


Table 15

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP

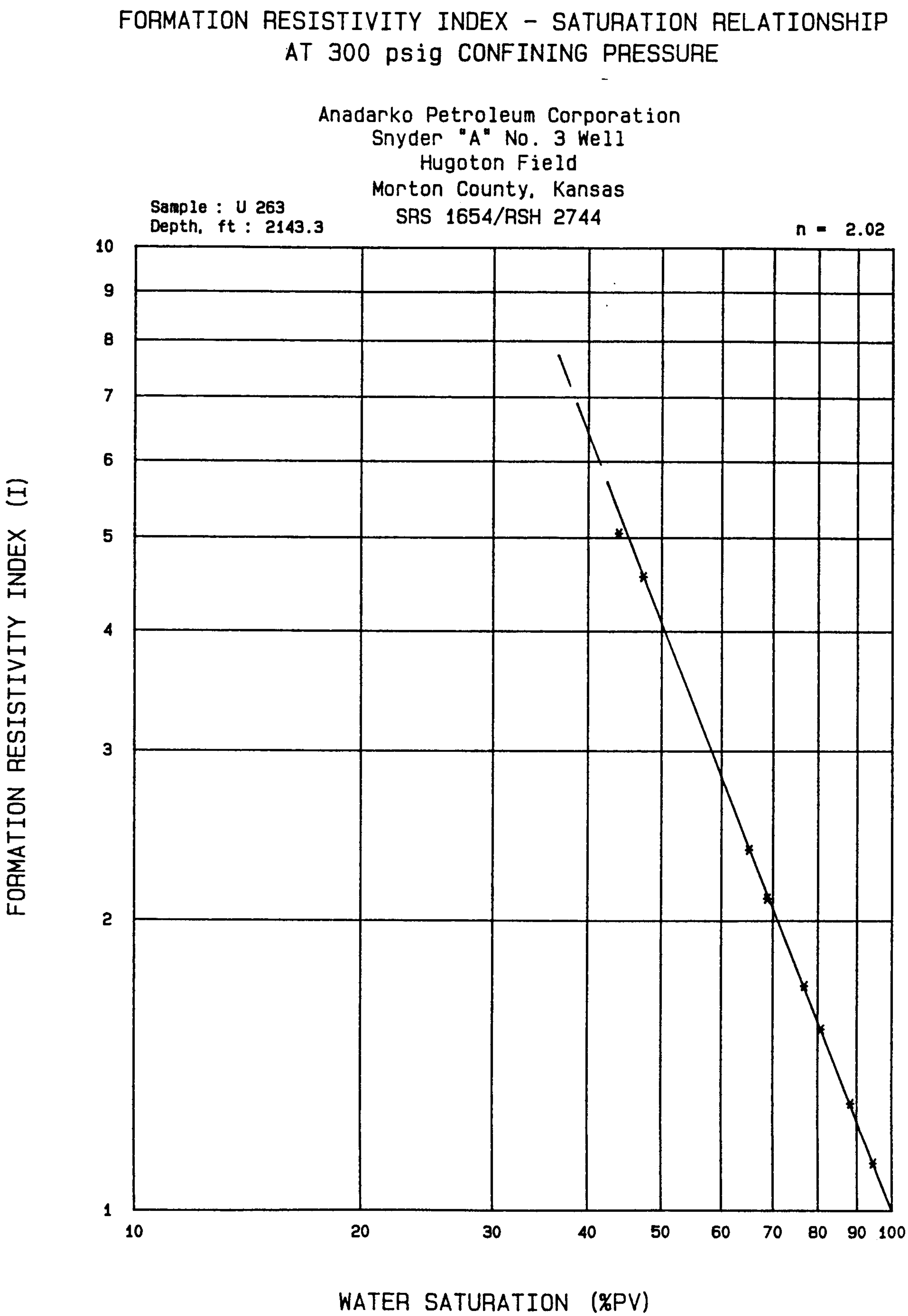
AT 300 psig CONFINING PRESSURE

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

Sample	Depth (ft)	Permeability To Gas (md)	Porosity (% BV)	Formation Resistivity Index (I)	Saturation (% PV)
U 263	2143.3	1.58	17.0	1.00	100.0
				1.12	94.5
				1.29	88.2
				1.54	80.7
				1.71	76.8
				2.11	68.8
				2.37	65.2
				4.56	47.3
				5.05	43.9

Rw = 0.046 ohm-meters @ 73 degrees Fahrenheit

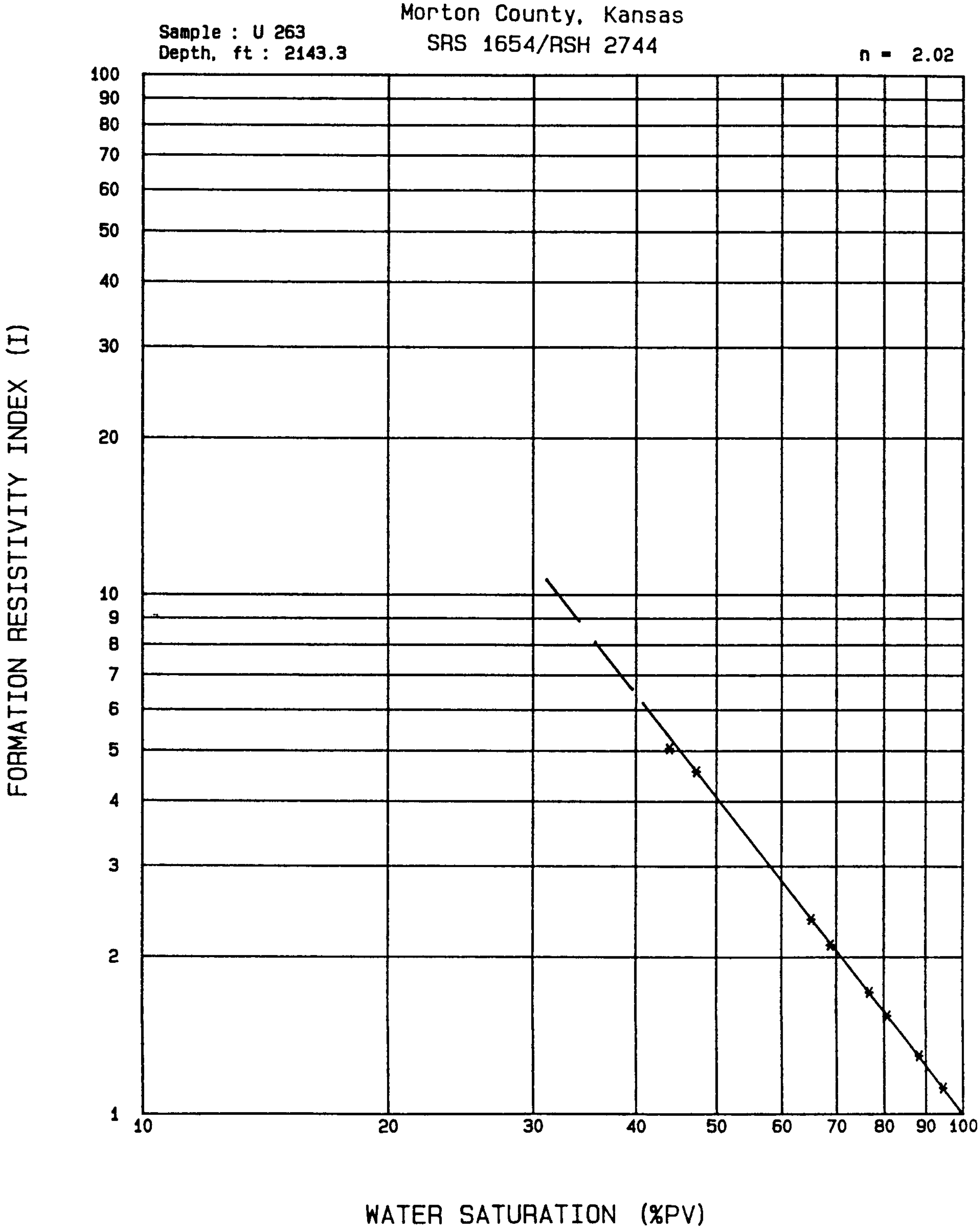
Figure 24



Reservoirs Inc.

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP AT 300 psig CONFINING PRESSURE

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



Reservoirs Inc.

Table 16

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP

AT 300 psig CONFINING PRESSURE

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

Sample	Depth (ft)	Permeability To Gas (md)	Porosity (% BV)	Formation Resistivity Index (I)	Saturation (% PV)
T 271	2147.2	0.839	19.9	1.00	100.0
				1.03	98.4
				1.17	91.6
				1.30	86.6
				1.51	79.3
				1.65	75.1

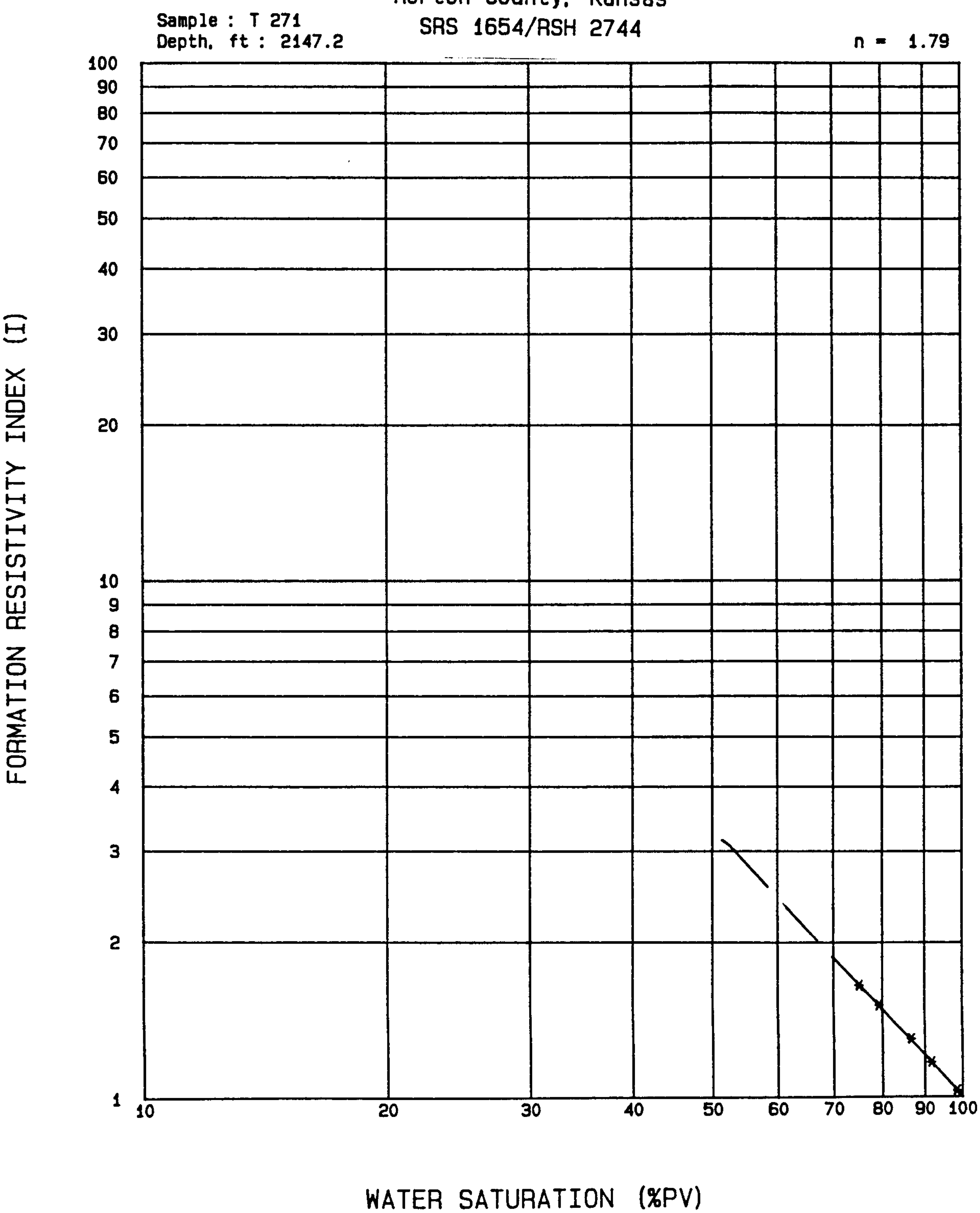
NOTE: Sample broke during testing at 75.1% Sw. Test aborted.

Rw = 0.046 ohm-meters @ 73 degrees Fahrenheit

Figure 26

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP AT 300 psig CONFINING PRESSURE

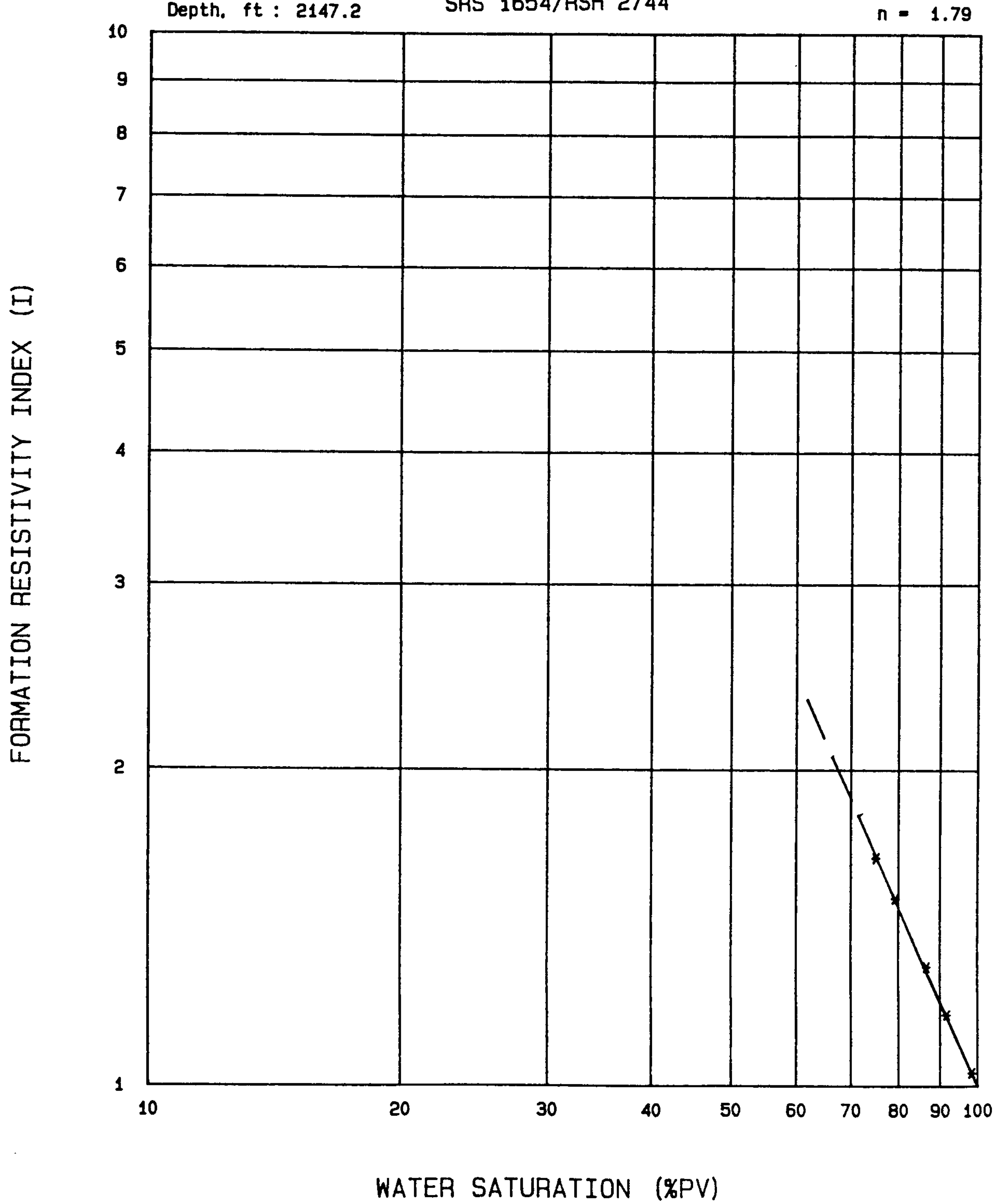
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744



FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP AT 300 psig CONFINING PRESSURE

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

Sample : T 271
Depth, ft : 2147.2



Reservoirs Inc.

Table 17

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP

AT 300 psig CONFINING PRESSURE

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

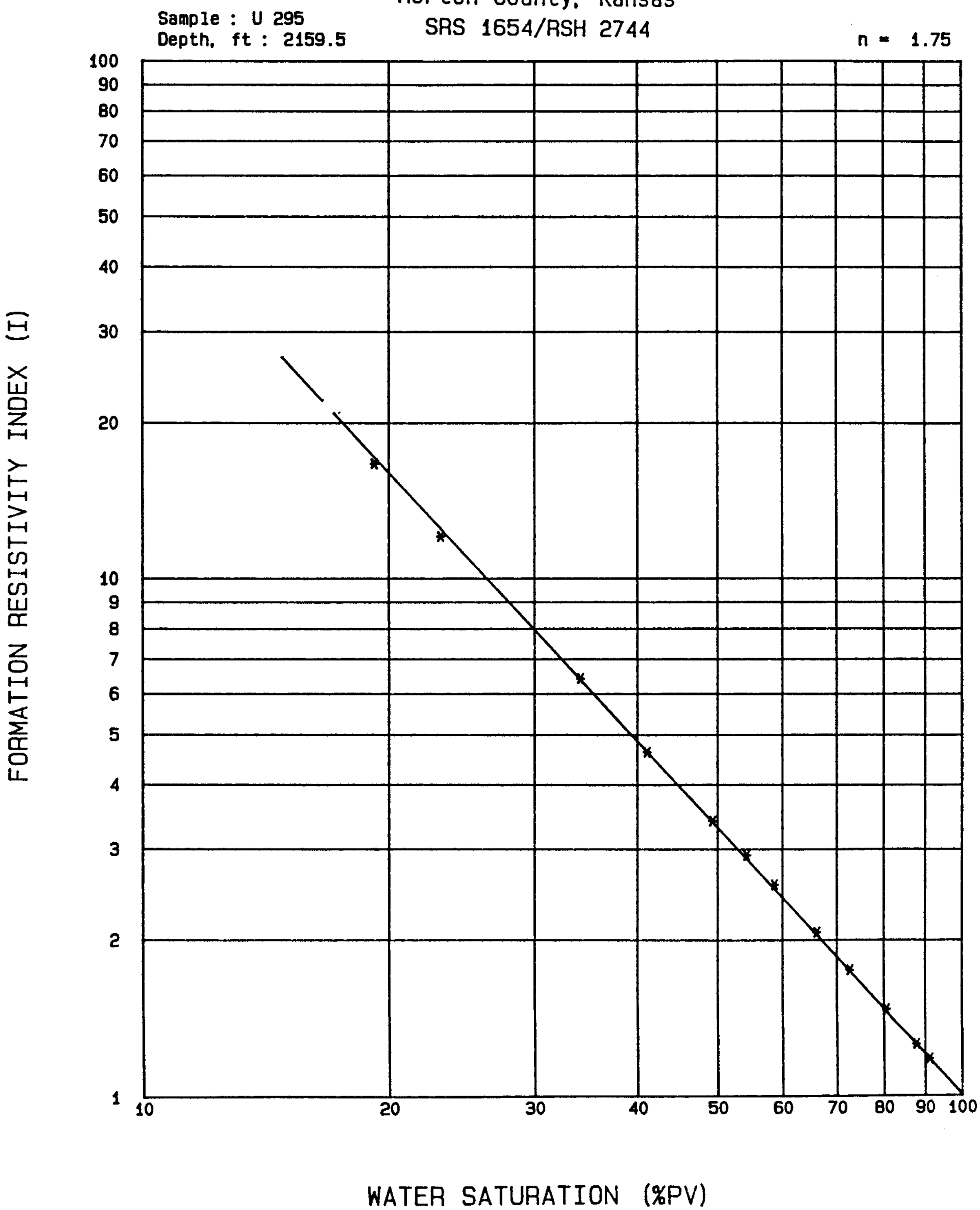
Sample	Depth (ft)	Permeability To Gas (md)	Porosity (% BV)	Formation Resistivity Index (I)	Saturation (% PV)
U 295	2159.5	31.0	20.7	1.00	100.0
				1.18	91.1
				1.26	87.7
				1.47	80.5
				1.75	72.6
				2.07	66.1
				2.56	58.6
				2.92	54.2
				3.40	49.3
				4.63	41.1
				6.42	34.1
				12.07	23.1
				16.69	19.2

Rw = 0.046 ohm-meters @ 73 degrees Fahrenheit

Figure 28

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP
AT 300 psig CONFINING PRESSURE

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



Reservoirs Inc.

FORMATION RESISTIVITY INDEX - SATURATION RELATIONSHIP AT 300 psig CONFINING PRESSURE

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

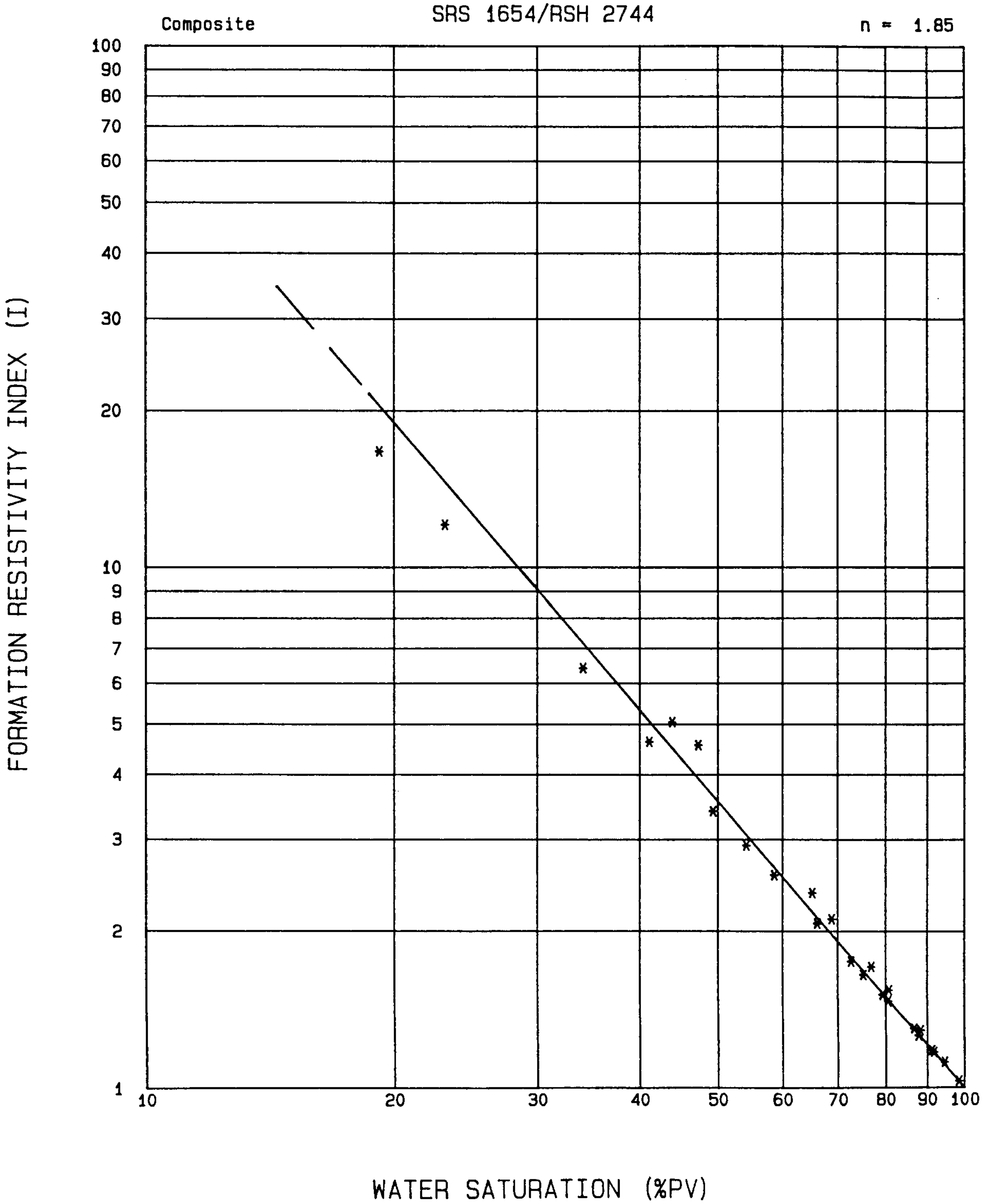


Table 18

MERCURY INJECTION CAPILLARY PRESSURE

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

Sample: U 263

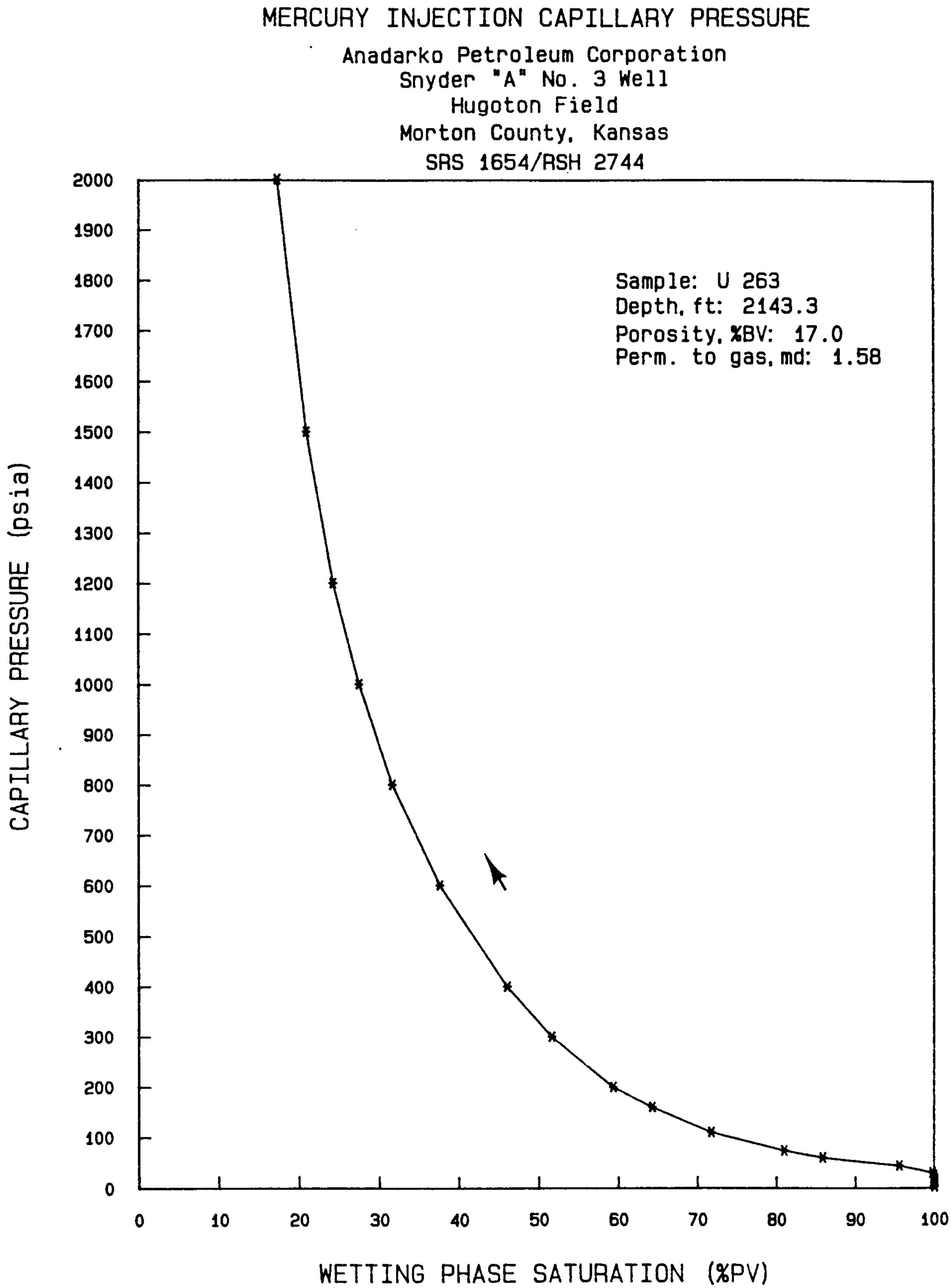
Porosity,% BV: 17.0

Depth, ft: 2143.3

Perm. to Gas, md: 1.58

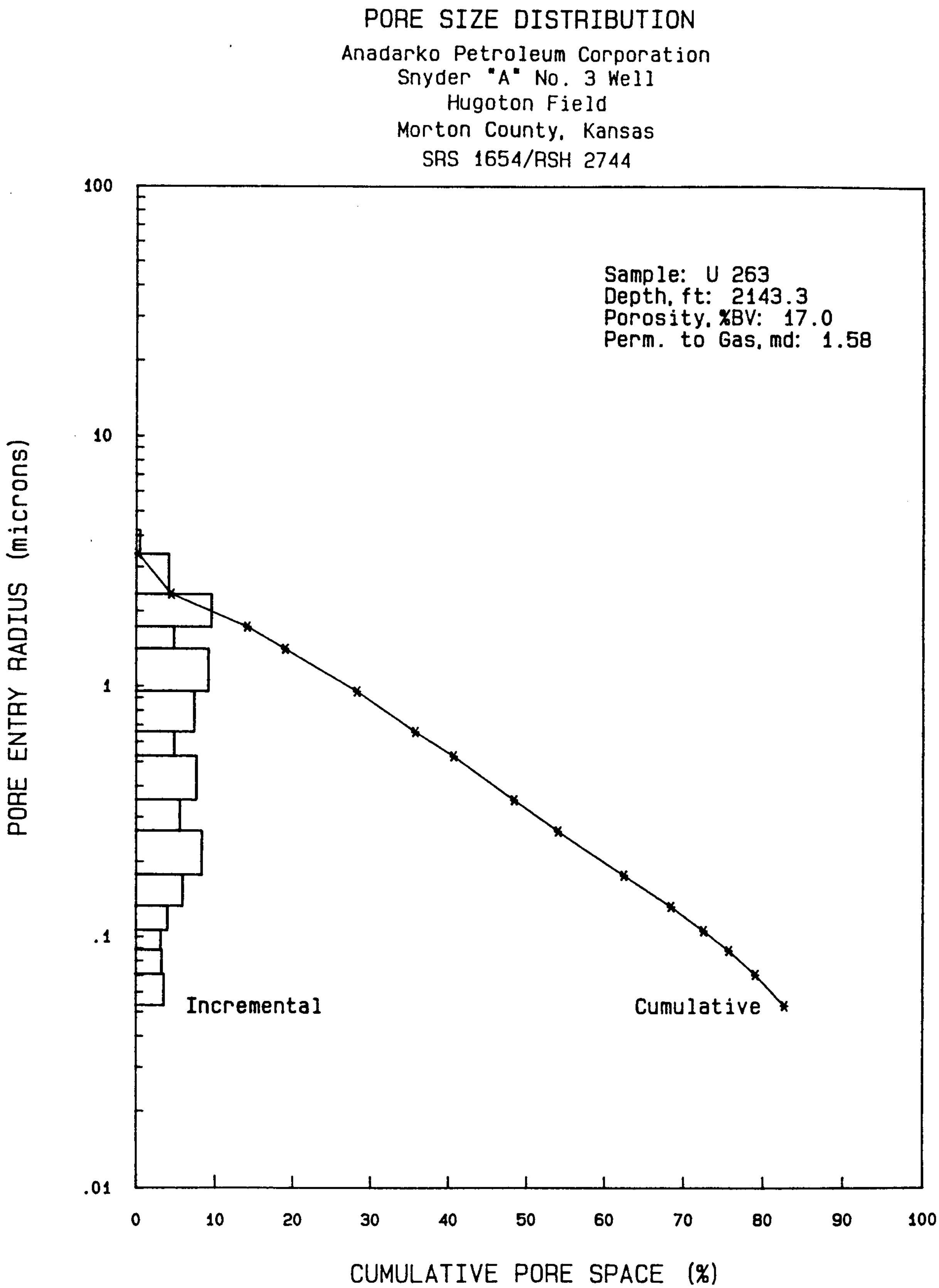
CAPILLARY PRESSURE (psia)	WETTING PHASE SATURATION (%PV)	PORE ENTRY RADIUS (microns)	LEVERETT'S J-FUNCTION
2.54	100.0	-	-
4.04	100.0	-	-
6.54	100.0	-	-
11.5	100.0	-	-
16.5	100.0	-	-
21.5	100.0	-	-
26.5	100.0	-	-
31.5	99.8	3.38	0.055
45.5	95.5	2.34	0.080
61.5	85.9	1.73	0.108
75.5	81.0	1.41	0.132
112	71.8	0.96	0.195
162	64.3	0.66	0.283
202	59.4	0.53	0.353
302	51.6	0.35	0.528
402	46.0	0.27	0.703
602	37.6	0.18	1.05
802	31.6	0.13	1.40
1001	27.5	0.11	1.75
1201	24.3	0.09	2.10
1501	21.0	0.07	2.63
2001	17.3	0.05	3.50

Figure 30



Reservoirs Inc.

Figure 31



Reservoirs Inc.

Table 19

MERCURY INJECTION CAPILLARY PRESSURE

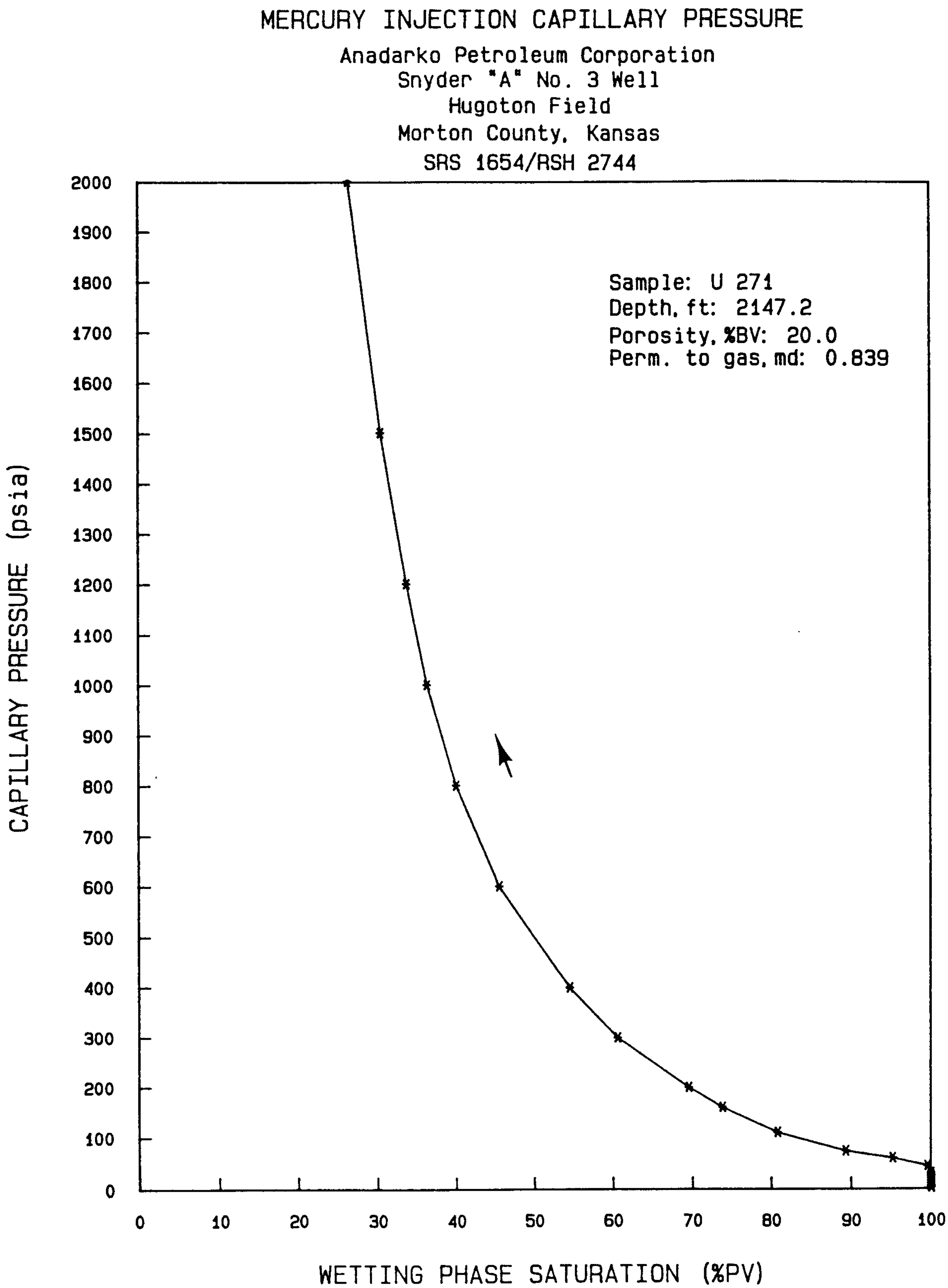
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744

Sample: U 271 Porosity,% BV: 20.0

Depth, ft: 2147.2 Perm. to Gas, md: 0.839

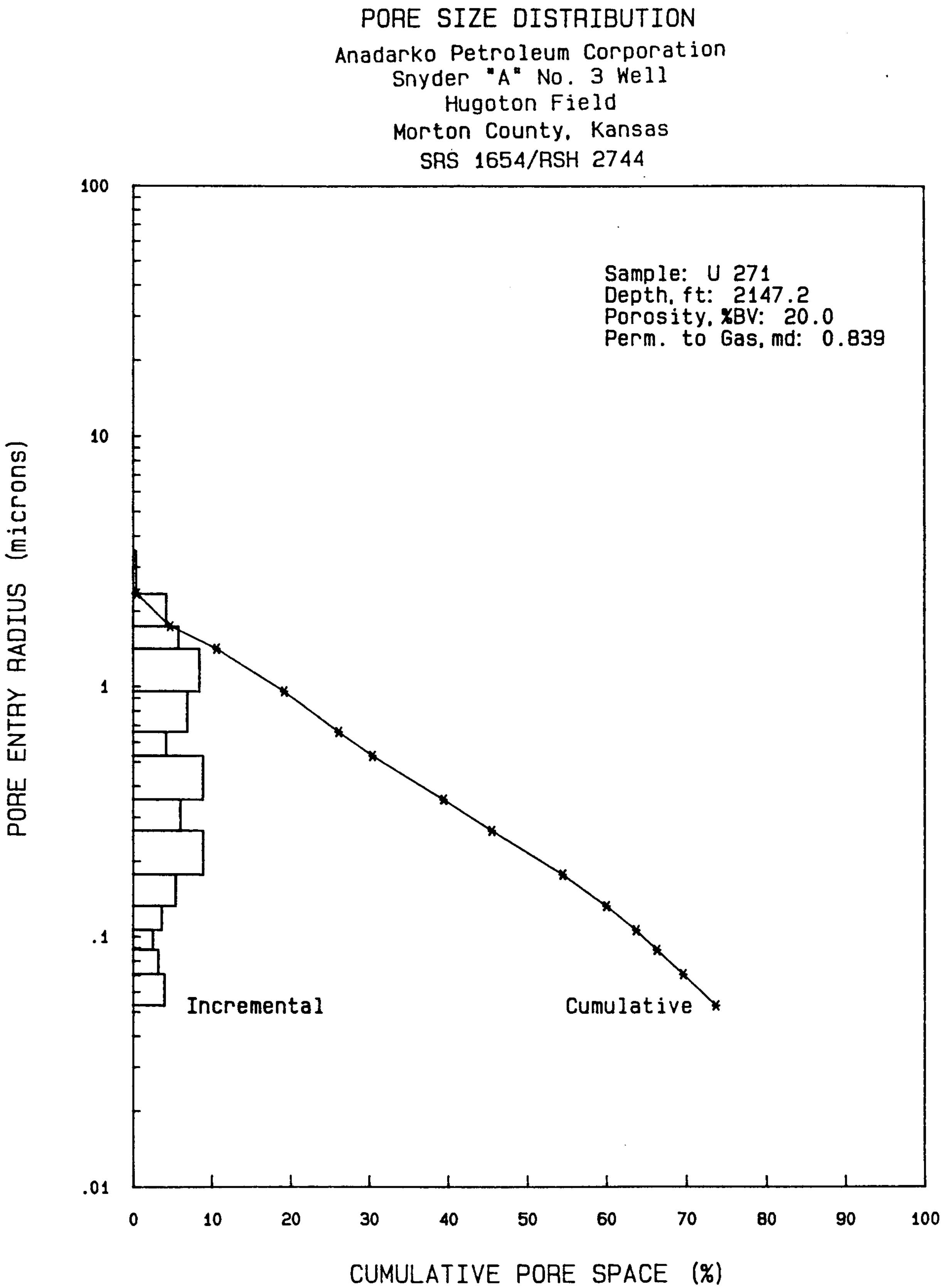
CAPILLARY PRESSURE (psia)	WETTING PHASE SATURATION (%PV)	PORE ENTRY RADIUS (microns)	LEVERETT'S J-FUNCTION
2.36	100.0	-	-
3.86	100.0	-	-
6.36	100.0	-	-
11.4	100.0	-	-
16.4	100.0	-	-
21.4	100.0	-	-
26.4	100.0	-	-
31.4	100.0	-	-
45.4	99.5	2.35	0.054
61.4	95.2	1.74	0.073
75.4	89.4	1.41	0.089
111	80.9	0.96	0.132
161	73.9	0.66	0.191
201	69.6	0.53	0.238
301	60.6	0.35	0.356
401	54.5	0.27	0.474
601	45.6	0.18	0.711
801	40.1	0.13	0.947
1000	36.3	0.11	1.18
1200	33.7	0.09	1.42
1500	30.5	0.07	1.77
2000	26.4	0.05	2.36

Figure 32



MERCURY INJECTION CAPILLARY PRESSURE
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744
Sample: U 271
Depth, ft: 2147.2
Porosity, %BV: 20.0
Perm. to gas, md: 0.839
CAPILLARY PRESSURE (psia)
WETTING PHASE SATURATION (%PV)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
10
20
30
40
50
60
70
80
90

Figure 33



Reservoirs Inc.

Table 20

MERCURY INJECTION CAPILLARY PRESSURE

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

Sample: U 295

Depth, ft: 2159.5

Porosity,% BV: 20.7

Perm. to Gas, md: 31.0

CAPILLARY PRESSURE (psia)	WETTING PHASE SATURATION (%PV)	PORE ENTRY RADIUS (microns)	LEVERETT'S J-FUNCTION
2.56	100.0	-	-
4.06	100.0	-	-
6.56	100.0	-	-
11.6	100.0	-	-
16.6	100.0	-	-
21.6	100.0	-	-
26.6	99.4	4.01	0.189
31.6	82.6	3.38	0.225
45.6	40.4	2.34	0.324
61.6	32.0	1.73	0.438
75.6	28.4	1.41	0.538
112	23.9	0.96	0.794
162	21.4	0.66	1.15
202	20.3	0.53	1.44
302	18.4	0.35	2.15
402	17.2	0.27	2.86
602	15.6	0.18	4.28
802	14.6	0.13	5.71
1001	13.8	0.11	7.13
1201	13.2	0.09	8.56
1501	12.4	0.07	10.69
2001	11.6	0.05	14.25

Figure 34

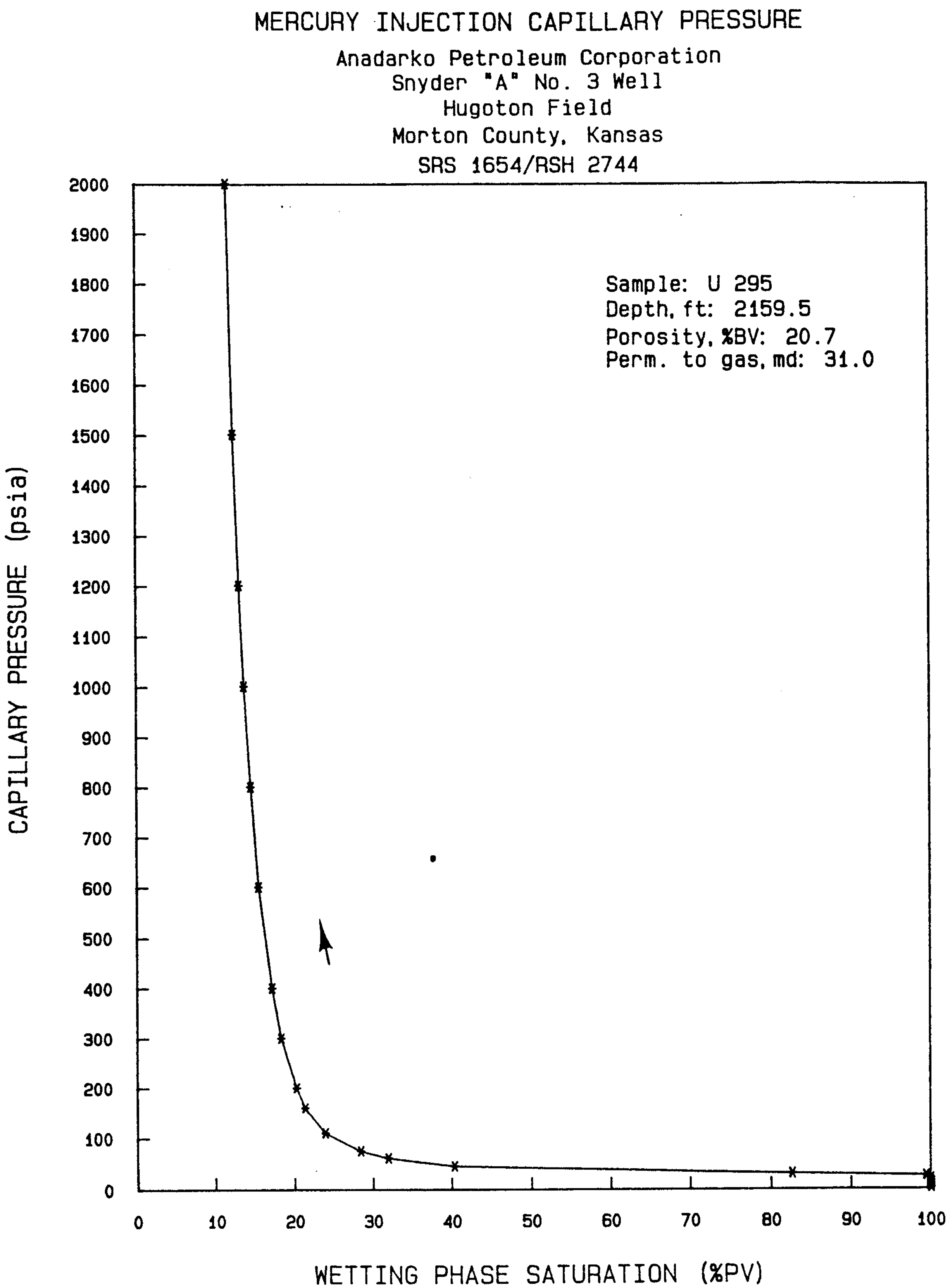
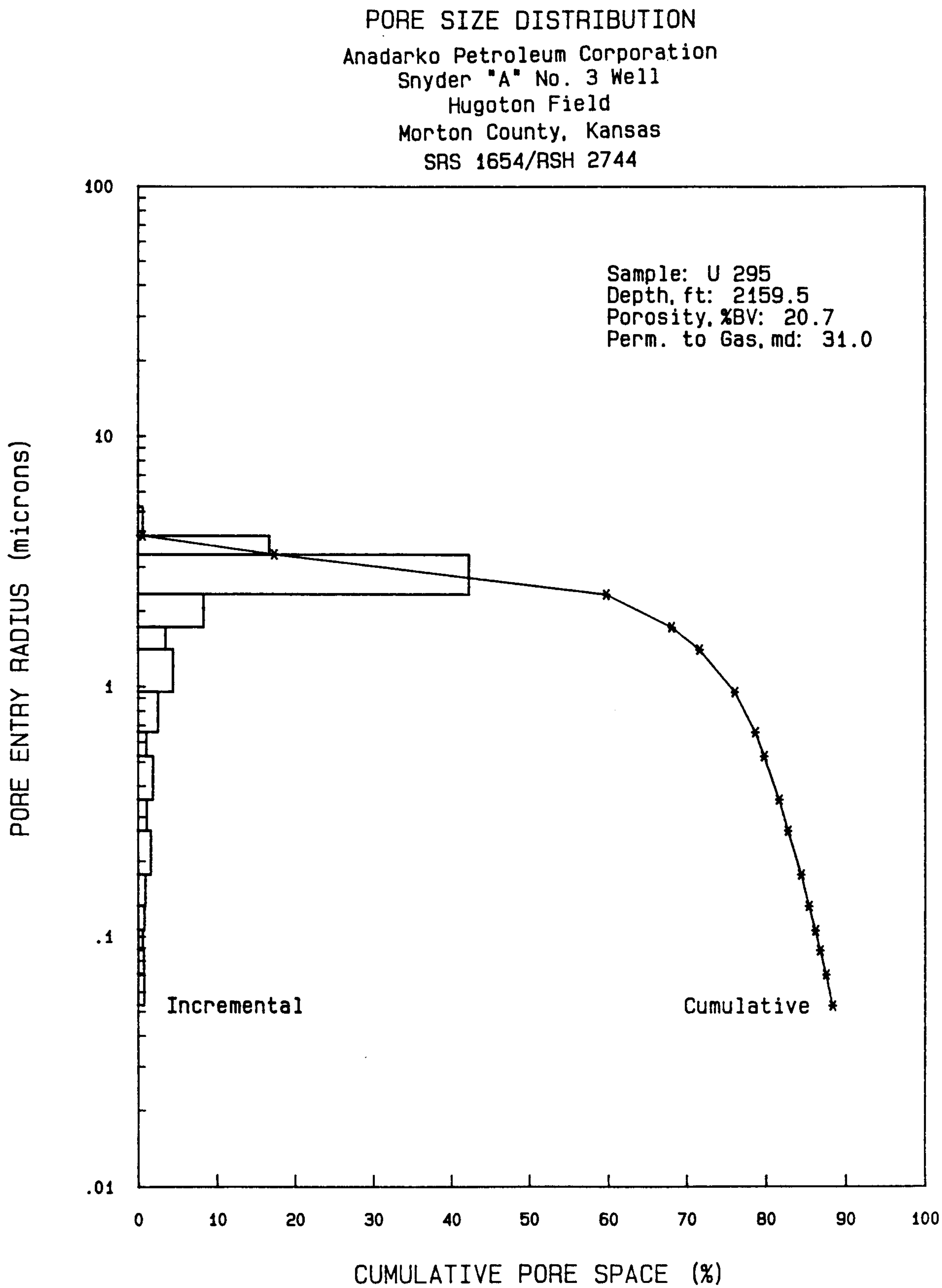

MERCURY INJECTION CAPILLARY PRESSURE
Anadarko Petroleum Corporation
Snyder "A" No. 3 Well
Hugoton Field
Morton County, Kansas
SRS 1654/RSH 2744
Sample: U 295
Depth, ft: 2159.5
Porosity, %BV: 20.7
Perm. to gas, md: 31.0
CAPILLARY PRESSURE (psia)
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
90
100
WETTING PHASE SATURATION (%PV)

Figure 35



Reservoirs Inc.