

25-31-38w
15-189-21857

**GEOLOGICAL ANALYSIS
OF CONVENTIONAL CORE FROM THE
ANADARKO PETROLEUM CORPORATION
FLOWER A-1 WELL
STEVENS COUNTY, KANSAS**

Prepared
for
Anadarko Petroleum Corporation
Houston, Texas

RSH 3123

CONFIDENTIAL
February, 1995

SUMMARY

1. A total of 553.8 feet (2441.0–2958.0 feet and 2968.0–3004.8 feet) of conventional core from the Anadarko Petroleum Corporation Flower A-1 well were analyzed in detail.

2. The principal depositional facies delineated in the core are:

Depositional Facies	% of Cored Strata	Lithologic Characteristics	Porosity Range* (%) (Average*)	Permeability Range* (md) (Average*)	Estimated Reservoir Potential
Paleosol/ Coastal Plain	32%	Mostly brick-red siltstone, argillaceous siltstone and silty claystone. Often dolomitic and/or calcareous. Root mottling common. Caliche nodules and anhydrite nodules also abundant. Thin anhydrite beds. Microporosity and thin, "clean", porous laminations.	0.6–17.6 (9.4)	0.013–2.638 (0.173)	Mostly poor. Grading to fair to good where this facies grades into tidal flat deposits.
Tidal Flat	15%	Laminated to ripple cross-stratified siltstone to very fine-grained sandstone. Locally bioturbated. Some dolomitized mudstones also noted. Parts have well preserved intergranular pores. Carbonate matrix and cement, anhydrite cement, and authigenic clay present as pore-filling constituents. Anhydrite nodules common.	1.3–24.9 (12.5)	0.03–97.63 (8.13)	Poor to very good.
Lagoon to Shallow Shelf	23%	Ranging from dolomitic siltstone to silty lime/dolomitic mudstone/wackestone. Bioturbation generally apparent. Chert nodules locally abundant. Little visible pore space, except for minor amounts of intercrystalline porosity and some secondary pore space in chert.	0.7–19.3 (8.5)	0.01–5.08 (0.266)	Poor. Locally ranging to fair where this facies grades into shoal/shoal flank and/or tidal flat deposits.
Algal Bank Subfacies	≈1%	Phylloid algal wackestone to grainstone. Abundant moldic pore space due to dissolution of calcareous algae. Fracture development yields very high permeability.	9.8–16.0 (12.3)	2.97–2568.40 (554)	Fair to excellent. Moldic pores and small fractures combine to yield very high permeability.
Carbonate Shoal to Shoal Flank	29%	Limestone to dolomite. Grainstone and packstone depositional textures predominate, locally grading to wackestone. Most of the strata contain a mixture of skeletal debris, peloids, oncoids, intraclasts and scattered ooids. Intergranular and moldic macropores common in limestones. Moldic, intercrystalline and subordinate intergranular macropores present in dolomites. Intragranular macropores (within skeletal fragments) also noted. In addition, locally extensive microporosity in micritic grains. Parts of this facies are extensively cemented with calcite, anhydrite and/or dolomite.	2.4–25.6 (13.7)	0.03–403.39 (27.6)	Poor to very good. Diagenesis very important in controlling reservoir potential. Dolomitic portions tend to have better reservoir potential.

* Excludes data from artificially fractured samples.

3. The paleosol/coastal plain facies consists of brick–red, reddish tan and greenish gray, dolomitic/calcareous siltstones, argillaceous siltstones and claystones. Root mottling, caliche nodules and other features indicate terrestrial sedimentation. Most of the measured pore volume is in the form of microporosity within altered micrite matrix. Excluding fractured samples, the average permeability of 0.173 md is thought to be representative of the paleosol/coastal plain strata. **No open natural fractures were observed.** Overall, the paleosol/coastal plain facies is judged to have rather **poor** reservoir potential, locally grading to **fair** reservoir potential.
4. The tidal flat facies consists of light olive–gray, tan and reddish tan, very well to well sorted, laminated to ripple cross–stratified siltstones and very fine–grained sandstones. Primary intergranular pores predominate. The range of porosity and permeability values in this facies largely reflects variations in the amount/distribution of carbonate matrix and cements and anhydrite cement. Overall, the tidal flat facies is judged to have variable reservoir potential, ranging from **poor** to **very good**. Horizontal permeability tends to be marginally higher than vertical permeability due to well preserved laminations.
5. The lagoon to shallow shelf facies is dominated by dark to medium gray, argillaceous, calcareous/dolomitic siltstones and silty mudstones/wackestones. Bioturbation is generally apparent and patchy silicification was noted. Average porosity is 8.5%, and average permeability is 0.266 md. These values are considered to be representative of this facies. Overall, the matrix–rich texture of these rocks results in rather **poor** reservoir potential. Marginally better reservoir potential occurs where this facies grades into the shoal/shoal flank or tidal flat facies.
6. The algal bank subfacies defines a distinct unit within the lagoon to shallow shelf facies. Although the algal bank deposits account for only about 1% of the recovered core, their complex diagenetic history results in fractures that lead to

very high permeability. These phylloid algal-bearing strata were not recognized in any of the other cores from Hugoton Field that have been examined to date. Porosity averages 12.3% and permeability averages 554 md. These deposits are judged to have **fair to excellent** reservoir potential.

7. The carbonate shoal/shoal flank facies consists of tan to gray grainstone and packstone with a minor amount of intercalated wackestone. These grain-rich deposits vary from limestone to dolomitic limestone to calcareous dolomite. The lithology of this facies appears to vary throughout the stratigraphic column. Above 2532.4 feet, the shoal/shoal flank deposits tend to be dolomite. By comparison, the shoal/shoal flank deposits between 2554.6 and 2712.9 feet contain a mixture of limestone and dolomitic limestone, and the deposits below 2733.9 feet are almost all limestone with only a subordinate amount of dolomitic limestone. Most of the grainstones and packstones contain a wide assemblage of carbonate particles. Routine core analysis data for the shoal/shoal flank facies reveals porosity values ranging from 2.4% to 25.6% (average of 13.7%), and permeability values ranging from 0.03 md to 403.39 md (average of 27.6 md). Some of the higher permeability measurements occur in samples that have natural fractures (such as at 2934 feet). These natural fractures should contribute to the effective pore network in the subsurface. Further evaluation of the porosity and permeability data demonstrates differences in the average values for limestones and dolomites.

Rock Type	Number of Measurements	Porosity Range (%) (Average)	Permeability Range (md) (Average)
Limestone	115	2.4–19.0 (11.6)	0.03–71.48 (3.752)
Dolomite	42	6.6–25.6 (19.3)	0.07–403.39 (92.8)

Although these numbers may be somewhat skewed because samples with natural fractures are included, the average porosity and permeability values for

the dolomites are higher than for the limestones. That is, overall, dolomitization acted to enhance the reservoir potential of the shoal and shoal flank grainstones and packstones. In the limestones, the highest porosity and permeability values occur where grainstone (matrix-free) textures result in well developed networks of intergranular pores. Some of the limestones that have high porosity but low permeability only have poorly interconnected moldic pores and/or microporosity. In the dolomites, high porosity values typically occur in association with a combination of 1) intercrystalline pores, 2) relict intergranular pores, and 3) moldic pores. Overall, the grain-rich limestones and dolomites of the carbonate shoal/shoal flank facies are judged to have **poor to very good** reservoir potential, with the dolomite portions generally having higher permeability values.

8. The dolomitized strata in the **Krider** interval of the Flower well has better porosity and permeability than the equivalent strata in the other three wells examined from Hugoton Field. In particular, the Krider interval in the Flower well is significantly better than the equivalent unit in the Cornell well. The dolomitized shoal/shoal flank deposits in the Krider interval contain nearly 25 feet of strata with permeability in excess of 100 md. **This unit stands out as one of the thickest, best developed porosity/permeability units encountered in this suite of wells.** At this location, the enhanced pore system appears to reflect better development of intercrystalline pores (i.e., a diagenetic variation), compared to the Krider strata in the other wells.

9. The stratigraphic sequence observed in the core reflects numerous transgressive and regressive cycles. This is recorded by the interfingering of the four depositional facies identified in the core. One of the byproducts of this type of cyclic sedimentation is the stacking of potential reservoir facies. For example, there are 11 tidal flat units and 18 individual shoal/shoal flank units, each separated by low porosity, low permeability paleosol/coastal plain or lagoon/shallow shelf deposits.

**GEOLOGICAL ANALYSIS
OF CONVENTIONAL CORE FROM THE
ANADARKO PETROLEUM CORPORATION
FLOWER A-1 WELL
STEVENS COUNTY, KANSAS**

INTRODUCTION

This report, prepared for Anadarko Petroleum Corporation, presents the results and conclusions obtained from geological analysis of 553.8 feet (2441.0–2958.0 feet and 2968.0–3004.8 feet) of conventional core from the Anadarko Petroleum Corporation Flower A-1 Well, located in Stevens County, Kansas.

The objectives of this study were to: 1) describe the conventional core and delineate lithologies, textures, sedimentary structures and contact relationships, 2) identify petrographic characteristics and diagenetic alterations that influence pore system properties, and 3) evaluate reservoir potential. In addition, observations and conclusions drawn from analysis of this core were to be compared with similar data obtained from: the Anadarko Petroleum Corporation Cornell University "C" 1-H well located in Morton County, Kansas (Reservoirs' Job Number RSH 2982), the Anadarko Petroleum Corporation Youngren "J" 1-H well, located in Stevens County, Kansas (Reservoirs' Job Number RSH 3036), and the Anadarko Petroleum Corporation Dunne-Hoffman "K" 3-H well, also located in Stevens County, Kansas (Reservoirs' Job Number RSH 3061). In order to meet these objectives, the following analytical program was utilized:

- Following full diameter core analysis measurements (Table 4), the conventional core was slabbed into one-third and two-third sections. Color continuous core photographs are provided in Figure 3.
- The core was described in detail. Rock types, depositional textures, sedimentary structures and contact relationships were delineated. This

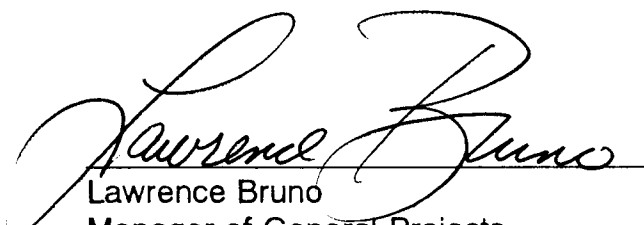
description is presented in Figure 2 and in the Core Description Panel at the end of this report.

- Individual core pieces were selected to show representative lithologies. These close core photographs are displayed in Figure 4.
- One hundred nine (109) samples were selected for thin section preparation. The samples were impregnated with blue-dyed epoxy to highlight pore space. The thin sections were then ground to 30 microns and stained with Alizarin Red-S, which aids in differentiating calcite from other carbonate minerals. All of these thin sections were examined, and petrographic observations are incorporated into the core description. The locations of these thin sections are shown on the Core Description Panel.
- Twenty (20) of these thin section samples were selected for detailed evaluation. These are:

Depth (ft)	Thin Section	XRD	Figure Nos.	Stratigraphic Unit
2473.6	X	X	5	Herington
2485.2	X	X	6	Herington
2505.4	X	X	7	Krider
2515.8	X	X	8 & 25	Krider
2526.1	X	X	9	Krider
2531.1	X	X	10 & 26	Krider
2550.5	X	X	11 & 27	Winfield Sand
2556.1	X	X	12	Winfield Sand
2579.4	X	X	13	Winfield Dolomite
2618.1	X	X	14	Towanda
2627.4	X	X	15	Towanda
2641.1	X	X	16	Towanda
2658.7	X	X	17	Holmesville
2681.7	X	X	18	Upper Ft. Riley
2700.5	X	X	19	Upper Ft. Riley
2772.5	X	X	20	Wreford
2877.1	X	X	21	Council Grove B1
2891.4	X	X	22	Council Grove B2
2932.5	X	X	23	Council Grove B4
2948.8	X	X	24 & 28	Council Grove B5

- Point count modal analysis (250 points) was used to determine the relative proportions of framework grains, pore-filling constituents, replacement products and pore types in the sandstone/siltstone samples. Point count data are presented in Table 2.
- Samples selected for X-ray diffraction (XRD) were ground to 40 microns to ensure homogeneity and analyzed through standard X-ray diffraction techniques. Bulk mineralogy XRD data are presented in Table 3 and in the figure captions.

Reservoirs' Job Number RSH 3123 was assigned to this study. Any communications regarding this report should refer to this Job Number. Five copies of this report were forwarded to Mr. Todd Montgomery, 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.



Lawrence Bruno
Manager of General Projects
RESERVOIRS, INC.

GEOLOGICAL ANALYSIS

This section of the report presents the results of geological analysis of 553.8 feet (2441.0–2958.0 feet and 2968.0–3004.8 feet) of conventional core from the Anadarko Petroleum Corporation Flower A–1 well, located in Stevens County, Kansas. The core recovered strata from 21 stratigraphic units as defined by Anadarko Petroleum Corporation (see Table 1 and Core Description Panel).

Core Description and Interpretation

Four principal depositional facies were delineated in the core; in addition, one of these has a distinct subfacies that, although accounting for only a very small portion of the total cored strata, has excellent reservoir potential. These depositional facies are summarized in the table on the following page.

Paleosol/Coastal Plain Facies

Description:

The paleosol/coastal plain facies accounts for roughly 32% of the cored strata, the most among the four principal depositional facies. Twelve individual units were delineated, ranging in thickness from 2.5 feet to 28.8 feet (see Figure 2 and the Core Description Panel). The deposits are dominated by **brick-red, reddish tan and greenish gray, dolomitic/calcareous siltstones and argillaceous siltstones, with a minor amount of silty claystone** (Figure 4,A). Some of the strata grade to silty dolomite. A few beds of anhydrite are present between 2441 and 2455 feet. Quartz and feldspar grains account for most of the framework constituents, with mica and heavy minerals noted as accessory grains. Root mottling and desiccation features are common, with caliche nodules (both calcite and dolomite) and anhydrite nodules observed at numerous horizons.

ANADARKO PETROLEUM CORPORATION

FLOWER A-1 WELL

STEVENS COUNTY, KANSAS

Depositional Facies	% of Cored Strata	Lithologic Characteristics	Porosity Range* (%) (Average*)	Permeability Range* (md) (Average*)	Estimated Reservoir Potential
Paleosol/ Coastal Plain	32%	Mostly brick-red siltstone, argillaceous siltstone and silty claystone. Often dolomitic and/or calcareous. Root mottling common. Caliche nodules and anhydrite nodules also abundant. Thin anhydrite beds. Microporosity and thin, "clean", porous laminations.	0.6-17.6 (9.4)	0.013-2.638 (0.173)	Mostly poor. Grading to fair to good where this facies grades into tidal flat deposits.
Tidal Flat	15%	Laminated to ripple cross-stratified siltstone to very fine-grained sandstone. Locally bioturbated. Some dolomitized mudstones also noted. Parts have well preserved intergranular pores. Carbonate matrix and cement, anhydrite cement, and authigenic clay present as pore-filling constituents. Anhydrite nodules common.	1.3-24.9 (12.5)	0.03-97.63 (8.13)	Poor to very good.
Lagoon to Shallow Shelf	23%	Ranging from dolomitic siltstone to silty lime/dolomitic mudstone/wackestone. Bioturbation generally apparent. Chert nodules locally abundant. Little visible pore space, except for minor amounts of intercrystalline porosity and some secondary pore space in chert.	0.7-19.3 (8.5)	0.01-5.08 (0.266)	Poor. Locally ranging to fair where this facies grades into shoal/shoal flank and/or tidal flat deposits.
Algal Bank Subfacies	≈1%	Phylloid algal wackestone to grainstone. Abundant moldic pore space due to dissolution of calcareous algae. Fracture development yields very high permeability.	9.8-16.0 (12.3)	2.97-2568.40 (554)	Fair to excellent. Moldic pores and small fractures combine to yield very high permeability.
Carbonate Shoal to Shoal Flank	29%	Limestone to dolomite. Grainstone and packstone depositional textures predominate, locally grading to wackestone. Most of the strata contain a mixture of skeletal debris, peloids, oncoids, intraclasts and scattered ooids. Intergranular and moldic macropores common in limestones. Moldic, intercrystalline and subordinate intergranular macropores present in dolomites. Intragranular macropores (within skeletal fragments) also noted. In addition, locally extensive microporosity in micritic grains. Parts of this facies are extensively cemented with calcite, anhydrite and/or dolomite.	2.4-25.6 (13.7)	0.03-403.39 (27.6)	Poor to very good. Diagenesis very important in controlling reservoir potential. Dolomitic portions tend to have better reservoir potential.

* Excludes data from artificially fractured samples.

Primary sedimentary structures are relatively uncommon in the paleosol/coastal plain facies, although faint laminations and ripples can locally be distinguished. Root mottling, desiccation cracks, and the development of caliche nodules and evaporite nodules probably disrupted bedding features.

Although short sections of the paleosol/coastal plain facies are rubble (such as at 2608 feet), core recovery through this facies was generally good. Careful examination of the unslabbed core through the paleosol/coastal plain facies revealed fractures that appear to be artifacts of coring, sample handling and/or full diameter core analysis. Numerous anhydrite-filled fractures were observed in several of the paleosol/coastal plain units, (for example at 2600–2601 feet, and at 2757 feet). **However, no open natural fractures were identified in the paleosol/coastal plain facies.**

The paleosol/coastal plain deposits are often in gradational contact with tidal flat strata (for example at 2469.8, 2547.0, 2590.8 and 2614.0 feet); in many instances, it is difficult to establish a specific contact between these two siliciclastic facies, especially where iron staining is extensive. Where the paleosol/coastal plain deposits are in contact with shoal/shoal flank or lagoon/shallow shelf facies, sharper contacts can generally be defined (such as at 2879.8, 2888.7, 2913.8 and 2930.8 feet).

Pore System Properties:

Routine core analysis data (excluding data from artificially fractured core pieces) show porosity values in the paleosol/coastal plain facies ranging from 0.6% to 17.6% (average of 9.4%), and permeability values ranging from 0.013 md to 2.638 md (average of 0.173 md). These values are thought to be representative of the paleosol/coastal plain strata, although some of the higher porosity values occur near gradational contacts between the paleosol/coastal plain and tidal flat facies. Examination of thin sections from the paleosol/coastal plain facies reveals that most of the pore space is in the form of 1) microporosity associated with the recrystallized matrix, and 2) patches of intergranular pores that sometimes occur in isolated ripples/laminations of "clean" siltstone/very fine-grained sandstone. Detrital clay, carbonate matrix, calcite and dolomite cements, iron oxide cement and patchy

anhydrite cement are the main pore-filling constituents in this facies. In general, the paleosol/coastal plain facies is judged to have rather **poor** reservoir potential. This facies may locally have **fair** reservoir potential where there is somewhat less matrix material, or where the deposits grade into tidal flat siltstones/sandstones.

Interpretation:

The paleosol/coastal plain deposits are interpreted to record terrestrial (non-marine) sedimentation. The brick-red (oxidized) color, abundance of root mottling, caliche nodules, anhydrite nodules, anhydrite interbeds, and desiccation features all support this interpretation. These characteristics are common attributes of ancient arid soils. In the idealized depositional model (Diagram 1), these paleosol/coastal plain deposits should thin, and may eventually pinch-out down depositional dip where they grade into areas of intertidal- and marine-dominated sedimentation. Throughout the core, the interfingering of numerous paleosol/coastal plain horizons with intertidal (tidal flat) and subtidal marine (lagoon/shallow shelf and shoal/shoal flank) deposits probably records cyclic sedimentation in response to repeated sea level fluctuations. The paleosol/coastal plain deposits were very likely widespread during relative low stands in sea level. The tops of these paleosol/coastal plain units may have been somewhat reworked during subsequent transgressions.

Tidal Flat Facies

Description:

The tidal flat facies, which accounts for roughly 15% of the cored interval, consists of **light olive-gray, tan and reddish tan, very well to well sorted, very fine-grained sandstones and siltstones** (Figure 4,B). These siliciclastic deposits are often dolomitic and/or calcareous, frequently containing dolomite and calcite cement and matrix as well as small carbonate grains (mostly peloids and skeletal fragments). There is a minor amount of laminated and desiccation cracked dolomudstone (for example at 2673 feet). In addition, a few thin interbeds of anhydrite and rather widely distributed anhydrite nodules are present. Some of the anhydrite has been partially replaced with chert.

Eleven individual tidal flat units were identified (Figure 2), with thicknesses ranging from 1.6 feet to 19.4 feet. The very fine-grained sandstones and siltstones range from finely laminated and ripple cross-stratified to bioturbated or massive. Minor soft-sediment deformation was also observed. Locally, burrowing and minor root mottling have disrupted bedding features.

The tidal flat deposits are often in gradational contact with either paleosol/coastal plain or lagoon/shallow shelf strata; the tidal flat deposits are less commonly directly in contact with shoal/shoal flank deposits, and rarely grade into these high energy carbonate accumulations.

Pore System Properties:

Routine core analysis measurements from the tidal flat facies (excluding data from fractured samples) show porosity values ranging from 1.3% to 24.9% (average of 12.5%), and permeability values ranging from 0.03 md to 97.63 md (average of 8.13 md). Point count data (Table 2) indicate that primary intergranular pores account for most of the pore volume, although there are also moldic pores from leached carbonate grains, and some pores in dolomitized carbonate matrix. Varying amounts of carbonate matrix (both calcite and dolomite), calcite, dolomite, anhydrite and quartz cements, and clay minerals act to reduce porosity in these fine-grained siliciclastic deposits (Table 2). In general, the range of porosity and permeability values largely reflects variations in the amount and distribution of carbonate matrix and cements and anhydrite. The higher range of porosity values occur where carbonate matrix is uncommon, and where calcite, dolomite, and anhydrite cements are sparsely distributed. The low porosity, low permeability portions of the tidal flat facies contain an abundance of carbonate matrix and/or cement, or have extensive anhydrite cementation. Authigenic clays have apparently replaced some macropores with less effective microporosity. SEM (scanning electron microscope) analysis would help to better evaluate the effects of these authigenic clay minerals.

The fine laminations and ripples in the tidal flat deposits often lead to millimeter-scale heterogeneities that reflect subtle variations in the amount of matrix material. This may

make it difficult to evaluate permeability measurements over a given stratigraphic interval, and could account for some of the differences between horizontal (average of 8.13 md) and vertical (average of 5.28 md) permeability (Table 4). Overall, the tidal flat facies is judged to have variable reservoir potential, ranging from **poor** to **very good**.

Interpretation:

The tidal flat deposits are interpreted to record sedimentation in a shallow subtidal to intertidal depositional environment. Where burrows are abundant, lower intertidal to shallow subtidal sedimentation is indicated. Conversely, where the deposits are finely laminated/ripple cross-stratified and/or where they grade into iron-stained paleosol/coastal plain facies, upper intertidal to perhaps supratidal deposition is more likely. In this overall intertidal to shallow subtidal depositional setting, sedimentation is dominated by tidal fluctuations that result in traction transport processes alternating with suspension deposition. Tidal flat deposits often form strike-elongate sandbodies that roughly parallel the paleocoastline. Tidal range, angle of depositional slope and sea level fluctuations will all influence the final geometry of the tidal flat lithosome. The repeated interfingering of tidal flat deposits with other facies identified in this core reflects cyclic sedimentation in response to sea level fluctuations. Because tidal flat deposits closely track subtle changes in sea level, they may be widely distributed, forming broad, sheet-like deposits. As with the paleosol/coastal plain deposits, the very fine-grained sandstones and siltstones of the tidal flat facies would be expected to gradationally thin, and may eventually pinch-out, down depositional dip; carbonate-rich, subtidal, marine-dominated facies (lagoon, shelf, shoal and shoal flank) should predominate in the down (depositional) dip areas.

Lagoon to Shallow Shelf Facies

Description:

Roughly 23% of the cored strata are interpreted as lagoon to shallow shelf deposits. These strata, which occur in 17 distinct zones ranging in thickness from less than 1 foot to nearly 34 feet, are dominated by **dark to medium gray, argillaceous, calcareous/ dolomitic siltstones** and **silty mudstones/wackestones** (Figure 4,D).

Locally, these deposits grade to calcareous shale. Some of the mudstones/wackestones are dolomite, while others are mostly limestone. However, matrix-selective dolomitization appears to be rather widespread. The lagoon to shallow shelf deposits are often in gradational contact with shoal, shoal flank and tidal flat facies. In addition, several of the paleosol/coastal plain units are capped by lagoon/shallow shelf deposits; these gradational transitions record the reestablishment of subtidal sedimentation over subaerially exposed strata.

Bioturbation is common, and there is generally poor preservation of primary sedimentary structures. In some places, relicts of ripples and/or laminations can be distinguished between burrows. Fragments of brachiopods, echinoderms, bryozoans, foraminifera, calcareous algae, pelecypods, and corals are present. In addition, oncoids, intraclasts and peloids were noted. Chert nodules and chert-replaced fossil fragments are locally abundant.

Pore System Properties:

Routine core analysis data show porosity values ranging from 0.7% to 19.3% (average of 8.5%), and permeability values ranging from 0.01 md to 5.08 md (average of 0.266 md). These measurements exclude values from fractured samples. The higher porosity and permeability values occur where: 1) the deposits grade into the higher energy (grain-rich) shoal/shoal flank facies, 2) primary intergranular pore space has been preserved in silt-rich layers, and/or 3) where matrix-selective dolomitization has acted to create intercrystalline pore space. Thin section analysis suggests that throughout most of the lagoon/shallow shelf facies a large portion of the measured pore volume is in the form of: 1) poorly interconnected intraskeletal pores (in foraminifera, bryozoans and calcareous algae), 2) microporosity within carbonate and siliciclastic matrix, 3) microporosity in diagenetically altered micritic grains (peloids, oncoids, and intraclasts), and 4) moldic pores from leached fossils. Overall, these deposits are judged to have only **poor** to **fair** reservoir potential.

Interpretation:

The rather extensive bioturbation, combined with the matrix-rich textures and marine fossils indicate low-energy, subtidal marine sedimentation. These deposits may form in shallow lagoons between the tidal flat and shoal environments, or as shallow shelf deposits seaward of, or peripheral to the carbonate bars.

Algal Bank Subfacies

Description:

One 8 foot thick interval (2948–2956 feet) was delineated as a distinct subfacies of the lagoon/shallow shelf facies. The strata in this subfacies consist of **tan, medium to light gray and greenish gray, phylloid algal-dominated lime wackestone and packstone** (Figure 4,E). A minor amount of grainstone is also present. Scattered anhydrite nodules were observed. Although there are similarities between these deposits and other shallow shelf deposits in the core, this unit differs in that **phylloid algae** are abundant. The more typical shallow shelf deposits in other parts of the core contain a diverse assemblage of grain types including: oncoids, peloids, brachiopods, bryozoans, echinoderms, pelecypods and "non-phylloid" calcareous algae.

The relative abundance of phylloid algae is an important characteristic in that these grains were very susceptible to leaching. This initially resulted in an abundance of moldic pore space, and eventually led to brittle collapse of the solution enhanced pore system (Figures 24 and 28). Numerous small fractures developed as part of this brittle deformation. Although some of these fractures were subsequently infilled with calcite or anhydrite cements, many remain open, yielding high permeability rocks.

Pore System Properties

Routine core analysis data for the algal bank subfacies show porosity values ranging from 9.8% to 16.0% (average of 12.3%), and permeability values ranging from 2.97 md to 2568.40 md (average of 554 md). Although the porosity values have a rather narrow range, the wide range of permeability values reflects the role that small fractures play in the permeability of these limestones. These fractures, most of which developed due to the "collapse" of the solution enhanced pore structure, greatly

improved both the permeability and the reservoir potential of these strata. Overall, these deposits are judged to have **fair to excellent** reservoir potential. Without the fractures, the biomoldic pores might have remained isolated from one another, yielding rocks with relatively high porosity but low permeability. Phylloid algal-bearing strata such as these form reservoir rocks in many Pennsylvanian and Permian Age carbonate shelf deposits.

Interpretation:

Phylloid algal deposits generally develop in shallow shelf environments, where these small (2–5 inch tall) algal plants may have baffled wave energy, effectively trapping interstitial micrite matrix and small grains. The high growth rate of these organisms and their ability to influence sedimentation may have resulted in the development of low relief mounds or banks. In other areas, phylloid algal-bearing deposits form broad, sheet-like biostromes with little relief. These organisms did not form rigid organic frameworks such as are commonly associated with reefs. Rather, the deposits consist of disarticulated fragments of the phylloid algae with a "matrix" of micrite, peloids and other fine-grained particles. It is difficult to predict the lateral continuity of this facies from a single cored interval, although this facies is not present in other Hugoton Field cores examined from this area.

Carbonate Shoal/Shoal Flank Facies

Description

The carbonate shoal/shoal flank facies accounts for 29% of the recovered strata. The deposits are dominated by **tan to gray grainstones and packstones** that occur in units ranging in thickness from 2.4 feet to 38.7 feet. A minor amount of wackestone is intercalated with these grain-rich strata. Eighteen individual shoal/shoal flank units were identified; however, some of these are "compound" units consisting of more than one shoaling-upward sequence. **These grain-rich deposits vary from limestone to dolomitic limestone to calcareous dolomite** (Figure 4,C). For example, the shoal/shoal flank deposits between 2497.5 and 2532.4 feet are entirely dolomite, while the deposits between 2674.2 and 2712.9 feet consist of a mixture of limestone, dolomitic limestone and dolomite, and the deposits between 2638.2 and 2652.6 feet

and between 2765.0 and 2773.2 feet are mostly limestone with only a minor amount of dolomitic limestone. The lithology of this facies appears to vary throughout the stratigraphic column. Above 2532.4 feet, the shoal/shoal flank deposits tend to be dolomite. By comparison, the shoal/shoal flank deposits between 2554.6 and 2712.9 feet contain a mixture of limestone and dolomitic limestone, and the deposits below 2733.9 feet are almost all limestone with only a subordinate amount of dolomitic limestone.

Most of the grainstones and packstones contain a mixture of carbonate particles, including a wide variety of skeletal debris (echinoderms, bryozoans, brachiopods, foraminifera, calcareous algae, pelecypods and ostracodes), as well as peloids, oncoids and intraclasts. In general, echinoderms, bryozoans, forams and calcareous algae tend to be the dominant bioclastic constituents. Scattered ooids were observed, although these generally account for a only minor portion of the framework constituents. In addition to the carbonate allochems, very fine-grained quartz sand and silt are sometimes scattered throughout these limestones and dolomites. Anhydrite can be present as a cement and/or as a replacement phase.

A few natural fractures were observed. Some of these appear to be partially open and could contribute significantly to reservoir potential (such as at 2515, 2896 and 2934 feet). Other fractures are filled with anhydrite cement (such as at 2508 feet) and probably play an insignificant role in reservoir performance. Chert and anhydrite nodules are widely distributed throughout these shoal/shoal flank deposits.

Most of these grainstones and packstones are rather massive in appearance, with only a minor amount of crude cross-stratification identified. Stylolites and compaction seams are relatively common.

Pore System Properties:

Routine core analysis data for the shoal/shoal flank deposits (excluding fractured samples, except those that have clearly natural, open fractures) reveal porosity values ranging from 2.4% to 25.6% (average of 13.7%), and permeability values ranging from

0.03 md to 403.39 md (average of 27.6 md). Some of the higher permeability measurements occur in samples that appear to have natural fractures (such as at 2934 feet). These natural fractures should contribute to the effective pore network in the subsurface.

Further evaluation of the porosity and permeability data demonstrates differences in the average values for limestones and dolomites.

Rock Type	Number of Measurements	Porosity Range (%) (Average)	Permeability Range (md) (Average)
Limestone	115	2.4–19.0 (11.6)	0.03–71.48 (3.752)
Dolomite	42	6.6–25.6 (19.3)	0.07–403.39 (92.8)

Although these numbers may be somewhat skewed because samples with natural fractures are included, the average porosity and permeability values for the dolomites are higher than for the limestones. That is, overall, dolomitization acted to enhance the reservoir potential of the shoal and shoal flank grainstones and packstones. The intercrystalline pores that developed during dolomitization probably account for the improved pore system properties. In particular, the dolomitized shoal/shoal flank grainstones between 2497.5 and 2532.4 feet (in the Krider unit) form one of the thickest high porosity, high permeability zones encountered throughout the series of cored wells from Hugoton Field. At this location, the enhanced pore system appears to reflect better development of intercrystalline pores (i.e., a diagenetic variation), compared to the Krider strata in the other wells.

Calcite cement is the principal pore-filling constituent in the limestone portions of this facies (Figures 12 and 20). Where the strata grade from grainstone to packstone, lime micrite becomes an important pore-filling phase (Figures 13 and 18). Patchy anhydrite cement/replacement also plays a role in porosity reduction. In the dolomite portions of this facies, dolomite cement, anhydrite cement, dolomitized micrite matrix and calcite cement are the main pore-filling constituents (Figures 7 through 9 and 25).

In the limestones, the highest porosity and permeability values occur where grainstone (matrix-free) textures result in well developed networks of **intergranular** pores (Figure 22). In other intervals **intraskkeletal** pores (within bryozoans, foraminifera, calcareous algae and other skeletal constituents) and **moldic** pores (where grains have been partially to completely leached) account for most of the macropores. Microporous micritic grains and matrix contribute little to the effective pore network, but sometimes account for a large portion of the total pore volume (Figures 13 and 18). Some of the limestones that have high porosity but low permeability have only poorly interconnected moldic and intraskkeletal pores and/or microporosity (Figures 12 and 15). Lower porosity and permeability values generally occur where calcite cement is extensive and/or where lime mud infills the interstitial areas.

In the dolomites, higher porosity values typically occur in association with a combination of: 1) intercrystalline pores, 2) relict intergranular pores, and 3) moldic pores (Figures 7 through 9 and 28). Matrix-selective dolomitization has locally enhanced reservoir potential by creating intercrystalline pores that improved pore interconnection (Figures 10 and 26). Overall, the grain-rich limestones and dolomites of the carbonate shoal/shoal flank facies are judged to have **poor to very good** reservoir potential, with the dolomite portions generally having higher porosity and permeability. In addition, local fracture development can substantially enhance the reservoir potential of these deposits.

Interpretation:

The grain-rich textures, along with the wide assortment of skeletal debris and other carbonate allochems indicate high-energy sedimentation in a shallow marine, carbonate shoal to shoal flank environment. The general paucity of matrix material reflects persistent wind, wave, and/or tide-driven currents. These deposits probably formed as bars in shallow subtidal settings. The geometries of these bars are difficult to determine without examining facies in a number of closely spaced wells. Sandbody geometry in carbonate shoals depends on tidal range, orientation of impinging currents, underlying bathymetry, and sea level fluctuations.

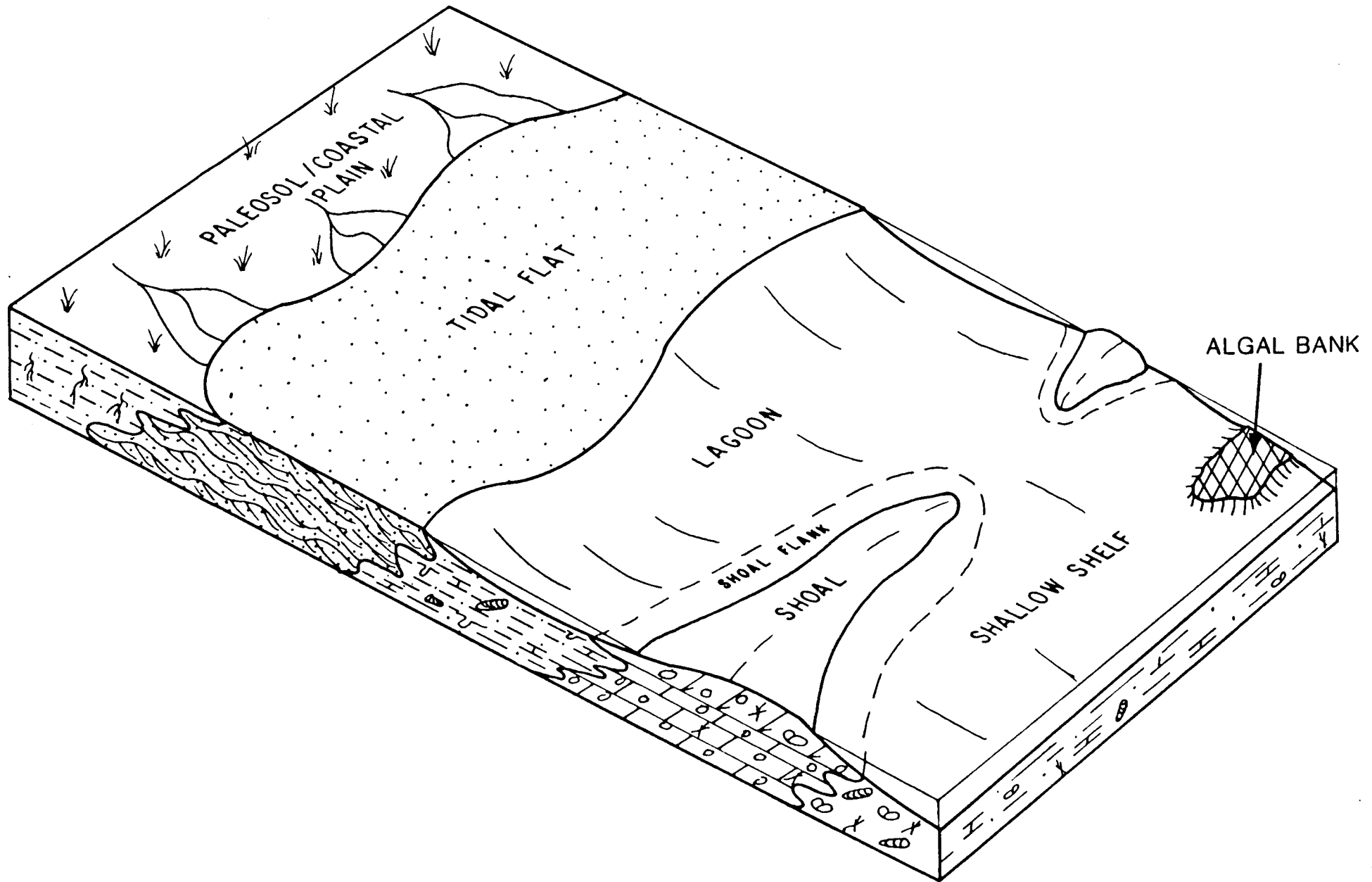
Depositional Model

An idealized depositional model for these deposits is presented in Diagram 1. Paleosol/coastal plain facies record terrestrial sedimentation, above normal high tide. Comparatively, the tidal flat facies is the product of intertidal and shallow subtidal deposition. Although tidal flat deposits tend to form belts that parallel the coastline, lateral facies migration in response to progradation and sea level fluctuations may yield broad, sheet-like lithosomes of this reservoir facies. Both the paleosol/coastal plain facies and the tidal flat facies should thin down depositional dip, where subtidal marine (more carbonate-rich) strata will predominate.

The lagoon/shallow shelf facies records low-energy, shallow subtidal sedimentation. These deposits may have formed in backshoal environments (lagoonal settings), as well as seaward of, and peripheral to, offshore carbonate shoals (shallow shelf areas). The faunal assemblage, depositional texture, and frequent gradations into tidal flat deposits indicate somewhat restricted, quiet water lagoon conditions for portions of this facies. Other parts of this facies have a slightly more diverse faunal assemblage and grade directly into shoal flank and shoal deposits, probably recording shallow shelf sedimentation. The algal bank deposits are considered to be a "subfacies" of the shallow shelf facies. These phylloid algal-dominated strata may have formed as a low relief organic bank on a shallow shelf. Although most of these phylloid algal-rich micritic strata were deposited with rather low porosity and permeability, diagenetic alterations and fracture development have dramatically enhanced the reservoir potential of this subfacies.

The carbonate shoal and shoal flank deposits are the product of high to medium energy sedimentation in areas with persistent currents. These deposits formed as carbonate sand bars. It is difficult to determine the sandbody geometry of the individual shoals without examining a series of closely spaced wells. These bars may have formed as either strike-oriented or dip-oriented sandbodies. The development

DIAGRAM 1
IDEALIZED DEPOSITIONAL MODEL



of lagoonal deposits suggests that at least some of these bars formed as strike-oriented barriers, in that they appear to have limited circulation between backshoal lagoon and shelf waters.

The stratigraphic sequence observed in the core reflects numerous progradational and retrogradational cycles that are the product of sea level fluctuations. This is recorded by the interfingering of the various depositional facies identified in the core. One of the byproducts of this type of cyclic sedimentation is the "stacking" of potential reservoir facies. For example, there are eleven tidal flat units and eighteen carbonate shoal/shoal flank intervals (as well as one algal bank unit), each separated by low porosity, low permeability paleosol/coastal plain or lagoon/shallow shelf deposits.

Petrography and Diagenesis

This section of the report presents the results of detailed petrographic analysis of 20 samples from the Anadarko Petroleum Corporation Flower A-1 well. In addition, diagenetic alterations that influence porosity and permeability are considered. These samples are broadly divided into two categories, Sandstone/Siltstone Samples and Carbonate Samples.

Sandstone/Siltstone Samples:

Five sandstone/siltstone samples were subjected to detailed petrographic analysis (Table 2). All of these are from the tidal flat facies. Four of the samples are siltstones with average grain size in the range of 0.039 to 0.062 mm (coarse silt). The fifth sample has an average grain size of 0.080 mm, in the range of lower very fine sand. The sand and silt grains are well or very well sorted. Although siliciclastic matrix is generally uncommon (0-2.8%), some of the samples do contain calcite and/or dolomite matrix (0-11.2%). In the "nonmatrix-rich" samples, sorting estimates and the amount of matrix material indicate that these sandstones and siltstones probably had initial porosities in the range of 35% to 42%. Minus cement porosities are now in the range of 30% to 40%, suggesting a loss of perhaps 3 to 10 porosity units can be attributed to compaction. This is consistent with **slight to moderate** compaction. **Angular** and **subangular** grain shapes predominate. This is a common attribute of fine-grained rocks such as these, and the angular shapes are generally not taken as a reliable indicator of energy conditions at the time of deposition, or as a means for evaluating the distance from the source area.

Quartz grains (22.4-46.4%) are the principal framework constituents in all of these samples. Potassium feldspar (1.2-4.0%) and plagioclase feldspar (1.6-12.0%) are also relatively common. One of the samples (from 2618.1 feet) has an abundance of carbonate grains. Minor to trace amounts of chert, metamorphic rock fragments, heavy minerals, fossils/carbonate grains, argillaceous rock fragments and mica are present

in nearly all of the samples. Based on the relative proportions of quartz, feldspar and rock fragments, most of these sandstones and siltstones can be classified as **subarkoses** and **arkoses**. X-ray diffraction analysis of the sandstone/siltstone samples show the following mineralogic compositions: quartz (31–73%), potassium feldspar (0–9%), plagioclase feldspar (0–16%), calcite (0–23%), dolomite (1–39%), anhydrite (0–24%), and clay minerals (2–6%)(Table 3). In general, petrographic observations are consistent with X-ray diffraction data. Most of the differences arise from the "patchy" distribution of carbonate cements and anhydrite. For example, the sample from 2473.6 feet has more anhydrite in X-ray diffraction than in thin section. In this case, patchy anhydrite cement is apparently underrepresented in the thin section sample. Some of the other differences could be due to the limitations in distinguishing matrix material from its associated microporosity with the petrographic microscope. In addition, some of the discrepancies are probably attributed to the inherent differences in comparing volume (from point count analysis) with weight percent (from X-ray diffraction).

The principal pore-filling constituents in the sandstone/siltstone samples are anhydrite cement (0–14.0%), dolomite cement (0.8–18.0%), calcite cement (0–14.0%), dolomite matrix (0–8.0%), calcite matrix (0–3.6%), and matrix clay (0–2.8%). In addition, quartz cement (0.8–4.0%), authigenic clay (0–3.2%), and feldspar cement (0.8–2.0%) are present (Table 2). Minor to trace amounts of iron oxide cement and pyrite cement were also observed. The main controls on porosity and permeability in the sandstone/siltstone samples are 1) the amount of matrix material, and 2) the amount of carbonate and anhydrite cements. SEM analysis and X-ray diffraction analysis of the clay fraction could better determine the effect that clay minerals have on porosity, permeability and reservoir potential.

Point count data indicate that both intergranular pores (6.8–16.8%) and secondary leached grain pores (0.8–3.6%) are present. In most of the samples, primary intergranular pores account for roughly 90% of the macropore volume. The sample from 2473.6 feet differs in that there is a relative abundance of secondary leached

grain pores, mostly from dissolved carbonate grains. The range in permeability values in these sandstone/siltstone samples (from 0.362 to 132 md) largely reflects variations in the amount and distribution of primary intergranular pore space. Where the network of primary intergranular pores is well preserved, permeabilities tend to be high. Where matrix material, carbonate cements and/or anhydrite cement are abundant permeabilities and porosities are low.

Carbonate Samples:

A total of 15 carbonate samples were analyzed in detail. Most of the samples are packstones or grainstones from the shoal/shoal flank facies. Four of the samples are dolomites, and eleven are limestones or dolomitic limestones.

Dolomites:

Of the four dolomite samples, three are grainstones/packstones, and one is a wackestone/mudstone. All four samples are from the Krider Zone, between 2505.4 and 2531.1 feet. Based on the size and shape of the framework grains, oncoids and peloids appear to be the main allochemical constituents; prior to dolomitization, these strata probably resembled many of the limestones identified in other parts of this core.

The pore systems in the dolomitized grainstones and packstones typically contain a mixture of: 1) moldic pores, 2) intercrystalline pores, and 3) varying amounts of relict intergranular pore space. Intercrystalline pores appear to be an important component of the pore system in that they facilitate interconnection of other pore types and enhance permeability (Figures 7 through 9 and 25). Dolomitization of the wackestone sample also resulted in the development of intercrystalline pore space (Figures 10 and 26). Although dolomitization also improved the reservoir potential of what had been a low porosity, low permeability micritic rock, the resultant small intercrystalline pores, narrow pore apertures and tortuous pore system yield only fair reservoir potential. **Overall, dolomitization acted to enhance reservoir potential.**

Limestones:

All eleven limestone samples are grainstones or packstones. Ten of the samples are from the shoal/shoal flank facies, and one is from the algal bank subfacies. Most of the shoal/shoal flank deposits contain a mixture of peloids, skeletal debris, oncoids and intraclasts. The bioclastic constituents include: bryozoans, brachiopods, echinoderms, foraminifera, calcareous algae, ostracodes and pelecypods. One of the samples (from 2891.4 feet – Figure 22) is dominated by well sorted peloids and foraminifera, while most of the other samples contain a more diverse assemblage of allochems and a wide range in grain size. The limestone from 2556.1 feet (Figure 12) has admixed feldspar and quartz grains.

Most of the shoal/shoal flank grainstones and packstones have reduced intergranular pore systems. Calcite cement and/or detrital carbonate matrix typically occlude many of the intergranular areas. Moldic pores from skeletal grains and intraskeletal pores (within the ultrastructure of foraminifera, bryozoans and calcareous algae) are also common. In addition to these macropores, microporosity is present in altered micritic grains and matrix. In some of the samples (for example at 2877.1 feet – Figure 21), microporosity may account for most of the measured pore volume.

In the sample from 2891.4 feet (Figure 22), a well sorted peloid–foram grainstone, most of the blocky calcite spar occurs in distinct patches. Although the resultant pore network is somewhat heterogeneous, the open intergranular pores yield a rock with relatively high permeability (48.7 md). The sample from 2949.8 feet is from the phylloid algal–bearing algal bank facies (Figures 24 and 28). This rock has a somewhat unusual texture that developed from a complex depositional and diagenetic history; the texture developed in response to 1) the sheltering of compaction by large plates of phylloid algae, 2) dissolution of the algal plates, and 3) "collapse" and brittle deformation of the unstable moldic pores. These factors combined to form a rock with: 1) patches of preserved intergranular pore space (Figure 24,B) in sheltered areas, 2) moldic pores from leached phylloid algae, and 3) fracture pores that developed due to brittle deformation. This pore structure yields a rock with very good reservoir potential.

In particular, the small natural fractures and brecciated fabric locally combine to form rocks with permeability in excess of 1 darcy.

COMPARISON OF THE
ANADARKO PETROLEUM CORP. FLOWER A-1 WELL,
ANADARKO PETROLEUM CORP. DUNNE-HOFFMAN "K" 3-H WELL,
ANADARKO PETROLEUM CORP. YOUNGREN "J" 1-H WELL,
&
ANADARKO PETROLEUM CORP. CORNELL UNIVERSITY "C" 1-H WELL

This section of the report provides a comparison of some of the important observations and conclusions obtained from geological analysis of conventional cores from the Anadarko Petroleum Corporation Flower A-1 well, the Anadarko Petroleum Corporation Dunne-Hoffman "K" 3-H well and the Anadarko Petroleum Corporation Youngren "J" 1-H well, all located in Stevens County, Kansas, and the Anadarko Petroleum Corporation Cornell University "C" 1-H well, located in Morton County, Kansas. All four of these cores are from Hugoton Field.

1. A total of 553.8 feet of conventional core (Wellington through Council Grove C) were analyzed from the Flower well, while 264.5 feet of conventional core (Krider through Florence) were analyzed from the Cornell well, 485.6 feet of conventional core (Herington through Council Grove B5) were analyzed from the Youngren well, and 448.2 feet of conventional core (Wellington through Council Grove B1) were analyzed from the Dunne-Hoffman well.

2. The same four principal depositional facies were delineated in all four cores. These are: 1) **paleosol/coastal plain**, 2) **tidal flat**, 3) **lagoon to shallow shelf**, and 4) **carbonate shoal to shoal flank**. In addition, a distinct subfacies of the lagoon to shallow shelf facies was delineated in the Flower A-1 well; these phylloid algal-bearing strata, which are interpreted as **algal bank** deposits, are not present in the other three wells. Subtle differences in facies terminology used for these four wells reflect refinement of sedimentological concepts based on the expanded database. Although the same four depositional facies are present in all four wells, there are differences in the relative proportions of these deposits:

Depositional Facies	% of Cored Strata Cornell University "C" 1-H Well	% of Cored Strata Youngren "J" 1-H Well	% of Cored Strata Dunne-Hoffman "K" 3-H Well	% of Cored Strata Flower A-1 Well
Paleosol/ Coastal Plain	28	26	17	32
Tidal Flat	29	18	16	15
Lagoon to Shallow Shelf	22	20	23	23
Algal Bank Subfacies	0	0	0	~1
Carbonate Shoal to Shoal Flank	21	36	44	29

There appear to be trends in the relative proportions of these four facies. For example, there is an overall decrease in the amount of siliciclastic-dominated strata (i.e., paleosol/coastal plain and tidal flat facies), from the Cornell (57%) to the Youngren (43%) to the Dunne-Hoffman (33%). At the same time there is an increase in the relative abundance of shoal to shoal flank deposits. In the Flower well, the paleosol/coastal plain facies alone accounts for nearly 1/3 of the recovered core. Together, the paleosol/coastal plain and tidal flat facies account for 47% of the recovered core, while the shoal/shoal flank facies accounts for only 29%. Only the Cornell well recovered more total siliciclastic strata (paleosol/coastal plain and tidal flat) and less shoal/shoal flank strata. The lagoon to shallow shelf facies appears to consistently account for 20% to 25% of the recovered core. It may be important to track these types of variations because nearly all of the deposits with reservoir potential are in the tidal flat and carbonate shoal to shoal flank facies. Among the four wells analyzed to date, the combined tidal flat and carbonate shoal/shoal flank strata account for 50% of the Cornell core, 54% of the Youngren core strata, 60% of the Dunne-Hoffman core strata and only 44% of the Flower core strata.

3. Routine core analysis data show variations in porosity and permeability values by facies among the four cored wells (see Table 5 on next page). It should be noted that the conventional core data from the Cornell well were derived from plug analysis, while the core analysis data for the Youngren, Dunne-Hoffman

TABLE 5

**COMPARISON OF CORE ANALYSIS DATA FROM
ANADARKO PETROLEUM CORPORATION WELLS
HUGOTON FIELD, KANSAS**

Depositional Facies	Cornell University "C" 1-H Well		Youngren "J" 1-H Well		Dunne-Hoffman "K" 3-H Well		Flower A-1 Well	
	Porosity Range* (%) (Average*)	Permeability Range* (md) (Average*)	Porosity Range* (%) (Average*)	Permeability Range* (md) (Average*)	Porosity Range* (%) (Average*)	Permeability Range* (md) (Average*)	Porosity Range* (%) (Average*)	Permeability Range* (md) (Average*)
Paleosol/ Coastal Plain	7.8-21.5 (13.2)	0.010-25.499 (1.169)	0.7-15.1 (6.4)	0.009-4.027 (0.327)	0.7-11.8 (4.3)	0.016-0.859 (0.199)	0.6-17.6 (9.4)	0.013-2.638 (0.173)
Tidal Flat	7.4-20.2 (13.9)	0.011-34.668 (2.848)	1.0-23.9 (12.9)	0.01-180.447 (10.4)	1.63-24.2 (8.8)	0.020-173.730 (5.43)	1.3-24.9 (12.5)	0.03-97.63 (8.13)
Lagoon to Shallow Shelf	3.8-19.9 (11.9)	0.002-22.244 (1.132)	0.5-12.9 (6.7)	0.01-260 (0.340)	0.8-19.8 (5.8)	0.010-7.880 (0.523)	0.7-19.3 (8.5)	0.01-5.08 (0.266)
Algal Bank Subfacies	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	9.8-16.0 (12.3)	2.97-2568.40 (554)
Carbonate Shoal/ Shoal Flank	3.2-26.8 (11.1)	0.005-52.351 (1.601)	2.1-30.8 (12.6)	0.04-88.5 (4.51)	0.7-34.3 (15.2)	0.020-274.650 (15.3)	2.4-25.6 (13.7)	0.03-403.39 (27.6)

* Excluding data from artificially fractured samples.

and the Flower wells were determined on full diameter core samples. Overall, the full diameter porosity and permeability data for the Youngren, Dunne-Hoffman and Flower wells appear to better reflect both the observed pore system properties and the differences among the four facies. That is, in all four wells the tidal flat and carbonate shoal/shoal flank facies clearly have better reservoir potential than the paleosol/coastal plain and lagoon to shallow shelf deposits. This is less apparent in the plug data from the Cornell well.

4. The average permeability for the carbonate shoal/shoal flank facies in the Flower well is much higher than the average values obtained for this facies in the other three wells (Table 5). **This largely reflects unusually good porosity and permeability development in the dolomitized Krider unit in the Flower well. This interval contains nearly 25 feet of dolomitized grainstone/packstone with permeability values in excess of 100 md. This unit stands out as one of the thickest, best developed porosity/permeability units encountered in this suite of wells.** Heterogeneously distributed natural fractures may slightly skew some of the average permeability values.
5. The algal bank subfacies identified in the Flower well has an average permeability of 554 md. Although these limestone deposits account for only about 1% of the cored strata, the brittle deformation and fracture development identified in these phylloid algal-rich deposits yield strata with very good to excellent reservoir potential. This facies was not identified in the other three cores, including the correlative interval in the Youngren well. The absence of similar deposits in the equivalent strata in the Youngren well may indicate patchy development of the algal bank facies, making it an elusive reservoir target.
6. Comparing the deposits over equivalent stratigraphic intervals yields several observations.

- The dolomitized strata in the Krider interval of the Flower well has better porosity and permeability than the equivalent strata in the other three wells. In particular, the Krider interval in the Flower well is significantly better than the equivalent unit in the Cornell well. The Krider deposits in the Flower well show somewhat better development of moldic and intercrystalline pores.

- The Towanda carbonates in the Flower well contain grainstones and packstones that are dominated by peloids, oncoids and skeletal debris. The equivalent Towanda strata in the Dunne–Hoffman, Cornell and Youngren wells are ooid–dominated grainstones. In the three wells where ooids are the dominant grain type, oomoldic pores and intergranular predominate. By comparison, the Towanda carbonate strata in the Flower well has a pore system that consists of intergranular, intraskeletal and biomoldic macropores. This change in pore structure affects porosity, permeability and petrophysical properties. Specifically, saturations exponents determined for the Dunne–Hoffman, Youngren and Cornell wells in the Towanda carbonates are probably not applicable in the Flower well. The new measurements of m and n should be used for log evaluation of the Towanda carbonate in the Flower well.

- The Upper Ft. Riley carbonates in the Flower well have better reservoir potential than equivalent strata in the Dunne–Hoffman and Youngren wells. Some of this may be due to slightly more extensive dolomitization and the associated porosity enhancement.

- The Council Grove B2 strata in the Flower well have better porosity and permeability development than the thinner, more micrite–rich equivalent deposits in the Youngren well. Similar observations hold true for the carbonate strata in the Council Grove B4 interval.

- The phylloid algal–rich deposits identified in the Council Grove B5 interval of the Flower well are not present in the equivalent interval in the Youngren well. This high permeability unit in the Flower well has very good to excellent reservoir potential.

TABLE 1**STRATIGRAPHIC UNITS****ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL***

Stratigraphic Unit	Log Depth (ft)†
Wellington	? - 2469
Herington	2469 - 2494
Krider	2494 - 2537
O'Dell	2537 - 2548
Winfield Sand	2548 - 2567
Winfield Dolomite	2567 - 2587
Gage	2587 - 2612
Towanda Dolomite	2612 - 2656
Holmesville	2656 - 2673
Upper Ft. Riley	2673 - 2710
Lower Ft. Riley	2710 - 2732
Upper Florence	2732 - 2741
Lower Florence	2741 - 2762
Wreford	2762 - 2790
Council Grove A	2790 - 2864
Council Grove B1	2864 - 2888
Council Grove B2	2888 - 2914
Council Grove B3	2914 - 2925
Council Grove B4	2925 - 2944
Council Grove B5	2944 - 2963
Council Grove C	2963 - ?

* Unit tops provided by Anadarko Petroleum Corporation.

† Log Depth = Core Depth + 2 Feet

TABLE 2

SANDSTONE THIN SECTION POINT COUNT DATA

**ANADARKO PETROLEUM CORPORATION
FLOWER A-1 WELL
STEVENS COUNTY, KANSAS**

<u>Depth (ft)</u>	<u>2473.6</u>	<u>2485.2</u>	<u>2550.5</u>	<u>2618.1</u>	<u>2658.7</u>
<u>Stratigraphic Unit</u>	Herington	Herington	Winfield Sand	Towanda	Holmesville
<u>WWRC#</u>	52417 : 471	62414 : 71	61324 : 761	62416 : 341	62415 : 43
<u>Texture</u>					
Average Grain Size (mm)	LVF Sand (0.080 mm)	Coarse Silt (0.049 mm)	Coarse Silt (0.055 mm)	Coarse Silt (0.062 mm)	Coarse Silt (0.039 mm)
Sorting	Well	Well	Very Well	Well	Well
<u>Framework Grains</u>					
Quartz	22.4%	46.4%	38.4%	35.2%	43.2%
Plagioclase Feldspar	1.6	5.6	10.4	4.4	12.0
Potassium Feldspar	1.2	3.2	3.6	1.6	4.0
Chert	0.8	2.0	1.6	--	--
Metamorphic Rock Fragments	--	1.6	1.2	1.2	0.8
Heavy Minerals	--	1.2	0.8	--	0.8
Fossils/Carbonate Grains	4.4	0.4	--	20.0	5.2
Argillaceous Rock Fragments	0.4	1.6	1.6	0.4	--
Mica	0.4	1.2	0.8	--	1.6
<u>Pore-Filling Constituents</u>					
Matrix Clay	--%	0.4%	2.8%	--%	Tr%
Matrix Calcite	--	--	--	3.6	3.2
Matrix Dolomite	8.0	--	--	4.0	8.0
Calcite Cement	--	--	1.2	14.0	0.8
Dolomite Cement	18.0	0.8	1.6	1.2	0.8
Anhydrite Cement	14.0	10.8	8.8	0.8	--
Quartz Cement	2.0	4.0	2.8	2.4	0.8
Authigenic Clay	--	1.2	3.2	--	Tr
Feldspar Cement	1.2	1.6	2.0	1.2	0.8
Iron Oxide Cement	--	--	0.4	--	--
Pyrite Cement	--	--	--	--	0.8
<u>Grain Replacements</u>					
Calcite	--%	--%	0.4%	0.4%	--%
Dolomite	15.2	--	--	0.8	4.4
Anhydrite	Tr	2.8	--	1.2	--
Clay	--	--	--	--	--
<u>Pore Space</u>					
Intergranular	6.8%	13.6%	16.8%	6.8%	11.2%
Leached Grain	3.6	1.6	1.6	0.8	1.6
<u>Measured Porosity(%)</u>	9.3	20.8	24.3	14.3	17.9
<u>Measured Permeability(md)</u>	0.362	48.2	132.	1.96	1.66

TABLE 3

MINERALOGICAL ANALYSIS BY X-RAY DIFFRACTION

ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL STEVENS COUNTY, KANSAS

Mineralogy of Whole Rock Sample

Relative Abundance in Percent

Depth (ft)	Unit	Qtz	Ksp	Plag	Cal	Dol	Anh	Pyr	Clay	Total	Gd	
2473.6	HER	31	0	0	0	39	24	0	6	100	2.80	
2485.2	HER	69	4	5	0	1	16	0	5	100	2.69	Ank
2505.4	KRI	0	0	0	0	100	0	0	0	100	2.85	Ank
2515.8	KRI	0	0	0	0	99	1	0	0	100	2.85	Ank
2526.1	KRI	0	0	0	0	89	11	0	0	100	2.86	
2531.1	KRI	9	2	1	4	80	1	1	2	100	2.81	Ank
2550.5	WS	58	7	16	2	1	13	0	3	100	2.68	Ank
2556.1	WS	3	24	7	31	0	35	0	0	100	2.74	
2579.4	WD	0	0	0	61	1	38	0	0	100	2.80	Ank
2618.1	TOW	60	6	7	23	0	2	0	2	100	2.66	
2627.4	TOW	4	7	0	88	0	1	0	0	100	2.70	
2641.1	TOW	3	0	0	78	0	19	0	0	100	2.75	
2658.7	HLM	73	9	8	0	5	0	0	5	100	2.65	Ank
2681.7	UFR	4	0	0	61	7	28	0	0	100	2.78	Ank
2700.5	UFR	6	5	1	57	12	19	0	0	100	2.76	Ank
2772.5	WRE	4	0	0	77	0	19	0	0	100	2.75	
2877.1	CGB1	3	0	0	95	2	0	0	0	100	2.71	Ank
2891.4	CGB2	1	0	0	79	0	20	0	0	100	2.75	
2932.5	CGB4	3	0	0	97	0	0	0	0	100	2.71	
2949.8	CGB5	0	0	0	100	0	0	0	0	100	2.71	
	Min	0	0	0	0	0	0	0	0		2.65	
	Max	73	24	16	100	100	38	1	6		2.86	
	Avg	17	3	2	43	22	12	0	1		2.75	

KEY:

HER = Herington

KRI = Krider

WS = Winfield Sand

WD = Winfield Dolomite

TOW = Towanda

TOW = Towanda

HLM = Holmesville

UFR = Upper Ft. Riley

WRE = Wreford

CGB1 = Council Grove B1

CGB2 = Council Grove B2

CGB4 = Council Grove B4

CGB4 = Council Grove B5

Qtz = quartz

Ksp = K-feldspar

Plag = plagioclase

Cal = calcite

Dol = dolomite

Anh = anhydrite

Pyr = pyrite

Clay = total clay

Gd = calculated grain density

Ank = contains ankerite/ferroan dolomite

TABLE 4
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
1	2,441.5	1.0	0.17	0.10	< 0.01	94.3	0.0	2.94	1
2	2,442.5	0.6	0.04	0.04	< 0.01	86.6	0.0	2.95	1
3	2,443.5	10.1	0.03	0.03	< 0.01	97.2	0.0	2.81	1
4	2,444.5	10.4	7.90 F			95.4	0.0	2.72	1
5	2,445.5	0.6	0.05	0.03	< 0.01	66.8	0.0	2.94	1
6	2,446.5	1.0	0.03	0.03	< 0.01	78.5	0.0	2.93	1
7	2,447.5	1.4	0.02	0.02	< 0.01	68.9	0.0	2.90	1
8	2,448.5	4.6	8.41 F	0.06	< 0.01	95.6	0.0	2.84	1
9	2,449.5	11.5	1.612 F		0.019	94.3	0.0	2.80	1
10	2,450.5	13.6	*	*	0.02	92.8	0.0	2.75	1
11	2,451.5	11.8	*	*	0.02	97.8	0.0	2.78	1
12	2,452.5	13.2	20.35 F	6.11	0.06	96.6	0.0	2.79	1
13	2,453.5	7.5	0.06	0.06	0.02	48.3	0.0	2.83	1
14	2,454.5	7.7	0.021			96.3	0.0	2.81	1
15	2,455.5	11.9	*	*	0.23	91.6	0.0	2.76	1
16	2,456.5	9.4	0.10	0.09	0.06	48.6	0.0	2.85	1
17	2,457.5	7.4	0.08	0.05	0.02	68.6	0.0	2.84	1
18	2,458.5	5.5	0.15	0.08	0.02	71.0	0.0	2.87	1
19	2,459.5	7.4	0.15	0.10	0.10	56.9	0.0	2.87	1
20	2,460.5	10.1	0.46	0.34	0.55	69.7	0.0	2.82	1
21	2,461.5	15.9	6.05 F	2.12	0.56	75.4	0.0	2.71	1
22	2,462.5	15.9	0.16			90.7	0.0	2.75	1
23	2,463.5	12.3	5.61 F	4.31	0.04	84.3	0.0	2.80	1
24	2,464.5	14.6	1.862 F		4.42	96.4	0.0	2.72	1
25	2,465.5	9.9	12.967 F	0.097	15.295	87.4	0.0	2.74	1
26	2,466.5	14.5	0.079			91.5	0.0	2.73	1
27	2,467.5	7.5	0.264 F	0.089	0.104	92.2	0.0	2.81	1
28	2,468.5	6.1	*		*	91.3	0.0	2.82	1
29	2,469.5	2.8	*		*	93.8	0.0	2.77	1
30	2,470.5	11.0	0.48	0.43	0.52	31.5	0.0	2.81	2
31	2,471.5	8.1	0.53	0.50	0.25	21.8	0.0	2.83	2
32	2,472.5	11.2	1.69	1.56	0.21	23.7	0.0	2.79	2
33	2,473.5	11.1	2.08	1.51	0.71	23.5	0.0	2.80	2
34	2,474.5	13.0	0.97	0.97	0.12	24.7	0.0	2.80	2
35	2,475.5	13.0	2.74	2.54	1.51	21.0	0.0	2.80	2
36	2,476.5	12.1	1.82	1.68	0.12	43.0	0.0	2.75	2
37	2,477.5	9.3	*			96.3	0.0	2.74	2
38	2,478.5	15.4	15.80 F	6.47	0.36	93.2	0.0	2.69	2
39	2,479.5	12.3	*			97.8	0.0	2.70	2
40	2,480.5	14.0	0.44	0.39	0.08	54.3	0.0	2.75	2

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
41	2,481.5	16.4	3.79	3.68	2.02	47.5	0.0	2.75	2
42	2,482.5	19.6	6.70	6.44	0.26	69.4	0.0	2.69	2
43	2,483.5	6.9	0.92	0.36	0.17	66.9	0.0	2.83	2
44	2,484.5	24.9	79.72	64.59	78.30	55.9	0.0	2.69	2
45	2,485.5	21.0	36.09	35.65	8.74	47.6	0.0	2.72	2
46	2,486.5	20.7	16.54	14.72	7.21	48.8	0.0	2.73	2
47	2,487.5	12.2	0.054		0.017	96.0	0.0	2.73	2
48	2,488.5	6.1	*			98.0	0.0	2.80	2
49	2,489.5	12.0	*			92.8	0.0	2.82	3
50	2,490.5	12.4	24.07 F	0.10	0.07	81.9	0.0	2.83	3
51	2,491.5	9.8	0.77	0.30	0.13	53.8	0.0	2.81	3
52	2,492.5	8.8	0.07	0.07	< 0.01	87.1	0.0	2.80	3
53	2,493.5	8.3	0.17	0.14	0.01	69.8	0.0	2.80	3
54	2,494.5	10.0	0.12	0.10	0.01	70.6	0.0	2.76	3
55	2,495.5	9.8	0.05	0.05	0.02	68.0	0.0	2.79	3
56	2,496.5	12.7	0.38	0.36	0.09	46.4	0.0	2.84	3
57	2,497.5	11.8	0.28	0.15	0.05	47.6	0.0	2.84	3
58	2,498.5	14.3	0.64	0.63	0.10	41.8	0.0	2.84	4
59	2,499.5	20.4	7.13	6.56	6.70	32.1	0.0	2.85	4
60	2,500.5	20.6	20.32	19.69	26.26	29.4	0.0	2.86	4
61	2,501.5	6.6	2.12	1.23	1.31	41.1	0.0	2.91	4
62	2,502.5	21.6	83.75	76.61	196.55	43.4	0.0	2.84	4
63	2,503.5	22.6	287.80	220.51	422.01	38.0	0.0	2.85	4
64	2,504.5	23.0	310.73	299.26	140.08	33.9	0.0	2.85	4
65	2,505.5	21.8	130.07	127.95	106.77	36.4	0.0	2.84	4
66	2,506.5	14.6	17.93	17.78	6.42	39.3	0.0	2.84	4
67	2,507.5	24.6	403.39	401.87	464.65	38.7	0.0	2.84	4
68	2,508.5	21.6	120.80	119.89	107.87	41.3	0.0	2.84	4
69	2,509.5	20.4	43.31	41.97	18.63	29.1	0.0	2.84	4
70	2,510.5	19.8	44.29	42.12	23.36	35.3	0.0	2.84	4
71	2,511.5	23.2	142.22	133.04	137.95	38.4	0.0	2.85	4
72	2,512.5	22.5	70.25	69.34	60.48	28.8	0.0	2.84	4
73	2,513.5	23.3	126.84	119.76	120.03	37.9	0.0	2.85	4
74	2,514.5	23.9	170.07	164.04	128.10	39.6	0.0	2.84	4
75	2,515.5	24.2	347.70	346.46	402.28	36.0	0.0	2.85	4
76	2,516.5	22.7	270.10	231.59	131.13	41.0	0.0	2.85	4
77	2,517.5	22.9	276.72	267.09	168.54	35.3	0.0	2.86	4
78	2,518.5	21.1	120.98	99.00	26.39	37.6	0.0	2.85	4
79	2,519.5	22.8	114.37	102.63	109.71	38.4	0.0	2.84	4
80	2,520.5	18.4	39.99	34.28	33.69	35.0	0.0	2.84	4

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
81	2,521.5	19.0	52.69	47.16	58.21	31.1	0.0	2.85	4
82	2,522.5	23.2	57.15	54.81	55.14	28.3	0.0	2.85	4
83	2,523.5	24.3	92.49	87.22	81.58	33.8	0.0	2.84	4
84	2,524.5	25.6	111.85	111.58	69.42	38.8	0.0	2.84	4
85	2,525.5	24.1	94.52	94.08	84.72	35.9	0.0	2.85	4
86	2,526.5	21.8	93.05	87.96	8.47	28.7	0.0	2.85	4
87	2,527.5	23.7	94.31	90.39	8.41	36.9	0.0	2.84	4
88	2,528.5	25.1	81.98	81.79	49.98	42.2	0.0	2.83	4
89	2,529.5	24.5	64.44	61.04	30.18	40.0	0.0	2.83	4
90	2,530.5	16.6	1.08	0.92	0.33	35.6	0.0	2.81	4
91	2,531.5	20.5	2.44	2.41	1.62	35.8	0.0	2.81	4
92	2,532.5	9.7	0.10	0.10	0.05	77.4	0.0	2.79	1
93	2,533.5	12.0	0.07	²	0.029	99.0	0.0	2.79	1
94	2,534.5	10.1	*	²	*	96.5	0.0	2.78	1
95	2,535.5	13.2	*	²	*	96.1	0.0	2.77	1
96	2,536.5	8.1	11.49 F	0.07	0.02	98.2	0.0	2.73	1
97	2,537.5	8.0	0.055	²	0.015	98.6	0.0	2.72	1
98	2,538.5	9.6	12.481 F	11.069	0.321	98.7	0.0	2.73	1
99	2,539.5	6.2	2.988 F	2.012	0.134	98.1	0.0	2.69	1
100	2,540.5	4.7	23.55 F	1.847	0.019	97.4	0.0	2.67	1
101	2,541.5	7.2	0.313	0.15	0.022	98.6	0.0	2.69	1
102	2,542.5	7.5	0.202	²	0.013	97.6	0.0	2.72	1
103	2,543.5	7.2	0.016	³		91.9	0.0	2.72	1
104	2,544.5	3.7	0.157	0.119	0.01	97.8	0.0	2.68	1
105	2,545.5	11.4	*	²	0.021	96.9	0.0	2.69	1
106	2,546.5	9.8	0.06	0.06	0.009	88.0	0.0	2.75	1
107	2,547.5	17.3	92.05	89.83	91.97	41.4	0.0	2.68	2
108	2,548.5	19.2	78.31	55.52	107.90	48.0	0.0	2.67	2
109	2,549.5	21.6	97.63	³		29.0	0.0	2.68	2
110	2,550.5	19.8	68.39	68.081	61.211	53.9	0.0	2.65	2
111	2,551.5	10.6	0.257	0.224	0.064	87.4	0.0	2.73	2
112	2,552.5	8.4	0.10	0.10	0.04	56.2	0.0	2.69	2
113	2,553.5	8.9	0.15	0.14	0.03	68.1	0.0	2.69	2
114	2,554.5	4.4	0.03	0.03	< 0.01	92.5	0.0	2.69	2
115	2,555.5	8.1	0.05	0.05	0.03	55.3	0.0	2.71	4
116	2,556.5	9.6	0.18	0.17	0.12	45.2	0.0	2.76	4
117	2,557.5	14.0	1.03	0.96	0.09	72.3	0.0	2.72	2
118	2,558.5	13.6	0.45	0.43	0.23	63.5	0.0	2.75	2
119	2,559.5	11.2	1.46	1.43	0.24	47.5	0.0	2.72	2
120	2,560.5	11.9	1.64	0.91	0.18	58.2	0.0	2.74	2

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
121	2,561.5	18.3	14.84	14.50	3.28	48.5	0.0	2.73	2
122	2,562.5	16.8	15.26	14.67	2.97	58.7	0.0	2.71	2
123	2,563.5	17.6	28.42	28.04	6.26	57.0	0.0	2.69	2
124	2,564.5	15.1	7.05	6.91	0.89	58.0	0.0	2.70	2
125	2,565.5	10.4	0.25	0.17	0.05	74.2	0.0	2.72	2
126	2,566.5	9.0	0.68	0.65	0.13	46.7	0.0	2.70	4
127	2,567.5	9.6	0.81	0.81	0.35	45.7	0.0	2.71	4
128	2,568.5	6.7	0.16	0.16	0.07	45.1	0.0	2.69	4
129	2,569.5	13.1	0.26	0.24	0.12	54.8	0.0	2.75	3
130	2,570.5	17.1	0.78	0.74	0.51	51.9	0.0	2.78	3
131	2,571.5	17.0	0.64	0.62	0.41	54.9	0.0	2.81	3
132	2,572.5	7.3	0.05	0.05	0.03	42.9	0.0	2.71	3
133	2,573.5	9.3	0.16	0.16	0.139	44.2	0.0	2.71	4
134	2,574.5	12.2	1.18	1.17	0.90	47.3	0.0	2.70	4
135	2,575.5	11.1	0.20	0.18	0.14	51.1	0.0	2.73	4
136	2,576.5	14.1	2.33	2.11	1.80	46.5	0.0	2.71	4
137	2,577.5	17.5	8.34	8.30	10.87	60.4	0.0	2.71	4
138	2,578.5	16.5	5.76	5.50	8.46	64.5	0.0	2.71	4
139	2,579.5	16.4	6.28	6.28	7.19	60.5	0.0	2.73	4
140	2,580.5	11.6	0.10	0.09	0.08	62.8	0.0	2.76	3
141	2,581.5	9.7	0.09	0.08	0.04	52.4	0.0	2.73	3
142	2,582.5	9.0	1.81	1.66	1.19	53.6	0.0	2.80	4
143	2,583.5	8.1	0.05	0.05	0.02	73.1	0.0	2.74	3
144	2,584.5	14.2	1.27	1.22	0.15	59.8	0.0	2.72	2
145	2,585.5	8.7	0.39	0.23	0.02	86.6	0.0	2.71	2
146	2,586.5	7.1	0.14	0.07	0.03	85.9	0.0	2.70	2
147	2,587.5	11.7	0.09	0.08	0.05	86.0	0.0	2.70	2
148	2,588.5	8.2	0.05	0.05	0.02	85.0	0.0	2.70	2
149	2,589.5	9.2	0.06	0.04	0.04	92.0	0.0	2.68	2
150	2,590.5	9.2	0.04	0.04	0.01	88.0	0.0	2.68	2
151	2,592.5	6.8	5.837 F	1.008	10.031	95.7	0.0	2.69	1
152	2,593.5	7.1	100.032 F		² 0.01	96.4	0.0	2.70	1
153	2,595.5	9.1	14.06 F	4.531	8.753	97.6	0.0	2.72	1
154	2,596.5	10.3	4.20 F ¹	0.801 ¹	0.645 ¹	95.4	0.0	2.69	1
155	2,597.5	9.7	25.138 F	24.915	7.165	95.5	0.0	2.75	1
156	2,598.5	11.0	23.828 F	14.995	2.086	93.9	0.0	2.71	1
157	2,600.5	9.5	0.888 F		² 0.786	94.1	0.0	2.73	1
158	2,601.5	5.9	30.909 F	11.083	0.02	94.9	0.0	2.67	1
159	2,602.5	6.5	11.538 F	7.361	0.071	97.7	0.0	2.71	1
160	2,603.5	6.7	8.857 F	8.106	2.579	95.9	0.0	2.71	1

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
161	2,604.5	9.6	8.217 F	4.72	10.566	96.8	0.0	2.73	1
162	2,605.5	8.8	5.936 F	3.406	0.071	95.4	0.0	2.72	1
163	2,606.5	5.3	3.75 F	3.628	0.025	97.6	0.0	2.67	1
164	2,607.5	7.0	8.002 F	1.613	0.006	96.1	0.0	2.69	1
165	2,608.5	11.7	0.064	0.054	0.017	94.4	0.0	2.69	1
166	2,609.5	12.5	0.127	0.125	0.056	95.4	0.0	2.69	1
167	2,610.5	9.6	0.086	0.063	0.01	97.6	0.0	2.70	1
168	2,611.5	17.5	0.433	0.415	0.254	60.5	0.0	2.71	1
169	2,612.5	16.2	0.483	0.467	0.296	58.6	0.0	2.71	1
170	2,613.5	8.4	*	²	0.092	80.0	0.0	2.72	1
171	2,614.5	8.1	70.18 F	0.08	78.334	85.7	0.0	2.70	2
172	2,615.5	12.3	0.16	0.15	0.05	77.2	0.0	2.70	2
173	2,616.5	11.9	0.094	²	0.479	87.4	0.0	2.62	2
174	2,617.5	14.1	1.87	1.85	1.51	34.8	0.0	2.69	2
175	2,618.5	15.4	1.85	1.84	1.98	38.1	0.0	2.69	2
176	2,619.5	17.5	1.86	1.83	1.51	50.6	0.0	2.68	2
177	2,620.5	14.0	0.87	0.85	0.66	42.1	0.0	2.68	2
178	2,621.5	16.5	1.01	0.96	0.26	52.3	0.0	2.68	2
179	2,622.5	8.3	0.22	0.22	0.12	78.5	0.0	2.70	3
180	2,623.5	8.6	0.06	0.05	0.05	76.4	0.0	2.71	3
181	2,624.5	17.4	1.55	0.95	0.59	62.9	0.0	2.68	3
182	2,625.5	12.6	0.63	0.63	0.46	41.4	0.0	2.70	3
183	2,626.5	14.4	2.18	2.14	2.10	41.4	0.0	2.71	4
184	2,627.5	13.3	1.16	1.11	1.12	47.0	0.0	2.70	4
185	2,628.5	11.7	0.34	0.33	0.10	44.6	0.0	2.71	4
186	2,629.5	11.2	0.12	0.12	0.07	46.0	0.0	2.72	3
187	2,630.5	9.7	0.07	0.07	0.04	65.8	0.0	2.72	3
188	2,631.5	11.6	0.16	0.15	0.07	46.3	0.0	2.72	3
189	2,632.5	13.8	3.77	3.61	4.46	49.2	0.0	2.72	4
190	2,633.5	13.4	5.26	5.21	6.34	50.8	0.0	2.72	4
191	2,634.5	12.1	2.43	2.39	2.70	47.1	0.0	2.70	4
192	2,635.5	10.6	0.10	0.09	0.05	61.0	0.0	2.72	3
193	2,636.5	10.2	0.09	0.08	0.04	65.5	0.0	2.71	3
194	2,637.5	9.5	0.07	0.07	0.03	77.6	0.0	2.71	3
195	2,638.5	15.0	2.65	2.61	2.65	48.2	0.0	2.71	4
196	2,639.5	15.1	3.63	3.61	3.63	51.3	0.0	2.70	4
197	2,640.5	17.6	8.15	7.83	9.80	56.1	0.0	2.70	4
198	2,641.5	18.3	13.07	12.98	17.15	57.0	0.0	2.70	4
199	2,642.5	18.1	9.75	9.66	12.39	60.4	0.0	2.70	4
200	2,643.5	17.4	4.93	4.91	5.65	58.1	0.0	2.70	4

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
201	2,644.5	16.1	1.77	1.76	1.54	50.3	0.0	2.70	4
202	2,645.5	15.1	2.41	2.27	1.81	52.1	0.0	2.71	4
203	2,646.5	11.1	0.26	0.25	0.12	43.3	0.0	2.72	4
204	2,647.5	14.1	4.15	3.75	3.45	53.0	0.0	2.72	4
205	2,648.5	14.3	4.57	4.12	3.56	42.7	0.0	2.73	4
206	2,649.5	12.0	0.37	0.33	0.16	35.8	0.0	2.70	4
207	2,650.5	11.9	0.47	0.44	0.15	44.6	0.0	2.71	4
208	2,651.5	10.3	0.89	0.85	0.36	35.7	0.0	2.76	4
209	2,652.5	11.1	0.69	0.67	0.54	32.5	0.0	2.73	4
210	2,653.5	15.9	0.56	0.56	0.41	38.3	0.0	2.75	3
211	2,654.5	9.9	0.08			63.6	0.0	2.74	3
212	2,655.5	10.5	0.11	0.09	0.03	68.5	0.0	2.74	3
213	2,656.5	16.7	1.40	1.38	0.59	57.8	0.0	2.71	2
214	2,657.5	15.0	0.43	0.43	0.10	70.2	0.0	2.71	2
215	2,658.5	16.2	1.03	1.00	0.24	64.5	0.0	2.71	2
216	2,659.5	16.8	1.31	1.30	0.11	64.4	0.0	2.71	2
217	2,660.5	15.0	0.41		² 0.06	64.8	0.0	2.72	2
218	2,661.5	10.1	0.043		² 0.06	80.0	0.0	2.70	2
219	2,662.5	4.9	*		²	* 92.4	0.0	2.73	2
220	2,663.5	13.0	0.13	0.11	0.07	90.6	0.0	2.72	2
221	2,664.5	12.7	0.13	0.10	0.04	84.0	0.0	2.72	2
222	2,665.5	11.4	1.34	F 0.50	0.06	90.6	0.0	2.70	2
223	2,666.5	20.3	28.04	F 8.05	0.54	98.1	0.0	2.79	1
224	2,667.5	15.4	*		²	* 86.9	0.0	2.72	1
225	2,668.5	13.7	3.48	1.62	0.13	94.8	0.0	2.70	2
226	2,669.5	10.0	0.81	0.21	0.03	90.7	0.0	2.73	2
227	2,670.5	9.0	0.712		² 0.03	87.8	0.0	2.73	2
228	2,671.5	13.5	1.87	0.95	0.09	69.0	0.0	2.75	2
229	2,672.5	15.1	0.088		² 0.116	88.4	0.0	2.70	2
230	2,673.5	18.1	0.33	0.32	0.09	59.9	0.0	2.82	2
231	2,674.5	14.0	0.53	0.52	0.40	47.3	0.0	2.75	4
232	2,675.5	19.0	5.89	5.59	4.14	45.6	0.0	2.79	4
233	2,676.5	11.0	1.36	1.35	1.51	53.9	0.0	2.75	4
234	2,677.5	16.4	2.09	2.06	1.40	46.2	0.0	2.72	4
235	2,678.5	13.4	1.83	1.06	1.52	51.4	0.0	2.72	4
236	2,679.5	12.5	1.99	1.36	0.21	53.3	0.0	2.74	4
237	2,680.5	16.0	0.74	0.69	0.68	39.4	0.0	2.76	4
238	2,681.5	16.1	1.28	1.17	0.96	50.4	0.0	2.72	4
239	2,682.5	17.6	2.28	2.21	2.23	58.2	0.0	2.73	4
240	2,683.5	17.1	2.67	2.67	2.52	62.9	0.0	2.74	4

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
241	2,684.5	14.9	2.83	2.70	2.99	71.5	0.0	2.73	4
242	2,685.5	14.7	1.13	1.08	0.87	53.2	0.0	2.73	4
243	2,686.5	16.2	1.41	1.40	1.36	52.7	0.0	2.72	4
244	2,687.5	16.9	1.53	1.51	1.27	44.7	0.0	2.72	4
245	2,688.5	17.2	1.31	1.30	1.33	44.1	0.0	2.74	4
246	2,689.5	17.2	1.57	1.53	1.42	43.9	0.0	2.73	4
247	2,690.5	15.1	2.41	2.20	2.61	47.9	0.0	2.76	4
248	2,691.5	15.8	2.31	2.26	2.68	46.8	0.0	2.75	4
249	2,692.5	12.5	1.61	1.53	0.87	40.6	0.0	2.78	4
250	2,693.5	14.5	1.38	1.33	1.24	37.0	0.0	2.75	4
251	2,694.5	14.8	0.92	0.90	0.65	35.5	0.0	2.73	4
252	2,695.5	14.4	0.49	0.48	0.40	34.3	0.0	2.75	4
253	2,696.5	14.6	0.48	0.46	0.25	34.1	0.0	2.76	4
254	2,697.5	4.8	0.08	0.06	0.02	42.9	0.0	2.84	4
255	2,698.5	6.1	0.30	0.24	0.10	38.6	0.0	2.82	4
256	2,699.5	12.6	0.33	0.32	0.17	36.8	0.0	2.74	4
257	2,700.5	13.9	0.50	0.50	0.40	37.1	0.0	2.76	4
258	2,701.5	14.4	0.47	0.47	0.35	45.1	0.0	2.74	4
259	2,702.5	13.3	0.39	0.37	0.25	46.5	0.0	2.72	4
260	2,703.5	12.3	0.27	0.25	0.24	48.1	0.0	2.72	4
261	2,704.5	11.6	0.18	0.18	0.10	49.5	0.0	2.73	4
262	2,705.5	9.8	0.10	0.09	0.11	66.3	0.0	2.73	4
263	2,706.5	11.8	0.12	0.11	0.07	64.8	0.0	2.75	4
264	2,707.5	9.9	0.08	0.08	0.04	60.2	0.0	2.73	4
265	2,708.5	10.4	0.08	0.08	0.12	63.3	0.0	2.71	4
266	2,709.5	9.6	0.09	0.08	0.06	77.6	0.0	2.72	4
267	2,710.5	13.9	0.32	0.27	0.17	74.2	0.0	2.74	4
268	2,711.5	12.4	0.10	0.09	0.01	80.0	0.0	2.72	4
269	2,712.5	8.4	0.07	0.06	0.03	72.8	0.0	2.72	4
270	2,713.5	10.5	0.119 F		0.278	75.0	0.0	2.82	3
271	2,714.5	12.5	2.829 F		0.806	60.6	0.0	2.88	3
272	2,715.5	9.2	7.73 F	2.65	0.04	76.9	0.0	2.72	3
273	2,716.5	8.9	4.39 F	1.47	0.01	72.0	0.0	2.69	3
274	2,717.5	8.5	0.36	0.11	0.01	62.2	0.0	2.68	3
275	2,718.5	9.9	0.17	0.08	0.01	63.8	0.0	2.70	3
276	2,719.5	7.0	0.014		0.01	82.0	0.0	2.64	3
277	2,720.5	6.9	1.07 F	0.79	0.01	74.6	0.0	2.67	3
278	2,721.5	8.3	11.88 F	5.25	0.01	79.0	0.0	2.68	3
279	2,722.5	7.2	0.31	0.25	0.01	79.4	0.0	2.66	3
280	2,723.5	7.7	2.93 F	1.83	0.01	82.4	0.0	2.66	3

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
281	2,724.5	8.5	0.28	0.15	0.01	73.8	0.0	2.66	3
282	2,725.5	7.3	0.044		² 0.01	83.0	0.0	2.65	3
283	2,726.5	7.0	0.02	0.02	0.04	86.8	0.0	2.66	3
284	2,727.5	7.1	0.77	0.53	0.03	83.5	0.0	2.66	3
285	2,728.5	9.1			² 1.129	83.4	0.0	2.71	3
286	2,729.5	4.1	0.45 F	0.10	0.07	95.5	0.0	2.66	3
287	2,730.5	6.2	2.45 F	1.56	0.15	88.8	0.0	2.70	3
288	2,731.5	6.0	0.206		² 0.01	89.7	0.0	2.71	3
289	2,732.5	6.0	0.018		² 0.09	74.0	0.0	2.69	3
290	2,733.5	6.4	0.07	0.07	0.10	63.2	0.0	2.69	3
291	2,734.5	9.4	0.14	0.14	0.09	44.9	0.0	2.72	4
292	2,735.5	8.9	0.24	0.24	0.24	32.6	0.0	2.74	4
293	2,736.5	7.0	0.06	0.05	< 0.01	63.3	0.0	2.70	4
294	2,737.5	7.0	0.05	0.04	0.02	64.0	0.0	2.70	4
295	2,738.5	10.6	0.23	0.05	0.08	62.0	0.0	2.68	2
296	2,739.5	10.8	0.30	0.22	0.21	53.9	0.0	2.68	2
297	2,740.5	9.7	0.179		² 0.04	69.1	0.0	2.69	2
298	2,741.5	9.3	0.07	0.06	0.04	84.9	0.0	2.70	2
299	2,742.5	8.9	0.07	0.07	0.08	87.3	0.0	2.67	2
300	2,743.5	7.9	0.08	0.08	0.05	79.6	0.0	2.68	2
301	2,744.5	7.7	0.03	0.02	0.01	99.2	0.0	2.68	2
302	2,745.5	8.5	1.56 F	0.05	0.01	75.7	0.0	2.67	2
303	2,746.5	6.7	5.613 F	5.364	11.40	99.2	0.0	2.69	1
304	2,747.5	8.9	12.495 F	6.395	5.598	89.1	0.0	2.77	1
305	2,748.5	8.3	0.132	0.128	0.008	97.0	0.0	2.73	1
306	2,749.5	8.9	1.975 F		³	92.5	0.0	2.76	1
307	2,750.5	8.4	0.131		³	90.2	0.0	2.76	1
308	2,751.5		*						1
309	2,752.5	4.9	1.285 F	0.13	0.001	96.8	0.0	2.69	1
310	2,753.5	4.9	0.348 F	0.171	0.001	98.4	0.0	2.67	1
311	2,754.5	7.4	0.026		² 0.015	98.3	0.0	2.71	1
312	2,755.5	6.5	3.114 F	2.893	0.005	94.5	0.0	2.71	1
313	2,756.5	7.4	1.355 F	0.996	0.001	96.4	0.0	2.69	1
314	2,757.5	9.3	0.078		² 0.076	96.2	0.0	2.72	1
315	2,758.5	7.8	2.558 F	0.546	0.001	94.3	0.0	2.72	1
316	2,759.5	10.7	15.818 F	15.654	28.832	94.8	0.0	2.78	1
317	2,760.5	7.2	16.45 F	11.643	5.221	98.8	0.0	2.71	1
318	2,761.5	11.2	0.501 F	0.092	0.021	97.6	0.0	2.68	1
319	2,762.5		*						1
320	2,763.5	9.9	0.07	0.06	< 0.01	85.0	0.0	2.74	2

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
321	2,764.5	4.2	0.33	F 0.04	0.02	72.7	0.0	2.69	2
322	2,765.5	10.4	0.17	0.16	0.11	49.8	0.0	2.73	4
323	2,766.5	11.5	0.27	0.27	0.185	49.7	0.0	2.74	4
324	2,767.5	7.9	0.05	0.05	0.04	76.0	0.0	2.72	4
325	2,768.5	6.7	0.05	0.04	0.02	66.5	0.0	2.70	4
326	2,769.5	9.2	0.07	0.07	0.06	58.3	0.0	2.72	4
327	2,770.5	9.5	0.16	0.16	0.11	48.5	0.0	2.72	4
328	2,771.5	9.3	0.34	0.31	0.30	46.0	0.0	2.74	4
329	2,772.5	14.2	14.55	14.53	14.82	31.3	0.0	2.78	4
330	2,773.5	7.5	0.071		² 0.02	69.3	0.0	2.71	3
331	2,774.5	13.7	0.375		1.86	27.5	0.0	2.72	3
332	2,775.5	10.4	0.10	0.09	0.03	73.1	0.0	2.68	3
333	2,776.5	9.9	0.10	0.10	0.07	57.8	0.0	2.70	3
334	2,777.5	10.3	0.12	0.09	0.06	82.5	0.0	2.70	3
335	2,778.5	11.7	0.38	0.34	0.16	79.2	0.0	2.67	3
336	2,779.5	14.1	0.51	0.51	0.17	74.0	0.0	2.67	3
337	2,780.5	19.3	5.08	4.92	1.202	25.8	0.0	2.76	3
338	2,781.5	12.6	8.39	F 5.89	4.26	36.2	0.0	2.79	3
339	2,782.5	13.6	1.34	1.30	0.71	35.0	0.0	2.73	3
340	2,783.5	6.4	0.33	0.07	0.05	67.1	0.0	2.70	3
341	2,784.5	8.7	0.11	0.11	0.09	55.0	0.0	2.72	4
342	2,785.5	7.9	0.10	0.09	0.08	53.5	0.0	2.73	4
343	2,786.5	7.9	9.96	F 5.78	0.12	76.7	0.0	2.73	4
344	2,787.5	5.7	0.676	F	² 0.254	62.3	0.0	2.73	2
345	2,788.5	6.6	2.02	F 0.41	3.31	42.9	0.0	2.73	1
346	2,789.5	6.5	*		² *	85.3	0.0	2.70	1
347	2,790.5		*						1
348	2,791.5	9.9	*		² *	92.3	0.0	2.76	1
349	2,792.5	8.2	*		² *	85.7	0.0	2.75	1
350	2,793.5	8.8	*		² *	87.3	0.0	2.74	1
351	2,794.5	6.4	13.858	F 4.029	0.011	95.9	0.0	2.73	1
352	2,795.5	8.0	4.703	F 2.474	0.121	98.3	0.0	2.74	1
353	2,796.5	11.8	*		² *	87.2	0.0	2.81	1
354	2,797.5	5.7	0.052	0.034	0.01	98.1	0.0	2.69	1
355	2,798.5	6.6	0.016	0.014	0.004	96.7	0.0	2.69	1
356	2,799.5	7.8	0.019	0.018	0.008	88.3	0.0	2.68	1
357	2,800.5	6.9	0.021	0.013	0.007	96.5	0.0	2.70	1
358	2,801.5	8.7	0.021	0.017	0.014	86.3	0.0	2.70	1
359	2,802.5	8.7	0.024	0.021	0.005	83.4	0.0	2.69	1
360	2,803.5	9.6	*		² *	97.0	0.0	2.76	1

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
361	2,804.5	6.3	0.645 F	0.411	0.01	98.1	0.0	2.68	1
362	2,805.5	7.9	0.013	0.012	0.009	86.6	0.0	2.71	1
363	2,806.5	9.4	0.031	0.03	0.012	91.1	0.0	2.74	1
364	2,807.5	12.8	0.052	0.041	0.017	91.2	0.0	2.73	1
365	2,808.5	11.6	0.531 F	0.103	0.021	92.3	0.0	2.79	1
366	2,809.5	12.5	0.042	0.04	0.005	98.3	0.0	2.73	1
367	2,810.5	4.3	1.111 F	0.16	0.011	88.5	0.0	2.74	1
368	2,811.5	4.7	0.05	0.05	0.04	87.3	0.0	2.80	2
369	2,812.5	1.3	0.03	0.03	0.01	96.5	0.0	2.80	2
370	2,813.5	2.9	0.05	0.03	0.01	89.3	0.0	2.79	2
371	2,814.5	12.3	0.16	0.15	0.09	87.1	0.0	2.83	2
372	2,815.5	9.4	9.91 F	6.29	0.01	86.7	0.0	2.79	3
373	2,816.5	9.8	7.03 F	3.58	0.06	77.4	0.0	2.78	3
374	2,817.5	8.7	21.63 F	18.62	1.23	92.0	0.0	2.77	3
375	2,818.5	12.4	*	²	*	92.3	0.0	2.77	3
376	2,819.5	11.6	*	²	*	86.3	0.0	2.74	3
377	2,820.5	2.8	0.03	0.03	0.01	94.7	0.0	2.67	3
378	2,821.5	1.6	11.03 F	1.34	0.06	93.9	0.0	2.66	3
379	2,822.5	5.8	7.65 F	4.26	0.01	94.2	0.0	2.69	3
380	2,823.5	7.8	40.28 F	28.03	0.37	91.7	0.0	2.73	3
381	2,824.5	2.2	0.03	0.03	0.01	93.1	0.0	2.62	3
382	2,825.5	0.7	0.03	0.02	0.01	96.9	0.0	2.66	3
383	2,826.5	6.1	9.04 F	5.78	0.02	97.0	0.0	2.69	3
384	2,827.5	8.7	0.107	²	3.05	87.9	0.0	2.71	3
385	2,828.5	9.9	*	²	*	92.9	0.0	2.70	3
386	2,829.5	10.9	*	²	16.10	88.2	0.0	2.69	3
387	2,830.5	12.4	*	²	*	76.2	0.0	2.68	3
388	2,831.5	9.9	*	²	*	90.7	0.0	2.68	3
389	2,832.5	11.9	*	²	*	83.6	0.0	2.67	3
390	2,833.5	9.4	*	²	*	95.8	0.0	2.69	3
391	2,834.5	11.5	*	²	*	74.3	0.0	2.68	3
392	2,835.5	7.9	*	²	0.03	81.2	0.0	2.67	3
393	2,836.5	8.5	0.943 F	²	0.02	92.3	0.0	2.65	3
394	2,837.5	8.5	0.03	0.02	0.01	81.7	0.0	2.65	3
395	2,838.5	7.2	4.25 F	1.13	0.02	93.9	0.0	2.67	3
396	2,839.5	6.4	2.25 F	1.54	0.02	96.4	0.0	2.65	3
397	2,840.5	11.1	0.023	²	0.01	86.1	0.0	2.64	3
398	2,841.5	11.0	0.018	²	< 0.01	83.1	0.0	2.66	3
399	2,842.5	10.2	0.016	²	< 0.01	85.0	0.0	2.66	3
400	2,843.5	10.5	0.03	²	< 0.01	85.3	0.0	2.65	3

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
401	2,844.5	10.8	1.965 F		² < 0.01	83.7	0.0	2.66	3
402	2,845.5	5.2	1.05 F	0.97	0.08	98.1	0.0	2.68	3
403	2,846.5	3.9	0.016		² 0.01	97.6	0.0	2.66	3
404	2,847.5	3.2	0.95 F	0.58	< 0.01	96.7	0.0	2.66	3
405	2,848.5	1.1	0.01	0.01	0.01	98.7	0.0	2.66	3
406	2,849.5	1.8	0.03	0.03	< 0.01	98.8	0.0	2.67	1
407	2,850.5	10.1	0.64 F	0.07	0.02	82.9	0.0	2.75	1
408	2,851.5	12.4	2.27 F	0.24	0.01	66.1	0.0	2.78	1
409	2,852.5	13.8	0.05	0.04	0.02	88.7	0.0	2.79	1
410	2,853.5	9.1	0.04	0.04	0.01	86.5	0.0	2.82	1
411	2,854.5	9.5	0.06	0.03	0.02	84.2	0.0	2.77	1
412	2,855.5	7.6	0.14	0.078	0.007	96.3	0.0	2.78	1
413	2,856.5	10.2	7.894 F		³ 0.017	90.5	0.0	2.78	1
414	2,857.5	10.0	0.26	0.17	0.21	86.4	0.0	2.71	1
415	2,858.5	13.7	0.13	0.12	0.08	73.3	0.0	2.68	1
416	2,859.5	13.7	0.12	0.12	0.02	68.6	0.0	2.71	1
417	2,860.5	7.7	0.04	0.04	0.01	75.0	0.0	2.71	1
418	2,861.5	8.0	0.07	0.05	0.01	80.2	0.0	2.70	1
419	2,862.5	7.6	10.156 F	8.451	0.23	97.4	0.0	2.74	1
420	2,863.5	10.7	17.944 F	2.273	0.482	96.1	0.0	2.73	1
421	2,864.5	2.7	0.04	0.03	0.01	98.5	0.0	2.66	4
422	2,865.5	7.2	0.94	0.42	0.04	54.3	0.0	2.71	4
423	2,866.5	11.2	2.29	2.24	0.24	37.8	0.0	2.74	4
424	2,867.5	4.6	0.06	0.05	0.02	50.0	0.0	2.71	4
425	2,868.5	6.1	0.09	0.09	0.06	36.9	0.0	2.72	4
426	2,869.5	3.7	0.11	0.06	0.06	60.3	0.0	2.75	4
427	2,870.5	3.3	0.05	0.04	0.01	77.5	0.0	2.70	4
428	2,871.5	6.6	0.05	0.05	0.01	86.4	0.0	2.76	3
429	2,872.5	5.8	0.07	0.06	0.01	86.6	0.0	2.71	3
430	2,873.5	6.1	0.11	0.09	0.04	59.1	0.0	2.73	3
431	2,874.5	8.1	0.39	0.15	0.04	84.3	0.0	2.69	3
432	2,875.5	7.1	0.12	0.05	0.06	62.3	0.0	2.71	3
433	2,876.5	11.1	1.07	0.53	0.99	54.2	0.0	2.70	4
434	2,877.5	11.2	0.76	0.74	0.58	47.4	0.0	2.73	4
435	2,878.5	11.4	0.66	0.63	0.26	54.9	0.0	2.71	4
436	2,879.5	7.9	0.07	0.07	0.04	79.9	0.0	2.71	4
437	2,880.5	12.9	0.062		² 0.099	80.3	0.0	2.69	1
438	2,881.5	7.4	0.278 F		³	82.0	0.0	2.71	1
439	2,882.3	12.2	0.072		² 0.09	97.4	0.0	2.80	1
440	2,883.5	8.1	*	*	11.519 ¹	97.4	0.0	2.74	1

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
441	2,884.5	8.1	0.317		³	93.3	0.0	2.72	1
442	2,886.5	8.4	4.29 F	0.347	0.015	95.5	0.0	2.71	1
443	2,887.5	6.0	0.957	0.571	0.014	97.4	0.0	2.70	1
444	2,888.5	6.6	5.84 F	5.62	5.76	97.5	0.0	2.73	1
445	2,889.5	11.9	329.684 F		² 11.201	92.8	0.0	2.75	4
446	2,890.5	14.3	4.54	3.76	3.65	53.0	0.0	2.70	4
447	2,891.5	11.7	25.59	23.36	8.16	44.4	0.0	2.72	4
448	2,892.5	11.1	67.458		² 126.213	83.5	0.0	2.72	4
449	2,893.5	9.9	13.31	13.26	14.74	45.1	0.0	2.72	4
450	2,894.5	8.8	2.56	2.11	1.031	43.7	0.0	2.72	4
451	2,895.5	9.5	0.13	0.07	0.07	63.7	0.0	2.72	4
452	2,896.5	13.9	2.40	0.53	4.33	77.9	0.0	2.71	4
453	2,897.5	12.3	0.49	0.39	0.46	72.1	0.0	2.70	4
454	2,898.5	10.4	0.32	0.19	0.10	86.1	0.0	2.71	4
456	2,900.5	2.2	0.04	0.01	0.01	62.7	0.0	2.69	3
458	2,902.5	8.7	1.456 F		² 0.013	96.1	0.0	2.76	1
459	2,903.5	6.0	1.349 F	0.102	0.012	95.9	0.0	2.69	1
460	2,904.5	6.7	30.433 F	2.106	2.036	95.0	0.0	2.74	1
461	2,905.5	8.1	78.847 F	4.019	0.04	99.0	0.0	2.74	1
462	2,906.5	5.8	0.036	0.036	0.029	97.5	0.0	2.69	1
463	2,907.5	12.4	0.186	0.173	0.088	92.8	0.0	2.76	1
464	2,908.5	8.2	0.068	0.05	0.006	97.2	0.0	2.66	1
465	2,909.5	7.2	0.044	0.039	0.021	92.8	0.0	2.66	1
466	2,910.5	9.5	0.156	0.125	0.083	94.9	0.0	2.71	1
467	2,911.5	8.6	0.069	0.068	0.066	95.1	0.0	2.71	1
468	2,912.5	8.1	0.033	0.033	0.008	98.1	0.0	2.70	1
469	2,913.5	14.9	32.48 F	15.11	6.94	63.2	0.0	2.75	1
470	2,914.5	13.1	3.959		² 2.474	58.1	0.0	2.76	4
471	2,915.5	8.8	0.51	0.37	0.29	62.2	0.0	2.73	4
472	2,916.5	6.8	0.06	0.06	0.07	57.3	0.0	2.72	4
473	2,917.5	7.1	0.80	0.14	0.02	60.9	0.0	2.72	4
474	2,918.5	15.4	15.086 F		³	98.6	0.0	2.78	1
475	2,919.5	12.8	4.436 F		³	97.0	0.0	2.73	1
476	2,920.5	12.1	0.318		³	97.4	0.0	2.72	1
477	2,921.5	17.6	2.638	2.534	1.052	88.9	0.0	2.69	1
478	2,922.5	15.8	1.434	1.246	0.635	96.0	0.0	2.71	1
479	2,923.5	10.6	8.919 F		² 0.011	97.3	0.0	2.70	1
480	2,924.5	7.0	0.041	0.034	0.007	90.8	0.0	2.71	1
481	2,925.5	4.8	0.05	0.03	< 0.01	68.2	0.0	2.68	1
482	2,926.5	5.0	0.024	0.015	0.014	86.2	0.0	2.67	1

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies	
			Kmax	K90	Kvert	Water	Oil			
483	2,927.5	5.6	0.026	0.025	0.014	91.8	0.0	2.67	1	
484	2,928.5	7.5	0.08	0.05	0.008	88.1	0.0	2.69	1	
485	2,929.5	12.9	*	³		94.3	0.0	2.75	1	
486	2,930.5	12.9	5.54	4.30	6.96	82.7	0.0	2.71	4	
487	2,931.5	13.7	71.478		² 12.06	93.6	0.0	2.71	4	
488	2,932.5	11.6	17.32	16.26	0.98	40.8	0.0	2.70	4	
489	2,933.5	13.3	14.31	13.41	17.20	45.9	0.0	2.72	4	
490	2,934.5	13.3	27.61	5.05	36.94	49.9	0.0	2.68	4	
491	2,935.5	10.9	5.31	1.29	5.84	72.5	0.0	2.68	4	
492	2,936.5	3.0	0.92	0.48	0.01	65.4	0.0	2.69	4	
493	2,937.5	13.8	0.109		0.016	95.7	0.0	2.71	1	
494	2,939.5	15.7	*	³		97.3	0.0	2.73	1	
495	2,940.5	13.0	*	³		93.5	0.0	2.74	1	
496	2,941.5	14.8	*	³		93.0	0.0	2.81	1	
497	2,942.5	5.8	41.74 F	11.47	35.96	65.4	0.0	2.72	3	
498	2,943.5	10.9	*	*	*	93.1	0.0	2.72	3	
499	2,944.5	5.2	252.74 F	248.91	95.69	96.2	0.0	2.70	3	
500	2,945.5	9.5	0.13		²	*	92.4	0.0	2.69	3
501	2,946.5	7.0	74.72 F	74.50	11.84	94.4	0.0	2.70	3	
502	2,947.5	3.7	8.96 F	7.96	1.38	97.0	0.0	2.72	3	
503	2,948.5	11.6	2.97	2.579	1.02	75.5	0.0	2.70	5	
504	2,949.5	14.1	65.24	64.26	42.53	55.1	0.0	2.70	5	
505	2,950.5	11.4	70.42	53.77	2389.44	78.7	0.0	2.71	5	
506	2,951.5	16.0	2568.40	1494.05	2250.64	94.8	0.0	2.71	5	
507	2,952.5	9.8	232.99	184.53	18.02	78.7	0.0	2.78	5	
508	2,953.5	10.8	*	*	*	86.2	0.0	2.75	5	
509	2,954.5	11.3	383.11	350.05	175.42	60.4	0.0	2.72	5	
510	2,955.5	13.4	*	³		51.2	0.0	2.71	5	
511	2,956.5	6.8	0.04		³	70.9	0.0	2.72	3	
512	2,957.5	5.8	0.02		³	82.8	0.0	2.70	3	
513	2,968.5	10.8	0.157		³	85.2	0.0	2.75	1	
514	2,969.5	10.6	*		³	96.0	0.0	2.73	1	
515	2,970.5	10.8	*		³	96.4	0.0	2.75	1	
516	2,971.5	12.2	*		*	97.8	0.0	2.78	1	
517	2,972.5	12.1	14.563 F	7.241	5.838	98.0	0.0	2.77	1	
518	2,973.5	8.7	*		*	97.2	0.0	2.70	1	
519	2,974.5	7.1	26.026 F	1.682	1.51	95.1	0.0	2.72	1	
520	2,975.5	9.9	4.363 F		² 0.165 ¹	94.4	0.0	2.74	1	
521	2,976.5	11.3	56.426 F	27.245	44.996	96.6	0.0	2.76	1	
522	2,977.5	13.9	84.191 F	48.539	34.968	96.0	0.0	2.76	1	

TABLE 4 (CONTINUED)
FULL DIAMETER CORE ANALYSIS
ANADARKO FLOWER A-1 WELL

Sample #	Depth (ft.)	Porosity (%)	Permeability (md)			Fluids (%)		Grain Density (g/cc)	Dep. Facies
			Kmax	K90	Kvert	Water	Oil		
523	2,978.5	7.3	0.63	0.449	0.008	98.6	0.0	2.68	1
524	2,979.5	8.1	14.873 F	0.988	0.002	96.7	0.0	2.70	1
525	2,980.5	9.2	15.29 F	2.723	0.082	93.7	0.0	2.71	1
526	2,981.5	6.2	0.158 F	²	0.008	98.3	0.0	2.71	1
527	2,982.5	13.4	0.113	³		99.6	0.0	2.77	1
528	2,983.5	9.0	2.916 F	³		99.3	0.0	2.73	1
529	2,984.5	11.2	*	³		99.3	0.0	2.75	1
530	2,985.5	3.8	0.05	0.04	0.03	75.5	0.0	2.75	4
531	2,986.5	6.0	0.24	0.12	0.03	85.3	0.0	2.71	4
532	2,987.5	9.3	0.17	0.16	0.10	83.7	0.0	2.75	4
533	2,988.5	4.1	0.03	0.03	0.03	58.3	0.0	2.73	4
534	2,989.5	2.4	0.50	0.04	< 0.01	96.9	0.0	2.70	4
535	2,990.5	1.0	0.01	0.01	< 0.01	98.5	0.0	2.69	3
536	2,991.5	2.3	0.02	0.02	0.01	77.9	0.0	2.68	3
537	2,992.5	7.3	*			95.1	0.0	2.76	3
538	2,993.5	1.4	0.30	0.20	< 0.01	90.6	0.0	2.66	3
539	2,994.5	3.2	0.20	0.19	< 0.01	96.5	0.0	2.70	3
540	2,995.5	4.1	0.27	0.02	< 0.01	91.1	0.0	2.70	3
541	2,996.5	1.4	0.17	0.10	< 0.01	95.3	0.0	2.68	3
542	2,997.5	2.3	0.08	0.03	< 0.01	95.7	0.0	2.66	3
543	2,998.5	3.3	0.19	0.18	< 0.01	98.6	0.0	2.69	3
544	2,999.5	4.0	1.25 F	0.34	< 0.01	91.5	0.0	2.69	3
545	3,000.5	4.0	0.11	0.03	< 0.01	92.0	0.0	2.70	3
546	3,001.5	2.4	0.36	0.13	< 0.01	82.4	0.0	2.67	3
547	3,002.5	2.1	0.09	0.03	0.01	58.6	0.0	2.69	3
548	3,003.5	2.1	0.14	0.05	0.01	88.3	0.0	2.69	3
549	3,004.5	2.4	0.02	0.01	< 0.01	99.6	0.0	2.68	3
Minimum:		0.6	0.01	0.01	0.001	21.0	0.0	2.62	
Maximum:		25.6	2568.40	1494.05	2389.44	99.6	0.0	2.95	
Average:		10.8	20.454	16.778	19.32	72.4	0.0	2.73	

* Sample was too broken for analysis

¹ Permeability prior to extraction

² Permeability from plug sample

³ Plug analysis

F Fractured sample

Depositional Facies

1 - Paleosol/Coastal plain

2 - Tidal flat

3 - Lagoon to shallow shelf

4 - Shoal/Shoal flank

5 - Algal bank

FIGURE 1

CORE TO LOG CORRELATION

ANADARKO PETROLEUM CORPORATION

FLOWER A-1

STEVENS COUNTY, KANSAS

LOG DEPTH \approx CORE DEPTH + 2 FEET

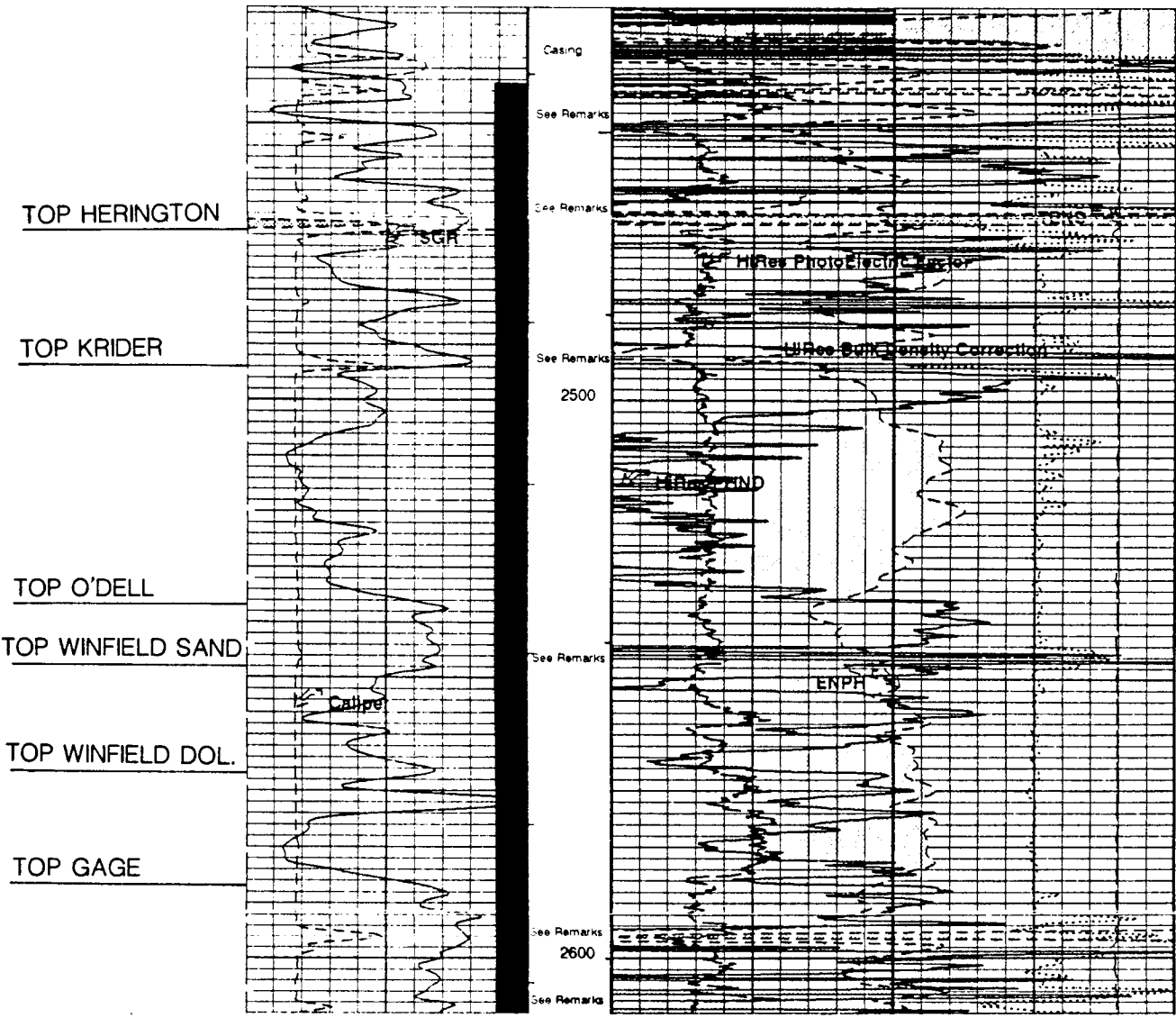
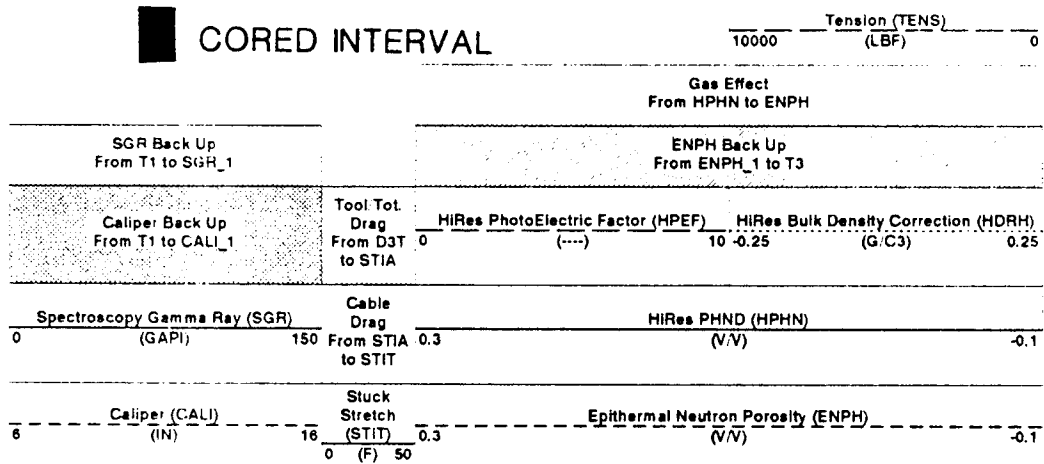


FIGURE 1 CONTINUED

ANADARKO PETROLEUM CORPORATION

FLOWER A-1

		Tension (TENS) 10000 (LBF) 0	
		Gas Effect From HPHN to ENPH	
SGR Back Up From T1 to SGR_1		ENPH Back Up From ENPH_1 to T3	
Caliper Back Up From T1 to CALI_1	Tool/Tot. Drag From D3T to STIA	HIRes PhotoElectric Factor (MPEF) 0 (----)	HIRes Bulk Density Correction (HDRH) 10 -0.25 (G/C3) 0.25
Spectroscopy Gamma Ray (SGR) 0 (GAPI) 150	Cable Drag From STIA to STIT	HIRes PHND (HPHN) 0.3 (V/V) -0.1	
Caliper (CALI) 6 (IN) 16	Stuck Stretch (STIT) 0 (F) 50	Epithermal Neutron Porosity (ENPH) 0.3 (V/V) -0.1	

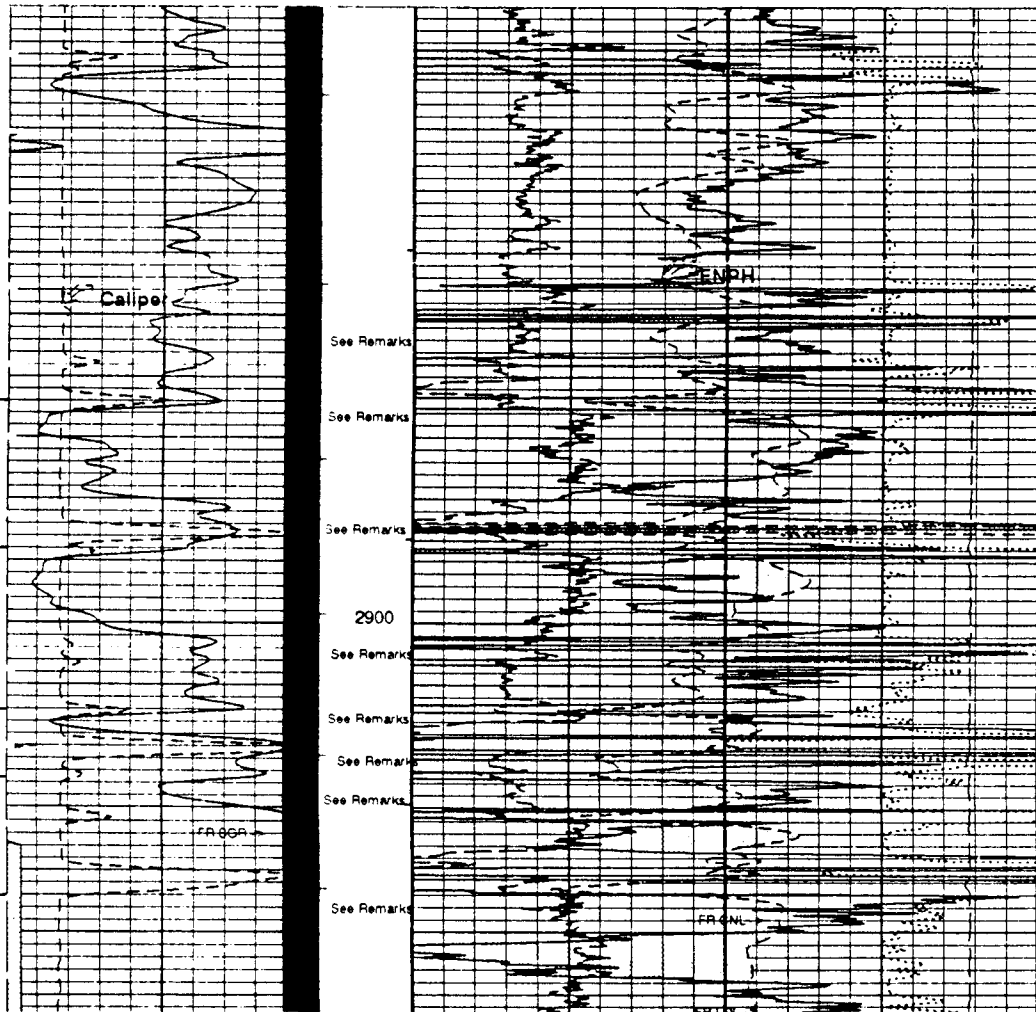
TOP
COUNCIL GROVE B1

TOP
COUNCIL GROVE B2

TOP
COUNCIL GROVE B3

TOP
COUNCIL GROVE B4






















TOP
COUNCIL GROVE B5











CORE CONTINUES BELOW LOG

CORE LEGEND




STRUCTURES

	RIPPLE CROSS-STRATIFICATION		MICROFAULT W/ DISPLACEMENT
	RIPPLE FORMS		MUDCRACKS
	CROSS-STRATIFICATION		ROOT CASTS
	LAMINATED		BORED HARDGROUND
	WAVY BEDDING		FRACTURE (SUBSCRIPT: A= ANHYDRITE-FILLED, B= BITUMEN-FILLED, C= CALCITE-FILLED, D= DOLOMITE-FILLED, O= OPEN NATURAL, CN= CLOSED NATURAL)
	CONTORTED BEDDING		FINING UPWARD
	BIOTURBATED		COARSENING UPWARD
	BURROW		SPREITE-FILLED BURROW
	ANHYDRITE NODULES		ANHYDRITE NODULE/VUG
	DIFFUSE COMPACTION SEAMS/SHALY LAMINAE		
	STYLOLITE		
	MICROSTYLOLITE		




ACCESSORY CONSTITUENTS

	Py- PYRITE		CLACITE-FILLED VUGS
	CALC. - CALCAREOUS		SSD - SOFT-SEDIMENT-DEFORMATION
	SiO2 - SILICEOUS		CARB. - CARBONACEOUS DEBRIS
	DOL. - DOLOMITE		
	ARG. - ARGILLACEOUS		









CONTACTS







	SHARP
	GRADATIONAL
	UNDULATORY/IRREGULAR

SAMPLE LOCATIONS

	TS - THIN SECTION
	AD - CLOSE CORE PHOTOGRAPH
	TS - THIN SECTION, XRD, SCAL SAMPLE

CARBONATE GRAIN VARIETIES

	PELECYPODS
	BRACHIOPODS
	GASTROPODS
	ECHINODERMS
	CALCAREOUS ALGAE (UNDIFFERENTIATED)
	CALCAREOUS RED ALGAE
	BRYOZOANS
	FORAMINIFERA

	CORAL
	OIDS
	ONCOIDS/ALGAL-COATED GRAINS
	PELOIDS
	PELLETS
	INTRACLASTS

LITHOLOGY













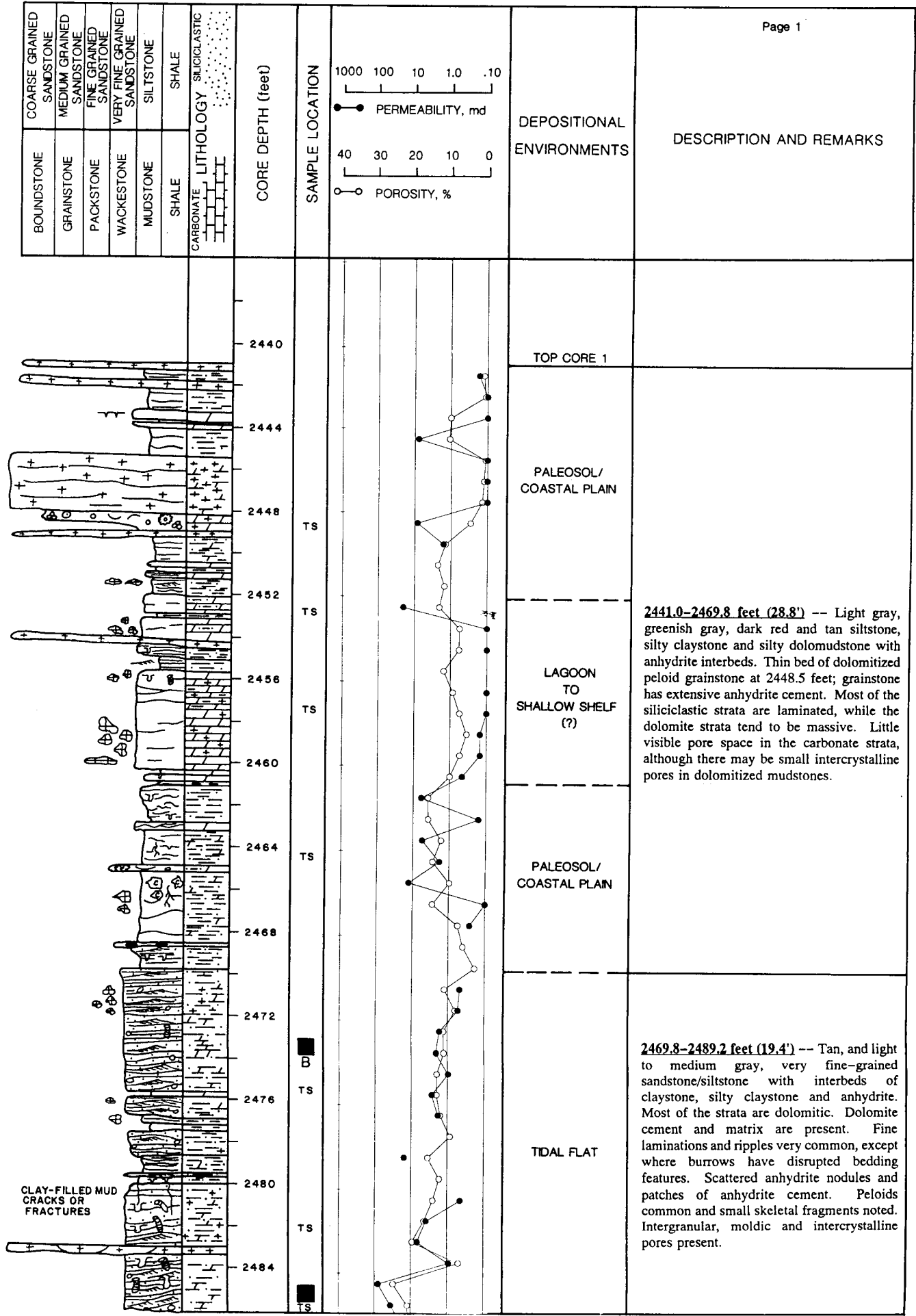
	SANDSTONE		CALCITIC
	SILTSTONE		DOLOMITIC
	SHALE		SILTY
	LIMESTONE		SHALY
	DOLOSTONE		SANDY
	ANHYDRITE		ANHYDRITIC

FIGURE 2
ANADARKO PETROLEUM CORPORATION
FLOWER A-1
STEVENS COUNTY, KANSAS



CLAY-FILLED MUD
CRACKS OR
FRACTURES

■ B
TS
■ TS

FIGURE 2 CONTINUED
ANADARKO PETROLEUM CORPORATION
FLOWER A-1

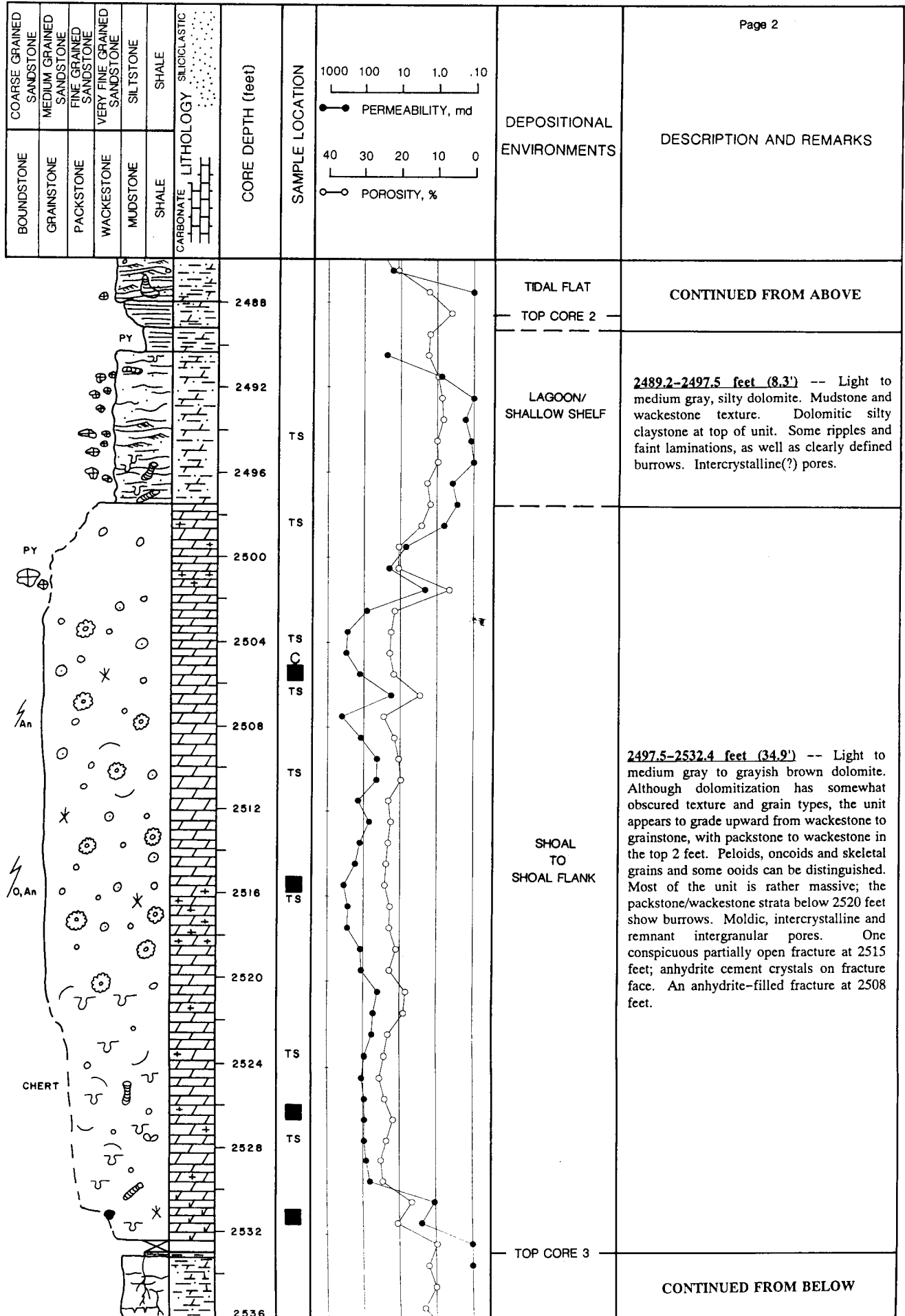


FIGURE 2 CONTINUED
ANADARKO PETROLEUM CORPORATION
FLOWER A-1

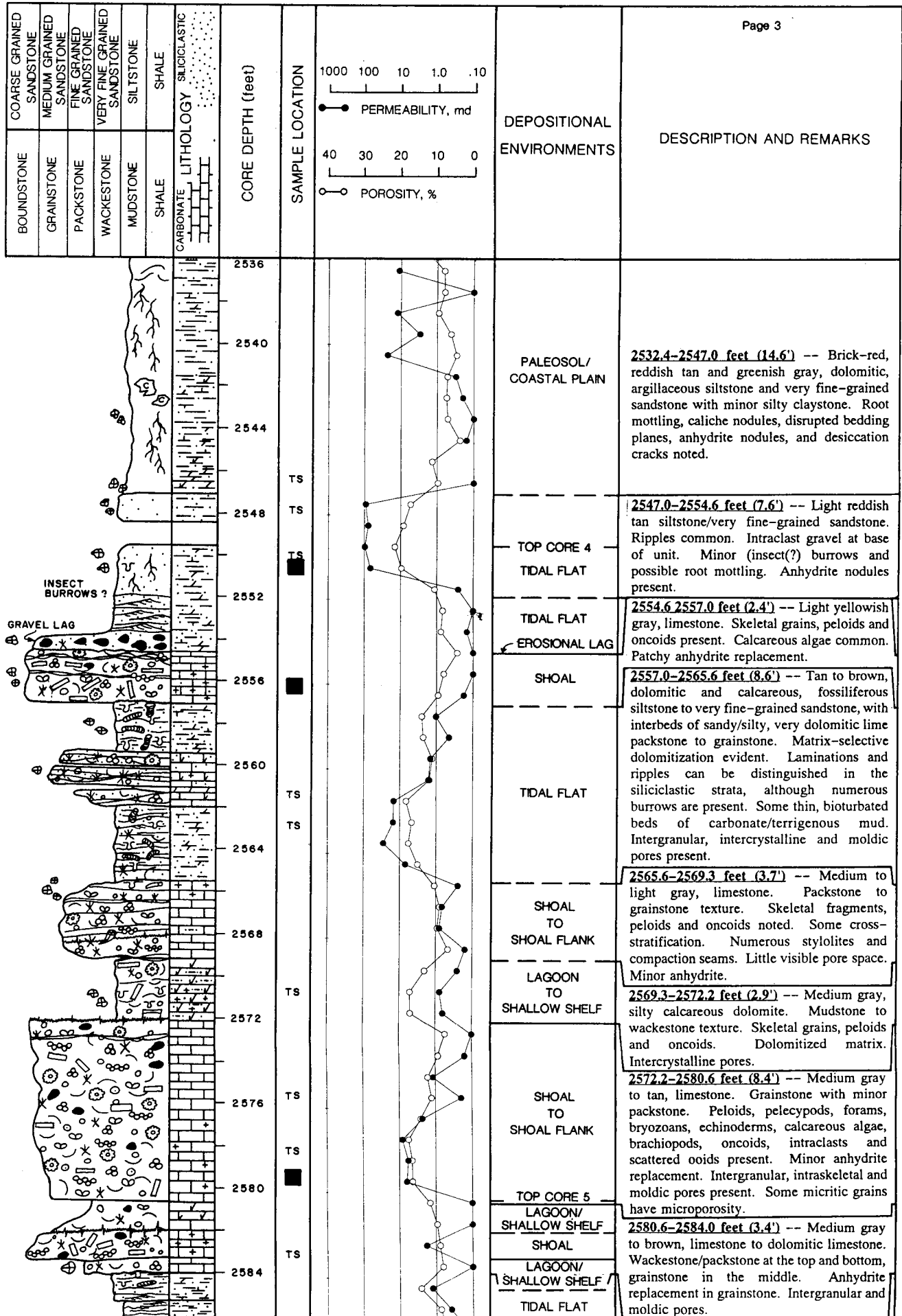
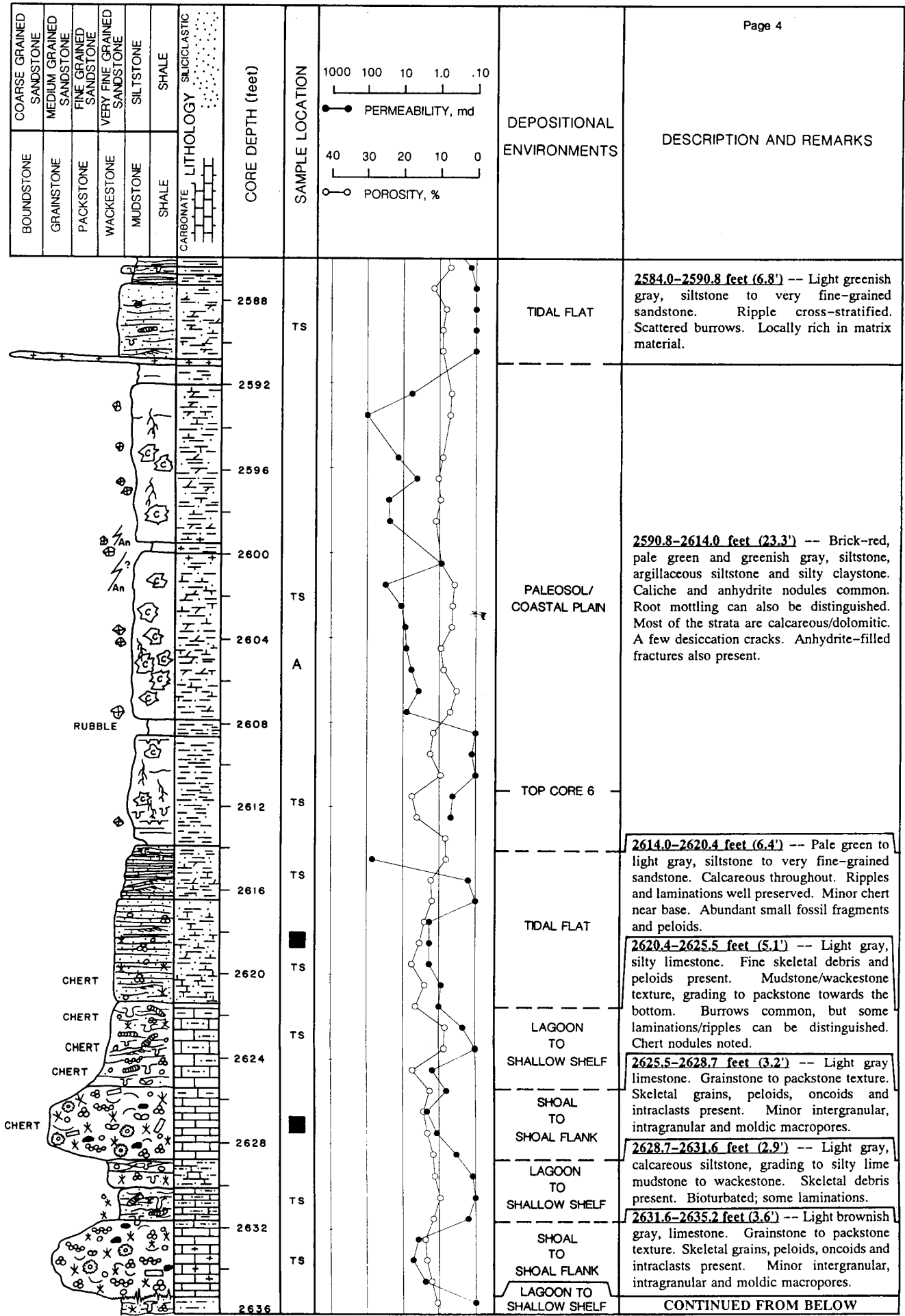


FIGURE 2 CONTINUED
ANADARKO PETROLEUM CORPORATION
FLOWER A-1



DESCRIPTION AND REMARKS

2584.0-2590.8 feet (6.8') -- Light greenish gray, siltstone to very fine-grained sandstone. Ripple cross-stratified. Scattered burrows. Locally rich in matrix material.

2590.8-2614.0 feet (23.3') -- Brick-red, pale green and greenish gray, siltstone, argillaceous siltstone and silty claystone. Caliche and anhydrite nodules common. Root mottling can also be distinguished. Most of the strata are calcareous/dolomitic. A few desiccation cracks. Anhydrite-filled fractures also present.

2614.0-2620.4 feet (6.4') -- Pale green to light gray, siltstone to very fine-grained sandstone. Calcareous throughout. Ripples and laminations well preserved. Minor chert near base. Abundant small fossil fragments and peloids.

2620.4-2625.5 feet (5.1') -- Light gray, silty limestone. Fine skeletal debris and peloids present. Mudstone/wackstone texture, grading to packstone towards the bottom. Burrows common, but some laminations/ripples can be distinguished. Chert nodules noted.

2625.5-2628.7 feet (3.2') -- Light gray limestone. Grainstone to packstone texture. Skeletal grains, peloids, oncoids and intraclasts present. Minor intergranular, intragranular and moldic macropores.

2628.7-2631.6 feet (2.9') -- Light gray, calcareous siltstone, grading to silty lime mudstone to wackstone. Skeletal debris present. Bioturbated; some laminations.

2631.6-2635.2 feet (3.6') -- Light brownish gray, limestone. Grainstone to packstone texture. Skeletal grains, peloids, oncoids and intraclasts present. Minor intergranular, intragranular and moldic macropores.

CONTINUED FROM BELOW

FIGURE 2 CONTINUED
ANADARKO PETROLEUM CORPORATION
FLOWER A-1

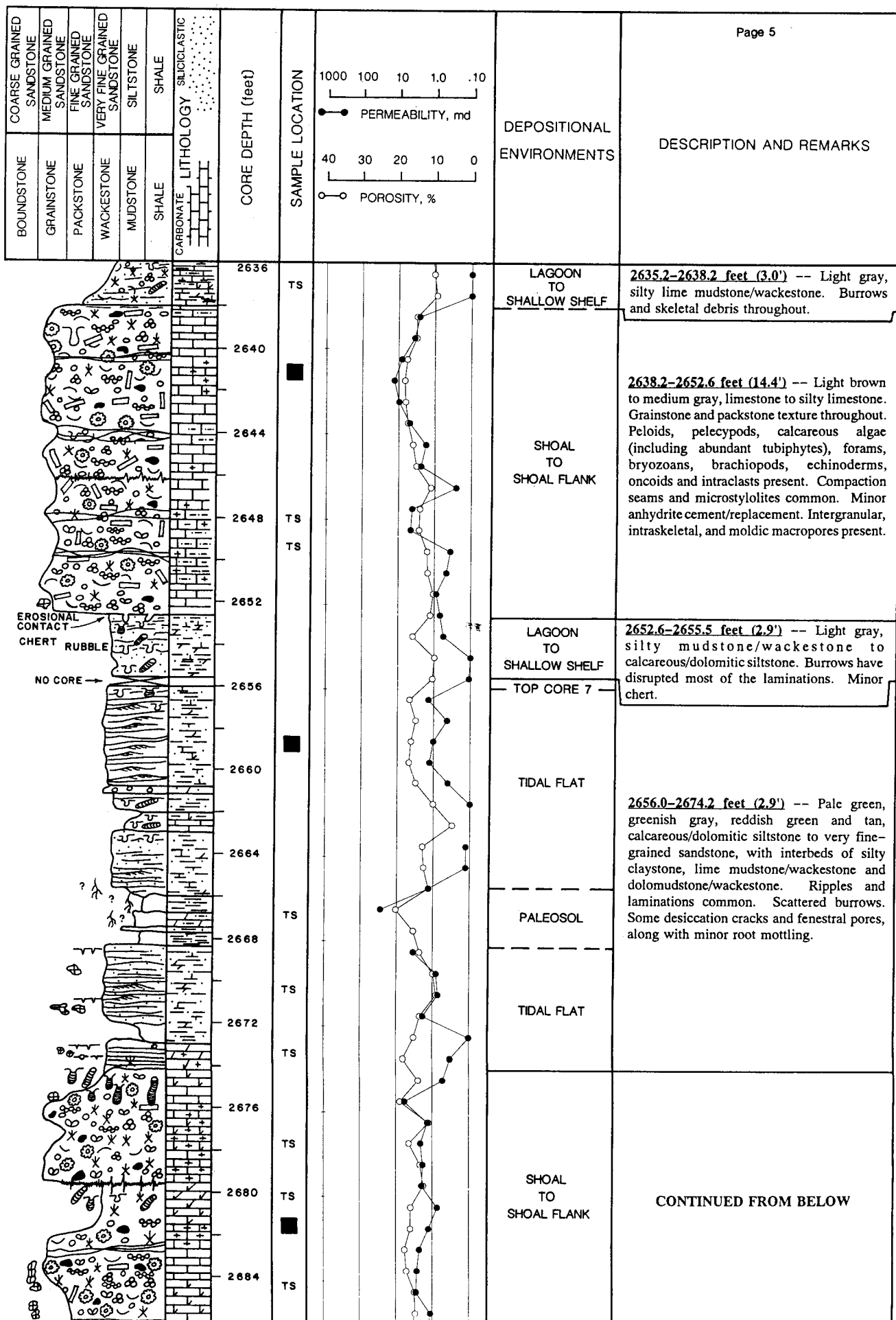
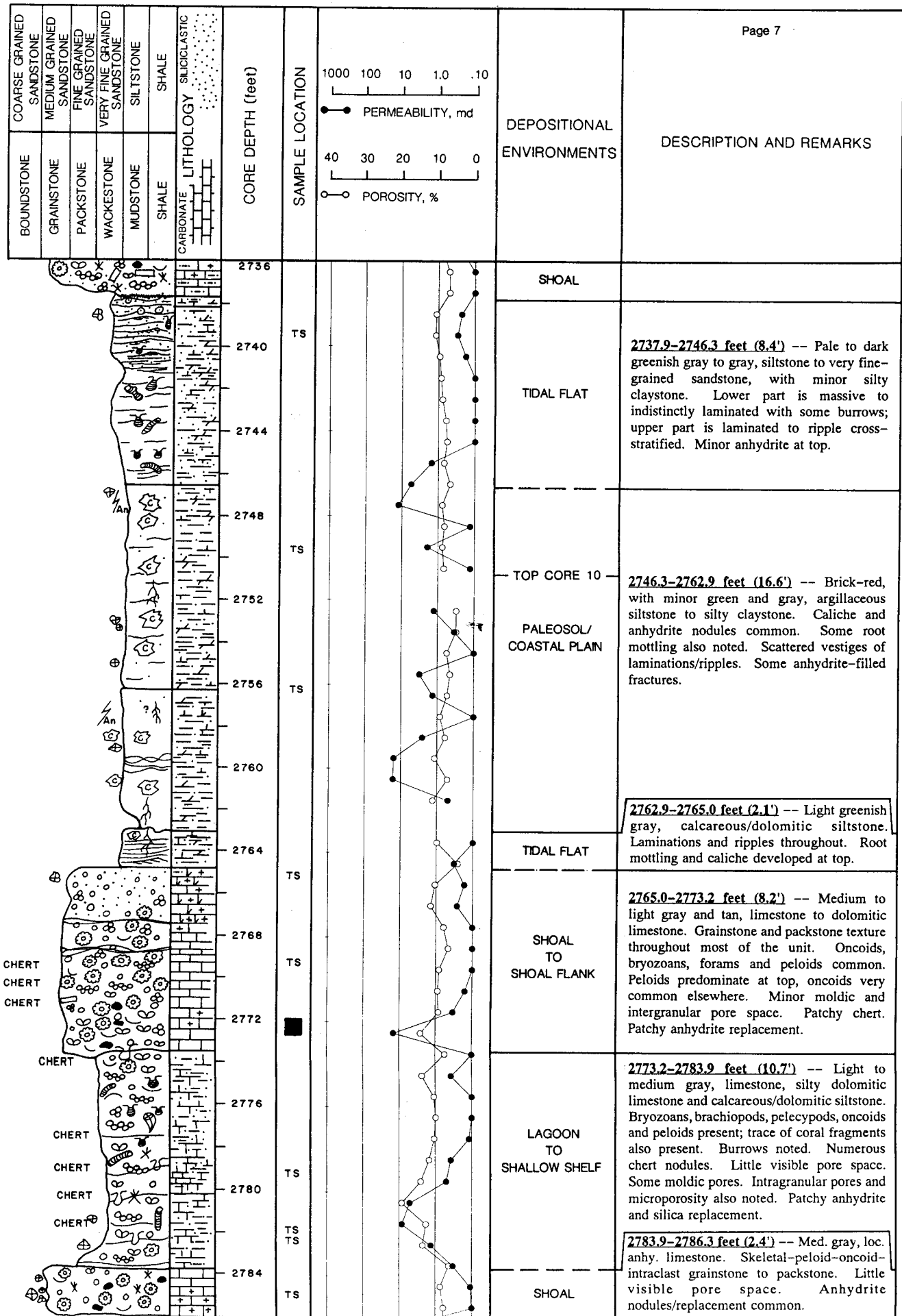























FIGURE 2 CONTINUED
ANADARKO PETROLEUM CORPORATION
FLOWER A-1



CORE LEGEND

STRUCTURES

	RIPPLE CROSS-STRATIFICATION		MICROFAULT W/ DISPLACEMENT
	RIPPLE FORMS		MUDCRACKS
	CROSS-STRATIFICATION		ROOT CASTS
	LAMINATED		BORED HARDGROUND
	WAVY BEDDING		FRACTURE (SUBSCRIPT: A = ANHYDRITE-FILLED, B = BITUMEN-FILLED, C = CALCITE-FILLED, D = DOLOMITE FILLED, O = OPEN NATURAL, CN = CLOSED NATURAL)
	CONTORTED BEDDING		ANHYDRITE NODULE /VUG
	BIOTURBATED		FINING UPWARD
	BURROW		COARSENING UPWARD
	ANHYDRITE NODULES		SPREITE-FILLED BURROW
	DIFFUSE COMPACTION SEAMS/SHALY LAMINAE		
	STYLOLITE		
	MICROSTYLOLITE		

ACCESSORY CONSTITUENTS

Py- PYRITE	⊙ - CLACITE-FILLED VUGS
CALC. - CALCAREOUS	SSD - SOFT-SEDIMENT-DEFORMATION
SiO ₂ - SILICEOUS	CARB. - CARBONACEOUS DEBRIS
DOL - DOLOMITE	
ARG. - ARGILLACEOUS	

CONTACTS








—	SHARP
----	GRADATIONAL
~~~~	UNDULATORY/IRREGULAR




## SAMPLE LOCATIONS

TS	- THIN SECTION
A-D	- CLOSE CORE PHOTOGRAPH







■ - THIN SECTION, XRD, SCAL SAMPLE

## CARBONATE GRAIN VARIETIES

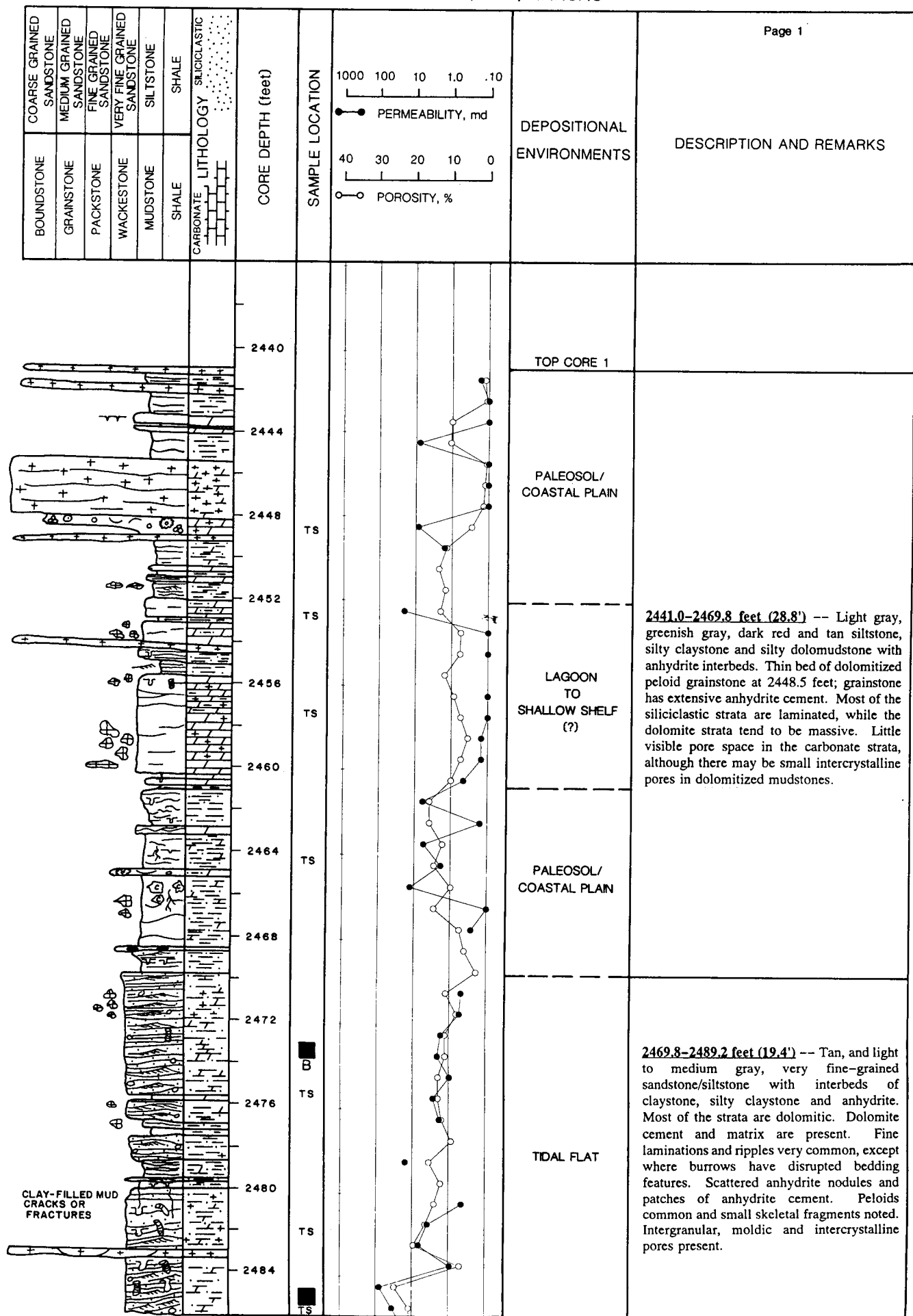
	PELECYPODS
	BRACHIOPODS
	GASTROPODS
x	ECHINODERMS
	CALCAREOUS ALGAE (UNDIFFERENTIATED)
	CALCAREOUS RED ALGAE
	BRYOZOANS
	FORAMINIFERA

	CORAL
⊙	OIDS
	ONCOIDS/ALGAL-COATED GRAINS
○	PELOIDS
○	PELLETS
	INTRACLASTS

## LITHOLOGY

	SANDSTONE	⊥	CALCITIC
	SILTSTONE	⊥	DOLOMITIC
	SHALE	---	SILTY
	LIMESTONE	---	SHALY
	DOLOSTONE	.....	SANDY
	ANHYDRITE	+	ANHYDRITIC

**FIGURE 2**  
**ANADARKO PETROLEUM CORPORATION**  
**FLOWER A-1**  
**STEVENS COUNTY, KANSAS**



CLAY-FILLED MUD  
CRACKS OR  
FRACTURES

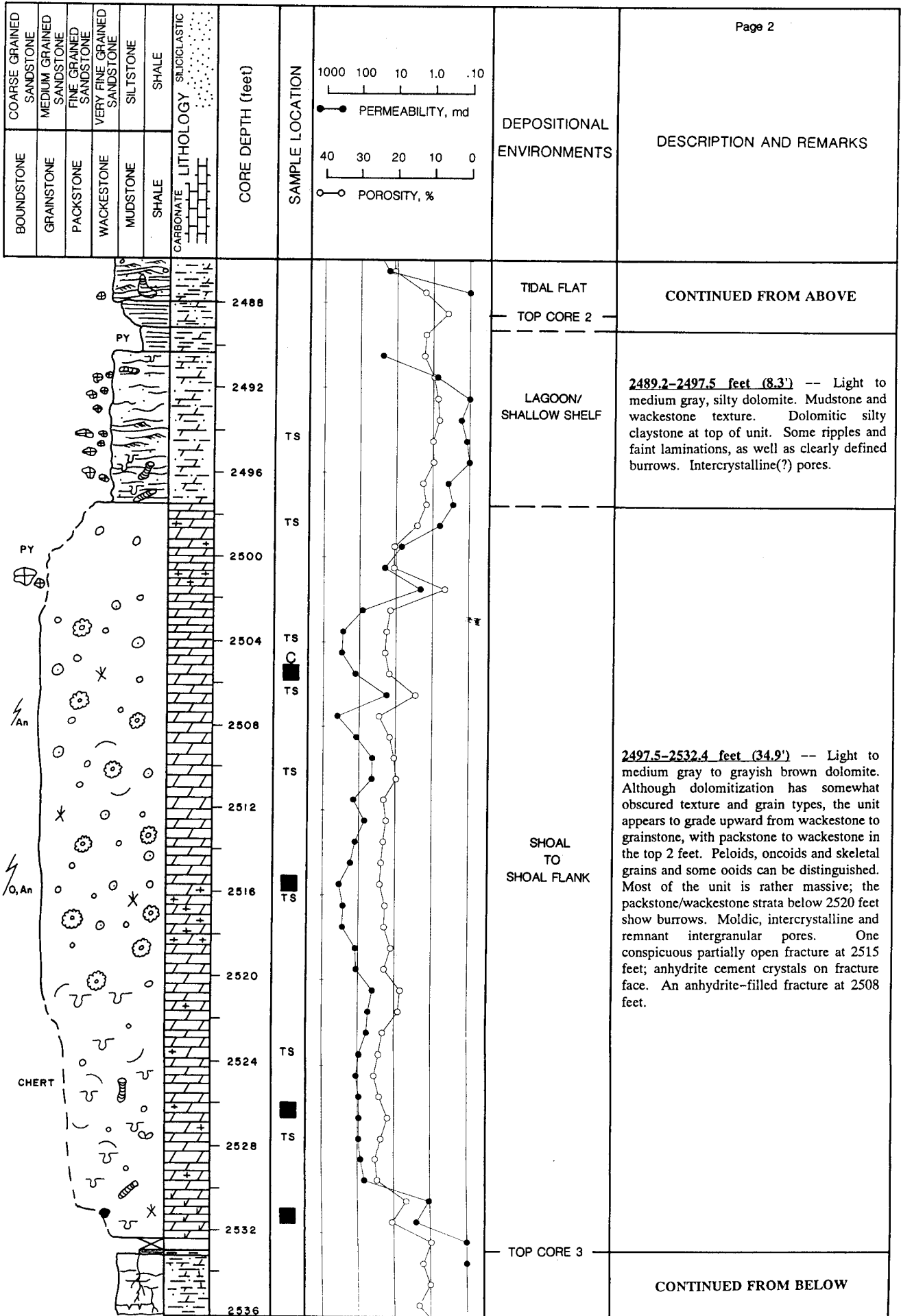
■ B

TS

TS

TS

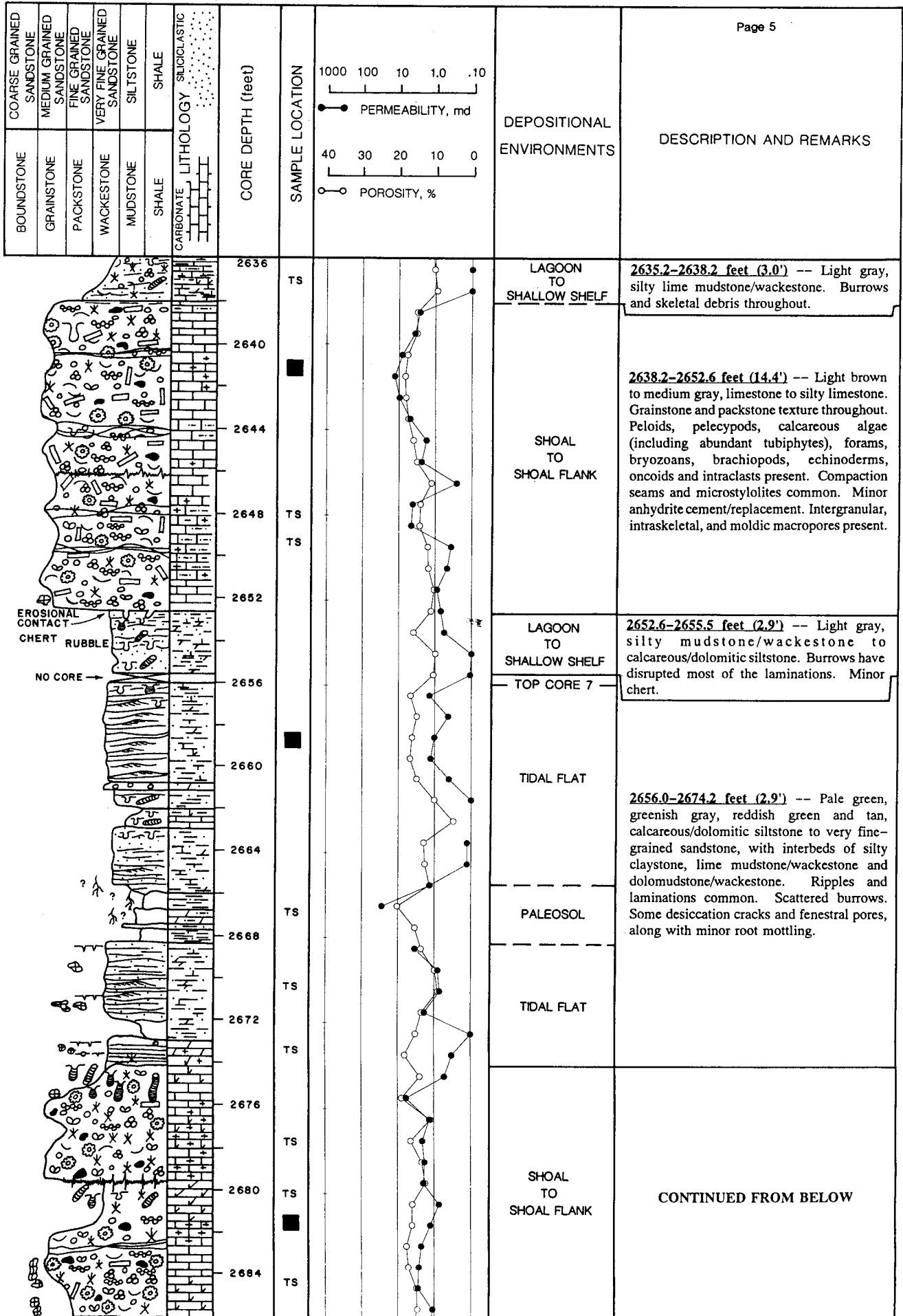
FIGURE 2 CONTINUED  
 ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1







**FIGURE 2 CONTINUED**  
**ANADARKO PETROLEUM CORPORATION**  
**FLOWER A-1**



CONTINUED FROM BELOW

FIGURE 2 CONTINUED  
 ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1

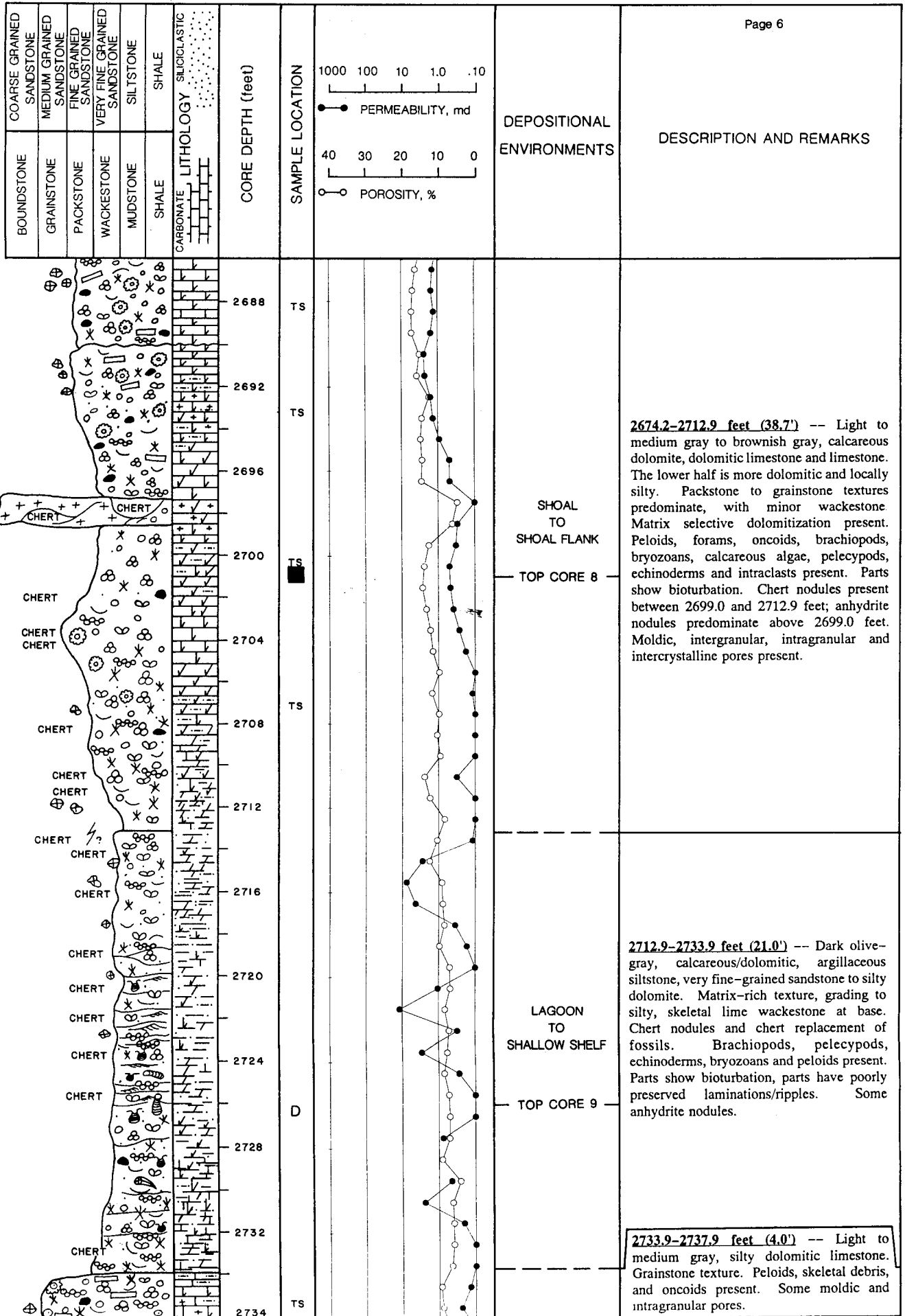


FIGURE 2 CONTINUED  
ANADARKO PETROLEUM CORPORATION  
FLOWER A-1

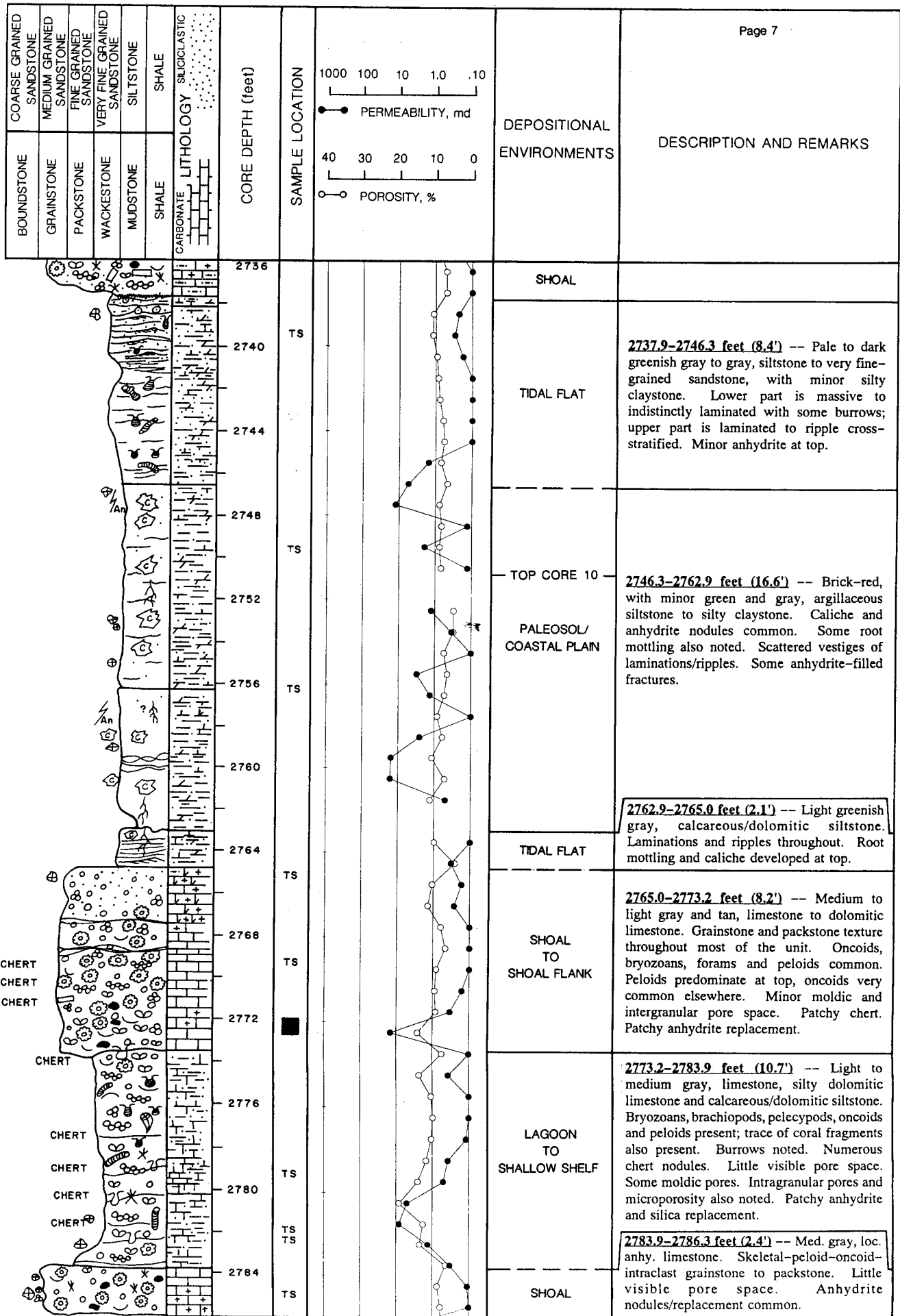


FIGURE 2 CONTINUED  
ANADARKO PETROLEUM CORPORATION  
FLOWER A-1

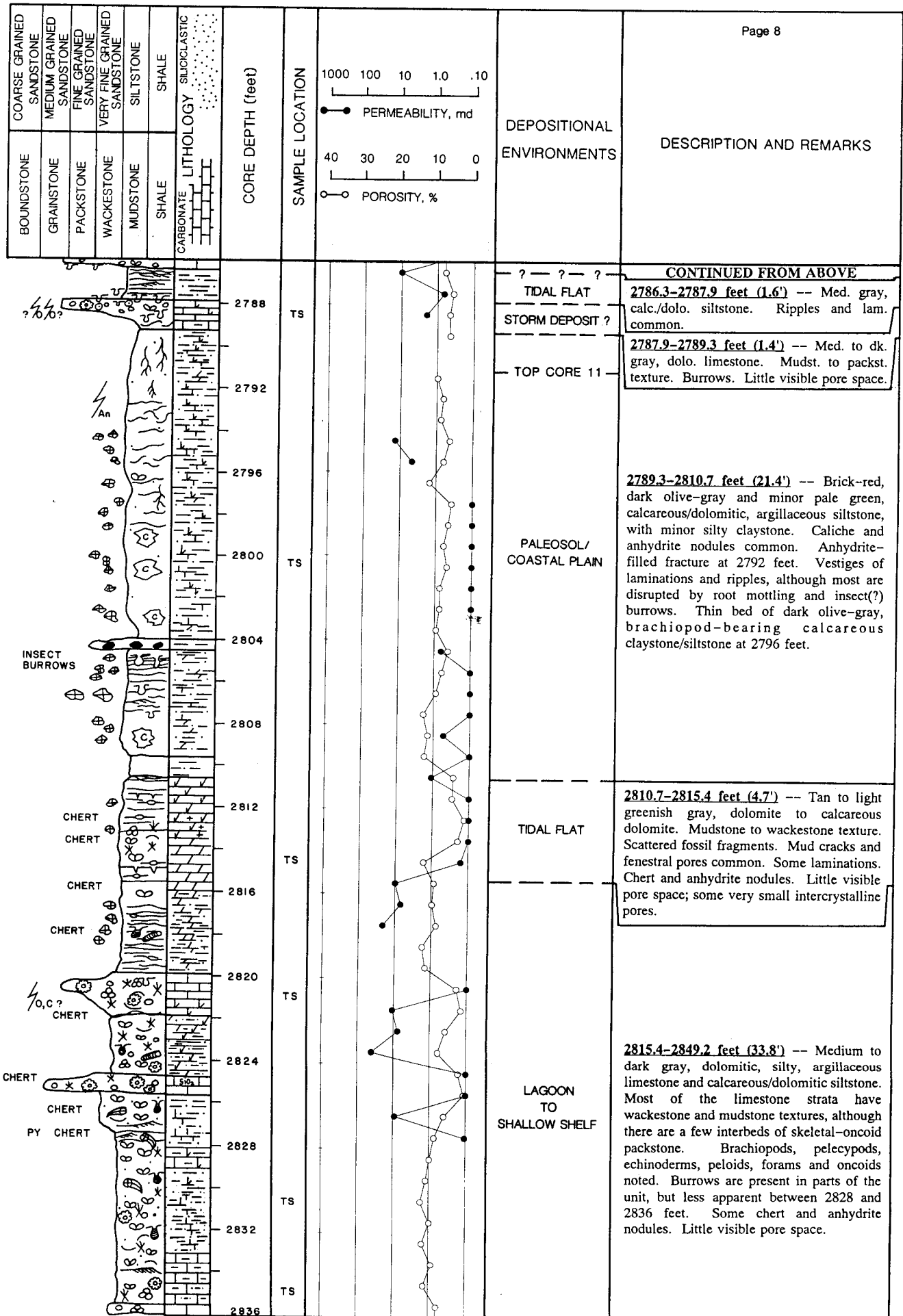
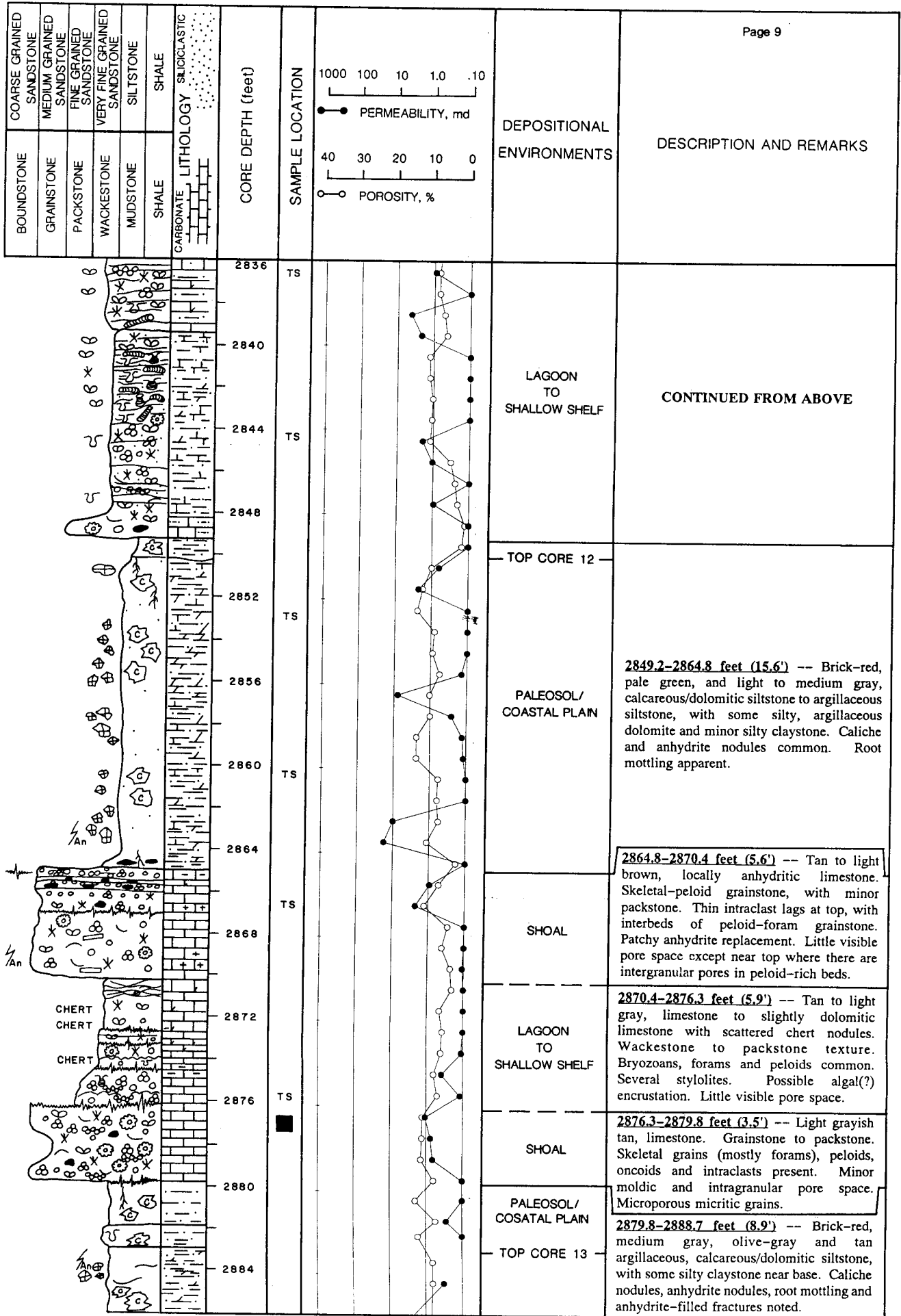
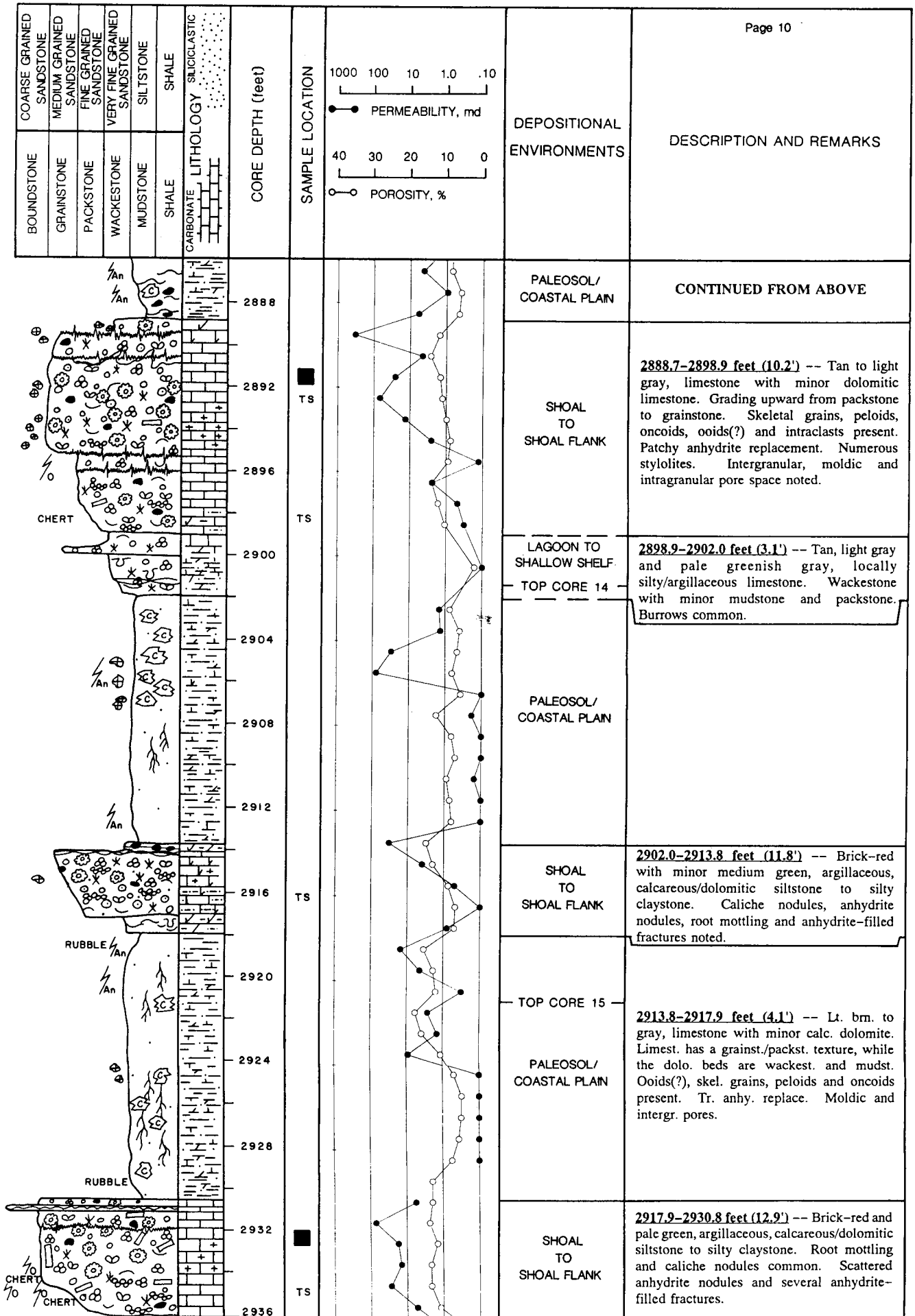


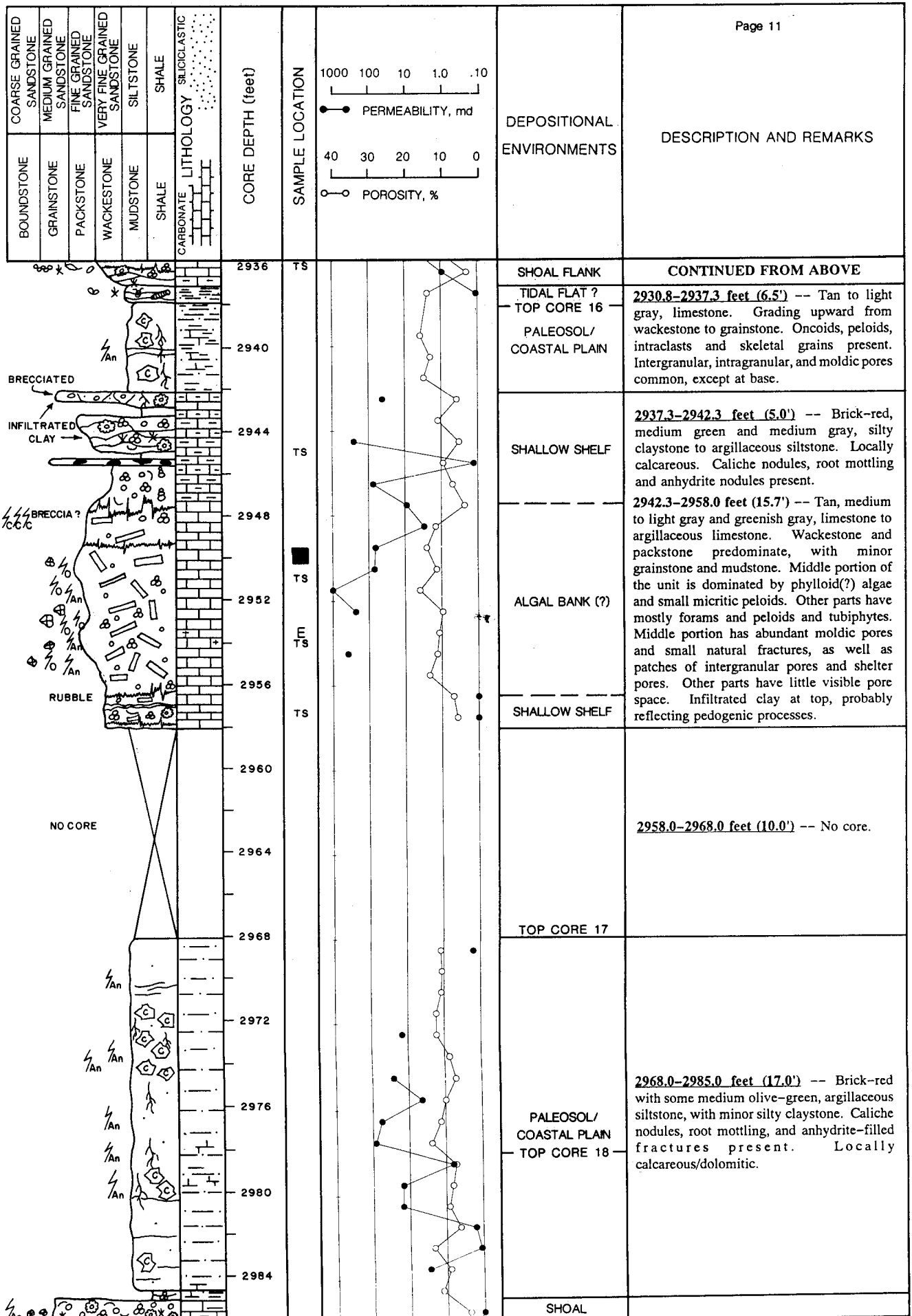
FIGURE 2 CONTINUED  
ANADARKO PETROLEUM CORPORATION  
FLOWER A-1



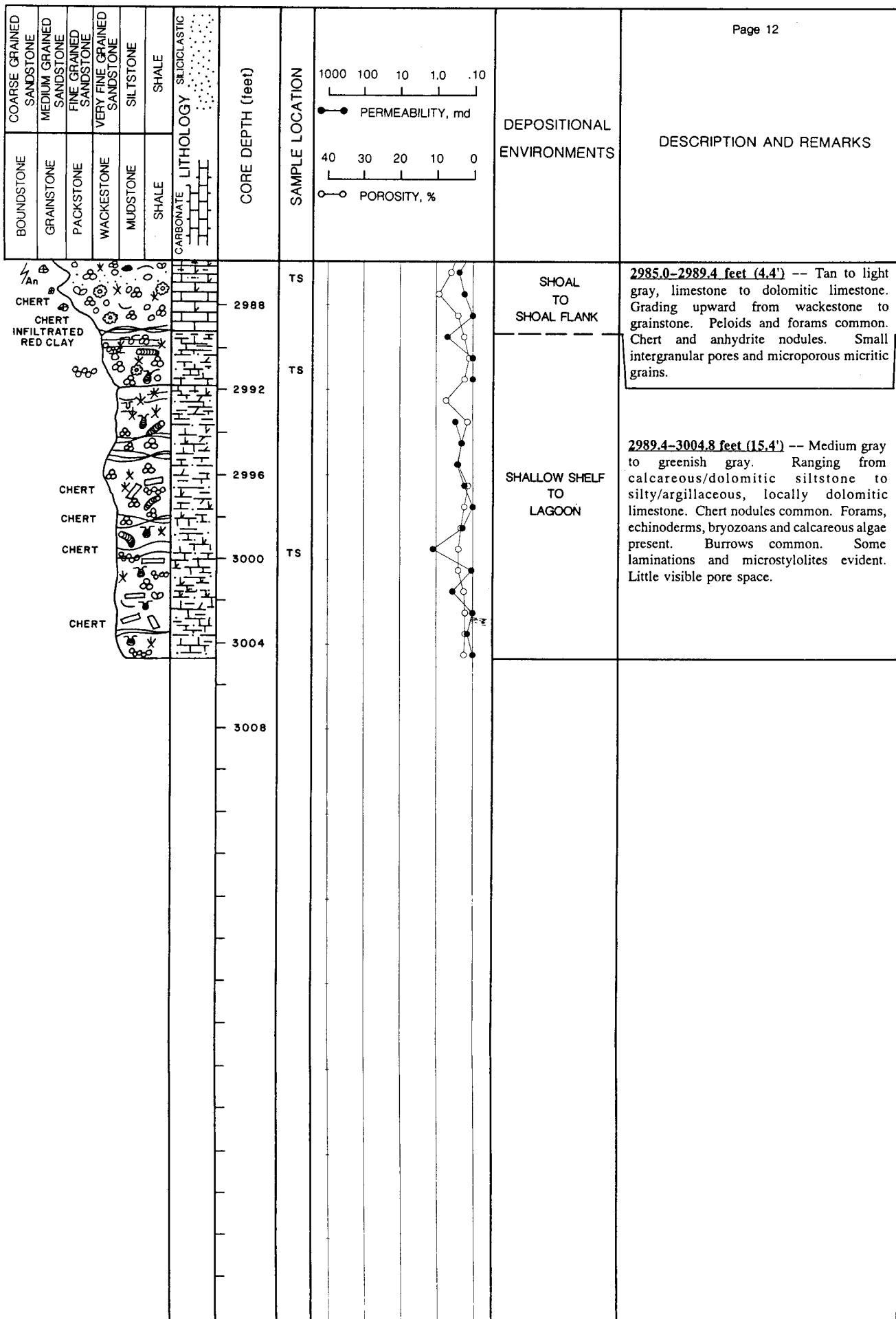
**FIGURE 2 CONTINUED**  
**ANADARKO PETROLEUM CORPORATION**  
**FLOWER A-1**



**FIGURE 2 CONTINUED**  
**ANADARKO PETROLEUM CORPORATION**  
**FLOWER A-1**



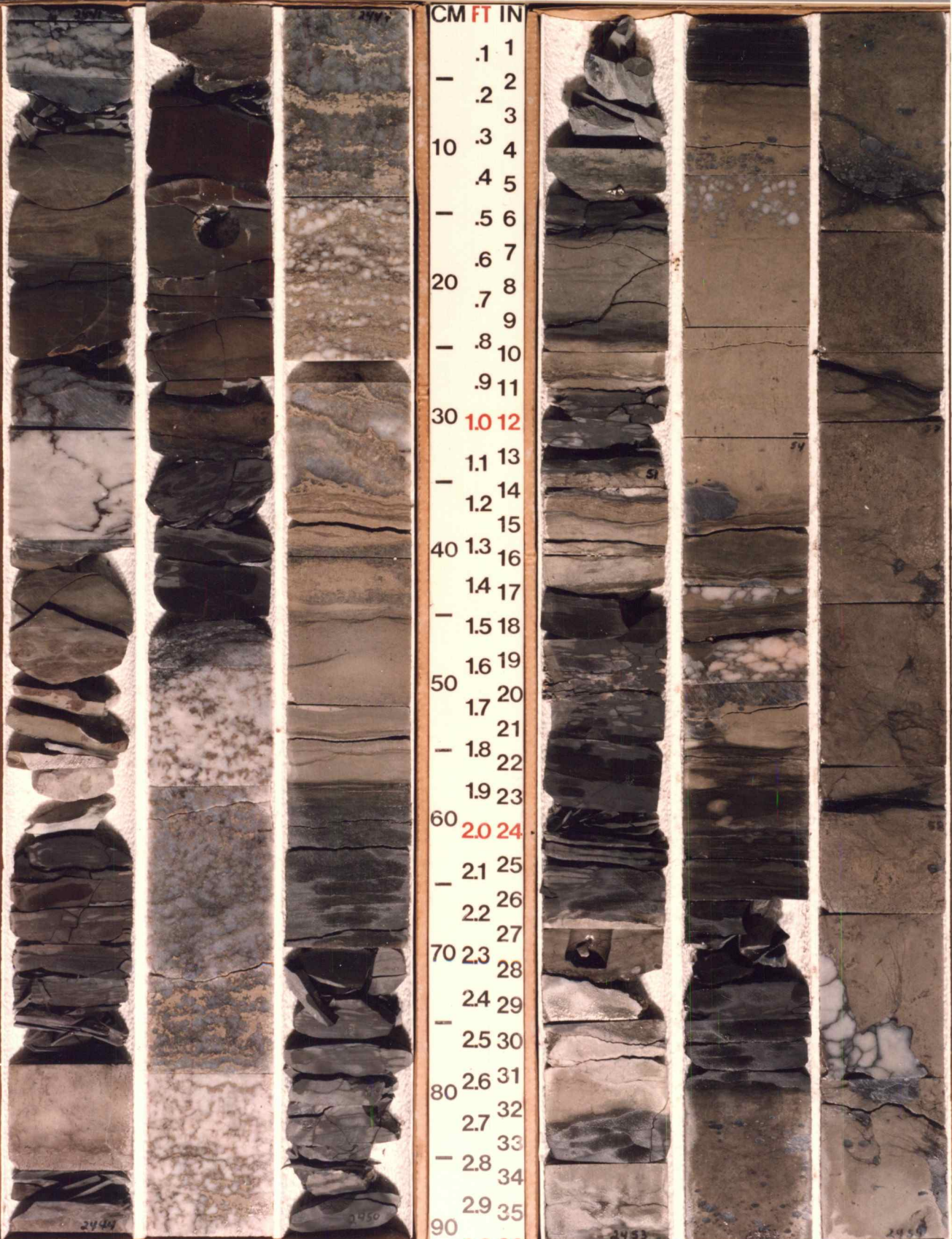
**FIGURE 2 CONTINUED**  
**ANADARKO PETROLEUM CORPORATION**  
**FLOWER A-1**



**FIGURE 3**

**CONTINUOUS CORE PHOTOGRAPHS  
ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL**

ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,441.0 - 2,459.0

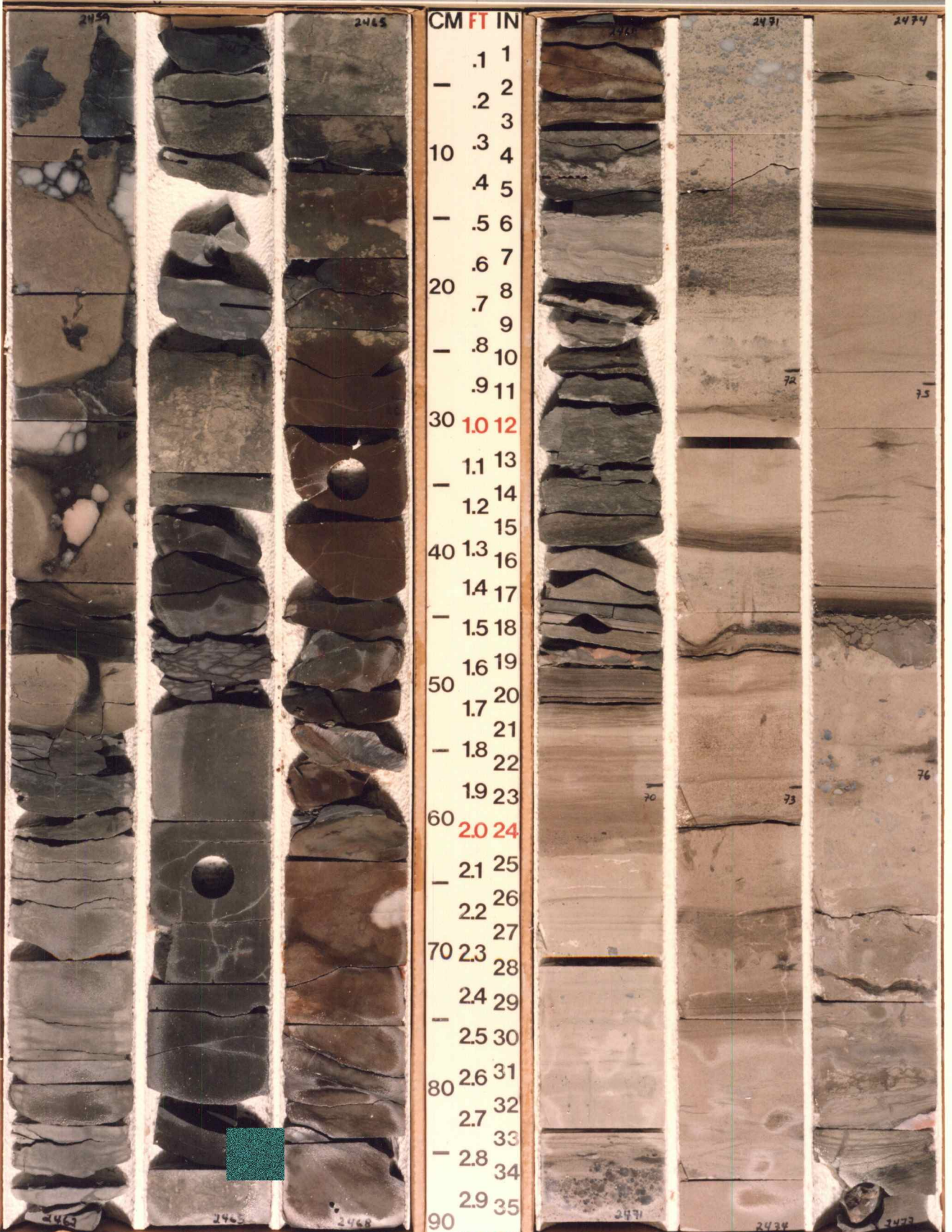


# ANADARKO PETROLEUM CORPORATION

## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,459.0 - 2,477.0

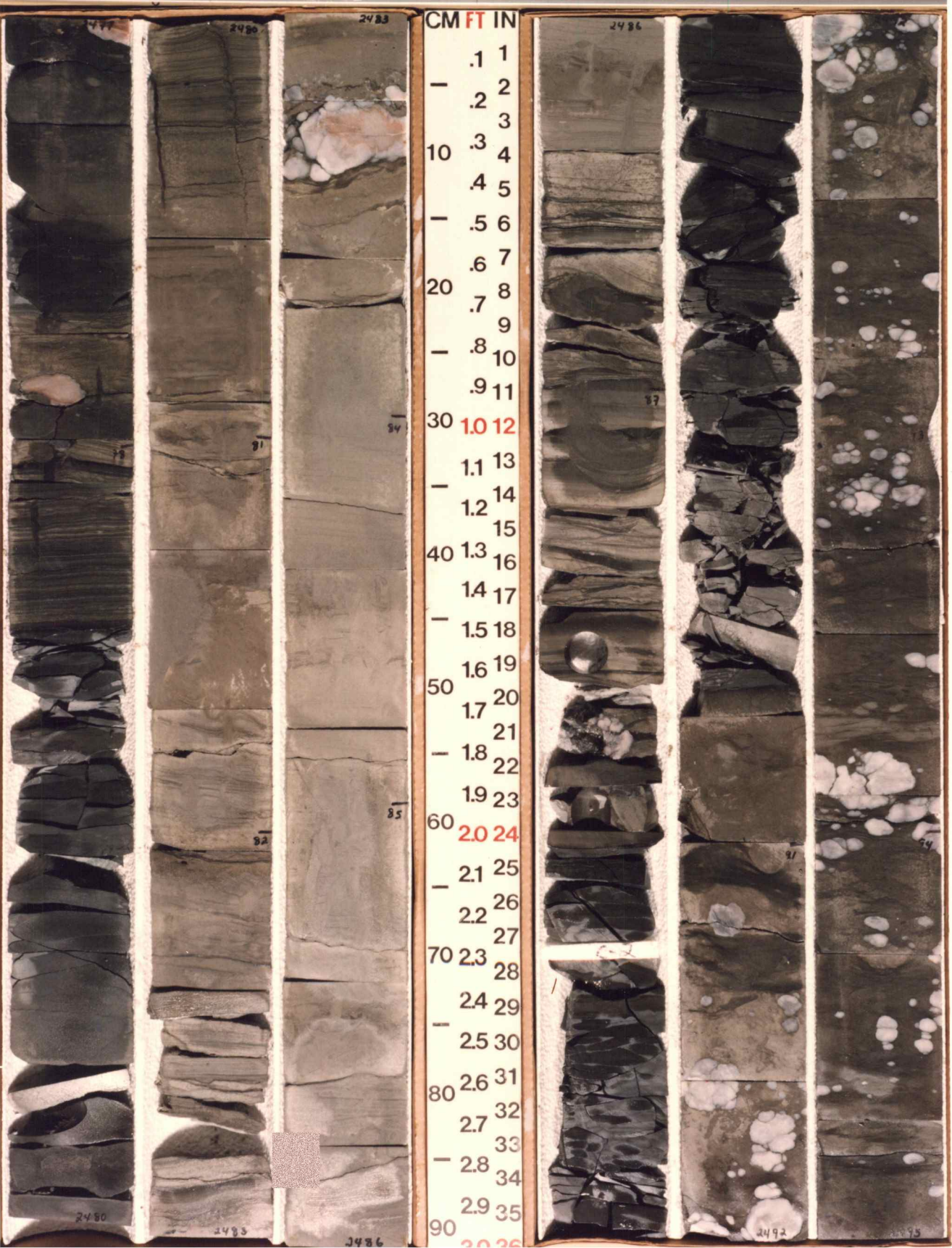


# ANADARKO PETROLEUM CORPORATION

## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,477.0 - 2,495.0

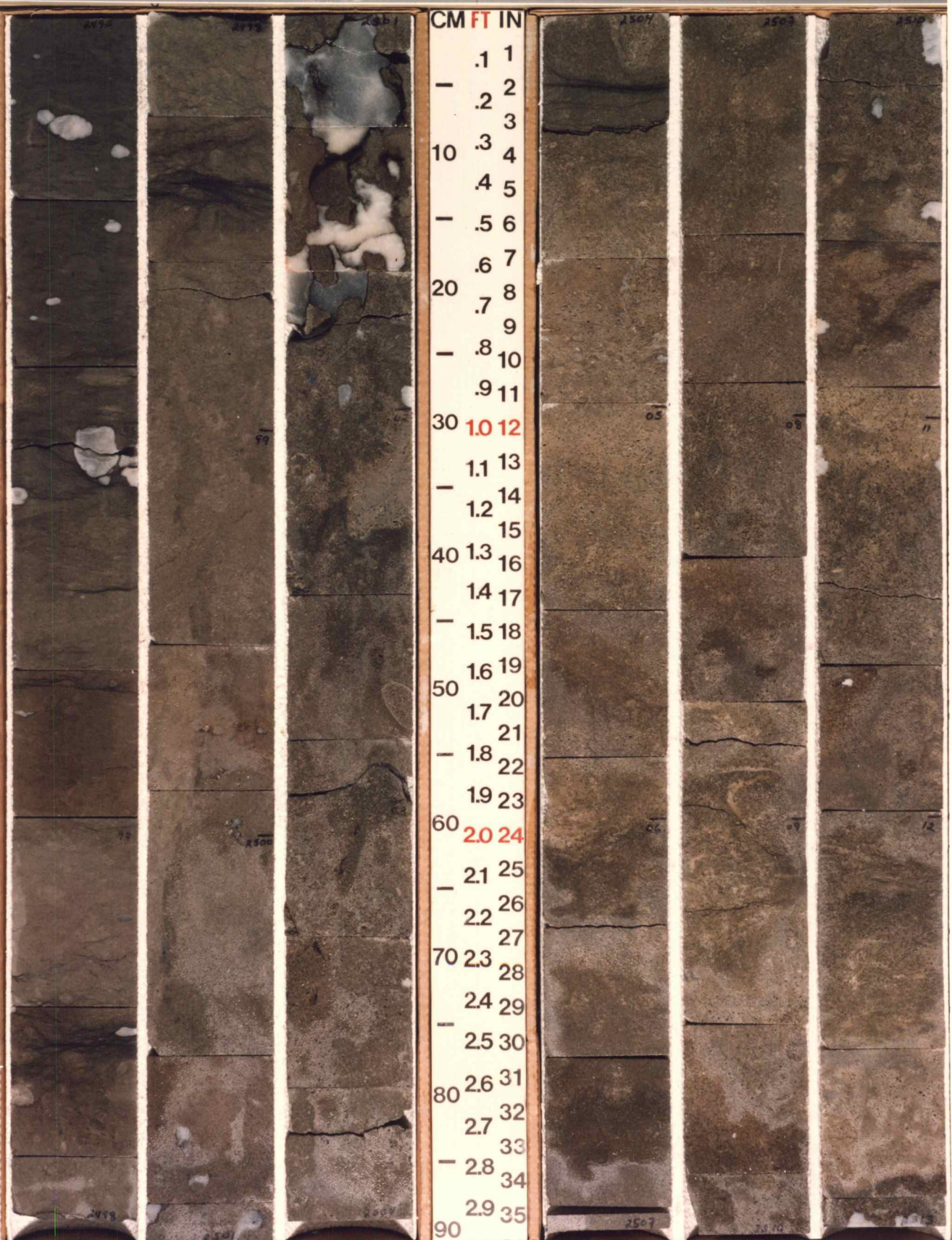


# ANADARKO PETROLEUM CORPORATION

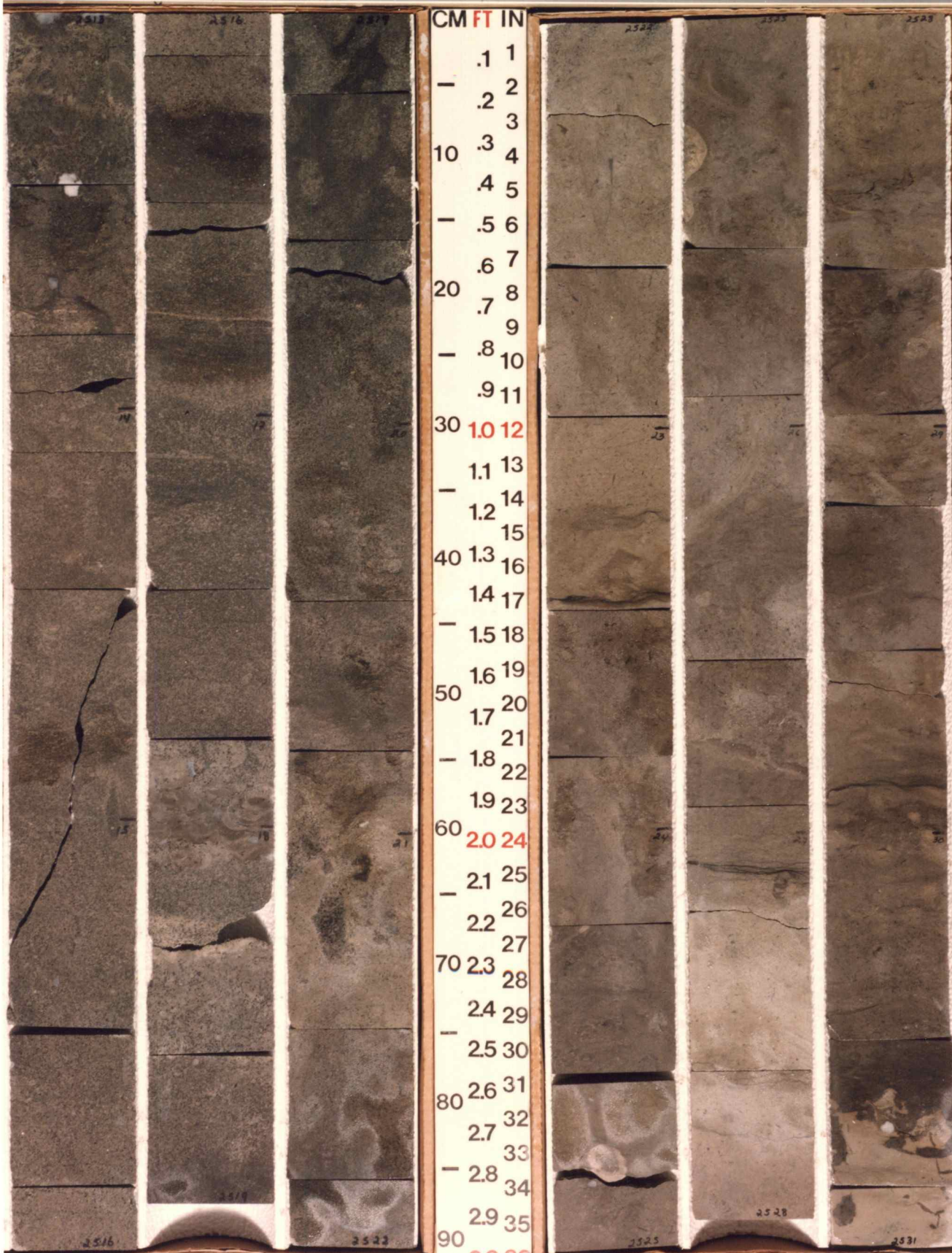
## FLOWER A - 1

### STEVENS COUNTY, KANSAS

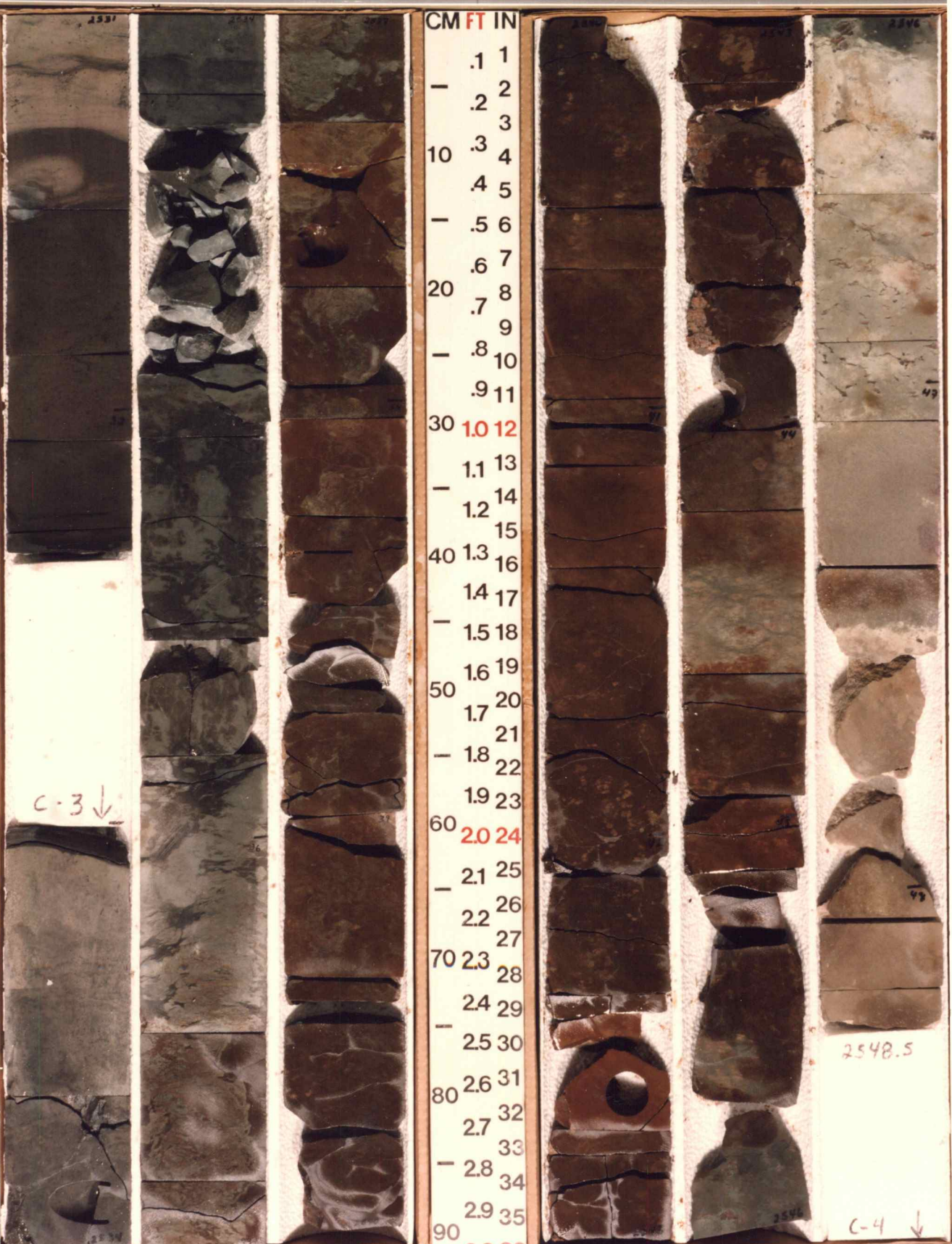
#### 2,495.0 - 2,513.0



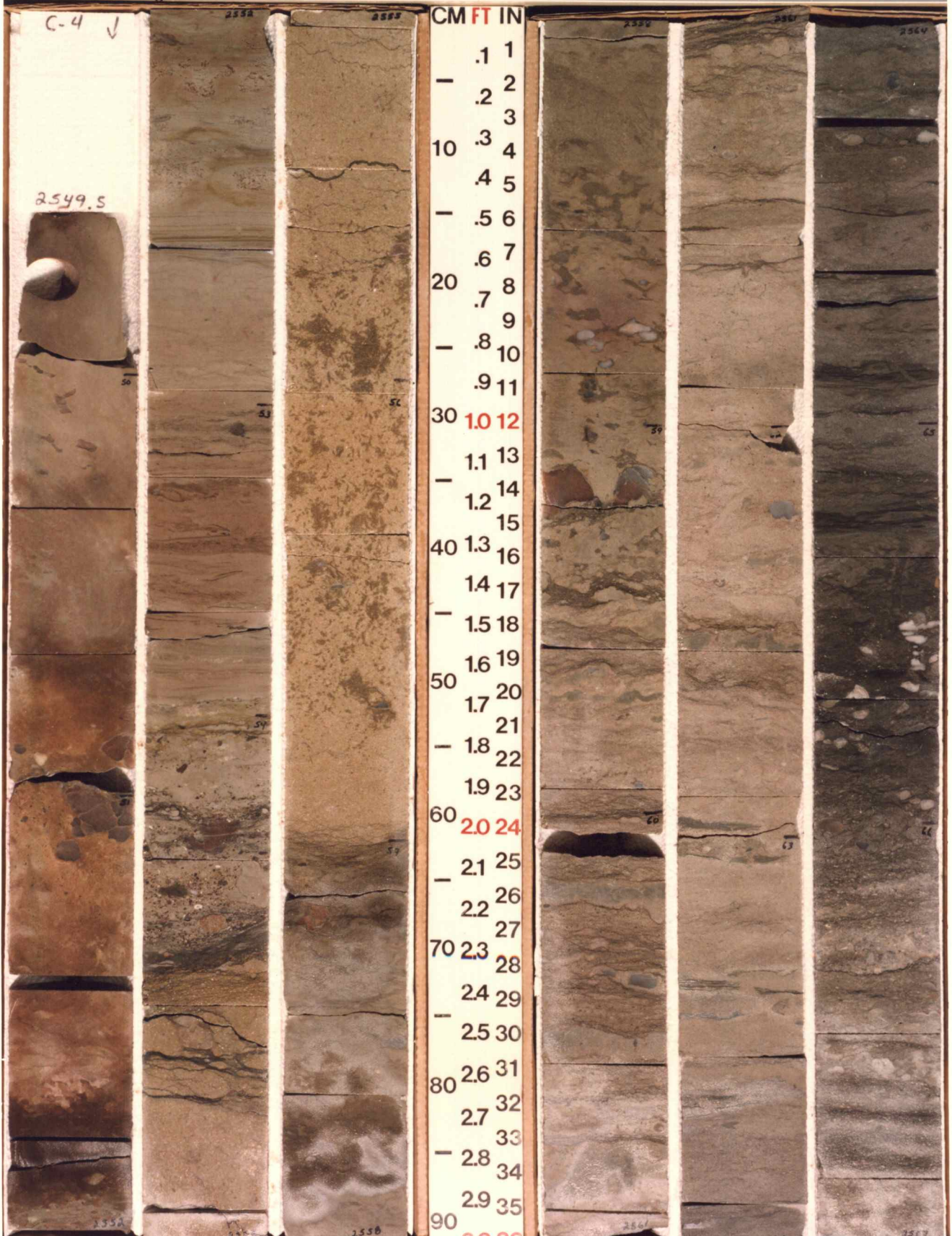
ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,513.0 - 2,531.0



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,531.0 - 2,548.5



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,549.5 - 2,567.0

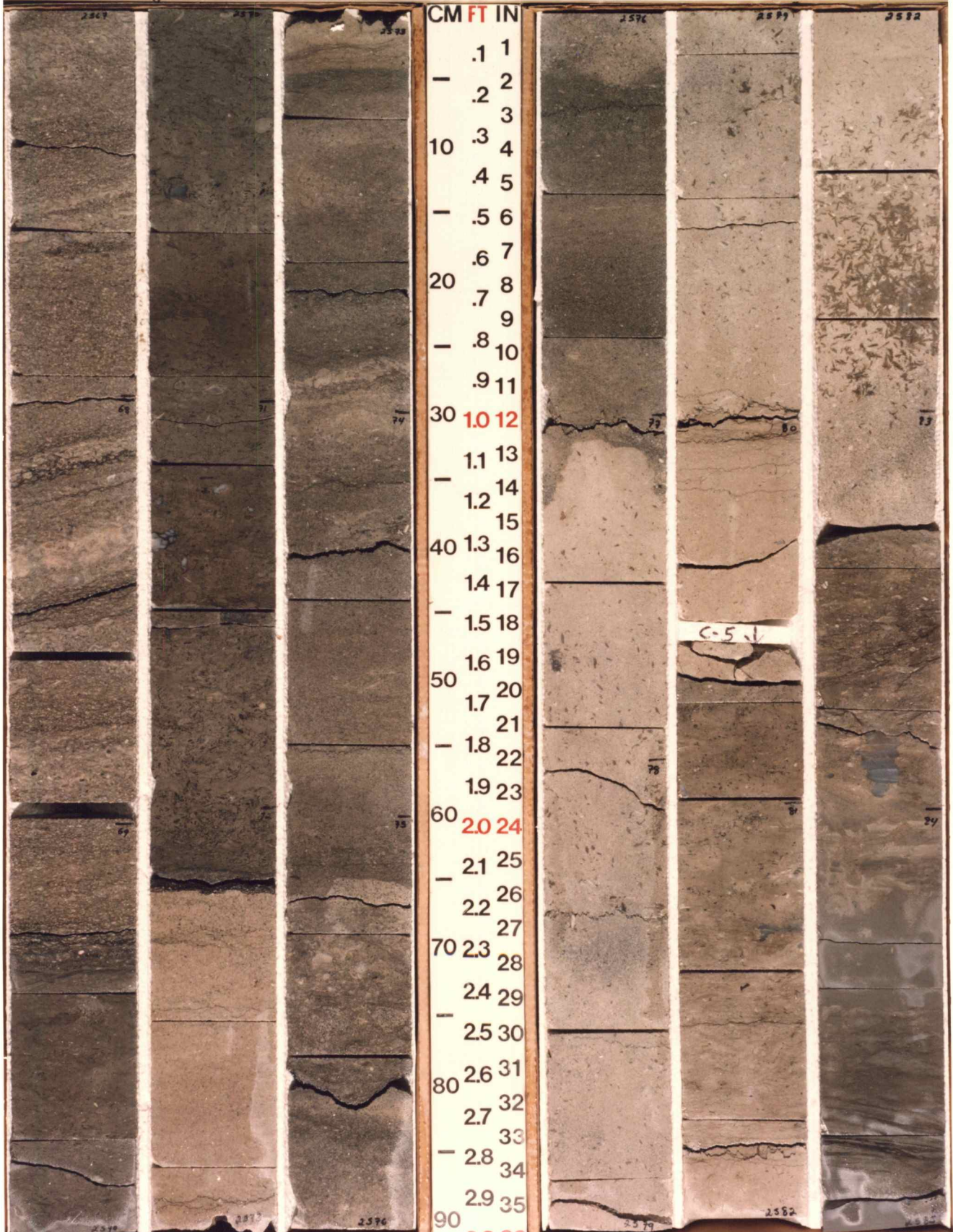


# ANADARKO PETROLEUM CORPORATION

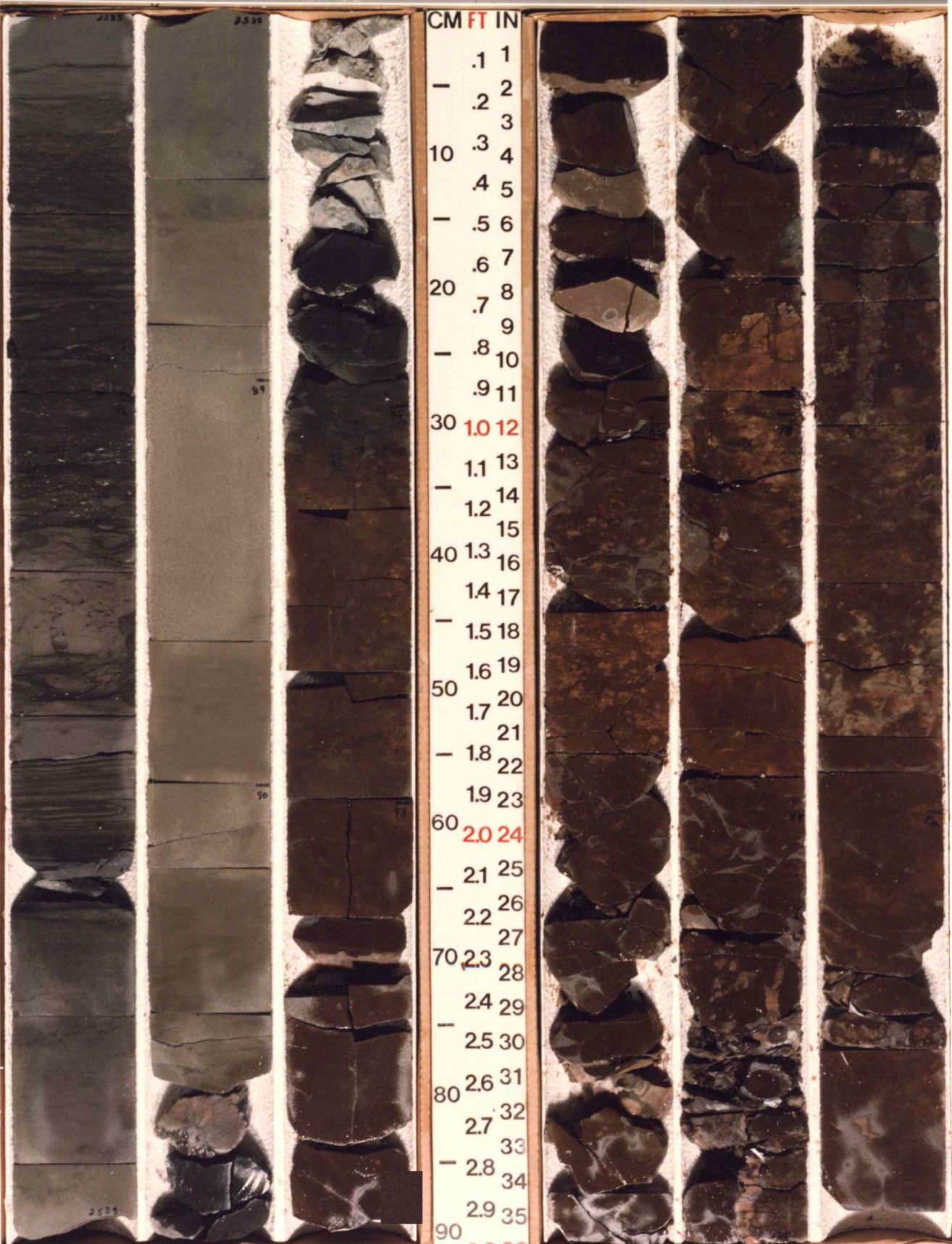
## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,567.0 - 2,585.0



ANADARKO PETROLEUM CORPORATION  
FLOWER A-1  
STEVENS COUNTY, KANSAS  
2,585.0 - 2,603.0

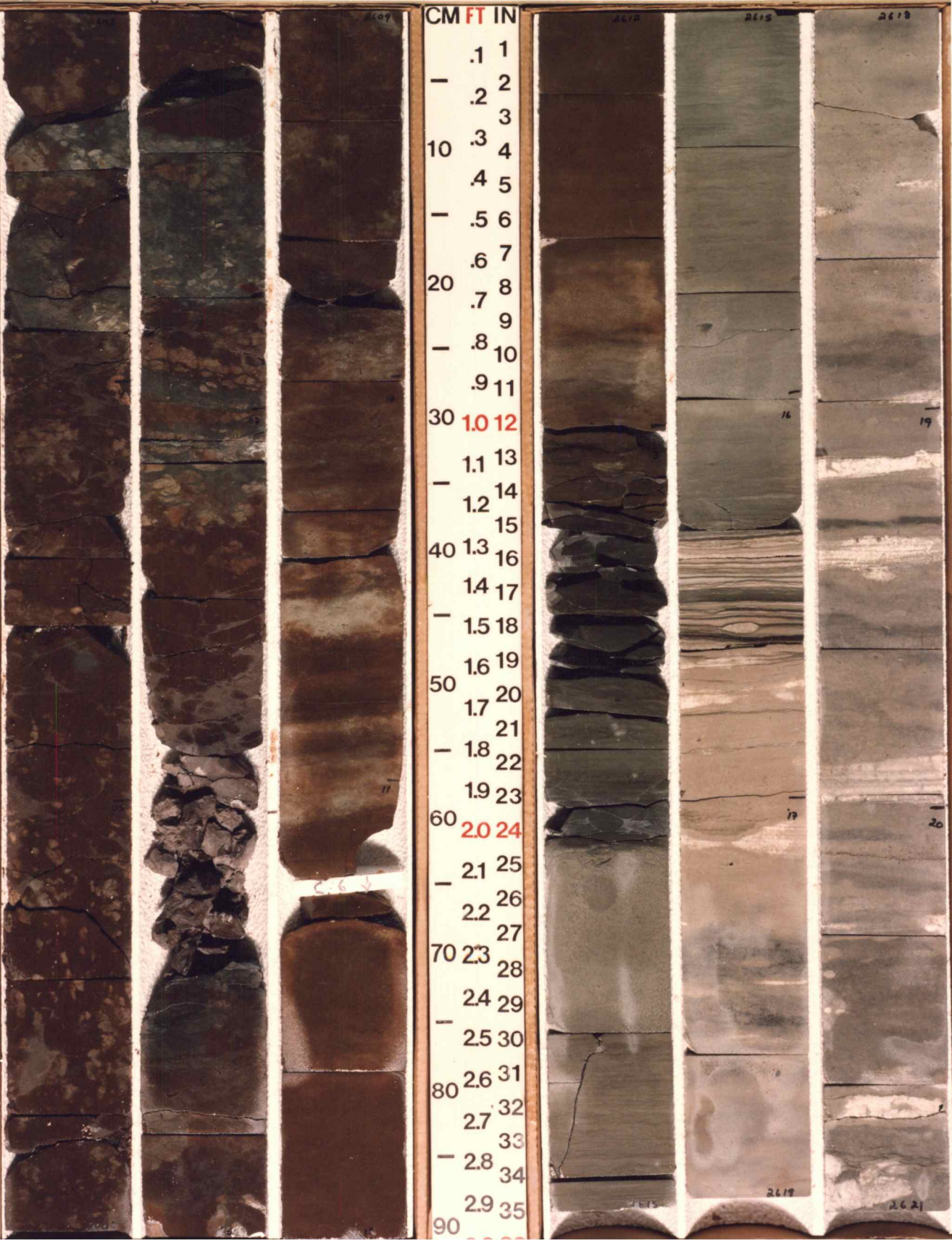


# ANADARKO PETROLEUM CORPORATION

## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,603.0 - 2,621.0

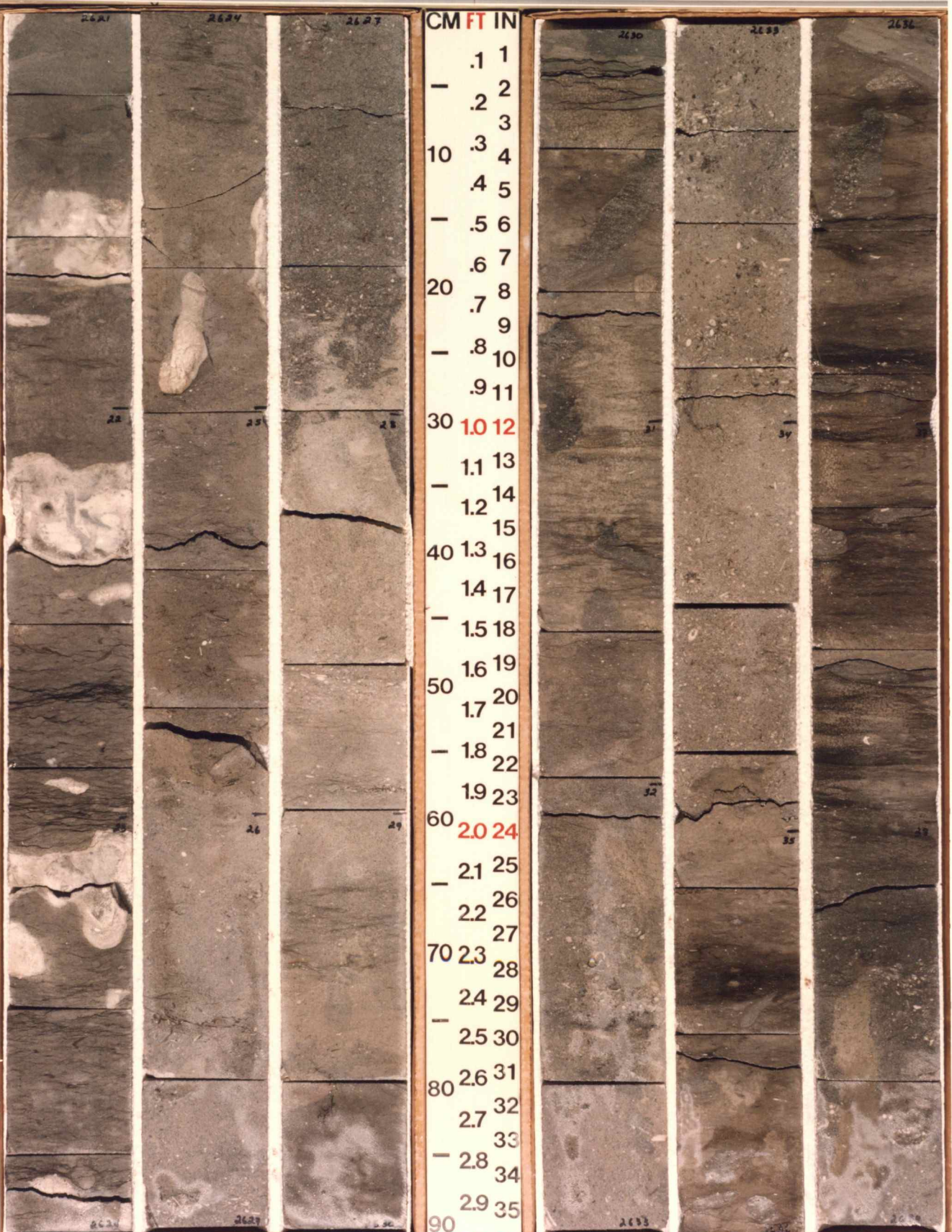


# ANADARKO PETROLEUM CORPORATION

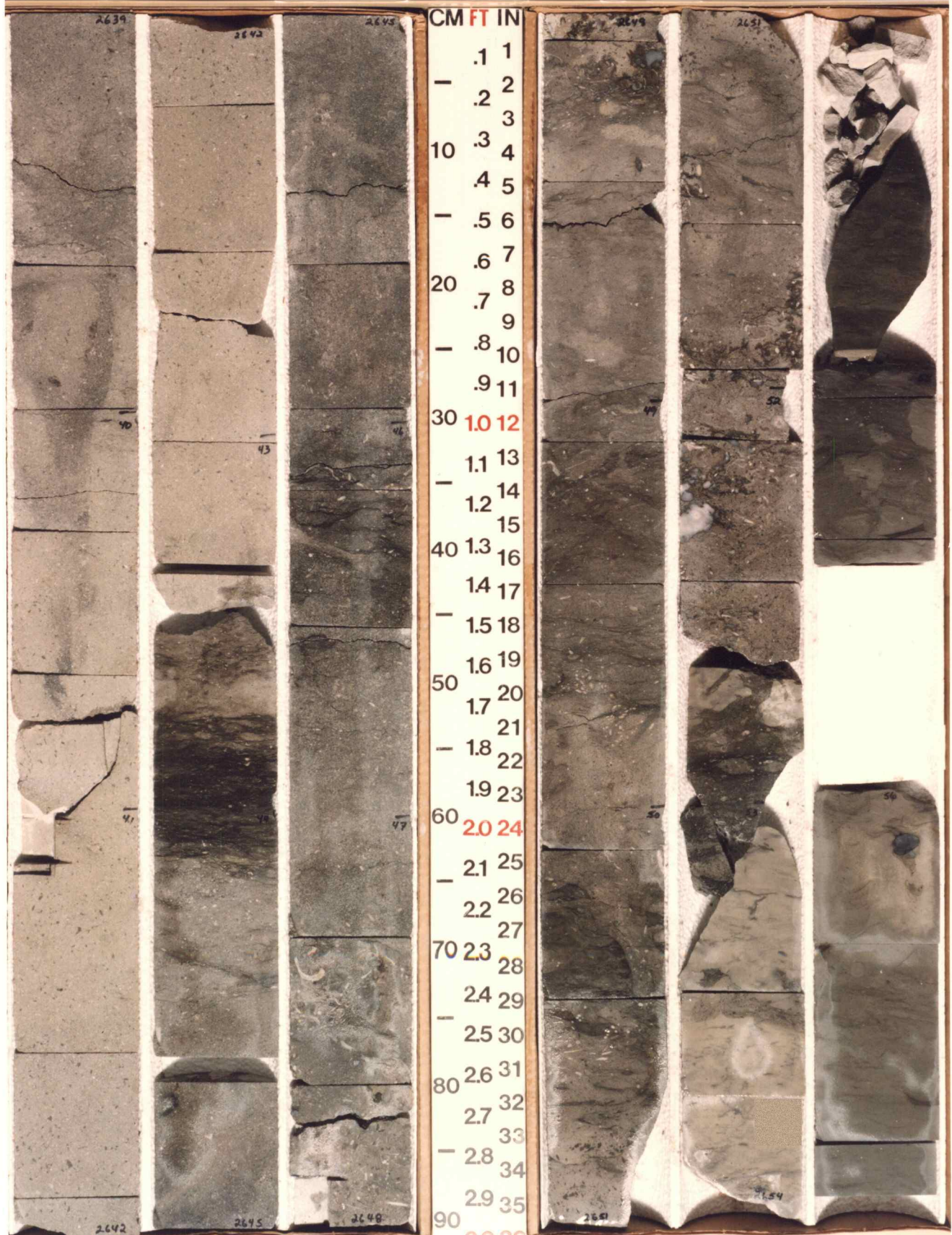
## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,621.0 - 2,639.0



# ANADARKO PETROLEUM CORPORATION FLOWER A-1 STEVENS COUNTY, KANSAS 2,639.0 - 2,657.0

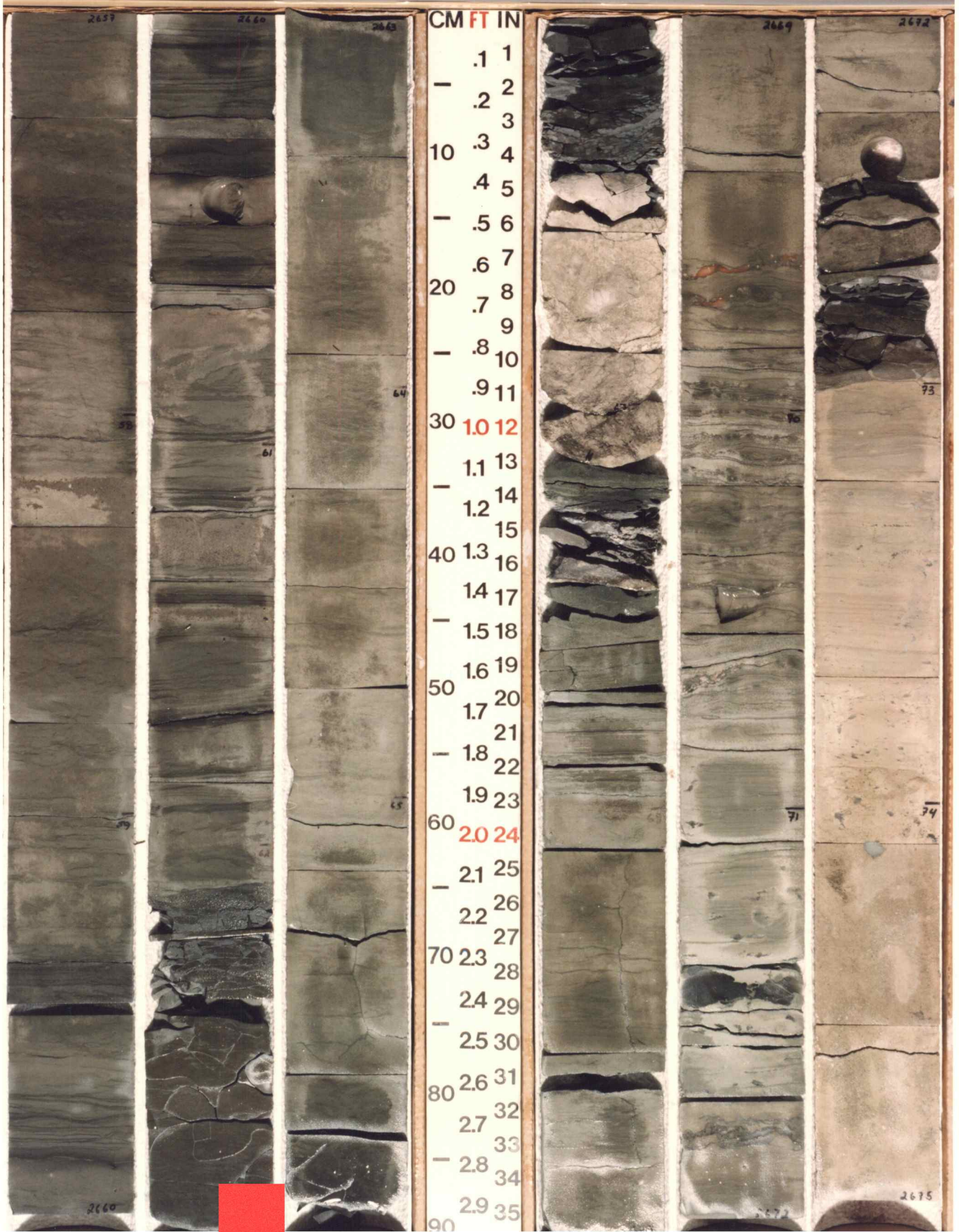


# ANADARKO PETROLEUM CORPORATION

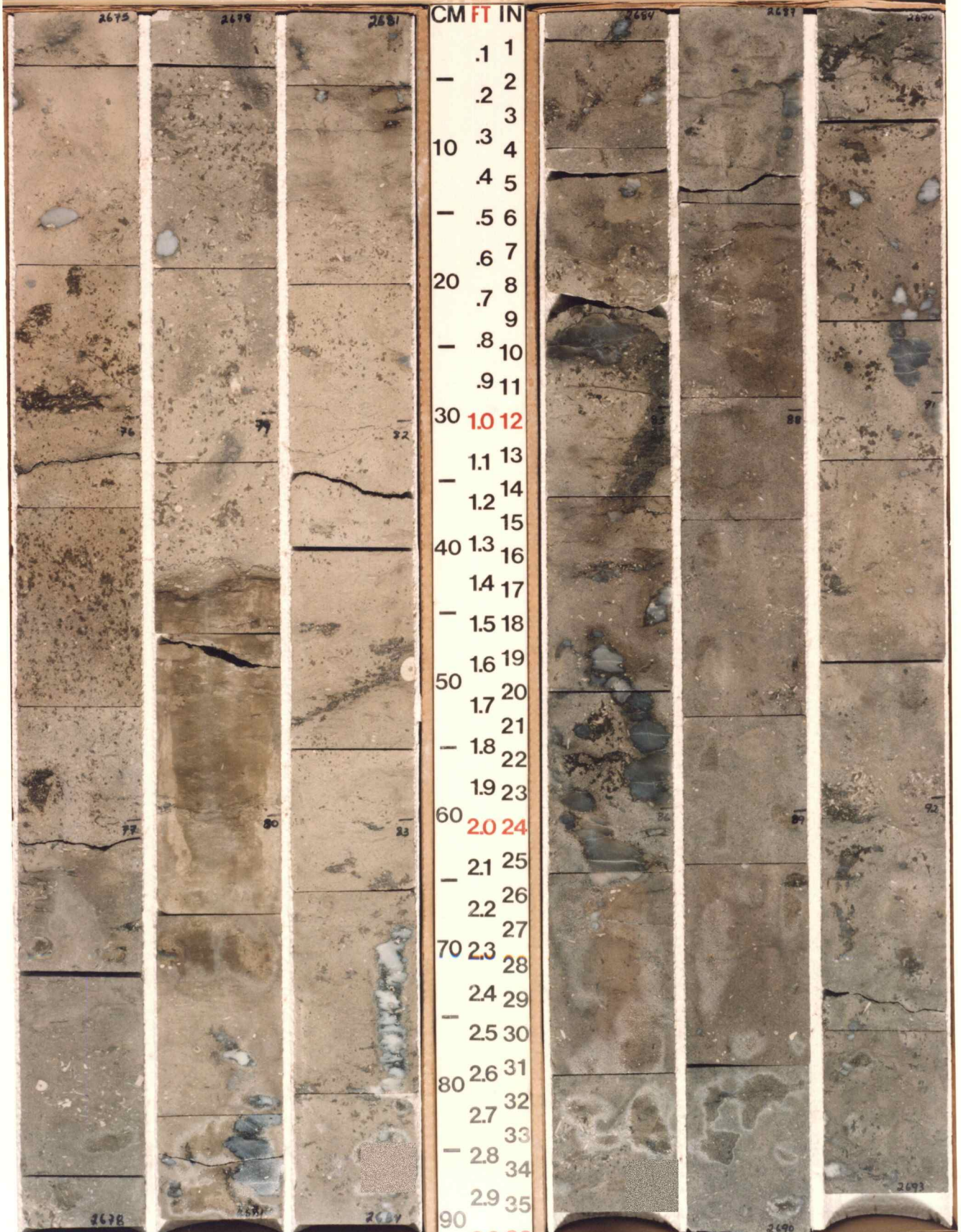
## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,657.0 - 2,675.0



# ANADARKO PETROLEUM CORPORATION FLOWER A-1 STEVENS COUNTY, KANSAS 2,675.0 - 2,693.0

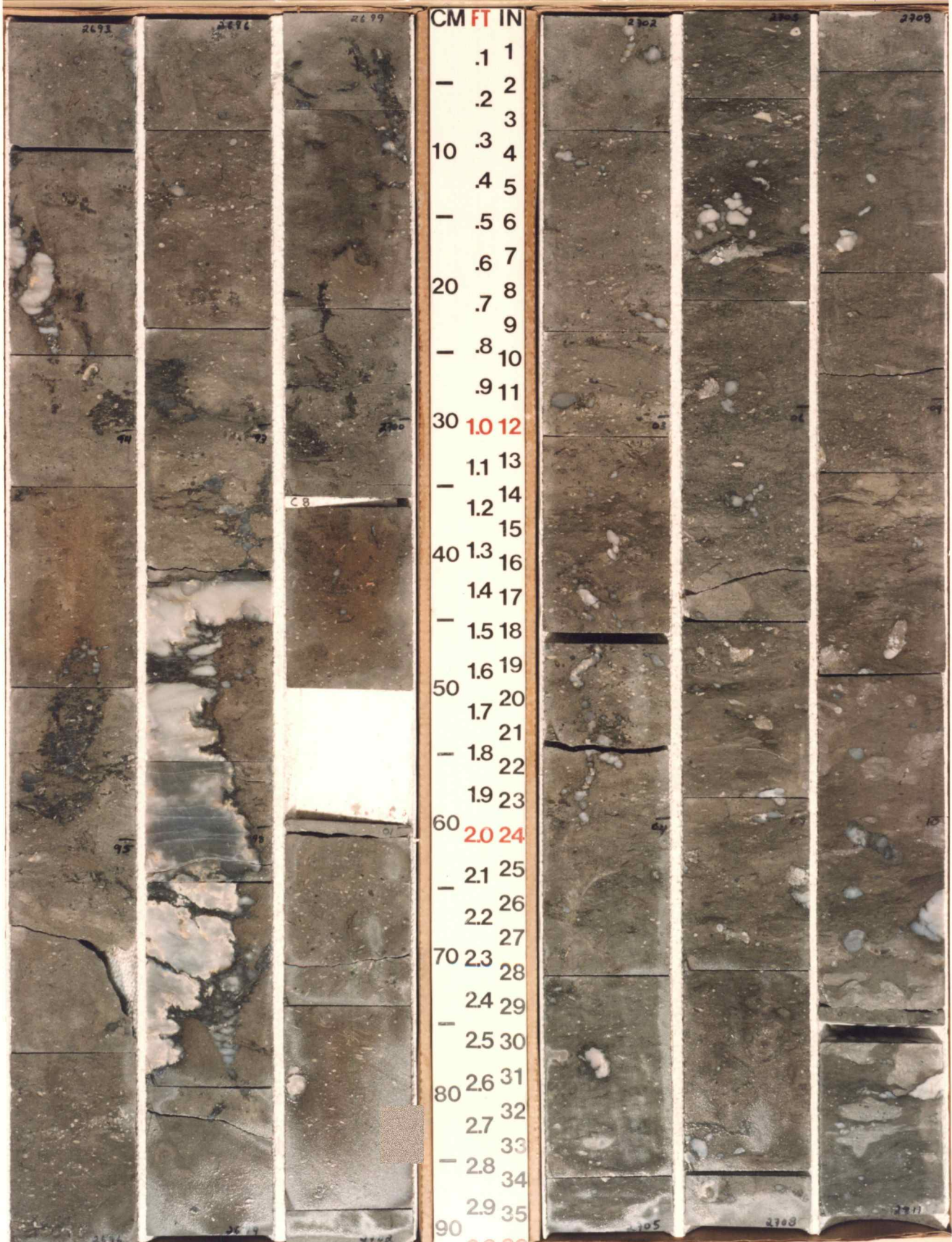


# ANADARKO PETROLEUM CORPORATION

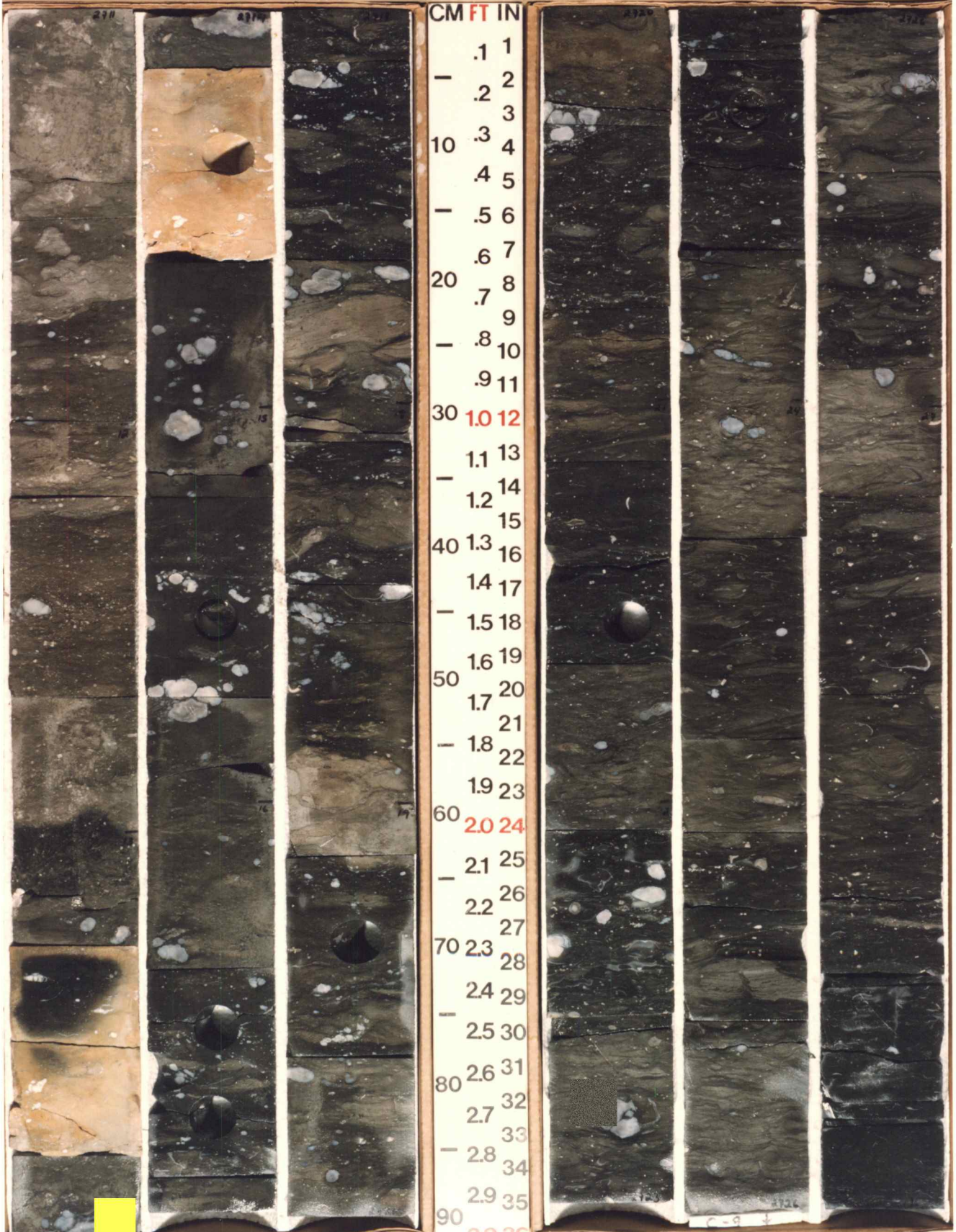
## FLOWER A-1

### STEVENS COUNTY, KANSAS

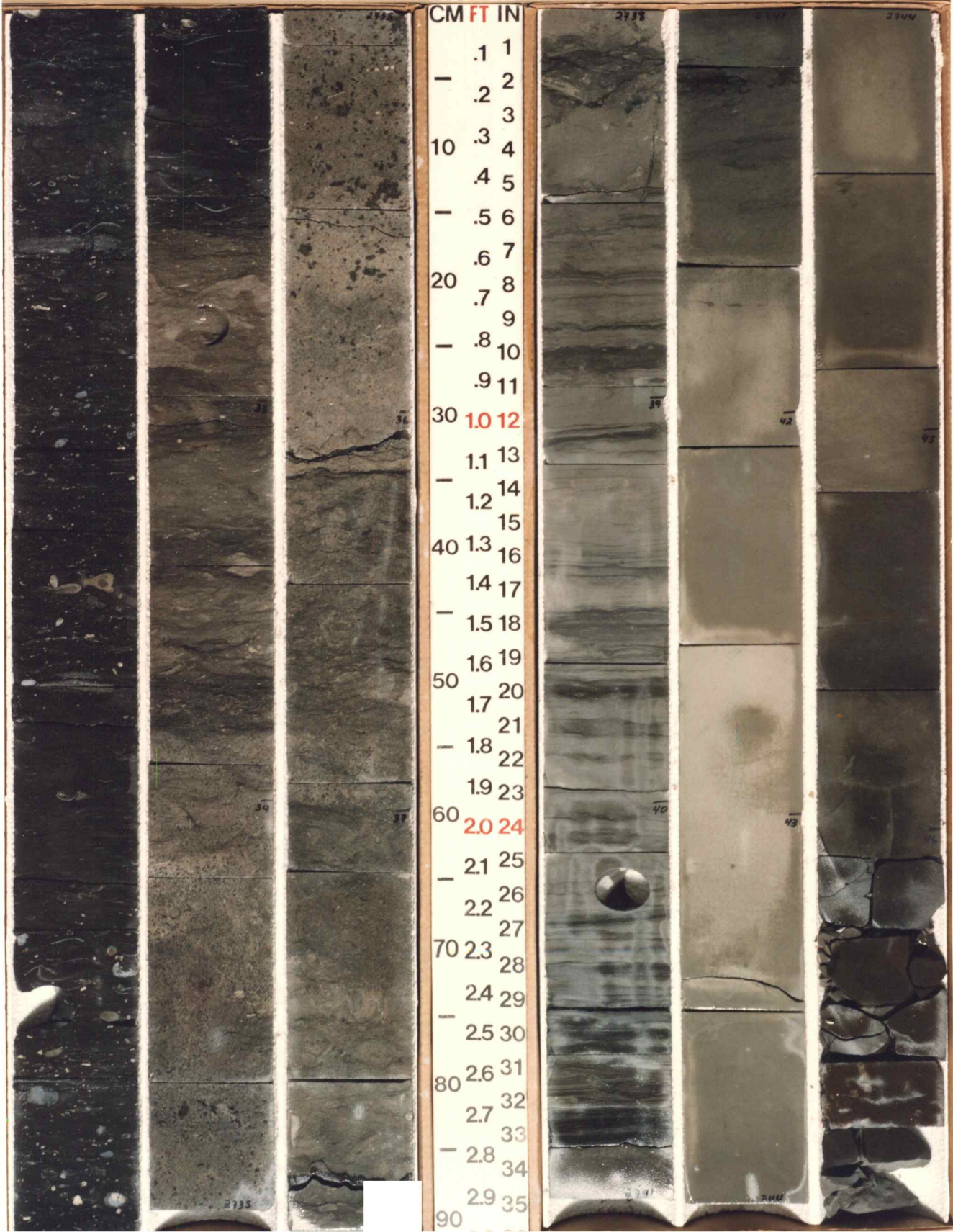
#### 2,693.0 - 2,711.0



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,711.0 - 2,729.0

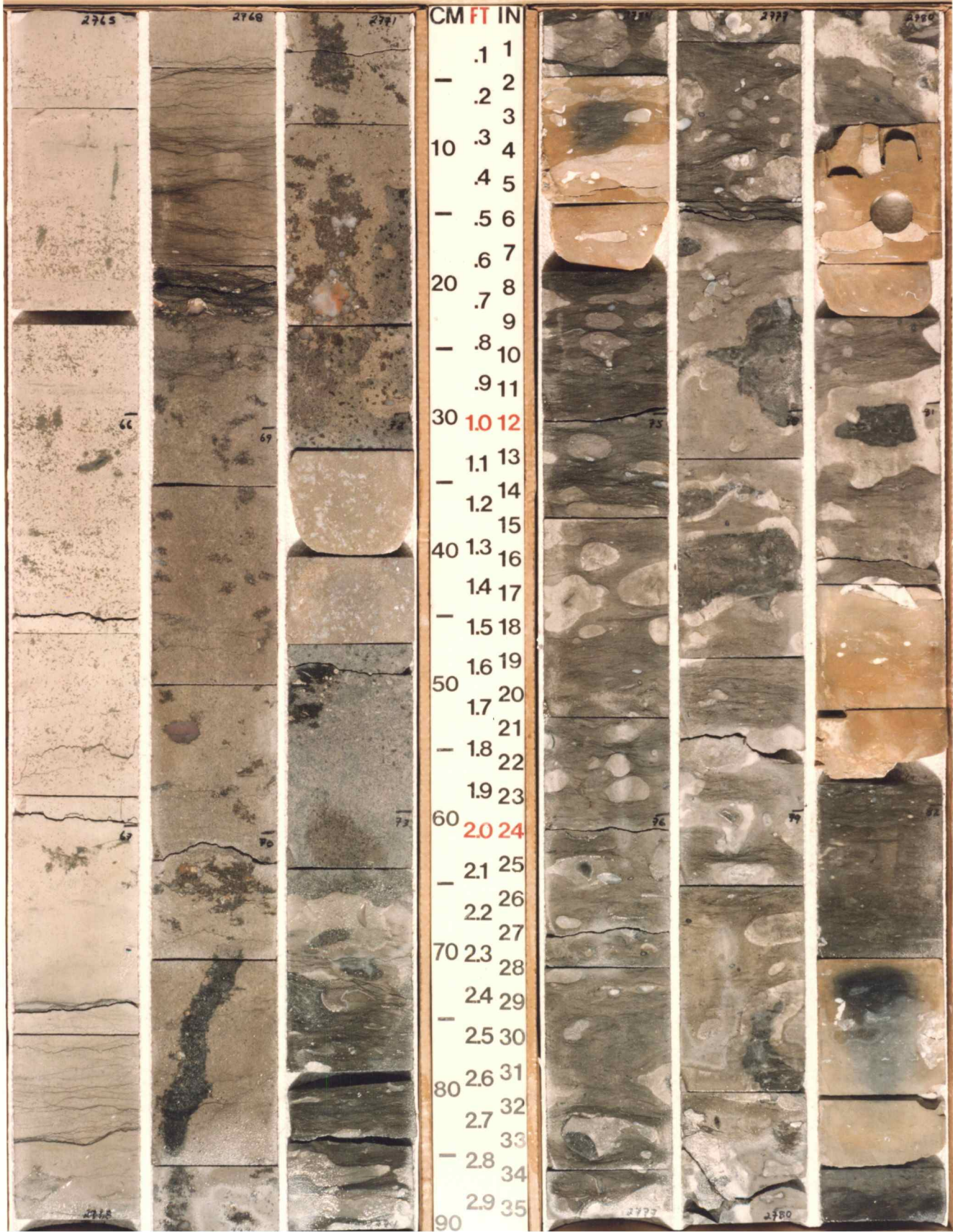


ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,729.0 - 2,747.0

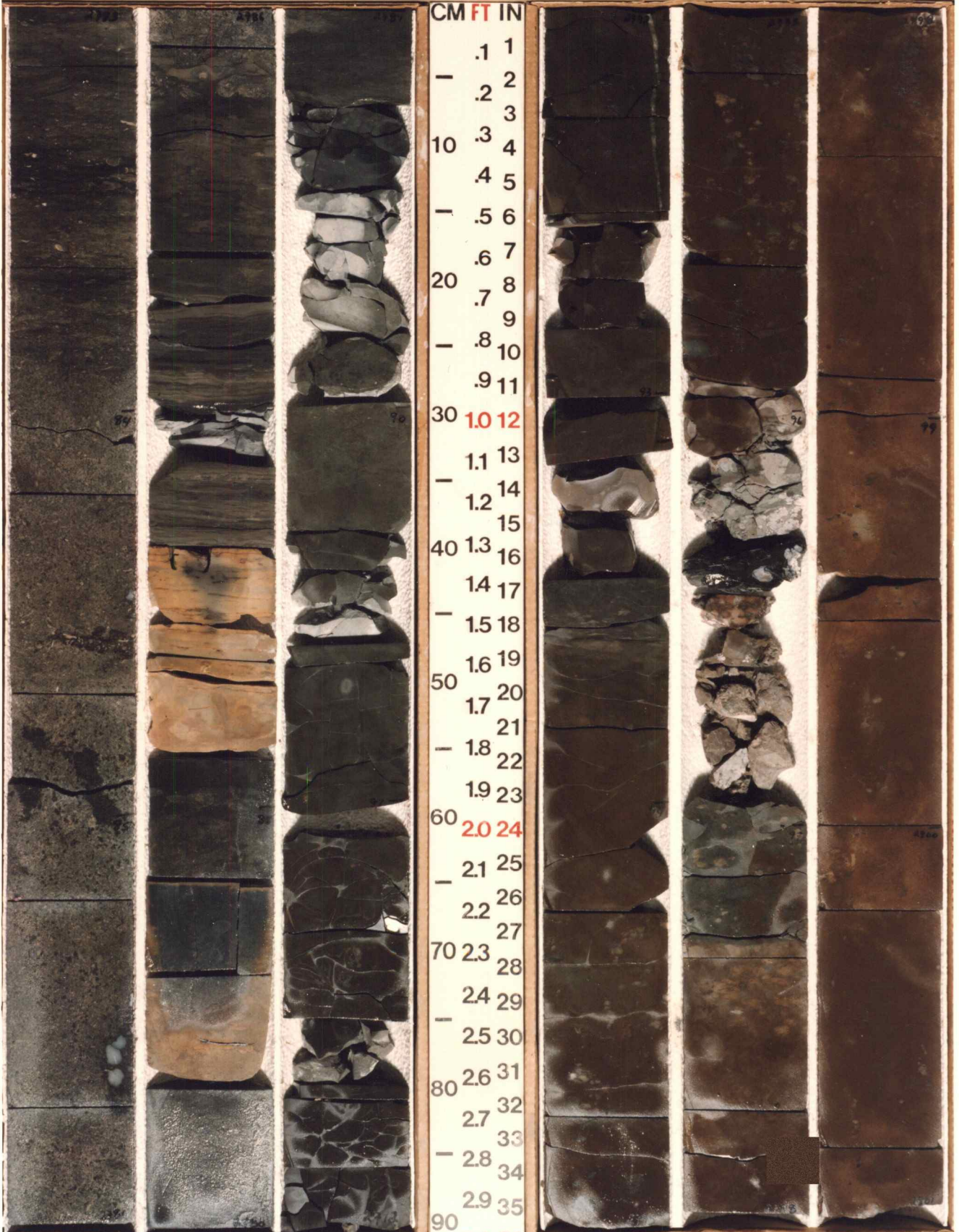




# ANADARKO PETROLEUM CORPORATION FLOWER A-1 STEVENS COUNTY, KANSAS 2,765.0 - 2,783.0



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,783.0 - 2,801.0

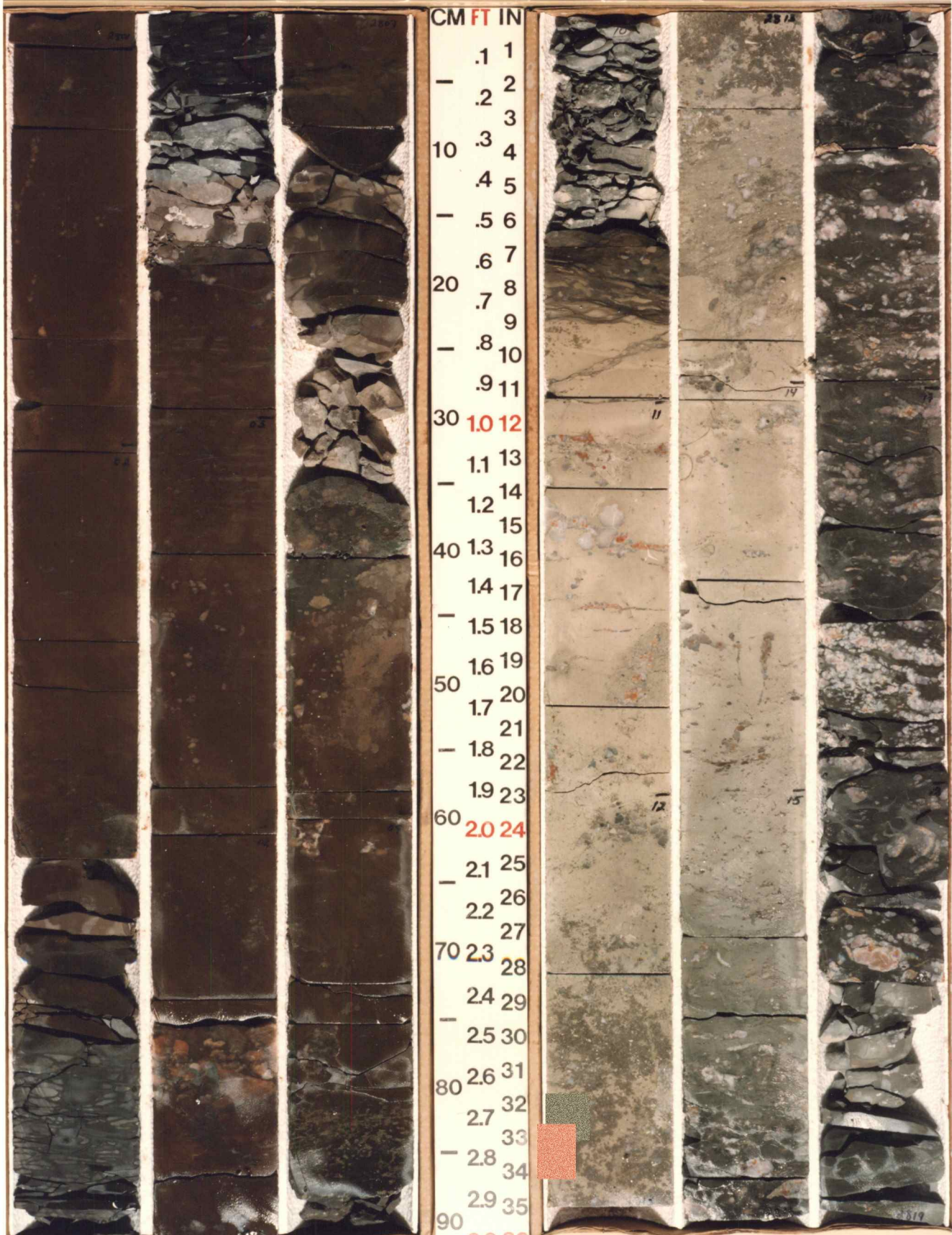


# ANADARKO PETROLEUM CORPORATION

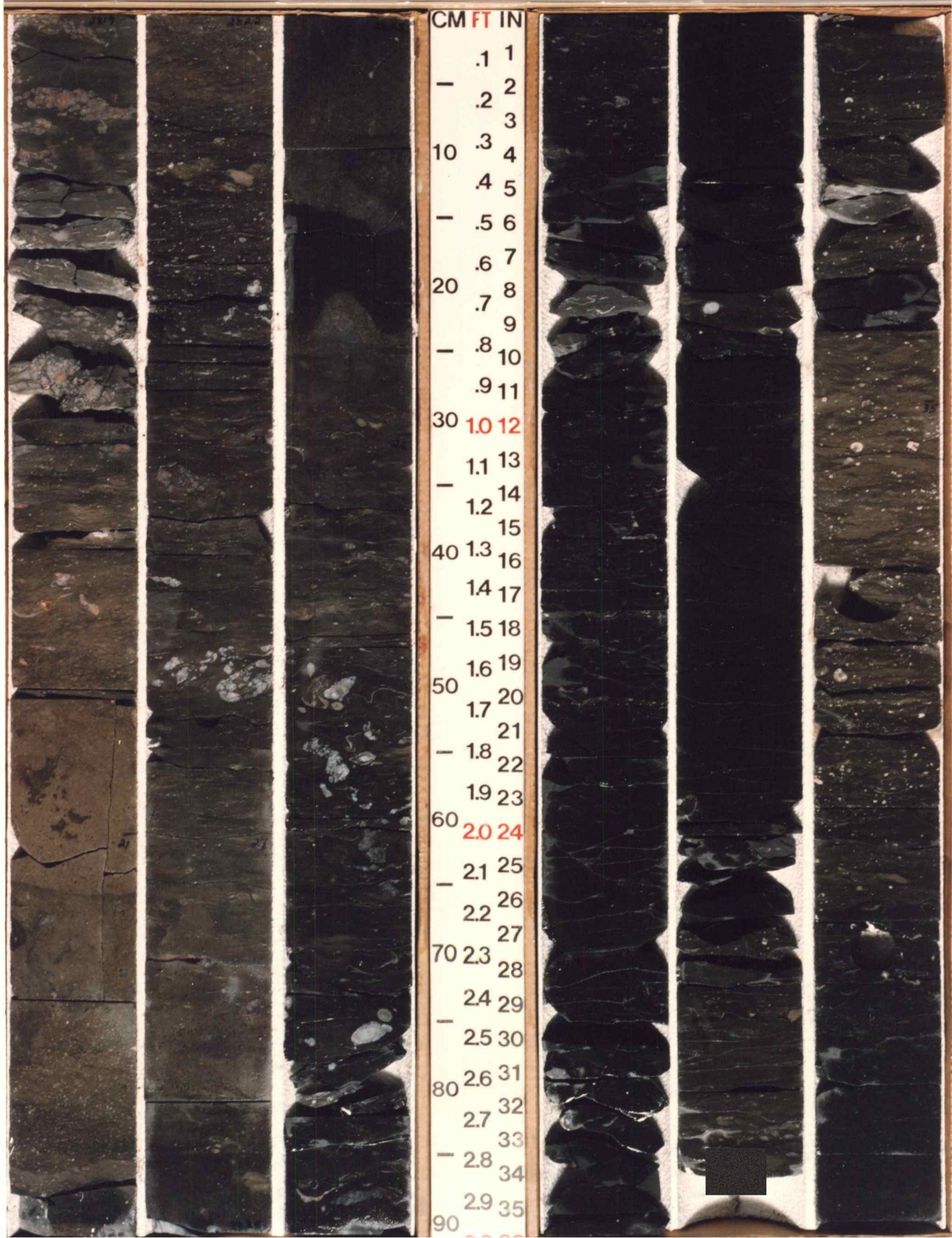
## FLOWER A-1

### STEVENS COUNTY, KANSAS

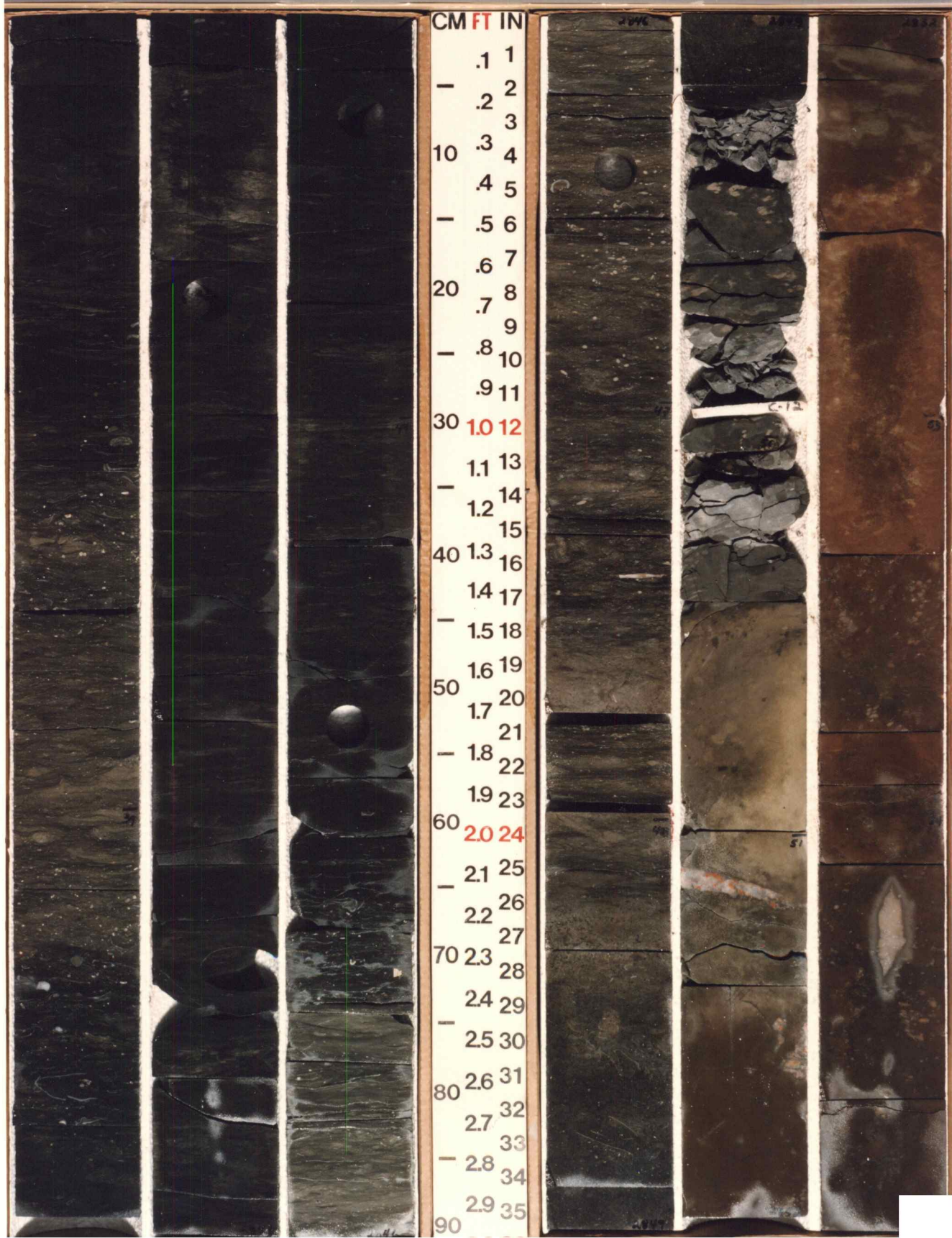
2,801.0 - 2,819.0



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,819.0 - 2,837.0



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,837.0 - 2,855.0



# ANADARKO PETROLEUM CORPORATION

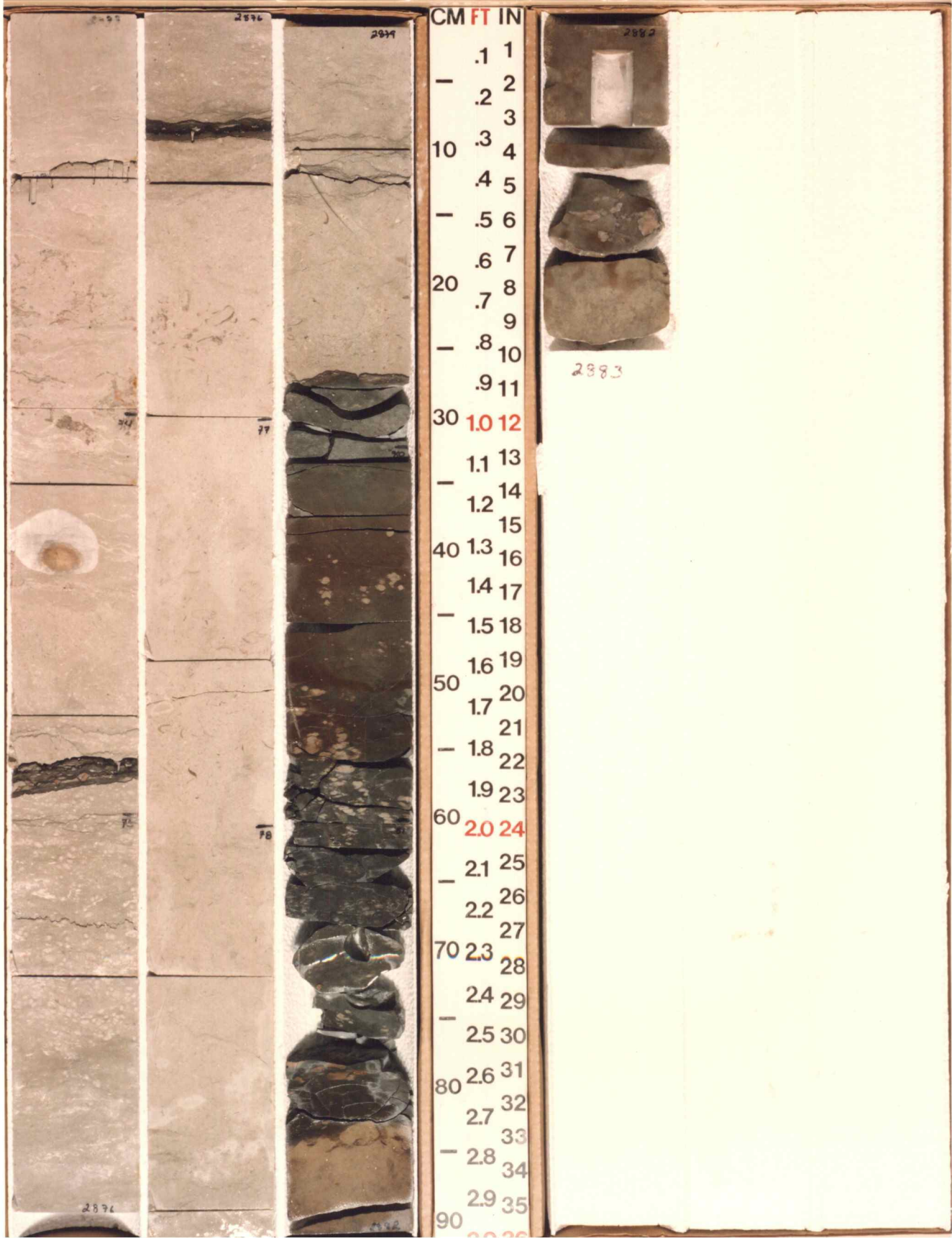
## FLOWER A-1

### STEVENS COUNTY, KANSAS

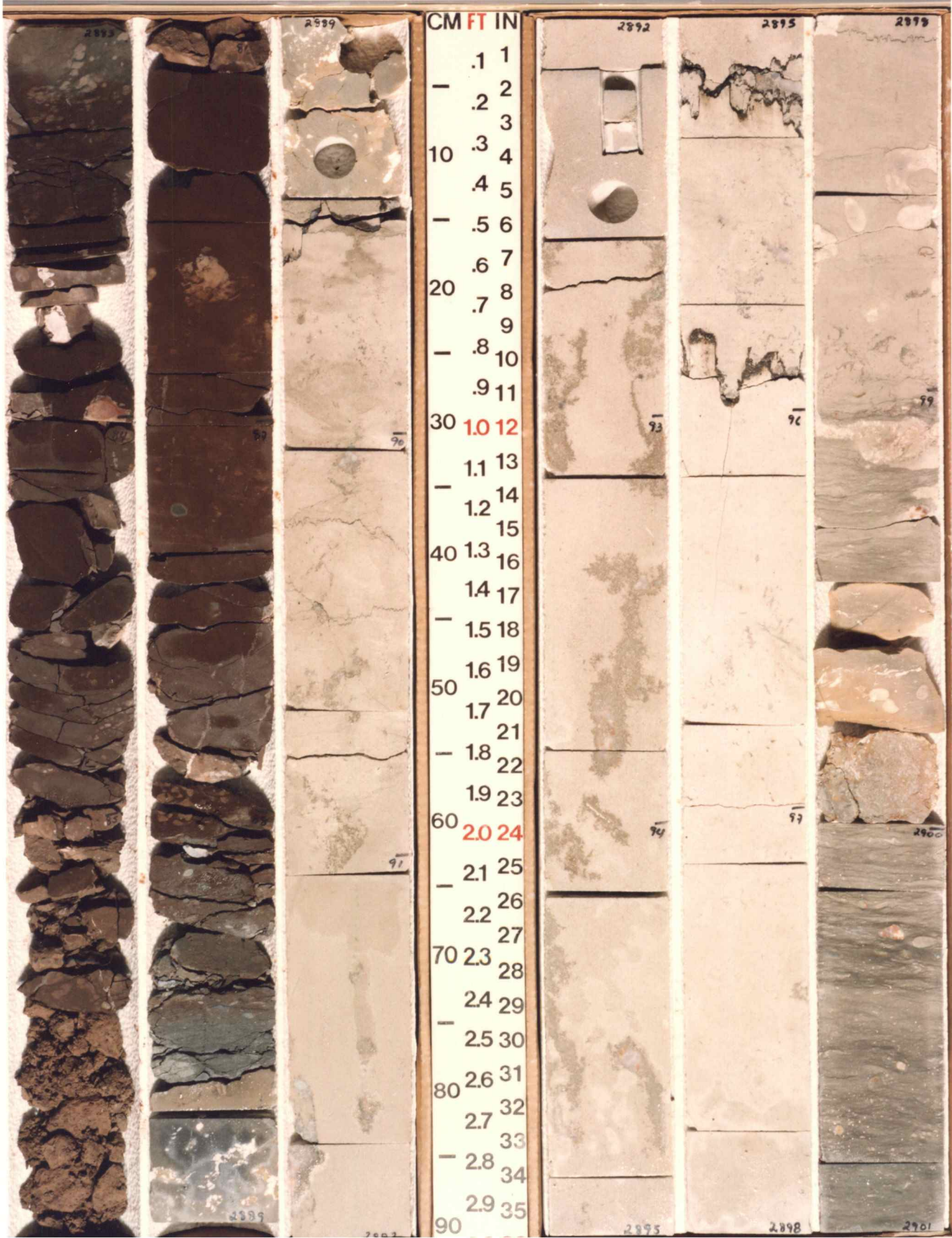
2,855.0 - 2,873.0



# ANADARKO PETROLEUM CORPORATION FLOWER A-1 STEVENS COUNTY, KANSAS 2,873.0 - 2,883.0



# ANADARKO PETROLEUM CORPORATION FLOWER A-1 STEVENS COUNTY, KANSAS 2,883.0 - 2,901.0

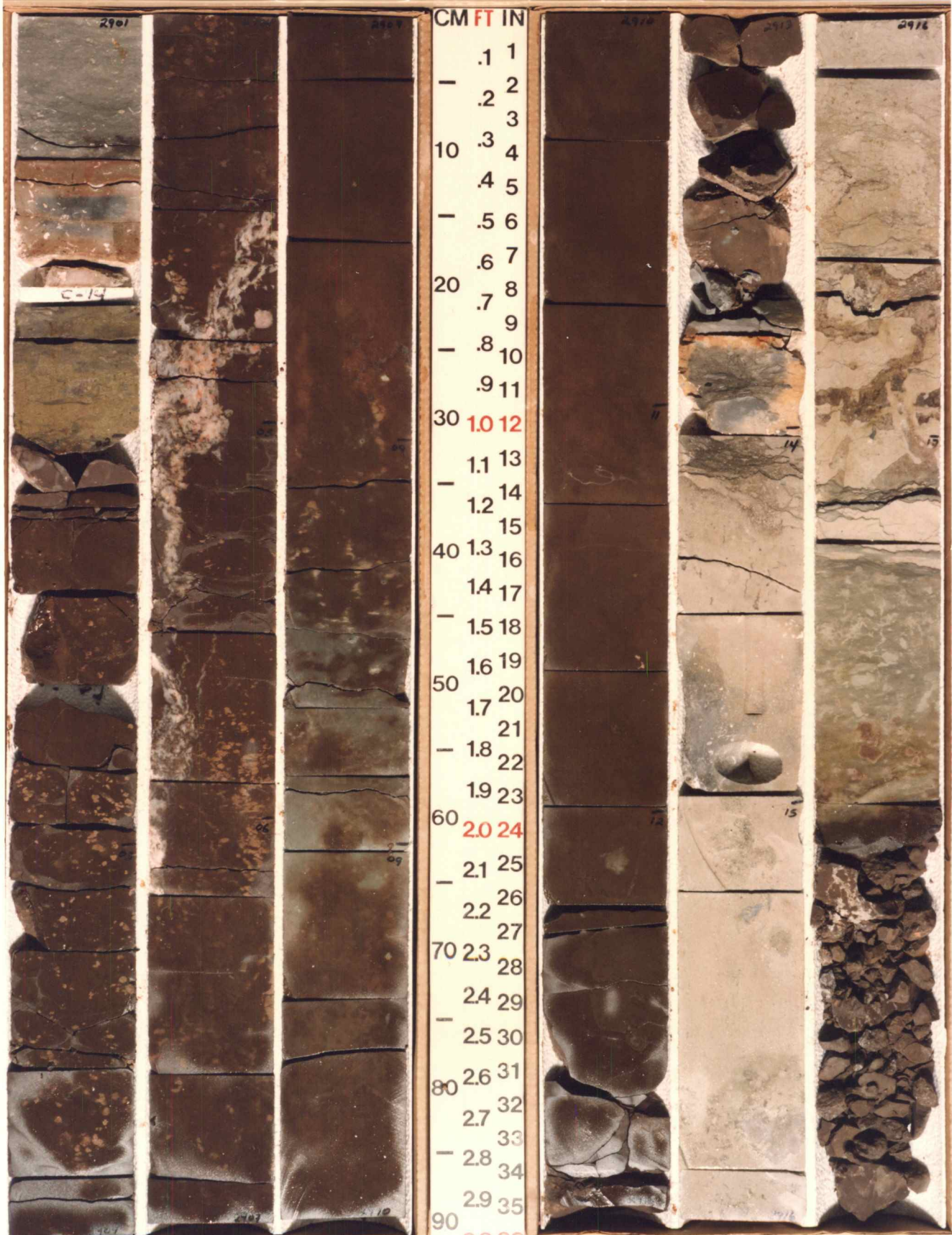


# ANADARKO PETROLEUM CORPORATION

## FLOWER A-1

### STEVENS COUNTY, KANSAS

#### 2,901.0 - 2,919.0



# ANADARKO PETROLEUM CORPORATION

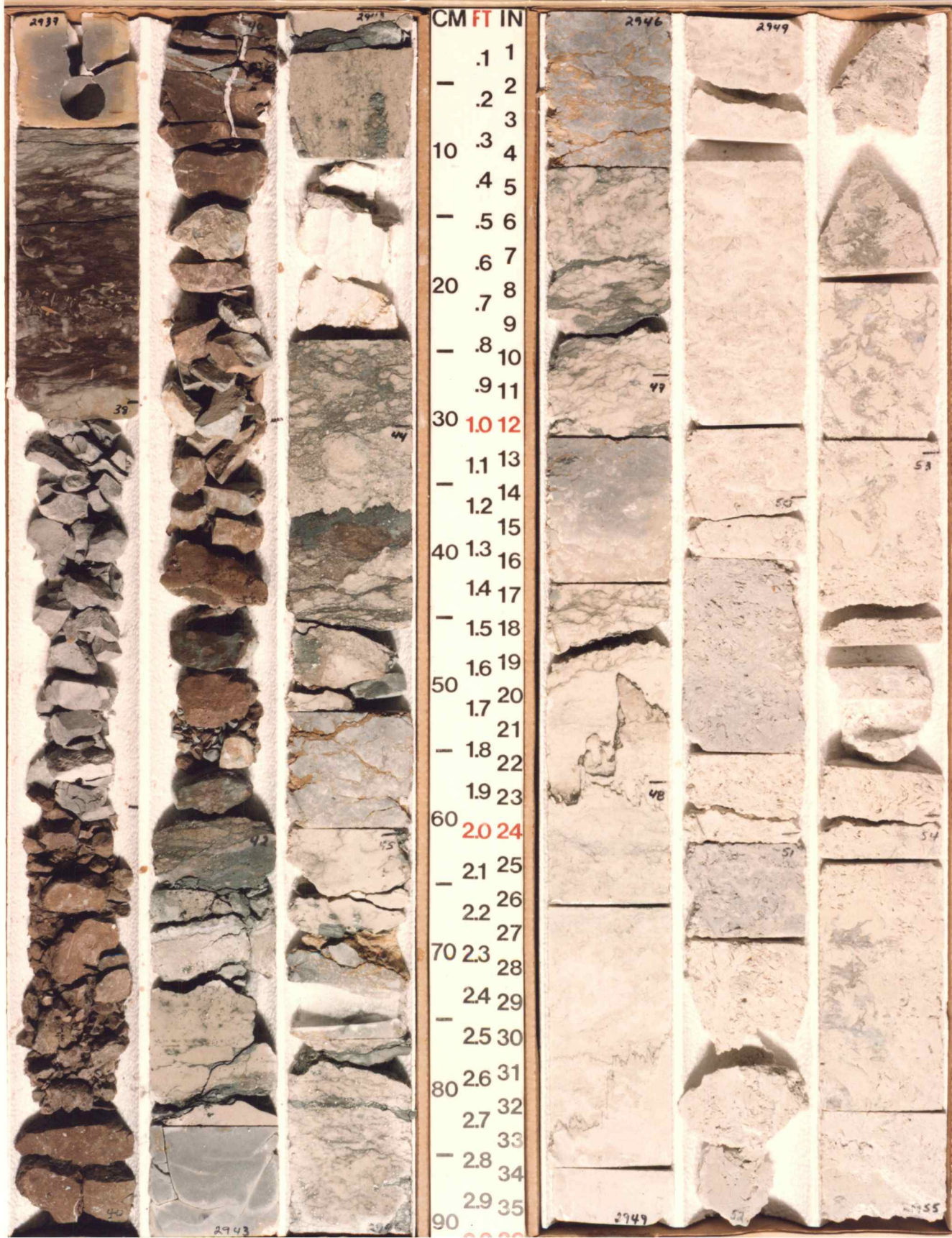
## FLOWER A-1

### STEVENS COUNTY, KANSAS

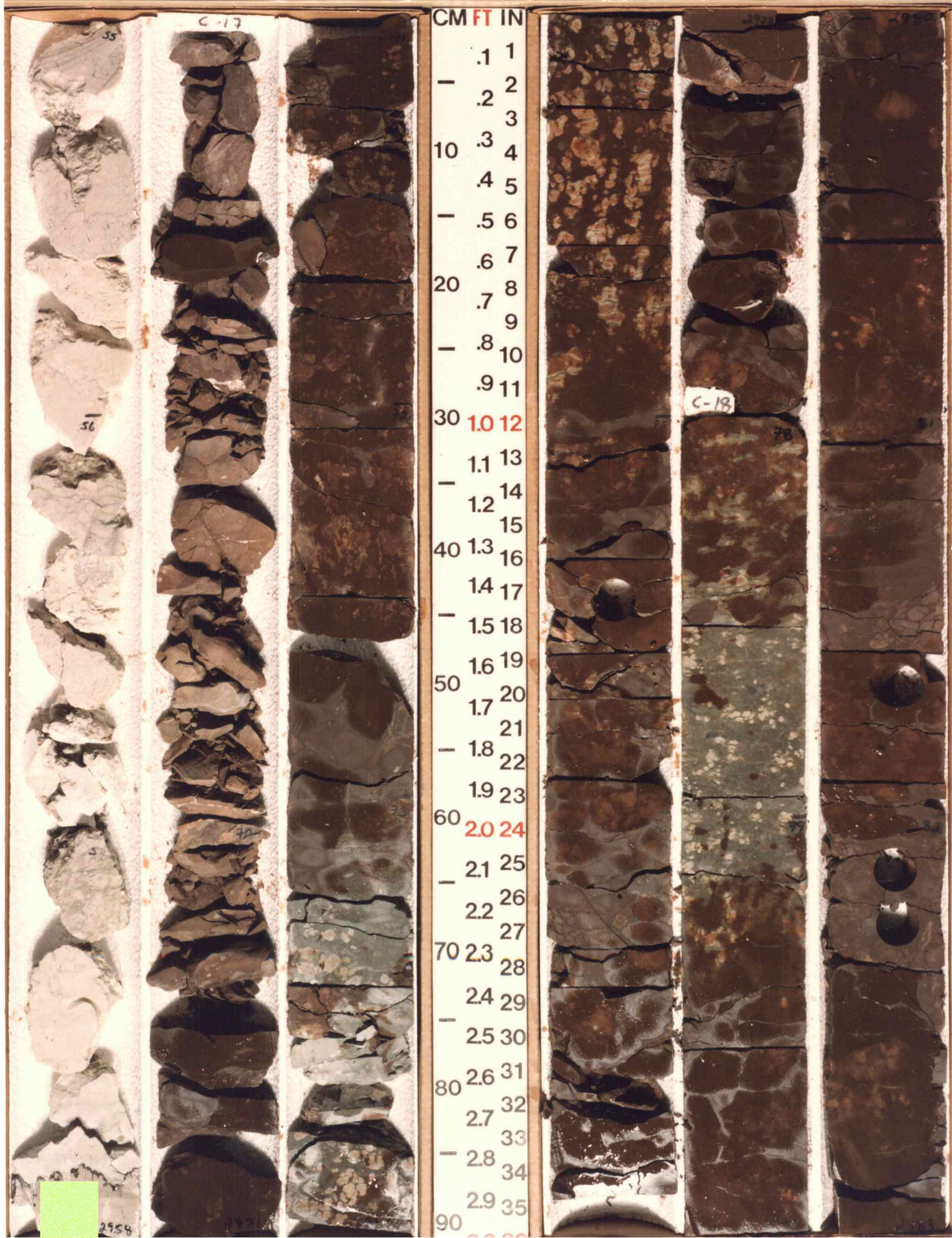
2,919.0 - 2,937.0



# ANADARKO PETROLEUM CORPORATION FLOWER A-1 STEVENS COUNTY, KANSAS 2,937.0 - 2,955.0



ANADARKO PETROLEUM CORPORATION  
 FLOWER A-1  
 STEVENS COUNTY, KANSAS  
 2,955.0 - 2,983.0

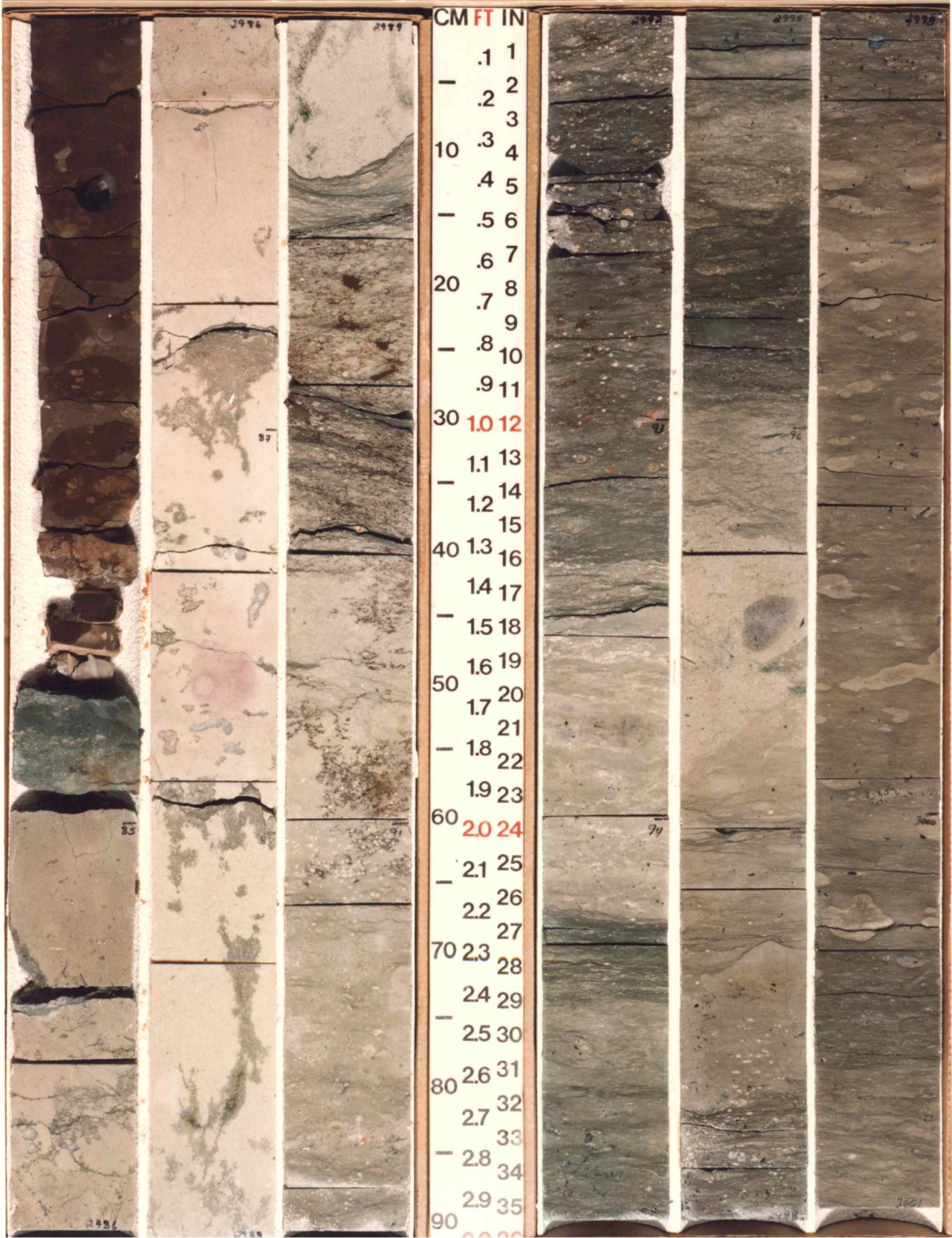


# ANADARKO PETROLEUM CORPORATION

## FLOWER A-1

### STEVENS COUNTY, KANSAS

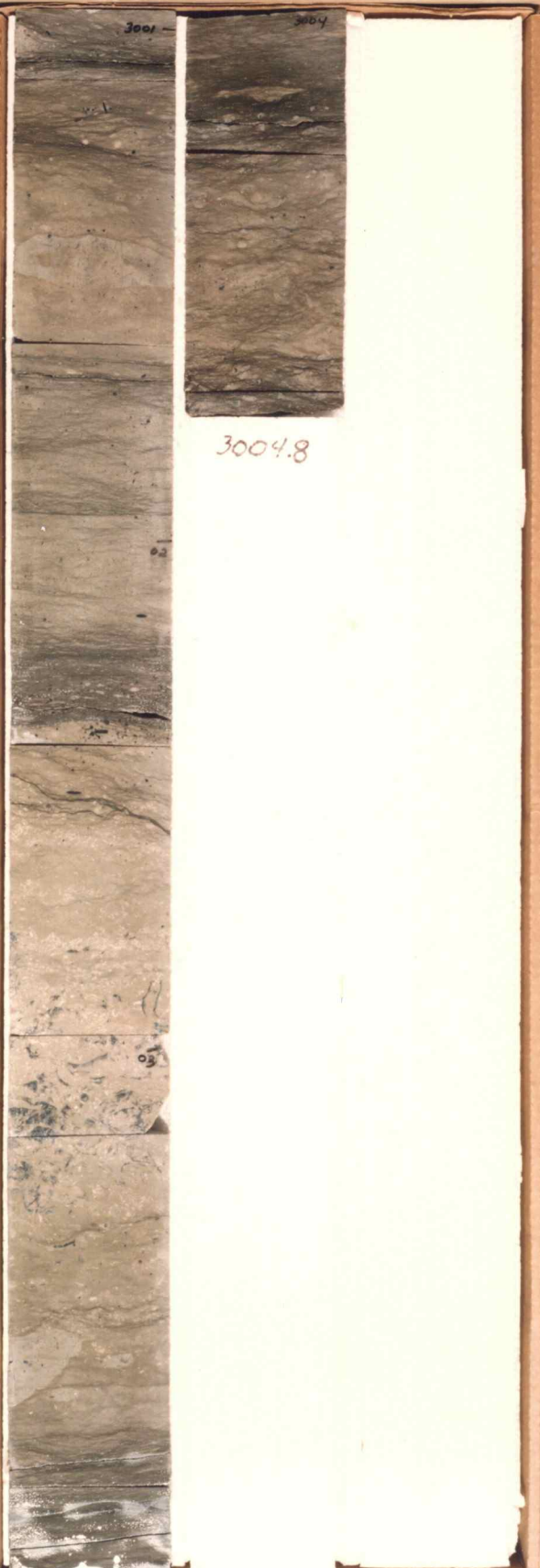
2,983.0 - 3,001.0



ANADARKO PETROLEUM CORPORATION  
FLOWER A-1  
STEVENS COUNTY, KANSAS  
3,001.0 - 3,004.8



CM FT IN  
- .1 1  
- .2 2  
10 .3 3  
- .4 4  
- .5 5  
- .6 6  
20 .7 7  
- .8 8  
- .9 9  
30 1.0 12  
- 1.1 13  
- 1.2 14  
40 1.3 16  
- 1.4 17  
- 1.5 18  
50 1.6 19  
- 1.7 20  
- 1.8 21  
- 1.9 22  
60 2.0 24  
- 2.1 25  
- 2.2 26  
70 2.3 27  
- 2.4 28  
- 2.5 29  
80 2.6 31  
- 2.7 32  
- 2.8 33  
- 2.9 34  
90 3.0 36



## FIGURE 4

### CLOSE CORE PHOTOGRAPHS

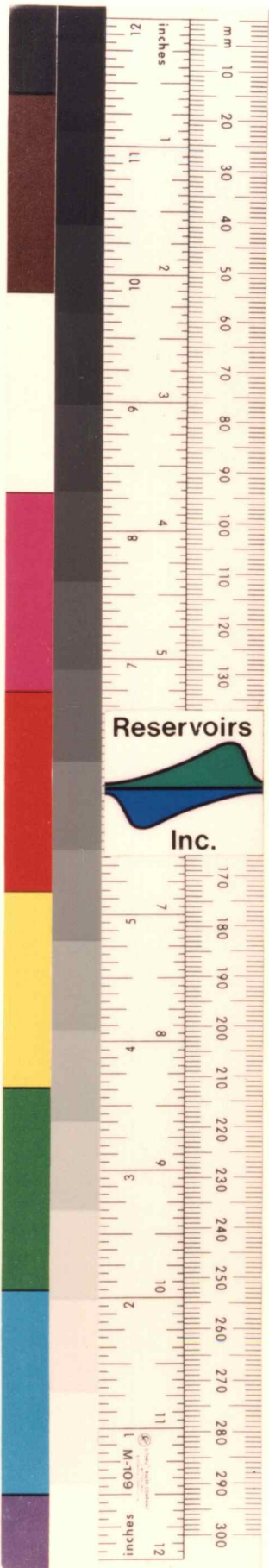
#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

A. Depth: 2605 feet Dep. Facies: Paleosol/Coastal Plain

The brick-red color and irregular caliche nodules displayed in this core piece are typical of the paleosol/coastal plain facies. Routine core analysis measurements from throughout these deposits indicate low permeability and poor reservoir potential. In addition to the caliche nodules, anhydrite nodules, root mottling and desiccation features are present in this facies.

B. Depth: 2474 feet Dep. Facies: Tidal Flat

Fine laminations and ripple cross-stratification are common in the siltstones/very fine-grained sandstones of the tidal flat facies. Where primary sedimentary structures are well preserved (such as here), upper intertidal sedimentation is inferred. Where burrowing is more extensive, lower intertidal sedimentation is suggested.



## FIGURE 4 (CONTINUED)

### CLOSE CORE PHOTOGRAPHS

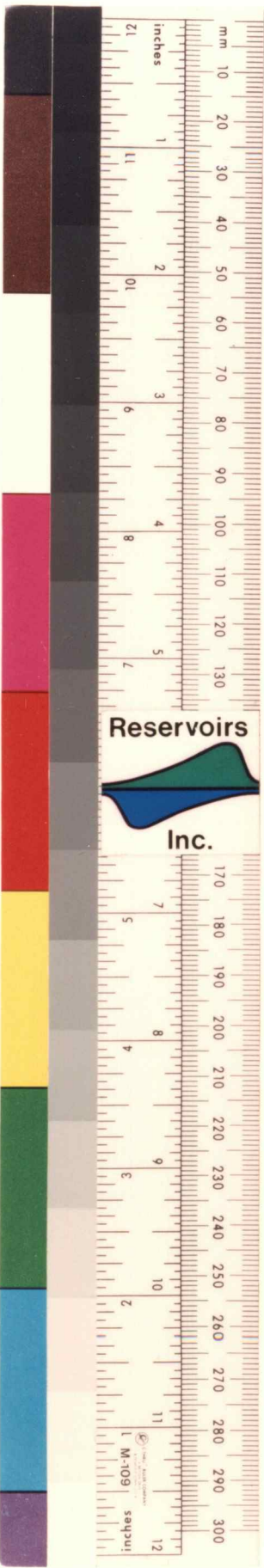
#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

- C. Depth: 2505 feet Dep. Facies: Shoal/Shoal Flank

This core piece is from a dolomitized interval of shoal/shoal flank grainstones. Thin section analysis indicates the presence of moldic pores, intercrystalline pores, and some remnant intergranular pores (see Figure 7). These various pore types combine to form an effective pore network, yielding a rock with very good reservoir potential. Routine core analysis measurements from near this depth range show porosity values in excess of 20% and permeability values of more than 100 md.

- D. Depth: 2727 feet Dep. Facies: Lagoon/Shallow Shelf

Although some vestiges of ripples and laminations can be distinguished in this dolomitic/calcareous siltstone, spherite-filled burrows are also evident. Brachiopods, echinoderms and other marine fossils are present. These strata record sedimentation under relatively low energy, shallow subtidal conditions. Routine core analysis measurements indicate that this facies typically has rather poor reservoir potential.



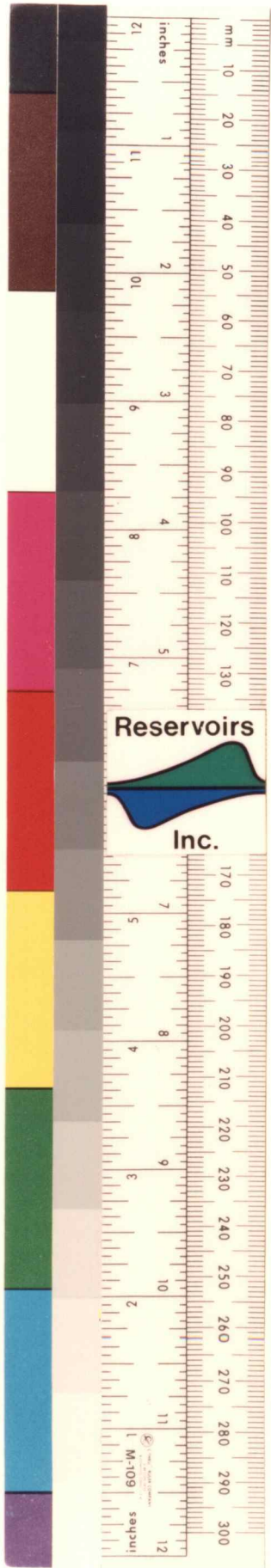
## FIGURE 4 (CONTINUED)

### CLOSE CORE PHOTOGRAPHS

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

E. Depth: 2954 feet Dep. Facies: Algal Bank

This sample is representative of the algal bank subfacies. These deposits are distinguished from other shallow shelf strata by the relative abundance of phylloid algae. The phylloid algae, which were originally composed of aragonite, were highly susceptible to dissolution. Following dissolution of the algal plates, the rock was subjected to brittle deformation. The small fractures that developed during this deformation greatly enhanced the interconnection of the moldic pores, yielding a rock with very good to excellent reservoir potential. Anhydrite (note the white areas) replacement and cementation results in patches of low porosity.



## FIGURE 5

### THIN SECTION PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2473.6 feet

Average Grain Size: Lower Very Fine Sand (0.080 mm)  
Sorting: Well Sorted

Porosity: 11.5%  
Permeability: 2.43 md

Stratigraphic Unit: Herington  
Dep. Facies: Tidal Flat

This rock contains subequal amounts of quartz sand/silt, dolomite and anhydrite. The dolomite is present in several phases, including: 1) very finely crystalline dolomite cement, 2) dolomitized micrite matrix, and 3) dolomitized carbonate grains (skeletal fragments and peloids (p)). The anhydrite (An) occurs as large, poikilotopic crystals that are heterogeneously distributed throughout the rock. The pore system consists of intergranular (lg) pores, intercrystalline pores within the dolomitized matrix, and secondary pores (white arrow) from leached carbonate grains.

A - 40X

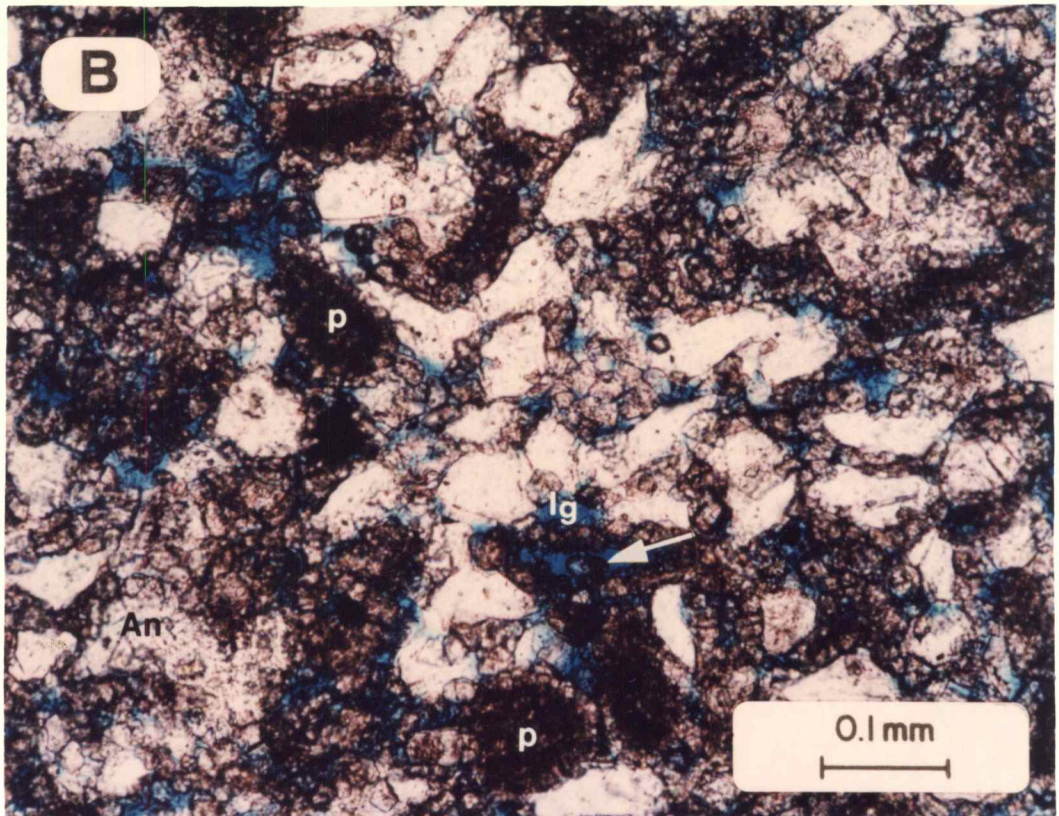
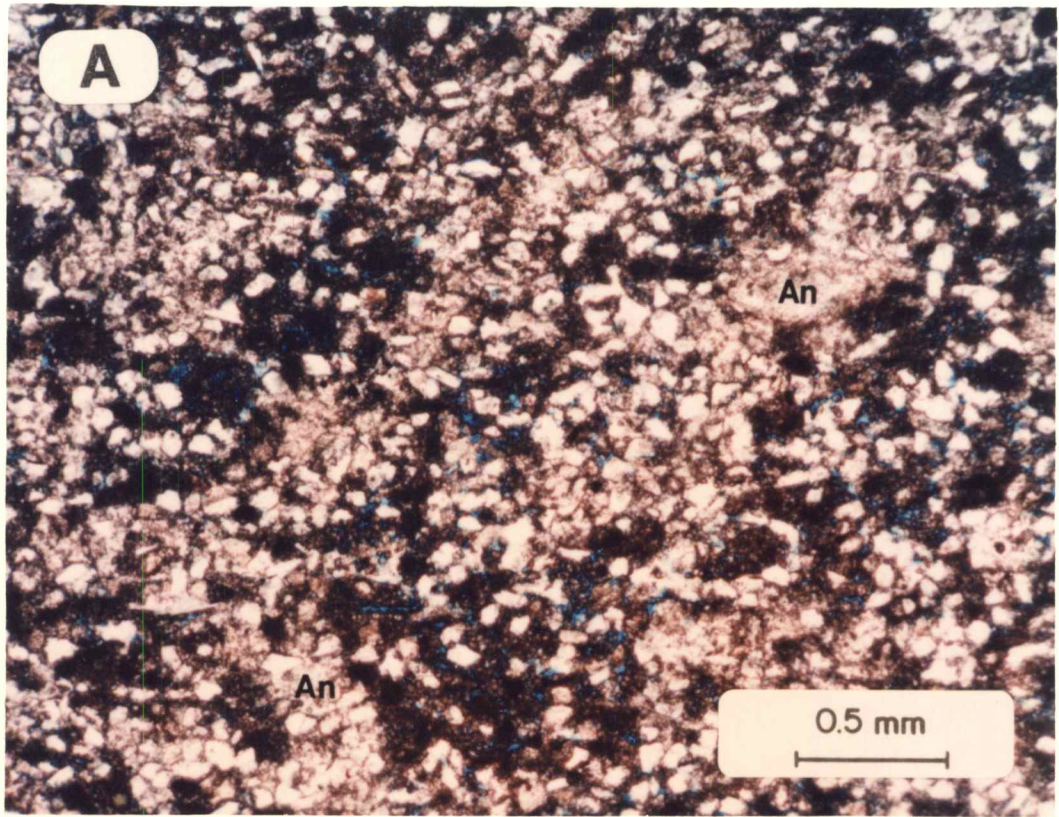
B - 160X

#### X-ray Diffraction Data

Quartz	31%
Dolomite	39%
Anhydrite	24%
Clay	6%

#### Petrophysical Data

Cementation Exponent (m): 1.99  
Saturation Exponent (n): Test in Progress



## FIGURE 6

### THIN SECTION PHOTOMICROGRAPHS

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2485.2 feet

Average Grain Size: Coarse Silt (0.049 mm)

Sorting: Well Sorted

Porosity: 20.8%

Permeability: 48.2 md

Stratigraphic Unit: Herington

Dep. Facies: Tidal Flat

Patches of anhydrite (An) cement are scattered throughout this siltstone. Only minor amounts of other cementing agents are present, yielding a rock with a well preserved network of primary intergranular pores and rather good reservoir potential. Quartz and feldspar account for most of the framework grains.

A - 40X

B - 160X

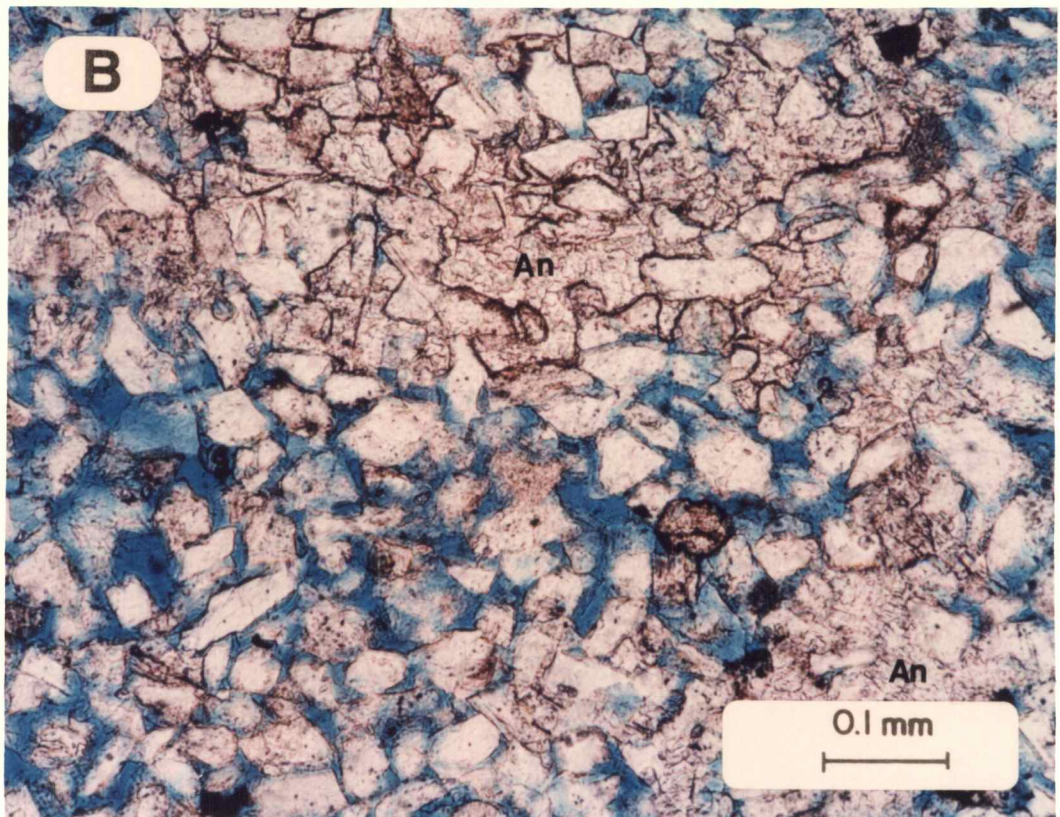
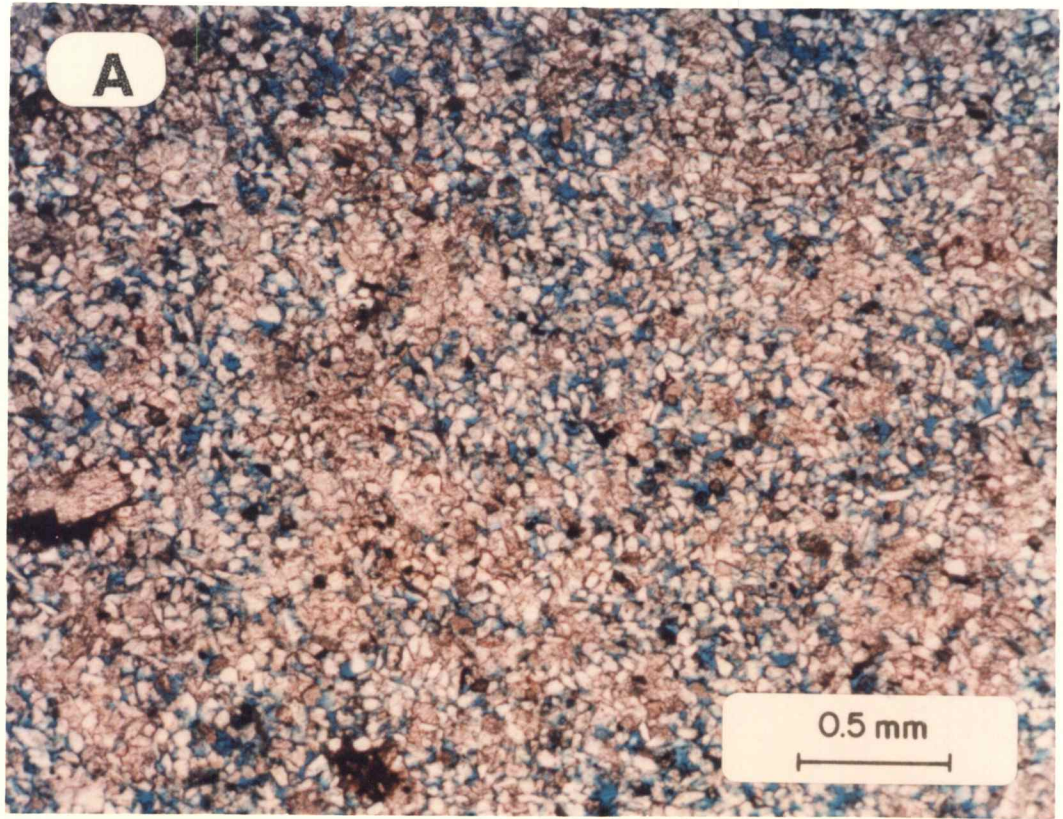
#### X-ray Diffraction Data

Quartz	69%
Potassium Feldspar	4%
Plagioclase Feldspar	5%
Dolomite	1%
Anhydrite	16%
Clay	5%

#### Petrophysical Data

Cementation Exponent (m): 1.92

Saturation Exponent (n): Test in Progress



## FIGURE 7

### THIN SECTION PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2505.4 feet

Rock Type: Dolomite

Depositional Texture: Grainstone

Porosity: 21.5%

Permeability: 122 md

Stratigraphic Unit: Krider

Dep. Facies: Shoal to Shoal Flank

Although dolomitization has obscured the grain types and fabric of this rock, the abundance of moldic (Mo) pores indicates a very grain-rich texture. The moldic pores account for a substantial portion of the total pore volume, but these larger pores are interconnected through a network of smaller intercrystalline pores (white arrows). Collectively, these moldic and intercrystalline pores combine to yield a rather effective pore network. Some of the intercrystalline pores could be relict intergranular pores preserved between the framework grains.

A - 40X

B - 160X

#### X-ray Diffraction Data

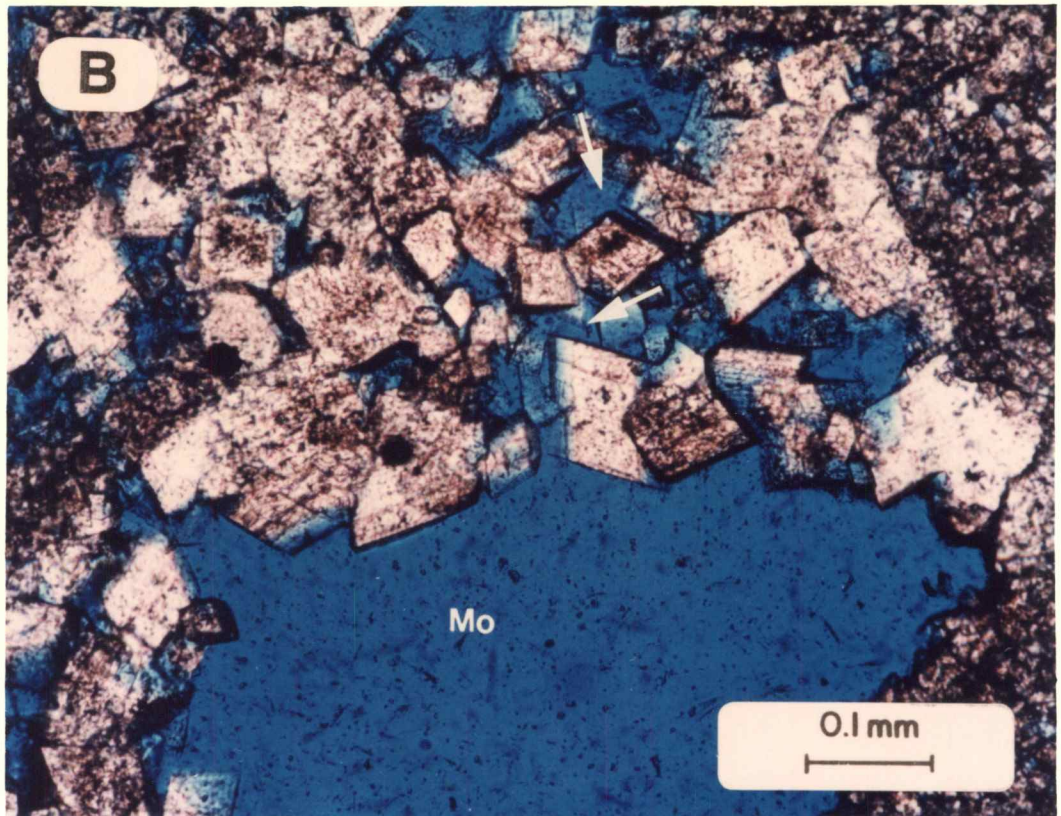
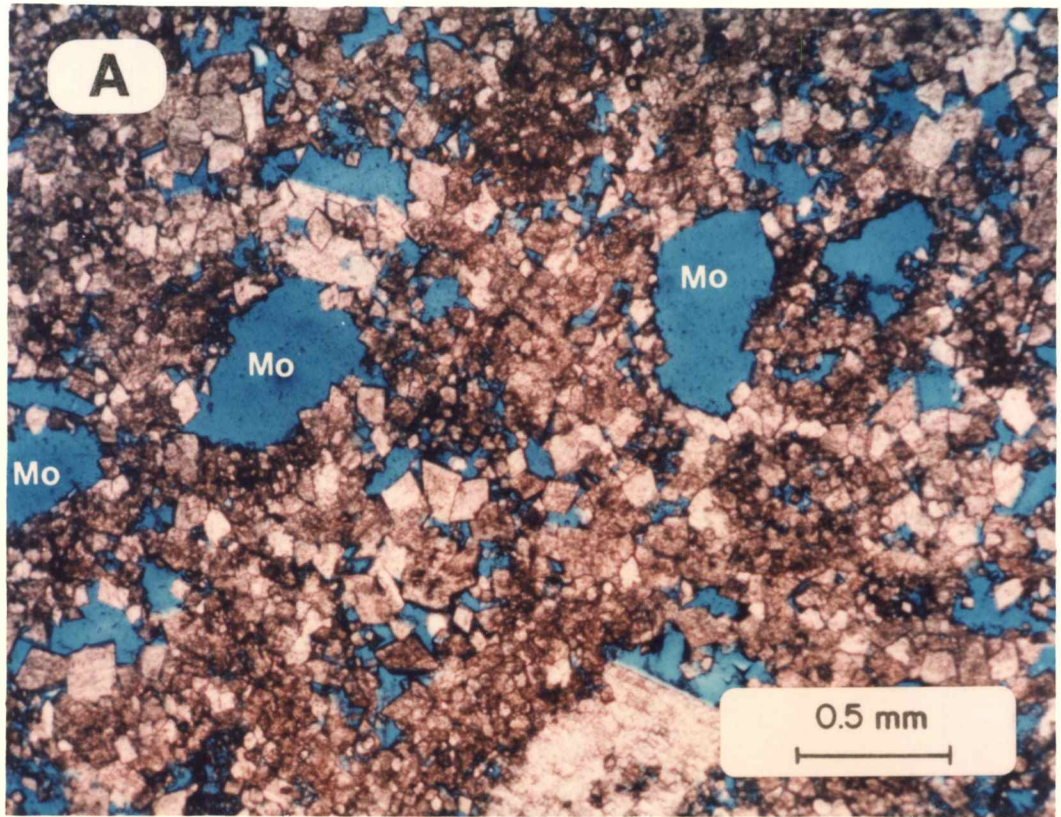
Dolomite

100%

#### Petrophysical Data

Cementation Exponent (m): 2.22

Saturation Exponent (n): Test in Progress



## FIGURE 8

### THIN SECTION PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2515.8 feet

Rock Type: Dolomite

Depositional Texture: Grainstone

Porosity: 22.3%

Permeability: 275 md

Stratigraphic Unit: Krider

Dep. Facies: Shoal to Shoal Flank

Large moldic (Mo) pores and smaller intercrystalline pores (white arrows) are present in this dolomitized grainstone. These secondary pores combine to form an efficient pore network that results in high permeability. Scattered large crystals of anhydrite (An) cement locally occlude both moldic and intercrystalline pores. Although dolomitization obscured the grain types, based on the size and shape of many of the framework particles, it appears that oncoids, peloids and skeletal debris accounted for most of the allochems; a small number of ooids may also be present.

A - 40X

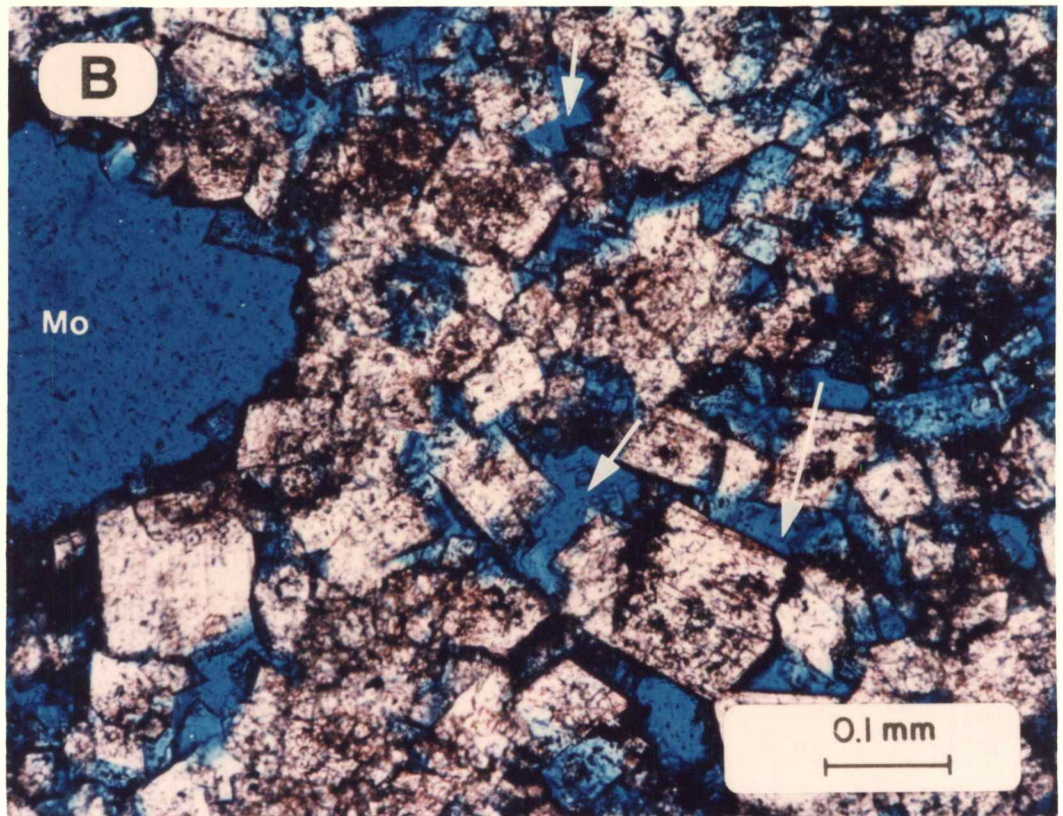
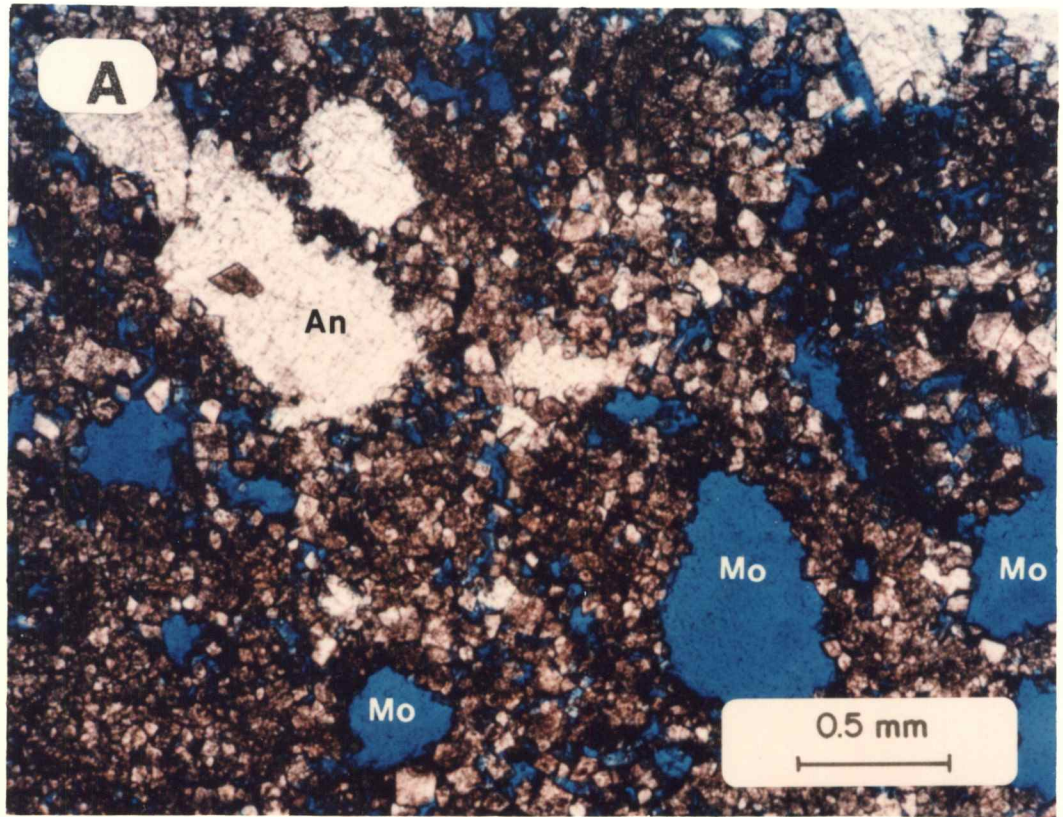
B - 160X

#### X-ray Diffraction Data

Dolomite	99%
Anhydrite	1%

#### Petrophysical Data

Cementation Exponent (m): 2.20  
Saturation Exponent (n): Test in Progress



## FIGURE 9

### THIN SECTION PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2526.1 feet

Rock Type: Dolomite

Depositional Texture: Packstone/Wackestone

Stratigraphic Unit: Krider

Dep. Facies: Shoal to Shoal Flank

Porosity: 24.7%

Permeability: 128 md

Compare this sample to the dolomite samples shown in Figures 7 and 8. This rock has fewer moldic pores, and the dolomite is more finely crystalline. This is interpreted to reflect a more micritic (packstone/wackestone) depositional texture in this rock. Dolomitization enhanced reservoir potential by creating intercrystalline pores in what had been low porosity, low permeability micrite matrix. Dissolution of framework grains added some molds (Mo) to the pore structure. Scattered patches of anhydrite (An) cement have occluded pore space, but overall this rock is judged to have good to very good reservoir potential.

A - 40X

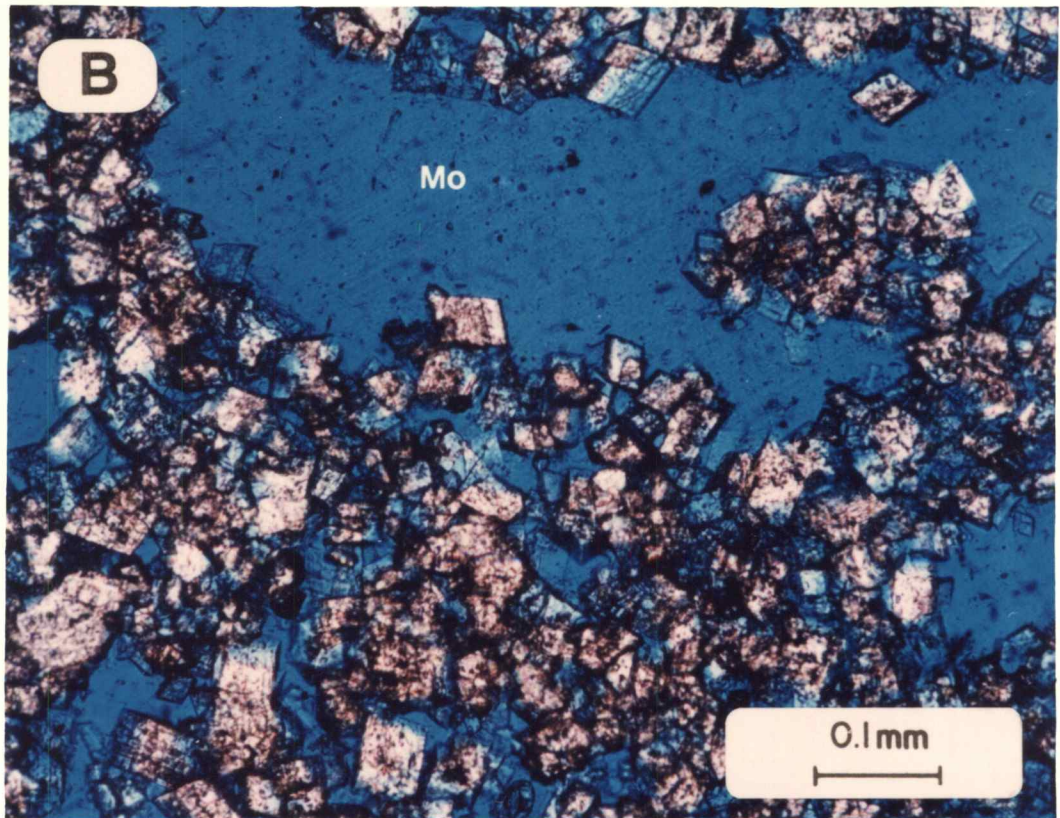
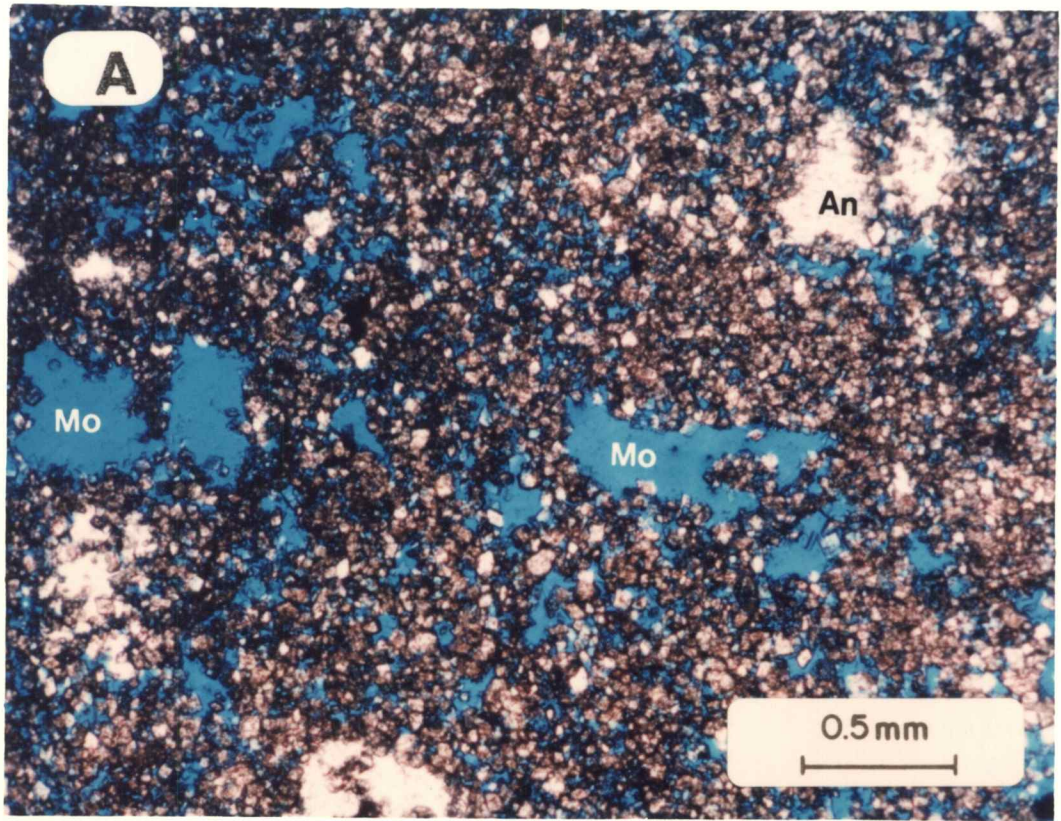
B - 160X

#### X-ray Diffraction Data

Dolomite	89%
Anhydrite	11%

#### Petrophysical Data

Cementation Exponent (m): 2.05  
Saturation Exponent (n): Test in Progress



# FIGURE 10

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2531.1 feet

Rock Type: Calcareous Dolomite

Depositional Texture: Wackestone/Mudstone

Stratigraphic Unit: Krider

Dep. Facies: Shoal Flank

Porosity: 17.5%

Permeability: 1.11 md

Although this rock has been extensively replaced by dolomite, the uniformly small crystal size and general lack of relict grain textures suggests a micrite-dominated (wackestone/mudstone) fabric. The dolomitization acted to create some intercrystalline pores within what had been a low porosity, low permeability micrite matrix. However, subsequent calcite (stained pink) cementation occluded pore space and reduced pore interconnection. This accounts for the relatively low permeability in this rock, compared to the more grain-rich sample from 2526.1 feet (Figure 9). A few crystals of authigenic pyrite (black) are scattered throughout this rock.

A - 40X

B - 160X

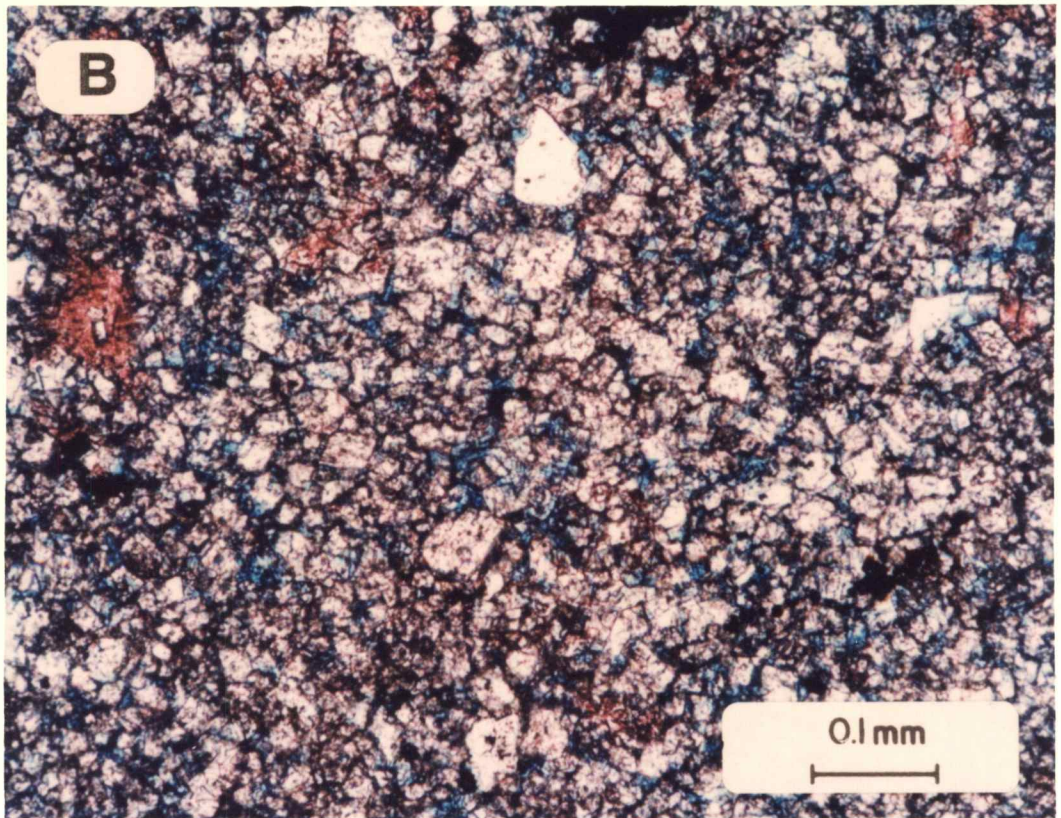
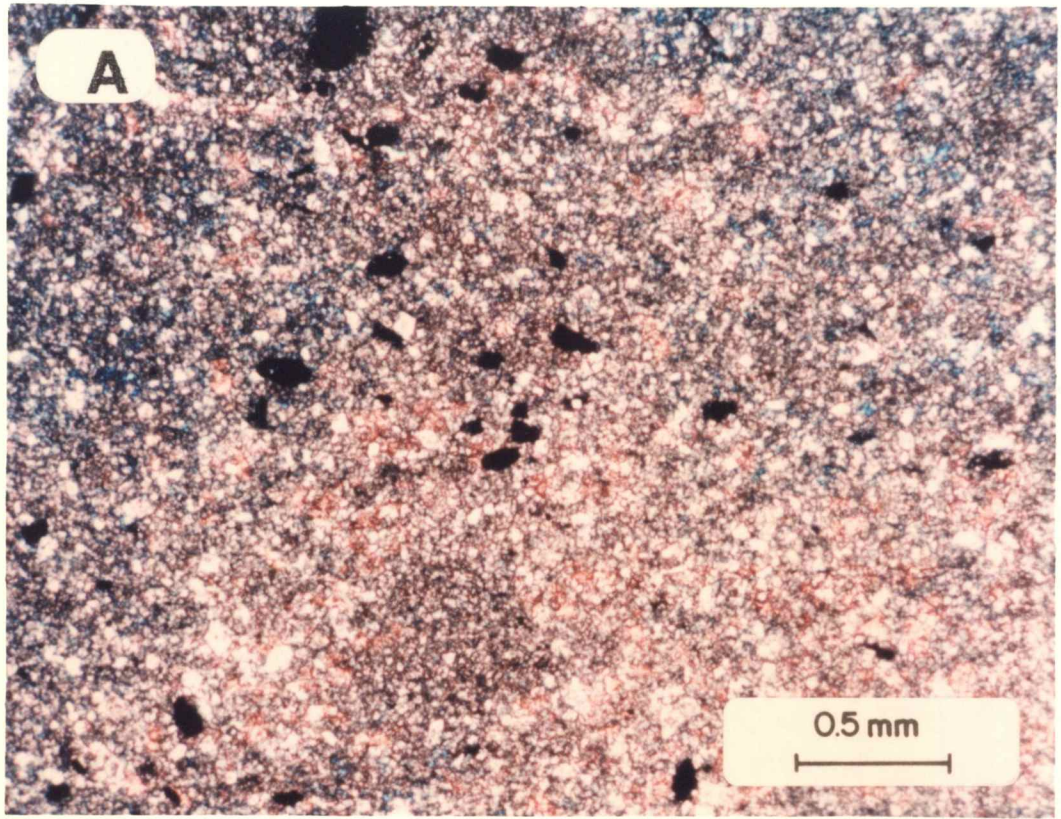
#### X-ray Diffraction Data

Quartz	9%
Potassium Feldspar	2%
Plagioclase Feldspar	1%
Calcite	4%
Dolomite	80%
Anhydrite	1%
Pyrite	1%
Clay	2%

#### Petrophysical Data

Cementation Exponent (m): 2.05

Saturation Exponent (n): Test in Progress



# FIGURE 11

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2550.5 feet

Average Grain Size: Coarse Silt (0.055 mm)

Sorting: Very Well Sorted

Porosity: 24.3%

Permeability: 132 md

Stratigraphic Unit: Winfield Sand

Dep. Facies: Tidal Flat

This very well sorted siltstone contains an abundance of open intergranular pore space. Although patches of calcite (stained pink in view A) and anhydrite (not shown here) cements are present, most of the intergranular pores contain only a minor amount of iron-stained clay. These primary intergranular pores are well interconnected and yield an effective pore network with high permeability. In addition, some secondary pores (white arrow in view B) may contribute to the pore network. Quartz and feldspar grains account for most of the framework grains.

A - 40X

B - 160X

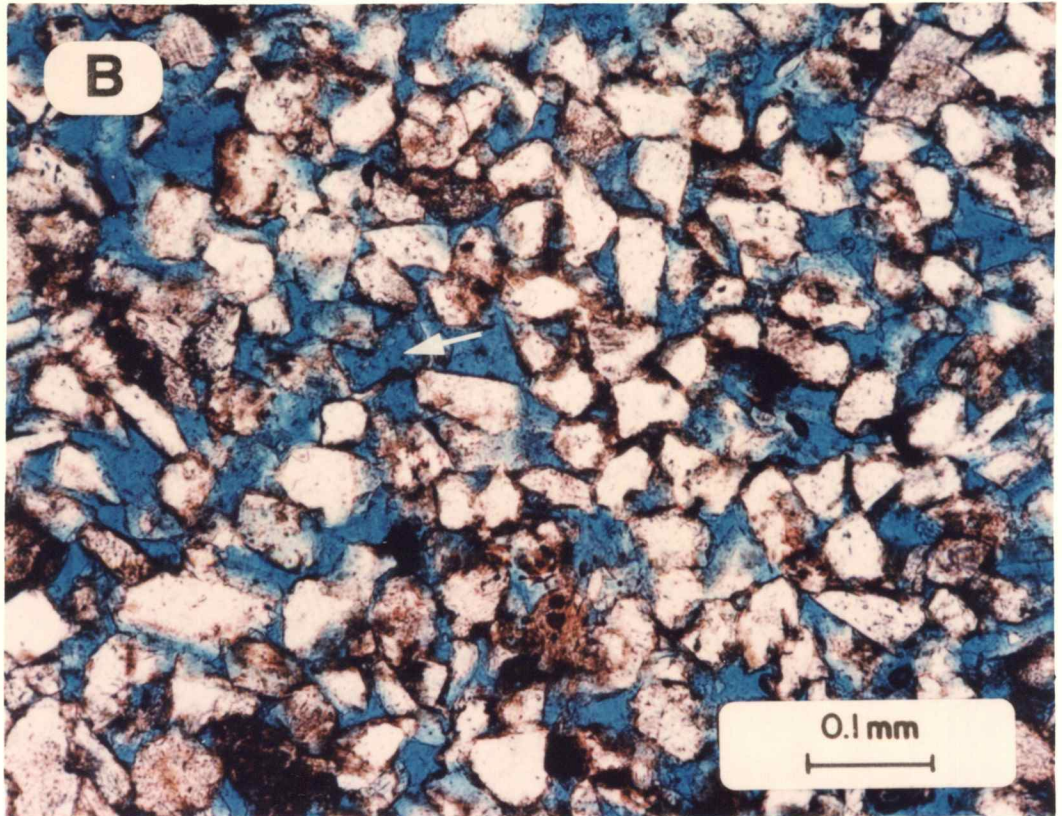
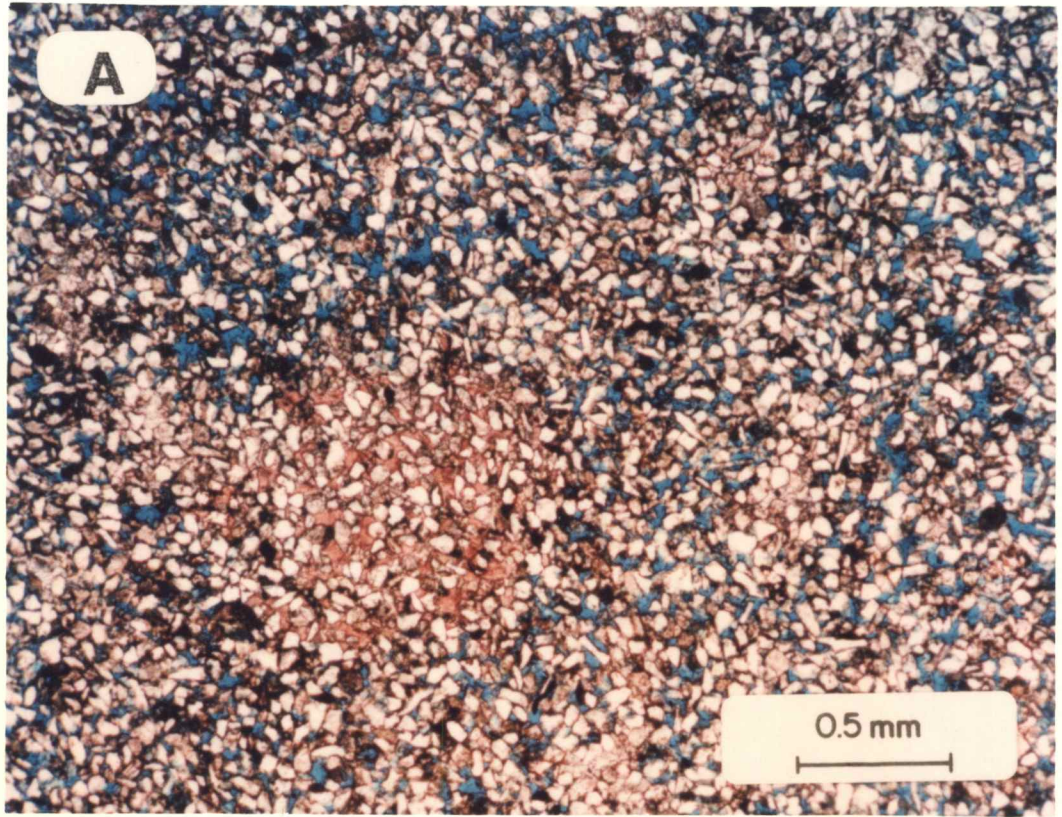
#### X-ray Diffraction Data

Quartz	58%
Potassium Feldspar	7%
Plagioclase Feldspar	16%
Calcite	2%
Dolomite	1%
Anhydrite	13%
Clay	3%

#### Petrophysical Data

Cementation Exponent (m): 1.88

Saturation Exponent (n): Test in Progress



# FIGURE 12

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2556.1 feet

Rock Type: Anhydritic, Sandy Limestone

Porosity: 9.0%

Depositional Texture: Grainstone/Packstone

Permeability: 0.129 md

Stratigraphic Unit: Winfield Sand

Dep. Facies: Shoal/Shoal Flank

This rock was deposited with a combination of carbonate grains (skeletal grains, intraclasts, oncoids, peloids and a few ooids), fine- to medium-grained siliciclastic sand and a minor amount of micrite. The siliciclastic sand is dominated by feldspar (F) and a subordinate amount of quartz (Q). Calcite cement (Ca) and anhydrite (An) cement/replacement occluded most of the intergranular pores. Only traces of the primary pore system remain. Secondary porosity developed due to grain dissolution of foraminifera and other bioclastic constituents. In addition, some of the micritic allochems were altered, resulting in the development of microporosity (white arrow in view B). Because the pore system is dominated by poorly interconnected moldic pores and microporosity, the rock has rather low permeability.

A - 40X

B - 160X

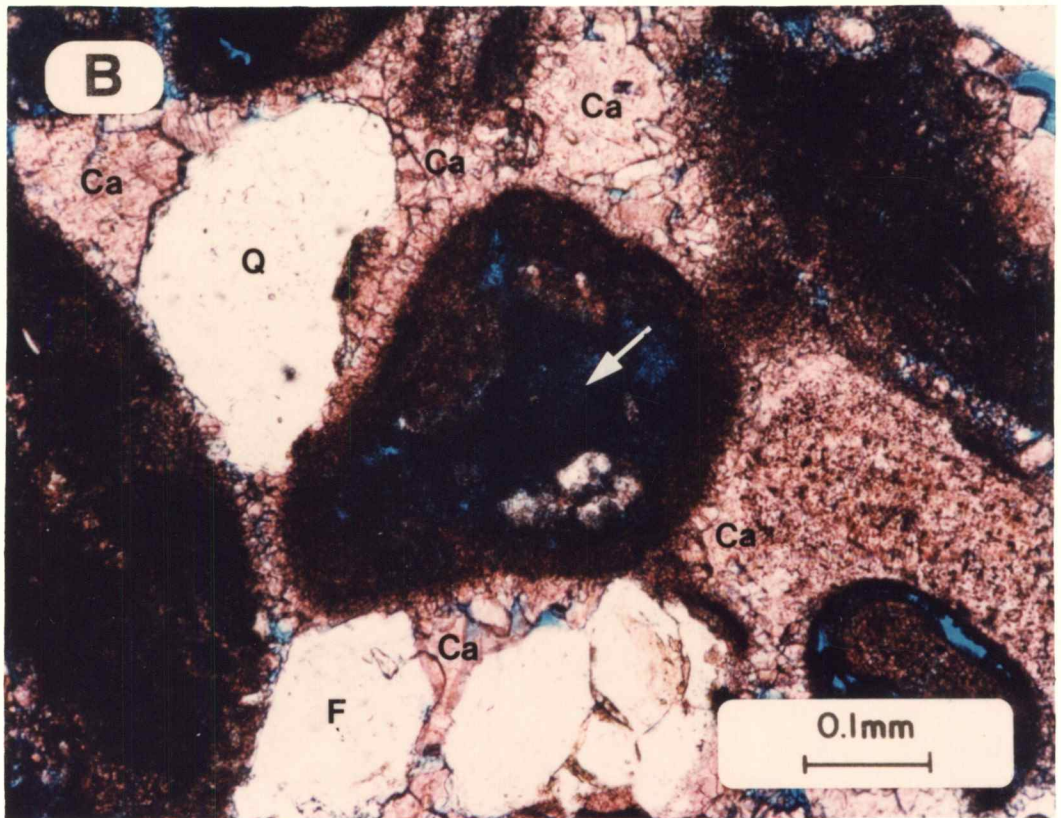
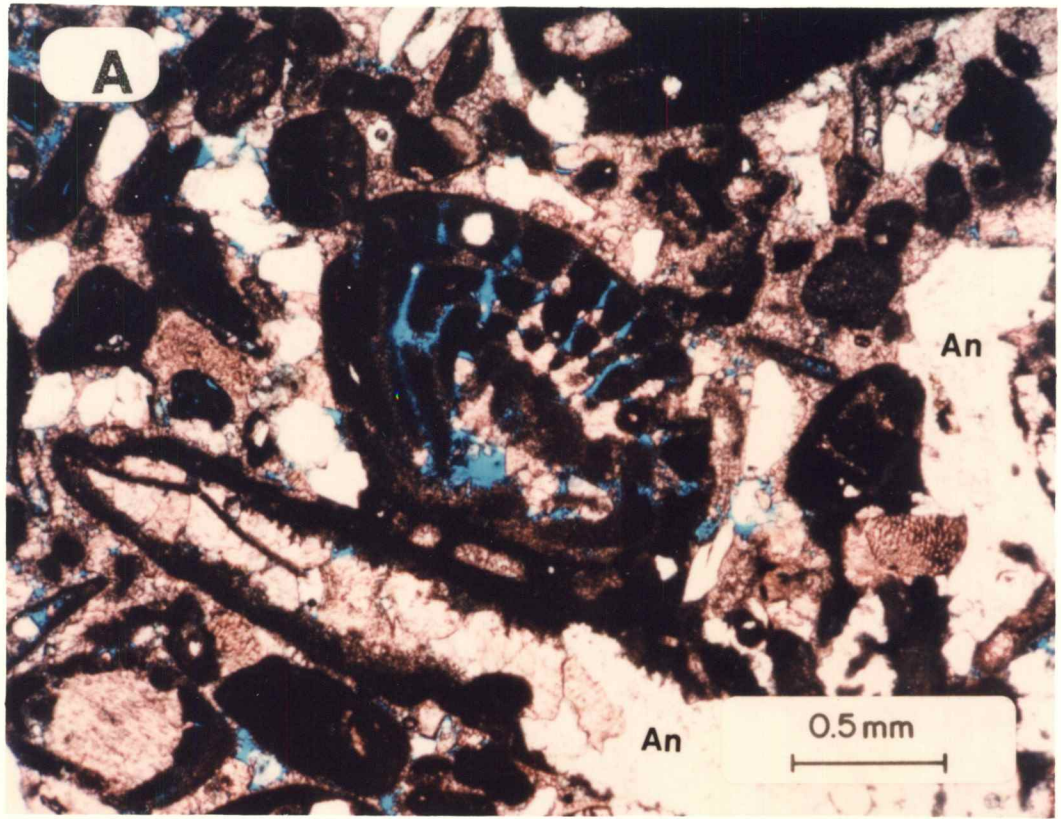
#### X-ray Diffraction Data

Quartz	3%
Potassium Feldspar	24%
Plagioclase Feldspar	7%
Calcite	31%
Anhydrite	35%

#### Petrophysical Data

Cementation Exponent (m): 1.98

Saturation Exponent (n): Test in Progress



# FIGURE 13

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2579.4 feet

Rock Type: Anhydritic Limestone

Porosity: 16.4%

Depositional Texture: Packstone

Permeability: 5.98 md

Stratigraphic Unit: Winfield Dolomite

Dep. Facies: Shoal to Shoal Flank

Most of the pore space in this packstone is in the form of: remnant intergranular (Ig) pores, moldic (Mo) pores (where skeletal constituents in oncoids have been partially leached), and microporosity (white arrows) in altered micritic grains and matrix. The intergranular voids probably account for most of the effective pores; the microporosity and moldic pores contribute little to the effective pore network. Rocks with this type of pore structure can have rather high immobile water saturations.

A - 40X

B - 160X

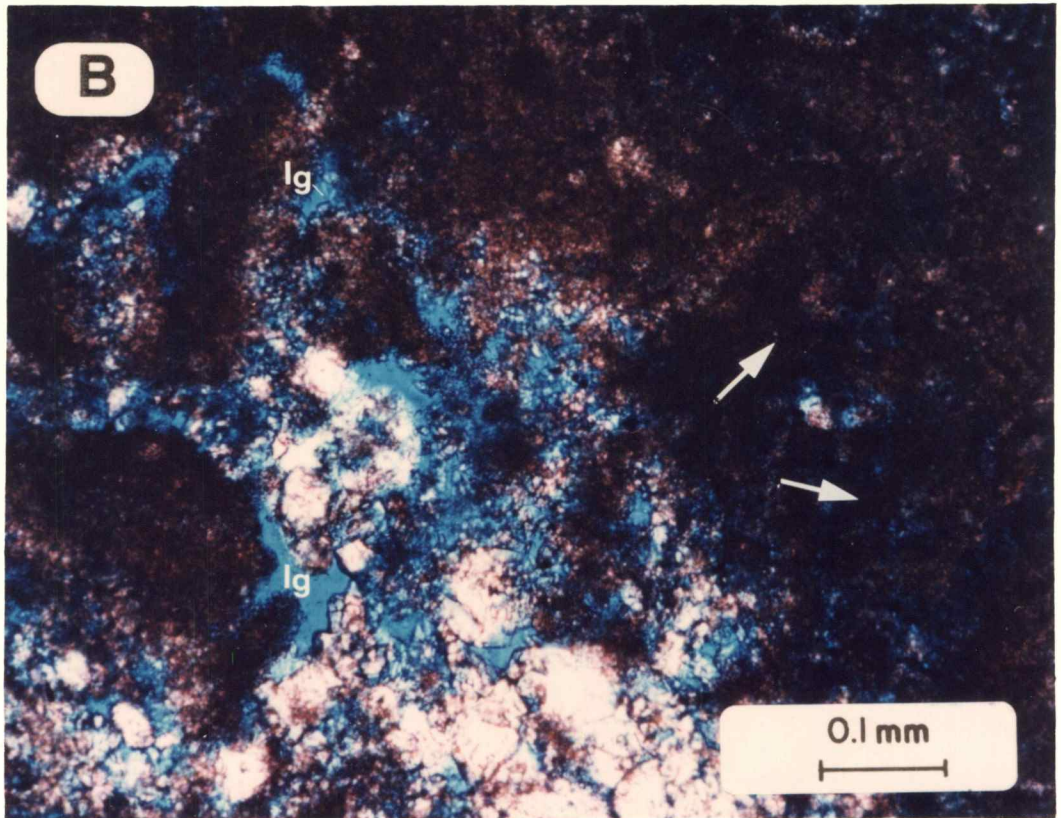
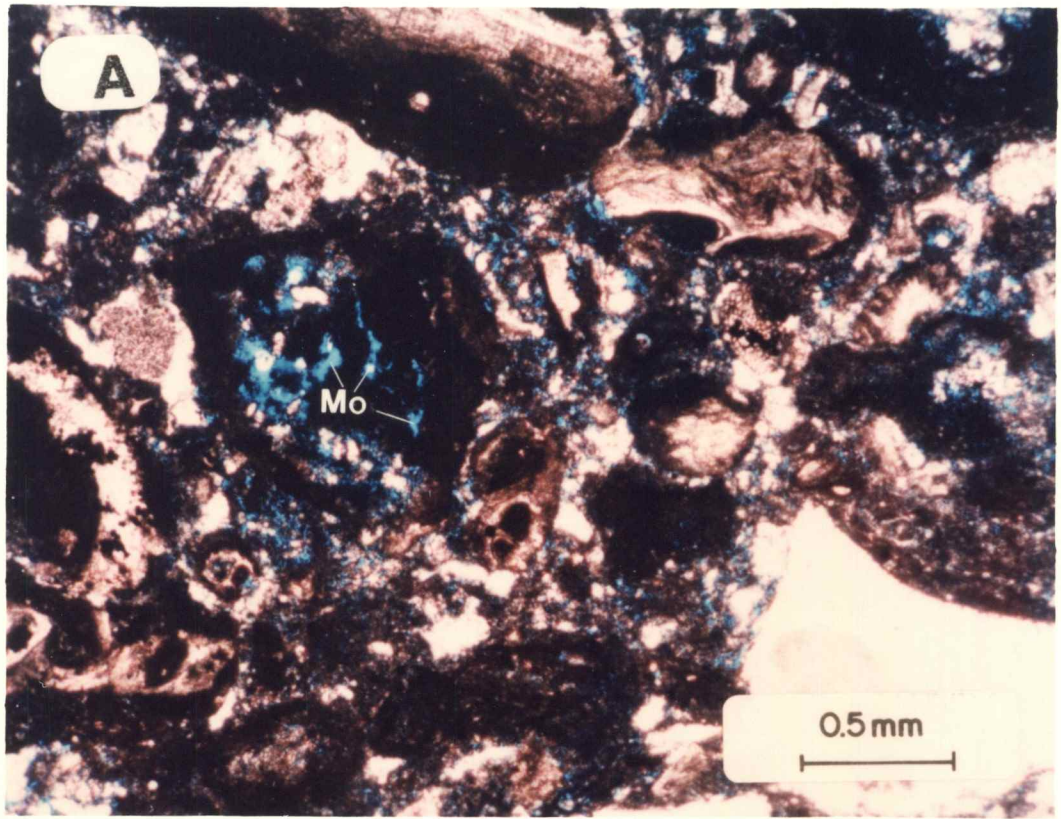
#### X-ray Diffraction Data

Calcite	61%
Dolomite	1%
Anhydrite	38%

#### Petrophysical Data

Cementation Exponent (m): 1.97

Saturation Exponent (n): Test in Progress



# FIGURE 14

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2618.1 feet

Average Grain Size: Coarse Silt (0.062 mm)

Sorting: Well Sorted

Porosity: 14.3%

Permeability: 1.96 md

Stratigraphic Unit: Towanda

Dep. Facies: Tidal Flat

The framework constituents in this siltstone consist of quartz, feldspar, peloids and skeletal fragments. The pore system has a combination of remnant intergranular voids (center of view B), and microporosity within peloids and other micritic grains. The microporous grains probably contribute little to the effective pore network. Calcite cement and carbonate matrix play roles in porosity reduction.

A - 40X

B - 160X

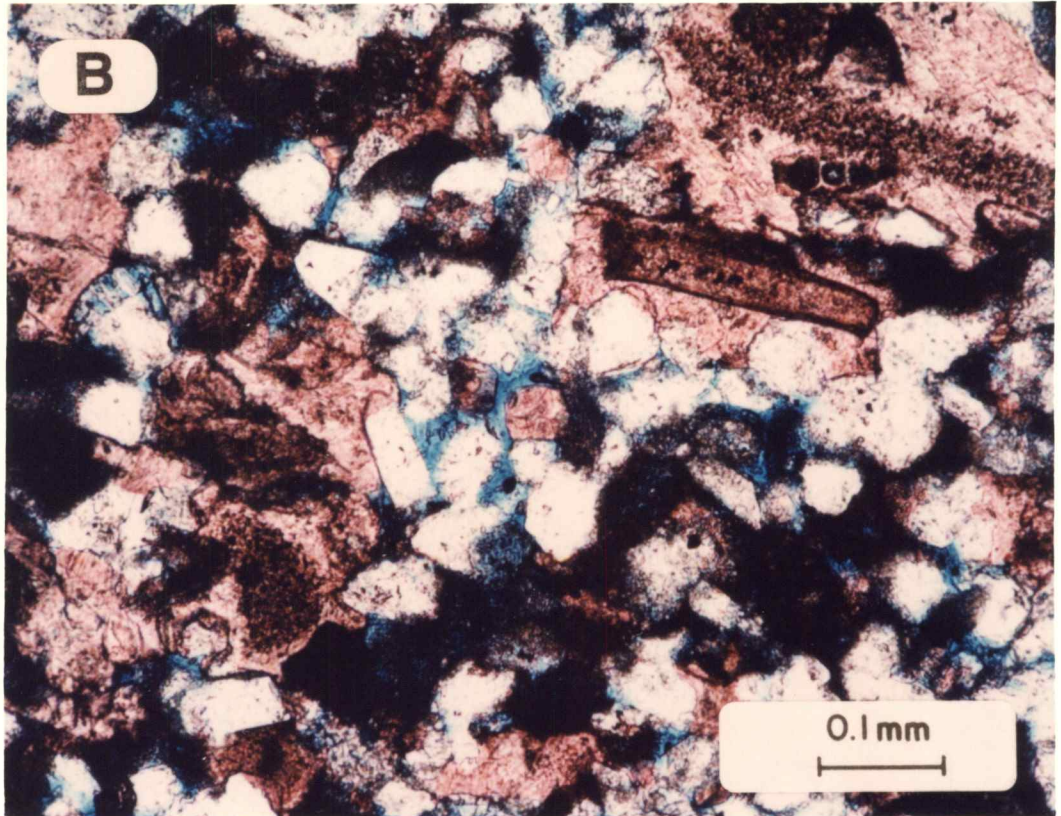
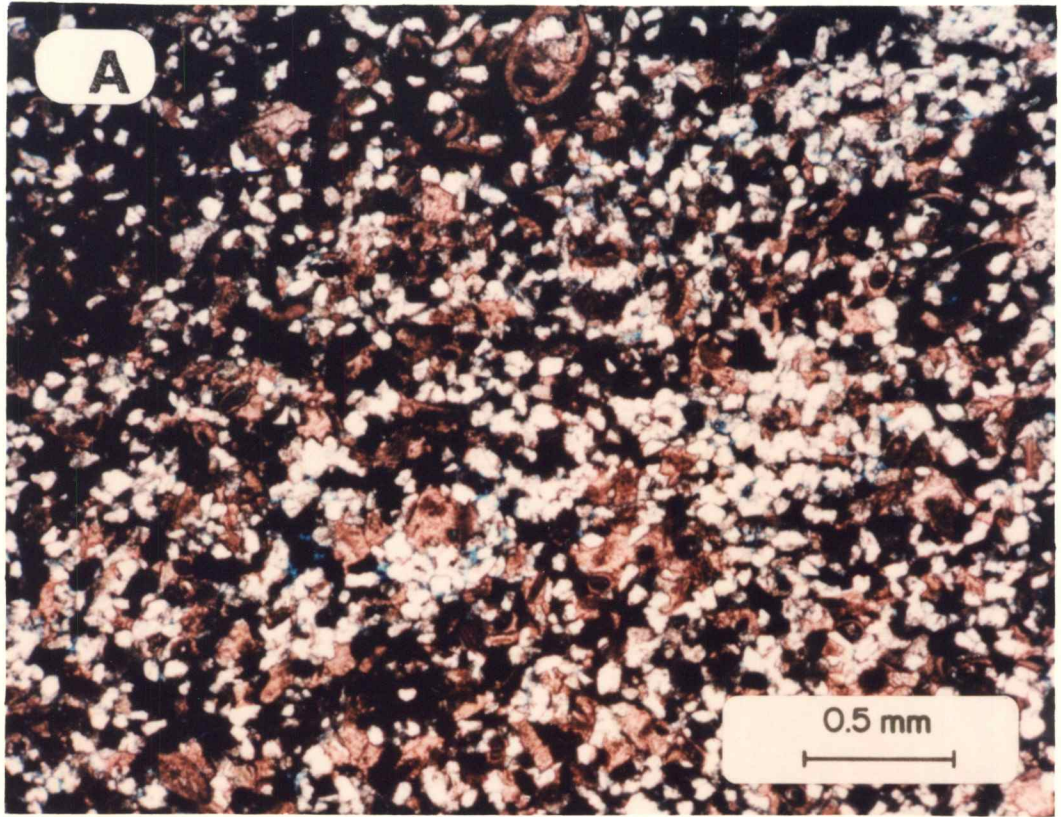
#### X-ray Diffraction Data

Quartz	60%
Potassium Feldspar	6%
Plagioclase Feldspar	7%
Calcite	23%
Anhydrite	2%
Clay	2%

#### Petrophysical Data

Cementation Exponent (m): 1.98

Saturation Exponent (n): Test in Progress



# FIGURE 15

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2627.4 feet

Rock Type: Limestone

Depositional Texture: Grainstone

Porosity: 13.2%

Permeability: 0.894 md

Stratigraphic Unit: Towanda

Dep. Facies: Shoal to Shoal Flank

The pore system in this grain-rich limestone is dominated by scattered moldic pores, intraskeletal pores and microporous micritic grains (such as highlighted in the center of view B). Only a minor amount of preserved primary intergranular pore space is apparent, reflecting an abundance of calcite cement and minor detrital micrite matrix. The remnant pore structure yields a rock with poorly interconnected macropores and microporosity. This accounts for the relatively high measured porosity but low permeability.

A - 40X

B - 160X

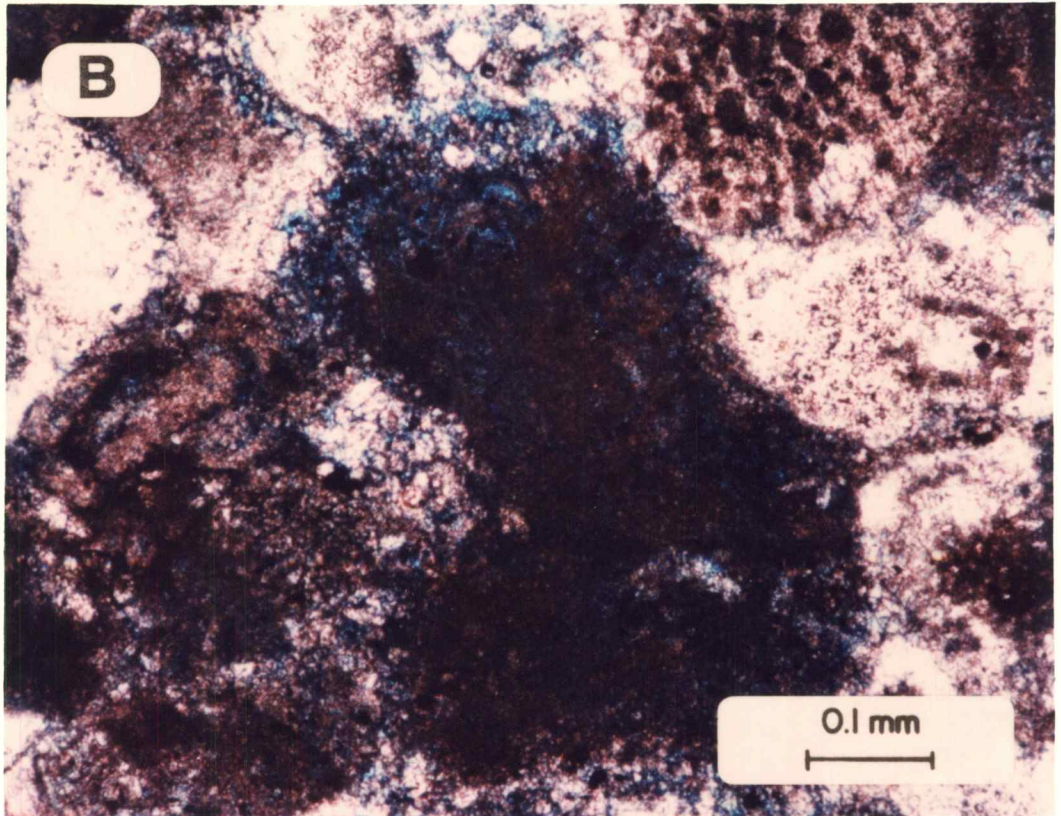
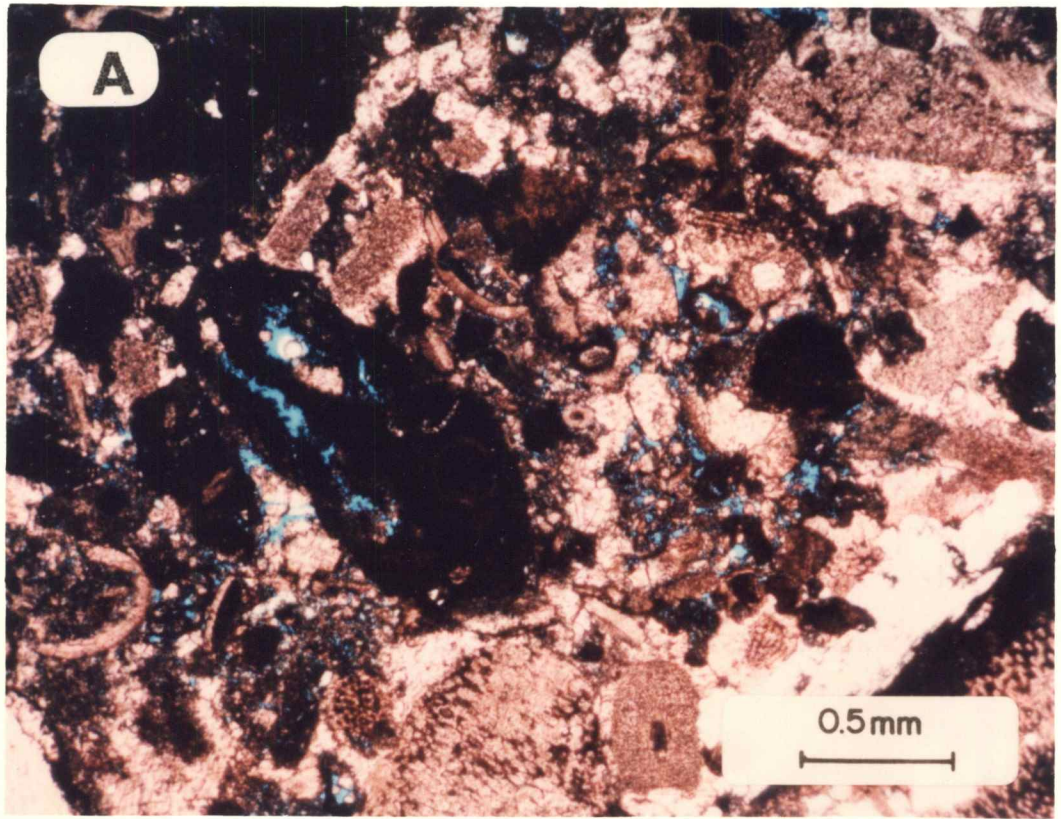
#### X-ray Diffraction Data

Quartz	4%
Potassium Feldspar	7%
Calcite	88%
Anhydrite	1%

#### Petrophysical Data

Cementation Exponent (m): 2.00

Saturation Exponent (n): Test in Progress



# FIGURE 13

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2579.4 feet

Rock Type: Anhydritic Limestone

Porosity: 16.4%

Depositional Texture: Packstone

Permeability: 5.98 md

Stratigraphic Unit: Winfield Dolomite

Dep. Facies: Shoal to Shoal Flank

Most of the pore space in this packstone is in the form of: remnant intergranular (Ig) pores, moldic (Mo) pores (where skeletal constituents in oncoids have been partially leached), and microporosity (white arrows) in altered micritic grains and matrix. The intergranular voids probably account for most of the effective pores; the microporosity and moldic pores contribute little to the effective pore network. Rocks with this type of pore structure can have rather high immobile water saturations.

A - 40X

B - 160X

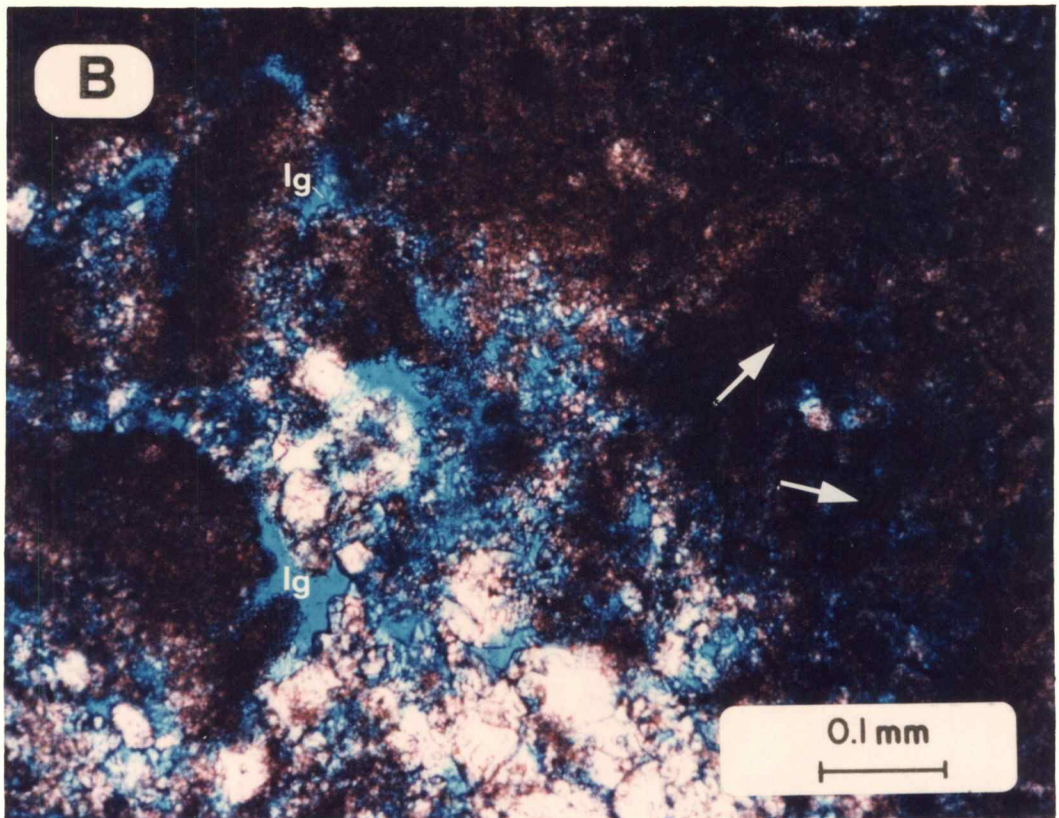
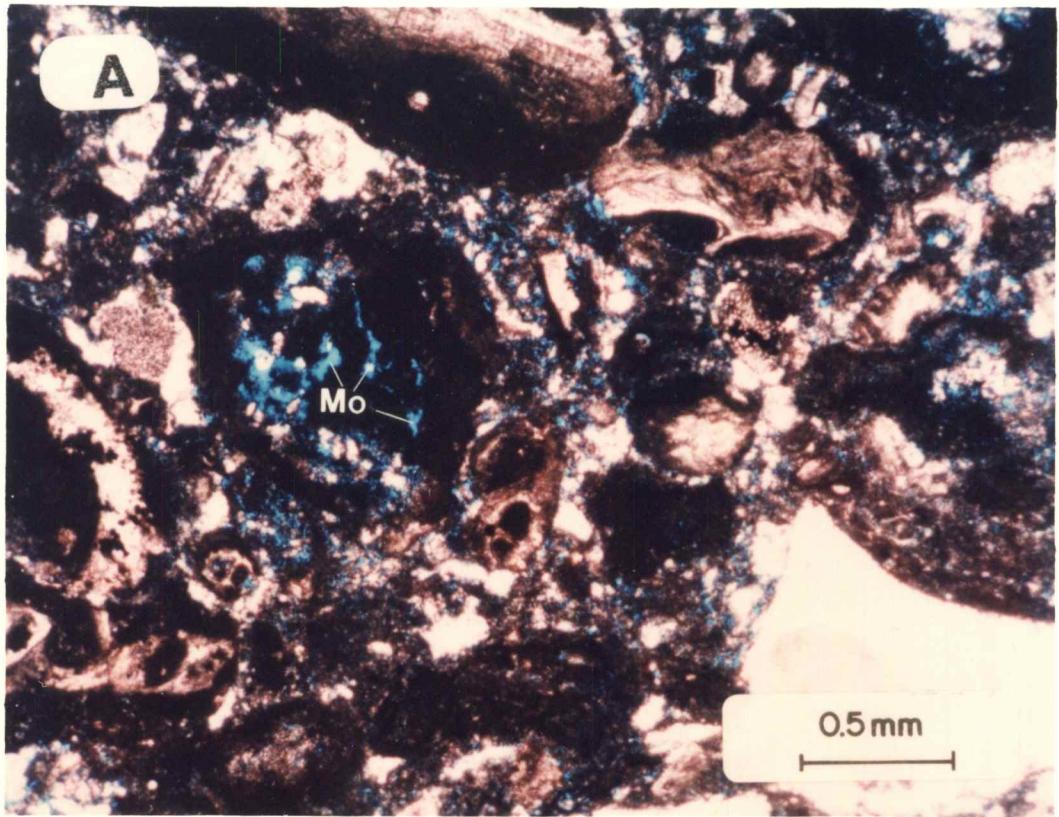
#### X-ray Diffraction Data

Calcite	61%
Dolomite	1%
Anhydrite	38%

#### Petrophysical Data

Cementation Exponent (m): 1.97

Saturation Exponent (n): Test in Progress



# FIGURE 14

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2618.1 feet

Average Grain Size: Coarse Silt (0.062 mm)

Sorting: Well Sorted

Porosity: 14.3%

Permeability: 1.96 md

Stratigraphic Unit: Towanda

Dep. Facies: Tidal Flat

The framework constituents in this siltstone consist of quartz, feldspar, peloids and skeletal fragments. The pore system has a combination of remnant intergranular voids (center of view B), and microporosity within peloids and other micritic grains. The microporous grains probably contribute little to the effective pore network. Calcite cement and carbonate matrix play roles in porosity reduction.

A - 40X

B - 160X

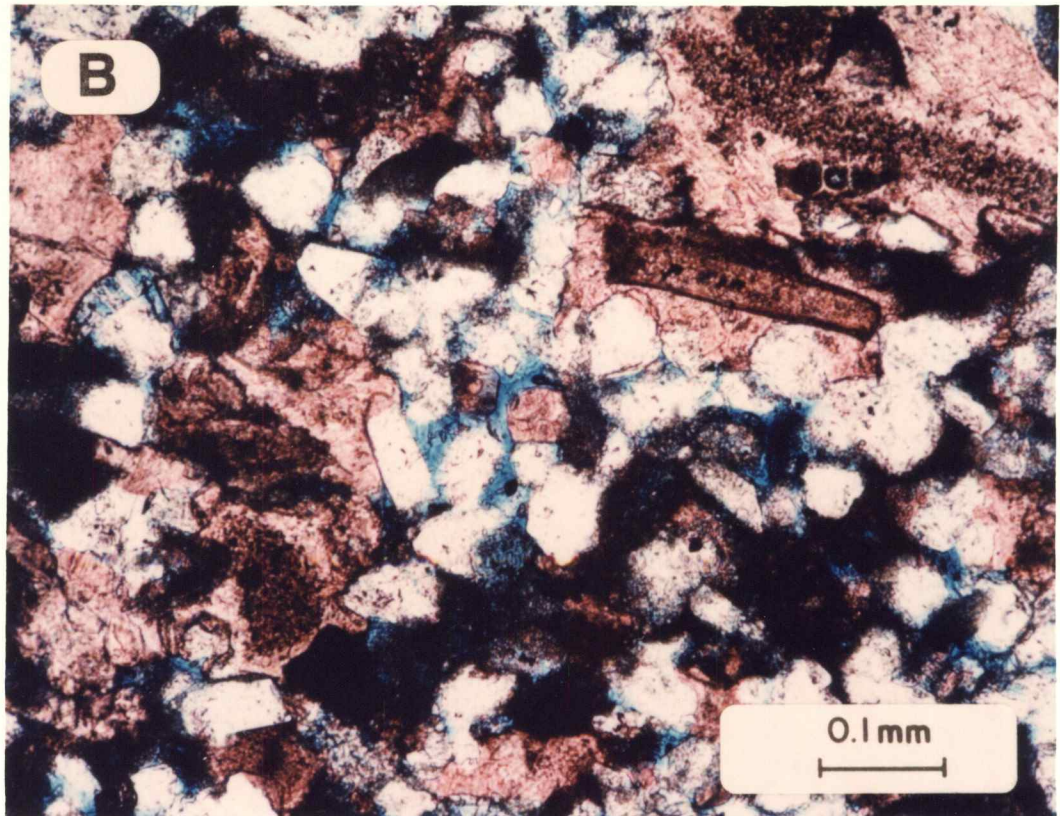
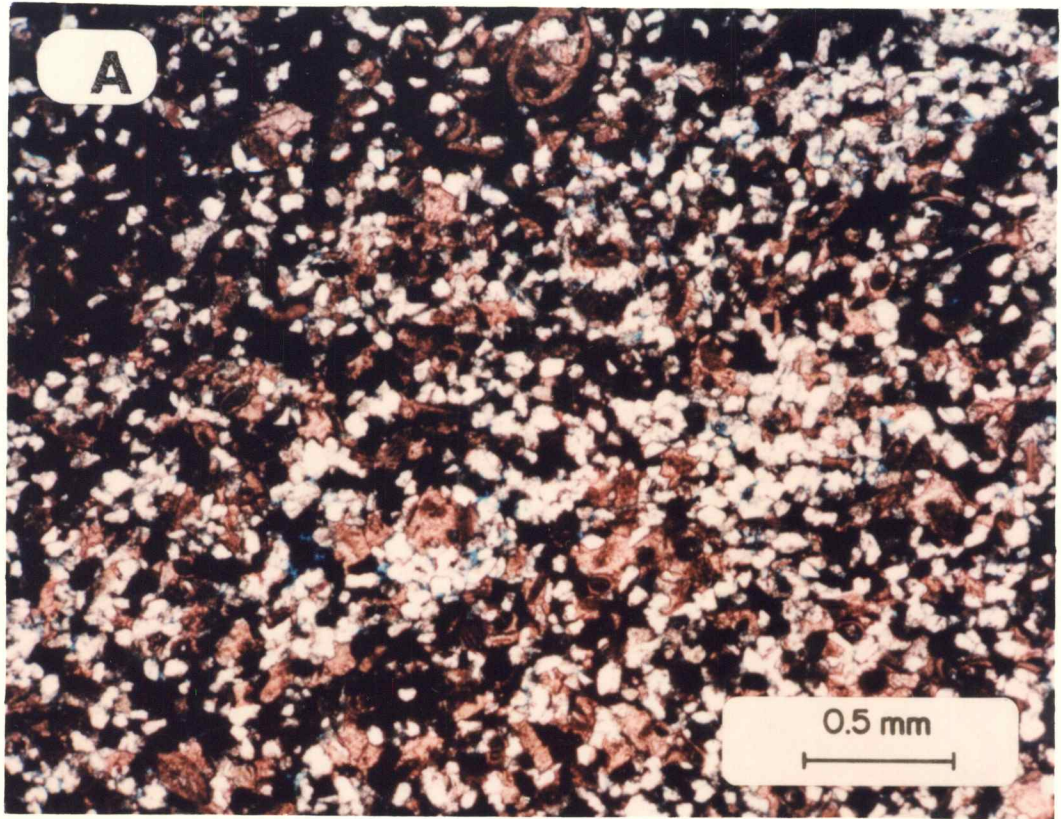
#### X-ray Diffraction Data

Quartz	60%
Potassium Feldspar	6%
Plagioclase Feldspar	7%
Calcite	23%
Anhydrite	2%
Clay	2%

#### Petrophysical Data

Cementation Exponent (m): 1.98

Saturation Exponent (n): Test in Progress



# FIGURE 15

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2627.4 feet

Rock Type: Limestone

Depositional Texture: Grainstone

Porosity: 13.2%

Permeability: 0.894 md

Stratigraphic Unit: Towanda

Dep. Facies: Shoal to Shoal Flank

The pore system in this grain-rich limestone is dominated by scattered moldic pores, intraskeletal pores and microporous micritic grains (such as highlighted in the center of view B). Only a minor amount of preserved primary intergranular pore space is apparent, reflecting an abundance of calcite cement and minor detrital micrite matrix. The remnant pore structure yields a rock with poorly interconnected macropores and microporosity. This accounts for the relatively high measured porosity but low permeability.

A - 40X

B - 160X

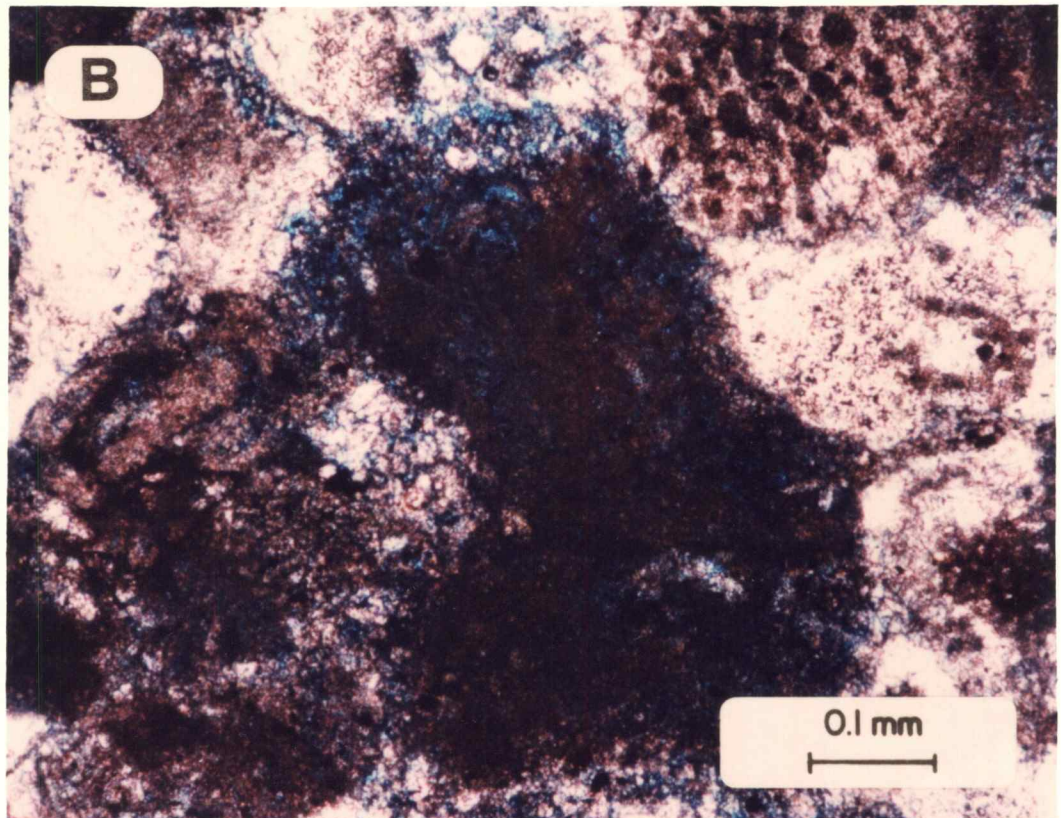
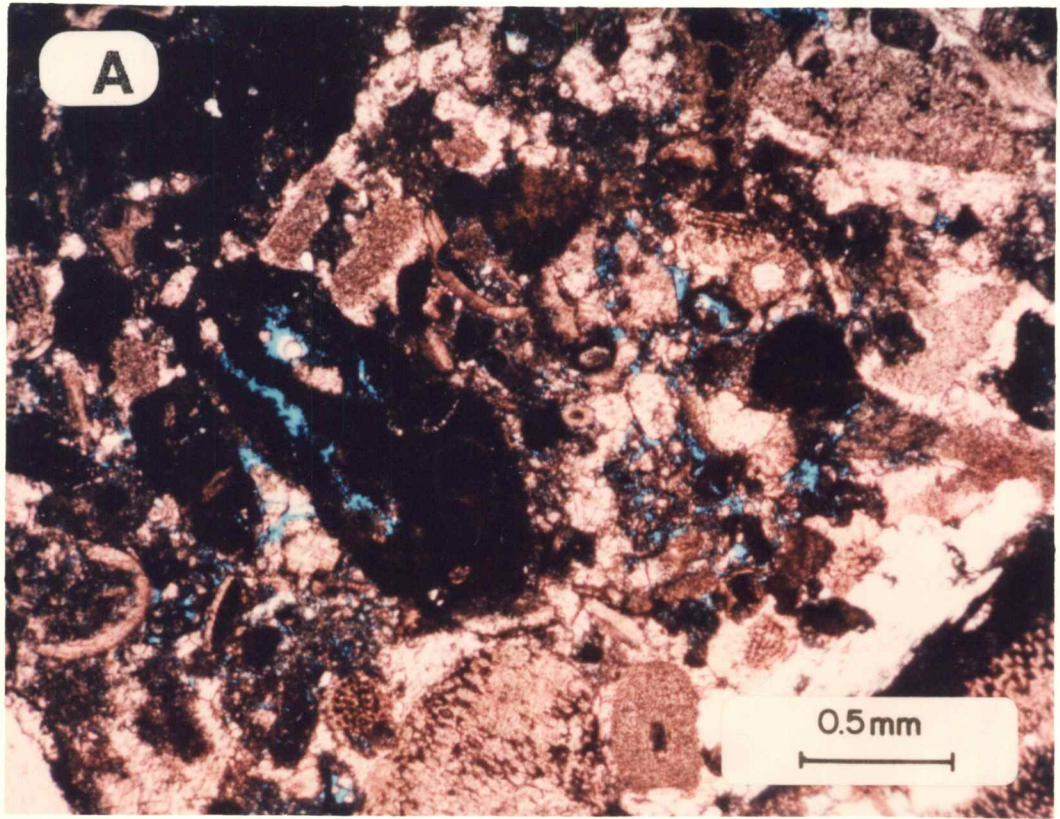
#### X-ray Diffraction Data

Quartz	4%
Potassium Feldspar	7%
Calcite	88%
Anhydrite	1%

#### Petrophysical Data

Cementation Exponent (m): 2.00

Saturation Exponent (n): Test in Progress



# FIGURE 16

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2641.1 feet

Rock Type: Limestone

Depositional Texture: Grainstone/Packstone

Stratigraphic Unit: Towanda

Dep. Facies: Shoal to Shoal Flank

Porosity: 18.5%

Permeability: 10.1 md

Compare this sample with the sample shown in Figure 15. Although these rocks have similar textures and framework constituents, this sample has more preserved primary intergranular (lg) pore space. This difference reflects subtle variations in compaction and calcite cementation. The relative abundance of remnant intergranular pore space results in a rock with comparatively high permeability. In addition to the intergranular pores, this rock also contains intraskeletal pores, moldic pores and microporosity in micritic grains and matrix.

A - 40X

B - 160X

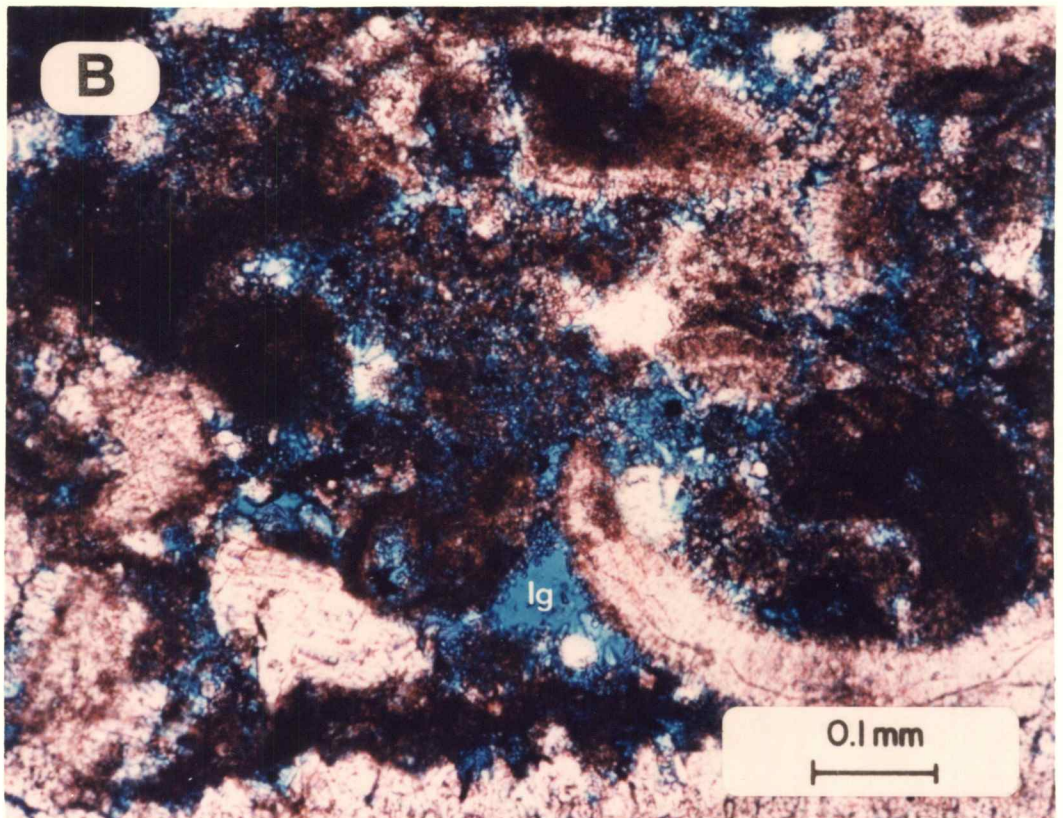
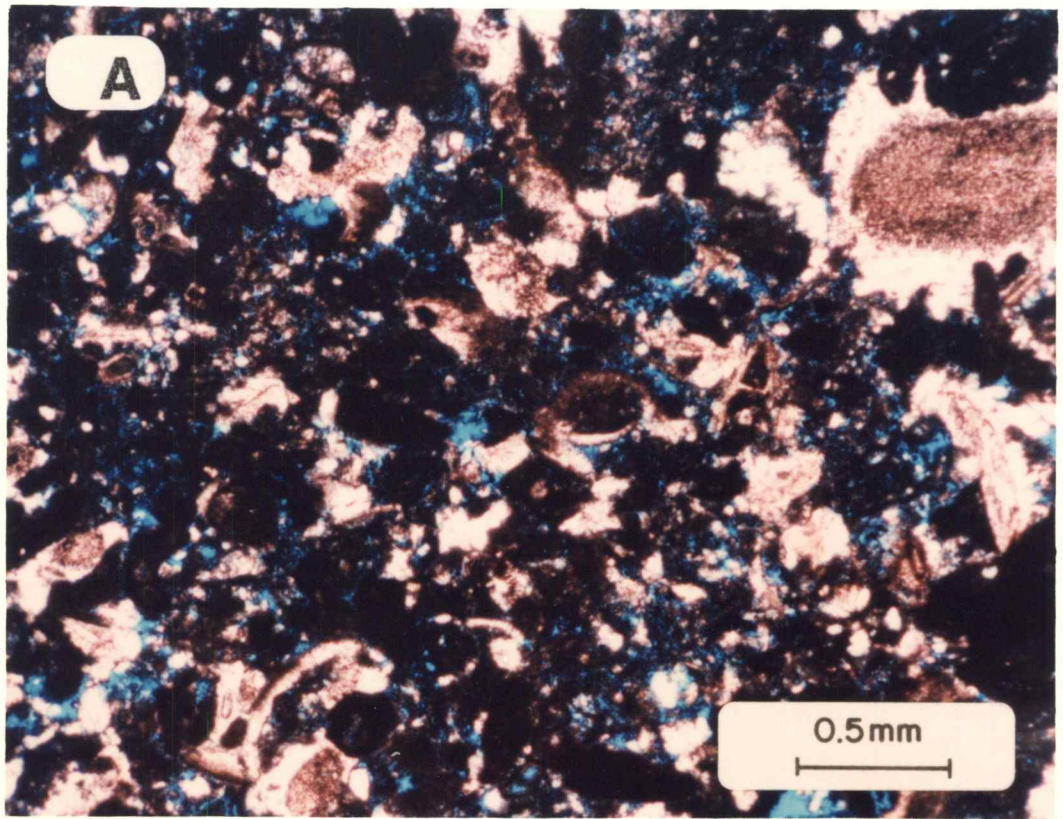
#### X-ray Diffraction Data

Quartz	3%
Calcite	78%
Anhydrite	19%

#### Petrophysical Data

Cementation Exponent (m): 2.01

Saturation Exponent (n): Test in Progress



# FIGURE 17

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2658.7 feet

Average Grain Size: Coarse Silt (0.039 mm)

Sorting: Well Sorted

Porosity: 17.9%

Permeability: 1.66 md

Stratigraphic Unit: Holmesville

Dep. Facies: Tidal Flat

Both carbonate (dolomite and calcite) and siliciclastic matrix are present as pore-filling constituents in this siltstone. Some of the matrix material is in the form of laminations; burrows have breached these laminations and reworked the matrix material, yielding a heterogeneous rock fabric. In addition to the preserved intergranular pores, a portion of the measured pore volume is in the form of microporosity associated with the matrix.

A - 40X

B - 160X

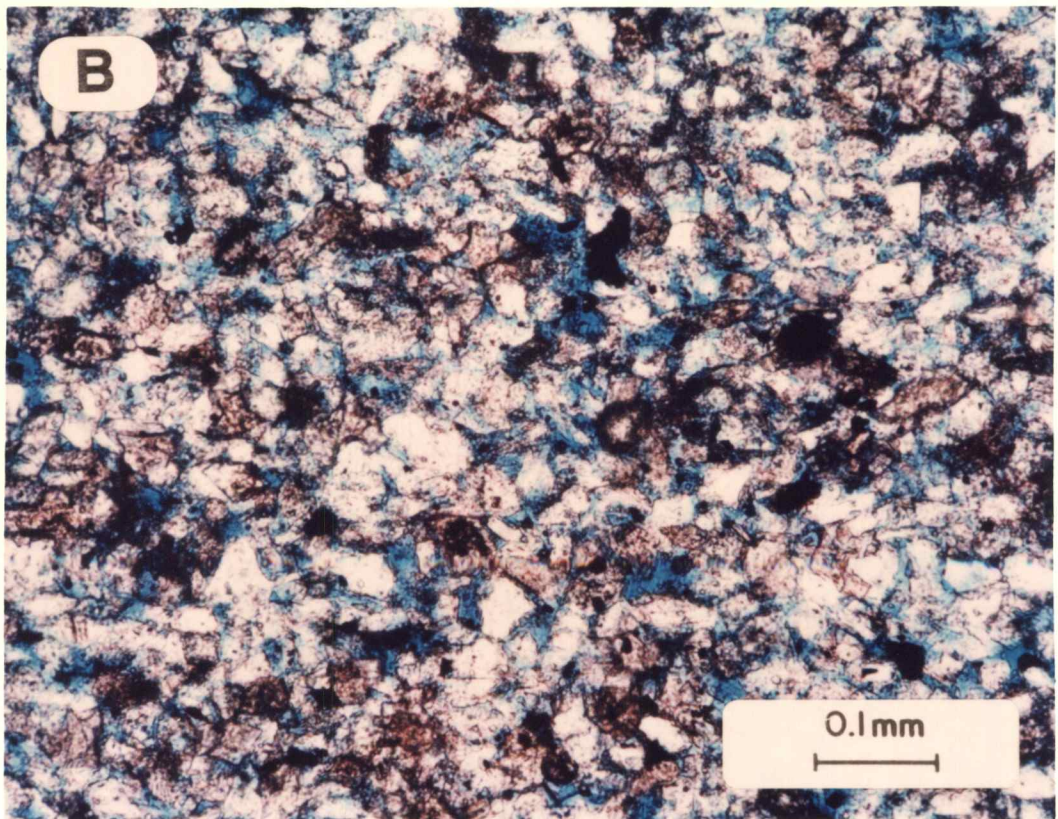
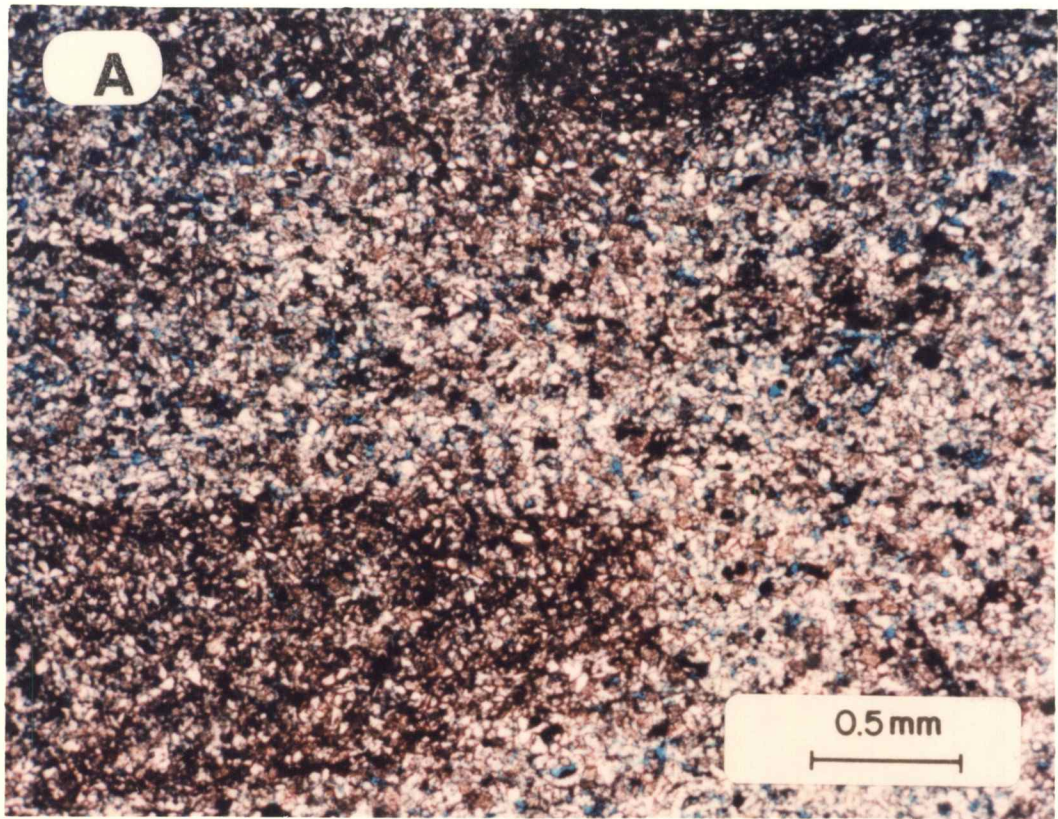
#### X-ray Diffraction Data

Quartz	73%
Potassium Feldspar	9%
Plagioclase Feldspar	8%
Dolomite	5%
Clay	5%

#### Petrophysical Data

Cementation Exponent (m): 1.93

Saturation Exponent (n): Test in Progress



# FIGURE 18

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2681.7 feet

Rock Type: Limestone

Depositional Texture: Packstone/Wackestone

Stratigraphic Unit: Upper Ft. Riley

Dep. Facies: Shoal to Shoal Flank

Porosity: 16.9%

Permeability: 2.28 md

Portions of this sample have a wackestone (micrite-dominated) texture and other parts have a packstone (grain-supported) texture. Only a minor amount of macropore space is present. The pore system consists of scattered intergranular pores, moldic pores, intraskeletal pores and microporosity (in micritic grains and matrix). The intergranular voids probably account for most of the effective pores. Rocks with this pore structure tend to have rather high immobile water saturations due to the large surface area to volume ratio.

A - 40X

B - 160X

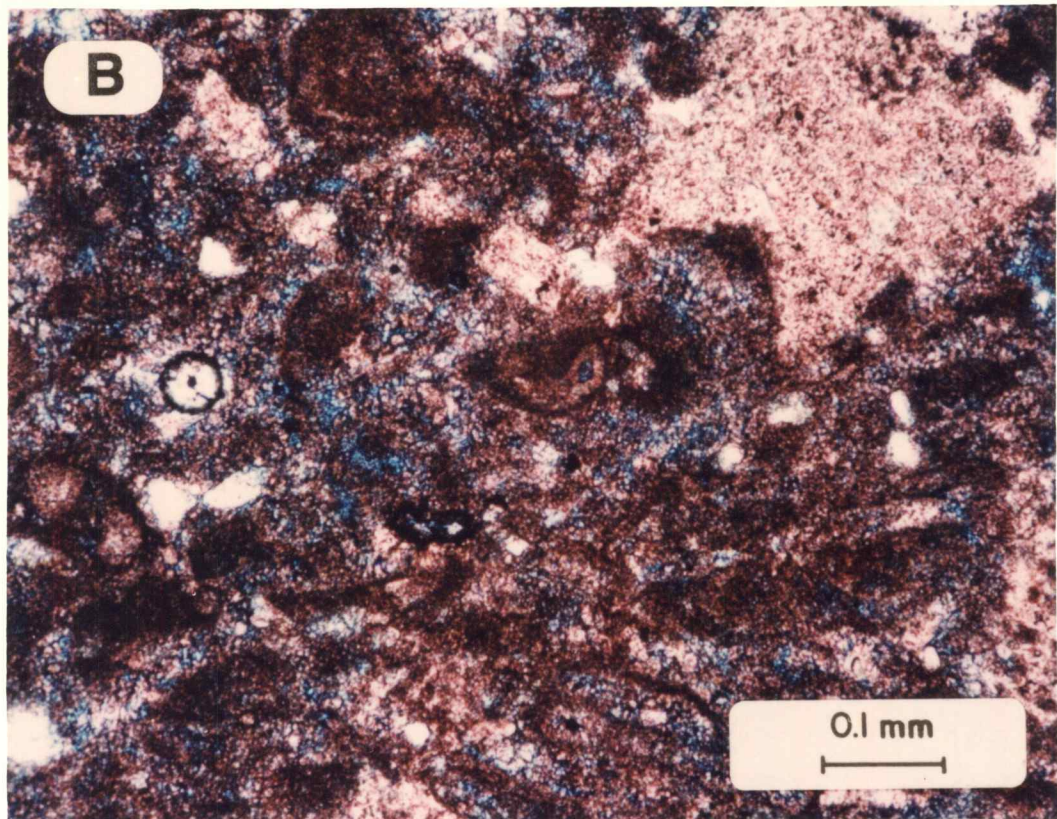
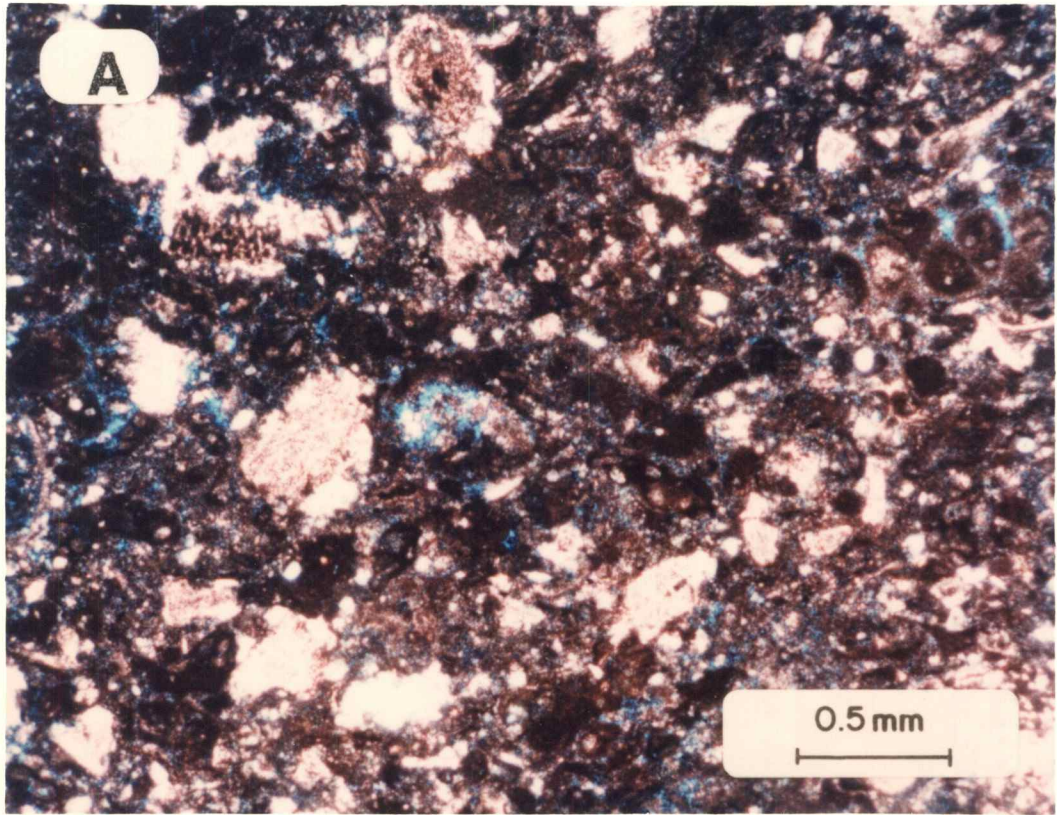
#### X-ray Diffraction Data

Quartz	4%
Calcite	61%
Dolomite	7%
Anhydrite	28%

#### Petrophysical Data

Cementation Exponent (m): 2.02

Saturation Exponent (n): Test in Progress



# FIGURE 19

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2700.5 feet

Rock Type: Dolomitic Limestone

Porosity: 15.2%

Depositional Texture: Wackestone

Permeability: 0.413 md

Stratigraphic Unit: Upper Ft. Riley

Dep. Facies: Shoal to Shoal Flank

This sample is from a micritic portion of the shoal flank facies. The rock contains a mixture of carbonate grains and matrix. The matrix has undergone partial dolomitization, although the grains are mostly still composed of calcite (stained pink). The dolomitization created fine intercrystalline pores that can only be distinguished under high magnification (blue areas in view B). Scattered intraskeletal pores and moldic pores were also observed, but overall, most of the pore space is in the altered matrix. The small pores, narrow pore apertures and tortuous pore system result in rather low permeability.

A - 40X

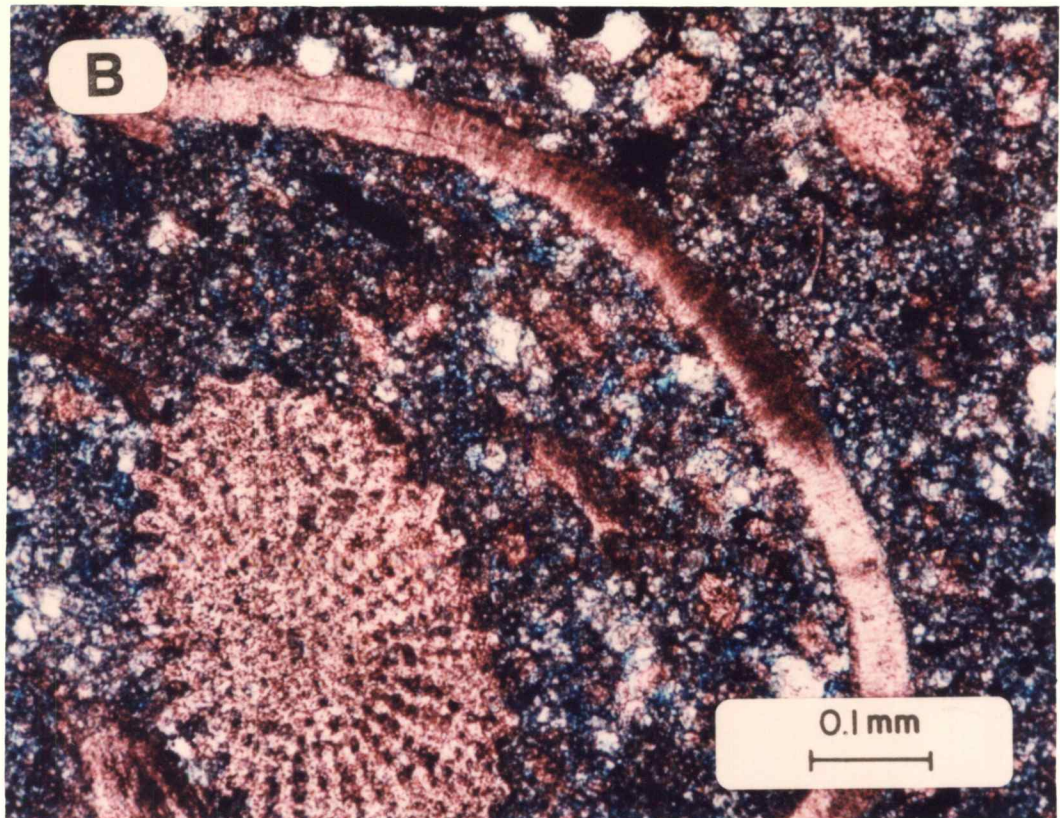
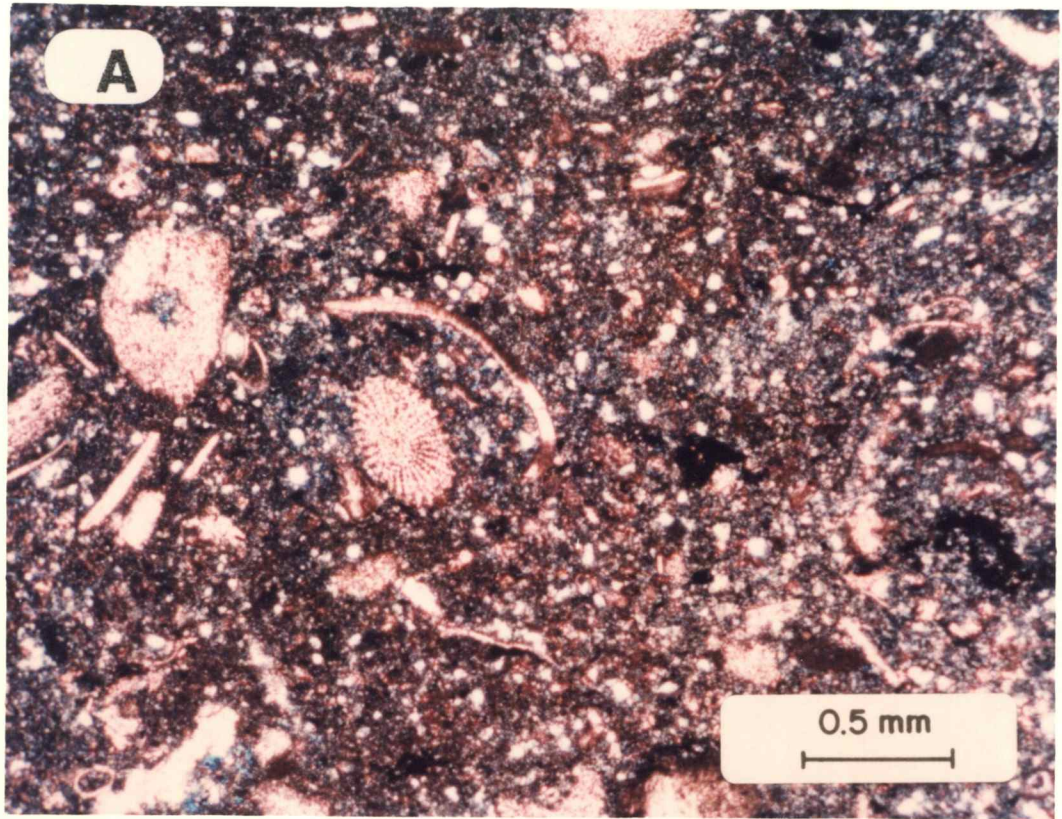
B - 160X

#### X-ray Diffraction Data

Quartz	6%
Potassium Feldspar	5%
Plagioclase Feldspar	1%
Calcite	57%
Dolomite	12%
Anhydrite	19%

#### Petrophysical Data

Cementation Exponent (m): 1.95  
Saturation Exponent (n): Test in Progress



## FIGURE 20

### THIN SECTION PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2772.5 feet

Rock Type: Anhydritic Limestone

Depositional Texture: Grainstone

Stratigraphic Unit: Wreford

Dep. Facies: Shoal to Shoal Flank

Porosity: 17.4%

Permeability: 12.4 md

Oncoids, peloids and skeletal fragments are present in this grainstone. Calcite (Ca) cement is rather extensive. The remnant pore structure consists of: 1) moldic (Mo) pores, 2) scattered intraskeletal pores, 3) reduced intergranular (Ig) pores, and 4) microporosity within altered micritic grains (white arrows). The resultant pore structure forms a rock with heterogeneous porosity preservation and a tortuous pore system. The intergranular pores probably account for most of the effective pore network and microporosity probably contribute little to the measured porosity.

A - 40X

B - 160X

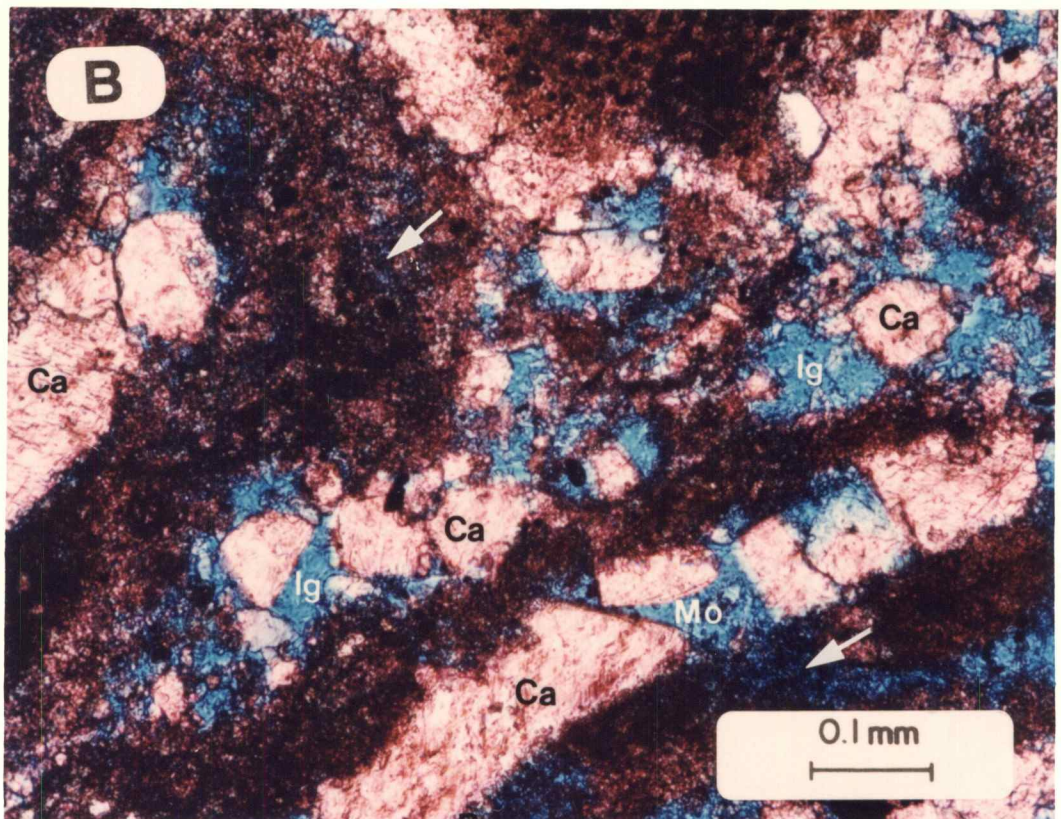
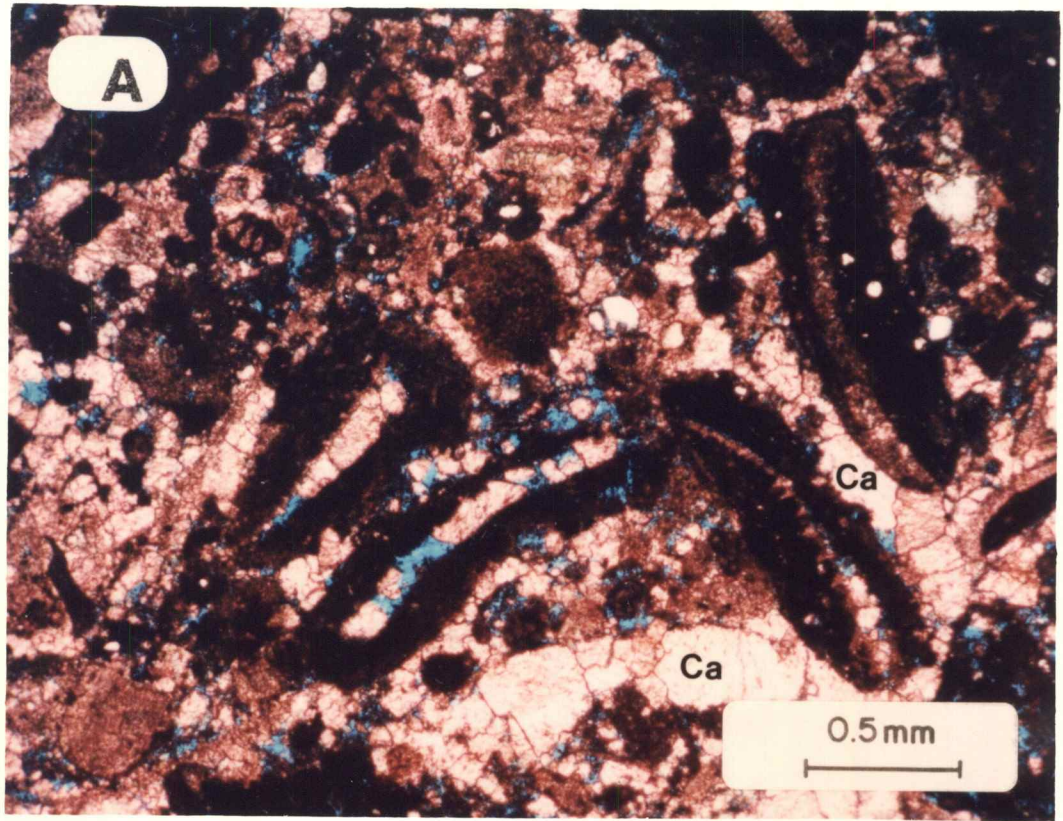
#### X-ray Diffraction Data

Quartz	4%
Calcite	77%
Anhydrite	19%

#### Petrophysical Data

Cementation Exponent (m): Test in Progress

Saturation Exponent (n): Test in Progress



# FIGURE 21

## THIN SECTION PHOTOMICROGRAPHS

### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2877.1 feet

Rock Type: Limestone

Porosity: 12.5%

Depositional Texture: Grainstone/Packstone

Permeability: 0.689 md

Stratigraphic Unit: Council Grove B1

Dep. Facies: Shoal to Shoal Flank

Throughout most of this sample, intergranular pore space has been occluded by a combination of calcite cement and detrital micrite matrix. Most of the remnant macropore space is in the form of scattered moldic, intraskeletal and reduced intergranular pores. In addition, alteration of micritic grains such as oncoids has led to the development of microporosity (white arrows in view B). This inefficient pore system results in rather low permeability.

A - 40X

B - 160X

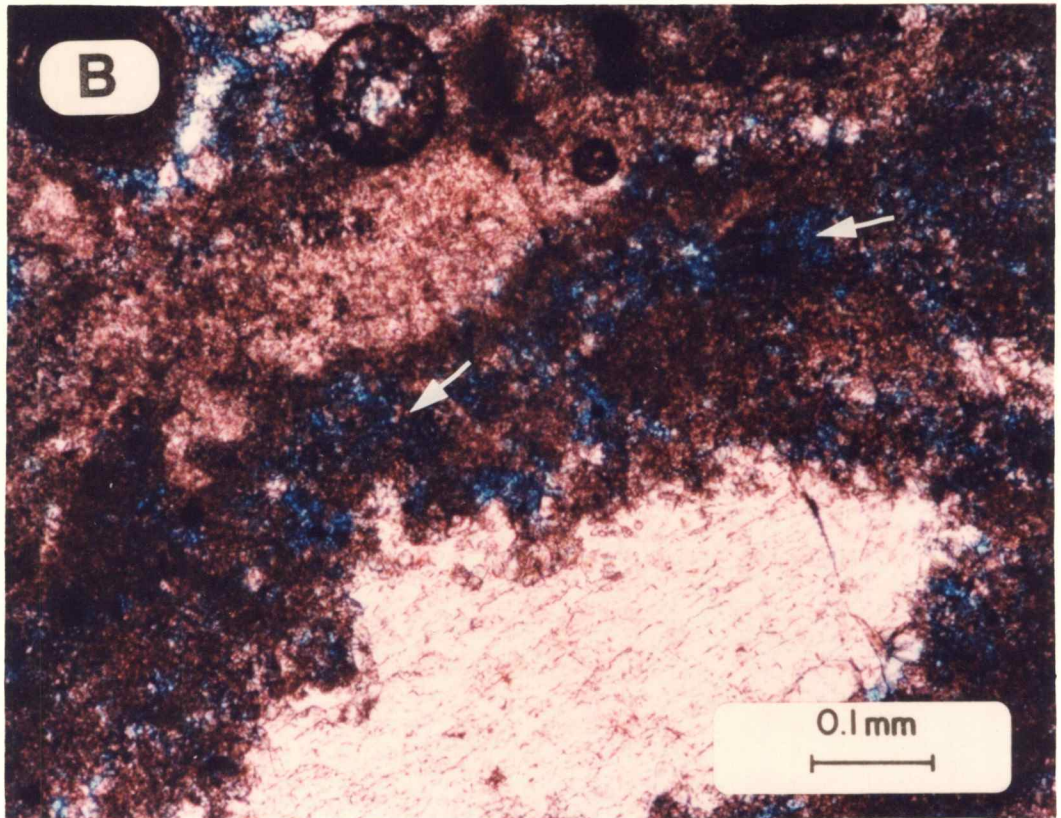
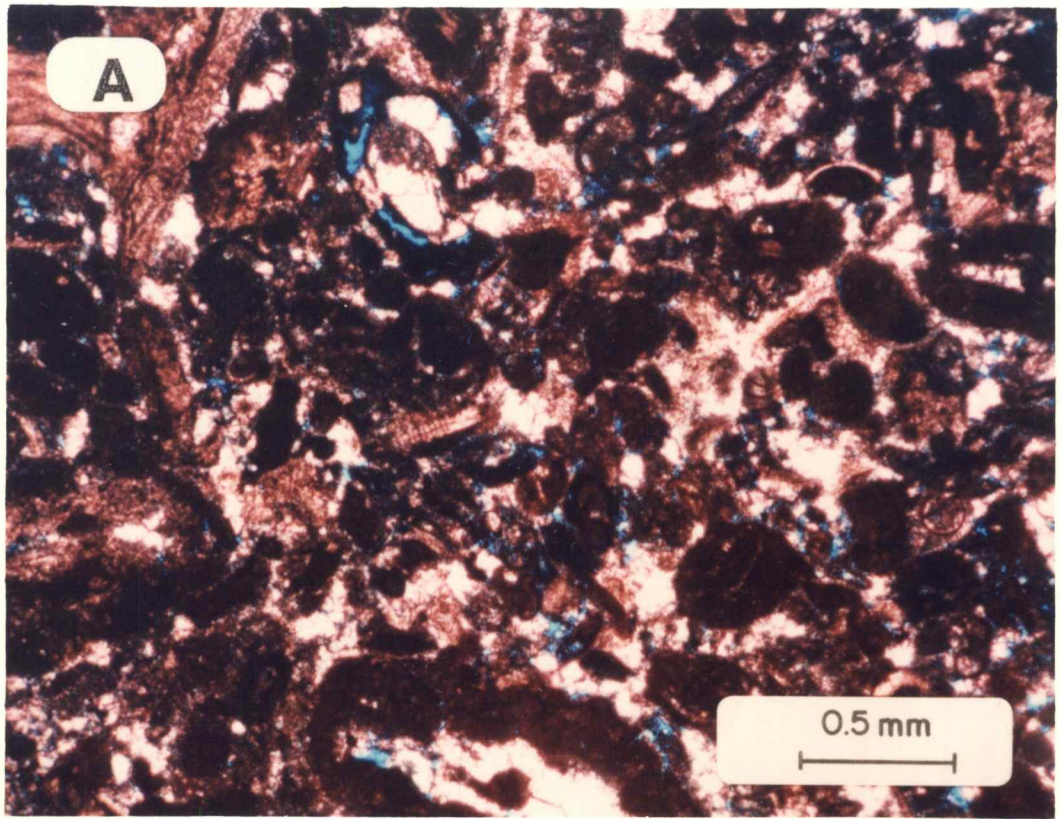
#### X-ray Diffraction Data

Quartz	3%
Calcite	95%
Dolomite	2%

#### Petrophysical Data

Cementation Exponent (m): 2.04

Saturation Exponent (n): Test in Progress



## FIGURE 22

### THIN SECTION PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2891.4 feet

Rock Type: Limestone

Porosity: 13.2%

Depositional Texture: Grainstone

Permeability: 48.7 md

Stratigraphic Unit: Council Grove B2

Dep. Facies: Shoal to Shoal Flank

This grainstone is dominated by well sorted peloids and foraminifera. Overall, the rock has a well preserved network of intergranular (Ig) pores. At least two generations of calcite cement have acted to occlude pore space. An early generation of finely crystalline cement (white arrow) surrounds many of the grains. A later generation of blocky calcite (Bc) spar more completely occludes some intergranular areas. In view A, note how the blocky calcite spar has a patchy distribution. Although calcite cement has reduced the pore system, the remnant intergranular pore space provides for an effective pore network and good reservoir potential.

A - 40X

B - 160X

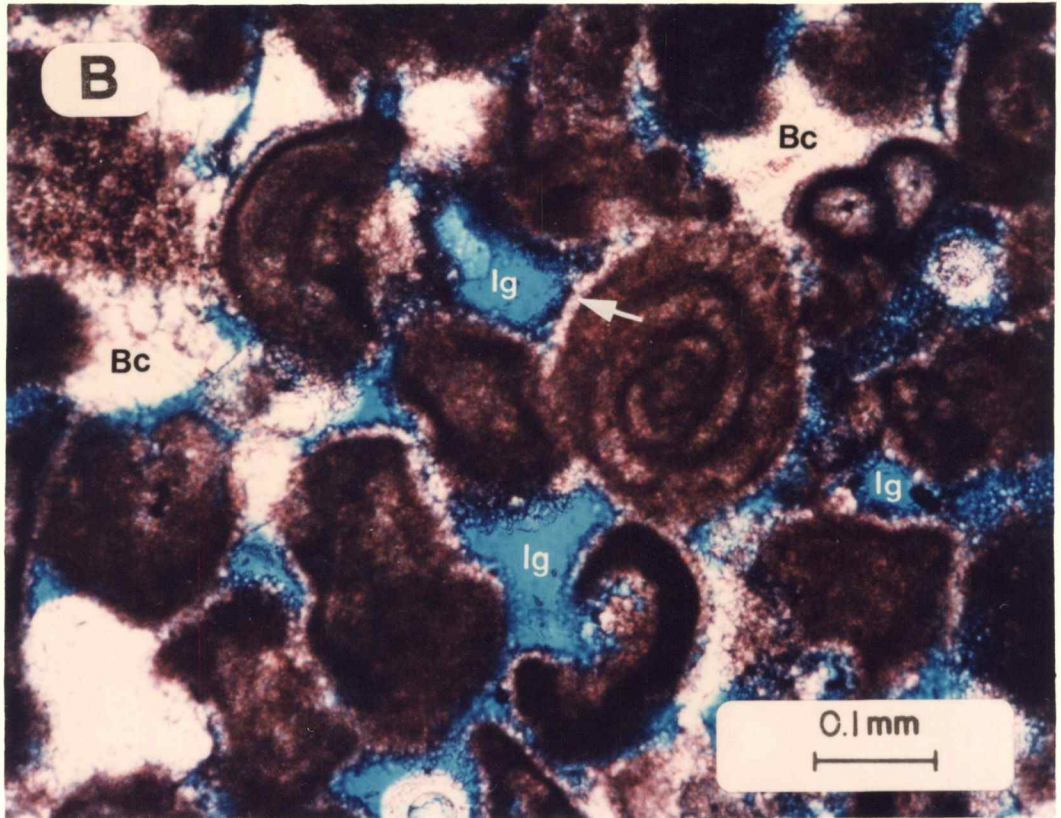
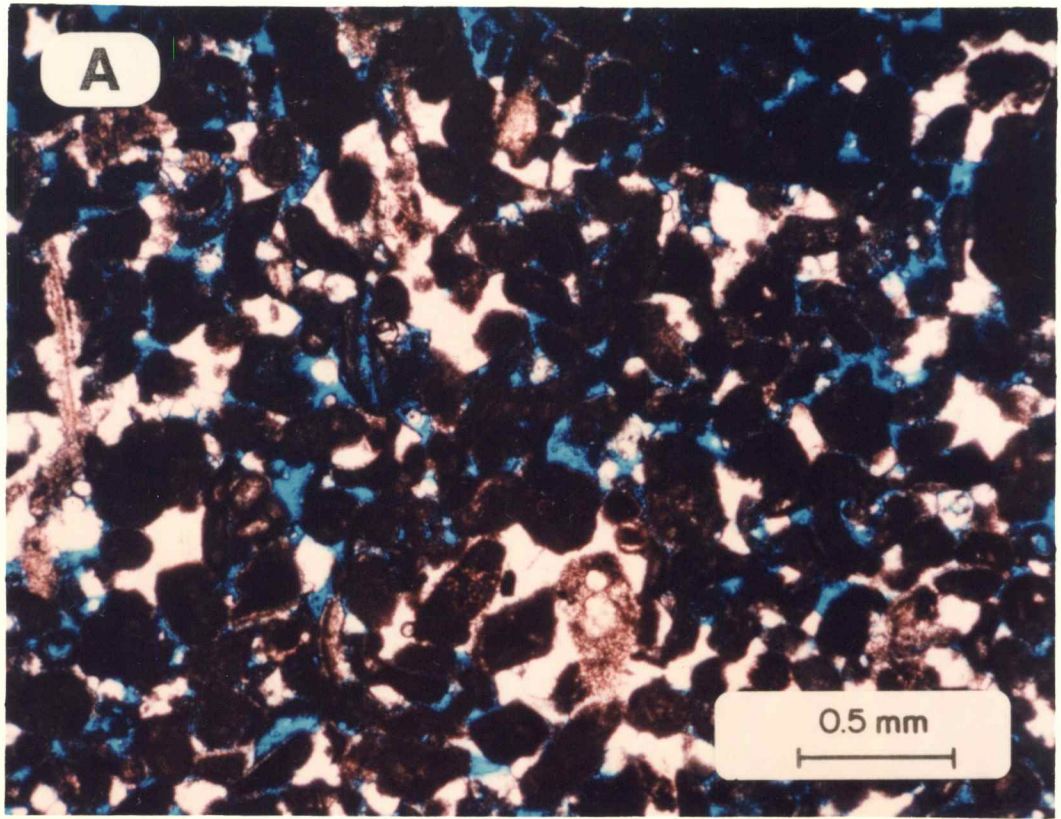
#### X-ray Diffraction Data

Quartz	1%
Calcite	79%
Anhydrite	20%

#### Petrophysical Data

Cementation Exponent (m): 2.09

Saturation Exponent (n): Test in Progress



## FIGURE 23

### THIN SECTION PHOTOMICROGRAPHS

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2932.5 feet

Rock Type: Limestone

Porosity: 11.7%

Depositional Texture: Grainstone

Permeability: 17.2 md

Stratigraphic Unit: Council Grove B4

Dep. Facies: Shoal to Shoal Flank

In addition to preserved intergranular (lg) pores, moldic and intraskeletal pores are present within foraminifera and calcareous algae. Patchy calcite (Ca) cement results in heterogeneous porosity distribution. However, the remnant network of intergranular pores still allow for efficient fluid movement throughout the rock.

A - 40X

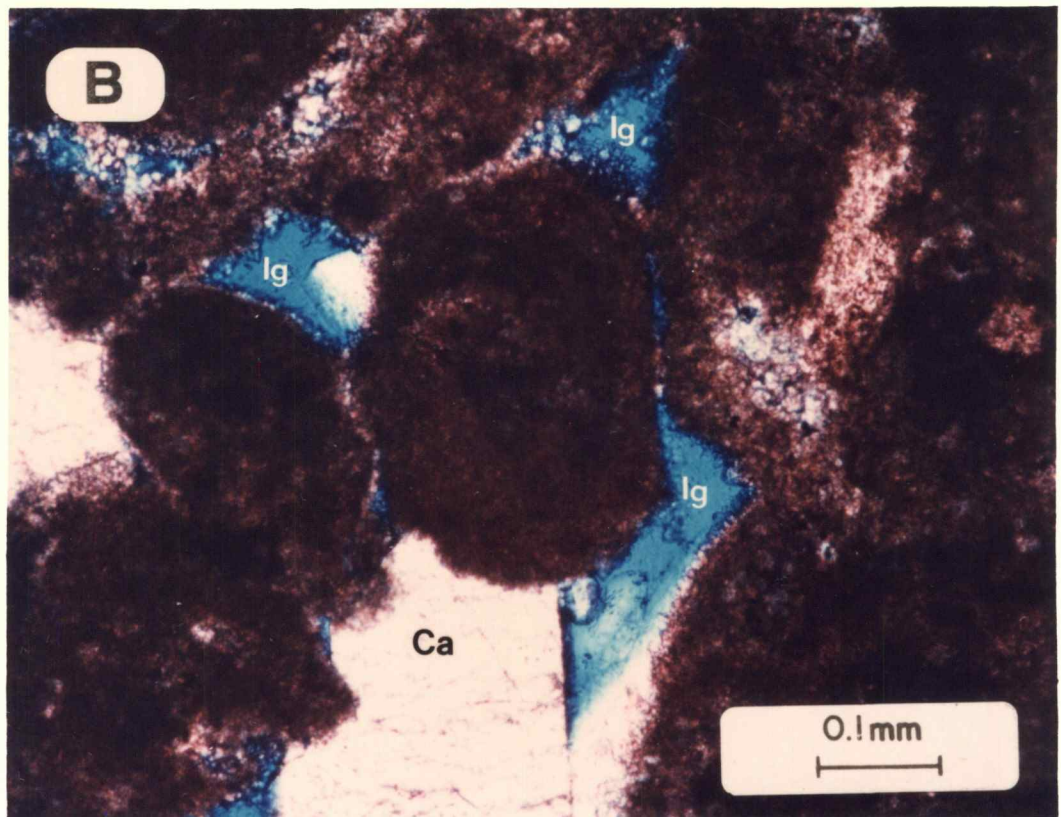
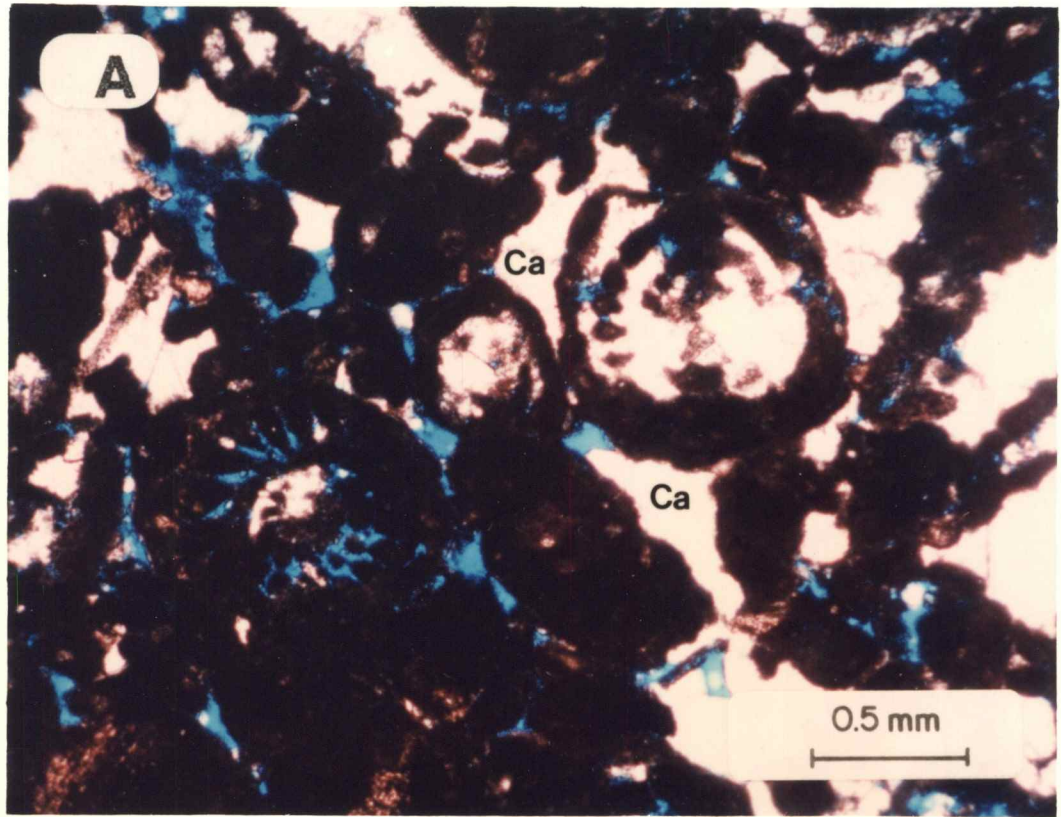
B - 160X

#### X-ray Diffraction Data

Quartz	3%
Calcite	97%

#### Petrophysical Data

Cementation Exponent (m): 2.11  
Saturation Exponent (n): Test in Progress



## FIGURE 24

### THIN SECTION PHOTOMICROGRAPHS

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2949.8 feet

Rock Type: Limestone

Porosity: 14.4%

Depositional Texture: Packstone

Permeability: 177 md

Stratigraphic Unit: Council Grove B5

Dep. Facies: Algal Bank

The depositional texture of this phylloid algal-bearing rock is heterogeneous. Some parts of the sample contain an abundance of micrite and tightly packed peloids (dark areas in view A), while other areas contain little micrite and have preserved intergranular pores (view B). The depositional texture has been somewhat obscured by the brecciation and brittle deformation that resulted in the development of fractures (F). The brecciation may have initiated due to extensive dissolution of the phylloid algae. This created an unstable porous rock that probably "collapsed" in response to overburden stresses. Although some of the fractures are partially filled with calcite (Ca) cement, many remain open. These fractures play an important role in the high permeability of this rock.

A - 40X

B - 160X

#### X-ray Diffraction Data

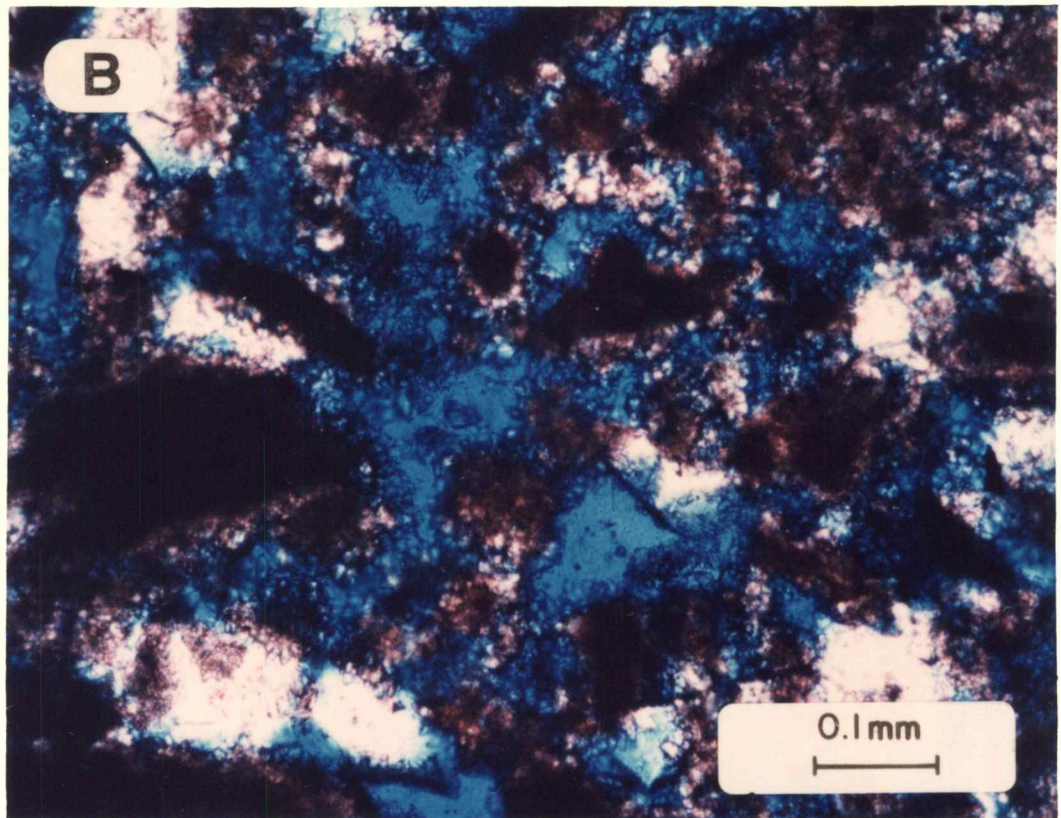
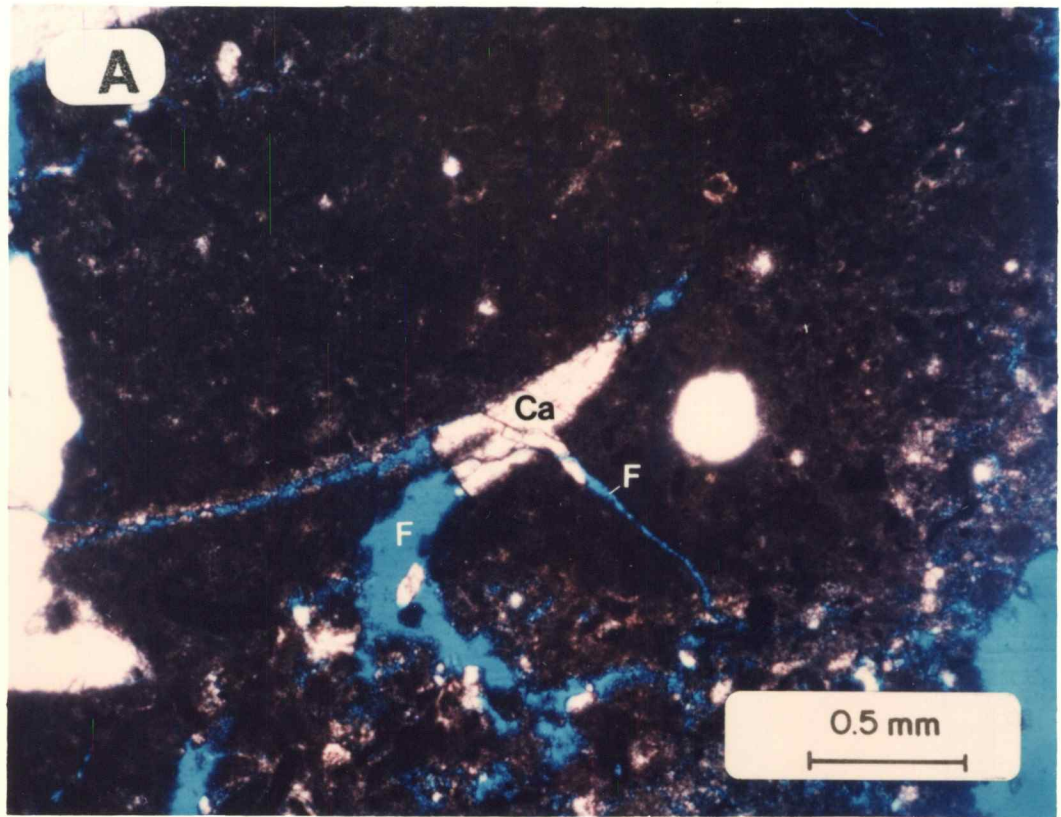
Calcite

100%

#### Petrophysical Data

Cementation Exponent (m): 2.06

Saturation Exponent (n): Test in Progress



## FIGURE 25

### WHOLE THIN SECTION PHOTOGRAPH

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2515.8 feet

Rock Type: Dolomite

Depositional Texture: Grainstone

Stratigraphic Unit: Krider

Dep. Facies: Shoal to Shoal Flank

Porosity: 22.3%

Permeability: 275 md

Note the abundance of large moldic pores and smaller intercrystalline pores throughout this dolomite. Although dolomitization has somewhat obscured the depositional texture of this rock, the abundance of grain relicts indicates a grainstone texture. The intercrystalline pores and remnant intergranular pores provide access to the moldic pores. Together, these pores combined to yield a rock with high permeability and very good reservoir potential. A few patches of coarsely crystalline anhydrite (bright white) cement are present. The space between the black bars at the bottom of the photograph equals 1 mm.

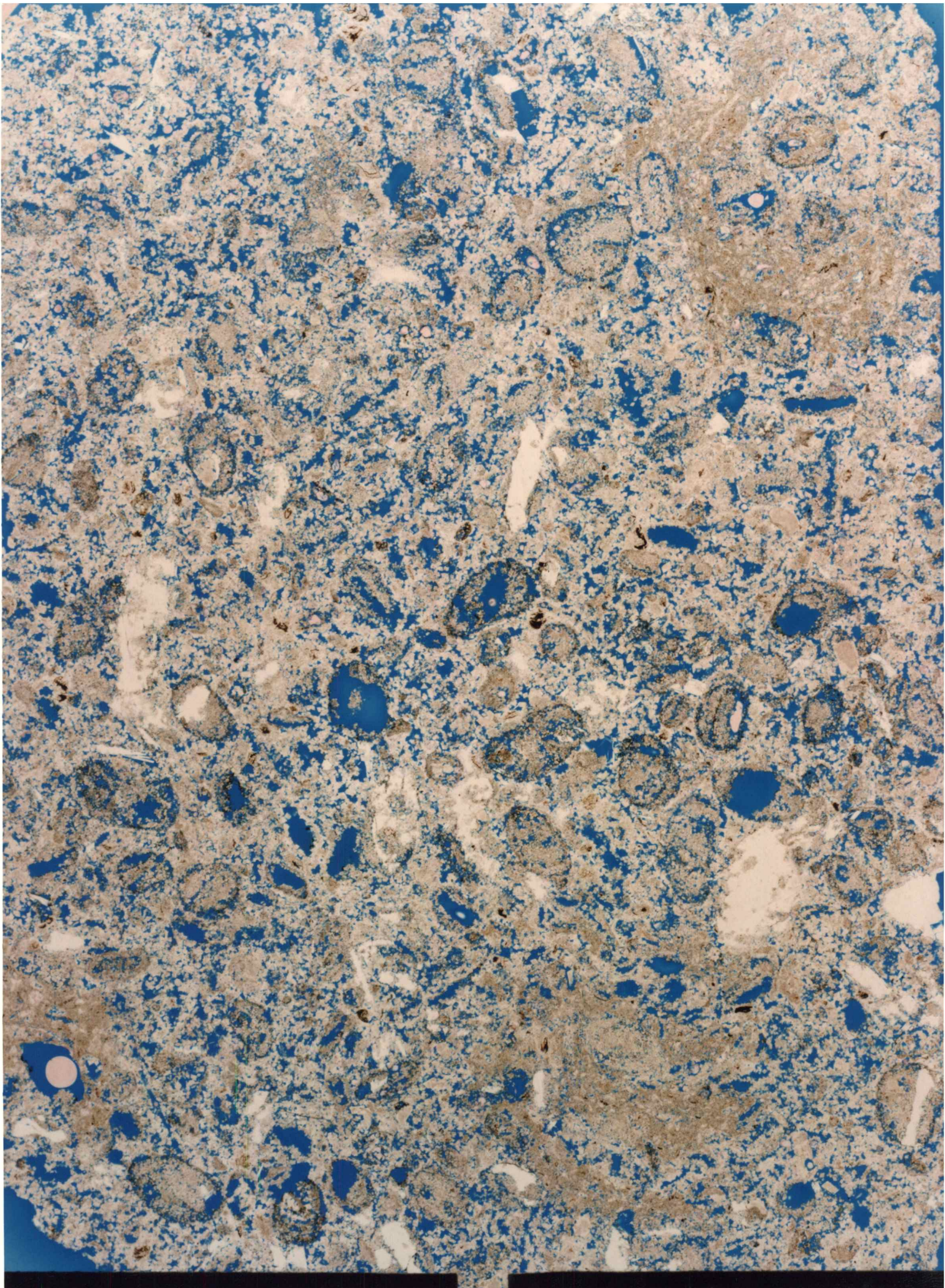
#### X-ray Diffraction Data

Dolomite	99%
Anhydrite	1%

#### Petrophysical Data

Cementation Exponent (m): 2.20

Saturation Exponent (n): Test in Progress



## FIGURE 26

### WHOLE THIN SECTION PHOTOGRAPH

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2531.1 feet

Rock Type: Calcareous Dolomite

Depositional Texture: Wackestone/Mudstone

Stratigraphic Unit: Krider

Dep. Facies: Shoal Flank

Porosity: 17.5%

Permeability: 1.11 md

Compare this sample to the dolomitized grainstone shown in Figure 25. The uniformly finely crystalline fabric and paucity of relict framework grains indicate that this rock accumulated with a micritic (wackestone/mudstone) texture. Dolomitization apparently enhanced reservoir potential by creating small intercrystalline pores in what had been low porosity/permeability carbonate matrix. However, the small size of the pores, combined with the narrow pore throat apertures and tortuous pore system yield a rock with only fair reservoir potential. Calcite cement (stained pink), anhydrite replacement (white) and pyrite replacement (black) account for minor portions of this sample. The space between the black bars equals 1 mm.

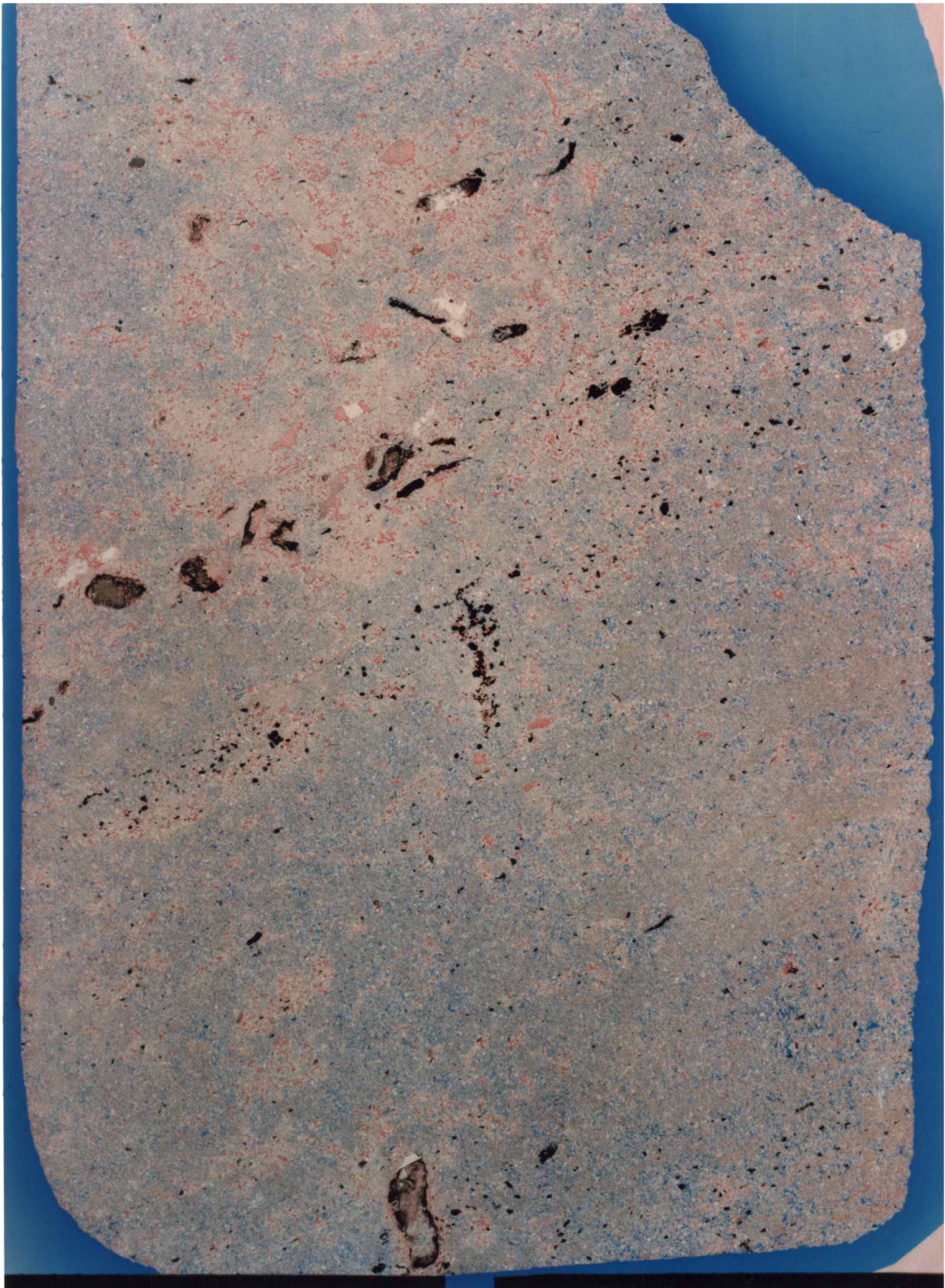
#### X-ray Diffraction Data

Quartz	9%
Potassium Feldspar	2%
Plagioclase Feldspar	1%
Calcite	4%
Dolomite	80%
Anhydrite	1%
Pyrite	1%
Clay	2%

#### Petrophysical Data

Cementation Exponent (m): 2.05

Saturation Exponent (n): Test in Progress



## FIGURE 27

### WHOLE THIN SECTION PHOTOGRAPH

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2550.5 feet

Average Grain Size: Coarse Silt (0.055 mm)

Sorting: Very Well Sorted

Porosity: 24.3%

Permeability: 132 md

Stratigraphic Unit: Winfield Sand

Dep. Facies: Tidal Flat

Although patches of calcite (stained pink) and anhydrite (white) cements are scattered throughout this siltstone, most of the sample has a rather well preserved network of primary intergranular pores (see also Figure 11). These intergranular pores are well interconnected, combining to form a rock with high permeability and very good reservoir potential. The space between the bars equals 1 mm.

#### X-ray Diffraction Data

Quartz	58%
Potassium Feldspar	7%
Plagioclase Feldspar	16%
Calcite	2%
Dolomite	1%
Anhydrite	13%
Clay	3%

#### Petrophysical Data

Cementation Exponent (m): 1.88

Saturation Exponent (n): Test in Progress



## FIGURE 28

### WHOLE THIN SECTION PHOTOGRAPH

#### ANADARKO PETROLEUM CORPORATION FLOWER A-1 WELL

Depth: 2949.8 feet

Rock Type: Limestone

Porosity: 14.4%

Depositional Texture: Packstone

Permeability: 177 md

Stratigraphic Unit: Council Grove B5

Dep. Facies: Algal Bank

This limestone has undergone a complex diagenetic history that included processes which dramatically improved the reservoir potential of the rock. This limestone was deposited with a heterogeneous texture; portions of the sample lack detrital micrite and have a fine-grained grainstone texture (see Figure 24,B), while other parts consist of densely packed peloids in a micrite matrix (i.e., wackestone to packstone texture). Some of these heterogeneities are attributable to phylloid algae which acted to create sheltered areas that were protected from micrite infiltration and early compaction. Subsequent dissolution of the phylloid algae created an abundance of moldic pore space. The resultant porous rock was unstable, and brecciation occurred. This collapse created numerous fractures. The presence of calcite cement in some of these fractures indicates that they are clearly natural fractures that will be open in the subsurface. Furthermore, it demonstrates that at least a portion of the calcite cement precipitated after brittle deformation (i.e., relatively late in the diagenetic history of this rock). The fractures combine with moldic pores, solution-enhanced pores and relict intergranular pores to provide for a rock with rather high permeability. The space between the black bars equals 1 mm.

#### X-ray Diffraction Data

Calcite

100%

#### Petrophysical Data

Cementation Exponent (m): 2.06

Saturation Exponent (n): Test in Progress

