

**GEOLOGICAL ANALYSIS
OF CONVENTIONAL CORE
FROM THE
ANADARKO PETROLEUM CORPORATION
RATCLIFF B-2 WELL
GENTZLER FIELD, STEVENS COUNTY, KANSAS**

Prepared
for
Anadarko Petroleum Corporation
Houston, Texas

RSH 2968

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CORE DESCRIPTION PANEL	In Pocket

SUMMARY

1. A total of 118.90 feet of conventional core from the Anadarko Petroleum Corporation Ratcliff B-2 well in the Gentzler Field, Stevens County, Kansas were analyzed to determine depositional environments and reservoir quality. The core recovered a basal Morrowan sequence of sandstone and shale, unconformably overlying Chesterian-age rocks.

2. The Morrowan rocks in the cored interval are a sequence of tide-dominated estuary to shallow marine facies composed of glauconitic sandstones with interbedded tidal flat and lagoonal facies composed of lenticular bedded shale. The estuarine sequence unconformably overlies an upper Mississippian shoal(?) limestone and paleosol.

3. The lithofacies are summarized below:

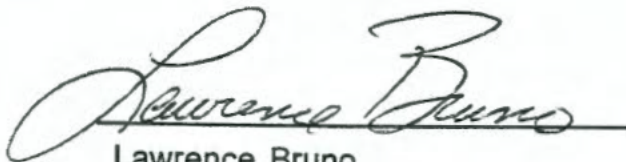
Facies/ Depositional Environment	Lithology	Percent of Cored Interval	Porosity Range (%) (Average)	Permeability Range (md) (Average)	Estimated Reservoir Potential
Shallow marine or lagoon	Dark gray shale with minor thin siltstone stringers and starved ripples. Trace of glauconite, mica and pyrite.	4%	N/A	N/A	Poor
Tidal inlet	Amalgamated, sharp-based, light gray, trough cross-stratified, fossiliferous, coarse-grained sandstone to granule conglomerate.	19%	1.4 - 11.7 (6%)	0.01 - 1.67 md (0.246 md)	Fair
Tidal flats or lagoon	Upward coarsening, dark gray, lenticular bedded shale to light gray bioturbated sandy shale to argillaceous coarse-grained sandstone.	14%	2.3 - 11.7% (8%)	0.012 - 3.98 md (0.798 md)	Fair
Bay mouth(?) tidal channels and sand bars	Interbedded, light olive gray, trough cross-stratified, fossiliferous, coarse-grained sandstone and olive-gray, ripple-stratified, medium-grained sandstone.	38%	4.1 - 18.0% (9%)	0.005 - 22.9 md (1.35 md)	Fair

Facies/ Depositional Environment	Lithology	Percent of Cored Interval	Porosity Range (%) (Average)	Permeability Range (md) (Average)	Reservoir Potential
Subtidal(?) upper estuary sand flats	Light gray, trough cross-stratified, medium-grained sandstone. Minor fossil content.	21%	4.1 - 15.6% (11%)	0.014 - 169 md (15.1 md)	Fair
Shallow marine shoal(?)	Dark olive gray skeletal grainstone.	1%	<0.1 - 0.6% (0.35%)	<0.001 - 0.080 md (0.041 md)	Poor
Paleosol	Medium olive gray claystone and fossiliferous shale.	3%	N/A	N/A	Poor

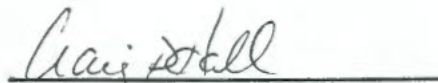
4. The tide-dominated estuarine depositional system probably produces elongate, dip-oriented, fine- to coarse-grained sand bodies bounded by lagoonal and tidal flat muds. The architecture of the depositional system is controlled by the sediment supply from updip fluvial systems, tidal range and sea level fluctuations. These dynamics create a somewhat heterogeneous internal geometry with numerous scoured internal contacts. Within this depositional setting, three major sandstone facies were delineated: 1) Tidal Inlet, 2) Bay Mouth(?) Tidal Channels and Sandbars, and 3) Subtidal(?) Upper Estuary Sand Flats.
5. Petrographic analyses document variations among the three major sandstone facies in terms of framework composition and cementation. The most important variation occurs in the volume of skeletal grains and calcite cement. **The tidal inlet facies contains the greatest quantity of skeletal material and the greatest volume of poikilotopic calcite cement. Samples from the subtidal sand flat facies contain the least skeletal material and much less calcite cement. Quartz cement is most abundant in the calcite cement-poor sand flat facies and rare in the calcite cemented tidal inlet sequence.**

6. **Porosity and permeability are largely controlled by the degree of calcite cementation.** The fossil-rich facies possess more calcite cement and the lowest average permeability of the three major sandstone facies. The relatively fossil-poor subtidal sand flat facies has less calcite cement; these strata are cemented predominantly by quartz and possess the highest average porosity and permeability.

7. Fractures varying from several inches to several feet in length are present in the core and most appear to be unmineralized, closed natural fractures.



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INTRODUCTION

This report, prepared for Anadarko Petroleum Corporation, presents the results and conclusions obtained from geological analysis of 118.90 feet of conventional core from the Anadarko Petroleum Corporation Ratcliff B-2 well, Stevens County, Kansas. The core consists of an interbedded sandstone and shale sequence from the basal Morrowan series.

The objectives of this study were to provide a geologic characterization and reservoir evaluation of the Morrowan sandstones, and to determine the factors controlling reservoir quality. In order to meet these objectives, the following analytical program was utilized:

- The core was slabbed into 1/3 and 2/3 sections.
- The core was photographed in color, in its entirety, to provide a permanent, easily accessible record of the cored interval.
- The core was sedimentologically described in detail to delineate rock color, depositional textures and grain size characteristics, sedimentary structures and contact relationships.

- Twenty (20) core samples were selected for thin section petrography. In addition, six of these samples were selected for scanning electron microscopy and X-ray diffraction analysis.
- The thin section specimens were impregnated with blue-dyed epoxy to highlight pore space and subsequently ground and polished to a thickness of 30 microns. The samples were then stained with Alizarin-Red-S which aids in differentiating calcite from other carbonate minerals. Point count modal analysis data (250 points) were obtained to provide information on relative proportion of grain types, pore-filling constituents and pore types.
- SEM analysis was conducted on freshly broken rock surfaces to identify pore system properties and types and modes of occurrence of pore-filling constituents, especially diagenetic clays.
- X-ray diffraction analysis was used to obtain semi-quantitative mineralogic data. The rocks were ground to 40 microns to insure homogeneity and analyzed through standard X-ray diffraction techniques. In addition, the less than 5 micron fractions were analyzed separately to determine the relative proportions of clay mineral species.

Reservoirs Job No. RSH 2968 was assigned to this study. Any communications regarding this report should refer to this job number. Three copies of this report have been forwarded to Mr. Mark Pinel, 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.

GEOLOGICAL ANALYSES

Core Description and Lithofacies

A sequence of Morrowan-aged coarse-grained, calcareous sandstone and shale was cored from 6,010 to 6,128.90 feet (core depths) in this well. Correlation of the core to open-hole logs indicates that from 7 to 8 feet need to be subtracted from the core depths to match the open-hole logs (Figure 1). A graphic core description, correlated to the open-hole logs and measured porosity and permeability data, is presented on the enclosed core description panel. Color core photographs are provided in Plates 1 through 7. Close core photographs of representative facies are provided in Plates 8 and 9.

Sedimentological analysis indicates that the cored interval is a basal, transgressive, tide-dominated, estuarine to shallow marine sequence (Figure 2). It overlies an unconformity near 6,123.00 feet, which marks the top of the Chesterian series. Below the unconformity is a short interval of paleosol overlain by a thin limestone, which appears to be a shallow marine shoal(?) facies.

Much of the cored sequence between 6,090.00 and 6,123.00 feet consists of interstratified glauconitic, medium-grained sandstones and shale, that were deposited in an upper estuary environment. Between 6,045.00 and 6,090.00 feet is a coarse-grained, fossiliferous, trough cross-stratified sandstone which was deposited as a bay mouth(?) tidal channel and sandbar complex. This facies contains abundant crinoid and bryozoa debris, and is variably cemented by calcite. **Between 6,036.00 and 6,045.00 feet is a dark gray, lenticular bedded claystone with sharply interbedded medium-grained sandstones. Burrow types include *Chondrites*, *Teichichnus*, and**

FIGURE 1

CORE TO LOG CORRELATION

ANADARKO PETROLEUM CORPORATION

RATCLIFF B-2 WELL

LOG DEPTH = CORE DEPTH - 7 TO 8 FEET

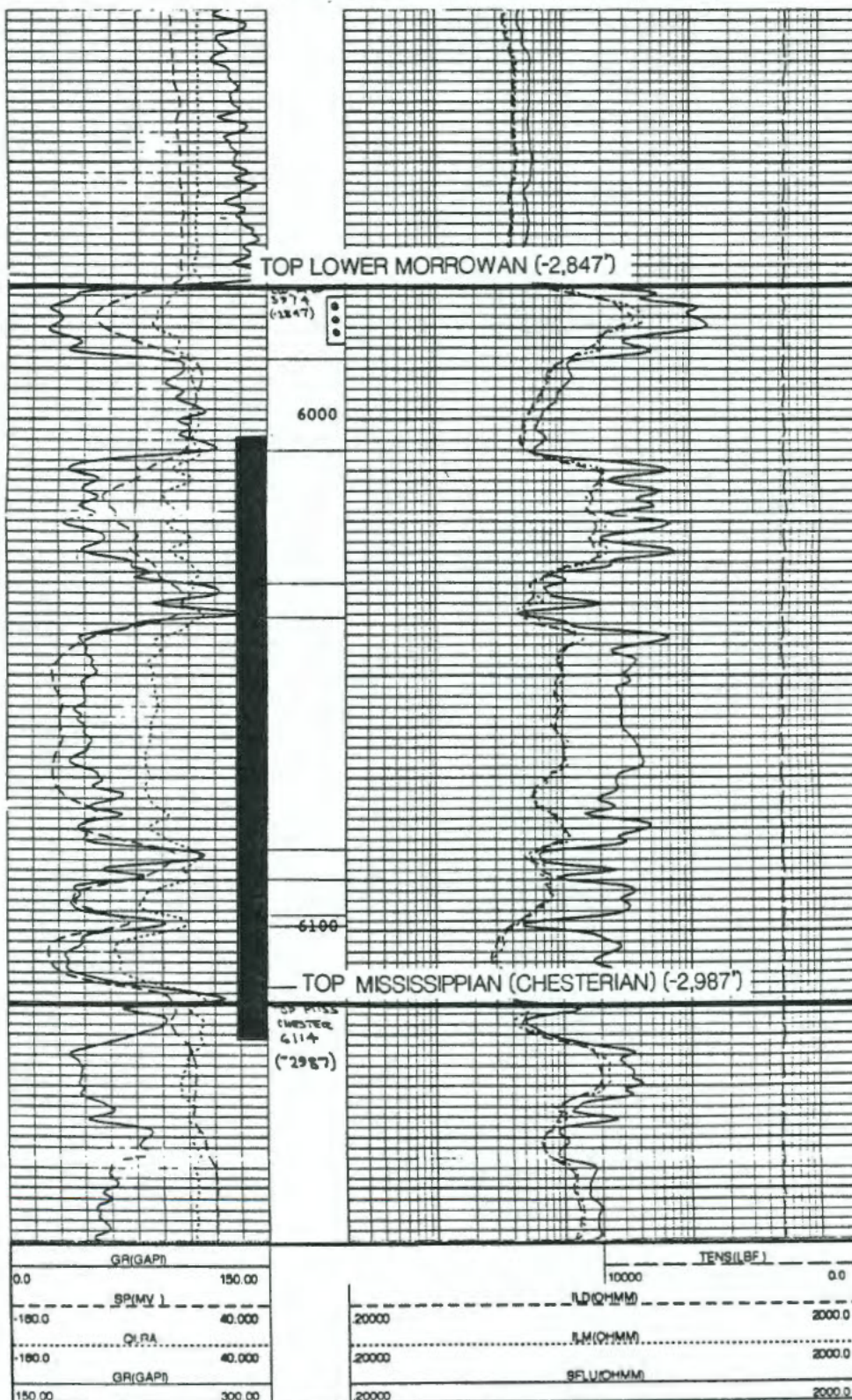


FIGURE 1-CONTINUED
 DENSITY LOG
 RATCLIFF B-2 WELL

LOG DEPTH = CORE DEPTH - 7 TO 8 FEET

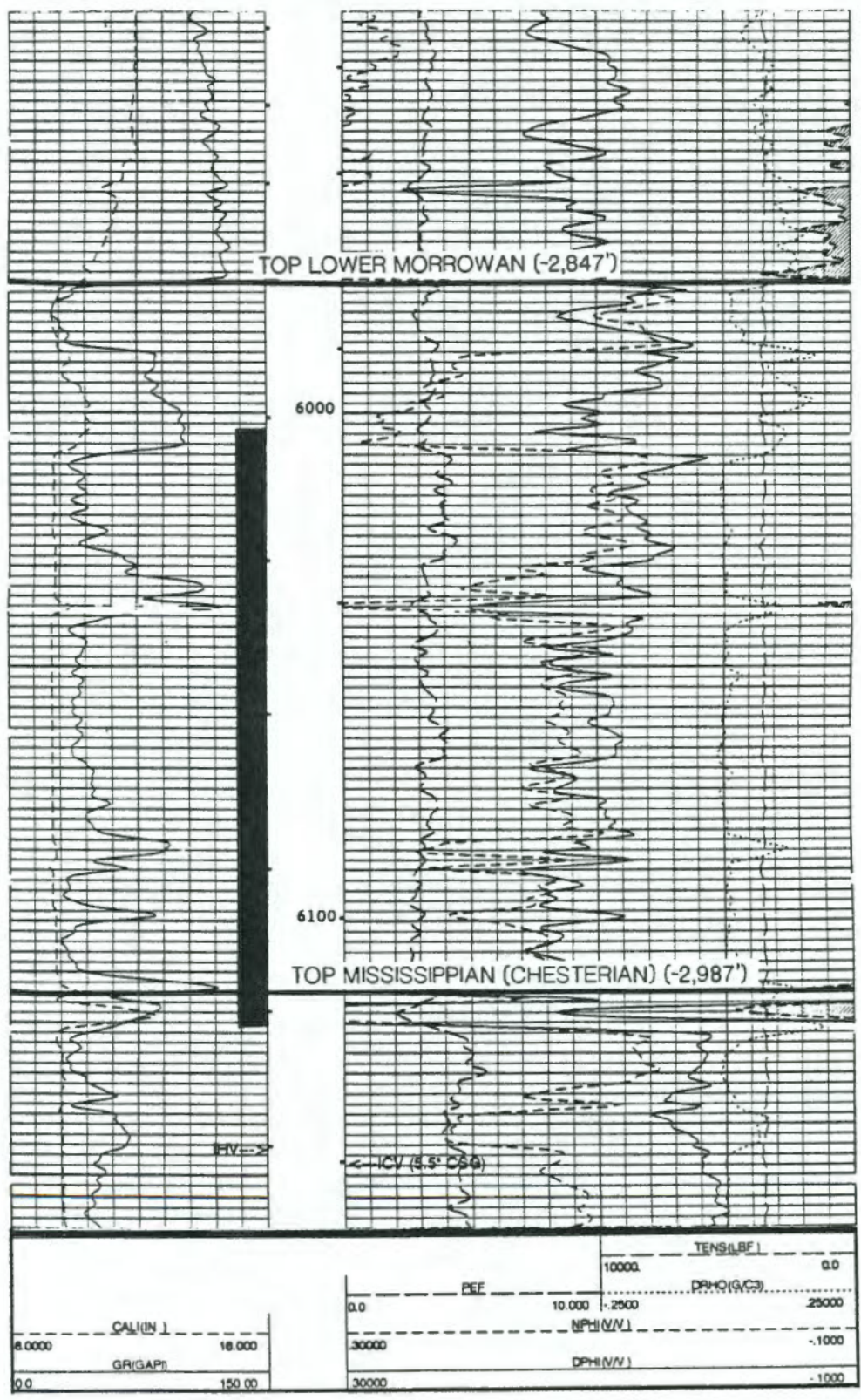
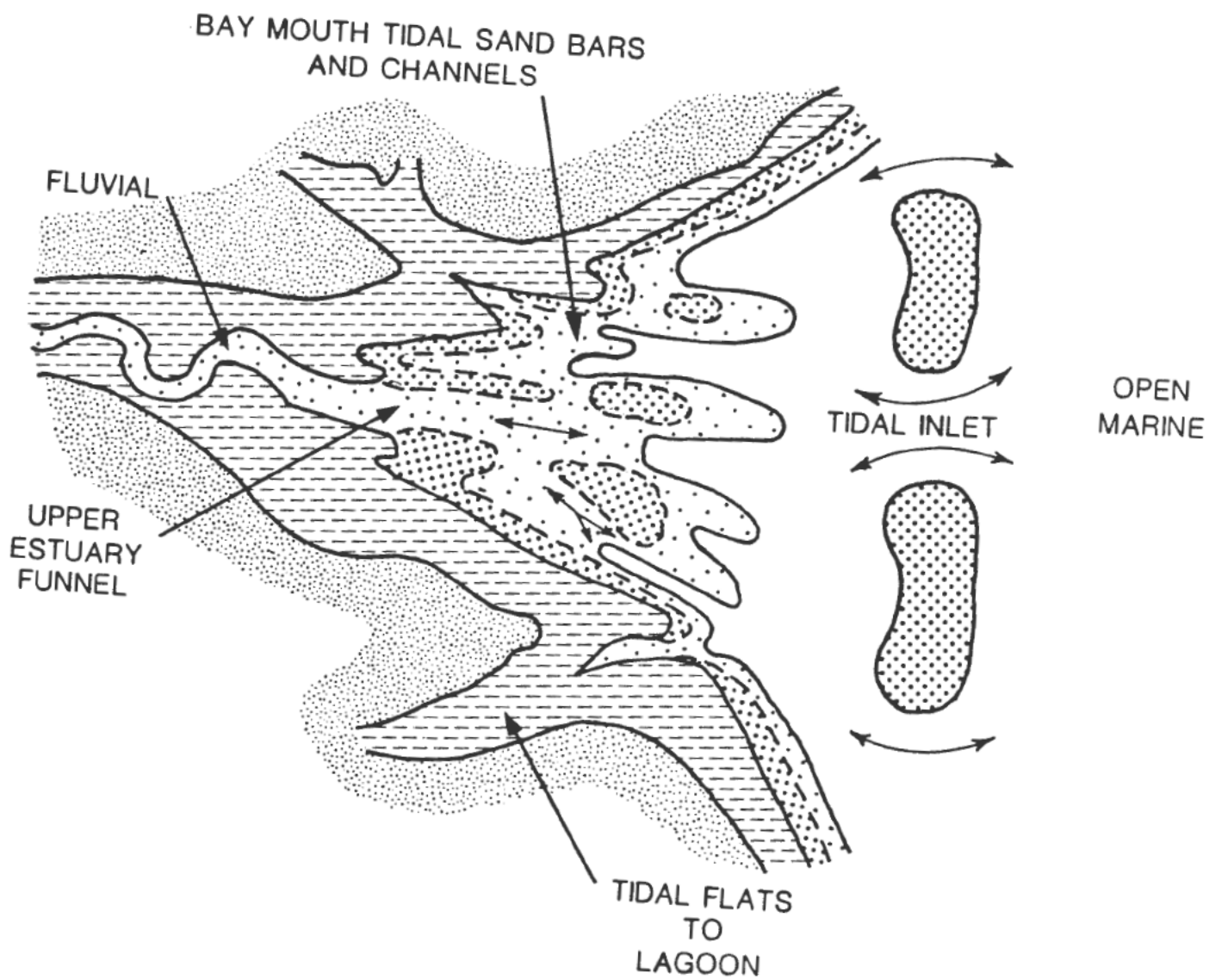


FIGURE 2
TIDE-DOMINATED ESTUARY
DEPOSITIONAL MODEL



(After Dalrymple, 1992)

Ophiomorpha(?), which suggest a marine influenced lagoonal environment. This is abruptly overlain by a tidal inlet sequence of coarse-grained, fossiliferous sandstone between 6,014.00 and 6,036.00 feet. Capping the cored interval is a thin, dark gray shale with minor siltstone stringers and millimeter-scale starved ripples, which may represent a shallow marine or lagoon environment. Overall, the cored interval above the unconformity documents an upward transition from terrestrial to marine or marine-influenced sedimentation.

Paleosol (6,124.20 - 6,128.90 Feet, 4.70 Feet)

Description:

The basal unit in the cored interval is a dark gray, fossiliferous, calcareous shale and medium gray to medium olive gray, non-fossiliferous claystone. The claystone consists of water-sensitive clay and is mostly rubble. Scattered throughout are granule-size, well-rounded quartz grains and small, rounded calcite concretions approximately 5 - 10 mm in diameter. The upper, fossil-rich portion contains spiriferid and strophomenid brachiopods, crinoid debris, and cryptostome and trepostome bryozoa.

Interpretation:

This unit is interpreted as a palesol containing small fragments of caliche and represents a period of subaerial exposure and weathering of marine strata.

Shallow Marine Shoal(?) (6,122.70 - 6,124.20 Feet, 1.50 Feet)

Description:

Overlying the palesol is a dark olive gray, skeletal grainstone. The most common fossil fragments include bryozoa debris and crinoid fragments. Ooids are present in small quantities as well. An *Archimedes* column with fragments of its frond lies on a bedding surface near 6,122.90 feet (Plate 9,D). Although *Archimedes* is not strictly age-diagnostic, its presence suggests a Mississippian age for the limestone. The upper contact is very sharp.

Interpretation:

This lithology is interpreted as a shallow marine shoal(?) facies on the basis of abundant skeletal grains, the presence of ooids, and the lack of substantial quantities of argillaceous material. The fossil types are typically open marine, clear water, bank dwellers that have been transported and broken, probably through wave action, prior to sedimentation.

Tidal Flats or Lagoon (6,036.25 - 6,045.40 Feet, 9.15 Feet), (6,091.00 - 6,094.85 Feet, 3.85 Feet), and (6,119.60 - 6,122.70 Feet, 3.10 Feet)

Description:

Abruptly overlying the shallow marine shoal(?) facies at 6,122.70 feet is a grayish black, lenticular bedded shale. The upper portion coarsens upwards to a ripple-stratified argillaceous sandstone, capped by a thin shale laminae containing *Chondrites* burrows. There are also possible small *Teichichnus* burrows present through the facies. Similar lithologies between 6,036.25 and

6,045.40 feet, and 6,091.00 and 6,094.85 feet are predominantly lenticular bedded, dark gray shale with minor interbeds of medium-grained sandstone (Plate 8,B). *Chondrites* and *Teichichnus* burrows are present in the lenticular bedded portions, and the argillaceous sandstone between 6,036.25 and 6,039.50 feet contains *Planolites*, and, possible short *Ophiomorpha*.

Interpretation:

The presence of marine-type burrowing in predominantly quiet water deposits with sharply interbedded ripple-stratified sandstones, suggests a tidal flat or lagoonal setting subjected to asymmetric currents. The presence of large pyrite concretions in the lower interval suggests temporary reducing or restricted conditions also existed during deposition.

Subtidal(?) Upper Estuary Sand Flats (6,094.85 - 6,119.60 Feet, 24.75 Feet)

Description:

Two sharp-based sandstone sequences in the lower portion of the cored interval are characterized by light gray to light olive gray, ripple-stratified and trough cross-stratified, glauconitic, medium-grained sandstone. Stratigraphically between these sequences is a thin facies of bioturbated sandy claystone, dark gray shale, and bioturbated argillaceous sandstone. The fossil debris is mostly bryozoa and crinoid stem pieces, and the burrows are simple, sand filled-types that appear to be mostly oblique to horizontal (Plate 9,C).

The facies appears to have an erosional and load-deformed basal contact at 6,119.60 feet overlain by bioturbated sandstone. Above 6,117 feet are several sharp based, fining upward, trough cross-stratified to possibly horizontal planar-stratified sandstones; a possible reactivation surface is present near 6,113.00

feet between two trough sets. The upper trough set appears to be abruptly over-steepened relative to the lower trough set, and may be slightly coarser-grained. The contact at 6,107.60 feet is gradational and bioturbated (Plate 9,B). The interval between 6,094.85 and 6,105.20 feet does not appear to have the scoured internal contacts, and the trough sets are typically thinner than in the lower interval. The upper contact at 6,094.85 feet is abrupt, and is marked by a thin coarse-grained sandstone containing fossil debris. Trough cross-stratification through this facies is typically highlighted by discontinuous clay laminae on the foreset planes. This facies contains scattered fossil debris, including bryozoa fragments

Interpretation:

This sequence is interpreted as a subtidal(?) sand flat, probably set in the upper estuary funnel. This interpretation is based on the scale and type of primary sedimentary structures and the presence of simple (terrestrial? or marginal marine) burrows. The clay laminae on foreset planes indicate rhythmic asymmetric currents. The presence of abundant glauconite and scattered fossil debris suggests flood-tide currents were capable of transporting mud, carbonate grains and fecal pellets from the downdip, restricted, quiet water estuarine environment into the upper estuary funnel.

The burrowed and bioturbated shale and sandy claystone facies between 6,105.20 and 6,107.60 feet records a period of relatively quiet-water conditions during the deposition of the upper estuary sand facies. During this period, marine(?), or brackish water burrowing organisms were able to colonize the substrate. The presence of large fossil fragments suggests marine water, at least periodically, inundated the location.

Bay Mouth(?) Tidal Channels and Sand Bar Complex (6,045.40 Feet - 6,091.00 Feet, 45.60 Feet)

Description:

This facies is predominantly light olive gray, trough cross-stratified, fossiliferous, coarse-grained sandstone to granule conglomerate, interbedded with olive gray ripple-stratified to irregularly horizontal stratified and massive-appearing medium-grained sandstone. The basal 6 inches consist of thinly interbedded, well-sorted, fine- to medium-grained herringbone cross-stratified sandstone, and poorly sorted, massive-appearing to horizontal planar stratified medium-grained sandstone containing fossil debris (Plate 9,A). Through the rest of the facies beds appear to vary in thickness from several inches to 2.5 feet, and contacts are typically marked by abrupt changes in grain size. The coarser-grained beds are often trough cross-stratified and possess abundant fossil debris. Finer-grained beds are usually massive appearing to faintly horizontal planar stratified, and possess smaller quantities of fossil debris. Several beds between 6,080.00 and 6,085.00 feet contain small volumes of clay and are burrowed to bioturbated. Although not as common as in the subtidal upper estuary sand flats discussed above, occasional trough sets are highlighted by discontinuous, irregular clay laminae. In addition, small scale ripples near the top of the facies are draped by clay laminae.

The interval between 6,046.00 and 6,051.00 feet appears to be a series of amalgamated, erosionally based, trough cross-stratified, medium- to coarse-grained sandstones. A contact marking an abrupt upward increase in dip angle between two sets of cross stratification at 6,050.00 feet may be either a reactivation surface or define the contact between two superposed bed forms. Soft-sediment deformation in the form of load casts and possible ball and pillow structures between 6,047.40 and 6,048.20 feet suggests the overlying trough

cross-stratified sandstone was deposited rapidly, over semi-cohesive sand and mud. Although the genetic relationships are difficult to distinguish, many of the trough cross-stratified, medium-grained sandstone beds are capped by thin layers of well-sorted, fine-grained, ripple-stratified sandstone (Plate 8,D). In addition to the clay laminae, stratification in many of the trough sets is also highlighted by alternations in grain size with foresets of coarse-grained sand alternating with foresets of medium-grained sand.

This facies also contains abundant fossil debris. Many of the fossil types are still recognizable and include crinoid debris, including stem pieces and a possible calyx near 6,088.30 feet. Fragments of trepostome bryozoa are common and several small ammonites are present near 6,068.00 and 6,082.00 feet. A fragment of a productid brachiopod with intact spines was noted near 6,054 feet.

Interpretation:

Complexly interbedded, trough cross-stratified, fossiliferous, medium and coarse-grained sandstone suggests a depositional environment subjected to rapid fluctuations in current energy and direction, and was situated to receive both broken and intact skeletons of marine organisms. Minor amounts of burrowing in the finer-grained beds may indicate intermittent access by marine-type burrowing organisms. The setting proposed for this facies is in the lower reaches of the estuary funnel or a transitional shallow marine setting where daily tidal currents worked coarse-grained siliciclastic sediment and skeletal debris.

Tidal Inlet (6,014.20 - 6,036.26 Feet, 22.05 Feet)

Description:

The uppermost sandstone facies in the core consists of amalgamated, fining-upward(?), light gray to light greenish gray, trough cross-stratified and irregularly horizontal or low angle planar-stratified, fossiliferous, coarse-grained sandstones to granule conglomerates. Several internal erosional contacts are overlain by shale-clast lag deposits. The shale clasts are set in a matrix of poorly sorted, coarse-grained sand and echinoderm fragments (Plate 8,B). Bed thicknesses are typically in excess of 2 feet, and several beds consist of single trough sets. Much of this stratification is highlighted by alternations in grain size, and a number of foresets are highlighted by granule- to pebble-sized, well rounded, phosphatic rock fragments and fossil debris (Plate 8,A). Rare, solitary corals are noted along with occasional ooids.

Interpretation:

This interval is interpreted as a series of tidal inlet channels. The thicker bedded nature of this facies compared with the bay mouth tidal channel and sand bar complex discussed above, scoured contacts, and abundant fossil debris, indicate a channelized, high energy, marine influenced setting where coarse-grained sand was deposited by high velocity currents.

Shallow Marine or Lagoon (6,010.00 - 6,014.20 Feet, 4.20 Feet)

Description:

The uppermost facies in the core is a very dark gray shale containing very thin silt stringers and millimeter-scale starved ripples. The shale also contains

traces of glauconite, mica and pyrite. Burrows are absent and the facies is very evenly laminated.

Interpretation:

The interpretation of this facies is problematic due to the absence of distinguishing characteristics such as burrowing, lenticular bedding or evidence of subaerial exposure. The stratigraphic position suggests a setting associated within the tide-dominated estuarine environment proposed for the underlying section. Two possible interpretations for the facies include shallow marine or lagoon; however, the absence of burrowing argues against the shallow marine interpretation, and the absence of interbedded or lenticular bedded sand is not typical of lagoonal deposits.

Mineralogy and Texture

CORE DEPTH	THIN SECTION	SEM	XRD	PLATE NO.
6,017.4	X		X	10
6,025.6	X	X	X	11, 12
6,030.4	X		X	13
6,034.7	X		X	14, 15
6,049.6	X		X	16
6,052.6	X	X	X	17, 18
6,055.4	X		X	19
6,065.5	X		X	20, 21
6,073.5	X		X	22
6,076.6	X	X	X	23, 24
6,081.7	X		X	25
6,085.5	X		X	26, 27
6,096.5	X		X	28
6,097.8	X	X	X	29, 30
6,101.6	X		X	31

CORE DEPTH	THIN SECTION	SEM	XRD	PLATE NO.
6,102.4	X		X	32
6,103.4	X	X	X	33, 34
6,113.5	X	X	X	35, 36
6,117.8	X		X	37
6,122.9	X		X	38

Samples for petrographic analysis were selected from all three sandstone facies in the cored interval. The stratigraphic positions of the samples are provided on the enclosed core description panel. Point count and X-ray diffraction data are provided in Tables 1 and 2, respectively, and representative thin section photomicrographs are included in Plates 10 through 38. In addition, scanning electron microscopy was performed on six of the samples, and representative photomicrographs are also included with the corresponding thin section photomicrographs.

Mean grain size increases upwards from lower medium sand (268 - 336 microns) in the subtidal sand flats, to lower fine to lower coarse sand (160 - 530 microns) in the bay mouth(?) channel and sandbar complex, to upper medium to upper coarse sand (448 - 842 microns) in the tidal inlet facies.

The degree of sorting also decreases upwards from moderately to well sorted in the subtidal sand flats to poorly to moderately sorted in the tidal inlet sequence. Compaction ranges from weak in calcite-cemented samples to moderate in the quartz-cemented sandstones of the subtidal sand flat facies.

Point count data reveal that **quartz** is the most abundant framework mineral in all three facies, ranging from **50 - 65%** in the **subtidal sand flat facies**, to **33 - 52%** in the **bay mouth(?) channel and bar complex**, to **28 - 48%** in the **tidal inlet facies**. **Skeletal grains**, including benthonic foraminifera (*Millerella*) (Morrowan) are most abundant in the tidal inlet facies and range from **16 - 31%** of the total rock volume, compared with **trace to 7%** skeletal grains in the subtidal sand flat facies. The next most abundant constituent are **rock fragments, including argillaceous sedimentary rock fragments, chert and phosphatic grains**. In addition, there are small numbers of rock fragments which are unidentifiable due to severe alteration or leaching. These **rock fragments** comprise from **2 - 5%** of the samples from the subtidal sand flats, **1 - 10%** of the samples from the bay mouth(?) bar and channel complex, and **1 - 6%** of the samples from the tidal inlet facies. **Feldspars** are only a minor constituent and typically range from **0 - 2%** in all three facies. **Accessory constituents, including mica, glauconite and heavy minerals, and a number of clay-coated grains** are also present and appear to be mostly angular quartz grains with poorly preserved clay coatings (Plate 21,B).

Whole rock X-ray diffraction analyses generally agree with point count data. **Quartz** is the most common mineral detected in the sandstones and ranges from **15 - 95%** (by weight). **Calcite**, which includes allochems and calcite-cement, ranges from **0 - 78%** with subordinates **dolomite (0 - 9%), clay (0 - 5%), plagioclase (0 - 5%), and siderite (0 - 1%)**. X-ray analyses of the limestone below the unconformity indicate it is predominantly **calcite (88%)** followed by **quartz (7%)** and **clay (5%)**.

X-ray analysis of the clay fraction in the samples at 6,075.6, 6,052.6, 6,076.6, 6,097.8, 6,103.4 and 6,113.5 feet indicate it is predominantly **illite** in quantities ranging from **13% to 70%**, and **chlorite** which ranges from **21% to 76%**. In

addition, all of the samples except that at 6,097.80 feet contain illite-rich mixed-layer illite/smectite (2% to 15%). The sample at 6,025.60 feet contains 1% kaolinite.

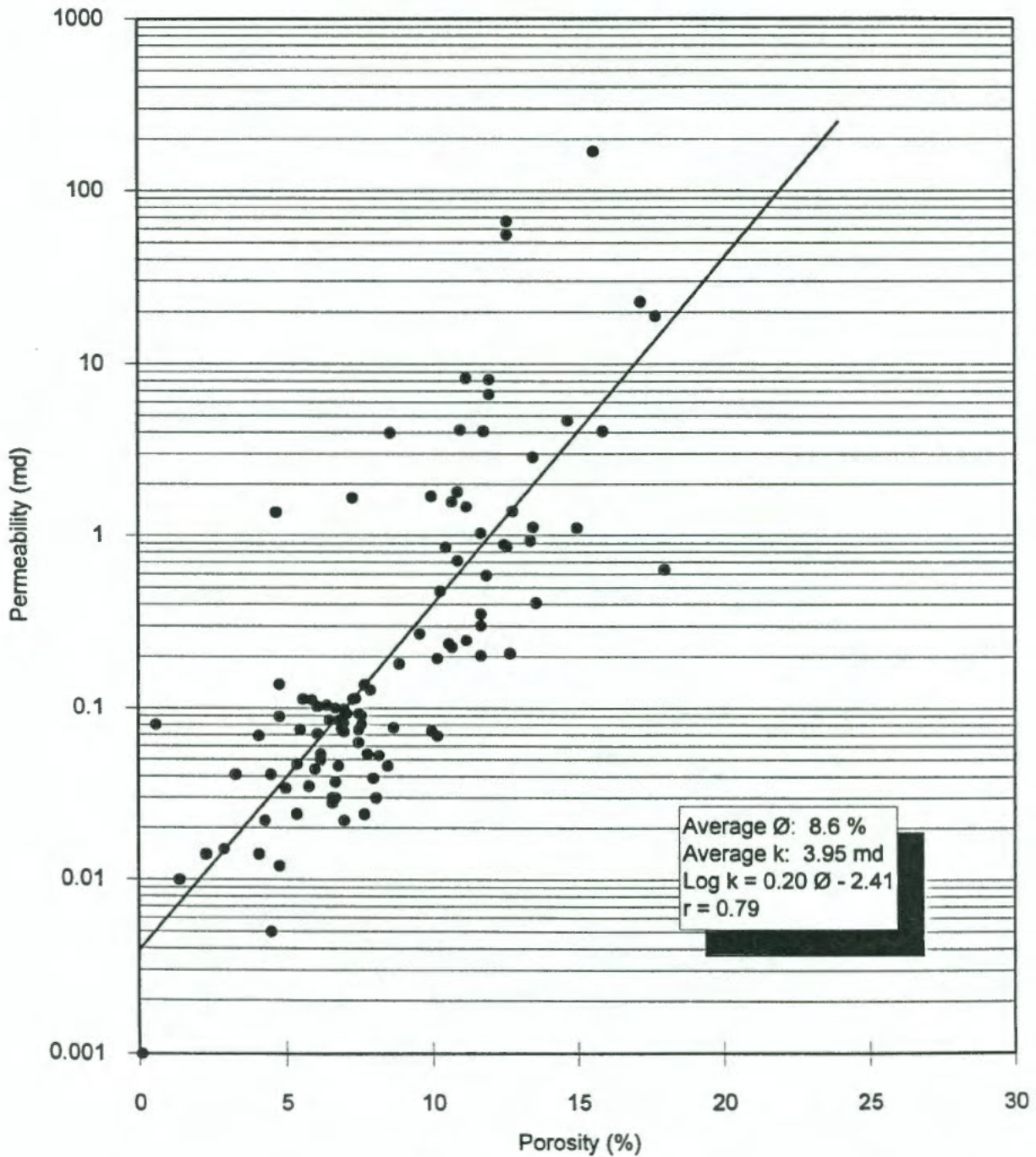
Pore-System Properties and Pore-Filling Constituents

Routine core analysis data are provided in Table 3 and a cross plot of porosity and permeability is shown in Figure 3. These data reveal that porosity values range from 0.1% - 18%, with an average of 8.6%, and permeability ranges from less than 0.001 md - 169 md with an average of 3.95 md. The cross plot indicates a good log normal distribution to porosity and permeability, with some scatter.

Porosity and permeability values are plotted with the core description on the enclosed panel. This plot shows that porosity and permeability are typically very low in the tidal inlet facies and in the lower portion of the bay mouth(?) channel and bar complex. Several streaks of permeability in excess of 10 md are present in the upper portion of the bay mouth(?) deposits, but they appear to be limited to beds of fine- to medium-grained sand containing little or no fossil debris. The best permeabilities are associated with the upper portion of the subtidal sand flat sequence near the base of the cored interval. Although there appear to be a number of tight streaks through this facies, permeabilities in excess of 1 md are present in the lower portion while permeabilities exceeding 10 md (and one value exceeding 100 md) are present in the upper portion.

Samples for thin section analysis were taken from the same plugs used for routine core analyses and so a direct comparison of measured porosity and visible porosity is possible. These data are included in each caption for the

FIGURE 3
POROSITY - PERMEABILITY CROSSPLOT
ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL



thin section photomicrographs and visible porosities are consistently below measured porosities.

The predominant pore-filling minerals in the three sandstone facies are **sparry calcite and quartz cements**. **The volume of calcite cement is typically proportional to the volume of skeletal grains**; samples containing abundant fossil debris are often cemented by poikilotopic calcite (Plates 10,A; 15,A; and 16,A). Thus, the more fossil-rich bay mouth tidal inlet and tidal channel and bar facies have more calcite cement. The cement appears to be an early phase and samples **cemented by calcite are weakly compacted and possess high intergranular volumes (22 - 35%)** (Plate 14). The average intergranular volume for the tidal inlet and the bay mouth(?) channel and bar complex are 30% and 31%, respectively. This is judged to indicate that the calcite cement precipitated early in the diagenetic history of these rocks, prior to most compaction.

Quartz is the predominant cement in the fossil-poor subtidal sand flat facies near the base of the cored interval, with volumes typically ranging from 0 - 15% (Plates 29,A; 31; and 33). One sample from the subtidal sand flat facies (6,102.40 feet; Plate 32) is anomalous and contains only trace quantities of skeletal grains, but abundant calcite (25%); quartz overgrowths were not detected in this sample supporting a paragenetic sequence for the facies in which calcite cementation predated development of quartz overgrowths. **The decrease in average intergranular volume from 30 and 31% in the calcite cemented facies to 27% in the quartz cemented facies suggests post-burial compaction further reduced interstitial volume by 4 porosity units prior to quartz cementation.**

The majority of visible pore space in the calcite cemented sandstones consists of moldic pores and leached grain secondary pores with remnants of the host grains still present (Plates 14; 20; 21,B; 22,B; and 25,B). Many of the moldic pores appear to be a result of removal of skeletal debris and are typically isolated within the calcite cement. In addition, the leached grain pores from dissolved feldspars are also often poorly interconnected. Intergranular pores are the most common pore type in the quartz cemented subtidal sand flat facies (Plates 29,A and 31,B). These pores have been reduced and partially isolated by quartz cement. There are also substantial quantities of leached grain secondary pores in the sand flat facies that are the result of the partial dissolution of feldspar grains.

Scanning electron microscopy reveals that **grain-coating chlorite is the most common authigenic clay** in the cored interval (Plates 18 and 24). The chlorite typically occurs as finely crystalline isopachous coatings on many framework grains and, where present, have inhibited or prevented nucleation of quartz overgrowths (Plates 18,B; 24,B; and 34,D). Grain-coating chlorite also possesses microporosity which would be detected during routine core analyses, however, would not be included as porosity during thin section analysis. Other authigenic clays include minor amounts of **kaolinite** (Plate 12,C). Minor quantities of authigenic **illite/smectite** were detected during SEM analysis (Plates 12,D; and 30,D), suggesting much of the illite in the X-ray diffraction data is being derived from argillaceous rock fragments. EDS analyses confirm the presence of phosphate in several rock fragments, even though no phosphate minerals were detected by X-ray diffraction techniques.

Point count and SEM analyses indicates that much of the under estimation of visible porosity compared with measured porosity may be due to the presence

of intercrystalline porosity within the calcite cement and microporosity within leached rock fragments and microporous authigenic chlorite, which were not detected during thin section analysis.

TABLE 1

PETROGRAPHIC DATA

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

DEPTH	6,017.4'	6,025.6'	6,030.4'	6,034.7'
GRAIN SIZE (MICRONS)	UC (842)	UM (448)	LC (614)	LC (566)
SORTING	Moderate	Poor	Moderate	Moderate
WWRC#	23517 : 34X	34516 : 341	23518 : 3XX	23518 : 3XX
FRAMEWORK CONSTITUENTS				
Siliciclastic/Lithics				
Quartz	28%	48%	34%	34%
Plagioclase	T	1	1	T
Rock Fragments				
Argillaceous Sedimentary RF	-	-	-	-
Phosphatic Grains	1	2	T	2
Unidentified RF	2	2	-	2
Chert	-	2	1	T
Mica	-	T	-	-
Glauconite	T	2	T	1
Coated Grains	T	1	T	T
Heavy Minerals	-	-	-	-
Allocherts				
Skeletal Grains	30	16	31	23
Carbonate Grains	2	2	3	1
Ooids	T	T	T	T
PORE-FILLING CONSTITUENTS				
Quartz Overgrowths	-	2	-	-
Dolomite	2	5	-	-
Calcite	30	6	28	33
Undifferentiated Clay	-	2	-	-
Chlorite	-	-	-	-
Pyrite/Opaques	T	T	T	-
Matrix Clay	-	-	-	-
INTRAGRANULAR REPLACEMENT				
Calcite	2	T	T	1
Dolomite	T	1	T	T
Other**	T	T	-	-
VISIBLE PORE SPACE				
Intergranular	-	2	-	-
Molds	1	4	T	2
Leached Grain	1	1	T	T
MEASURED POROSITY (%)	6.2	11.7	4.3	4.7
MEASURED PERMEABILITY (md)	0.054	1.03	0.022	1.37

*Mostly echinoids, crinoids, bryozoa, brachiopods, gastropods, fusulinids (*Millerella*).

**includes pyrite, possible siderite, possible collophane.

TABLE 1

PETROGRAPHIC DATA

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

DEPTH	6,049.6'	6,052.6'	6,055.4'	6,065.5'
GRAIN SIZE (MICRONS)	UM (380)	LM (266)	LF (160)	LM (324)
SORTING	Well	Well	Well	Moderate
WWRC#	32517 : 31X	32525 : 164	42515 : 164	33517 : 364

FRAMEWORK CONSTITUENTS

Siliciclastic/Lithics

Quartz	44%	55%	55%	40%
Plagioclase	2	T	-	-
Rock Fragments				
Argillaceous Sedimentary RF	-	-	-	-
Phosphatic Grains	1	1	T	1
Unidentified RF	-	3	2	1
Chert	-	T	-	1
Mica	-	T	T	-
Glauconite	4	2	6	2
Coated Grains	T	T	T	3
Heavy Minerals	-	-	T	-
Allochems				
Skeletal Grains*	12	5	3	15
Carbonate Grains	T	T	1	1
Ooids	T	T	-	T

PORE-FILLING CONSTITUENTS

Quartz Overgrowths	1	16	17	-
Dolomite	-	2	2	T
Calcite	30	2	1	31
Undifferentiated Clay	-	2	1	1
Chlorite	-	2	1	-
Pyrite/Opaques	-	T	1	-
Matrix Clay	-	-	-	-

INTRAGRANULAR REPLACEMENT

Calcite	1	T	T	1
Dolomite	1	-	T	T
Other**	T	T	T	T

VISIBLE PORE SPACE

Intergranular	-	4	6	T
Molds	2	-	-	1
Leached Grain	T	4	3	1

MEASURED POROSITY (%)	6.7	17.7	17.2	8.2
MEASURED PERMEABILITY (md)	0.037	19.0	22.9	0.053

*Mostly echinoids, crinoids, bryozoa, brachiopods, gastropods, fusulinids (*Millerella*).

**Includes pyrite, possible siderite, possible colophonane.

TABLE 1

PETROGRAPHIC DATA

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

DEPTH	6,073.5'	6,076.6'	6,081.7'	6,085.5'
GRAIN SIZE (MICRONS)	UF (198)	LF (166)	UM (378)	LC (530)
SORTING	Poor	Moderate	Poor	Moderate
WWRC#	44517 : 34X	43525 : 146	34517 : 34X	23517 : 36X

FRAMEWORK CONSTITUENTS

Siliciclastic/Lithics

Quartz	33%	52%	39%	38%
Plagioclase	1	-	T	T
Rock Fragments				
Argillaceous Sedimentary RF	T	2	1	1
Phosphatic Grains	1	T	2	8
Unidentified RF	2	2	3	1
Chert	-	-	1	-
Mica	-	T	-	T
Glauconite	T	2	1	T
Coated Grains	1	2	3	1
Heavy Minerals	-	T	-	-
Allochems				
Skeletal Grains*	25	5	15	20
Carbonate Grains	1	1	1	T
Ooids	T	T	-	-

PORE-FILLING CONSTITUENTS

Quartz Overgrowths	-	12	-	-
Dolomite	1	4	T	-
Calcite	30	2	25	24
Undifferentiated Clay	T	4	-	1
Chlorite	-	T	-	-
Pyrite/Opaques	T	-	-	-
Matrix Clay	-	-	-	-

INTRAGRANULAR REPLACEMENT

Calcite	-	2	4	1
Dolomite	1	2	1	-
Other**	1	-	T	-

VISIBLE PORE SPACE

Intergranular	T	3	-	-
Molds	1	-	2	3
Leached Grain	1	4	T	1

MEASURED POROSITY (%)	7.1	15.9	7.7	7.3
MEASURED PERMEABILITY (%)	0.093	4.07	0.024	0.113

*Mostly echinoids, crinoids, bryozoa, brachiopods, gastropods, fusulinids (*Millerella*).

**Includes pyrite, possible siderite, possible collophane.

TABLE 1
PETROGRAPHIC DATA

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

DEPTH	6,096.5'	6,097.8'	6,101.6'	6,102.4'
GRAIN SIZE (MICRONS)	LM (336)	LM (288)	LM (300)	LM (296)
SORTING	Well	Moderate	Well	Moderate
WWRC#	32516 : 134	33515 : 136	32516 : 41X	33517 : 36X
FRAMEWORK CONSTITUENTS				
Siliciclastic/Lithics				
Quartz	50%	65%	64%	62%
Plagioclase	2	2	T	T
Rock Fragments				
Argillaceous Sedimentary RF	T	1	-	T
Phosphatic Grains	1	2	1	T
Unidentified RF	1	1	1	1
Chert	T	-	T	1
Mica	-	-	-	T
Glauconite	8	6	1	6
Coated Grains	T	-	T	1
Heavy Minerals	T	T	-	-
Allocherns				
Skeletal Grains*	7	1	T	T
Carbonate Grains	-	-	-	1
Ooids	T	-	-	-
PORE-FILLING CONSTITUENTS				
Quartz Overgrowths	12	16	10	-
Dolomite	4	-	10	-
Calcite	8	T	-	25
Undifferentiated Clay	T	T	-	-
Chlorite	-	T	-	-
Pyrite/Opaques	-	1	-	T
Matrix Clay	-	-	-	-
INTRAGRANULAR REPLACEMENT				
Calcite	2	-	-	T
Dolomite	2	-	2	T
Other**	T	T	T	-
VISIBLE PORE SPACE				
Intergranular	1	2	7	-
Molds	-	-	-	1
Leached Grain	1	2	2	1
MEASURED POROSITY (%)	10.2	15.6	12.6	7.4
MEASURED PERMEABILITY (md)	0.069	169	66.2	0.114

*Mostly echinoids, crinoids, bryozoa, brachiopods, gastropods, fusulinids (*Millerella*).

**Includes pyrite, possible siderite, possible collophane.

TABLE 1

PETROGRAPHIC DATA

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

DEPTH	6,103.4'	6,113.5'	6,117.8'	6,122.9'
GRAIN SIZE (MICRONS)	LM (298)	LM (268)	LM (280)	Grainstone
SORTING	Well	Moderate	Moderate	
WWRC#	32526 : 146	33516 : 143	33516 : 14X	7118 : XXX

FRAMEWORK CONSTITUENTS

Siliciclastic/Lithics

Quartz	56%	59%	50%	-
Plagioclase	1	T	1	-
Rock Fragments		-	-	-
Argillaceous Sedimentary RF	-	-	2	1
Phosphatic Grains	2	1	1	-
Unidentified RF	2	1	1	1
Chert	1	1	-	-
Mica	-	T	T	-
Glauconite	7	6	4	-
Coated Grains	-	T	T	-
Heavy Minerals	-	T	-	-
Allochems				
Skeletal Grains*	1	T	3	70
Carbonate Grains	-	-	3	T
Ooids	-	-	-	T

PORE-FILLING CONSTITUENTS

Quartz Overgrowths	11	15	12	-
Dolomite	8	11	12	-
Calcite	1	1	-	19
Undifferentiated Clay	4	T	T	-
Chlorite	T	T	-	-
Pyrite/Opaques	-	-	-	2
Matrix Clay	-	-	-	-

INTRAGRANULAR REPLACEMENT

Calcite	T	T	-	4
Dolomite	-	1	3	-
Other**	T	T	T	2

VISIBLE PORE SPACE

Intergranular	2	3	5	-
Molds	-	-	-	-
Leached Grain	2	T	2	-

MEASURED POROSITY (%)	12.6	12.0	11.0	0.6
MEASURED PERMEABILITY (md)	55.5	667	4.14	0.080

*Mostly echinoids, crinoids, bryozoa, brachiopods, gastropods, fusulinids (*Millerella*).

**Includes pyrite, possible siderite, possible colophonane.

TABLE 2

X-RAY DIFFRACTION DATA

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Mineralogy of Whole Rock

	<u>6,017.4</u>	<u>6,025.6</u>	<u>6,030.4</u>	<u>6,034.7</u>	<u>6,049.6</u>
Quartz	40%	74%	33%	15%	59%
Plagioclase	0	3	2	3	0
Calcite	57	16	62	78	38
Dolomite	1	3	0	4	0
Siderite	0	1	0	0	0
Clay	2	3	3	0	3

Mineralogy of Whole Rock

	<u>6,052.6</u>	<u>6,055.4</u>	<u>6,065.5</u>	<u>6,073.5</u>	<u>6,076.6</u>
Quartz	92%	93%	60%	61	85%
Plagioclase	0	0	0	0	0
Calcite	5	3	36	35	8
Dolomite	1	1	0	1	3
Siderite	0	0	0	0	0
Clay	2	3	4	3	4

Mineralogy of Whole Rock

	<u>6,081.7</u>	<u>6,085.5</u>	<u>6,096.5</u>	<u>6,097.8</u>	<u>6,101.6</u>
Quartz	77%	44%	78%	94%	86%
Plagioclase	0	5	1	2	1
Calcite	18	43	15	0	0
Dolomite	1	5	2	0	9
Siderite	1	0	0	0	0
Clay	3	3	4	4	4

Mineralogy of Whole Rock

	<u>6,102.4</u>	<u>6,103.4</u>	<u>6,113.5</u>	<u>6,117.8</u>	<u>6,122.9</u>
Quartz	68%	95%	87%	89%	7%
Plagioclase	1	1	2	5	0
Calcite	31	0	2	0	88
Dolomite	0	2	6	3	0
Siderite	0	0	0	0	0
Clay	0	2	3	3	5

TABLE 2 - Continued
ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Mineralogy of <5 Micron Size Fraction

	<u>6,025.6</u>	<u>6,052.6</u>	<u>6,076.6</u>	<u>6,097.8</u>	<u>6,103.4</u>	<u>6,113.5</u>
Illite/Smectite	15%	8%	11%	0%	2%	5%
Chlorite	22	60	76	47	34	25
Kaolinite	1	0	0	0	0	0
Illite	63	32	13	53	64	70

TABLE 3
ROUTINE CORE ANALYSIS
ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Depth (ft)	Porosity (%)	Permeability (md)	Saturation (%PV)			Grain Density (g/cc)	Core	
			Water	Oil	Gas			
6,014.3	1.4	0.010	31.9	40.3	27.8	2.73	1	
6,015.7	3.3	0.041	59.9	10.4	29.7	2.72	1	
6,016.6	5.4	0.047	58.8	4.9	36.3	2.75	1	
6,017.4	6.2	0.054	52.3	9.2	38.5	2.72	1	
6,018.7	7.5	0.093	64.8	5.5	29.7	2.74	1	
6,019.3	6.2	0.050	57.8	8.7	33.5	2.73	1	
6,020.4	7.0	0.073	60.6	6.0	33.4	2.72	1	
6,021.4	7.0	0.099	61.8	3.2	35.0	2.72	1	
6,022.3	6.4	0.104	61.9	1.1	37.0	2.72	1	
6,023.4	6.9	0.076	61.6	0.0	38.4	2.72	1	
6,024.4	6.8	0.085	64.0	1.5	34.5	2.71	1	
6,025.6	11.7	1.03	61.4	5.9	32.7	2.72	1	
6,026.5	7.0	0.082	59.1	0.0	40.9	2.71	1	
6,027.6	6.1	0.071	60.7	0.0	39.3	2.72	1	
6,028.6	5.5	0.075	70.0	0.0	30.0	2.72	1	
6,029.3	4.8	0.138	*	71.6	3.2	25.2	2.71	1
6,030.4	4.3	0.022	51.8	16.5	31.7	2.71	1	
6,031.4	6.5	0.085	63.5	16.3	20.2	2.73	1	
6,032.4	6.1	0.102	73.8	0.0	26.2	2.73	1	
6,033.4	7.3	1.67	79.3	0.0	20.7	2.74	1	
6,034.7	4.7	1.37	70.9	8.1	21.0	2.73	1	
6,035.3	4.5	0.041	55.8	22.7	21.5	2.71	1	
6,036.1	3.5		**	87.3	0.0	12.7	2.72	1
6,037.5	10.0	1.71	82.0	7.9	10.1	2.69	1	
6,038.5	11.7	0.302	70.8	12.6	16.6	2.71	1	
6,039.7	10.2	0.196	74.5	10.6	14.9	2.70	1	
6,040.7	8.7	0.077	90.9	0.0	9.1	2.73	1	
6,041.6	8.6	3.98	*	79.0	5.9	15.1	2.71	1
6,042.8	4.8	0.012	67.3	0.0	32.7	2.71	1	
6,043.2	4.8	0.089	95.5	0.0	4.5	2.70	1	
6,045.7	2.3	0.014	85.3	0.0	14.7	2.70	1	
6,046.6	6.0	0.044	76.6	2.8	20.6	2.69	1	
6,047.6	13.5	1.12	78.8	3.2	18.0	2.69	1	
6,048.6	4.1	0.069	60.1	15.0	24.9	2.70	1	
6,049.6	6.7	0.037	49.3	29.0	21.7	2.69	1	
6,050.5	12.5	0.886	61.5	19.4	19.1	2.71	1	
6,051.4	6.7	0.100	57.7	31.4	10.9	2.71	1	

TABLE 3 (CONTINUED)

ROUTINE CORE ANALYSIS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Depth (ft)	Porosity (%)	Permeability (md)	Saturation (%PV)			Grain Density (g/cc)	Core
			Water	Oil	Gas		
6,052.6	17.7	19.0	61.9	4.6	33.5	2.67	1
6,053.3	5.0	0.034	30.3	57.3	12.4	2.70	1
6,054.4	5.4	0.024	48.9	22.3	28.8	2.70	1
6,055.4	17.2	22.9	59.4	3.2	37.4	2.67	1
6,056.5	13.5	2.89	36.9	40.3	22.8	2.69	1
6,057.6	6.7	0.030	39.6	36.7	23.7	2.69	1
6,058.6	12.8	1.39	73.0	1.5	25.5	2.69	1
6,059.7	7.5	0.075	46.8	37.2	16.0	2.70	1
6,060.6	7.5	0.063	48.4	37.2	14.4	2.70	1
6,061.6	11.2	1.48	72.7	5.4	21.9	2.68	1
6,062.5	10.9	0.715	70.9	3.6	25.5	2.71	1
6,063.4	7.0	0.022	28.5	62.2	9.3	2.70	1
6,064.4	8.1	0.030	30.5	59.0	10.5	2.70	1
6,065.5	8.2	0.053	44.9	51.5	3.6	2.70	1
6,066.5	7.6	0.090	82.6	9.1	8.3	2.70	1
6,067.4	12.6	0.862	78.2	5.5	16.3	2.70	1
6,068.5	7.8	0.054	47.0	47.4	5.6	2.70	1
6,069.4	7.9	0.128	70.4	23.5	6.1	2.70	1
6,070.5	9.6	0.272	77.5	9.4	13.1	2.72	1
6,071.2	8.9	0.182	76.8	11.9	11.3	2.71	1
6,072.6	7.6	0.081	79.2	6.1	14.7	2.71	2
6,073.5	7.1	0.093	82.4	3.2	14.4	2.71	2
6,074.6	10.7	0.228	80.3	5.8	13.9	2.72	2
6,075.7	10.5	0.855	74.4	8.8	16.8	2.69	2
6,076.6	15.9	4.07	69.3	5.7	25.0	2.67	2
6,077.6	6.6	0.028	61.5	22.9	15.6	2.70	2
6,078.6	6.6	0.030	62.9	25.4	11.7	2.70	2
6,079.7	13.4	0.933	75.1	5.1	19.8	2.69	2
6,080.6	18.0	0.636	71.9	6.3	21.8	2.67	2
6,081.7	7.7	0.024	69.9	16.4	13.7	2.70	2
6,082.6	8.0	0.039	72.1	13.7	14.2	2.70	2
6,083.6	8.5	0.046	76.6	9.2	14.2	2.69	2
6,084.7	5.9	0.112	79.6	5.9	14.5	2.72	2
6,085.5	7.3	0.113	78.5	4.2	17.3	2.70	2
6,086.5	7.7	0.137	78.9	2.5	18.6	2.71	2
6,087.4	5.6	0.113	79.0	2.8	18.2	2.71	2
6,088.3	10.3	0.478	75.2	4.9	19.9	2.70	2

TABLE 3 (CONTINUED)
ROUTINE CORE ANALYSIS
ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Depth (ft)	Porosity (%)	Permeability (md)	Saturation (%PV)			Grain Density (g/cc)	Core
			Water	Oil	Gas		
6,089.5	5.8	0.035	80.3	4.7	15.0	2.69	2
6,090.6	4.5	0.005	62.6	5.8	31.6	2.63	2
6,094.9	2.9	0.015	70.1	22.6	7.3	2.71	2
6,095.3	4.1	0.014	47.1	32.8	20.1	2.68	2
6,096.5	10.2	0.069	75.8	6.1	18.1	2.69	2
6,097.8	15.6	169.	57.5	7.5	35.0	2.66	2
6,098.6	11.2	8.32	69.3	5.5	25.2	2.69	2
6,099.6	12.0	8.12	68.1	6.5	25.4	2.68	2
6,100.3	6.9	0.085	67.5	14.1	18.4	2.67	2
6,101.6	12.6	66.2	52.7	10.6	36.7	2.67	2
6,102.4	7.4	0.114	79.8	1.1	19.1	2.67	2
6,103.4	12.6	55.5	65.1	5.6	29.3	2.67	2
6,104.3	10.9	1.80	70.6	1.8	27.6	2.68	2
6,105.4	10.6	0.238	85.9	1.4	12.7	2.71	2
6,106.2	10.0	0.074	82.0	8.2	9.8	2.70	2
6,107.7	11.7	0.203	79.3	4.0	16.7	2.69	2
6,108.5	11.9	0.586	81.1	0.0	18.9	2.68	2
6,109.4	13.6	0.409	85.0	0.0	15.0	2.70	2
6,110.6	10.7	1.58	74.6	1.0	24.4	2.69	2
6,111.2	11.8	4.07	73.4	2.3	24.3	2.70	2
6,112.4	11.2	0.248	80.7	7.9	11.4	2.69	2
6,113.5	12.0	6.67	80.8	1.9	17.3	2.69	2
6,114.5	11.7	0.351	74.5	9.1	16.4	2.71	2
6,115.6	15.0	1.11	79.7	5.1	15.2	2.68	2
6,116.3	14.7	4.70	88.0	0.0	12.0	2.68	2
6,117.8	11.0	4.14	74.8	1.0	24.2	2.70	2
6,118.4	6.8	0.046	53.3	33.3	13.4	2.68	2
6,119.4	12.7	0.209	73.8	6.6	19.6	2.70	2
6,122.9	0.6	0.080	66.4	6.6	27.0	2.73	2
6,123.7	< 0.1	< 0.001	0.0	0.0	100.0	2.71	2
Average:	8.6	3.945	66.9	11.5	21.6	2.70	
Minimum:	0.1	< 0.001	0.0	0.0	3.6	2.63	
Maximum:	18.0	169.0	95.5	62.2	100.0	2.75	

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

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

PLATES 1 - 7

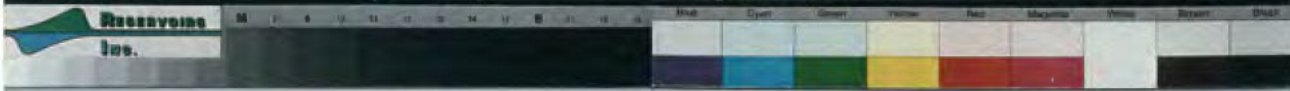
CORE PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION

RATCLIFF B-2 WELL

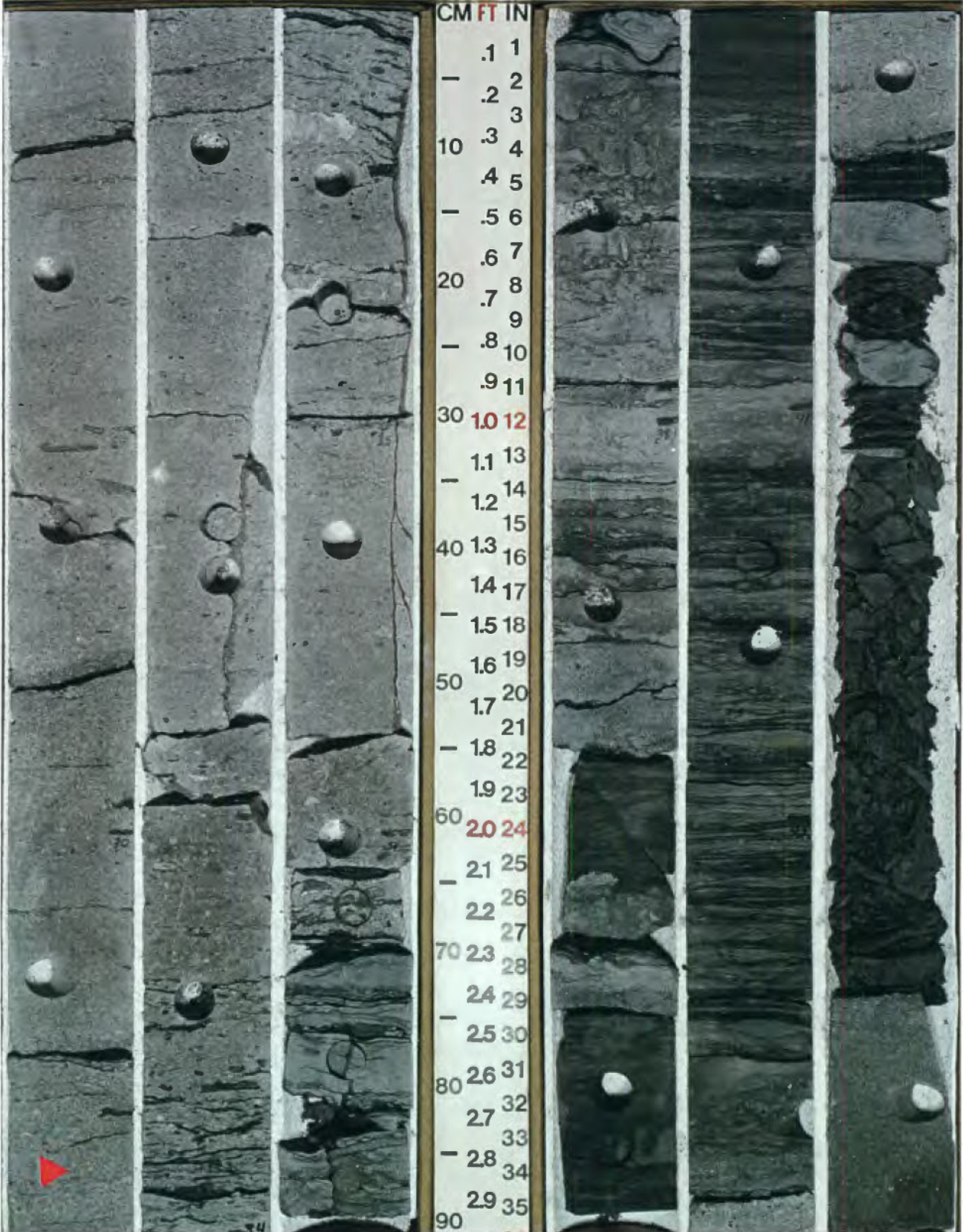
<u>Core Depths</u>	<u>Depositional Environments</u>
6,010.00' - 6,014.20'	Shallow Marine or Lagoon
6,014.20' - 6,036.25'	Tidal Inlet
6,036.25 - 6,045.40'	Tidal Flats or Lagoon
6,045.40' - 6,091.00'	Bay Mouth(?) Tidal Channels and Sand Bars
6,091.00' - 6,094.85'	Tidal Flats or Lagoon
6,094.85' - 6,119.60'	Subtidal(?) Upper Estuary Sand Flats
6,119.60' - 6,122.70'	Tidal Flats or Lagoon
6,122.70' - 6,124.20'	Shallow Marine Shoal(?)
6,124.20' - 6,128.90'	Paleosol

ANADARKO PETROLEUM CORPORATION
RATCLIFF NO. B-2
GENTZLER FIELD
STEVENS COUNTY, KANSAS
6,019.0 - 6,028.0

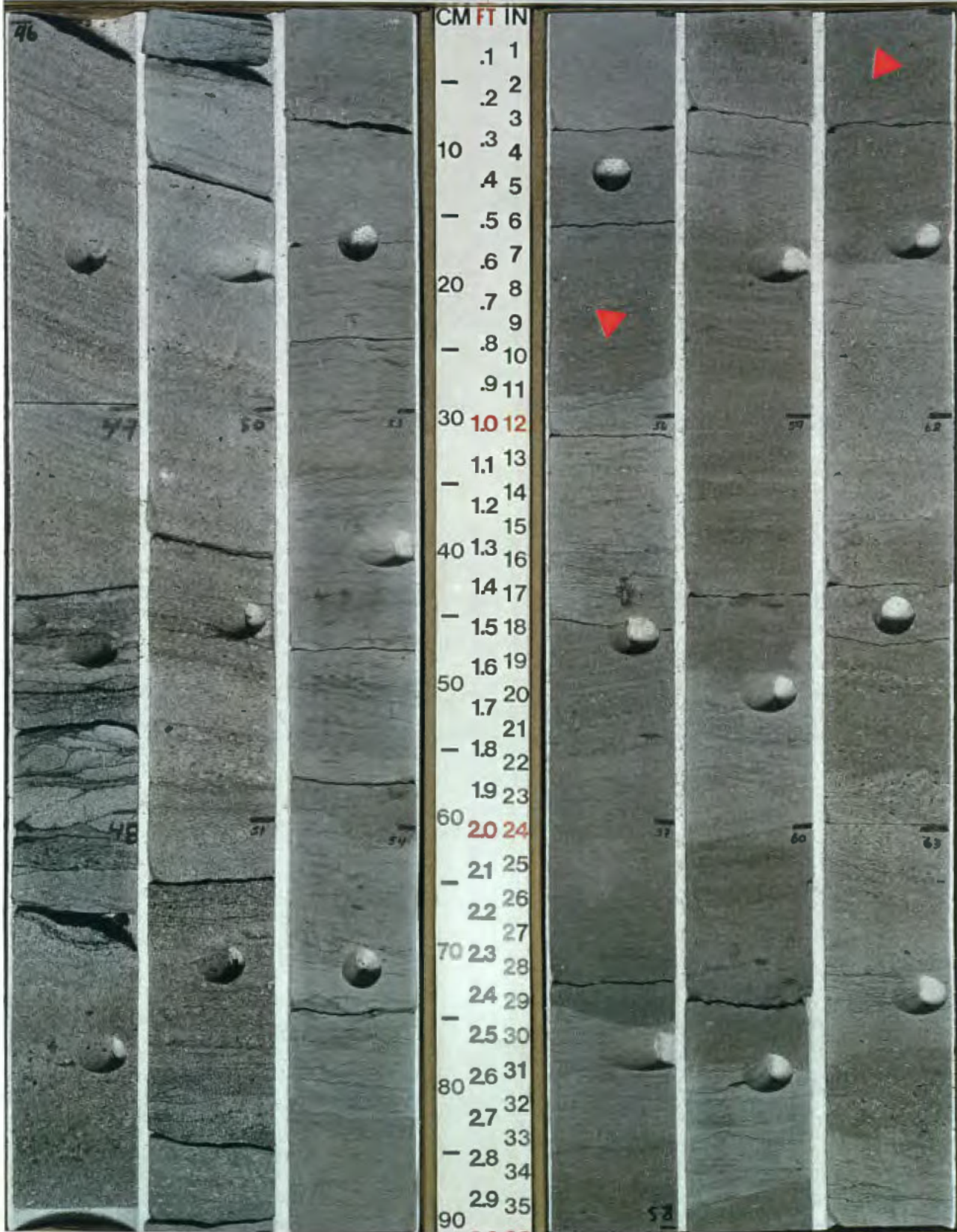
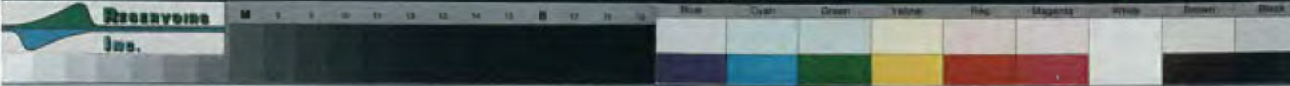


CM	FT	IN
.1	1	
— .2	2	
3		
10 .3	4	
4 5		
— .5	6	
.6	7	
20 .7	8	
.8	9	
— .9	10	
.11		
30 1.0	12	
.13		
— 1.1	13	
.14		
40 1.2	14	
.15		
14 1.3	16	
14 17		
— 1.5	18	
1.6	19	
50 1.7	20	
.21		
— 1.8	22	
1.9	23	
60 2.0	24	
.25		
— 2.1	25	
.26		
2.2	26	
.27		
70 2.3	28	
.29		
— 2.4	29	
.30		
80 2.5	30	
.31		
2.6	31	
.32		
2.7	32	
.33		
— 2.8	34	
.34		
2.9	35	
90		

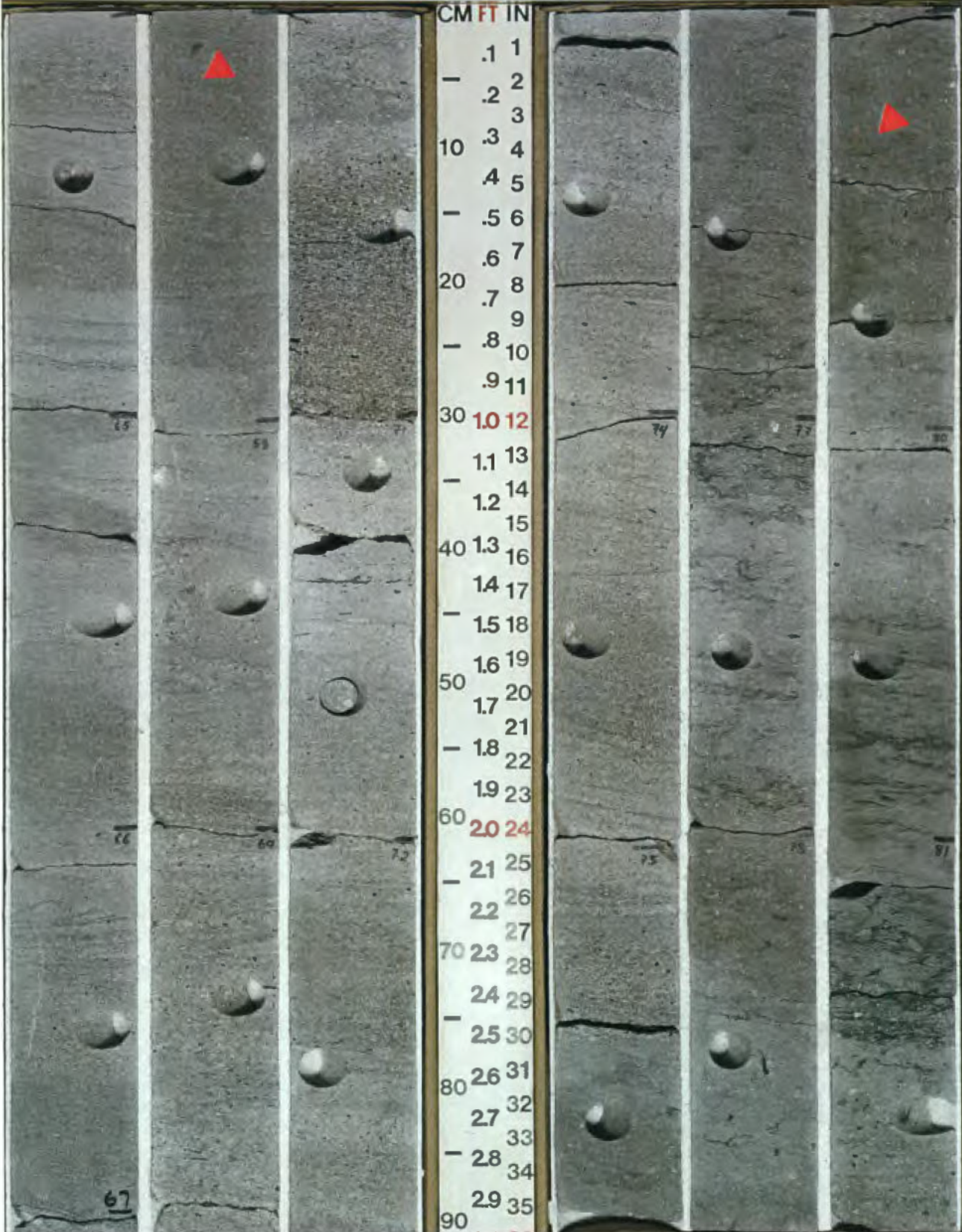
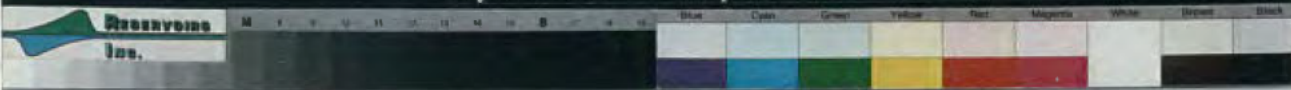
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 RATCLIFF NO. B-2
 GENTZLER FIELD
 STEVENS COUNTY, KANSAS
 6,028.0 - 6,046.0



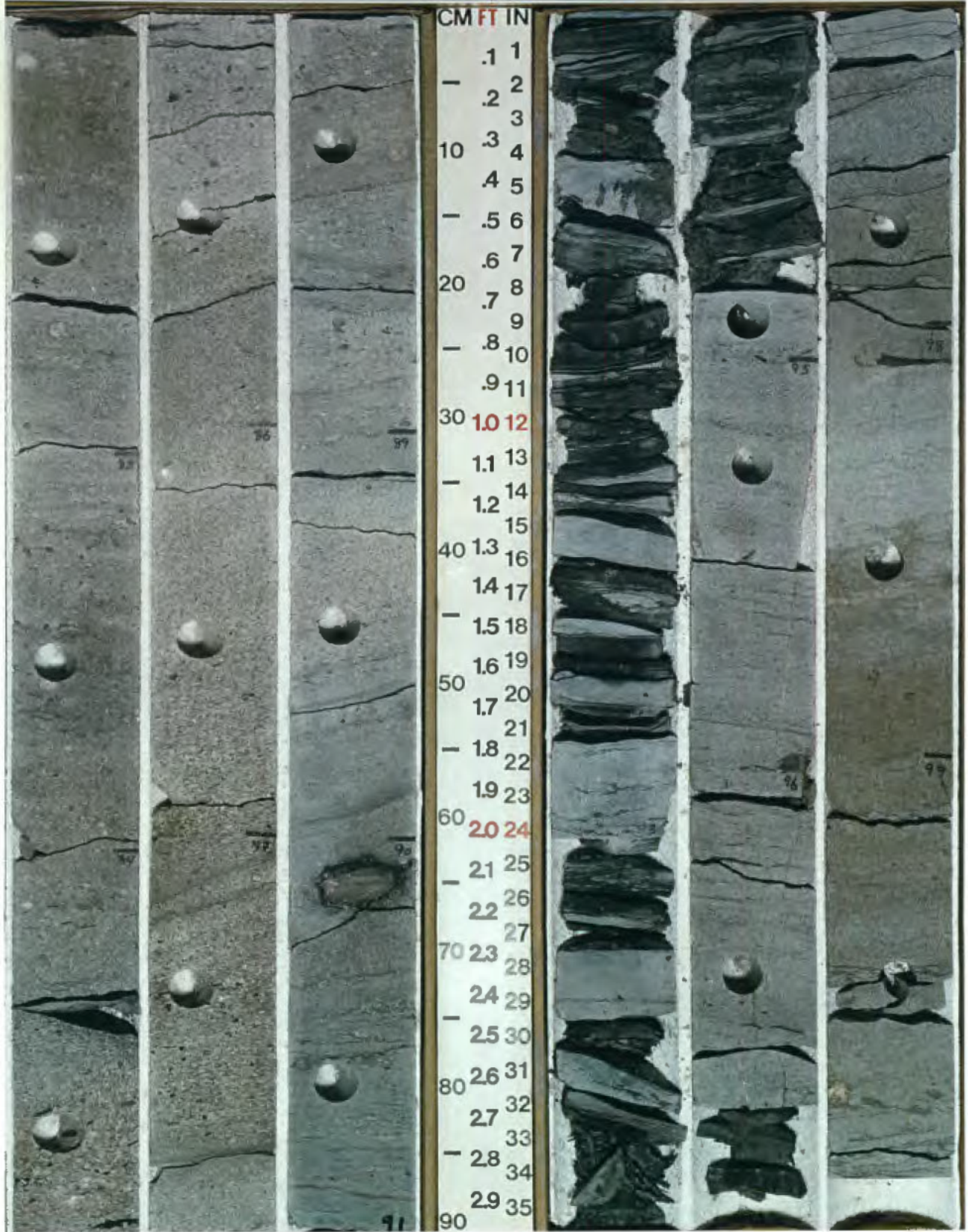
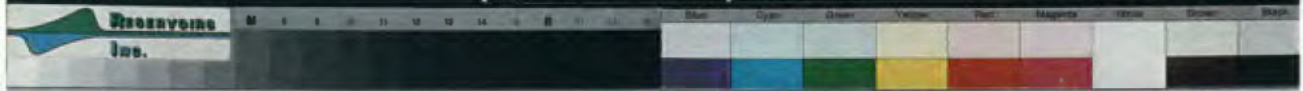
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 RATCLIFF NO. B-2
 GENTZLER FIELD
 STEVENS COUNTY, KANSAS
 6,046.0 - 6,064.0



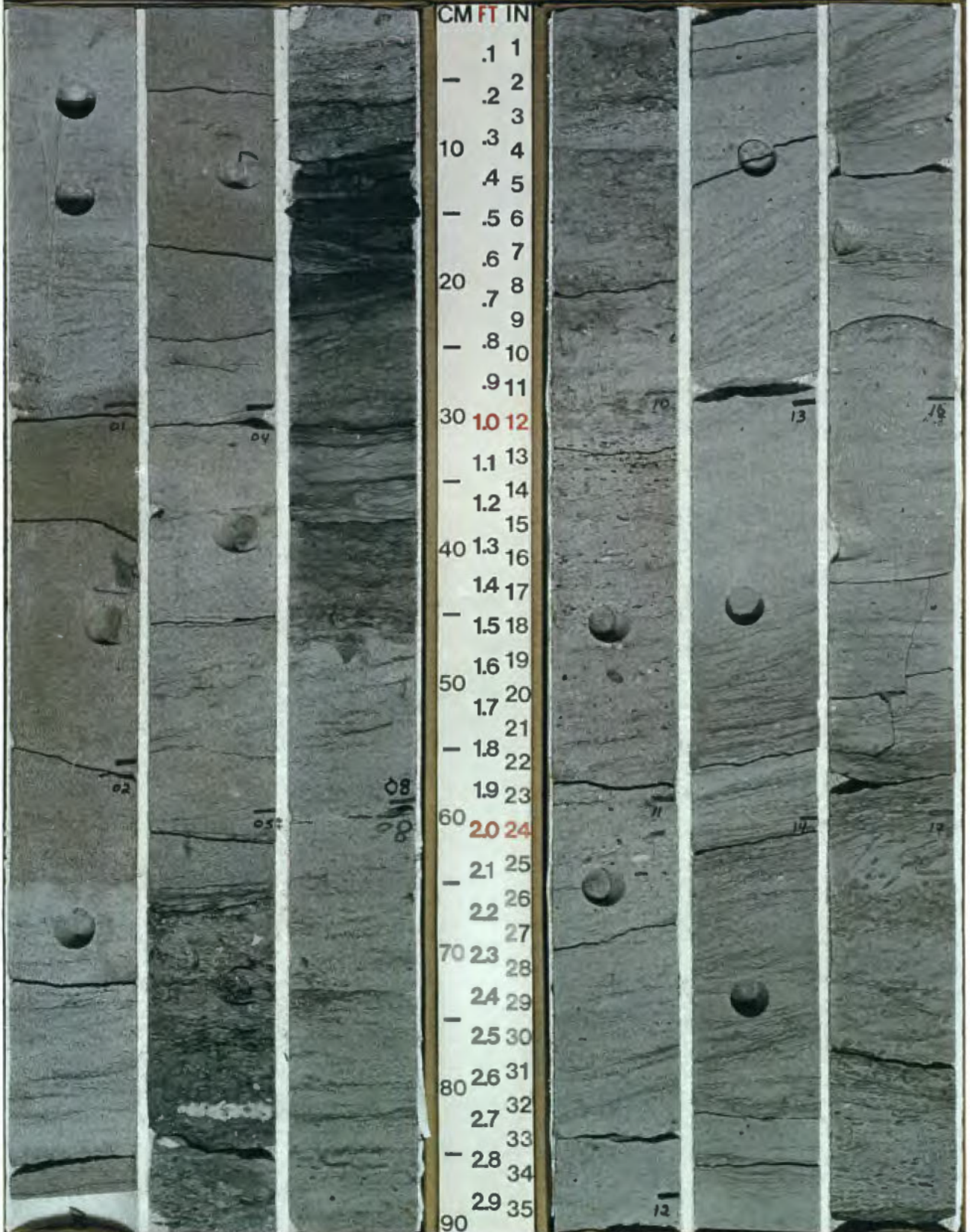
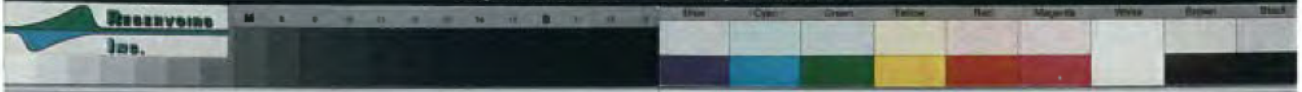
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 RATCLIFF NO. B-2
 GENTZLER FIELD
 STEVENS COUNTY, KANSAS
 6,064.0 - 6,082.0



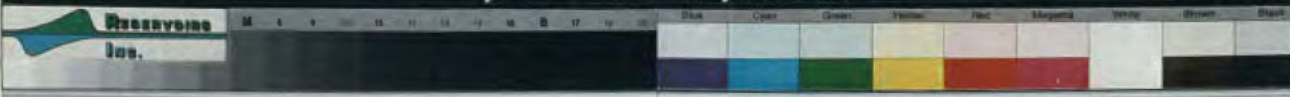
ANADARKO PETROLEUM CORPORATION
 RATCLIFF NO. B-2
 GENTZLER FIELD
 STEVENS COUNTY, KANSAS
 6,082.0 - 6,100.0



ANADARKO PETROLEUM CORPORATION
RATCLIFF NO. B-2
GENTZLER FIELD
STEVENS COUNTY, KANSAS
6,100.0 - 6,118.0



ANADARKO PETROLEUM CORPORATION
 RATCLIFF NO. B-2
 GENTZLER FIELD
 STEVENS COUNTY, KANSAS
 6,118.0 - 6,128.9



CM FT IN
 .1 1
 - .2 2
 .3 3
 10 .4 4
 .5 5
 - .6 6
 .7 7
 20 .8 8
 .9 9
 - .10 10
 .11 11
 30 1.0 12
 .11 13
 - .12 14
 .15 15
 40 1.3 16
 .14 17
 - .15 18
 .16 19
 50 1.7 20
 .17 21
 - .18 22
 .19 23
 60 2.0 24
 .21 25
 - .22 26
 .27 27
 70 2.3 28
 .24 29
 - .25 30
 .26 31
 80 2.7 32
 .27 32
 - .28 33
 .29 34
 90 2.9 35



6128.9

PLATE 8

CORE SLAB PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

- A. Depth: 6,024 Feet Depositional Facies: Tidal Inlet

This slab is from the moderately to poorly sorted, trough cross-stratified coarse-grained sandstone facies, which is common in the upper two-thirds of the cored interval. Note the subvertical calcite-filled fracture along the left side of the slab, and a natural, fracture that appears to branch off from it in the lower portion. Many of the coarser-grained foresets are highlighted by echinoderm and bryozoa fragments, as well as argillaceous and phosphatic rock fragments. The large, dark object just below the letter "A" is a trepostome bryozoa fragment.

- B. Depth: 6,034 Feet Depositional Facies: Tidal Inlet

Dark gray shale rip-up clasts and phosphatic rock fragments are set in a poorly sorted sand matrix in this core piece. A similar lithology two feet lower overlies an abrupt contact. Both horizons appear to be lag deposits over erosional contacts.

- C. Depth: 6,042 Feet Depositional Facies: Tidal Flats or Lagoon

This is a very dark gray, lenticular bedded shale to thinly bedded, wavy stratified, very fine-grained sandstone. Numerous, small *Chondrites* burrows are present in the lower half of the slab. Several, small spreite-filled burrows may be *Teichichnus*.

- D. Depth: 6,058 Feet Depositional Facies: Bay Mouth(?) Tidal Channel and Sand Bar

This core slab illustrates the ripple-stratified, well-sorted, medium-grained sandstone facies which is commonly interbedded with trough cross-stratified coarse-grained sandstone. The 2-inch-thick trough set at the base of the slab is overlain by approximately 4 inches of ripple-stratification. The lighter color of the ripple-stratified bed is due to calcite cement.



PLATE 9

CORE SLAB PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

- A. Depth: 6,091 Feet Depositional Facies: Bay Mouth(?) Tidal Sand Bars and Channels

Several thin sets of herringbone-stratification are present in the lower half of this slab. The stratification occurs in well-sorted, fine-grained sandstone interbedded with more poorly sorted sandstone containing fossil debris and granule-sized argillaceous rock fragments. The clay laminae just above the core plug hole outline two sets of ripple-stratification with opposite apparent dips.

- B. Depth: 6,108 Feet Depositional Facies: Subtidal(?) Upper Estuary Sand Flats

This slab illustrates a set of trough cross-stratified glauconitic sandstone overlain by graded, bioturbated, argillaceous sandstone. The upper portion of the sand layer was colonized following cessation of traction-dominated deposition.

- C. Depth: 6,117 Feet Depositional Facies: Subtidal(?) Upper Estuary Sand Flats

This core slab is a burrowed, fine-grained, glauconitic sandstone facies which occurs near the base of the cored interval. Burrows appear to be simple, sand-filled oblique structures. There appears to be relict ripple-stratification at the top and bottom of the slab.

- D. Depth: 6,123 Feet Depositional Facies: Shallow Marine Shoal(?)

The thin limestone near the base of the cored interval is a slightly argillaceous grainstone with abundant brachiopod and bryozoa debris. Many white skeletal grains are visible here. Ooids are also common. Note the *Archimedes* column (left side) at the top of the core piece. Portions of the frond are still associated with the column.



PLATE 10

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,017.4 Feet

WWRC#: 2 3 5 1 7 : 3 4 X

Ave. Grain Size = Upper Coarse Sand (842 μ) Measured Porosity = 6.2%
Sorting = Moderate Measured Permeability = 0.054 md
Visible Porosity = 2% Grain Density = 2.72 g/cc

Nearly equal proportions of siliciclastic grains and allochems are cemented by poikilotopic calcite in this sandstone. Skeletal grains include bryozoa, crinoid, and echinoid (E) fragments. Quartz is the predominant non-carbonate grain, followed by lesser amounts of plagioclase, rock fragments, phosphatic grains (PG), glauconite, ooids and clay-coated grains. Visible porosity consists of isolated moldic pores (Pm) and leached-grain secondary pores.

A - 20X

B - 40X

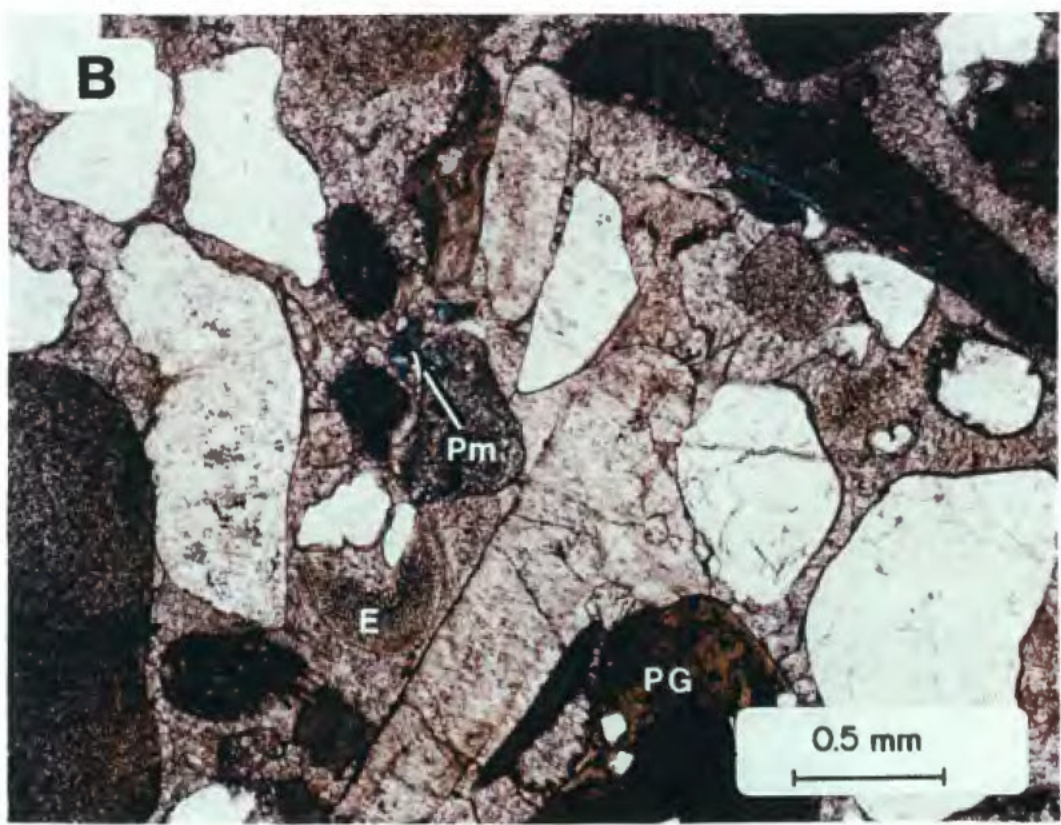
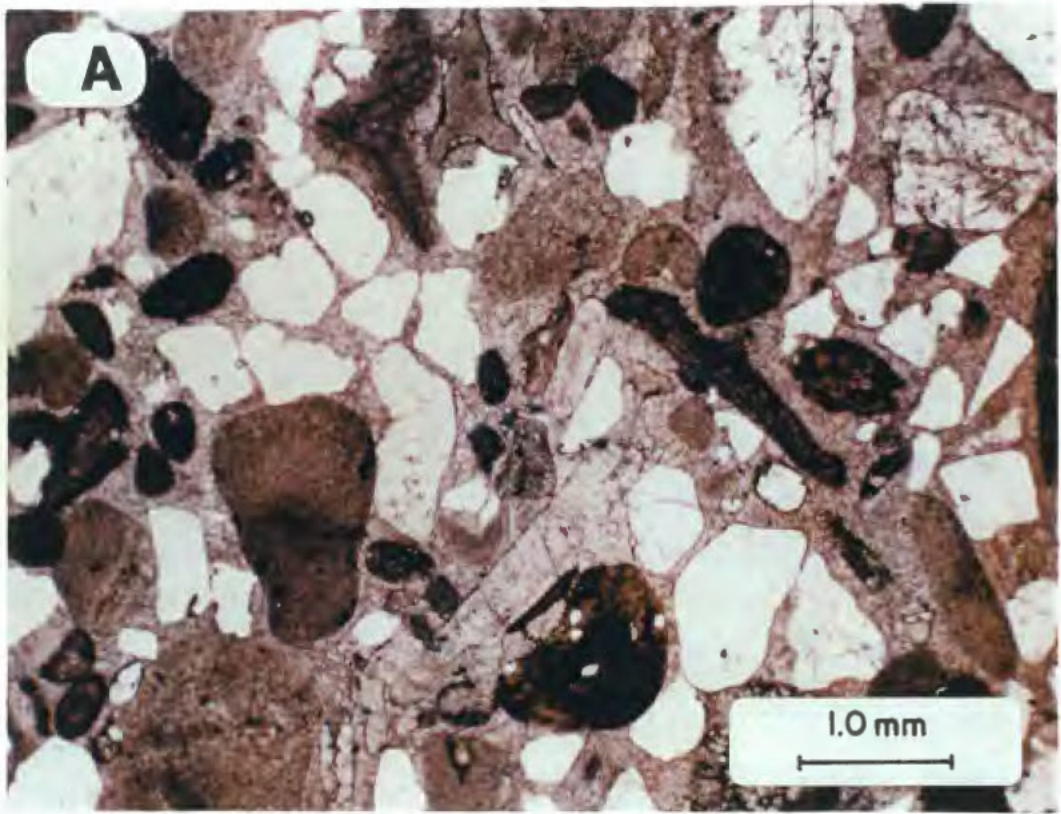


PLATE 11

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,025.6 Feet

WWRC#: 3 4 5 1 6 : 3 4 1

Ave. Grain Size = Upper Med. Sand (448 μ) Measured Porosity = 11.7%
Sorting = Poor Measured Permeability = 1.03 md
Visible Porosity = 7% Grain Density = 2.72 g/cc

This sample is a poorly sorted sandstone composed of predominantly of quartz, allochems and rock fragments, with lesser quantities of glauconite, clay-coated grains and plagioclase. Calcite is the most common cement. A large, dark amber-colored phosphatic grain (PG) is seen in view A. Much of the phosphate appears to be finely crystalline collophane. Quartz overgrowths are well developed on grain surfaces in open pores, but poorly developed or absent where grains are in contact with interstitial clay (CL) or calcite. Dolomite occurs as a pore-filling cement (D), and as a replacement mineral (Dr). Visible pore space consists mostly of isolated molds and lesser quantities of intergranular pores (P) and leached-grain secondary pores.

A - 20X

B - 40X

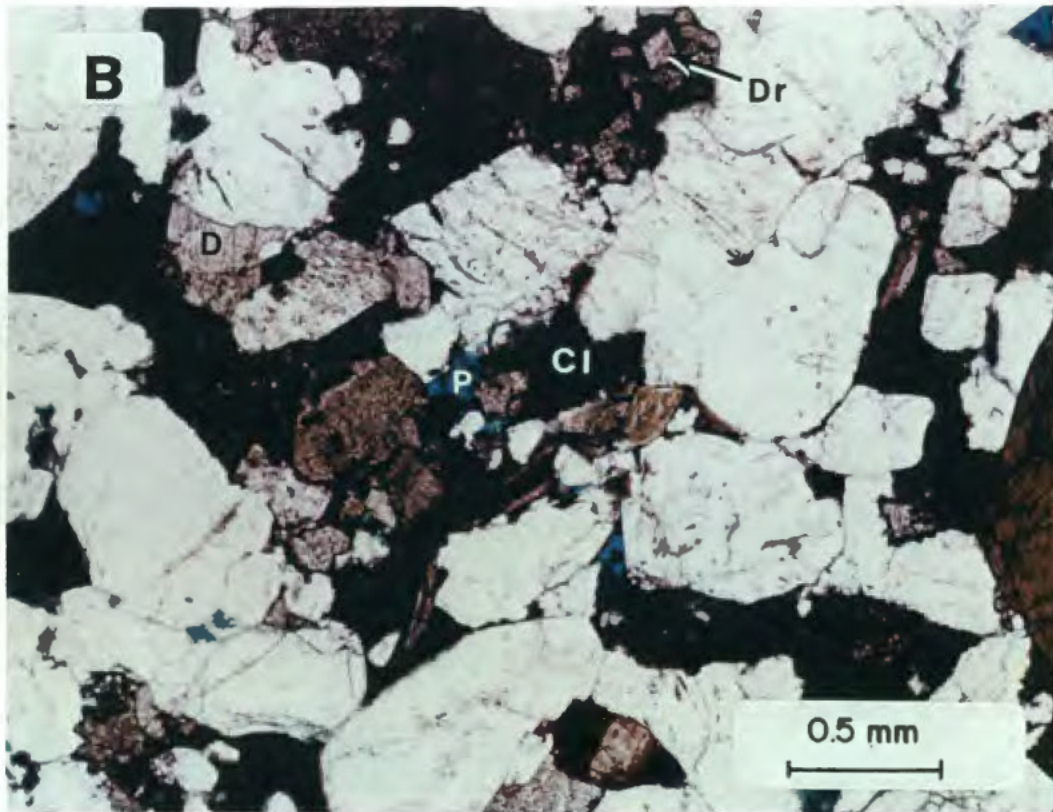
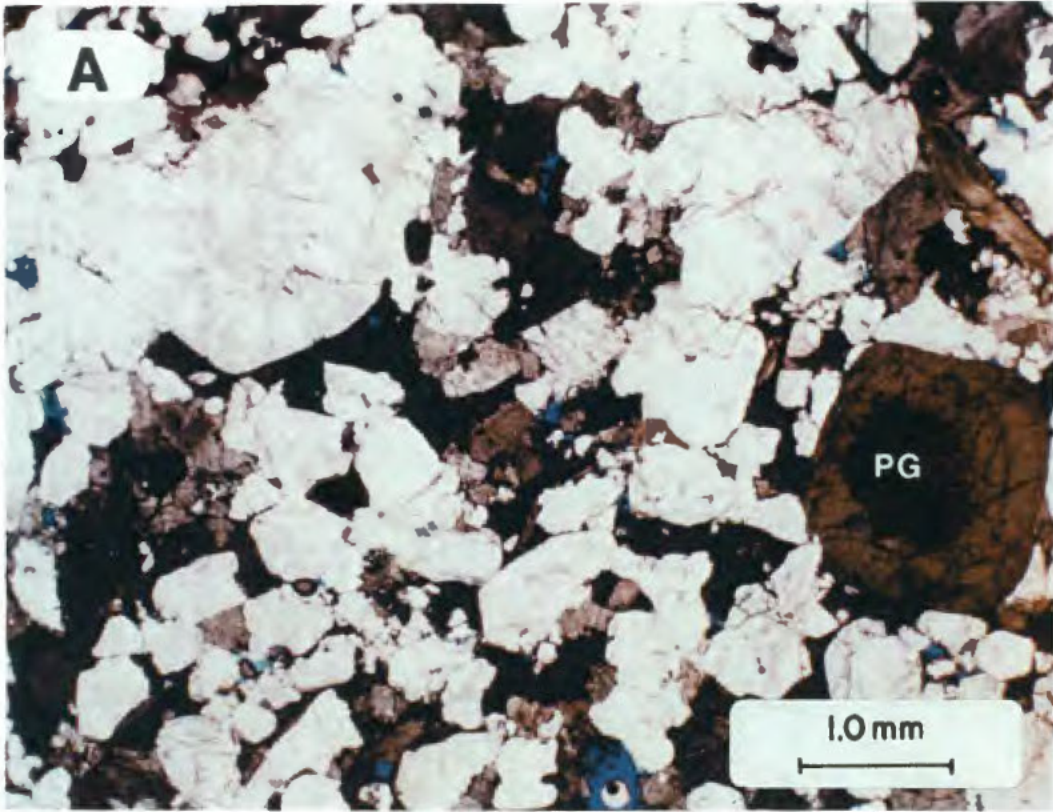


PLATE 12

SCANNING ELECTRON PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,025.6 Feet

WWRC#: 3 4 5 1 6 : 3 4 1

Ave. Grain Size = Upper Med. Sand (448 μ) Measured Porosity = 11.7%
Sorting = Poor Measured Permeability = 1.03 md
Visible Porosity = 7% Grain Density = 2.72 g/cc

Scanning electron microscopy reveals the presence of large, well-developed quartz overgrowths (QO) and abundant authigenic clay. The clay appears to be mostly grain-coating authigenic chlorite (Ch) and mixed-layer illite/smectite (I/S). In addition, small quantities of pore-filling kaolinite (K) are also present. Macropores (P) are frequently reduced or occluded and isolated by these authigenic minerals. The grain-coating chlorite appears to have inhibited nucleation of authigenic quartz, and "chlorite-free" grains possess well-developed quartz overgrowths (view A).

A - 200X (First area)

B - 1000X

C - 200X (Second area)

D - 1000X

X-RAY DIFFRACTION DATA

Whole Rock

Quartz - 74%
Plagioclase - 3%
Calcite - 16%
Dolomite - 3%
Siderite - 1%
Clay - 3%

Clay Mineralogy

Chlorite - 22%
Illite - 62%
Kaolinite - 1%
Mixed-Layer Illite/Smectite - 15%



PLATE 13

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,030.4 Feet

WWRC#: 2 3 5 1 8 : 3 X X

Ave. Grain Size = Lower Coarse Sand (614 μ) Measured Porosity = 4.3%
Sorting = Moderate Measured Permeability = 0.022 md
Visible Porosity = Trace Grain Density = 2.71 g/cc

This coarse-grained sandstone is composed of moderately sorted quartz grains and an equal amount of allochems, including skeletal grains and carbonate grains. In addition, the sample contains lesser quantities of chert and plagioclase, and accessory amounts of phosphatic grains, glauconite, and clay-coated grains. The skeletal grains include crinoid stem pieces (C), bryozoa (B), and large echinoid fragments (E). Glauconite (Gl) appears to be fresh to partially leached and partially replaced by calcite and colophonane. Many grains appear to have been desiccated or fractured and, subsequently, filled with calcite. Glauconite also appears to fill intraparticle voids in a skeletal grain (SG). Small moldic pores (arrow) are isolated by calcite cement. The hexagonal grain in the lower right may be a garnet.

A - 20X

B - 40X

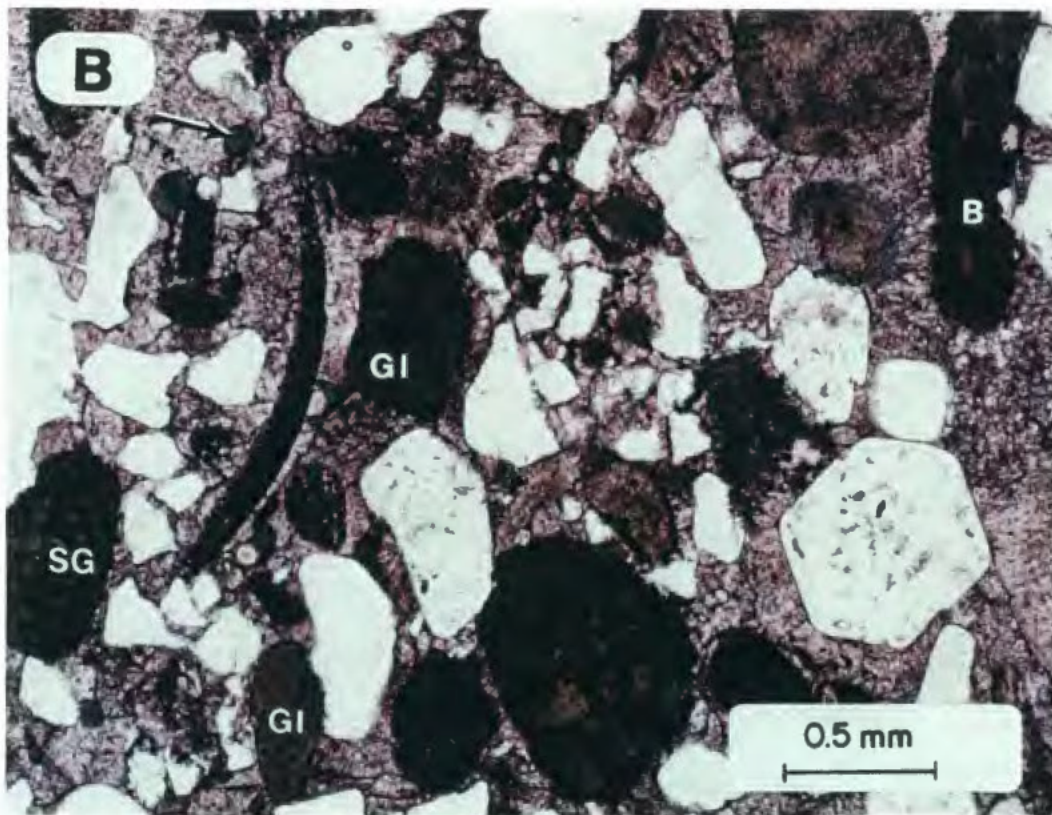
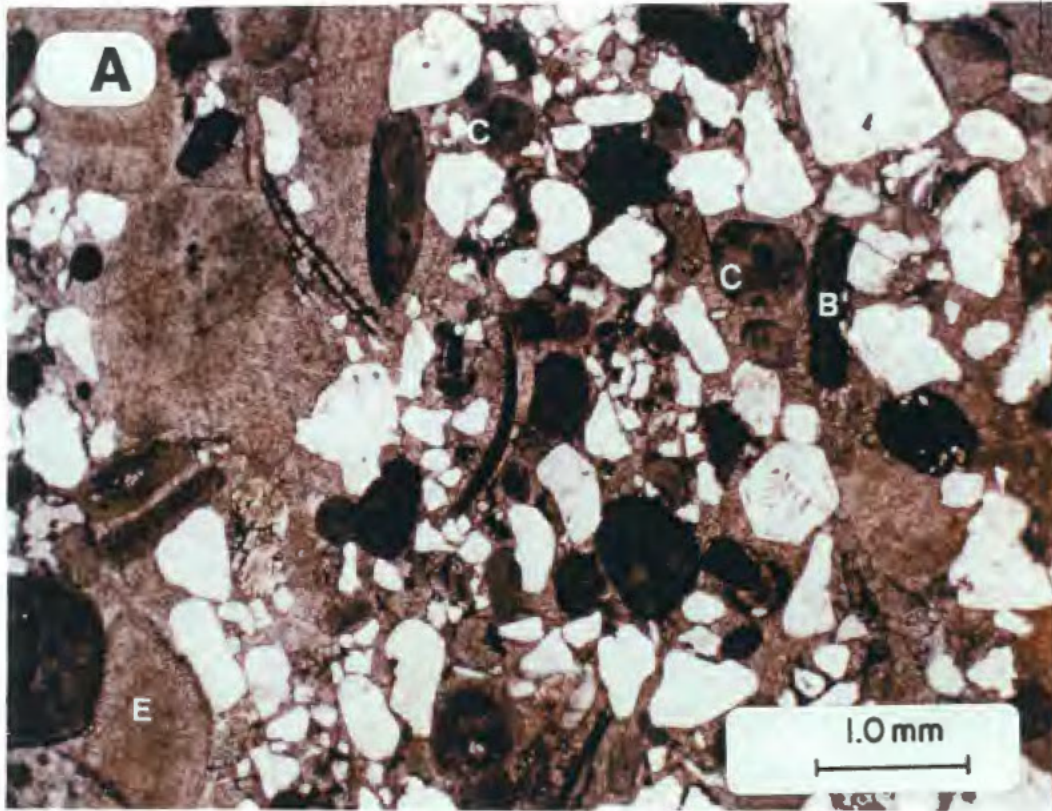


PLATE 14

WHOLE THIN SECTION PHOTOMICROGRAPH

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,034.7 Feet

WWRC#: 2 3 5 1 8 : 3 X X

Ave. Grain Size = Lower Coarse Sand (566 μ) Measured Porosity = 4.7%
Sorting = Moderate Measured Permeability = 1.37 md
Visible Porosity = 2% Grain Density = 2.73 g/cc

This low magnification photomicrograph illustrates the heterogeneous texture of the sample. Unevenly distributed, moderately sorted quartz and skeletal grains are cemented by calcite cement (pink). In addition to the quartz, large, brown phosphatic grains, and partially leached glauconite particles are present. Most of the fossil grains are echinoid fragments (mostly crinoids), bryozoa, and occasional bivalve (mostly brachiopod?) shell fragments. Several fusulinids are also present. Note the low-amplitude, bitumen(?) -lined stylolite down the left side of the sample. Moldic pores of varying sizes are present throughout the rock, but they are isolated from one another by the calcite cement (see also Plate 15). Notch in bar along lower edge is 1 mm.

10X



PLATE 15

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,034.7 Feet

WWRC#: 2 3 5 1 8 : 3 X X

Ave. Grain Size = Lower Coarse Sand (566 μ) Measured Porosity = 4.7%
Sorting = Moderate Measured Permeability = 1.37 md
Visible Porosity = 2% Grain Density = 2.73 g/cc

This sample is very similar to the one at 6,030.4 feet, however, moldic pores (Pm) are more common. A gastropod shell (Ga) is partially infilled with calcite and clay. Echinoid fragments appear to be the most common skeletal grain. The poikilotopic calcite cement appears to have precipitated early in the burial history of the rock as evidenced by minimal compaction. Note the absence of significant overgrowths on the white quartz grains.

A - 20X

B - 40X

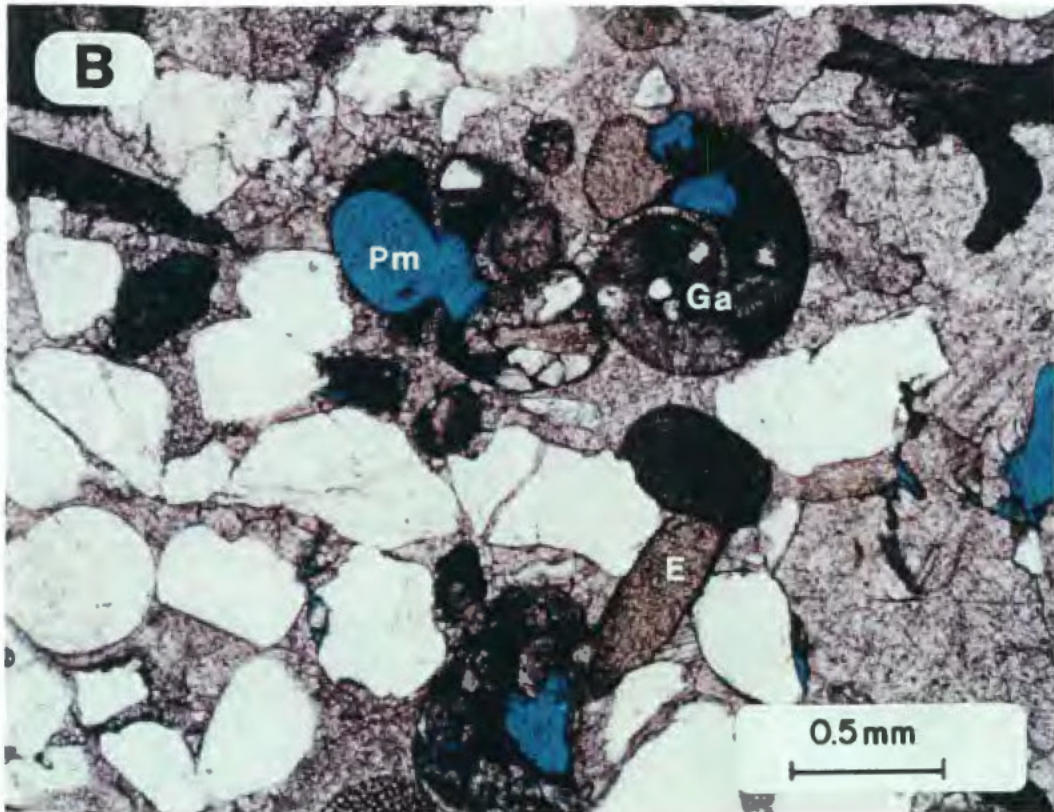
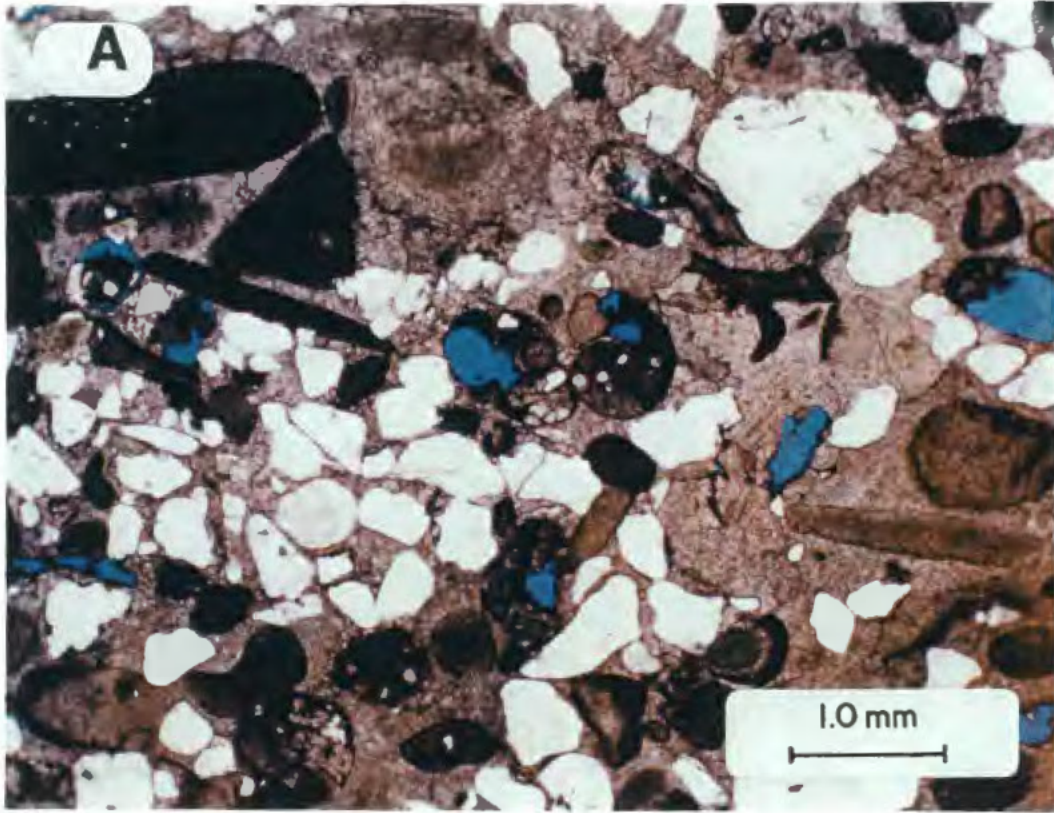


PLATE 16

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,049.6 Feet

WWRC#: 3 2 5 1 7 : 3 1 X

Ave. Grain Size = Upper Med. Sand (380 μ)
Sorting = Well
Visible Porosity = 2%

Measured Porosity = 6.7%
Measured Permeability = 0.037 md
Grain Density = 2.69 g/cc

A more quartzose lithology is reflected in the slightly lower grain density for this sample compared with previous calcite-cemented samples (Plates 10 to 15). Although poikilotopic calcite cement is still pervasive, the ratio of siliciclastic grains to total calcite is much greater. Non-carbonate constituents are predominantly quartz and glauconite, with lesser quantities of plagioclase and phosphatic grains. Clay-coated grains (CG) are also present in small quantities, typically with the clay coating partially to completely leached. Glauconite (GI) has the same appearance as in previous samples. The most common skeletal grains appear to be echinoid fragments (E).

A - 20X

B - 40X

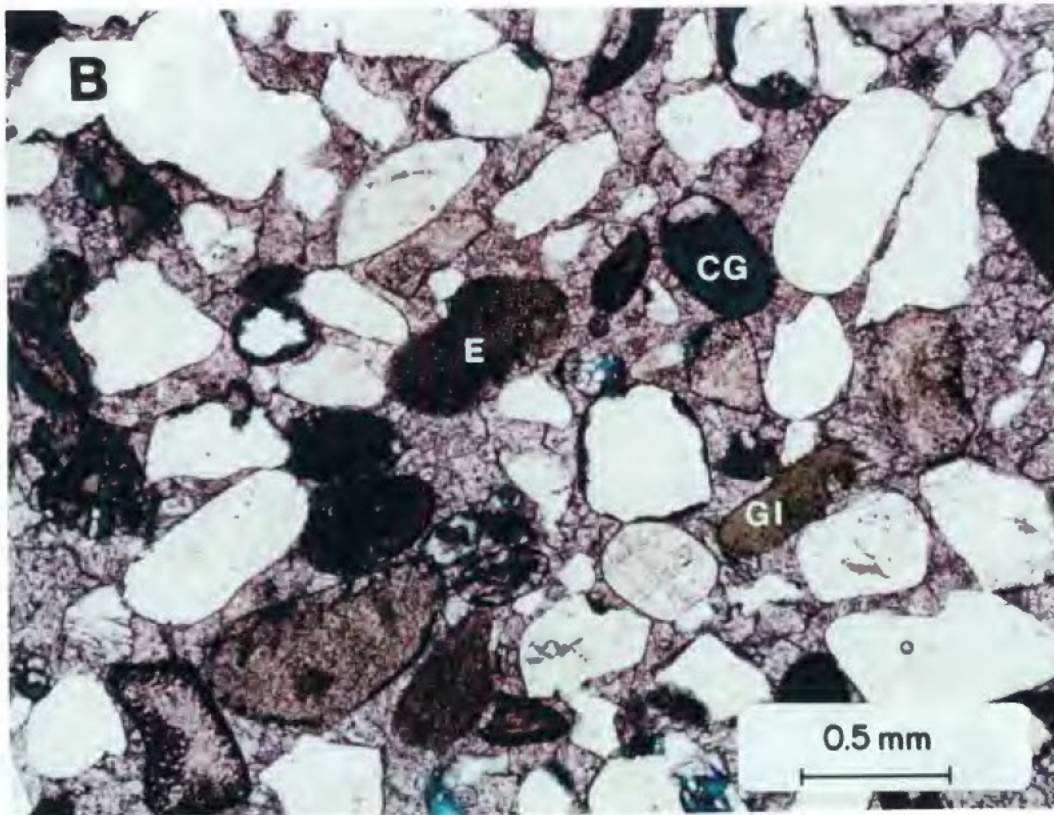
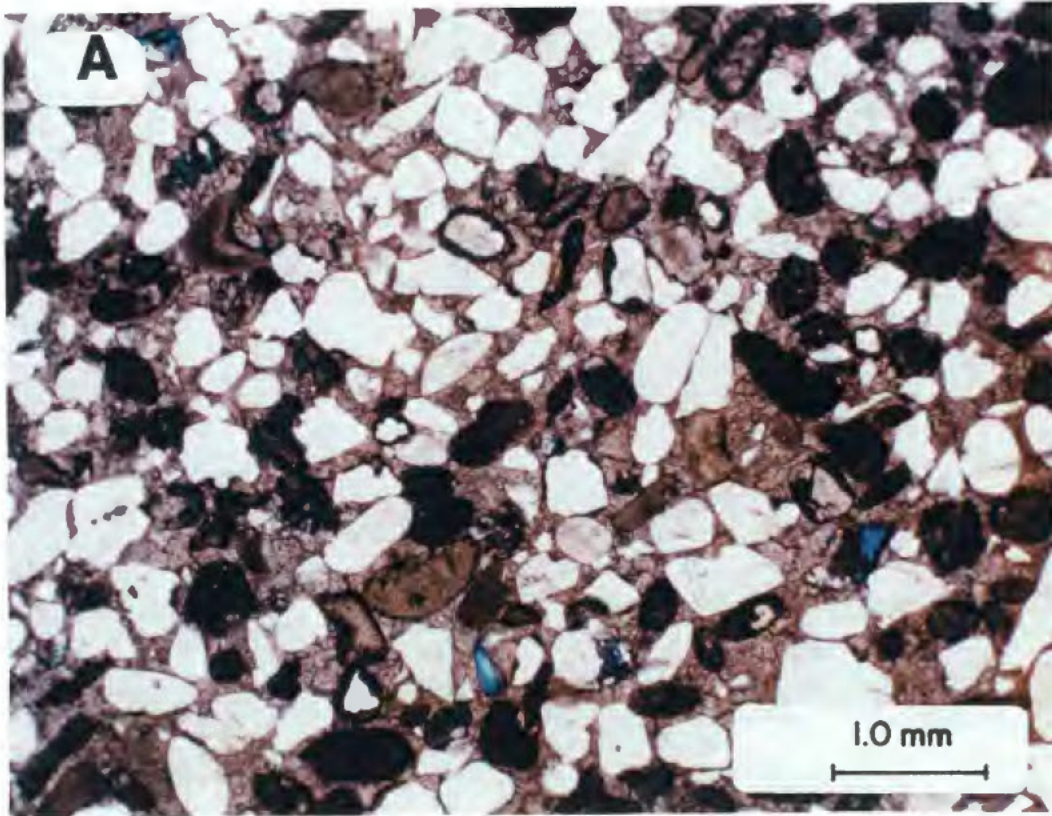


PLATE 17

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,052.6 Feet

WWRC#: 3 2 5 2 5 : 1 6 4

Ave. Grain Size = Lower Med. Sand (266 μ) Measured Porosity = 17.7%
Sorting = Well Measured Permeability = 19.0 md
Visible Porosity = 8% Grain Density = 2.67 g/cc

This is a well-sorted, medium-grained sandstone composed mostly of quartz with small quantities of rock fragments and skeletal grains, and cemented by authigenic quartz in the form of overgrowths (QO). Small quantities of undifferentiated clay (CI) also lithify the grains and occasionally appear as a finely crystalline green clay underlying incomplete quartz overgrowths (arrow). Moderate amounts of compaction are indicated by bent and crushed skeletal grains (SG). Intergranular pores (P) are frequently reduced by the well developed quartz overgrowths and interstitial clay. Pink calcite crystals (C) partially replace the clay.

A - 40X

B - 160X

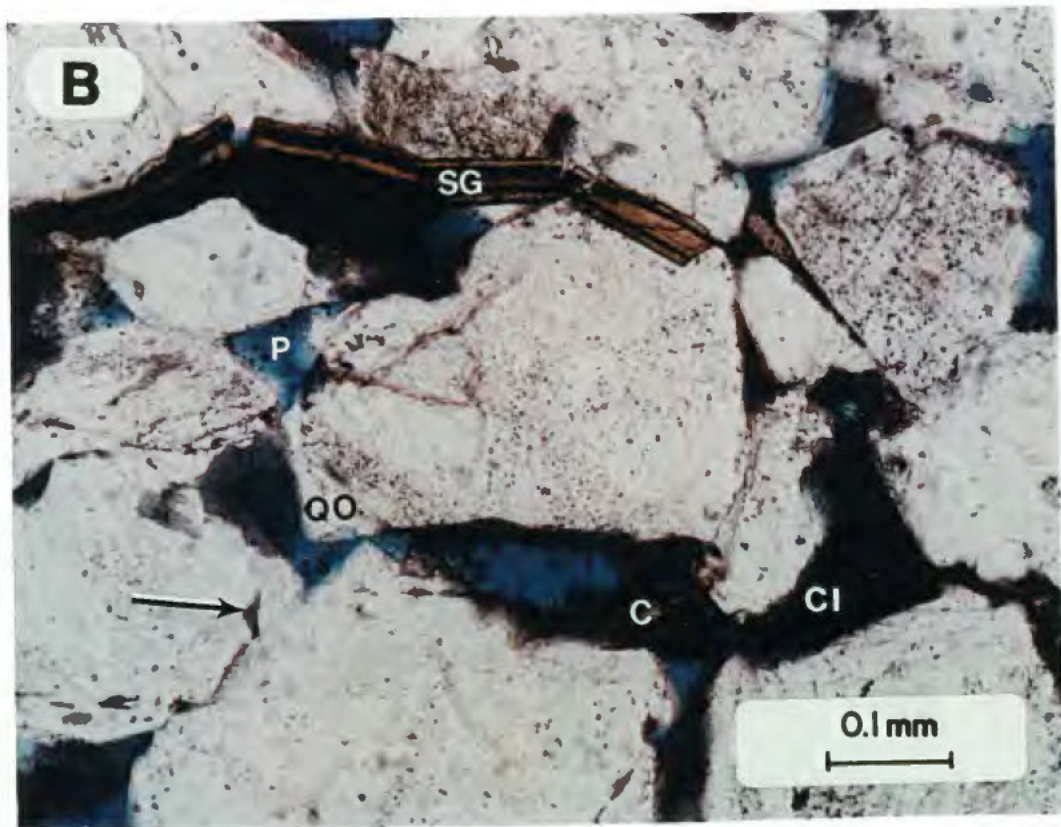
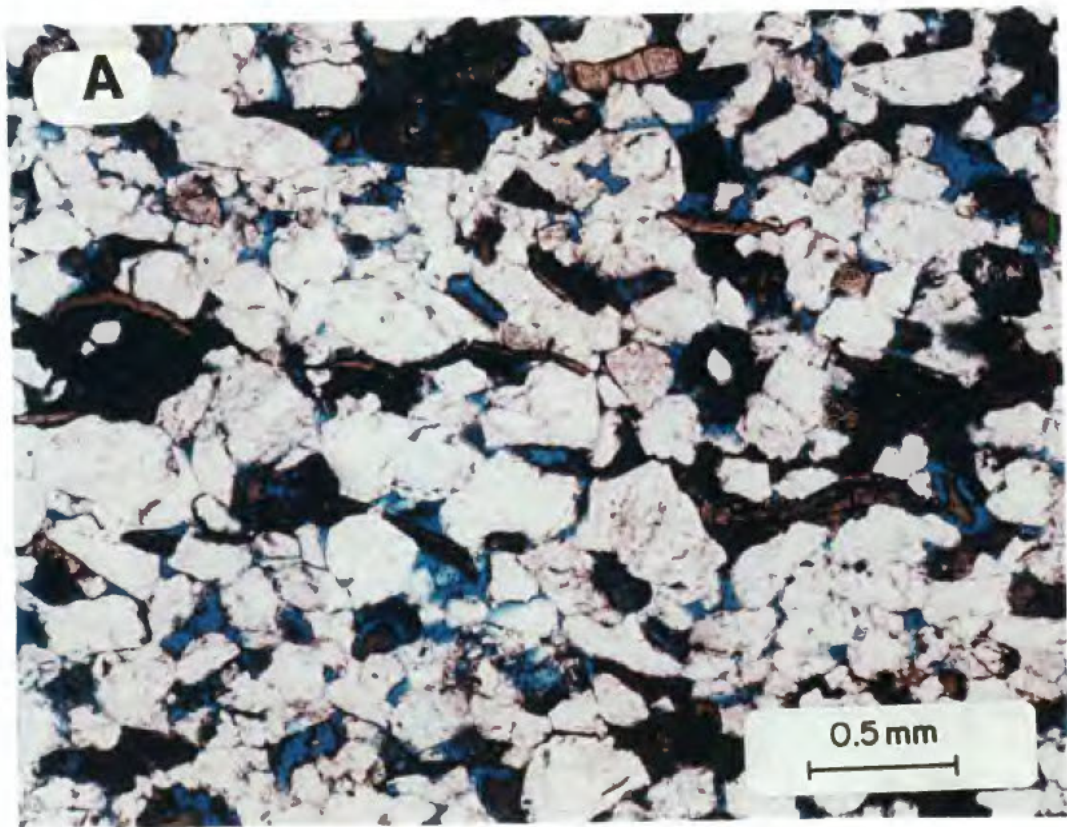


PLATE 18

SCANNING ELECTRON PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,052.6 Feet

WWRC#: 3 2 5 2 5 : 1 6 4

Ave. Grain Size = Lower Med. Sand (266 μ) Measured Porosity = 17.7%
Sorting = Well Measured Permeability = 19.0 md
Visible Porosity = 8% Grain Density = 2.67 g/cc

Abundant, well-developed quartz overgrowths (QO) have somewhat reduced macropores (P) and pore throats in this sandstone. However, development of the overgrowths on some grains appears to have been limited by the presence of grain-coating authigenic chlorite (Ch). The chlorite has a finely crystalline morphology, which may explain the nondescript appearance of the clay in the thin section photomicrographs (Plate 17).

A - 100X (First area)

B - 500X

C - 200X (Second area)

D - 1000X

X-RAY DIFFRACTION DATA

Whole Rock

Quartz - 92%
Plagioclase - 0%
Calcite - 5%
Dolomite - 1%
Siderite - 0%
Clay - 2%

Clay Mineralogy

Chlorite - 60%
Illite - 32%
Kaolinite - 0%
Mixed-Layer Illite/Smectite - 8%

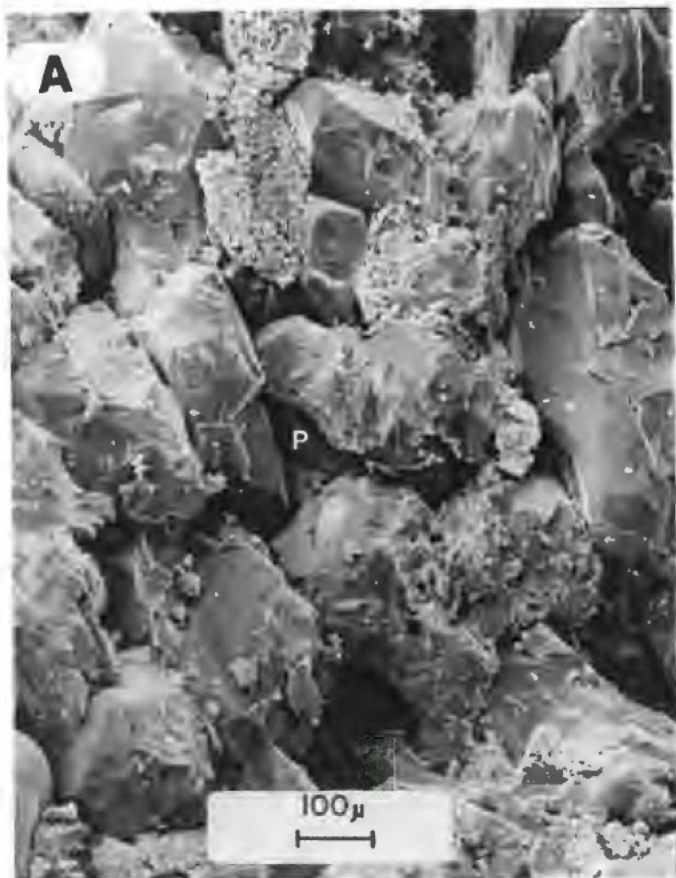


PLATE 19

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,055.4 Feet

WWRC#: 4 2 5 1 5 : 1 6 4

Ave. Grain Size = <u>Lower Fine Sand (160 μ)</u>	Measured Porosity = <u>17.2%</u>
Sorting = <u>Well</u>	Measured Permeability = <u>22.9 md</u>
Visible Porosity = <u>9%</u>	Grain Density = <u>2.67 g/cc</u>

This sample possesses the smallest average grain size of all the samples selected from the core and is composed predominantly of quartz, with lesser quantities of glauconite, skeletal grains, rock fragments and carbonate grains. The framework grains are cemented by authigenic quartz (arrows), which partially reduces intergranular pores (P) and attenuates pore throat apertures. Leaching of unstable framework grains has created some secondary porosity (Ps), which contributes to total pore volume and enhances permeability. Small quantities of calcite, dolomite, undifferentiated clay and chlorite are also present as pore-filling agents.

A - 40X

B - 160X

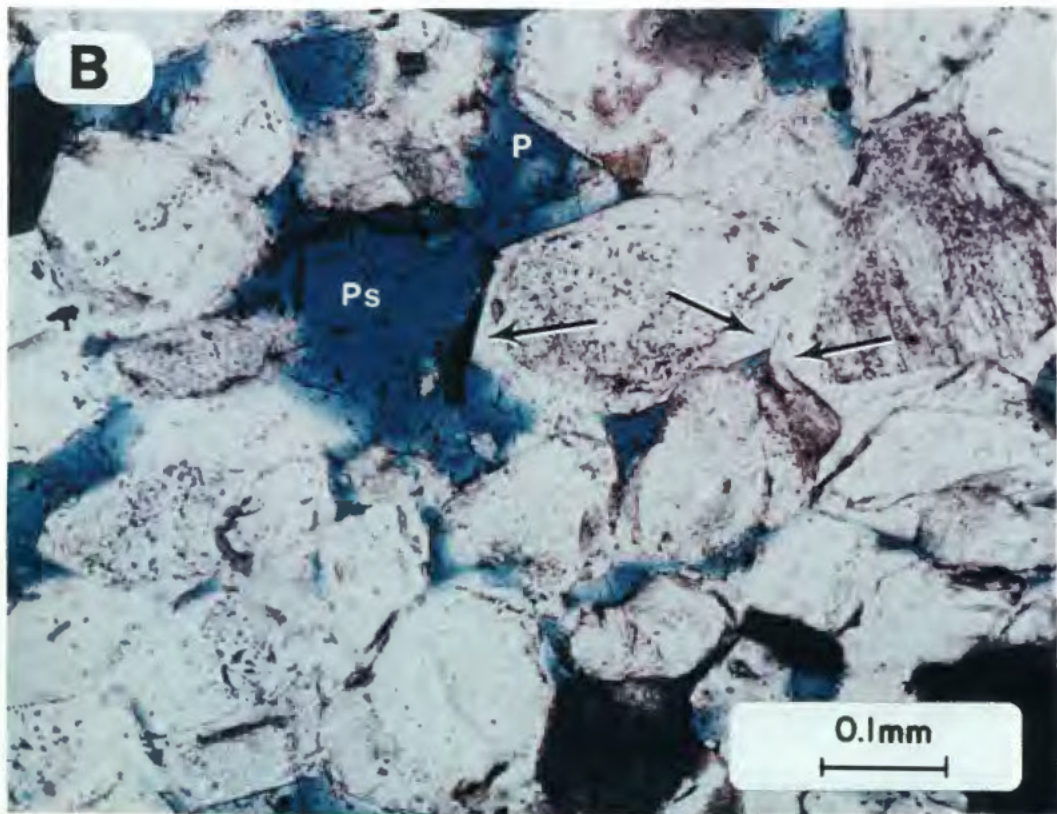
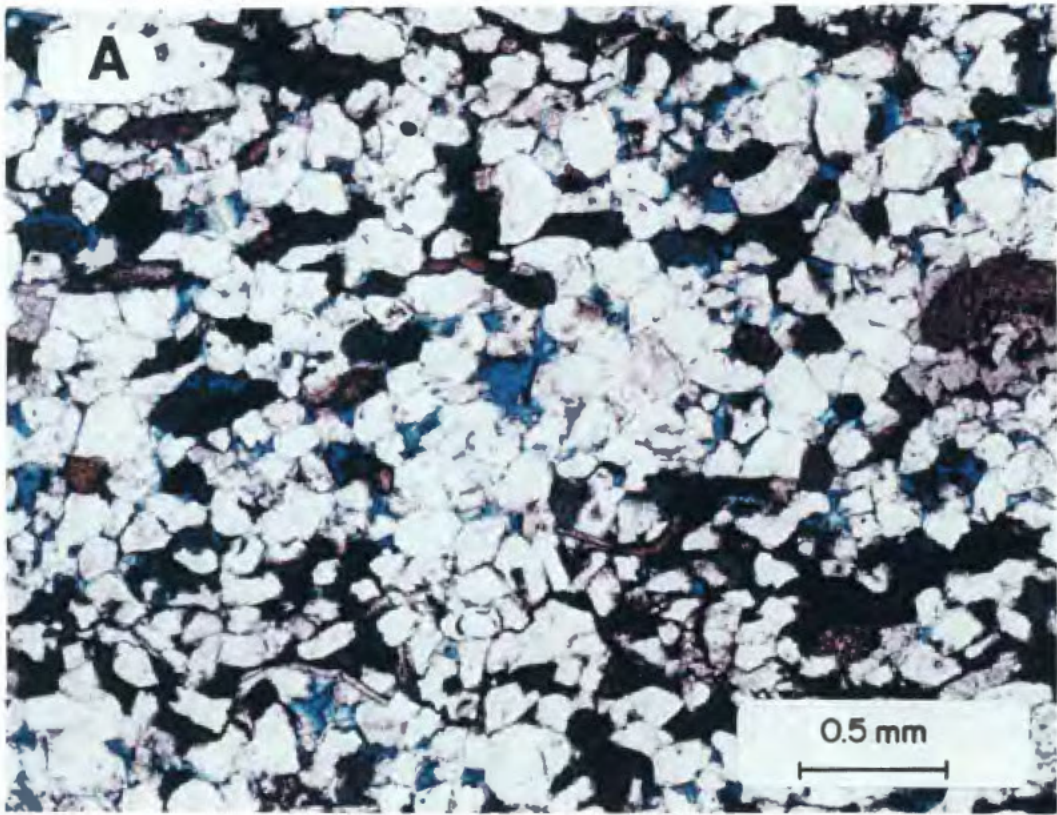


PLATE 20

WHOLE THIN SECTION PHOTOMICROGRAPH

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,065.5 Feet

WWRC#: 3 3 5 1 7 : 3 6 4

Ave. Grain Size = Lower Med. Sand (324 μ) **Measured Porosity = 8.2%
Sorting = Moderate **Measured Permeability = 0.053 md**
Visible Porosity = 2% **Grain Density = 2.7 g/cc****

This is a weakly compacted, calcite-cemented sandstone. Several bitumen(?) -lined stylolites extend from the lower left to upper right and indicate post-cementation compaction. The moldic pores are unevenly distributed and are more abundant in quartz-rich areas. Many of the leached-grain pores are derived from glauconite and feldspars. Notch in bar along lower edge is 1 mm.

10X

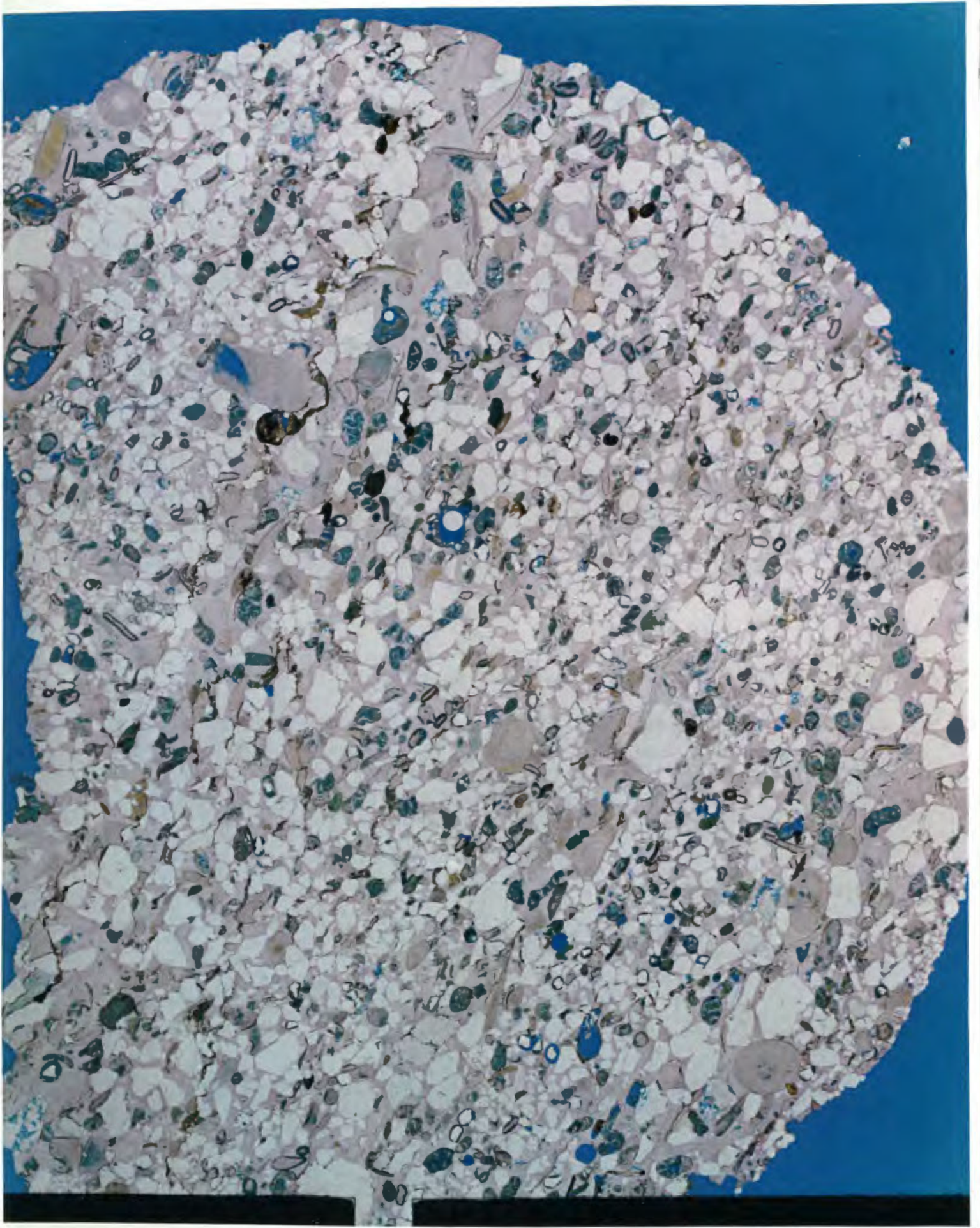


PLATE 21

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,065.5 Feet

WWRC#: 3 3 5 1 7 : 3 6 4

Ave. Grain Size = <u>Lower Med. Sand (324 μ)</u>	Measured Porosity = <u>8.2%</u>
Sorting = <u>Moderate</u>	Measured Permeability = <u>0.053 md</u>
Visible Porosity = <u>2%</u>	Grain Density = <u>2.7 g/cc</u>

Quartz and skeletal grains are the most common framework constituents in this moderately sorted sandstone. The skeletal grains include echinoid fragments and the fusulinid *Millerella* (F). Dolomite (D) appears to have replaced several large framework grains in the upper left corner of view A. Note the absence of quartz overgrowths. This suggests that calcite cementation preceded quartz cementation. In addition to moldic pores (arrow) and secondary porosity within leached feldspar grains (LF), minor amounts of secondary porosity have also developed from the dissolution of the clay coatings around many clay-coated grains (CG).

A - 40X

B - 160X

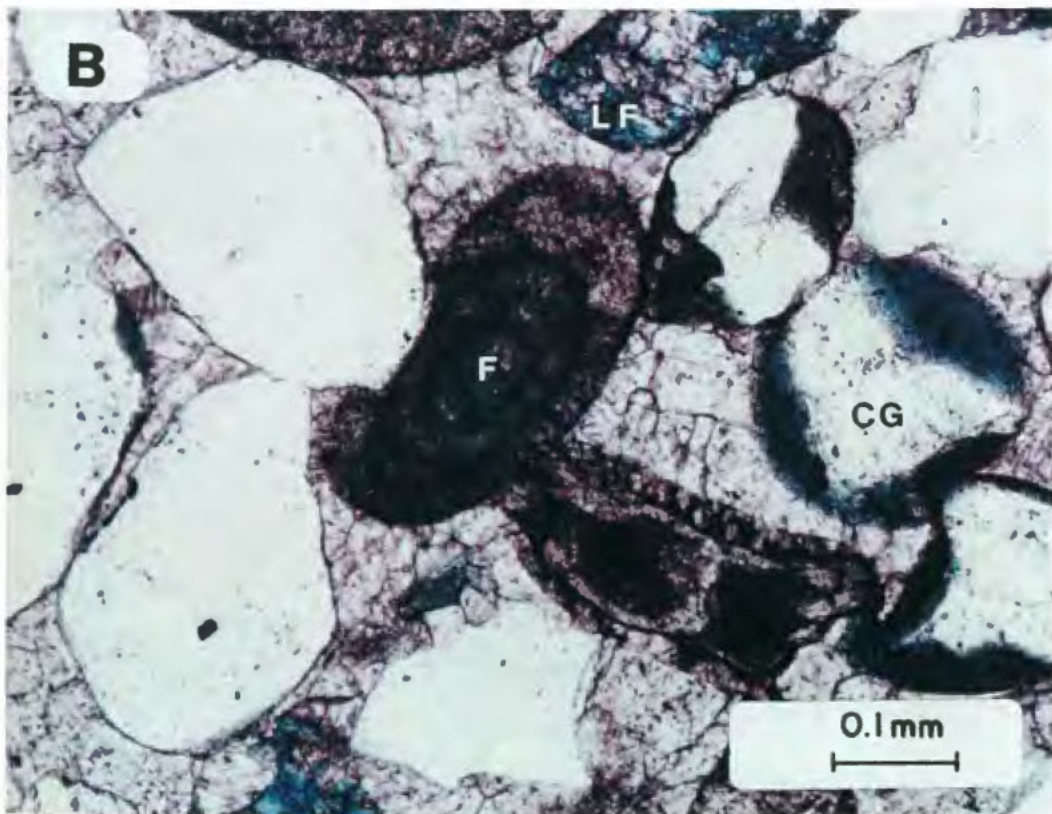
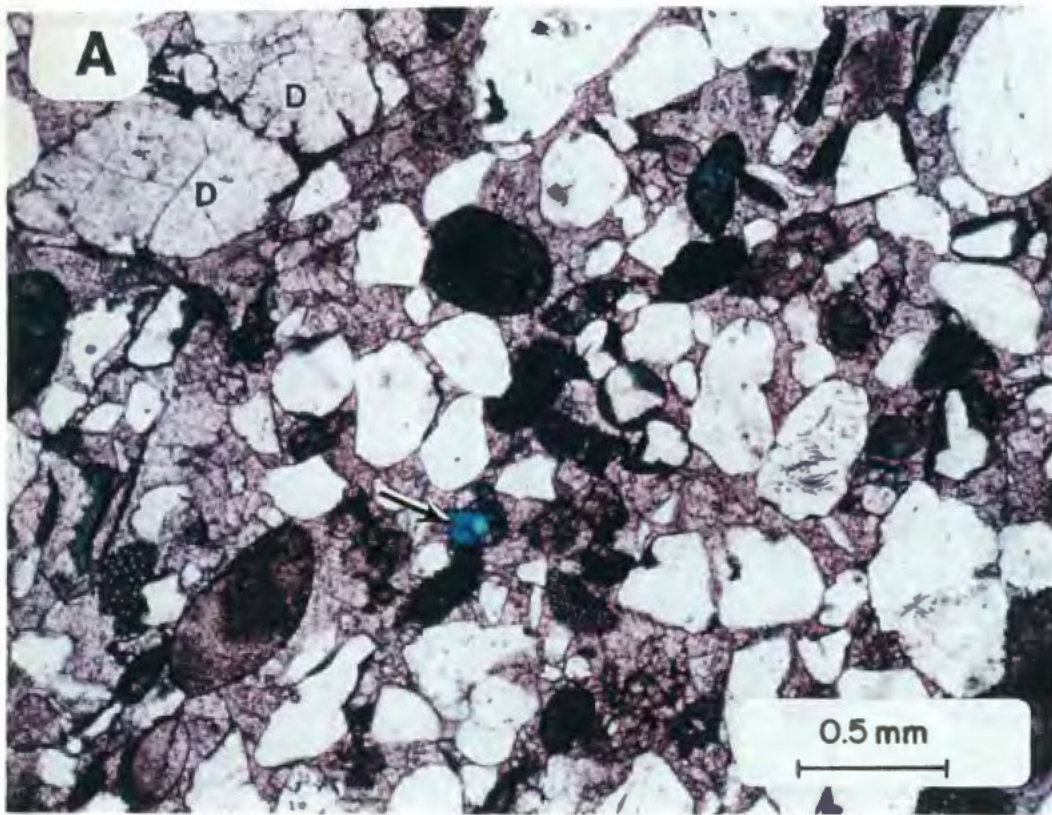


PLATE 22

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,073.5 Feet

WWRC#: 4 4 5 1 7 : 3 4 X

Ave. Grain Size = <u>Upper Fine Sand (198 μ)</u>	Measured Porosity = <u>7.1%</u>
Sorting = <u>Poor</u>	Measured Permeability = <u>0.093 md</u>
Visible Porosity = <u>2%</u>	Grain Density = <u>2.71 g/cc</u>

The most common framework grains in this sample are quartz and skeletal grains. The grains are poorly sorted with approximately 3 to 4 size classes represented in the sample. Much of the fossil debris appears to be echinoid fragments (E), and phosphatic grains or phosphate-replaced grains are present. Intergranular areas are filled with calcite cement. Visible pore space (blue) consists of isolated moldic pores (Pm) and leached-grain secondary pores. Also note the large pore space around the coated grain (CG) which has resulted from removal of the grain coat.

A - 20X

B - 40X

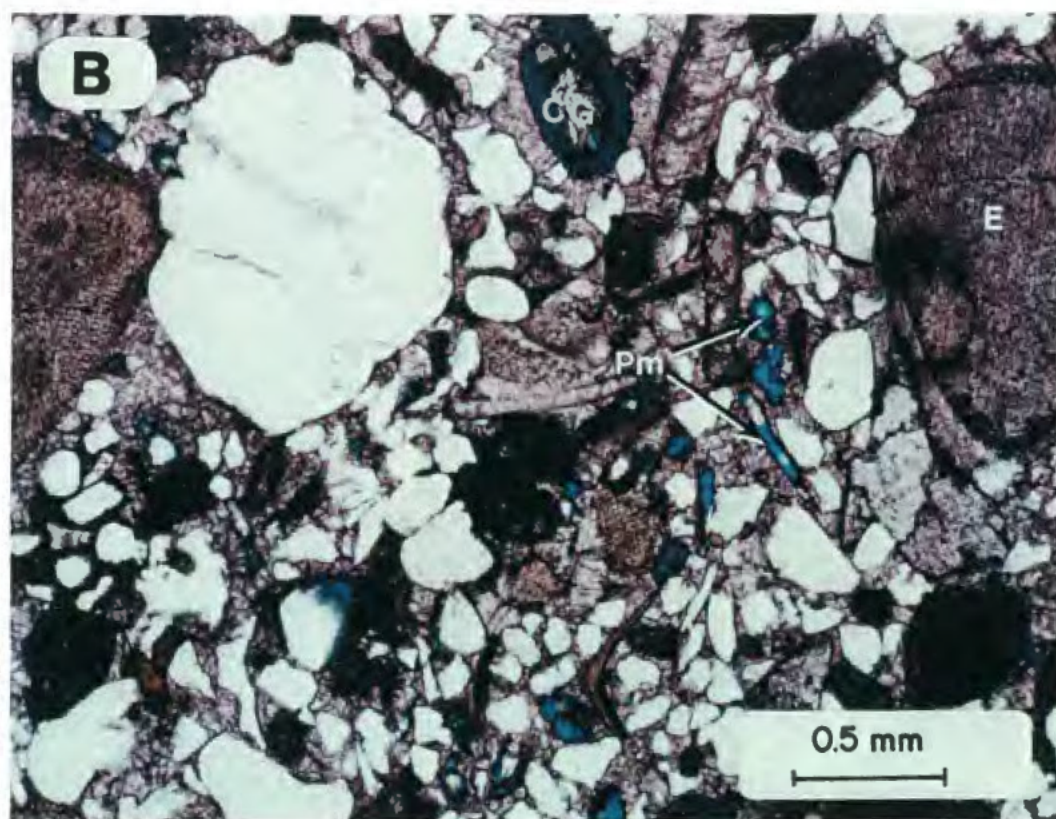
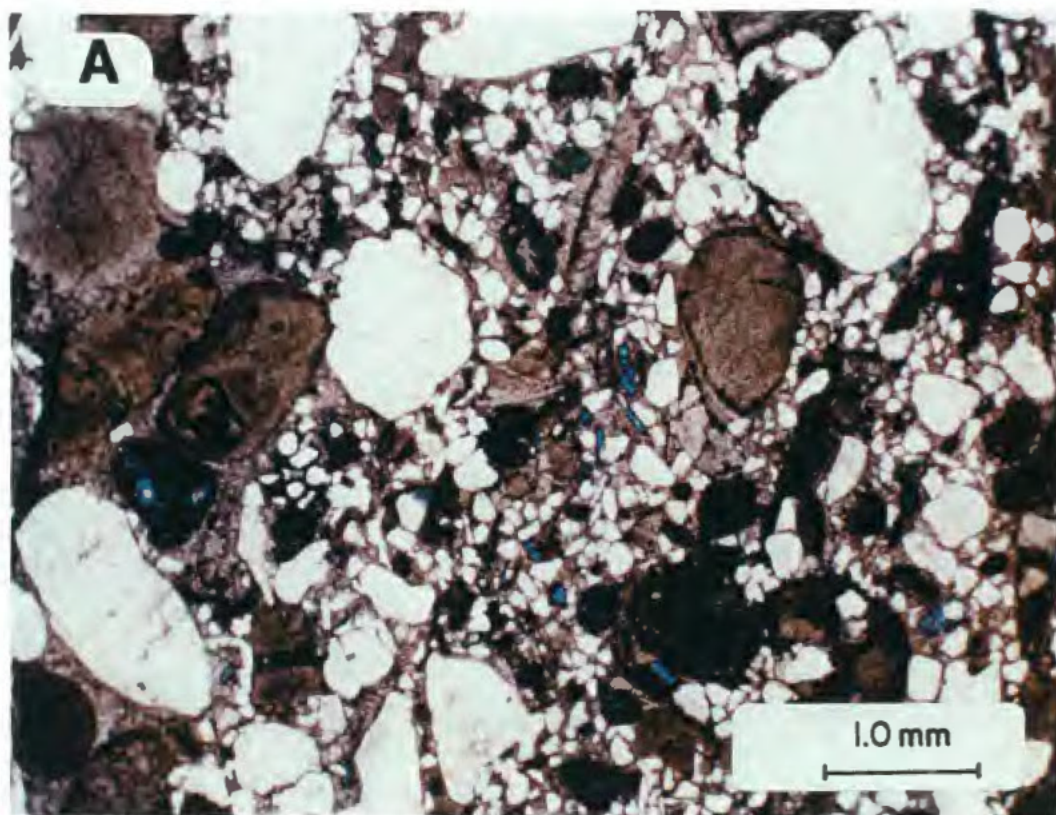


PLATE 23

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,076.6 Feet

WWRC#: 4 3 5 2 5 : 1 4 6

Ave. Grain Size = Lower Fine Sand (166 μ) Measured Porosity = 15.9%
Sorting = Moderate Measured Permeability = 4.07 md
Visible Porosity = 7% Grain Density = 2.67 g/cc

The framework grains in this sample are predominantly quartz with lesser amounts of skeletal grains, rock fragments and glauconite. In addition, accessory amounts of mica and phosphatic grains are also present. Authigenic quartz is the most common cementing agent (arrow), along with small quantities of dolomite, clay and calcite. Visible pore space (blue) consists of intergranular pores (P) and numerous secondary pores (Ps) after the dissolution of unstable siliciclastic framework grains. Glauconite (Gi) occurs as both a framework grain and a cavity-fill within, or partially replacing, fossils such as such as this brachiopod (Br) fragment.

A - 40X

B - 160X

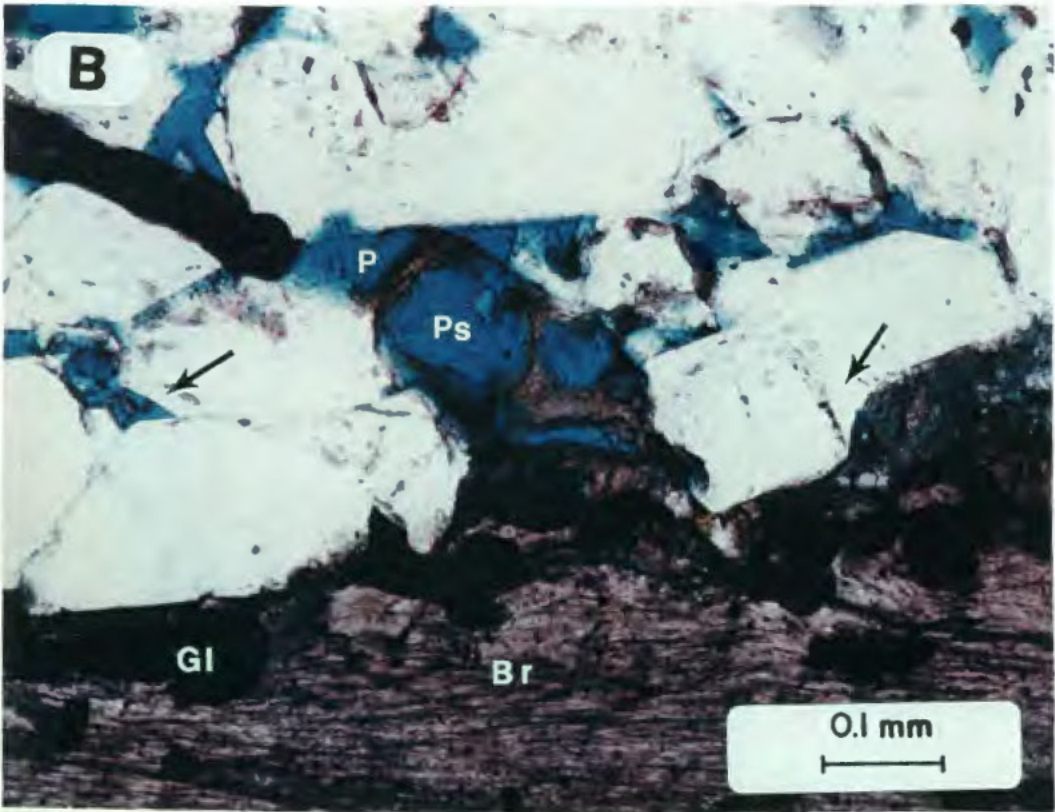
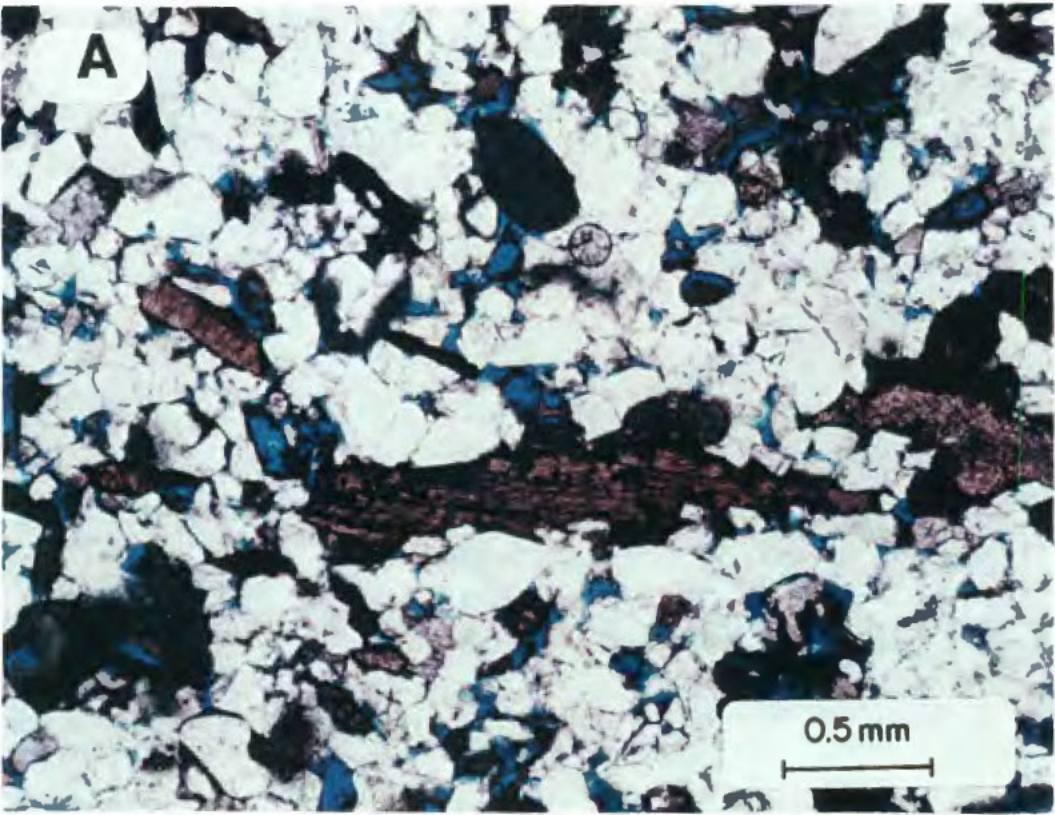


PLATE 24

SCANNING ELECTRON PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,076.6 Feet

WWRC#: 4 3 5 2 5 : 1 4 6

Ave. Grain Size = Lower Fine Sand (166 μ) Measured Porosity = 15.9%
Sorting = Moderate Measured Permeability = 4.07 md
Visible Porosity = 7% Grain Density = 2.67 g/cc

Quartz overgrowths (QO) are variably developed in this sample. Where present, authigenic grain-coating chlorite (Ch) excludes or inhibits the development of authigenic quartz (views B and D). A clay-rich rock fragment (RF) appears to be replaced by chlorite and also possesses a finer crystalline chlorite grain coat (Ch). Macropores (P) are often isolated by the authigenic quartz, and pore throat apertures have been reduced by the clay.

A - 100X (First area)

B - 500X

C - 200X (Second area)

D - 1000X

X-RAY DIFFRACTION DATA

Whole Rock

Quartz - 85%
Plagioclase - 0%
Calcite - 8%
Dolomite - 3%
Siderite - 0%
Clay - 4%

Clay Mineralogy

Chlorite - 76%
Illite - 13%
Kaolinite - 0%
Mixed-Layer Illite/Smectite - 11%

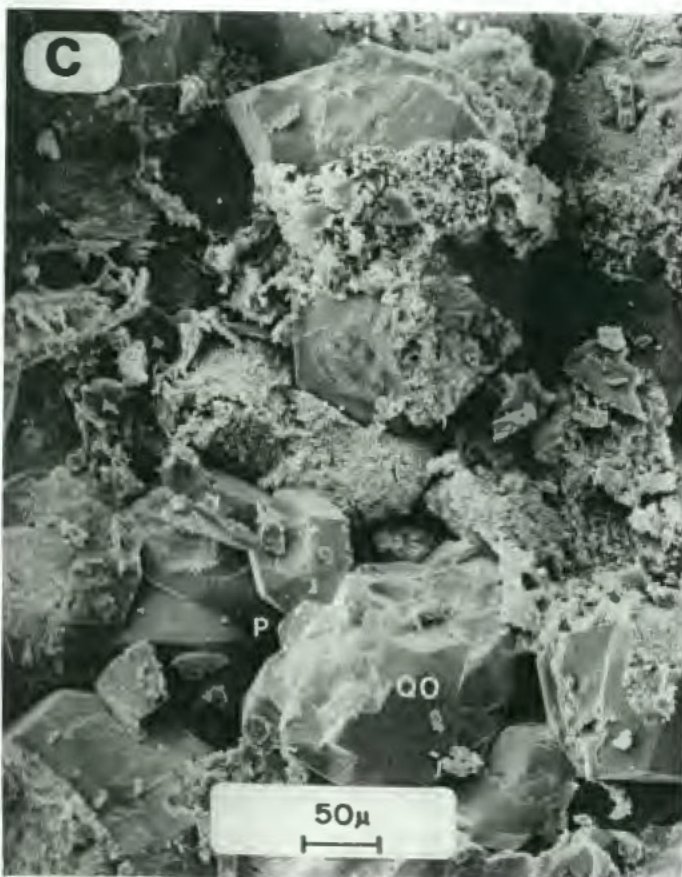


PLATE 25

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,081.7 Feet

WWRC#: 3 4 5 1 7 : 3 4 X

Ave. Grain Size = Upper Med. Sand (378 μ)

Sorting = Poor

Visible Porosity = 2%

Measured Porosity = 7.7%

Measured Permeability = 0.024 md

Grain Density = 2.70 g/cc

This poorly sorted sandstone is composed predominantly of quartz and skeletal grains. In addition, there are lesser quantities of rock fragments, clay-coated grains and glauconite. Abundant calcite cement fills all interstitial areas and isolates moldic and secondary pores within leached rock fragments (LRF). Clay rinds on many clay-coated grains have also been partially to completely leached.

A - 20X

B - 40X

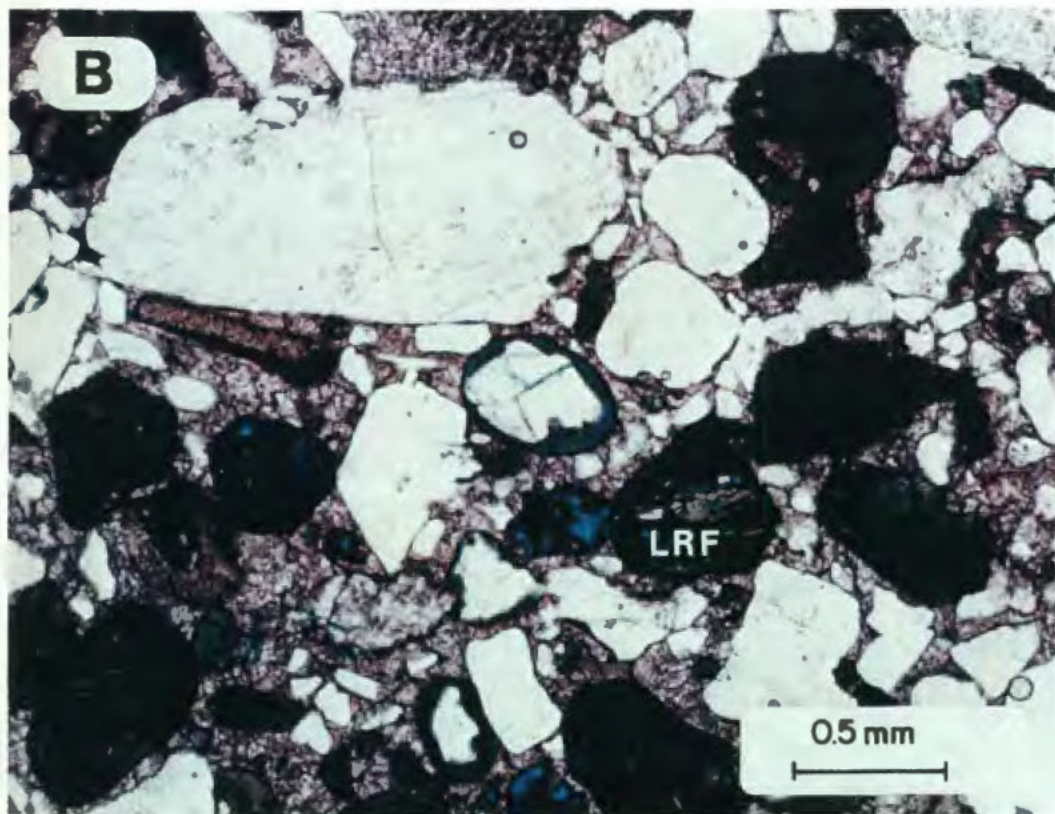
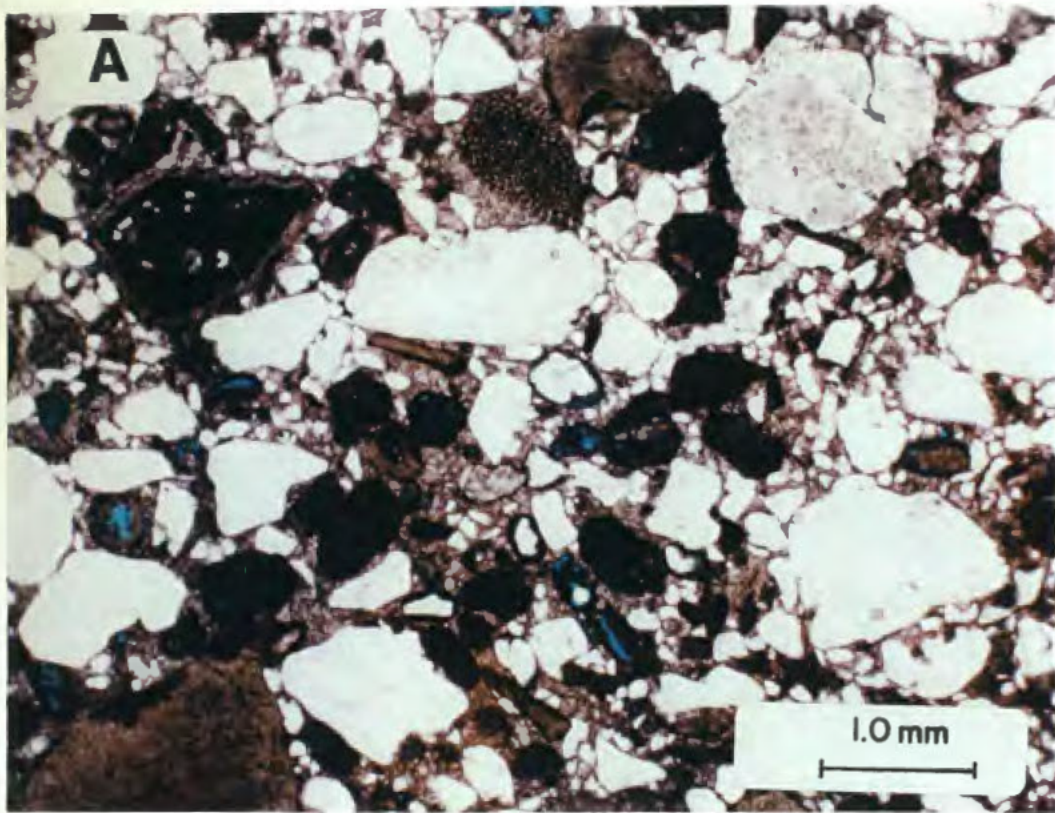


PLATE 26

WHOLE THIN SECTION PHOTOMICROGRAPH ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,085.5 Feet

WWRC#: 2 3 5 1 7 : 3 6 X

Ave. Grain Size = Lower Coarse Sand (530 μ) Measured Porosity = 7.3%
Sorting = Moderate Measured Permeability = 0.113 md
Visible Porosity = 4% Grain Density = 2.70 g/cc

Two, large phosphatic rock fragments are highlighted in this photomicrograph. The fragments appear to be partially leached, and traces of blue-dyed epoxy within the grains indicate the presence of microporosity. Other brown grains in the sample are also phosphatic. Several rounded, silty, phosphate grains, such as that in the upper left, may be altered fecal pellets. Isolated moldic pores are common and have probably resulted from the complete removal of skeletal grains and/or rock fragments. Notch in bar along lower edge is 1 mm.

10X

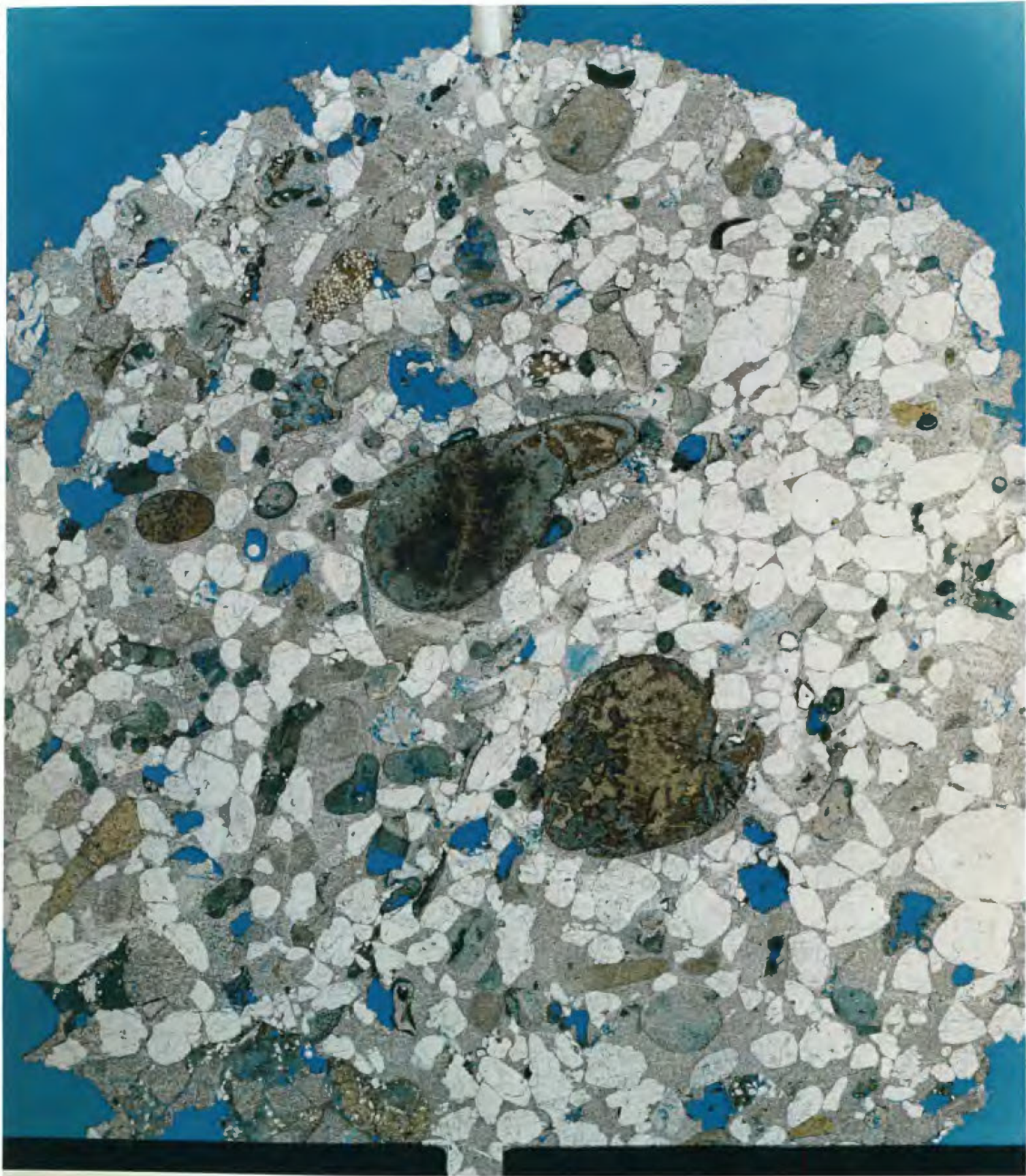


PLATE 27

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,085.5 Feet

WWRC#: 2 3 5 1 7 : 3 6 X

Ave. Grain Size = Lower Coarse Sand (530 μ) Measured Porosity = 7.3%
Sorting = Moderate Measured Permeability = 0.113 md
Visible Porosity = 4% Grain Density = 2.70 g/cc

Large, moldic pores (Pm) are common, but isolated by abundant poikilotopic calcite cement (pink). The framework grains are mostly quartz and skeletal grains. The phosphatic grain (PG) in view A is one of the grains highlighted in Plate 26. Echinoid debris (E) is the most common type of skeletal grain. In addition to the moldic pores, most plagioclase grains have been partially leached (LF), creating some secondary porosity.

A - 20X

B - 40X

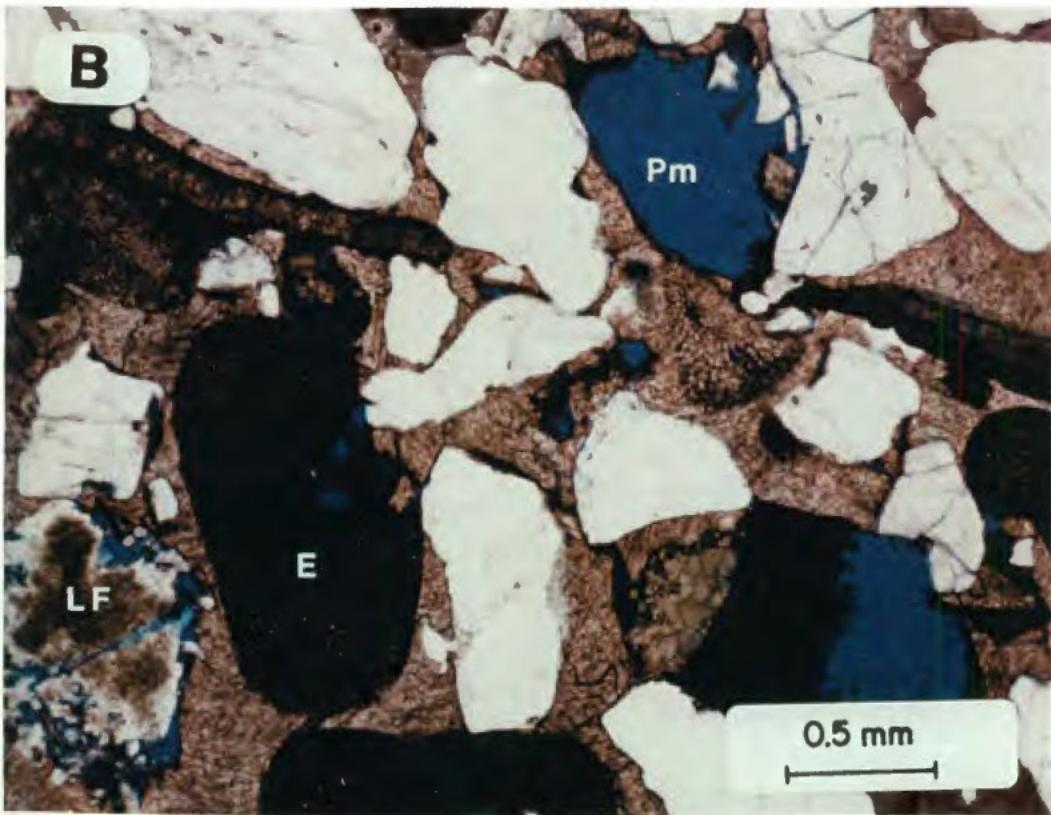
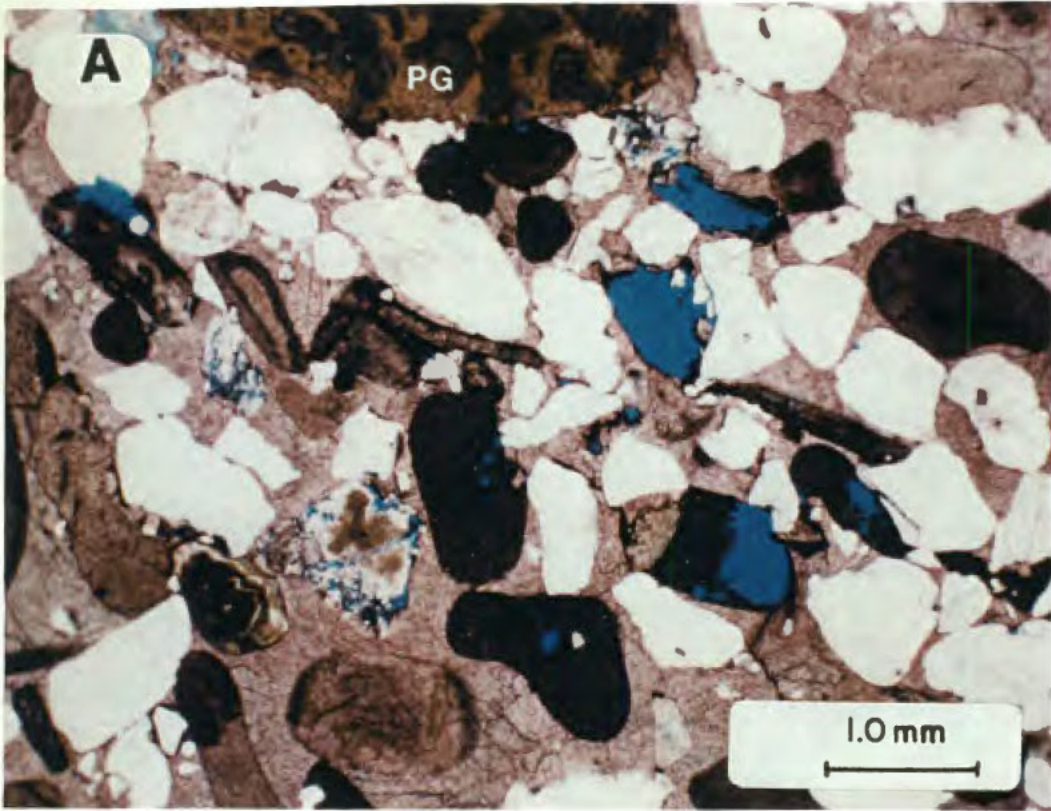


PLATE 28

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,096.5 Feet

WWRC#: 3 2 5 1 6 : 1 3 4

Ave. Grain Size = Lower Med. Sand (336 μ) Measured Porosity = 10.2%
Sorting = Well Measured Permeability = 0.069 md
Visible Porosity = 2% Grain Density = 2.69 g/cc

Quartz is the most common framework grain type in this well sorted sandstone, along with smaller quantities of glauconite and rock fragments. Authigenic quartz, calcite and dolomite are present as cementing agents. Euhedral quartz overgrowths (Qo) are common on grain surfaces that are adjacent to open pores (view B), or where in contact with pore-filling dolomite (arrow) suggesting the dolomite post-dates the quartz overgrowths. By comparison, quartz overgrowths are poorly developed in areas with pore-filling calcite, indicating the calcite may predate the authigenic quartz. Also note the absence of dolomite (D) in the secondary porosity surrounding the remnant of a leached phosphate grain (PG), which may indicate dissolution of the grain occurred after precipitation of the dolomite. The skeletal grain (SG) appears to be a partially leached echinoid fragment.

A - 40X

B - 160X

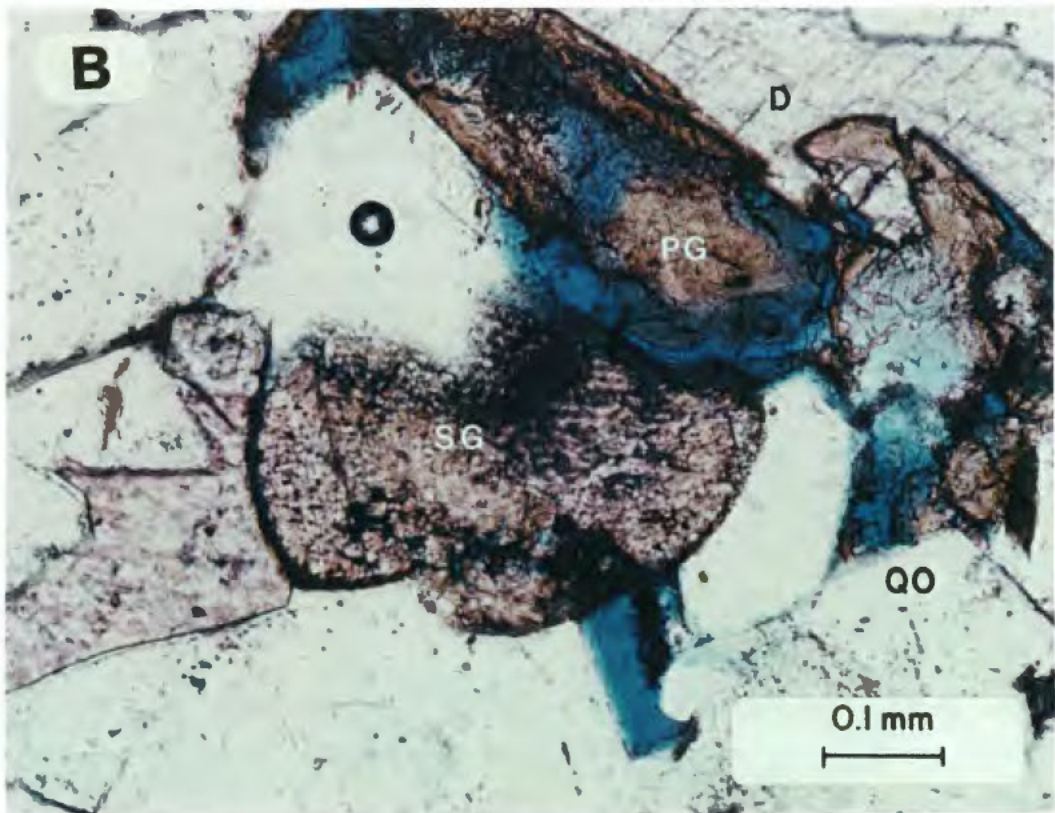
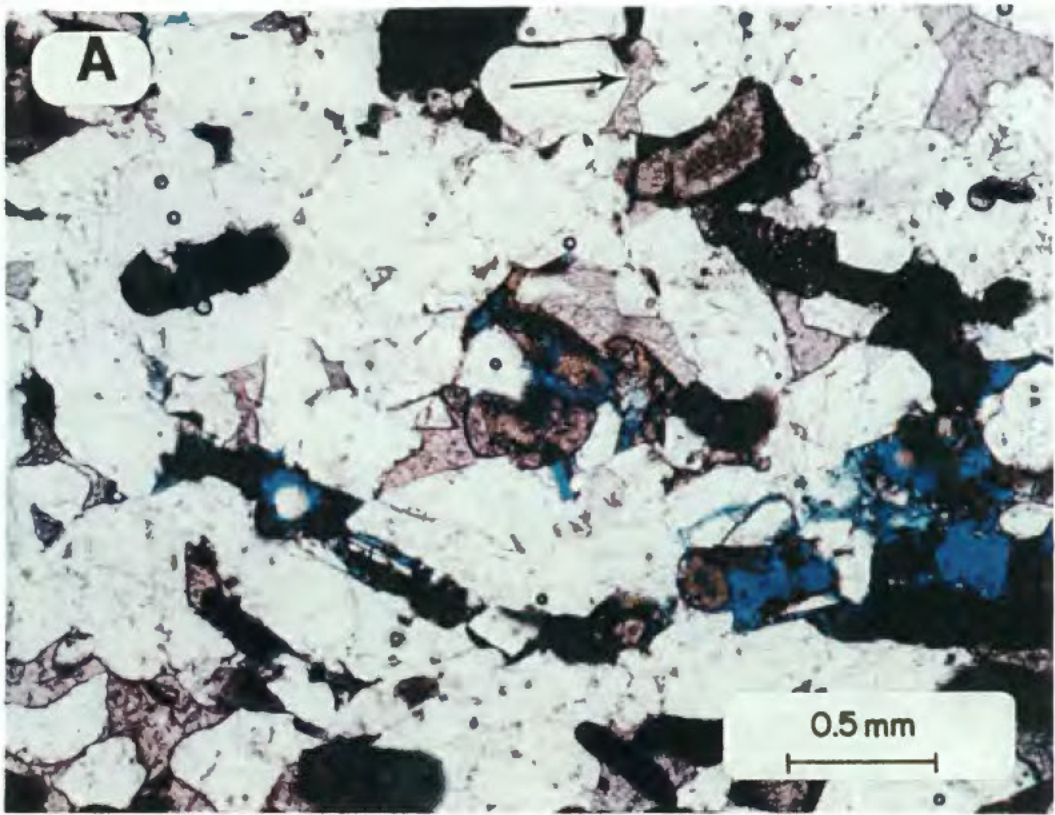


PLATE 29

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,097.8 Feet

WWRC#: 3 3 5 1 5 : 1 3 6

Ave. Grain Size = <u>Lower Med. Sand (288 μ)</u>	Measured Porosity = <u>15.6%</u>
Sorting = <u>Moderate</u>	Measured Permeability = <u>169 md</u>
Visible Porosity = <u>4%</u>	Grain Density = <u>2.66 g/cc</u>

The most permeable sample in the cored interval is a quartz-rich sandstone cemented by authigenic quartz. The visible pore space (blue) is composed of equal proportions of intergranular pores and secondary pores within leached framework grains (Ps). In addition to the authigenic quartz (QO), small quantities of chlorite(?) are present outlining partially leached-grains (view B) and lining some intergranular pores. Glauconite (Gl) is present and typically exhibits brown alteration rinds. A quartz grain in the upper left of view B may possess two generations of authigenic quartz. There is a thick first generation (1) overgrowth may be overlain by a much thinner second generation (2) overgrowth.

A - 40X

B - 160X

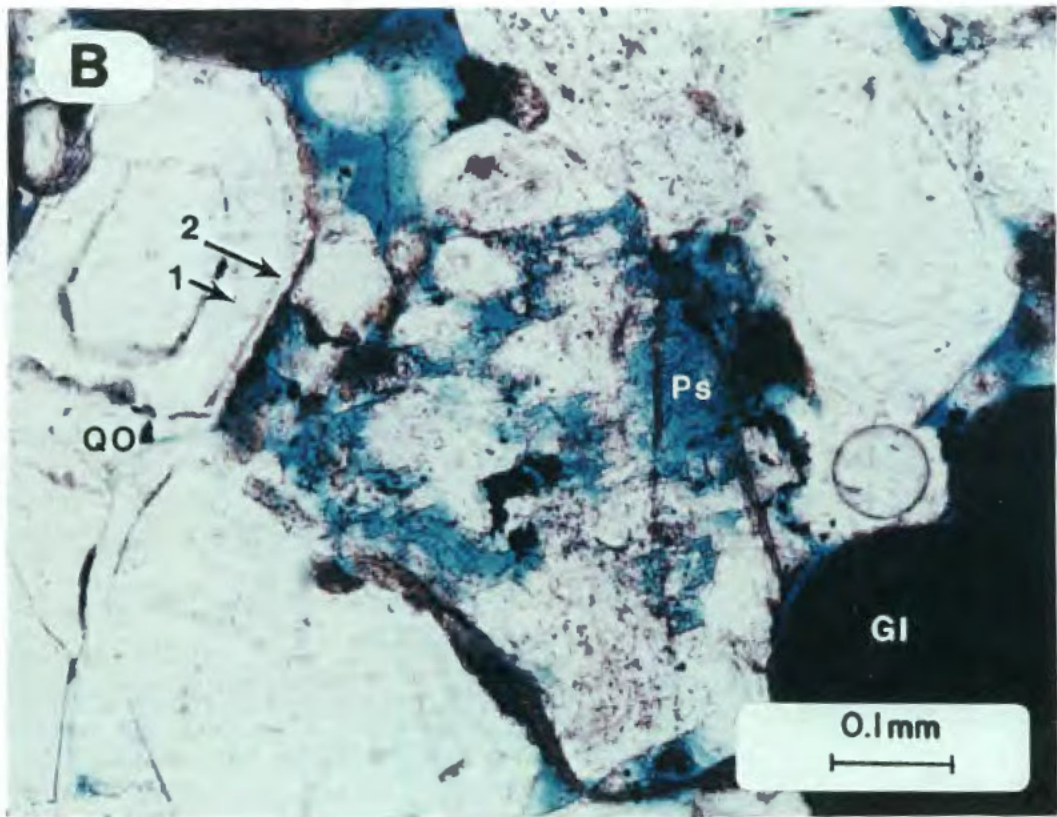
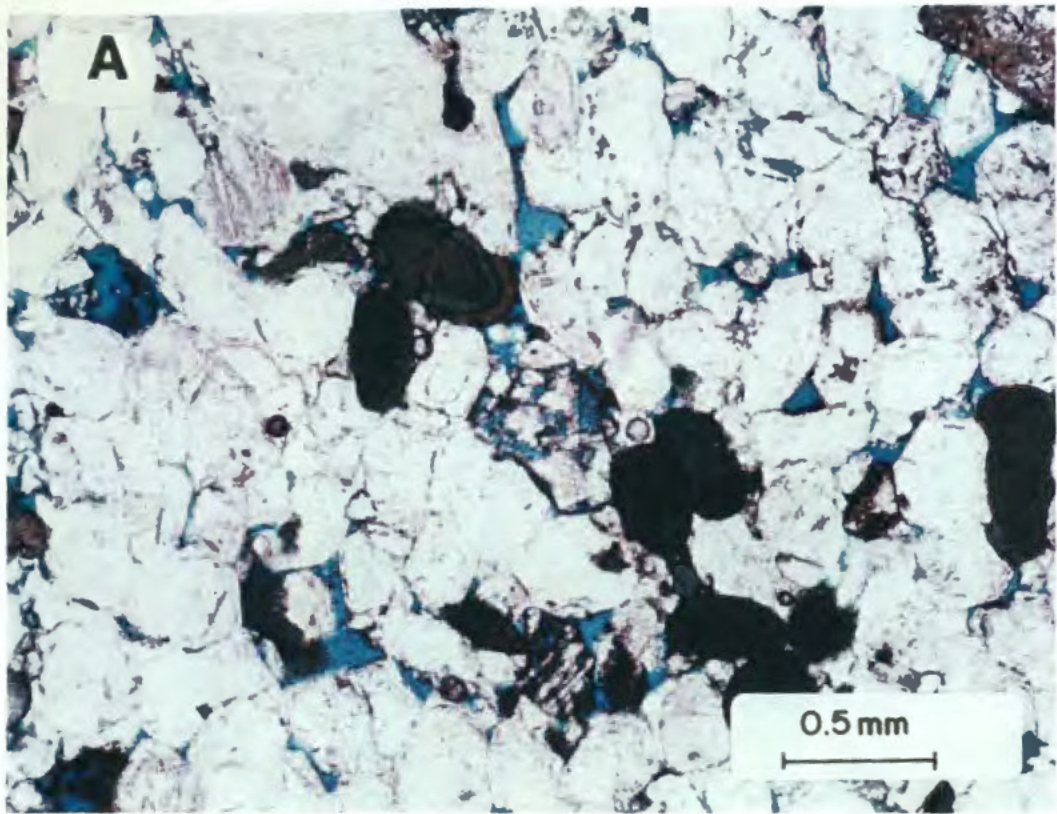


PLATE 30

SCANNING ELECTRON PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,097.8 Feet

WWRC#: 3 3 5 1 5 : 1 3 6

Ave. Grain Size = Lower Med. Sand (288 μ) Measured Porosity = 15.6%
Sorting = Moderate Measured Permeability = 169 md
Visible Porosity = 4% Grain Density = 2.66 g/cc

Macropores (P) are locally isolated by unevenly distributed quartz overgrowths (QO) in this sample. Many pore throats are also reduced or occluded by grain-coating authigenic chlorite (Ch). The overgrowths appear to overlie the chlorite, and view B shows a number of bitumen globules on the surface of an overgrowth. Some microporosity has developed within a leached rock fragment in the center of view C, and a close-up in view D suggests the remaining or replacing clay is illitic.

A - 100X (First area)

B - 500X

C - 100X (Second area)

D - 500X

X-RAY DIFFRACTION DATA

Whole Rock

Quartz - 94%
Plagioclase - 2%
Calcite - 0%
Dolomite - 0%
Siderite - 0%
Clay - 4%

Clay Mineralogy

Chlorite - 47%
Illite - 53%
Kaolinite - 0%
Mixed-Layer Illite/Smectite - 0%

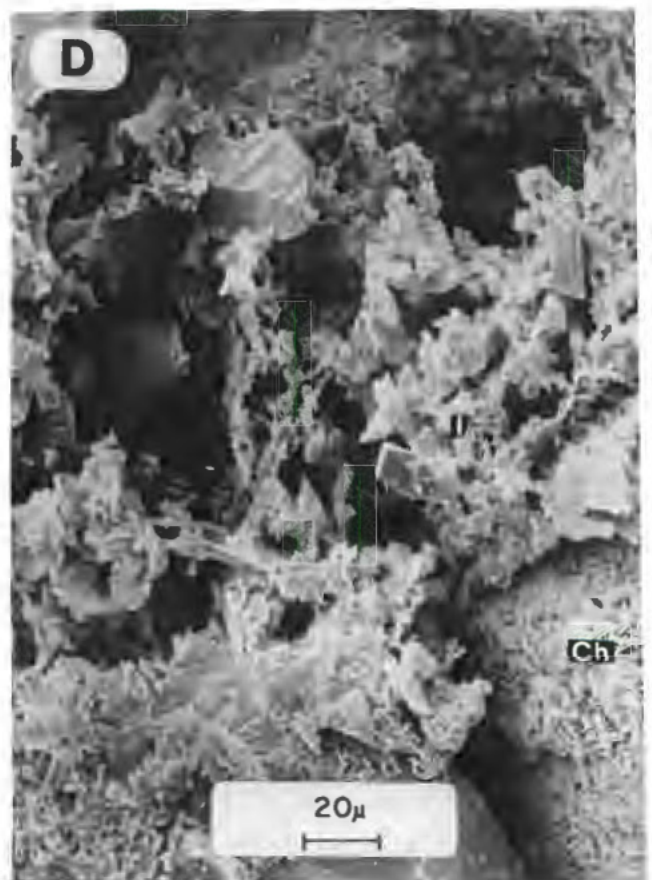
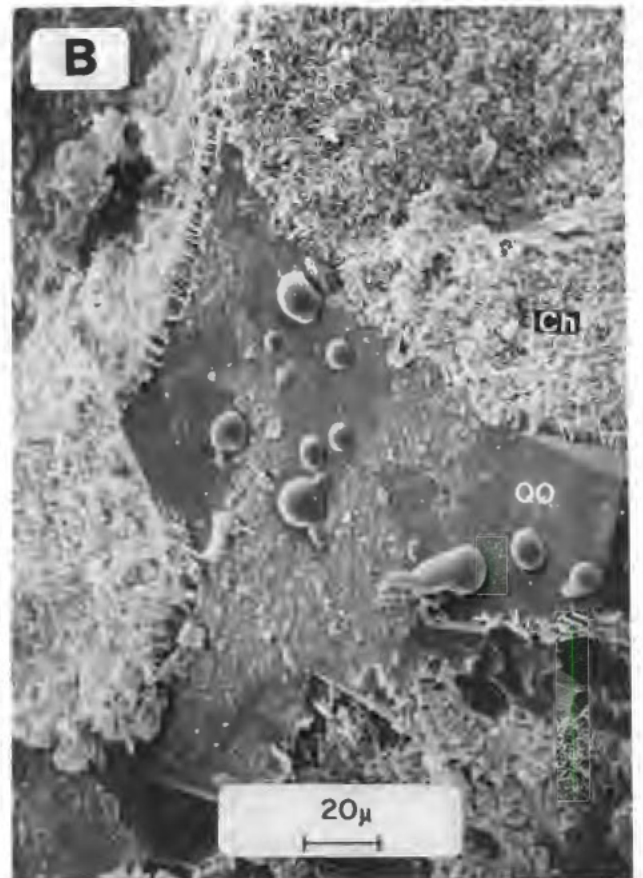
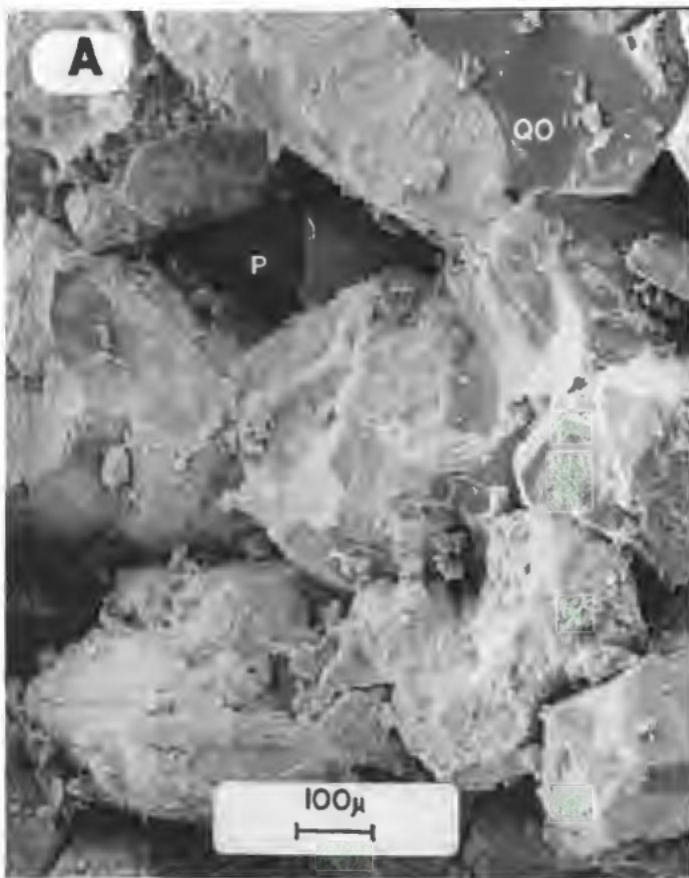


PLATE 31

THIN SECTION PHOTOMICROGRAPHS
ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,101.6 Feet

WWRC#: 3 2 5 1 6 : 4 1 X

Ave. Grain Size = <u>Lower Med. Sand (300 μ)</u>	Measured Porosity = <u>12.6%</u>
Sorting = <u>Well</u>	Measured Permeability = <u>66.2 md</u>
Visible Porosity = <u>9%</u>	Grain Density = <u>2.67 g/cc</u>

Equal quantities of authigenic quartz and dolomite act to cement well-sorted, medium sand sized grains of quartz, rock fragments and glauconite. Only trace quantities of skeletal grains are present. Note the absence of calcite cement. The authigenic quartz typically occurs as well developed quartz overgrowths (QO), which frequently reduce intergranular pores (P). The quartz overgrowths are usually euhedral where they are in contact with dolomite cement, suggesting the dolomite post-dates the quartz.

A - 40X

B - 160X

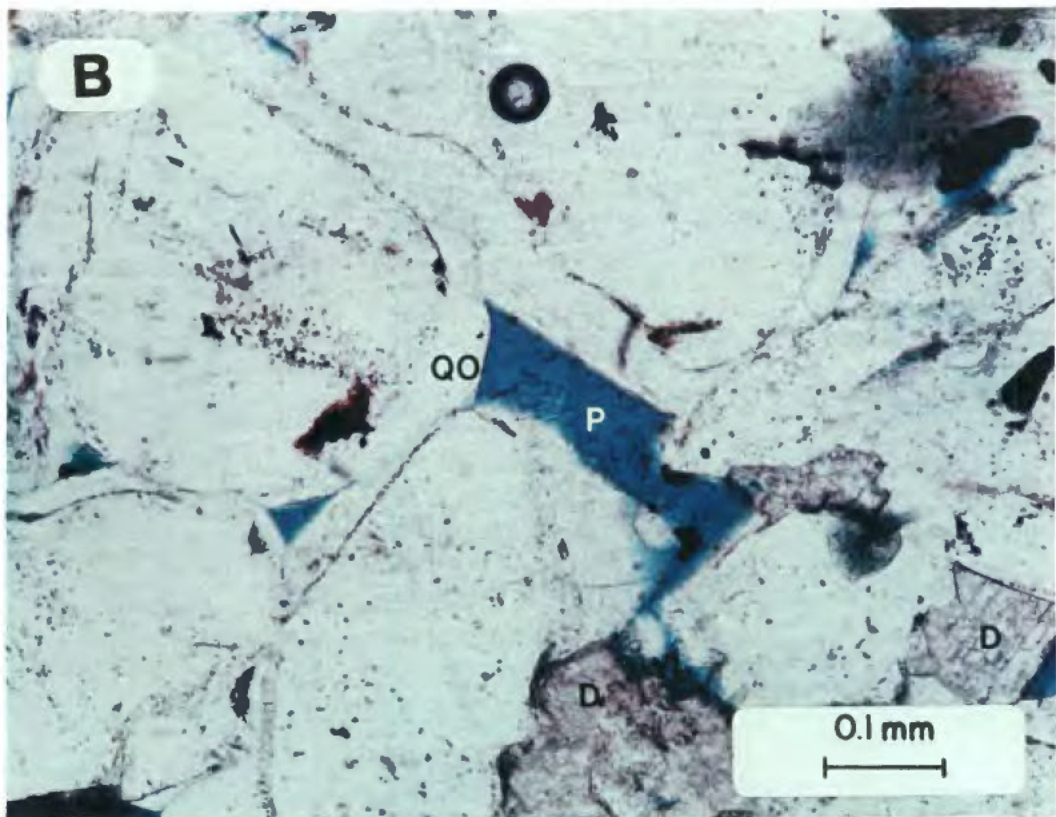
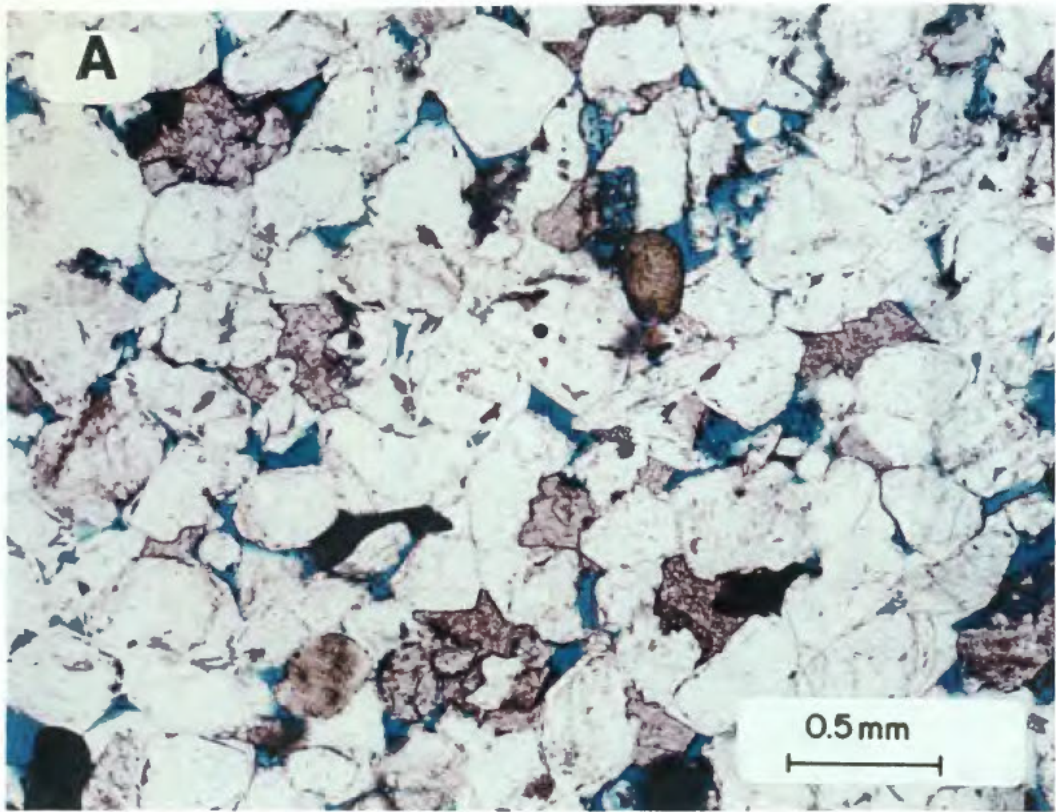


PLATE 32

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,102.4 Feet

WWRC#: 3 3 5 1 7 : 3 6 X

Ave. Grain Size = <u>Lower Med. Sand (296 μ)</u>	Measured Porosity = <u>7.4%</u>
Sorting = <u>Moderate</u>	Measured Permeability = <u>0.114 md</u>
Visible Porosity = <u>2%</u>	Grain Density = <u>2.67 g/cc</u>

Abundant poikilopic calcite acts to cement framework grains composed predominantly of quartz with lesser quantities of glauconite and rock fragments. The calcite occupies all interstitial areas and in some places has partially replaced quartz grains (arrow). Isolated moldic pores (Pm) and leached-grain secondary pores are the dominant pore types noted.

A - 40X

B - 160X

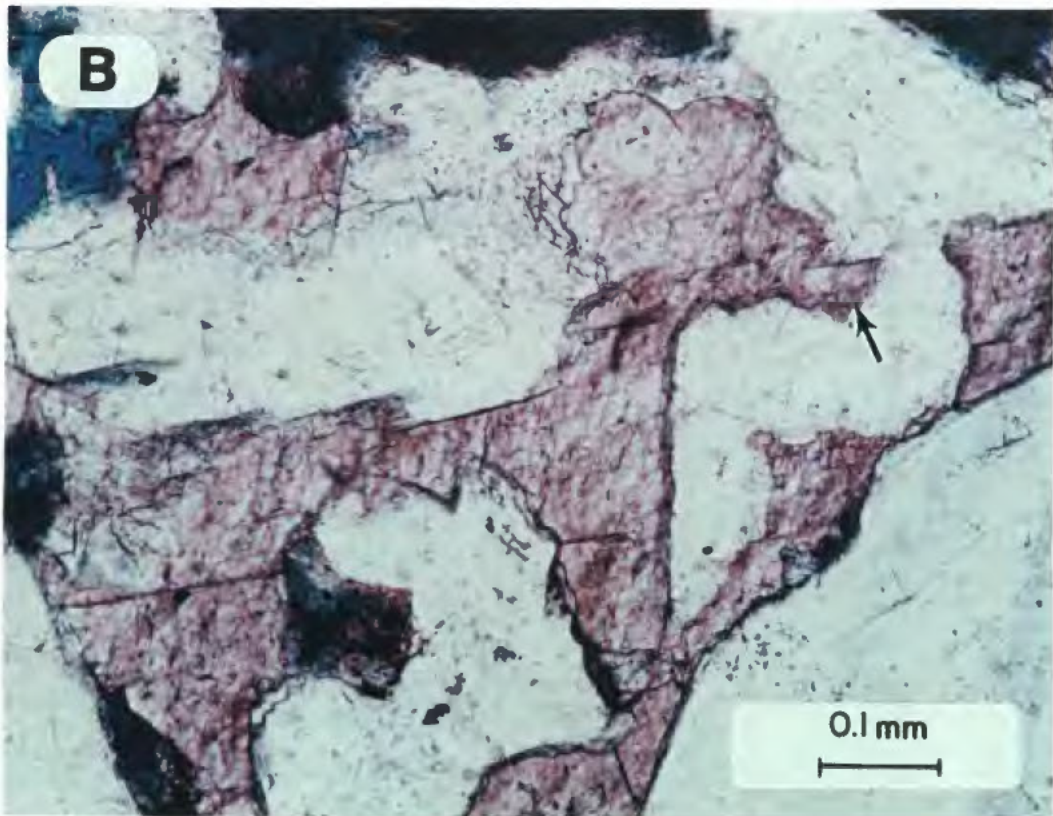
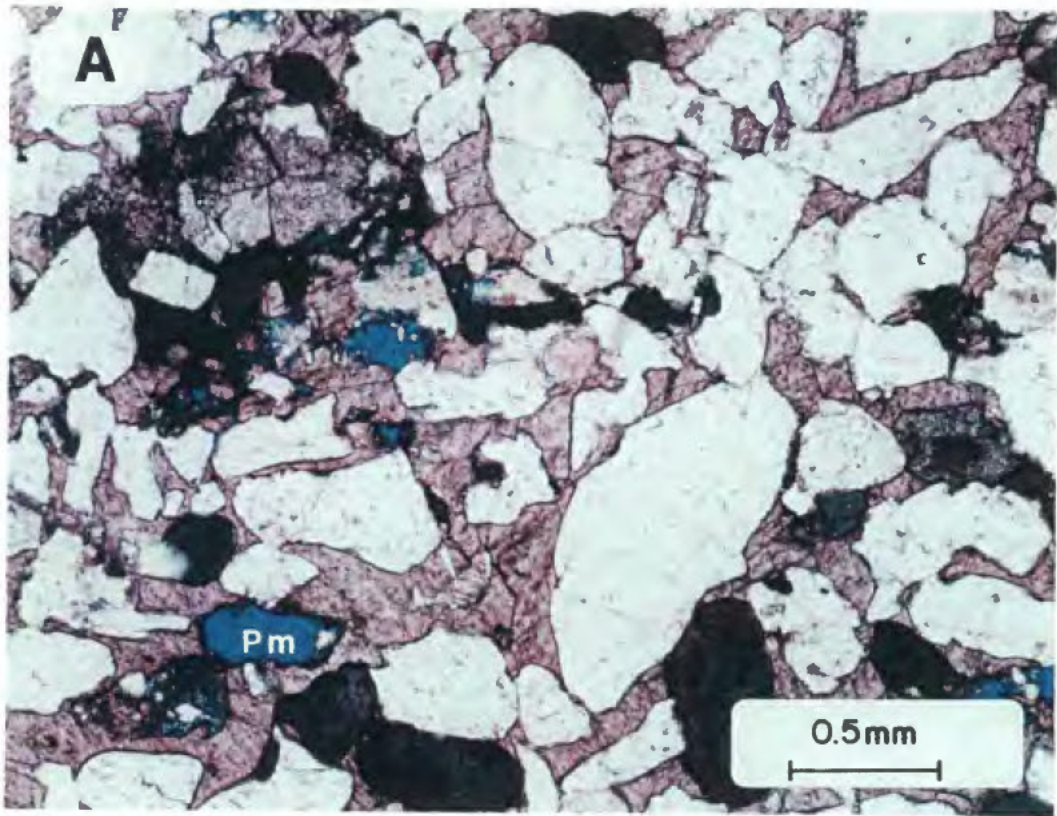


PLATE 33

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,103.4 Feet

WWRC#: 3 2 5 2 6 : 1 4 6

Ave. Grain Size = Lower Med. Sand (298 μ) Measured Porosity = 12.6%
Sorting = Well Measured Permeability = 55.5 md
Visible Porosity = 4% Grain Density = 2.67 g/cc

Well-sorted, medium sand sized grains of quartz, glauconite and rock fragments are cemented by quartz overgrowths, dolomite and clay in this sample. The dolomite (D) cement appears to post-date quartz overgrowths and is frequently in contact with euhedral overgrowth terminations (arrow). Glauconite (Gl) is common and typically exhibits brown alteration rinds. Visible pore space (blue) is composed of equal proportions of reduced intergranular pores (P) and secondary pores within leached rock fragments (LRF).

A - 40X

B - 160X

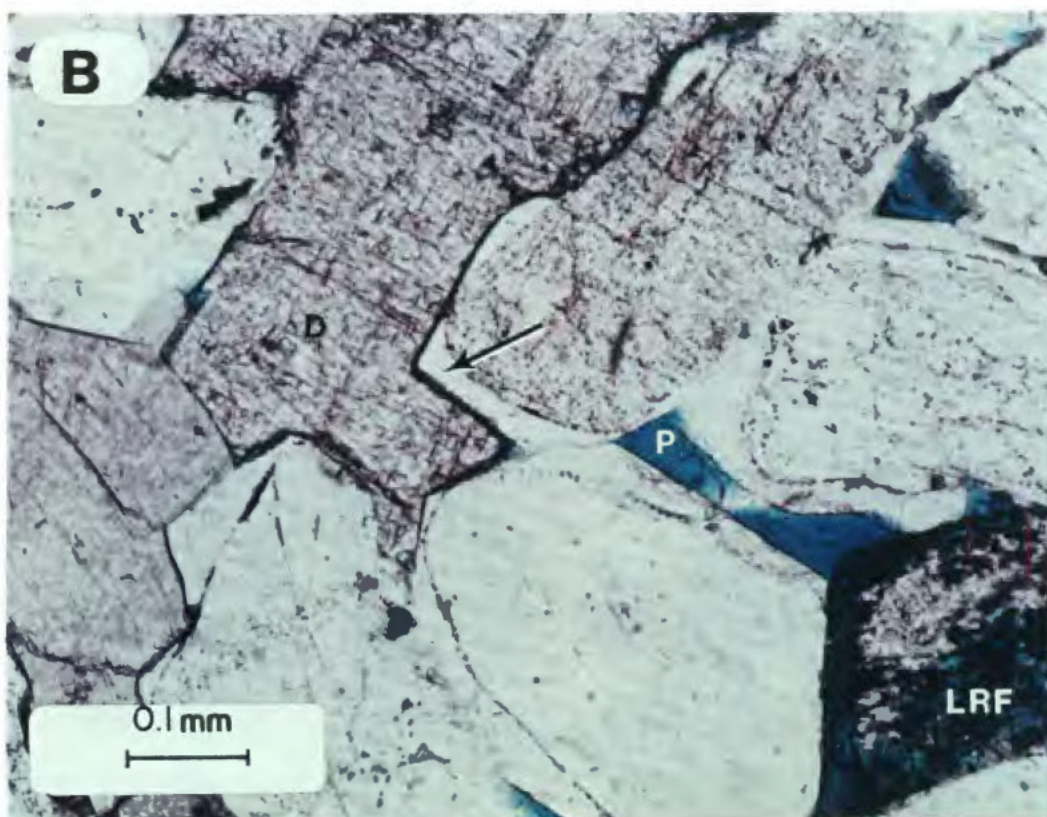
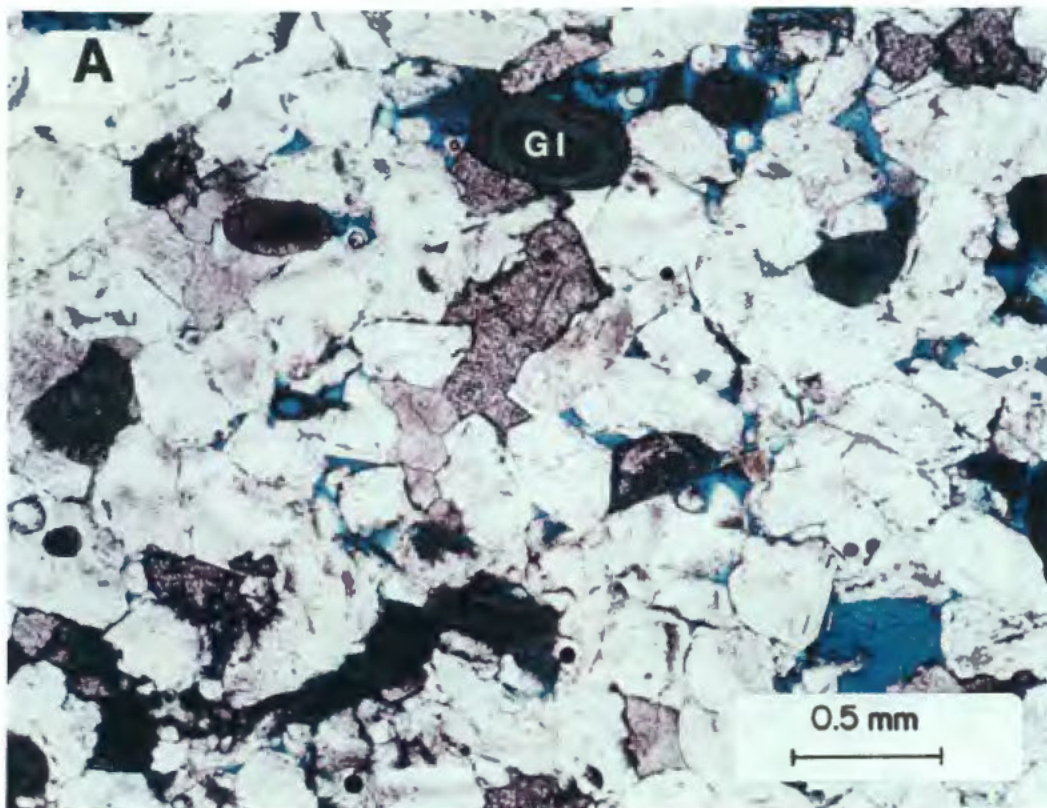


PLATE 34

SCANNING ELECTRON PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,103.4 Feet

WWRC#: 3 2 5 2 6 : 1 4 6

Ave. Grain Size = Lower Med. Sand (298 μ) Measured Porosity = 12.6%
Sorting = Well Measured Permeability = 55.5 md
Visible Porosity = 4% Grain Density = 2.67 g/cc

Macropores (P) are frequently reduced by quartz overgrowths (QO) in this sandstone. The overgrowths appear to be best developed on siliceous grains possessing minimal chlorite grain-coatings (Ch). Authigenic dolomite (D) occurs as rhombohedral crystals within intergranular pores. A leached rock fragment in view A (RF) possesses some microporosity.

A - 100X (First area)

B - 500X

C - 100X (Second area)

D - 500X

X-RAY DIFFRACTION DATA

Whole Rock

Quartz - 95%
Plagioclase - 1%
Calcite - 0%
Dolomite - 2%
Siderite - 0%
Clay - 2%

Clay Mineralogy

Chlorite - 34%
Illite - 64%
Kaolinite - 0%
Mixed-Layer Illite/Smectite - 2%

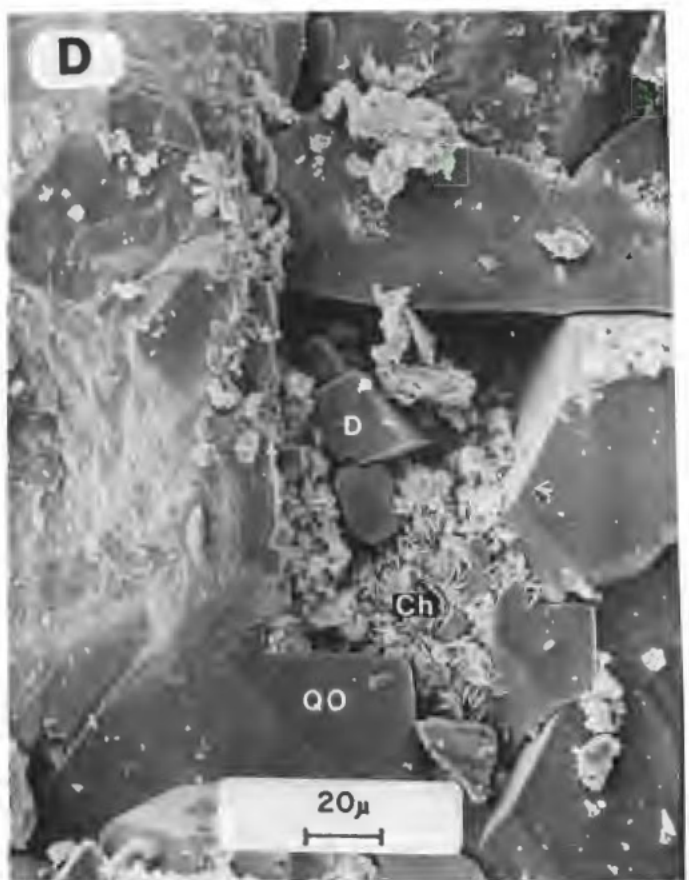
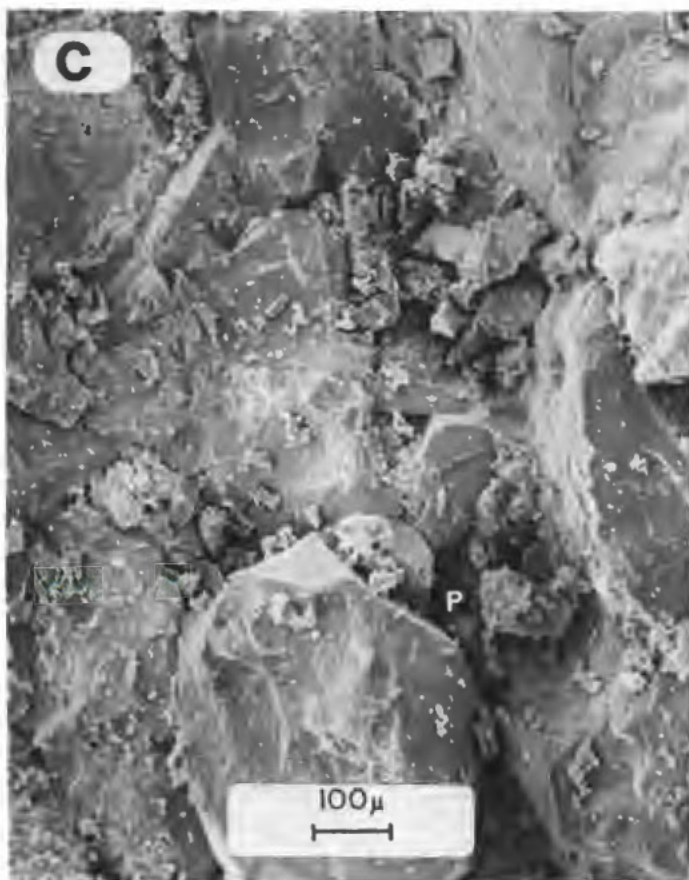
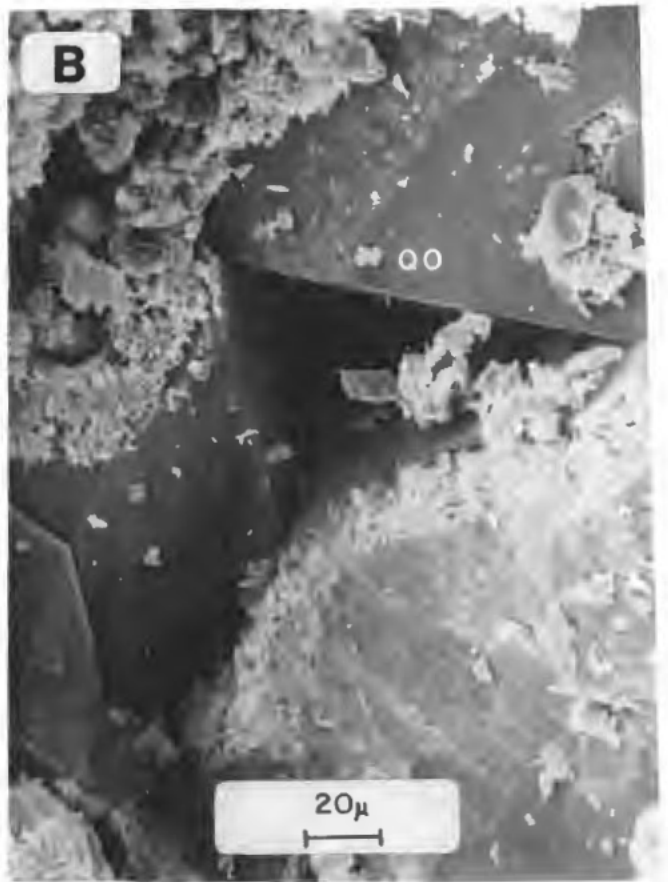
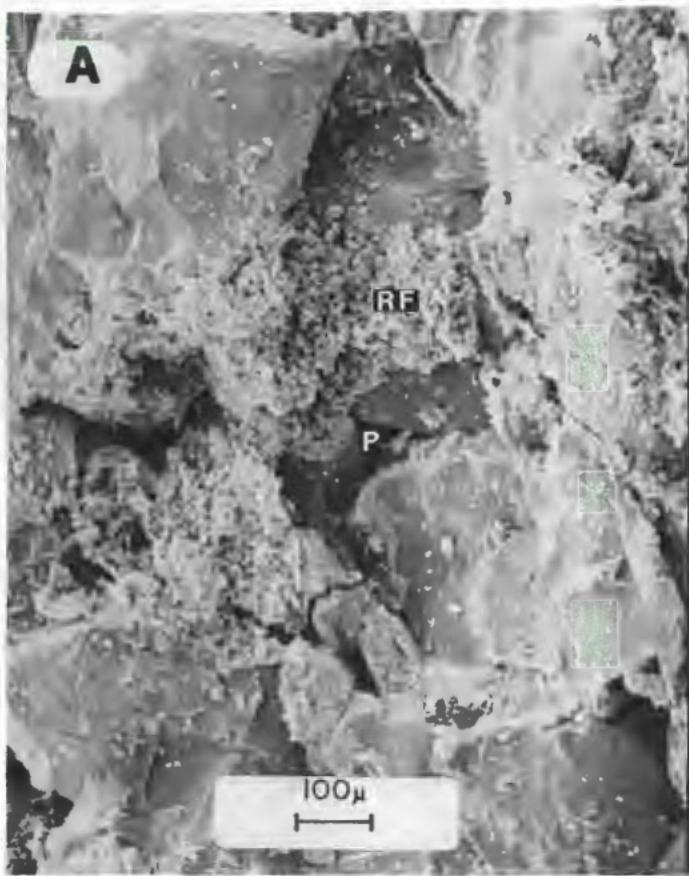


PLATE 35

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,113.5 Feet

WWRC#: 3 3 5 1 6 : 1 4 3

Sub. Grain Size = Lower Med. Sand (268 μ) Measured Porosity = 12%
Sorting = Moderate Measured Permeability = 6.67 md
Visible Porosity = 3% Grain Density = 2.69 g/cc

This medium-grained sandstone is composed predominantly of quartz, glauconite and rock fragments. The grains are cemented by quartz overgrowths and patchy dolomite (D). Visible pore space is mostly reduced intergranular pores and leached-grain secondary pores (Ps). In addition, extensive leached glauconite and other rock fragments result in the presence of microporosity.

A - 40X

B - 160X

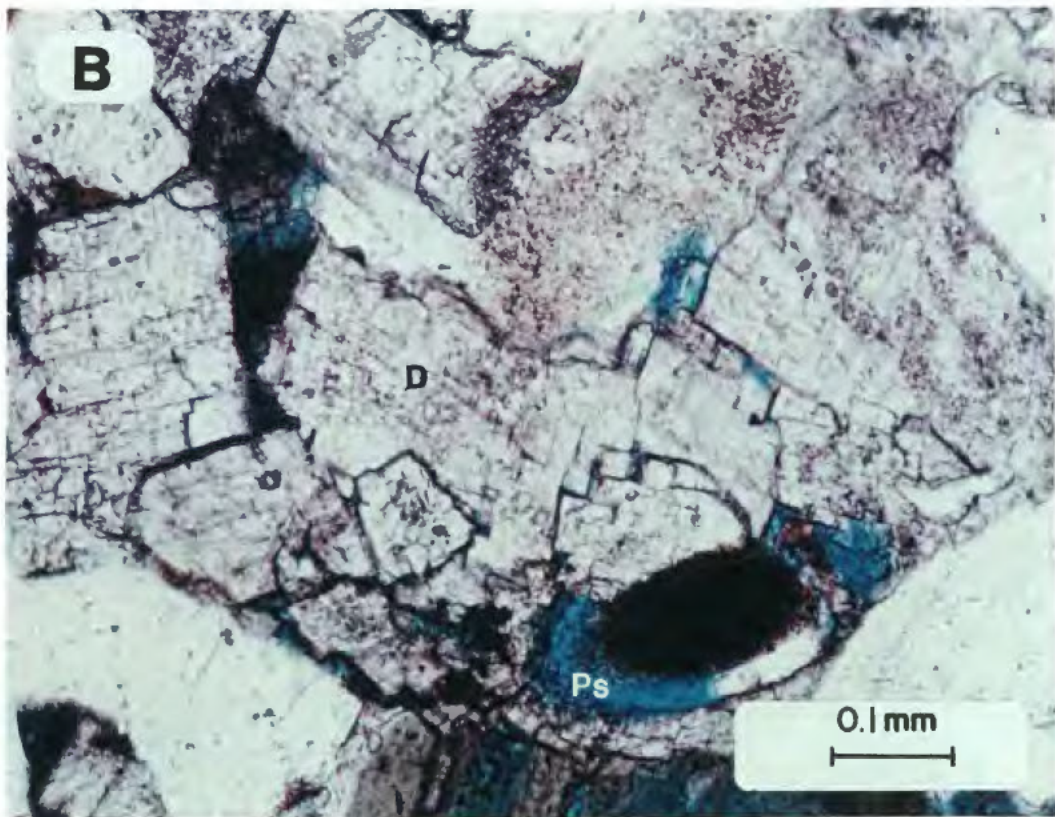
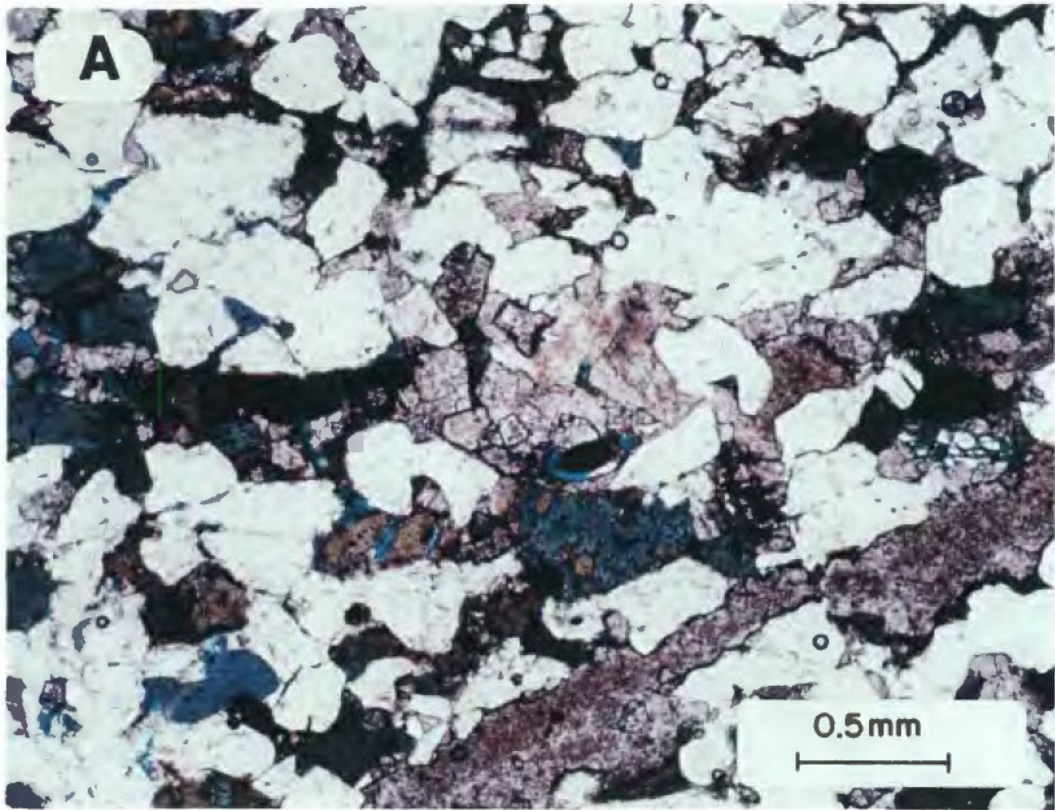


PLATE 36

SCANNING ELECTRON PHOTOMICROGRAPHS ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,113.5 Feet

WWRC#: 3 3 5 1 6 : 1 4 3

Ave. Grain Size = Lower Med. Sand (268 μ)
Sorting = Moderate
Visible Porosity = 3%

Measured Porosity = 12%
Measured Permeability = 6.67 md
Grain Density = 2.69 g/cc

SEM analysis reveals that many of the macropores (P) in this sample are isolated by quartz and dolomite (D) cements. Quartz overgrowths (QO) have developed on many framework grains but, as in previous samples, development has been inhibited on grains possessing grain-coating chlorite (view B). The curved cleavage planes of baroque dolomite (arrow) are evident in view C. The dolomite and quartz overgrowths have substantially reduced total pore volume.

A - 100X (First area)

B - 500X

C - 100X (Second area)

D - 500X

X-RAY DIFFRACTION DATA

Whole Rock

Quartz - 87%
Plagioclase - 2%
Calcite - 2%
Dolomite - 6%
Siderite - 0%
Clay - 3%

Clay Mineralogy

Chlorite - 25%
Illite - 70%
Kaolinite - 0%
Mixed-Layer Illite/Smectite - 5%

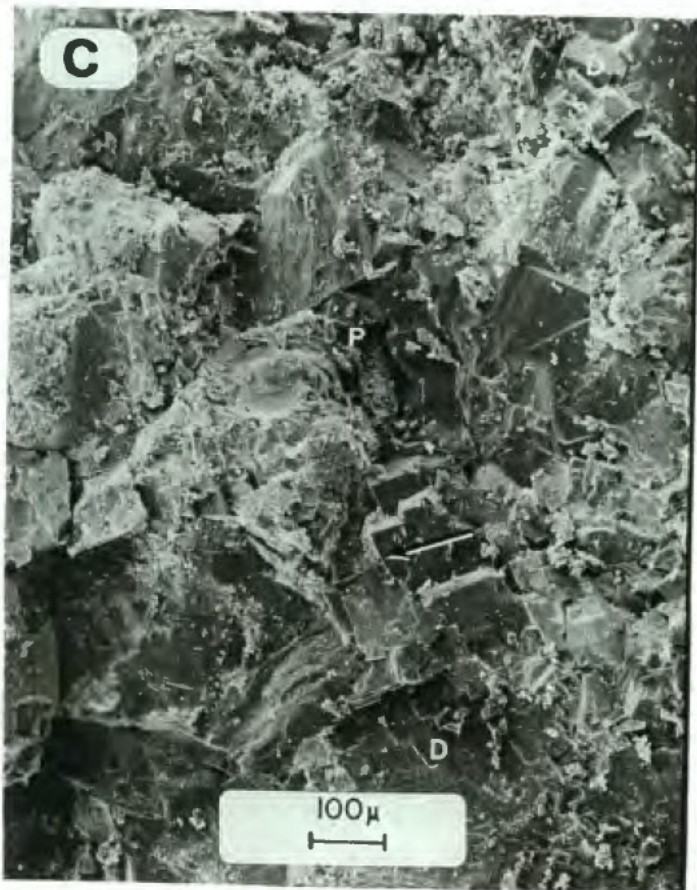
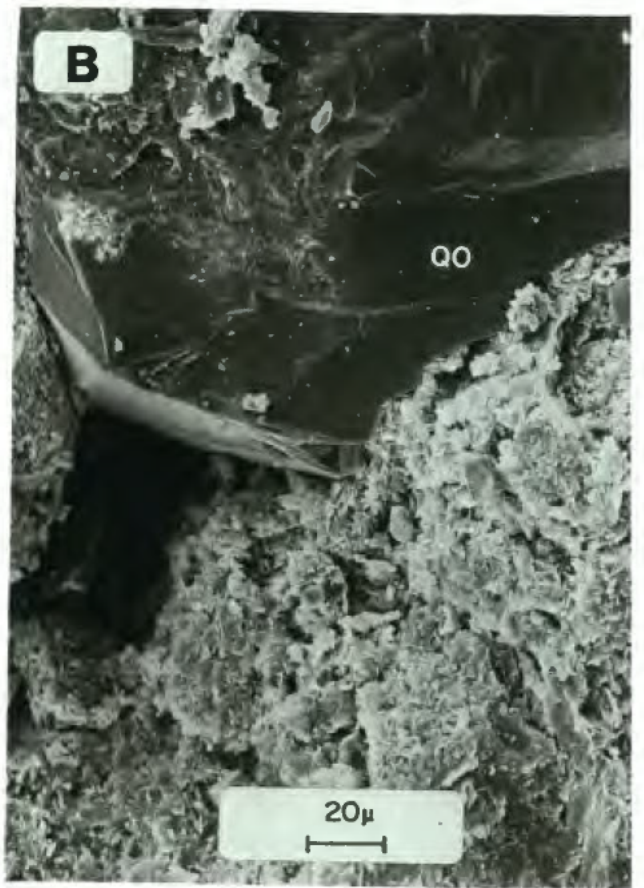
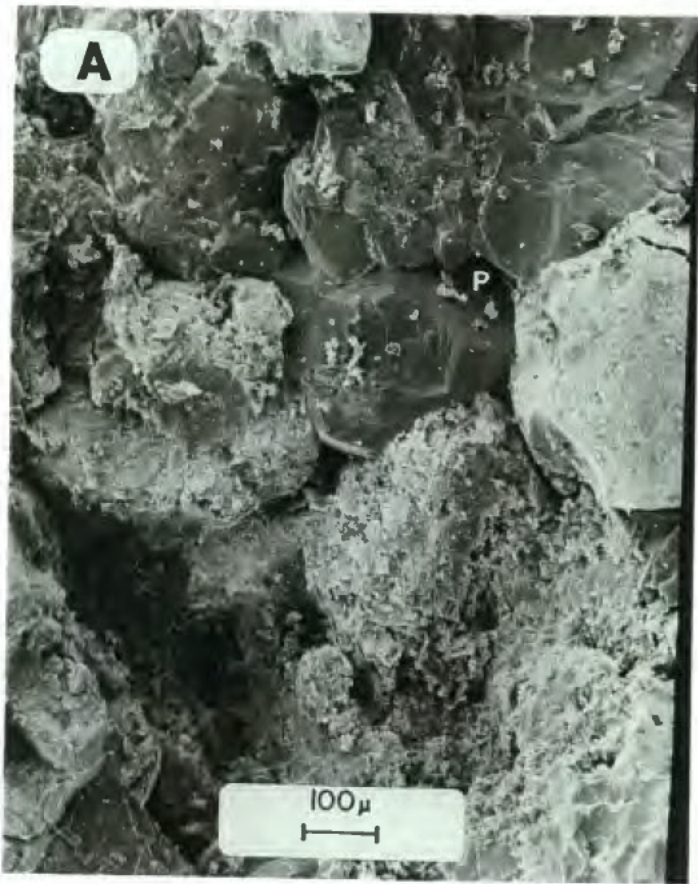


PLATE 37

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,117.8 Feet

WWRC#: 3 3 5 1 6 : 1 4 X

Ave. Grain Size = <u>Lower Med. Sand (280 μ)</u>	Measured Porosity = <u>11%</u>
Sorting = <u>Moderate</u>	Measured Permeability = <u>4.14 md</u>
Visible Porosity = <u>7%</u>	Grain Density = <u>2.70 g/cc</u>

This moderately sorted sandstone is composed of medium sand-sized grains of quartz, with lesser amounts of rock fragments, glauconite and skeletal grains, and accessory quantities of mica and clay-coated grains. Equal proportions of authigenic quartz and dolomite act to cement the framework grains and reduce pore volume. Replacive dolomite (D) is common within patches of undifferentiated clay or in mechanically deformed rock fragments (RF). The dolomite also occasionally replaces portions of framework grains (arrow, view A). The authigenic quartz occurs as incomplete euhedral overgrowths (arrows, view B). Visible porosity is composed mostly of reduced intergranular pores (P), and small quantities of leached-grain secondary pores.

A - 40X

B - 160X

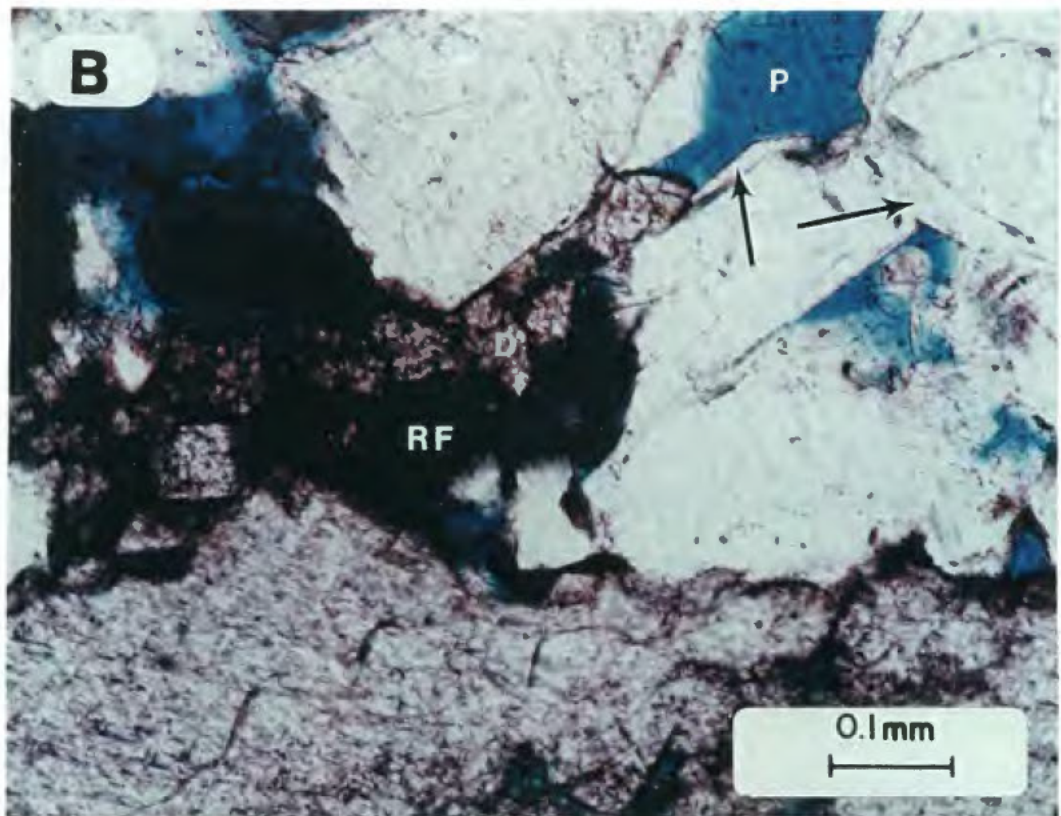
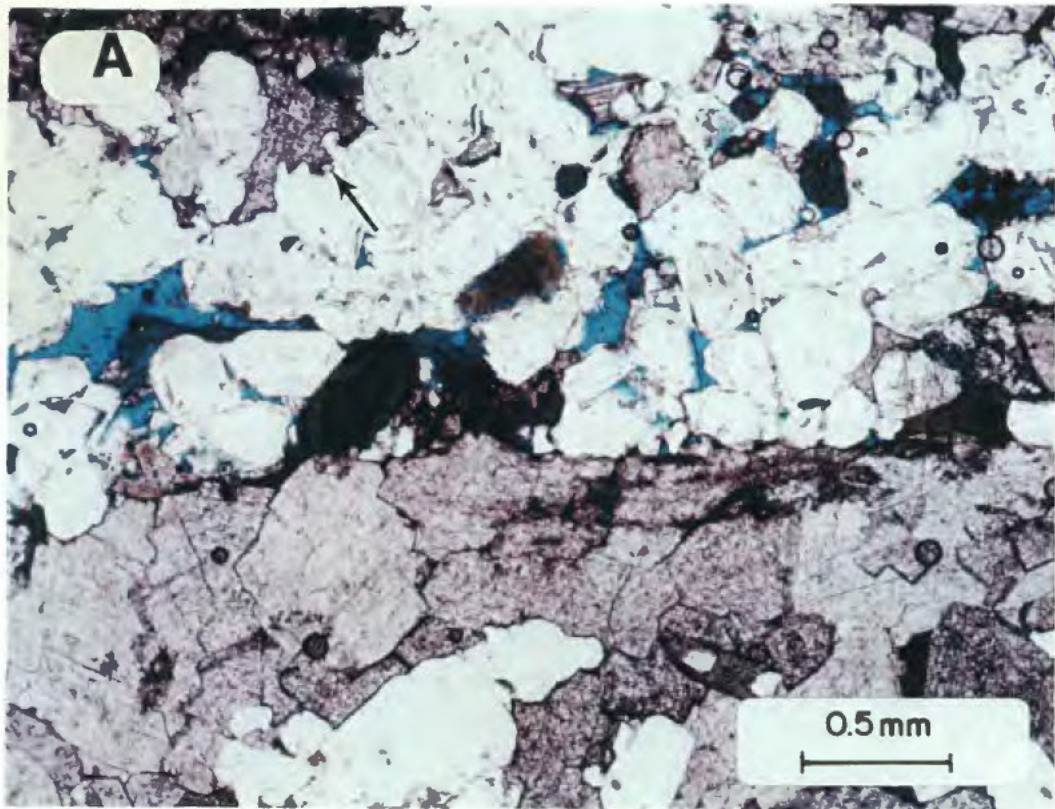


PLATE 38

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION RATCLIFF B-2 WELL

Core Depth = 6,122.9 Feet

WWRC#: 7 1 1 8 : X X X

Rock Type = Limestone
Texture = Ave. Grainstone
Visible Porosity = 0%

Measured Porosity = 0.6%
Measured Permeability = 0.080 md
Grain Density = 2.73 g/cc

A skeletal grainstone comprised largely of echinoid (E), crinoid (C) and bryozoa (B) fragments is highlighted in these photomicrographs. Minor amounts of argillaceous rock fragments and other unidentified rock fragments are also present. The grains are cemented by a finely crystalline equant calcite cement with scattered blebs of pyrite (Py).

A - 40X

B - 160X



