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GEOLOGICAL ANALYSIS OF CONVENTIONAL CORE FROM THE ANADARKO PETROLEUM CORPORATION CORNELL UNIVERSITY "C" 1-H WELL, MORTON COUNTY, KANSAS

RESERVOIRS INC.

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OF CONVENTIONAL CORE FROM THE

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL,

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INTRODUCTION

This report, prepared for Anadarko Petroleum Corporation, presents the results and conclusions obtained from geological analysis of 264.5 feet of conventional core from the Anadarko Petroleum Corporation Cornell University "C" 1-H well, located in Morton County, Kansas.

The objectives of this study were to 1) describe the conventional core and delineate lithologies, textures, sedimentary structures and contact relationships, 2) identify petrographic characteristics and diagenetic alterations that influence pore system properties, and 3) evaluate reservoir potential. In order to meet these objectives, the following analytical program was utilized:

-- The conventional core, which had previously been slabbed and photographed, was described in detail. Rock types, depositional textures, grain size, sedimentary structures and contact relationships were delineated. This description is presented in Figure 2, and in a panel at the end of this report.

-- Individual core pieces were selected to show representative lithologies. These close core photographs are presented in Figure 3.

-- Fifty-nine samples were selected for thin section preparation. The samples were impregnated with blue-dyed epoxy to highlight pore space. The thin sections were then ground to 30 microns and stained with Alizarin Red-S, which aids in differentiating calcite from other carbonate minerals. All of these thin sections were examined, and petrographic observations are incorporated into the core description. The locations of these 59 thin sections are shown on the core description.

-- Twelve (12) samples were selected for detailed petrographic evaluation. These are:

Depth (ft)	TS	XRD	Figure No.	Strat. Unit
2320.9	*	*	4	Krider Sand
2353.7	*	*	5	Krider Lime (Lower)
2356.3	*	*	6	Krider Lime (Lower)
2389.3	*	*	7	Winfield Sand
2391.7	*	*	8	Winfield Sand
2405.2	*	*	9	Winfield Dolomitic Lime
2461.2	*	*	10	Towanda Lime
2463.5	*	*	11	Towanda Lime
2465.4	*	*	12	Towanda Lime
2514.6	*	*	13	Homeville Sand
2532.8	*	*	14	Fort Riley Lime
2573.2	*	*	15	Florence Sand

-- Point count modal analysis (250 points) was used to determine the relative proportions of framework grains, pore-filling constituents, replacement products and pore types in the sandstone samples. Point count data are presented in Table 2. Thin section photomicrographs are provided in Figures 4 through 15.

-- Samples selected for X-ray diffraction (XRD) analysis were ground to 40 microns to ensure homogeneity, and analyzed through standard X-ray diffraction techniques. XRD data are presented in Table 3.

Reservoirs' Job Number RSH 2982 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. Todd Montgomery, Anadarko Petroleum Corporation, Houston, Texas. Additional copies may be obtained for reproduction costs. All data, interpretations, and other matters related to this study are considered highly confidential and the sole property of Anadarko Petroleum Corporation, Houston, Texas.

Lawrence Bruno

Lawrence Bruno
Manager of General Projects
RESERVOIRS, INC.

GEOLOGICAL ANALYSIS

This section of the report presents the results of geological analysis of 264.5 feet of conventional core from the Anadarko Petroleum Corporation University "C" 1-H well, located in Morton County, Kansas. The core recovered strata from fourteen stratigraphic units as defined by Anadarko Petroleum Corporation (Table 1).

Core Description and Interpretation

Four principal depositional facies were delineated in the core. These are:

Depositional Facies	% of Cored Strata	Lithologic Characteristics	Porosity Range* (Average)*	Permeability Range* (Average)*	Estimated Reservoir Potential
Paleosol/ Coastal Plain	28	Mostly brick-red silty claystone, argillaceous siltstone and siltstone. Often dolomitic. Root mottling common. Scattered caliche nodules and anhydrite nodules. Microporosity and thin, "clean", porous laminations.	7.8-21.5 (13.2)	0.010-25.499 (1.169)	Mostly poor. Fair where strata grade into tidal flat deposits.
Tidal Flat	29	Laminated to ripple cross-stratified siltstone and very fine-grained sandstone. Locally well preserved intergranular pore space. Carbonate matrix and cement, as well as authigenic clay, present as pore-filling constituents.	7.4-20.2 (13.9)	0.011-34.668 (2.848)	Fair to very good.
Carbonate Lagoon/Bay (and Shallow Shelf?)	22	Ranging from dolomitic siltstone to silty dolomitic mudstone/wackestone. Bioturbation generally apparent. Scattered fossil fragments, peloids and other carbonate grains. Usually minor amounts of intercrystalline pore space.	3.8-19.9 (11.9)	0.002-20.244 (1.132)	Poor. Locally grading to fair where depositional texture is more grain-rich.
Carbonate Shoal	21	Limestone to dolomite. Locally silty grainstone and packstone depositional textures. Locally ooid-dominated, but mostly rich in skeletal debris, peloids and oncoids. Intergranular and moldic macropores. Locally extensive intragranular microporosity development in micritic grains. Parts extensively cemented with calcite. Also anhydrite and dolomite cements.	3.2-26.8 (11.1)	0.005-52.351 (1.606)	Poor to very good.

* Excludes data from fractured plugs. See text for further discussion.

Paleosol/Coastal Plain Facies

Description:

The paleosol/coastal plain facies accounts for 28% of the cored strata. Seven individual units were delineated, showing a range in thickness from 2 feet to slightly more than 25 feet (see Figure 2 and the core description panel). The deposits are dominated by **brick-red, reddish-tan and greenish-gray, often dolomitic, silty claystones, argillaceous siltstones and siltstones** (Figure 3,A). In addition to quartz silt, iron-stained detrital clay, very finely crystalline dolomite and calcite, and mica are present in these strata. **Root mottling** and desiccation features are common, and caliche nodules and anhydrite nodules were noted at numerous horizons. In several cases, these paleosol/coastal plain deposits are in gradational contact with tidal flat deposits (e.g. near 2387 feet). As such, it is sometimes difficult to establish specific contact depths between these two facies, especially where iron-staining is extensive.

Although sedimentary structures have largely been disrupted by root mottling, thin laminations and ripples were observed in a few places, such as between 2446 and 2453 feet, and between 2486.5 and 2498.7 feet. Portions of the core through the paleosol/coastal plain facies are rubble. There is some indication of a fine fracture network through parts of this facies. However, it is unclear if this apparent fracture network is natural or an artifact of coring, core handling and/or dehydration of the rock (subsequent to core retrieval). Based on close examination of the rock, it is currently believed that many of these fractures are **artificial**. There is no indication of mineralization on the faces of these fractures. Furthermore, if they are natural fractures, they may be closed in the subsurface. Proper core handling and full diameter core analysis may help to better determine if these fractures are induced or part of the natural rock fabric. A small number of anhydrite-filled fractures are present (e.g. at 2438 feet).

Pore System Properties:

Routine core analysis data (excluding data from samples reported as fractured plugs) show porosity values in the paleosol/coastal plain facies ranging from 7.8% to 21.5% (average of 13.2%), and permeability values ranging from 0.010 md to 25.499 md (average of 1.169 md). The average porosity and permeability values for this facies are skewed toward the high end by a small number of samples taken from near the contact between the paleosol/coastal plain facies and the more porous and permeable tidal flat deposits. As previously noted it is often difficult to define a precise contact between these two gradationally related facies. For example, the core plug from 2510.7 feet has a permeability of 25.499 md; excluding just this one sample (which is from near the contact with underlying tidal flat deposits) lowers the average permeability for the paleosol/coastal plain facies to just 0.528 md. This value is probably more representative of the strata, but may still be slightly high. Examination of thin section samples from the paleosol/coastal plain facies suggests that most of the pore space is in the form of 1) microporosity associated with recrystallized matrix, and 2) intergranular pores in isolated ripples/laminations of "clean" siltstone. In general, this facies is judged to have rather **poor** reservoir potential, locally grading to **fair** reservoir potential where somewhat less detrital clay and/or carbonate matrix/cement are present.

Interpretation:

The paleosol/coastal plain deposits are interpreted to record sedimentation in a terrestrial (non-marine) environment. The brick-red (oxidized) color, abundance of root mottling and desiccation features, and the scattered caliche nodules and anhydrite nodules support this interpretation. All of these are common attributes of **ancient soils**. In the idealized depositional model (Diagram 1), these paleosol/coastal plain deposits should thin, and eventually pinch-out down depositional dip where the deposits grade into areas of marine-dominated sedimentation. The interfingering of numerous paleosol horizons with intertidal (tidal flat) and subtidal marine (lagoon/bay and shoal) deposits probably records cyclic sedimentation in response to repeated sea level fluctuations. Specifically, the paleosol/coastal plain deposits may have been widespread during relative low stands in sea level.

Tidal Flat Facies

Description:

The tidal flat facies, which accounts for 29% of the cored interval, is dominated by **reddish-tan, tan and light olive-gray, very well sorted, very fine-grained sandstones and siltstones** (Figure 3,B). A total of 11 individual tidal flat units were identified (Figure 2), showing thicknesses ranging from slightly more than 2 feet to as much as 18 feet. The siltstones and very fine-grained sandstones are typically finely laminated and/or ripple cross-stratified. Locally, some burrowing can be delineated, and root mottling may be present (particularly where tidal flat deposits grade into paleosol/coastal plain facies). The well preserved laminations and ripples suggest regular, intermittent exposure of the deposits; if these strata were predominantly subtidal accumulations, bioturbation would be expected to be more extensive, and the fine sedimentary structures would have been disrupted. Carbonate grains such as peloids and small fossil fragments, are scattered throughout the tidal flat deposits.

Carbonate matrix (both calcite and dolomite), finely crystalline calcite and dolomite cements, anhydrite cement, and authigenic clay minerals are the principal pore-filling constituents in these siliciclastic deposits.

Pore System Properties:

Routine core analysis measurements from the tidal flat facies show porosity values ranging from 7.4% to 20.2% (average of 13.9%), and permeability values ranging from 0.011 md to 34.668 md (average of 2.848 md). Point count data indicate that primary intergranular pores account for most of the total pore volume. Varying amounts of calcite matrix, dolomite matrix, calcite cement, dolomite cement, anhydrite cement and authigenic clay minerals act to reduce porosity in these siliciclastic deposits (Table 2). In general, the range in porosity and permeability values largely reflects variations in the amount/distribution of carbonate matrix and cements (Table 2). The higher range of porosity and permeability values occur where carbonate matrix is uncommon, and where calcite and dolomite cements are relatively sparsely distributed (Figure 13). Authigenic clays have apparently replaced some macropores with less effective microporosity. SEM (scanning electron microscope) analysis would help to better evaluate the effects of these authigenic clay minerals. Because these tidal flat deposits tend to be finely laminated and/or ripple cross-stratified, there are often millimeter-scale heterogeneities that reflect subtle variations in the amount of carbonate matrix. This may make it difficult to evaluate permeability measurements over a given stratigraphic interval, and may lead to substantial differences between horizontal and vertical permeability. Overall, the tidal flat facies is judged to have variable reservoir potential, ranging from **poor** to **very good**.

Interpretation:

The tidal flat deposits are interpreted to record sedimentation in a shallow subtidal to intertidal depositional setting. Where burrows are more abundant, lower intertidal to shallow subtidal sedimentation is inferred. Conversely, where the deposits grade into iron-stained paleosol/coastal plain deposits, upper intertidal to perhaps supratidal deposition is more likely. In this overall intertidal to shallow subtidal depositional setting, sedimentation is dominated by traction transport processes associated with daily tidal fluctuations. In the rock record, tidal flat deposits often form strike-elongate lithosomes that roughly parallel the paleocoastline (Diagram 1). The width of the deposits will be governed by several factors, including tidal range, the angle of depositional slope and sea level fluctuations. As previously noted, the strata recovered in this core probably reflect cyclic sedimentation in response to numerous sea level fluctuations. Because tidal flat deposits closely track subtle changes in sea level, they may be widely distributed, forming broad, sheet-like deposits. As with the paleosol/coastal plain deposits, the intertidal to shallow subtidal siltstones and very fine-grained sandstones of the tidal flat facies would be expected to gradationally thin, and eventually pinch-out, down depositional dip, where subtidal, marine-dominated facies should predominate.

Carbonate Lagoon/Bay (and Shallow Shelf?) Facies

Description:

Roughly 22% of the cored strata are interpreted as carbonate lagoon/bay deposits. These strata, which occur in six distinct zones ranging in thickness from slightly more than 1 foot to nearly 16 feet, are dominated by **dark to medium gray,**

calcareous/dolomitic siltstones and silty mudstones/wackestones (Figure 3,B). Some of the mudstones/wackestones are dolomite, while others are mostly limestone. These deposits are often in gradational contact with either tidal flat or carbonate shoal deposits.

Bioturbation is common, and there is little or no preservation of primary sedimentary structures. Marine fossils, including brachiopods, echinoderms and bryozoans, were observed. Other carbonate particles such as oncoids and peloids are also present. The interval between 2550 and 2560 feet is somewhat distinct, in that it contains a relatively large number of silicified coral fragments and whole brachiopods; by comparison, coral fragments and whole brachiopods are less common in other intervals. Scattered quartz silt, anhydrite nodules, and a few anhydrite-filled fractures are other features observed in this facies.

Pore System Properties:

Routine core analysis data show porosity values ranging from 3.8% to 19.9% (average of 11.9%), and permeability values ranging from 0.002 md to 20.244 md (average of 1.132 md). The average permeability value is skewed by just 4 measurements (out of 82 measurements reported on plugs without fractures - Table 4). Three of the measurements are from thin beds/laminations of "clean" siltstone/sandstone, and one (from 2319.3 feet) is from a fractured plug that was apparently overlooked during routine core analysis. Excluding these four measurements, the average permeability is recalculated to just 0.474 md, a value that is more representative of the strata. In general, most of the pore space is in the form of intercrystalline voids where dolomite predominates. For example, compare porosity values for the dolomite strata between 2339 and 2347 feet to values for the limestone strata between 2547 and 2563 feet. The limestone has lower porosity.

As a generalization, these deposits are judged to have only **poor** to **fair** reservoir potential, with most of the deposits having permeability values below 0.5 md.

Interpretation:

The presence of bioturbation, combined with the micritic textures and marine fossils, indicate low-energy, subtidal marine sedimentation. In addition, the frequently observed gradation of this facies into tidal flat deposits support the interpretation that sedimentation occurred in a carbonate-dominated (locally grading to siliciclastic-rich) **lagoon/bay** environment. A slightly different interpretation could be offered for the strata between 2547.0 and 2563.0 feet. This 16-foot interval contains a faunal assemblage (i.e., corals and large whole brachiopods) that is more suggestive of **shallow shelf** sedimentation.

Carbonate Shoal Facies

Description:

The carbonate shoal facies, which accounts for 21% of the cored interval, consists of **tan to gray, grainstones and packstones** (Figure 3,D). A total of 6 individual units ranging in thickness from 2 feet to 27 feet were delineated (Figure 2). The grainstones and packstones vary from limestone to dolomitic limestone to calcareous dolomite; overall, most of these deposits are limestones and dolomitic limestones. Although some of these grain-rich strata have an abundance of ooids (for example between 2462 and 2466 feet)(Figures 11 and 12), most contain a mixture of skeletal debris, oncoids, peloids, ooids and intraclasts. Within the bioclastic constituents, fragments of bryozoans, echinoderms, brachiopods, pelecypods, corals, foraminifera and perhaps some stromatoporoids were observed. In addition to the carbonate allochems, very fine-grained quartz sand and silt are sometimes scattered throughout these limestones and dolomites. Anhydrite can be present as a cement and/or a replacement phase.

Stylolites and compaction seams are relatively common, however, most of these grainstones and packstones are rather massive in appearance. The ooid-dominated grainstones between 2462 and 2466 feet do show indications of cross-stratification.

Pore System Properties:

Routine core analysis data reveal porosity values ranging from 3.2% to 26.8% (average of 11.1%), and permeability values ranging from 0.005 md to 52.351 md (average of 1.606 md). Calcite cement is the principal pore-filling constituent in the limestone portions of this facies (Figure 6, 10, 11, and 12). Anhydrite cement can also be present. In the dolomite portions of this facies, anhydrite cement, dolomite cement (Figure 9) and dolomitized matrix (Figure 5) are the principal pore-filling constituents.

The highest porosity and permeability values occur in the ooid grainstones between 2462 and 2466 feet. The ooid-dominated deposits contain 1) an abundance of primary intergranular pores, 2) secondary pores due to dissolution of ooids, and 3) microporosity within leached and partially leached grains (Figures 11 and 12). Most of the other non-ooid-dominated grainstones have less intergranular pore space due to more extensive calcite cementation (Figures 6 and 10). In these grainstones, moldic pore space (where fossil fragments and/or oncoid nuclei have been leached) and microporosity (within micritic grains such as oncoids and intraclasts) predominate. These more extensively cemented grainstones are associated with the lower range of permeability values in this facies.

Within the dolomitized grainstones, patchy anhydrite cement sometimes occludes larger moldic pores (Figure 9); remnant intergranular pores and intercrystalline pores tend to predominate. Dolomitization probably had only a slight impact on porosity and permeability in the grainstones. Dolomitization in the packstones may have created some intercrystalline pores and marginally enhanced reservoir quality. Overall, the grain-rich limestones and dolomites of the carbonate shoal facies are judged to have **fair** to **very good** reservoir potential.

Interpretation:

The grain-rich textures and wide assortment of skeletal debris and carbonate allochems indicate high-energy sedimentation in a shallow marine, carbonate shoal environment. The paucity of matrix material reflects persistent wind-, wave- or tide-driven currents. These deposits probably formed as bars in a shallow subtidal setting. It is impractical to estimate the geometry of these bars from one core. Strike-oriented or dip-oriented bars may develop, depending on tidal range, orientation of impinging currents and underlying paleobathymetry. The development of a lagoon/bay could suggest strike-oriented bars that acted to limit communication between back-shoal and open marine waters. In modern deposits, these types of accumulations generally form in water depths of 2 to 20 feet, and many are nearly exposed during low tide.

Depositional Model

An idealized depositional model for these deposits is presented in Diagram 1. Paleosol/coastal plain facies record terrestrial sedimentation, above high tide. The tidal flat facies is the product of intertidal and shallow subtidal deposition. Although tidal flat deposits tend to form in belts that parallel the paleocoastline, lateral facies migration in response to progradation and sea level fluctuations may yield broad, sheet–like lithosomes. Both the paleosol/coastal plain facies and the tidal flat facies should thin down depositional dip where subtidal marine (more carbonate–rich?) strata will predominate. The carbonate lagoon/bay facies records sedimentation in a low–energy, shallow subtidal environment. The faunal assemblage, texture and frequent gradation into tidal flat deposits may indicate somewhat restricted, quiet water conditions such as in a lagoon environment. The carbonate shoal facies is the product of high–energy sedimentation in areas with persistent currents. These deposits formed as carbonate sand bars. It is impractical to try to determine sandbody geometry from just one core. These bars may have formed as either strike–oriented or dip–oriented sandbodies. The occurrence of restricted(?) lagoon–bay deposits could imply that the bars formed as strike–oriented barriers that limited circulation between back–shoal and shelf waters.

The stratigraphic sequence observed in the core reflects numerous transgressive and regressive cycles. These cycles are probably the product of sea level fluctuations. This is recorded in the repeated interfingering of the four depositional facies identified in the core. Diagram 2 shows idealized illustrations that help to explain some of the stacking patterns that can be produced during these fluctuations. In view A, a carbonate lagoon/bay resides landward of a carbonate shoal. Tidal flats are deposited in the intertidal zone, and soils develop along the terrestrial coastal plain. A relative rise in sea level (view B) yields a transgressive sequence which results in a "landward" facies shift. Subsequently (view C), renewed progradation yields a regressive sequence as the facies migrate in a seaward direction. Repeating the cycle results in a stratigraphic sequence similar to the one observed in the core. Note how these kinds of fluctuations can result in the stacking of potential reservoir zones.

DIAGRAM 1

IDEALIZED DEPOSITIONAL MODEL

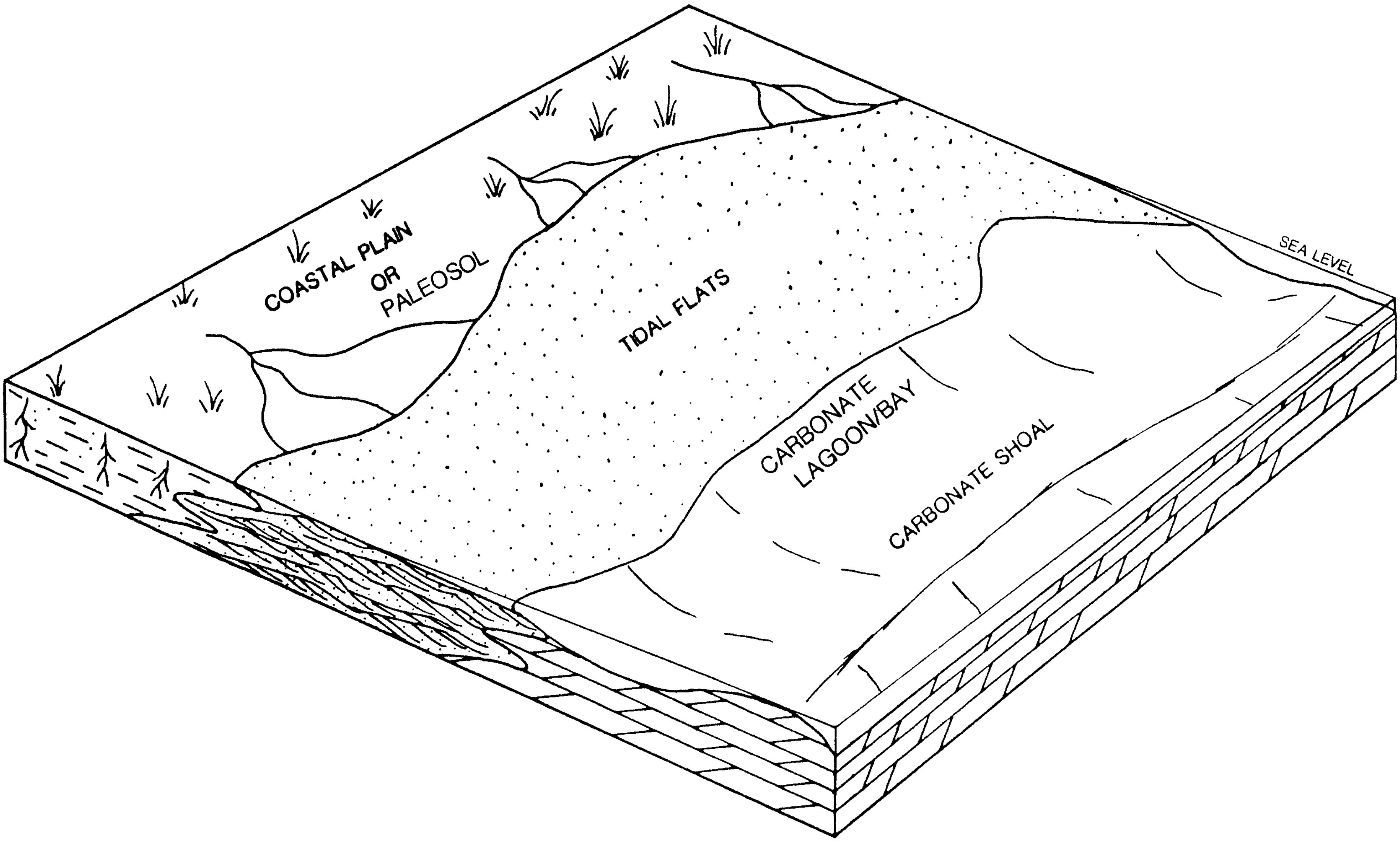
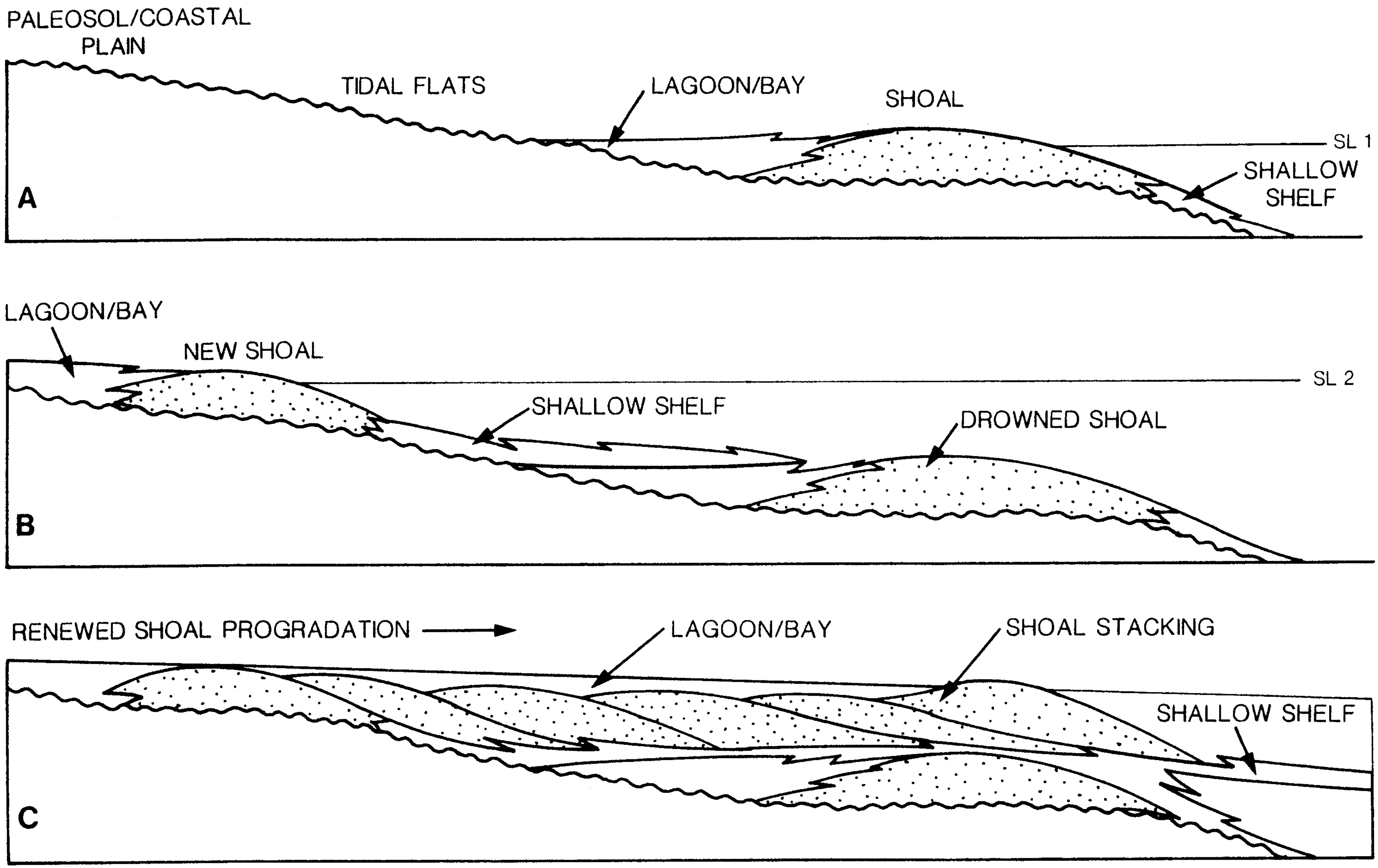


DIAGRAM 2

IDEALIZED STACKING MODEL



Petrography and Diagenesis

This section of the report presents the results of detailed petrographic analysis of 12 samples. The samples are broadly subdivided into two categories, sandstone/siltstone samples and carbonate samples.

Sandstone/Siltstone Samples:

Five sandstone/siltstone samples were subjected to detail petrographic analysis (Table 2). All of the samples are **siltstones** or **very fine-grained sandstones**. The coarsest sample has an average grain size in the range of lower very fine sand (0.087 mm). All five samples are **very well sorted**. Only one sample (from 2573.2 feet) has more than a minor amount of detrital clay, although carbonate matrix is present in all of the samples. Based on the observed sorting and the amount of matrix material, these sandstones/siltstones probably had initial porosities in the range of 32% to 40%. Minus cement porosities are now in the range of 28% to 33%, suggesting that a loss of perhaps of 4 to 8 porosity units can be attributed to compaction. This is consistent with **slight** to **moderate** compaction. **Angular** and **subangular** grain shapes predominate. This is common in fine-grained rock such as these, and is generally not taken as an indication of energy conditions at the time of deposition or the distance from the source area.

The principal pore-filling constituents in these sandstone/siltstone samples are: **calcite matrix (0.8-6.4%)**, **dolomitized carbonate matrix (2.8-8.8%)**, **calcite cement (1.2-10.4%)**, **dolomite cement (3.2-8.0%)**, **anhydrite cement (trace-4.0%)**, and **authigenic clay (2.4-6.0%)**. The samples with the least carbonate matrix and carbonate cement have the highest porosities, and the samples with the most carbonate matrix and cement have the lowest porosities. **Therefore, the principal factor controlling porosity preservation in the sandstone/siltstone samples is the amount of carbonate matrix and cement.** Locally, anhydrite cement can also be a factor. Authigenic clay may play a role in controlling permeability. These clay minerals have replaced macropores with less effective micropores. Combining SEM analysis with X-ray diffraction analysis of the clay fraction would help to better determine the effect that clay minerals have on porosity, permeability and reservoir potential.

Quartz grains (39.2–48.4%) are the principal framework constituent in all of these samples. Potassium feldspar (4.0–8.4%) and plagioclase feldspar (3.6–5.6%) are also common. Minor to trace amounts of chert, metamorphic rock fragments, heavy minerals, mica and fossil fragments/other carbonate grains were observed. Based on the relative proportions of quartz, feldspar and rock fragments, these sandstones/siltstones can be classified as **subarkoses** and **arkoses**. XRD detected quartz (49–66%), potassium feldspar (8–17%), plagioclase feldspar (6–13%), calcite (0–12%), dolomite (1–11%), anhydrite (0–6%) and clay minerals (3–5%). The quartz and feldspar identified through XRD account for most of the framework grains. In general, petrographic observations indicate more calcite and dolomite than were found through XRD. Part of this could be associated with the limitation involved in distinguishing matrix material from associated microporosity that is difficult to resolve in thin section.

Grain replacements are relatively uncommon, with only minor to trace amounts of dolomite, anhydrite, and clay noted.

Point count data indicate that intergranular pore space (8.0–17.2%) and secondary leached grain pores (trace–2.0%) are present. Based on the relative proportions of primary and secondary pores, it appears that primary intergranular pores account for at least 80% of macropore volume. Microporosity occurs in association with authigenic clay and the carbonate matrix. The differences between measured porosity and point count porosity in part reflect the presence of microporosity.

Carbonate Samples:

A total of seven carbonate samples were analyzed in detail. Five of these are lime grainstones/packstones and two are dolomite grainstones/packstones.

Limestones:

Within the five **lime grainstones/packstones**, ooids are the main framework constituents in two of the samples (Figures 11 and 12), while peloids, skeletal fragments and oncoids are the main allochemical constituents in the other three samples (Figures 6, 10 and 14). The ooid grainstones have rather well preserved networks of primary intergranular pores, as well as secondary pores from leached and partially leached grains. In addition, some microporosity is also present within altered framework grains. Relatively thin coatings of bladed to equant calcite cement surround most of the framework grains. This early calcite cement helped to preserved porosity by limiting compaction. Only minor amounts of later-stage calcite cement are apparent. These ooid-dominated limestones have among the best reservoir potential of any facies encountered in the core. In comparison, the other three lime grainstones/packstones tend to have significantly less primary intergranular pore space due to a combination of more extensive calcite cementation and compaction. In these "non-ooid-dominated" grainstones and packstones, relatively large portions of the total pore volume tend to be in the form of 1) moldic pores where skeletal fragments and oncoid nuclei have been leached, and 2) as microporosity within altered micritic grains such as oncoids, intraclasts and peloids. Combined, these secondary pore types appear to be rather ineffective components of the pore network. This tends to lead to high pore system tortuosity and relatively low permeability (compared to measured porosity).

Patchy anhydrite cementation/replacement is apparent in many of these limestones. In some cases, the anhydrite crystals are very heterogeneously distributed; for example, X-ray diffraction analysis determined that the sample from 2465.4 feet contains 43% anhydrite. Examination of the thin section reveals only minor amounts of anhydrite (perhaps 2-6%). However, examination of the conventional core from near this sample depth (Figure 3,D) reveals centimeter-sized crystals of anhydrite. Evidently, the X-ray diffraction sample contained some of these large anhydrite crystals.

Dolomites:

One of the dolomite samples (Figure 5) was deposited as a packstone, while the other (Figure 9) is a grainstone. In the packstone sample from 2353.7 feet, dolomitization of the matrix yields a rock with 1) small intercrystalline pores between the dolomite rhombs, 2) moldic pores where grains have been partially leached, and 3) intragranular microporosity within partially altered micritic grains such as oncoids. The moldic pores and intragranular microporosity are apparently rather ineffective components of the pore system. This pore system yields a rock with high porosity (12.2%) but low permeability (0.456 md). In comparison, the dolomitic grainstone from 2405.2 feet has preserved intergranular pores and secondary macropores reflecting rather extensive grain dissolution (Figure 9). Prior to late-stage anhydrite cementation, this grainstone may have had total porosity in excess of 20%. The rock now has a porosity of 15.8% and a permeability of 10.983 md. Apparently dolomitization had relatively little effect on reservoir quality. The tighter, more micritic packstone may have had a slight porosity enhancement (in the form of intercrystalline pores) due to dolomitization, but the grain-rich rock had significant porosity prior to dolomitization. Subsequent diagenetic alterations (specifically anhydrite cementation) acted to infill larger pores and reduce overall reservoir quality in the dolomitized grainstones.

SUMMARY

1. A total of 264.5 feet of conventional core from the Anadarko Petroleum Corporation Cornell University "C" 1-H well were analyzed in detail.

2. Four principal depositional facies were delineated in the core. These are:

Depositional Facies	% of Cored Strata	Lithologic Characteristics	Porosity Range* (Average)*	Permeability Range* (Average)*	Estimated Reservoir Potential
Paleosol/ Coastal Plain	28	Mostly brick-red silty claystone, argillaceous siltstone and siltstone. Often dolomitic. Root mottling common. Scattered caliche nodules and anhydrite nodules. Microporosity and thin, "clean", porous laminations.	7.8-21.5 (13.2)	0.010-25.499 (1.169)	Mostly poor. Fair where strata grade into tidal flat deposits.
Tidal Flat	29	Laminated to ripple cross-stratified siltstone and very fine-grained sandstone. Locally well preserved intergranular pore space. Carbonate matrix and cement, as well as authigenic clay, present as pore-filling constituents.	7.4-20.2 (13.9)	0.011-34.668 (2.848)	Fair to very good.
Carbonate Lagoon/Bay (and Shallow Shelf?)	22	Ranging from dolomitic siltstone to silty dolomitic mudstone/wackestone. Bioturbation generally apparent. Scattered fossil fragments, peloids and other carbonate grains. Usually minor amounts of intercrystalline pore space.	3.8-19.9 (11.9)	0.002-20.244 (1.132)	Poor. Locally grading to fair where depositional texture is more grain-rich.
Carbonate Shoal	21	Limestone to dolomite. Locally silty grainstone and packstone depositional textures. Locally ooid-dominated, but mostly rich in skeletal debris, peloids and oncoids. Intergranular and moldic macropores. Locally extensive intragranular microporosity development in micritic grains. Parts extensively cemented with calcite. Also anhydrite and dolomite cements.	3.2-26.8 (11.1)	0.005-52.351 (1.606)	Poor to very good.

* Excludes data from fractured plugs. See text for further discussion.

3. The paleosol/coastal plain facies consists of brick-red, reddish-tan and greenish-gray, often dolomitic, silty claystones, argillaceous siltstones and siltstones. The average permeability value is skewed toward the high end by

one sample from near the contact with underlying tidal flat deposits. Excluding this one sample, average permeability is calculated at 0.528 md, a value that is considered to be more representative of the strata. Overall, the paleosol/coastal plain facies is judged to have rather poor reservoir potential, locally grading to fair reservoir potential.

4. The tidal flat facies consists of reddish-tan, tan and light olive-gray, very well sorted, very fine-grained sandstones and siltstones. Ripple cross-stratification and laminations are well preserved. Primary intergranular pores predominate. The average porosity of 13.9% and average permeability of 2.848 md are the highest of any of the 4 facies encountered in this core. The range of porosity and permeability values in this facies largely reflects variations in the amount/distribution of carbonate matrix and cements. Overall, the tidal flat facies is judged to have variable reservoir potential, ranging from poor to very good.

5. The carbonate lagoon/bay facies consists of dark to medium-gray, calcareous/dolomitic siltstones and silty mudstones and wackestones. Parts of this facies are dolomite, while others are mostly limestone. Excluding a small number of measurements from "clean" laminations in this facies, the average permeability is recalculated to 0.474 md, a value that is more representative of the strata. Overall, the carbonate lagoon/bay facies is judged to have only poor to fair reservoir potential.

6. The carbonate shoal facies consists of tan to gray, grainstones and packstones. The strata vary from limestone to dolomitic limestone to calcareous dolomite, with a predominance of limestones and dolomitic limestones. Parts of this facies are ooid-rich, but more typically skeletal debris, oncoids, peloids, ooids and intraclasts are admixed. The ooid-rich portions of this facies (within the Towanda Lime) have among the highest porosity and permeability values in the core, reflecting a well preserved network of primary intergranular pores and

subordinate amounts of oomoldic pores and microporosity. In most of the other grainstones, extensive calcite cementation has limited the amount of primary pore space, and secondary pores predominate. Because the secondary pores are in the form of 1) leached grains and 2) microporosity in altered framework grains, they tend to be poorly interconnected; permeability values are usually substantially lower, although porosity values may remain high. Dolomitization appears to have had only a marginal effect on reservoir quality in these rocks. A minor amount of porosity enhancement may have resulted from the development of intercrystalline pores due to matrix selective dolomitization. Other, grain-rich strata probably had high initial porosities prior to dolomitization. Overall, the carbonate shoal facies is judged to have fair to very good reservoir potential.

7. The stratigraphic sequence observed in the core reflects numerous transgressive and regressive cycles. These cycles are probably the product of sea level fluctuations. This is recorded by the repeated interfingering of the four depositional facies identified in the core.

TABLE 1

STRATIGRAPHIC UNITS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL*

Stratigraphic Unit	Core Depth (ft)
Krider Sand	2314.1-2338.0
Krider Lime (Upper)	2338.0-2347.4
Krider Lime (Lower)	2347.4-2362.0
O'dell Sand	2362.0-2387.6
Winfield Sand	2387.6-2400.8
Winfield Dolomitic Lime	2400.8-2407.3
Gage Sand - 1	2407.3-2414.0
Gage Lime	2414.0-2416.0
Gage Sand - 2	2416.0-2453.2
Towanda Sand	2453.2-2456.6
Towanda Lime	2456.6-2477.0
Homeville Sand	2477.0-2519.7
Fort Riley Lime	2519.7-2572.0
Florence Sand	2572.0-2581.5(?)

* Unit tops provided by Anadarko Petroleum Corporation.

TABLE 2

SANDSTONE THIN SECTION POINT COUNT DATA

ANADARKO PETROLEUM CORPORATION
CORNELL UNIVERSITY "C" 1-H WELL
MORTON COUNTY, KANSAS

Depth (ft)	2320.9	2389.3	2391.7	2514.6	2573.2
Stratigraphic Unit	Krider	Winfield	Winfield	Homeville	Florence
WWRC#	61425 : 436	51425 : 436	51426 : 436	51325 : 347	61436 : 364
Texture					
Average Grain Size (mm)	C. Silt (0.056 mm)	LVF Sand (0.073 mm)	LVF Sand (0.074 mm)	LVF Sand (0.087 mm)	C. Silt (0.053 mm)
Sorting	Very Well	Very Well	Very Well	Very Well	Very Well
Framework Grains					
Quartz	40.8%	39.6%	39.6%	48.4%	42.4%
Plagioclase Feldspar	5.2	5.6	4.4	5.2	3.6
Potassium Feldspar	8.0	8.4	6.8	5.2	4.0
Chert	0.8	--	--	0.8	0.4
Metamorphic Rock Fragment	1.2	0.8	--	0.8	2.0
Heavy Minerals	0.8	0.8	1.2	0.4	1.6
Mica	--	0.4	1.2	1.2	0.8
Fossil/Carbonate Grains	--	0.8	2.0	0.8	4.0
Pore-Filling Constituents					
Matrix Clay	0.4%	0.4%	--%	0.4%	4.4%
Matrix Calcite	1.2	4.4	6.4	0.8	4.0
Matrix Dolomite	8.8	7.2	7.2	2.8	4.0
Calcite Cement	1.2	2.4	7.6	4.0	10.4
Dolomite Cement	8.0	8.0	8.4	3.2	6.8
Anhydrite Cement	1.2	2.0	1.2	4.0	Tr
Quartz Cement	1.2	0.8	Tr	1.2	Tr
Authigenic Clay	4.0	6.0	4.8	2.8	2.4
Grain Replacements					
Calcite	--%	--%	--%	--%	--%
Dolomite	2.8	0.4	0.4	0.4	Tr
Anhydrite	0.4	--	--	0.4	0.4
Clay	--	--	--	Tr	Tr
Pore Space					
Intergranular	12.8%	10.0%	8.0%	17.2%	8.4%
Leached Grain	1.2	2.0	0.8	Tr	0.4
Measured Porosity(%)	15.7	15.3	12.7	18.8	11.1
Measured Permeability(md)	2.454	4.070	0.556	34.668	14.842

TABLE 3

MINERALOGICAL ANALYSIS BY X-RAY DIFFRACTION

ANADARKO PETROLEUM CORPORATION
CORNELL UNIVERSITY "C" NO. 1-H WELL
MORTON COUNTY, KANSAS

Mineralogy of Whole-Rock Sample

Relative Abundance in Percent

Depth (ft)	Unit	Qtz	Ksp	Plag	Cal	Dol	Anh	Clay	Total	Gd	
2320.9	KS	65	14	11	0	6	0	4	100	2.64	Ank
2353.7	KLL	4	0	1	31	64	0	0	100	2.80	
2356.3	KLL	5	0	0	82	6	7	0	100	2.73	Ank
2389.3	WS	49	17	12	7	11	0	4	100	2.66	Ank
2391.7	WS	54	11	7	11	8	6	3	100	2.68	Ank
2405.2	WDL	2	0	0	17	42	39	0	100	2.85	Ank
2461.2	TL	4	0	0	94	1	1	0	100	2.71	Ank
2463.5	TL	9	0	0	77	4	10	0	100	2.73	Ank
2465.4	TL	1	0	0	55	1	43	0	100	2.81	Ank
2514.6	HS	59	12	13	6	1	4	5	100	2.65	Ank
2532.8	FRL	10	0	8	74	1	6	1	100	2.71	Ank
2573.2	FLO	66	8	6	12	4	0	4	100	2.66	Ank
Min		1	0	0	0	1	0	0		2.64	
Max		65	17	13	94	64	43	5		2.85	
Avg		24	5	5	41	13	11	2		2.72	

KEY:

Qtz = quartz
Ksp = K-feldspar
Plag = plagioclase
Cal = calcite
Dol = dolomite
Anh = anhydrite
Clay = total clay
Gd = calculated grain density
Ank = contains ankerite/ferroan dolomite

KS = Krider Sand
KLL = Krider Lime (Lower)
WS = Winfield Sand
WDL = Winfield Dolomitic Lime
TL = Towanda Lime
HS = Homeville Sand
FRL = Ft. Riley Lime
FLO = Florence Sand

TABLE 4
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,310.1	9.3	12.1	F	11.7	2.65	1
2,311.2	11.9				2.68	1
2,311.9	9.6	11.6	F	10.5	2.72	1
2,312.2	10.9	10.9	F	9.70	2.77	1
2,312.4	10.5	11.8	F	10.6	2.63	1
2,313.2	11.7	13.5	F	12.2	2.80	1
2,313.7	17.7	26.7	F	23.4	2.82	1
2,314.4	7.8	12.7	F	12.5	2.66	2
2,314.8	11.5	0.225		0.134	2.72	2
2,315.2	11.8	0.132		0.072	2.74	2
2,315.8	15.1	0.369		0.228	2.77	2
2,316.1	15.0	0.054		0.030	2.81	2
2,316.4	14.8	0.064		0.026	2.81	2
2,318.3	8.6	44.1	F	37.9	2.76	3
2,318.6	7.8	34.3	F	30.	2.74	3
2,319.3	9.8	9.842		8.796	2.76	3
2,319.8	10.0	0.009		0.004	2.68	3
2,320.4	19.4	34.2	F	31.4	2.66	2
2,320.9	15.7	2.454		1.953	2.69	2
2,321.3	13.5	1.122		0.872	2.75	2
2,321.6	16.3	10.588		9.031	2.71	2
2,322.2	12.8	8.299		7.209	2.71	2
2,322.7	14.1	4.638		3.835	2.71	2
2,323.3	12.9	1.923		1.834	2.77	2
2,323.7	13.9	1.416		1.112	2.68	2
2,324.2	16.7	3.183		2.647	2.68	2
2,324.8	16.4	2.05		1.69	2.67	2
2,325.3	17.2	3.494		2.805	2.67	2
2,325.8	12.1	0.424		0.302	2.73	2
2,326.1	12.1	0.369		0.287	2.73	2
2,326.2	9.8	0.035		0.021	2.72	2
2,327.2	13.5	44.9	F	43.7	2.67	2
2,327.8	7.9	0.011		0.007	2.64	2
2,328.2	9.9	0.119		0.107	2.74	2
2,328.8	15.2	0.284		0.169	2.78	2
2,329.1	13.4	0.053		0.022	2.78	2
2,329.7	11.1	0.056		0.026	2.74	2
2,330.2	12.7	0.241		0.178	2.74	2
2,330.4	12.3	0.364		0.277	2.74	2
2,331.3	14.0	1.79		1.458	2.73	2
2,331.8	13.6	16.2	F	15.6	2.68	2
2,332.1	17.2	3.84		3.054	2.69	2

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,332.8	10.7	6.213		5.669	2.75	2
2,333.4	15.1	0.103		0.051	2.79	2
2,333.7	17.9	4.90		4.378	2.80	2
2,334.2	16.3	0.553		0.439	2.81	2
2,334.8	13.3	0.449		0.298	2.76	2
2,335.2	14.5	0.947		0.672	2.74	2
2,335.8	14.3	0.291		0.181	2.75	2
2,336.3	16.7	1.203		0.850	2.78	2
2,336.8	12.4	16.	F	15.4	2.73	2
2,337.3	15.2	26.4	F	26.2	2.69	2
2,337.8	17.3	1.856		1.466	2.69	2
2,339.4	12.6	0.055		0.031	2.78	3
2,339.8	15.3	0.159		0.086	2.79	3
2,340.3	17.1	1.023		0.700	2.81	3
2,340.8	16.8	0.679		0.441	2.83	3
2,341.1	16.9	1.213		0.868	2.84	3
2,341.7	14.5	1.072		0.770	2.85	3
2,342.3	14.4	1.667		1.266	2.85	3
2,342.8	13.2	1.219		0.915	2.84	3
2,343.2	16.9	1.954		1.454	2.83	3
2,343.9	12.3	0.982		0.716	2.84	3
2,344.2	16.6	2.502		1.908	2.81	3
2,344.7	13.6	1.40		1.06	2.84	3
2,345.3	14.1	1.342		1.001	2.84	3
2,345.7	14.9	1.389		1.032	2.83	3
2,346.3	14.3	2.108		1.65	2.84	3
2,346.8	15.1	1.674		1.26	2.83	3
2,347.3	13.8	0.523		0.356	2.79	3
2,347.8	13.3	1.349		1.091	2.72	3
2,348.3	12.1	0.107		0.060	2.73	3
2,348.8	13.4	1.275		1.024	2.71	3
2,349.3	13.8	0.200		0.125	2.75	3
2,349.7	14.4	1.217		0.986	2.75	3
2,350.2	14.3	0.183		0.107	2.77	3
2,350.7	15.2	0.280		0.169	2.78	3
2,351.8	14.4	0.171		0.097	2.77	3
2,351.8	14.6	0.321		0.207	2.79	3
2,352.3	13.1	0.154		0.085	2.79	3
2,352.7	10.0	0.091		0.046	2.77	3
2,353.2	10.9	0.037		0.015	2.78	3
2,353.7	12.2	0.456		0.376	2.79	3
2,354.3	11.0	0.095		0.046	2.78	4

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,354.8	11.4	0.595		0.457	2.78	4
2,355.3	10.5	0.205		0.118	2.73	4
2,355.9	12.6	0.576		0.388	2.71	4
2,356.3	12.8	0.613		0.409	2.71	4
2,356.7	13.5	1.102		0.797	2.71	4
2,357.2	12.1	0.446		0.290	2.73	4
2,357.7	13.3	0.810		0.561	2.73	4
2,358.2	13.2	0.705		0.474	2.73	4
2,358.9	13.1	2.002		1.546	2.73	4
2,359.2	11.3	0.913		0.674	2.74	4
2,359.8	11.2	1.02		0.752	2.73	4
2,360.2	9.4	0.114		0.061	2.75	4
2,360.8	10.0	0.092		0.045	2.76	4
2,361.3	11.1	0.185		0.104	2.75	4
2,361.7	9.9	0.477		0.452	2.74	4
2,362.1	7.7	11.3	F	11.1	2.61	1
2,362.4	8.0	16.3	F	15.1	2.66	1
2,363.5	11.4	0.029		0.012	2.79	1
2,363.8	12.8	16.	F	14.9	2.76	1
2,364.2	13.1	0.187		0.106	2.75	2
2,364.6	14.7	0.745		0.522	2.73	2
2,365.2	15.3	1.263		0.919	2.72	2
2,365.8	14.2	0.518		0.365	2.72	2
2,366.3	14.0	0.585		0.427	2.73	2
2,366.7	14.4	0.891		0.655	2.71	2
2,367.2	10.5	0.044		0.022	2.70	2
2,367.7	11.7	75.3	F	49.2	2.75	2
2,368.3	14.2	9.13	F	8.87	2.79	1
2,368.6	13.1	5.88	F	5.74	2.80	1
2,369.3	13.2	13.6	F	12.2	2.74	1
2,369.8	12.6	11.1	F	9.96	2.76	1
2,370.2	11.9	10.4	F	9.28	2.74	1
2,370.6	10.4	7.97	F	7.06	2.69	1
2,371.3	11.5	9.78	F	8.69	2.79	1
2,371.7	13.8	12.2	F	10.9	2.77	1
2,372.3	10.7	13.2	F	11.9	2.75	1
2,372.7	9.7	17.8	F	16.3	2.71	1
2,373.3	10.1	18.2	F	16.8	2.72	1
2,373.7	10.0	20.9	F	19.7	2.72	1
2,374.3	10.7	101.7	F	77.	2.76	1
2,374.7	8.5	15.2	F	14.	2.70	1
2,375.4	10.3				2.75	1

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,375.9	7.1	16.6	F	15.4	2.70	1
2,376.3	6.4	14.1	F	13.	2.71	1
2,376.7	8.2	25.2	F	24.8	2.72	1
2,377.1	9.7	37.2	F	34.2	2.72	1
2,377.4	10.8	39.6	F	35.3	2.73	1
2,378.2	20.7				2.73	1
2,378.4	7.1	16.9	F	16.7	2.72	1
2,379.5	5.7	10.3	F	10.2	2.70	1
2,379.8	6.2	21.4	F	21.	2.69	1
2,380.3	6.7	19.1	F	18.7	2.72	1
2,380.7	3.1				2.73	1
2,381.0	8.6	18.6	F	18.2	2.79	1
2,381.5	5.5	8.67	F	8.56	2.71	1
2,382.2	8.6				2.72	1
2,382.9	8.7				2.70	1
2,383.3	9.7	26.2	F	24.4	2.70	1
2,383.7	12.3	23.4	F	23.1	2.72	1
2,384.3	12.2	0.043		0.018	2.72	1
2,384.7	12.0	0.057		0.023	2.73	1
2,385.3	17.6	2.999		2.274	2.70	1
2,385.7	17.8	5.767		4.645	2.69	1
2,386.3	20.0	3.909		3.054	2.65	1
2,386.7	16.5	0.330		0.186	2.66	1
2,387.2	13.0	0.052		0.028	2.73	1
2,387.7	17.1	5.633		4.585	2.71	2
2,388.3	16.3	11.846		10.218	2.71	2
2,388.8	17.7	7.67		6.236	2.69	2
2,389.3	15.3	4.07		3.222	2.69	2
2,389.8	15.6	4.008		3.207	2.70	2
2,390.3	13.3	1.201		0.885	2.69	2
2,390.8	13.5	0.753		0.532	2.69	2
2,391.3	13.0	0.552		0.380	2.69	2
2,391.7	12.7	0.556		0.475	2.69	2
2,392.3	11.9	0.194		0.114	2.71	3
2,392.7	15.2	0.826		0.575	2.68	3
2,393.3	11.9	0.124		0.069	2.76	3
2,393.8	18.3	17.597		14.853	2.68	3
2,394.3	19.9	20.244		17.07	2.70	3
2,394.7	17.5	2.058		1.553	2.66	3
2,395.4	13.6	0.749		0.518	2.67	3
2,395.8	14.2	1.12		0.817	2.67	3
2,396.3	13.0	1.665		1.292	2.67	3

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)	Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,396.7	5.8	0.014	0.007	2.71	3
2,397.3	5.5	0.008	0.004	2.65	3
2,397.8	5.8	0.029	0.025	2.72	3
2,398.3	7.5	1.983	1.868	2.72	2
2,398.8	10.0	0.534	0.396	2.73	2
2,399.2	12.7	3.708	3.067	2.72	2
2,399.6	13.0	3.88	3.256	2.73	2
2,400.4	7.6	0.034	0.017	2.80	3
2,400.8	11.2	0.284	0.186	2.79	3
2,401.3	13.5	0.491	0.335	2.77	3
2,401.8	10.9	0.023	0.010	2.68	3
2,402.3	8.6	0.090	0.050	2.72	4
2,402.8	13.6	1.713	1.484	2.84	4
2,403.3	16.2	4.187	3.561	2.83	4
2,403.8	16.8	5.464	4.894	2.85	4
2,404.4	17.9	10.892	9.409	2.83	4
2,404.8	16.5	8.559	7.433	2.84	4
2,405.2	15.8	10.983	9.582	2.84	4
2,405.7	12.3	1.258	0.965	2.83	4
2,406.3	9.9	0.760	0.598	2.86	4
2,406.3	8.1	0.520	0.412	2.87	4
2,407.2	14.9	0.578	0.398	2.83	4
2,407.7	10.5	0.043	0.024	2.77	2
2,408.3	18.8	1.768	1.327	2.77	2
2,408.7	20.1	1.954	1.395	2.78	2
2,409.2	18.7	0.961	0.635	2.75	2
2,409.7	16.7	0.851	0.591	2.73	2
2,410.3	15.7	0.459	0.294	2.73	2
2,410.6	16.3	0.561	0.364	2.73	2
2,411.2	14.7	0.089	0.040	2.79	3
2,411.7	11.6	0.071	0.030	2.79	3
2,412.3	9.0	0.032	0.014	2.75	3
2,412.7	9.5	0.067	0.032	2.74	3
2,413.3	9.6	0.071	0.033	2.73	3
2,413.8	10.7	0.188	0.110	2.74	3
2,414.3	10.6	0.206	0.125	2.72	4
2,414.8	3.2	0.034	0.023	2.86	4
2,415.4	9.6	0.101	0.053	2.71	4
2,415.8	7.3	0.033	0.017	2.72	4
2,416.3	7.6	0.018	0.011	2.75	2
2,416.8	14.7	0.064	0.025	2.77	2
2,417.3	15.8	0.498	0.312	2.74	2

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,417.7	15.5	0.067		0.025	2.74	2
2,418.3	16.3	35.6	F	30.3	2.72	2
2,418.9	13.6	16.8	F	16.3	2.72	2
2,419.3	16.5	35.3	F	30.2	2.71	2
2,419.9	12.9	20.2	F	20.1	2.69	2
2,420.3	16.5	20.4	F	19.7	2.72	2
2,420.7	14.2	0.501		0.332	2.71	2
2,421.2	17.0	1.854		1.424	2.71	2
2,421.7	16.6	19.4	F	18.7	2.68	2
2,422.3	16.4	18.3	F	17.9	2.69	2
2,422.9	16.2	17.7	F	17.2	2.72	2
2,423.3	14.6	32.2	F	30.2	2.69	2
2,423.8	12.2	15.4	F	14.9	2.67	2
2,424.3	13.2	0.084		0.034	2.67	2
2,424.7	14.0	0.301		0.172	2.68	2
2,425.2	12.2	0.132		0.069	2.68	2
2,425.7	11.8	0.138		0.073	2.70	2
2,426.3	13.2	0.130		0.063	2.67	2
2,426.7	13.3	0.195		0.106	2.68	2
2,427.3	12.1	0.046		0.017	2.68	2
2,427.6	11.4	56.3	F	49.4	2.68	2
2,428.2	9.7	14.2	F	13.5	2.75	1
2,428.8	8.6	17.4	F	16.	2.73	1
2,429.3	9.2	18.7	F	16.8	2.74	1
2,429.5	9.8	26.8	F	26.6	2.72	1
2,435.3	11.7	42.5	F	41.4	2.73	1
2,435.7	10.2	74.4	F	65.8	2.70	1
2,437.5	11.4	11.2	F	10.2	2.73	1
2,437.8	9.3	25.7	F	25.5	2.71	1
2,438.3	10.3	38.5	F	27.4	2.72	1
2,438.8	8.9	16.3	F	16.	2.72	1
2,439.5	10.0	27.2	F	26.3	2.69	1
2,439.8	11.1	109.	F	82.6	2.72	1
2,441.9	6.7	51.3	F	49.7	2.76	1
2,442.3	6.8	3.91	F	3.59	2.78	1
2,442.7	10.8	7.54	F	7.40	2.76	1
2,443.4	14.4	48.1	F	46.6	2.74	1
2,444.5	13.9	31.8	F	31.3	2.72	1
2,444.7	15.0	25.2	F	23.7	2.72	1
2,445.3	14.1	67.2	F	52.5	2.70	1
2,445.8	14.7	30.4	F	28.3	2.71	1
2,446.2	15.4	0.298		0.183	2.72	1

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,446.7	15.3	0.276		0.172	2.72	1
2,447.2	14.2	0.121		0.065	2.71	1
2,447.7	13.7	0.064		0.026	2.72	1
2,448.2	14.8	0.166		0.092	2.72	1
2,448.6	15.1	0.258		0.160	2.72	1
2,449.2	13.6	0.056		0.023	2.72	1
2,449.5	10.9	42.3	F	40.1	2.70	1
2,450.3	5.2				2.74	1
2,450.8	11.5	26.7	F	26.6	2.73	1
2,451.2	9.2	21.6	F	20.9	2.71	1
2,451.6	11.2	31.8	F	31.2	2.72	1
2,452.2	11.1	0.052		0.027	2.72	1
2,452.7	9.5	27.8	F	27.5	2.72	1
2,454.9	12.0	13.8	F	13.1	2.68	2
2,455.4	12.5	18.1	F	17.2	2.68	2
2,455.8	13.9	25.4	F	24.2	2.67	2
2,456.3	11.4	17.3	F	16.7	2.69	2
2,457.3	9.5	0.216		0.138	2.71	4
2,457.7	9.7	0.215		0.131	2.72	4
2,458.3	10.8	0.360		0.236	2.71	4
2,458.6	12.1	731.	F	671.	2.71	4
2,459.3	11.1	0.400		0.268	2.71	4
2,459.8	8.9				2.68	4
2,460.8	7.3	0.032		0.015	2.67	4
2,461.2	11.1	0.577		0.408	2.71	4
2,461.5	13.8	2.098		1.653	2.80	4
2,463.5	26.8	52.351		49.343	2.73	4
2,465.4	23.4	15.443		13.926	2.73	4
2,465.8	22.2	13.094		12.036	2.74	4
2,466.2	16.8	0.015		0.009	2.68	3
2,466.7	10.0	0.080		0.037	2.73	3
2,467.3	11.8	0.129		0.065	2.74	3
2,467.8	10.7	0.097		0.047	2.74	3
2,468.4	10.9	0.084		0.039	2.75	3
2,468.8	12.7	0.165		0.088	2.77	3
2,469.3	10.5	0.067		0.031	2.76	3
2,469.8	11.9	0.103		0.052	2.76	3
2,470.2	11.3	0.109		0.055	2.74	3
2,470.7	9.9	0.106		0.056	2.74	3
2,471.3	11.0	0.082		0.040	2.75	3
2,471.7	10.7	0.065		0.032	2.74	3
2,472.5	10.9	0.057		0.030	2.74	3

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,472.8	10.2	0.056		0.029	2.73	3
2,473.3	8.5	0.030		0.016	2.73	3
2,473.7	9.3	0.175		0.106	2.72	3
2,474.3	8.0	0.010		0.005	2.68	3
2,474.8	12.8	0.228		0.132	2.81	3
2,475.2	10.9	0.153		0.087	2.75	3
2,475.7	10.6	0.078		0.037	2.74	3
2,476.2	11.1	0.095		0.046	2.74	3
2,476.8	15.6	8.127		6.675	2.73	3
2,477.2	14.7	1.903		1.415	2.74	2
2,477.9	17.9	16.248		14.092	2.69	2
2,478.2	12.9	2.02		1.699	2.74	2
2,478.6	14.3	0.156		0.086	2.79	2
2,479.2	17.5	4.55		3.631	2.70	2
2,479.7	18.3	4.637		3.587	2.69	2
2,480.3	19.7	12.079		9.93	2.70	2
2,480.7	18.9	7.054		5.60	2.70	2
2,481.2	18.1	3.341		2.497	2.72	2
2,481.7	18.3	4.166		3.176	2.70	2
2,482.3	20.2	7.162		5.63	2.68	2
2,482.8	19.6	6.713		5.296	2.68	2
2,483.2	19.9	5.86		4.54	2.68	2
2,483.8	14.0	0.121		0.054	2.67	2
2,484.3	14.1	0.136		0.064	2.68	2
2,484.8	14.7	0.202		0.105	2.67	2
2,485.2	11.4	0.042		0.022	2.70	2
2,485.2	13.2	0.077		0.031	2.68	2
2,486.2	12.0	24.7	F	23.4	2.68	2
2,486.7	10.6	71.1	F	60.5	2.67	1
2,487.3	12.8	26.4	F	25.6	2.69	1
2,487.9	13.1	20.8	F	20.4	2.67	1
2,488.2	13.3	18.7	F	17.	2.69	1
2,488.7	11.5	27.	F	25.5	2.72	1
2,489.3	10.1	32.	F	27.6	2.71	1
2,490.2	20.3	30.9	F	26.8	2.66	1
2,490.6	12.8	62.1	F	46.4	2.68	1
2,491.1	15.9	17.7	F	17.4	2.68	1
2,492.8	11.2	22.7	F	21.7	2.69	1
2,493.8	9.9	7.73	F	7.38	2.61	1
2,494.3	12.2	22.1	F	20.3	2.69	1
2,494.8	11.2	20.2	F	18.6	2.70	1
2,495.4	14.0				2.73	1

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,495.8	11.3	14.7	F	13.4	2.73	1
2,496.8	16.4	17.8	F	17.	2.77	1
2,497.5	14.5	16.9	F	16.6	2.74	1
2,497.7	12.3	0.028		0.012	2.64	1
2,498.1	12.8	15.7	F	14.2	2.72	1
2,498.5	13.0	0.052		0.021	2.72	1
2,506.2	14.6	0.102		0.051	2.71	1
2,506.7	13.7	0.093		0.042	2.71	1
2,507.3	13.9	0.125		0.065	2.70	1
2,507.7	14.3	0.119		0.061	2.70	1
2,508.3	14.6	0.690		0.602	2.69	1
2,508.6	11.3	0.043		0.028	2.67	1
2,509.2	12.5	36.1	F	35.7	2.70	1
2,509.7	15.9	0.137		0.065	2.78	1
2,510.2	20.5	3.672		2.85	2.66	1
2,510.7	21.5	25.499		22.107	2.66	1
2,511.4	14.4	0.285		0.245	2.75	2
2,511.8	12.8	0.480		0.346	2.68	2
2,512.2	17.7	7.394		6.212	2.66	2
2,512.8	13.0	0.242		0.165	2.68	2
2,513.2	11.0	1.522		1.318	2.69	2
2,513.6	12.0	0.586		0.436	2.67	2
2,514.2	9.9	5.293		5.05	2.68	2
2,514.6	18.8	34.668		31.418	2.65	2
2,515.2	19.5	78.8	F	70.	2.64	2
2,515.6	12.3	2.074		1.688	2.65	2
2,516.3	16.4	58.5	F	53.8	2.67	2
2,516.8	12.9	0.486		0.365	2.67	2
2,517.3	10.4	0.153		0.080	2.69	2
2,517.8	14.2	7.123		6.028	2.67	2
2,518.3	15.5	14.176		12.403	2.68	2
2,518.8	9.5	0.076		0.038	2.71	2
2,519.3	12.9	1.071		0.821	2.68	2
2,519.9	8.3				2.72	4
2,520.3	10.3	0.151		0.086	2.71	4
2,520.8	11.4	0.335		0.217	2.70	4
2,521.3	11.3	0.484		0.331	2.71	4
2,521.9	11.1	0.261		0.163	2.71	4
2,522.3	10.8	0.223		0.138	2.71	4
2,522.8	9.3	0.103		0.057	2.71	4
2,523.5	7.4	0.038		0.023	2.72	4
2,523.9	9.5	0.191		0.114	2.73	4

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)	Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,524.3	10.7	0.221	0.132	2.75	4
2,524.8	11.9	0.337	0.211	2.71	4
2,525.5	11.2	0.250	0.156	2.70	4
2,525.7	10.0	0.082	0.046	2.71	4
2,526.3	10.8			2.70	4
2,526.7	7.2	0.050	0.024	2.72	4
2,527.3	12.2	0.542	0.369	2.70	4
2,527.8	11.9	0.475	0.350	2.70	4
2,528.3	11.6	0.278	0.169	2.70	4
2,528.8	11.1	0.198	0.118	2.72	4
2,529.3	12.4	0.439	0.348	2.71	4
2,529.7	9.9	0.077	0.039	2.71	4
2,530.3	7.9	0.062	0.030	2.72	4
2,530.8	10.7	0.193	0.119	2.71	4
2,531.4	11.3	0.567	0.425	2.72	4
2,531.8	11.8	0.799	0.598	2.71	4
2,532.3	12.3	0.603	0.424	2.70	4
2,532.8	14.6	2.95	2.299	2.71	4
2,533.2	11.9	1.203	0.900	2.72	4
2,533.7	13.1	1.267	0.942	2.71	4
2,534.3	11.4	0.392	0.277	2.70	4
2,534.7	9.7	0.141	0.082	2.71	4
2,535.3	7.8	0.040	0.023	2.71	4
2,535.8	12.8	1.582	1.20	2.71	4
2,536.5	12.6	1.227	0.894	2.70	4
2,536.8	11.3	0.721	0.524	2.71	4
2,537.3	11.9	0.798	0.554	2.69	4
2,537.7	12.5	0.790	0.546	2.69	4
2,538.3	12.7	0.543	0.358	2.72	4
2,538.7	10.5	0.210	0.121	2.70	4
2,538.9	10.3	0.192	0.113	2.71	4
2,539.4	11.9	0.584	0.400	2.71	4
2,539.8	10.4	0.232	0.140	2.70	4
2,540.3	9.6	0.145	0.082	2.70	4
2,540.7	10.1	0.175	0.102	2.70	4
2,541.3	10.7	0.229	0.140	2.71	4
2,541.7	10.3	0.211	0.122	2.70	4
2,542.3	10.6	0.237	0.142	2.70	4
2,542.7	9.7	0.126	0.070	2.70	4
2,543.3	10.0	0.108	0.056	2.70	4
2,543.8	10.8	0.229	0.143	2.71	4
2,544.3	9.8	0.127	0.071	2.71	4

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,544.6	8.5	0.067		0.034	2.71	4
2,545.2	10.3	0.130		0.070	2.71	4
2,545.7	11.0	0.303		0.200	2.71	4
2,546.2	8.8	0.068		0.034	2.71	4
2,546.7	7.4	0.034		0.019	2.71	4
2,547.2	4.7	0.005		0.002	2.72	3
2,547.9	4.8	0.008		0.005	2.71	3
2,548.3	3.2				2.70	3
2,548.7	3.0				2.68	3
2,549.3	3.8	0.002		0.001	2.71	3
2,549.8	3.8	0.002		0.001	2.70	3
2,550.3	2.0			< 0.001	2.63	3
2,551.3	1.4			< 0.001	2.64	3
2,551.7	1.2			< 0.001	2.64	3
2,552.3	4.2	0.073		0.048	2.63	3
2,552.8	3.9			< 0.001	2.61	3
2,553.2	4.1			< 0.001	2.59	3
2,553.7	4.5			< 0.001	2.58	3
2,554.3	4.0			< 0.001	2.63	3
2,554.7	4.7			< 0.001	2.64	3
2,555.3	4.1			< 0.001	2.60	3
2,555.7	4.8			< 0.001	2.64	3
2,556.2	4.8			< 0.001	2.58	3
2,556.8	4.7			< 0.001	2.58	3
2,557.3	2.1				2.61	3
2,557.8	4.3	0.005		0.002	2.67	3
2,558.3	2.8			< 0.001	2.66	3
2,558.8	2.0			< 0.001	2.67	3
2,559.3	1.4			< 0.001	2.65	3
2,559.7	4.5	9.06	F	8.88	2.67	3
2,560.2	4.0				2.65	3
2,560.8	6.3				2.69	3
2,561.3	6.6				2.66	3
2,561.9	5.2	11.	F	10.8	2.63	3
2,562.2	4.5	11.7	F	11.5	2.65	3
2,562.7	3.6	8.81	F	8.70	2.68	3
2,563.2	3.5	9.63	F	9.56	2.68	2
2,563.8	7.7	0.030		0.014	2.70	2
2,564.3	11.3	0.182		0.098	2.69	2
2,564.8	10.9	0.255		0.149	2.69	2
2,565.3	13.2	0.706		0.461	2.69	2
2,565.8	13.0	0.876		0.592	2.69	2

TABLE 4 (CONTINUED)
ROUTINE CORE ANALYSIS DATA*
ANADARKO CORNELL UNIV. "C" NO. 1-H WELL

Depth (ft.)	Porosity (%)	Permeability to air (md)		Permeability-Infinite (md)	Grain Density (g/mm)	Dep. Facies
2,566.4	12.8	0.820		0.553	2.69	2
2,566.8	12.3	0.628		0.414	2.69	2
2,567.3	9.2	0.148		0.083	2.69	2
2,567.8	10.9	0.473		0.350	2.69	2
2,568.3	8.4	0.066		0.031	2.69	2
2,568.8	7.4	0.045		0.023	2.69	2
2,569.3	4.8	0.010		0.005	2.72	4
2,569.9	4.2	0.005		0.002	2.71	4
2,570.3	4.3	0.009		0.004	2.73	4
2,570.7	5.8	0.018		0.009	2.73	4
2,571.3	6.1	0.024		0.013	2.73	4
2,571.8	6.5	0.026		0.013	2.70	4
2,572.3	9.7	0.046		0.021	2.71	2
2,572.7	9.8	13.661		13.379	2.70	2
2,573.2	11.1	14.842		14.706	2.68	2
2,573.9	12.3	23.9	F	23.1	2.69	2
2,574.2	11.4	14.406		14.141	2.68	2
2,574.6	11.7	369.	F	308.	2.68	2
2,575.1	10.9	15.706		15.544	2.68	2
2,575.7	13.8	18.556		18.044	2.69	2
2,576.4	9.4	0.075		0.034	2.69	1
2,576.8	11.0	0.078		0.037	2.66	1
2,577.3	10.9	0.049		0.021	2.69	1
2,577.8	9.6	0.034		0.014	2.69	1
2,578.3	9.6	0.047		0.020	2.70	1
2,578.7	10.6	0.086		0.040	2.70	1
2,579.3	10.2	0.063		0.028	2.71	1
2,579.8	9.3	0.025		0.009	2.71	1
2,580.3	8.2	0.013		0.005	2.73	1
2,580.8	8.6	0.017		0.006	2.69	1
2,581.2	7.8	0.010		0.004	2.70	1
2,581.6	8.3	0.043		0.037	2.69	1
Min.:	1.2	0.0		0.0	2.58	
Max.:	26.8	731.0		671.0	2.87	
Avg.:	11.8	10.1		8.7	2.72	

* Data provided by Core Laboratories, Inc
NOB is 800 psig
F Indicates a fractured sample

Depositional Facies
1 - Paleosol/Coastal Plain
2 - Tidal Flat
3 - Carbonate Lagoon/Bay
4 - Carbonate Shoal

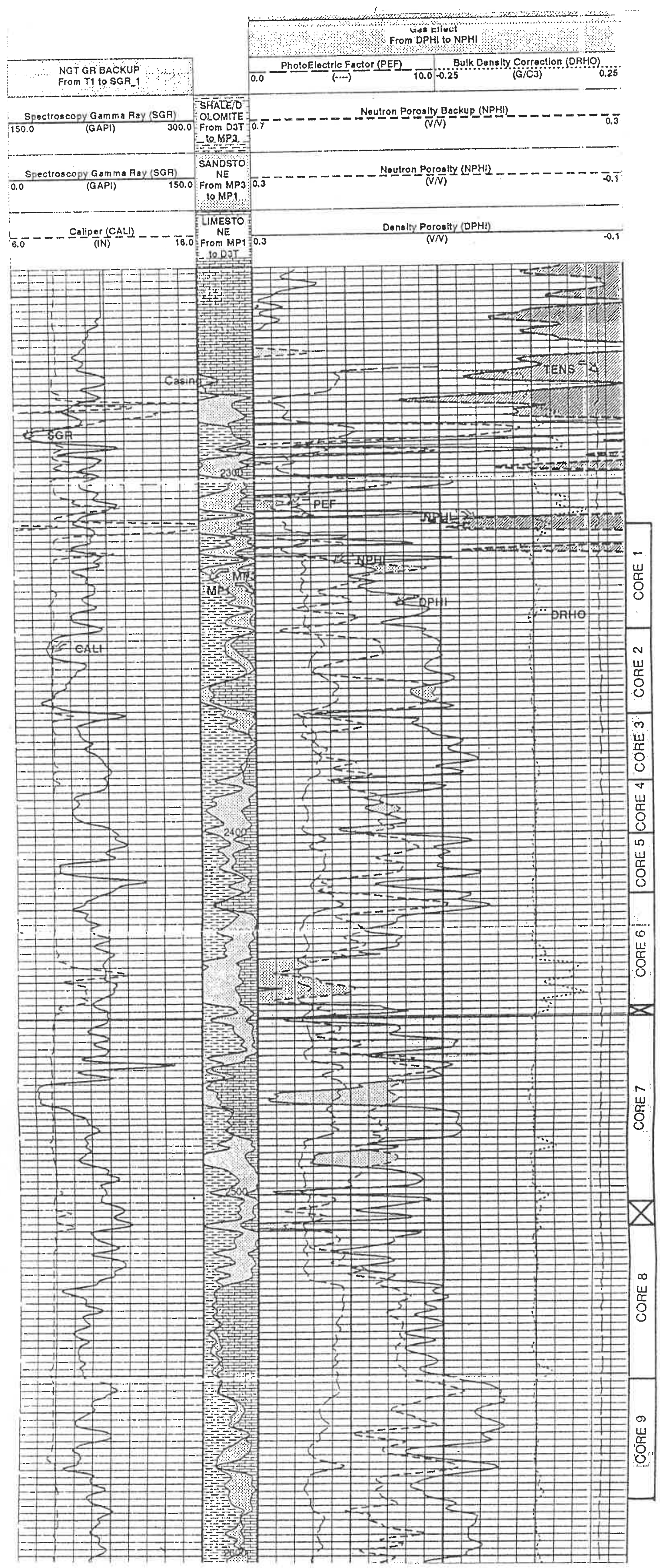
35-32-40W
15-129-21249

FIGURE 1

CORE TO LOG CORRELATION
ANADARKO PETROLEUM CORPORATION
CORNELL UNIVERSITY "C" NO. 1-H WELL
HUGOTON FIELD
MORTON COUNTY, KANSAS

CORE 1 - 6 CORE DEPTH +5 FEET = LOG DEPTH

CORE 7 - 9 CORE DEPTH +6 FEET = LOG DEPTH



CORE LEGEND

STRUCTURES

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

ACCESSORY CONSTITUENTS

Py- PYRITE

CALC. - CALCAREOUS

SiO_2 - SILICEOUS

DOL. - DOLOMITE

ARG. - ARGILLACEOUS

© - CLACITE-FILLED VUGS

SSD - SOFT-SEDIMENT-DEFORMATION

CARB. - CARBONACEOUS DEBRIS

CONTACTS

- SHARP
- GRADATIONAL
- UNDULATORY/IRREGULAR

SAMPLE LOCATIONS

TS - THIN SECTION

A-D - CLOSE CORE PHOTOGRAPH

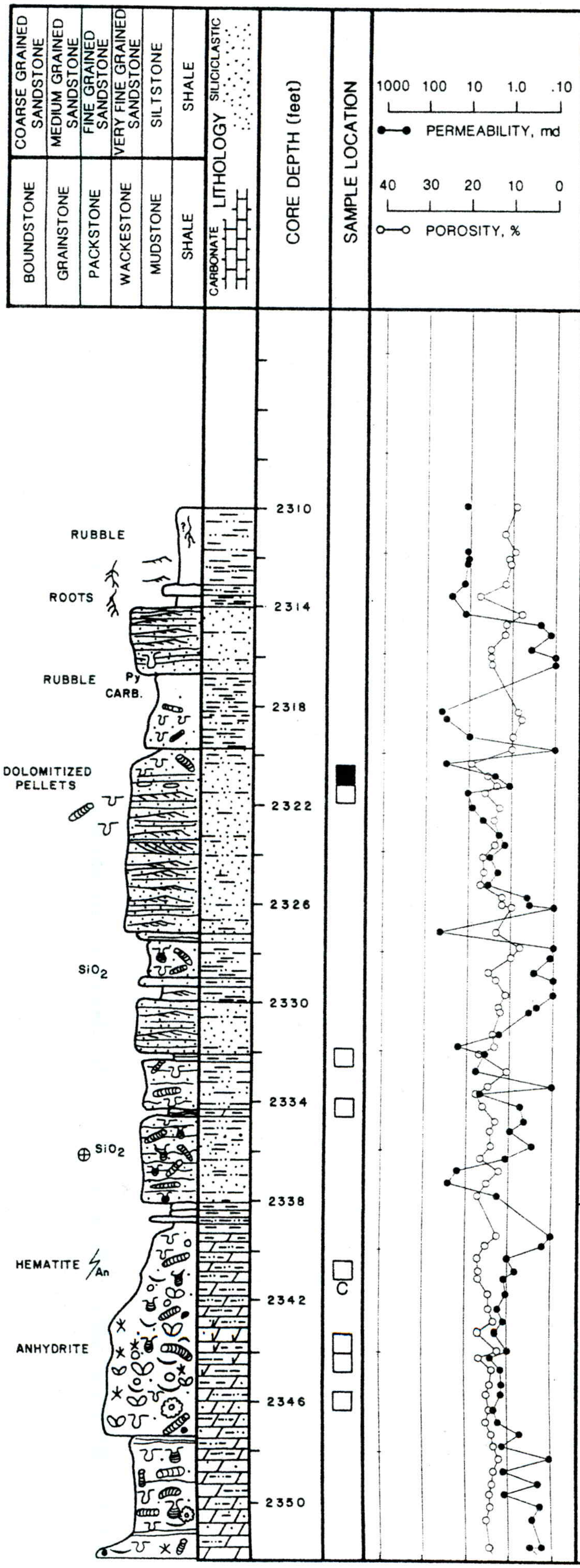
■ - THIN SECTION, XRD, SCAL SAMPLE

CARBONATE GRAIN VARIETIES

- PELECYPODS
- BRACHIOPODS
- GASTROPODS
- ECHINODERMS
- CALCAREOUS ALGAE (UNDIFFERENTIATED)
- R CALCAREOUS RED ALGAE
- BRYOZOANS
- FORAMINIFERA
- CORAL
- OOIDS
- ONCOIDS/ALGAL-COATED GRAINS
- PELOIDS
- PELLETS
- INTRACLASTS

LITHOLOGY

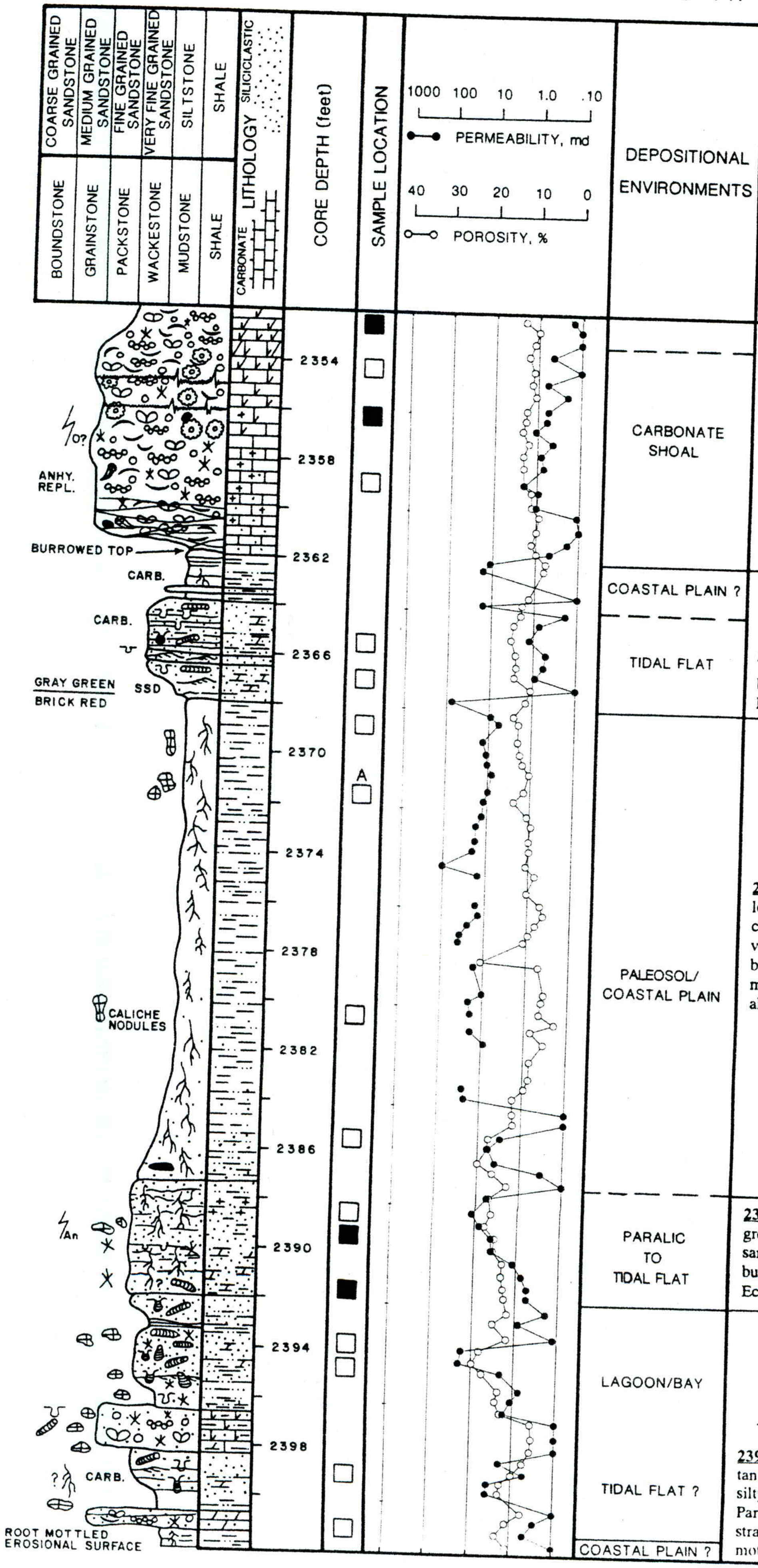
SANDSTONE	⊥ CALCITIC
SILTSTONE	DOLOMITIC
SHALE	-·- SILTY
LIMESTONE	--- SHALY
DOLOSTONE	...... SANDY
ANHYDRITE	+ ANHYDRITIC



DEPOSITIONAL ENVIRONMENTS	DESCRIPTION AND REMARKS
	TOP OF CORE 1
PALEOSOL/ COASTAL PLAIN	<u>2310.0-2314.1 feet (4.1')</u> -- Brick-red, greenish-gray, and gray silty claystone with minor siltstone. Some root mottling. A few ripples.
TIDAL FLAT	<u>2314.1-2316.5 feet (2.4')</u> -- Tan to light gray, ripple cross-stratified to laminated very fine-grained sandstone to siltstone.
LAGOON/BAY ?	<u>2316.5-2320.0 feet (3.5')</u> -- Medium olive-gray, argillaceous siltstone to silty claystone. Small burrows common.
TIDAL FLAT	<u>2320.0-2338.0 feet (18.0')</u> -- Beige to medium gray, siltstone/very fine-grained sandstone, interbedded with argillaceous very fine-grained sandstone/siltstone and silty claystone. The "clean" sandstones and siltstones show ripple cross-stratification and thin, horizontal laminations. The argillaceous strata show more extensive bioturbation. A few chert nodules (after evaporites?). Patchy silica cement. ← Thin dolomite lamination.
CARBONATE LAGOON/BAY	BOTTOM OF CORE 1 TOP OF CORE 2 <u>2338.0-2362.0 feet (24.0')</u> -- Medium gray to tan, limestone, dolostone and silty/sandy dolostone. The lowermost 8 feet consist of slightly dolomitic lime packstone to grainstone; a wide variety of skeletal fragments and peloids are present. The remaining 16 feet are argillaceous, silty/sandy dolowackestone to mudstone; extensive bioturbation noted. Minor dolomitic shale at top of unit. Anhydrite-filled molds, vugs and fractures. Brachiopods, pelecypods, bryozoans, echinoderms and coral fragments are present. Peloids, oncoids and intraclasts also present. Many of the grains are algally coated.

FIGURE 2 CONTINUED

CORNELL UNIVERSITY "C" 1-H



DESCRIPTION AND REMARKS

Patchy anhydrite replacement between 2357.5 and 2350.0 feet. Possible open(?) fracture at 2357–58 feet. Intergranular, intercrystalline, and moldic pores present in grainstone. Other parts have little visible porosity.

BOTTOM OF CORE 2

TOP OF CORE 3

<u>2362.0–2368.0 feet (6.0')</u> -- Light grayish-brown very fine-grained sandstone/siltstone, grading to dark gray silty claystone at top. The sandstone/siltstone is partially bioturbated and partially cross-stratified. Minor carbonaceous debris.

<u>2368.0–2387.6 feet (19.6')</u> -- Brick-red to locally green, argillaceous siltstone to silty claystone, grading upward from argillaceous very fine-grained siltstone to siltstone at the base. Scattered anhydrite nodules. Root mottled throughout. Some caliche nodules also noted. Trace of carbonaceous debris.

BOTTOM OF CORE 3

TOP OF CORE 4

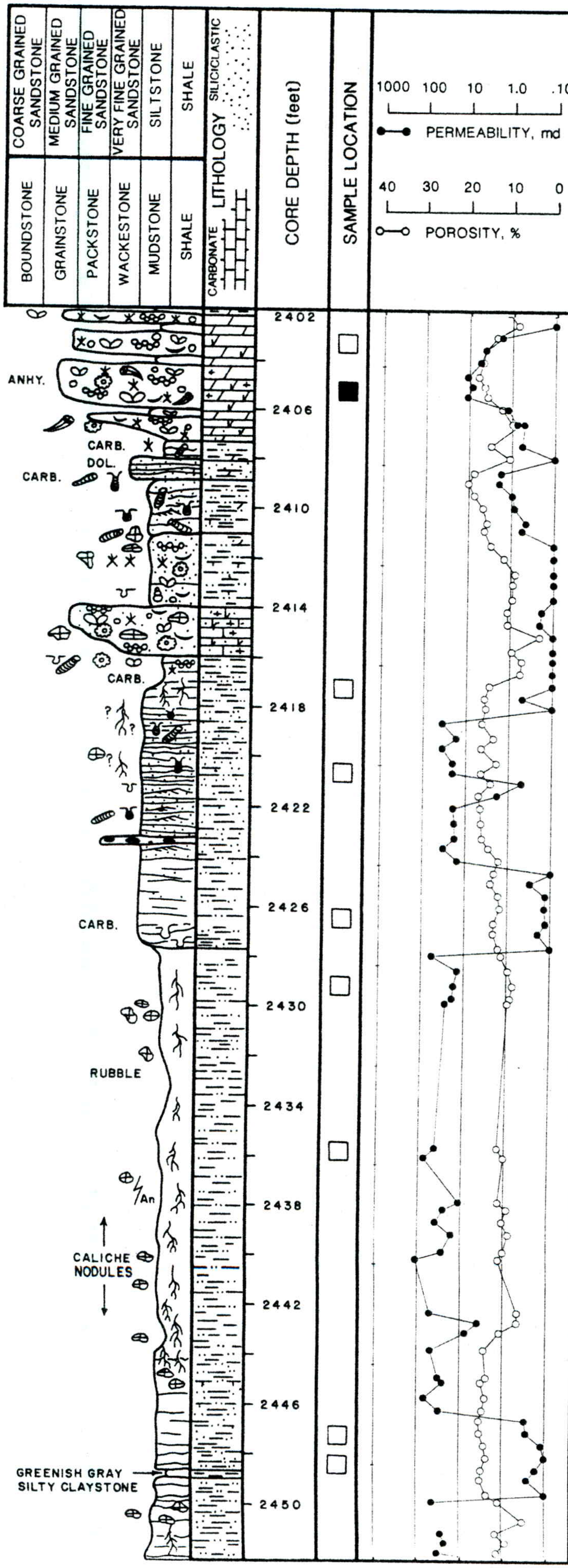
<u>2387.6–2392.1 feet (4.5')</u> -- Reddish- to greenish-tan, argillaceous very fine-grained sandstone. Root mottled at top. A few burrows near base. Anhydrite nodules. Echinoderms present. Dolomitic.

BOTTOM OF CORE 4

TOP OF CORE 5

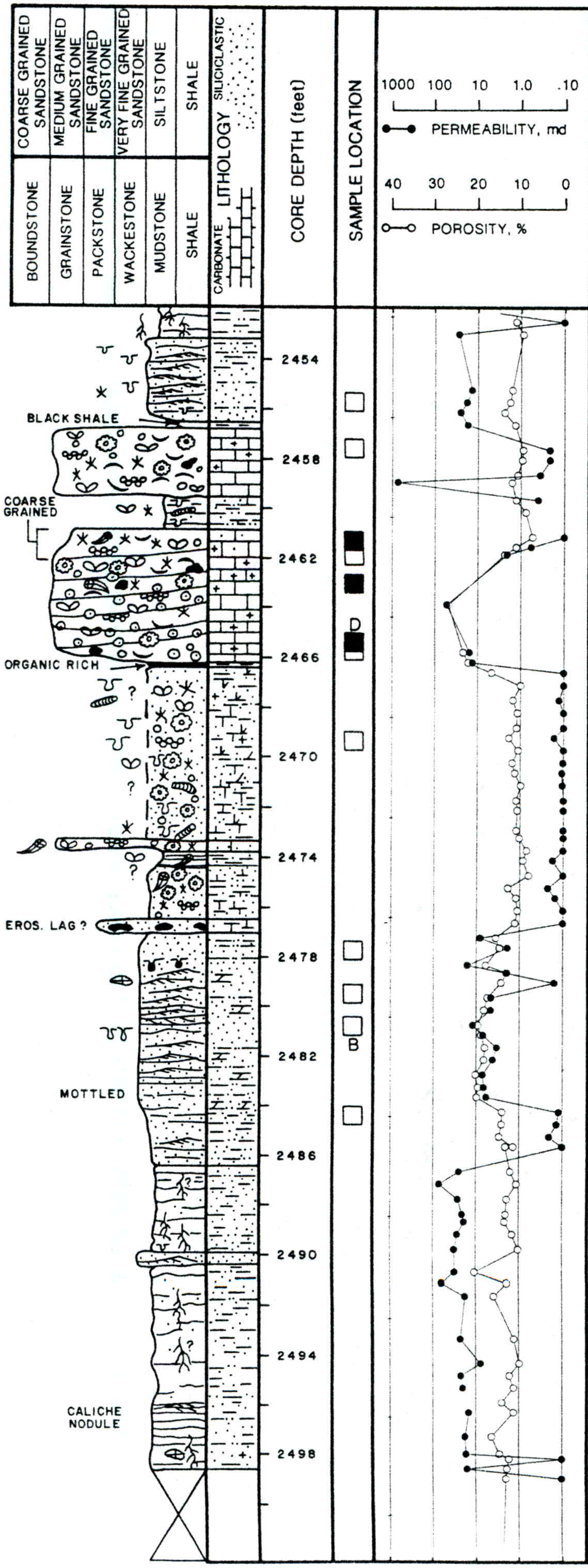
<u>2392.1–2402.1 feet (10.0')</u> -- Medium gray, tan and olive-gray, argillaceous siltstone, silty claystone and silty dolomitic limestone. Parts are bioturbated, parts are ripple cross-stratified and/or laminated. Some root mottling. Anhydrite nodules common.

FIGURE 2 CONTINUED
CORNELL UNIVERSITY "C" 1-H



DEPOSITIONAL ENVIRONMENTS	DESCRIPTION AND REMARKS
	Scour surface at 2402 feet.
CARBONATE SHOAL	**2402.1-2407.3 feet (5.2')** -- Tan to light brown, dolomite. Skeletal-peloid grainstone with thin interbeds of mudstone. Bryozoans, corals, brachiopods, pelecypods, peloids and echinoderms. Minor moldic and intergranular pore space.
TIDAL FLAT LAGOON/BAY CORE 5 CORE 6	**2407.3-2414.0 feet (6.7')** -- Dark to medium gray and tan, argillaceous, locally calcareous/dolomitic, fossiliferous, very fine-grained sandstone to siltstone. Ripples and laminations in the upper half, burrows and fossils in the lower half. Several anhydrite nodules.
CARBONATE SHOAL/ FORESHORE	**2414.0-2416.0 feet (2.0')** -- Tan to gray, somewhat dolomitic, lime wackestone to grainstone. Anhydrite nodules.
TIDAL FLAT GRADING TO COASTAL PLAIN	**2416.0-2427.8 feet (11.8')** -- Tan to greenish-gray and reddish-brown siltstone to very fine-grained sandstone. Top and bottom are argillaceous. Thin argillaceous beds throughout. Ripples and horizontal laminations common throughout most of unit. A few scattered burrows and phosphatic skeletal grains.
PALEOSOL/ COASTAL PLAIN	**2427.8-2453.2 feet (25.4')** -- Brick-red, argillaceous siltstone to silty claystone. Anhydrite nodules and caliche nodules present. Root mottling evident throughout. Some laminations toward bottom of unit. BOTTOM OF CORE 6 TOP OF CORE 7

FIGURE 2 CONTINUED
CORNELL UNIVERSITY "C" 1-H



DEPOSITIONAL ENVIRONMENTS	DESCRIPTION AND REMARKS
COASTAL PLAIN	CONTINUED FROM ABOVE
TIDAL FLAT	2453.2-2456.6 feet (3.4') -- Tan to light gray, ripple cross-stratified, very fine-grained sandstone/siltstone. A few burrows noted.
CARBONATE SHOAL	2456.6-2466.2 feet (10.0') -- Medium gray to light brown, lime grainstone with a few interbeds of dark gray siltstone. The grainstone contains skeletal debris, ooids, superficial ooids, peloids and oncoids. Crude cross-stratification in lower unit. Patchy anhydrite replacement. Minor micrite. Scattered siliciclastic grains.
LAGOON/BAY	2466.2-2477.0 feet (10.8') -- Medium gray, argillaceous, calcareous/dolomitic siltstone to very fine-grained sandstone. Burrows common. Scattered oncoids, peloids and skeletal debris. Thin carbonate bed at 2473-74.0 feet. Erosional lag at base. Locally anhydritic.
TIDAL FLAT	2477.0-2486.5 feet (9.5') -- Tan to light olive-gray, very fine-grained sandstone/siltstone. Ripple cross-stratified to finely laminated. Minor bioturbation. Slightly dolomitic.
PALEOSOL/ COASTAL PLAIN	2486.5-2498.7 feet (12.2') -- Brick-red to mottled, argillaceous siltstone with minor silty claystone and argillaceous very fine-grained sandstone. Root mottling evident in parts; other parts may be root mottled. Caliche and anhydrite nodules at base.
	BOTTOM OF CORE 7
	2498.70-2505.75 feet -- No core.

FIGURE 2 CONTINUED
CORNELL UNIVERSITY 'C' 1-H

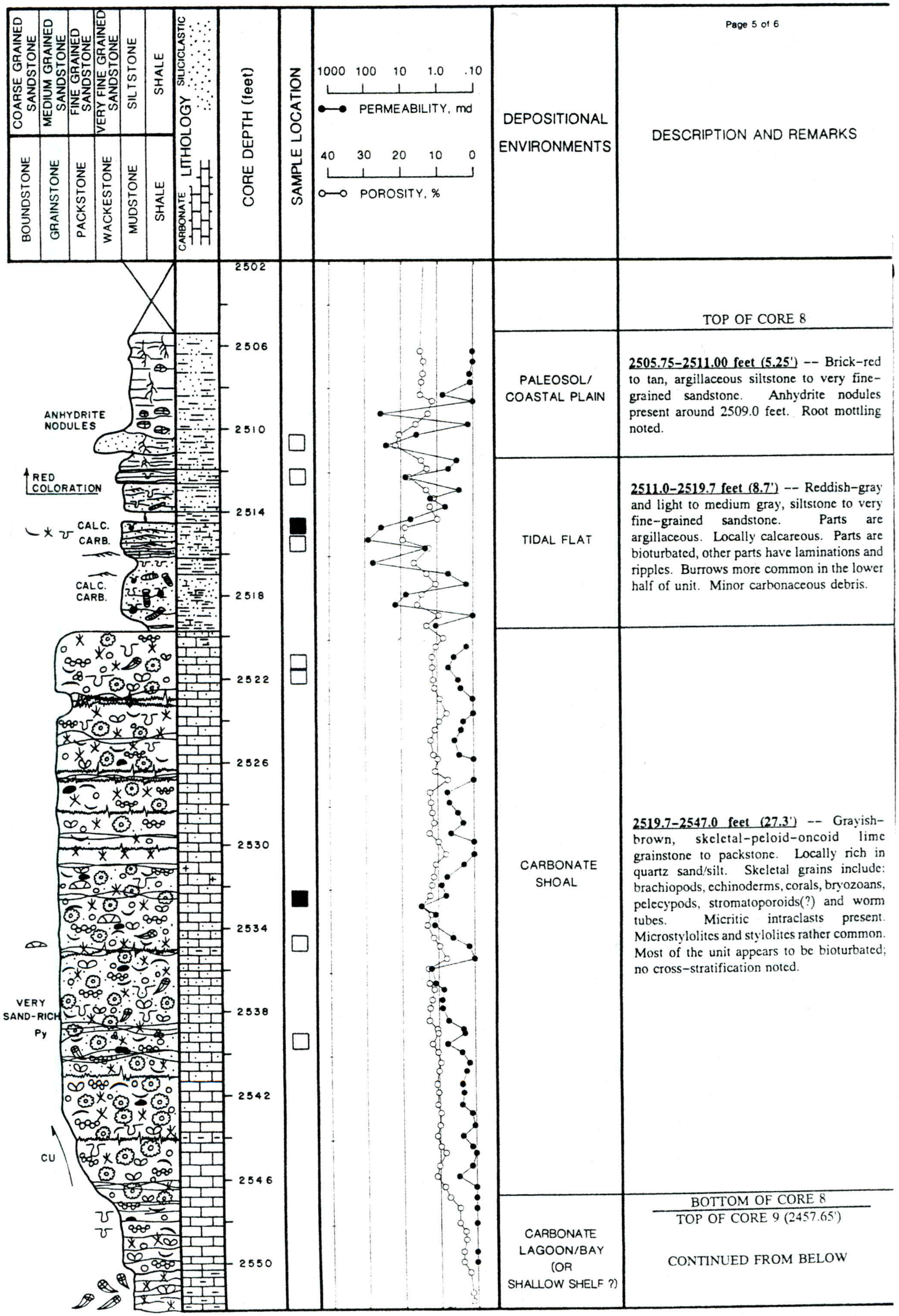
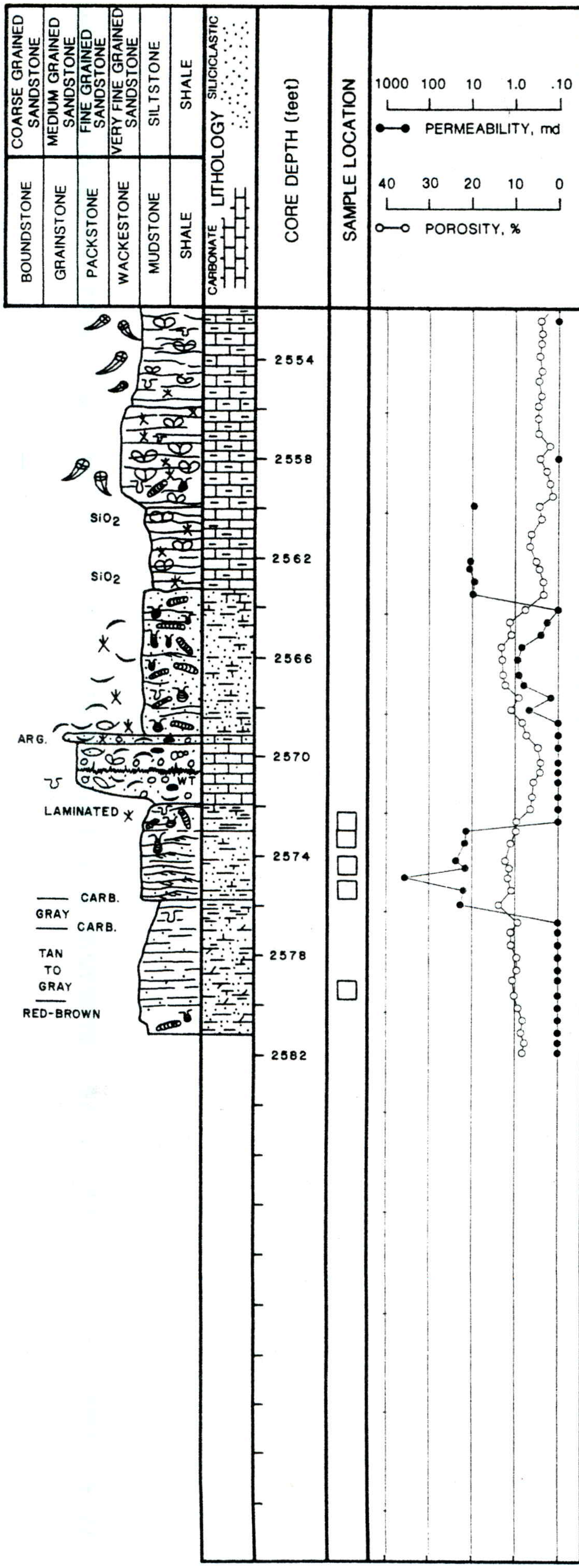


FIGURE 2 CONTINUED
CORNELL UNIVERSITY "C" 1-H



DEPOSITIONAL ENVIRONMENTS	DESCRIPTION AND REMARKS
CARBONATE LAGOON/BAY (OR SHALLOW SHELF ?)	<u>2547.0–2563.0 feet (16.0')</u> -- Dark gray, argillaceous lime wackestone to mudstone. Crude laminations common. Brachiopods (*Productids*), corals, echinoderms and bryozoans present. Patchy silicification, some of which could have replaced anhydrite nodules. Faint bioturbation. No visible pores.
LOWER TIDAL FLAT OR LAGOON/BAY	<u>2563.0–2569.2 feet (6.2')</u> -- Light to medium gray, extensively burrowed, calcareous, siltstone to very fine-grained sandstone. Scattered skeletal fragments; mostly echinoderms and pelecypods.
CARBONATE SHOAL	<u>2569.2–2572.0 feet (2.8')</u> -- Tan to dark gray, sandy, lime grainstone to packstone. Peloids, pelecypods, brachiopods, worm tubes and intraclasts present.
TIDAL FLAT	<u>2572.0–2575.9 feet (3.9')</u> -- Light gray, laminated and ripple cross-stratified very fine-grained sandstone to siltstone. Bioturbated at top. Fine-grained skeletal debris. Locally argillaceous.
COASTAL PLAIN ?	<u>2575.9–2581.5 feet (5.6')</u> -- Gray, tan and reddish-brown, siltstone to very fine-grained sandstone. Argillaceous toward top. Carbonaceous debris toward top. A few burrows.
	BOTTOM OF CORE 9

FIGURE 3

CLOSE CORE PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

A. Depth: <u>2371 feet</u> Depth Facies: <u>Paleosol/Coastal Plain</u>

The predominant brick-red coloration, apparent root mottling, desiccation features, and anhydrite nodules/fractures (upper left) are all characteristic of the paleosol/coastal plain facies. These features are interpreted to indicate that these silty claystones and argillaceous siltstones accumulated as soil horizons.

B. Depth: <u>2481 feet</u> Depth Facies: <u>Tidal Flat</u>

Note the fine, uniform grain size, well preserved laminations and ripples, and scattered vertical burrows in this sample. These characteristics are common features in tidal flat deposits. Where bioturbation is somewhat more extensive, than shown here, a lower intertidal to shallow subtidal environment is inferred. Where bioturbation is less common, an upper intertidal to supratidal environment is more likely.

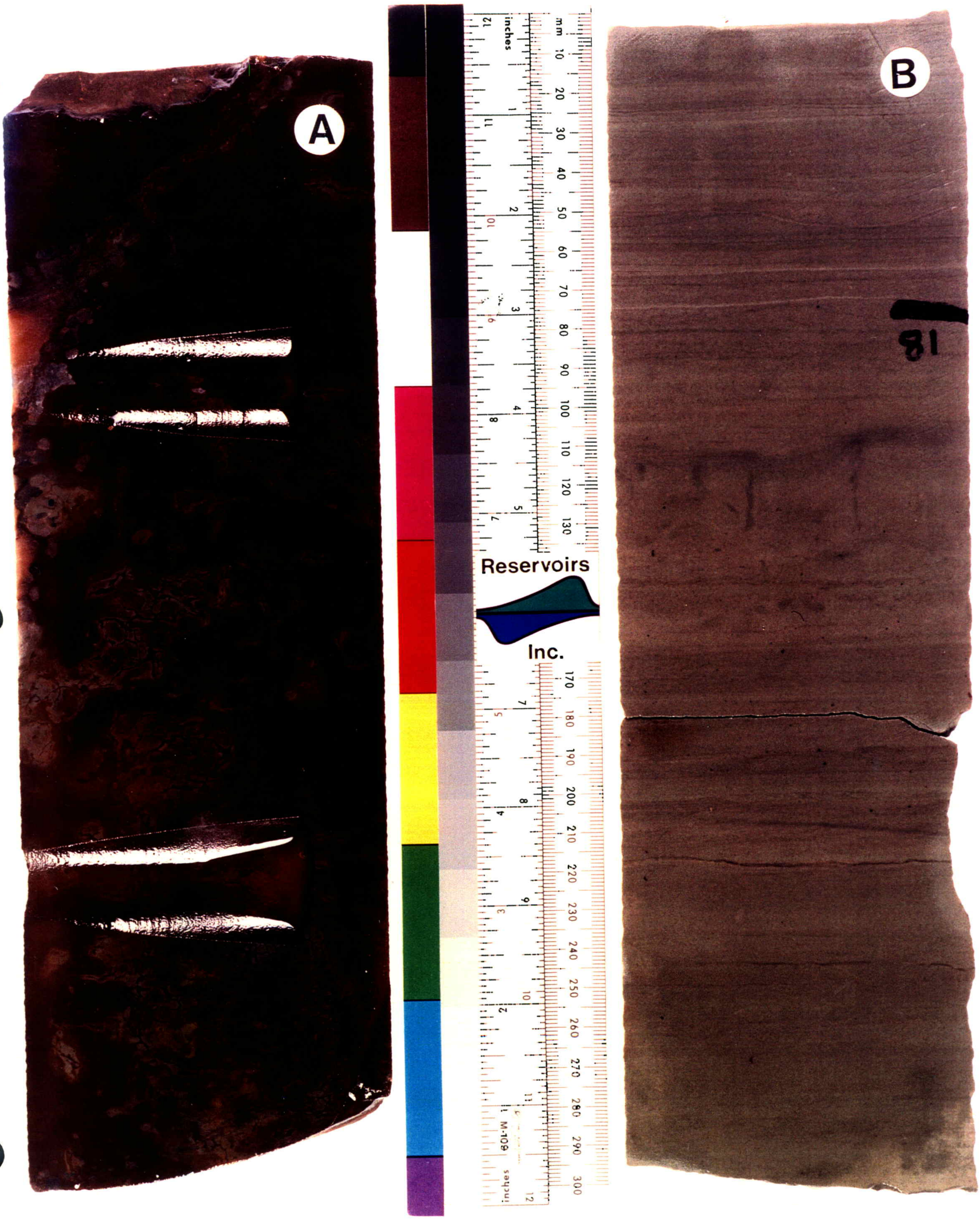

A
B
Reservoirs
Inc.

FIGURE 3 (CONTINUED)

CLOSE CORE PHOTOGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

C. Depth: 2341 feet Depth Facies: Carbonate Lagoon/Bay

Note the burrow-mottled fabric in this silty, dolomitic wackestone. Skeletal debris, peloids, intraclasts and other carbonate allochems are present. The texture is consistent with moderate to low-energy subtidal sedimentation, probably in a restricted lagoon or bay environment.

D. Depth: 2465 feet Depth Facies: Carbonate Shoal

This rock has preserved planar cross-stratification. This, combined with the grainstone texture, reflects rather persistent high-energy conditions at the site of deposition. The sample shown here comes from an ooid-rich portion of the shoal facies. In other places, this facies is dominated by peloids and skeletal debris. The small dark-colored patches reflect areas of anhydrite cementation/replacement.

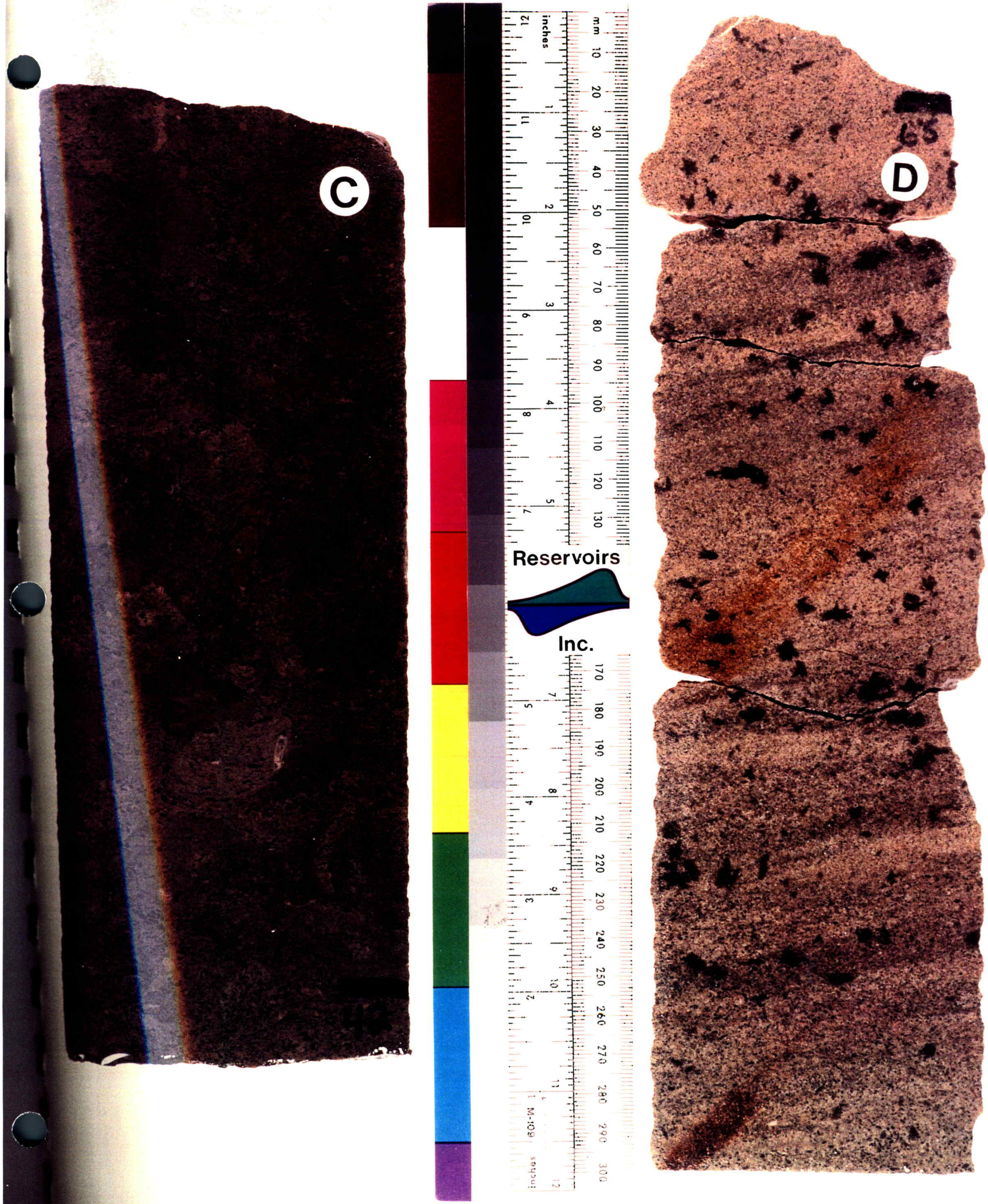

C
D
Reservoirs
Inc.

FIGURE 4

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2320.9 feet

Average Grain Size: 0.056 mm (Coarse Silt)
Sorting: Very Well Sorted

Porosity: 15.7%
Permeability: 2.454 md

Stratigraphic Unit: Krider Sand
Dep. Facies: Tidal Flat

Although primary intergranular pores are well preserved in parts of this siltstone, other parts are rich in dolomicrite and very finely crystalline dolomite cement (lower half of view B). Some of these heterogeneities may reflect irregularities created by bioturbation. Where this dolomicrite matrix and dolomite cement are less common, the rock is judged to have a well interconnected network of intergranular pores. Note the very fine grain size and the uniform sorting. Quartz and feldspar grains account for nearly all of the framework constituents.

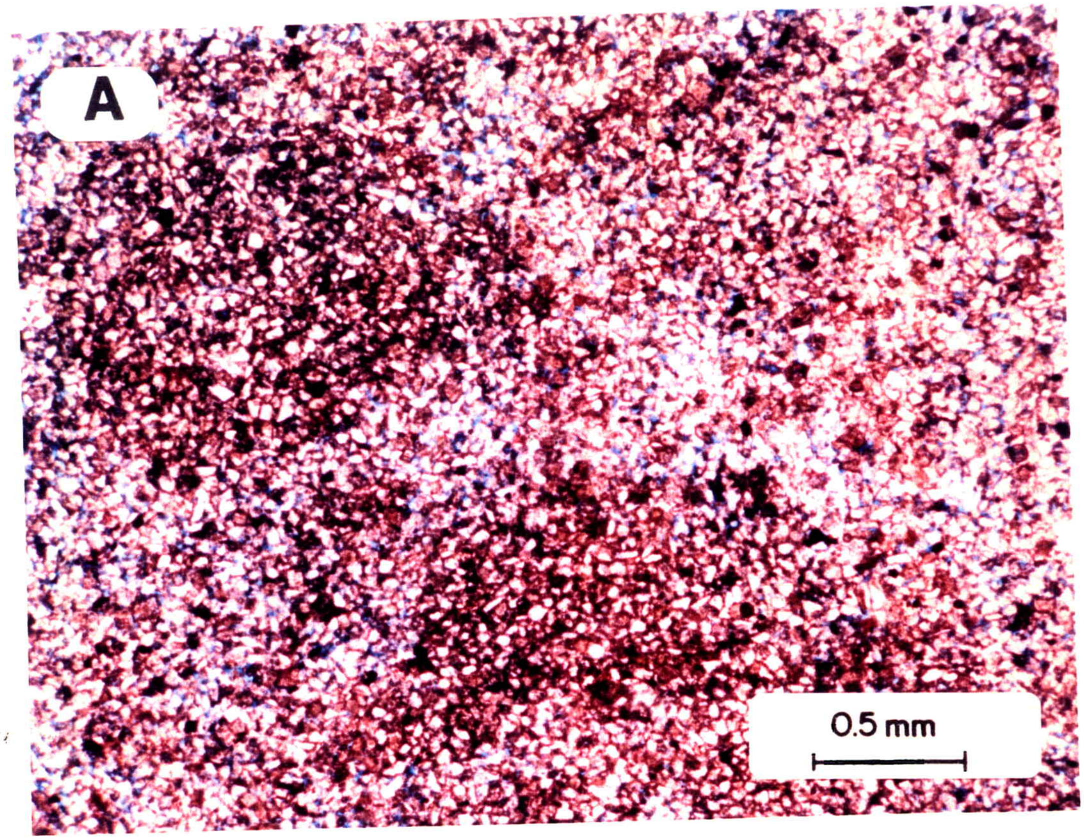
A – 40X

B – 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	65%
Potassium Feldspar	14%
Plagioclase Feldspar	11%
Dolomite	6%
Clay	4%


A
0.5 mm

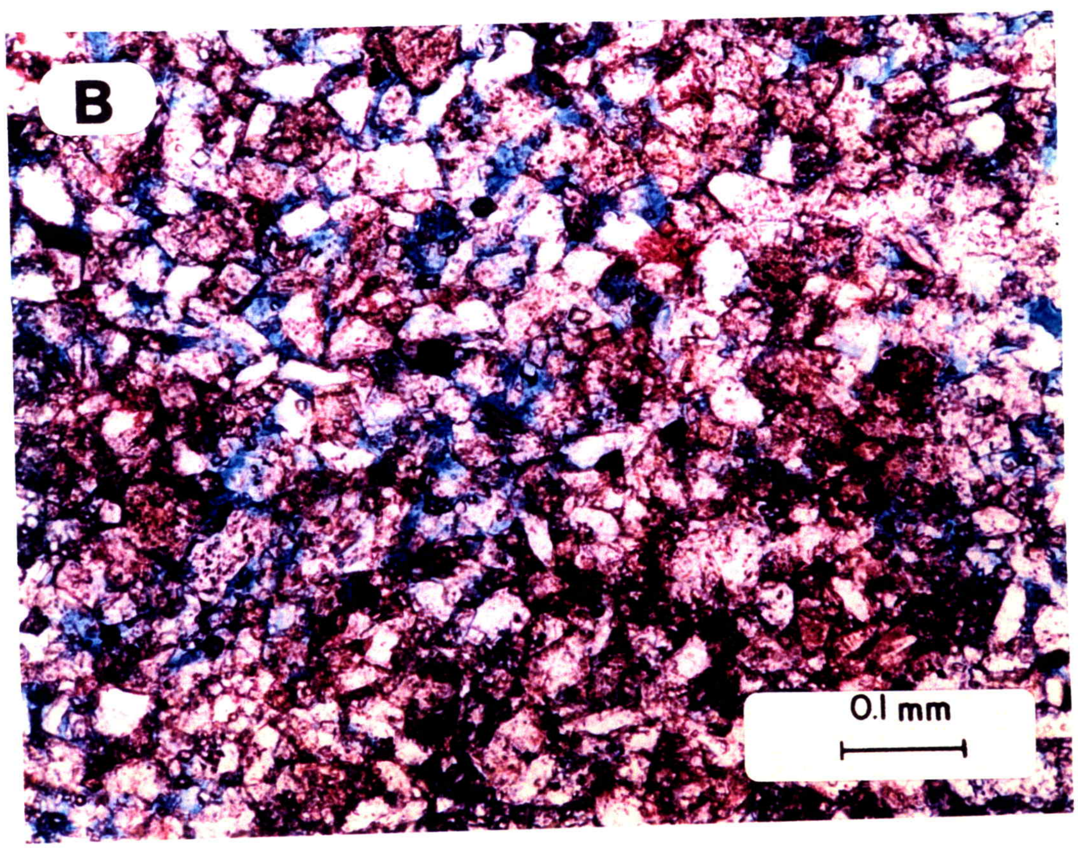

B
0.1 mm

FIGURE 5

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2353.7 feet

Rock Type: Calcareous Dolomite
Depositional Texture: Packstone
Porosity: 12.2%
Permeability: 0.456 md
Stratigraphic Unit: Krider Lime (Lower)
Dep. Facies: Carbonate Shoal

A combination of dolomite cement and dolomitized micrite matrix have eliminated most of the intergranular macropores in this packstone. Most of the measured pore volume appears to be in the form of: 1) small intercrystalline pores (black arrows) between the dolomite rhombs, 2) moldic pores where grains have been partially leached, and 3) as intragranular microporosity within partially altered micritic grains (such as oncoids). The moldic pores and intragranular microporosity are probably rather ineffective components of the pore system. Oncoids, skeletal fragments and peloids are the main framework constituents.

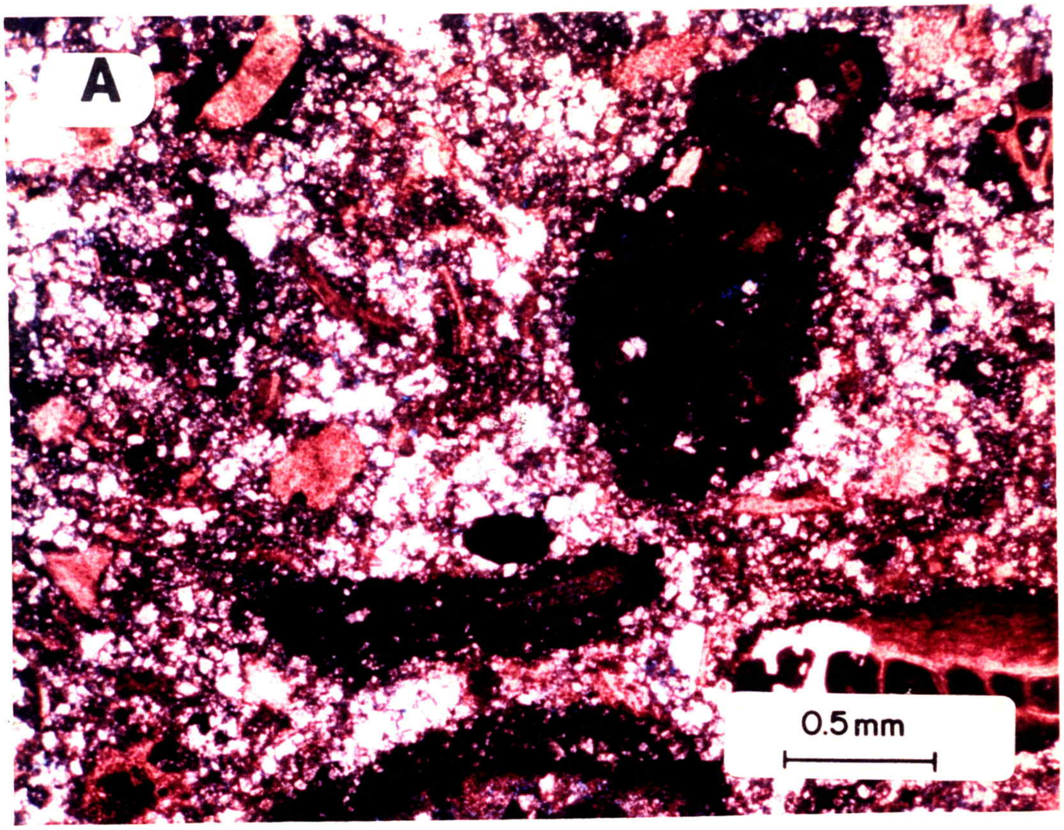
A - 40X

B - 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	4%
Plagioclase Feldspar	1%
Calcite	31%
Dolomite	64%


A
0.5 mm

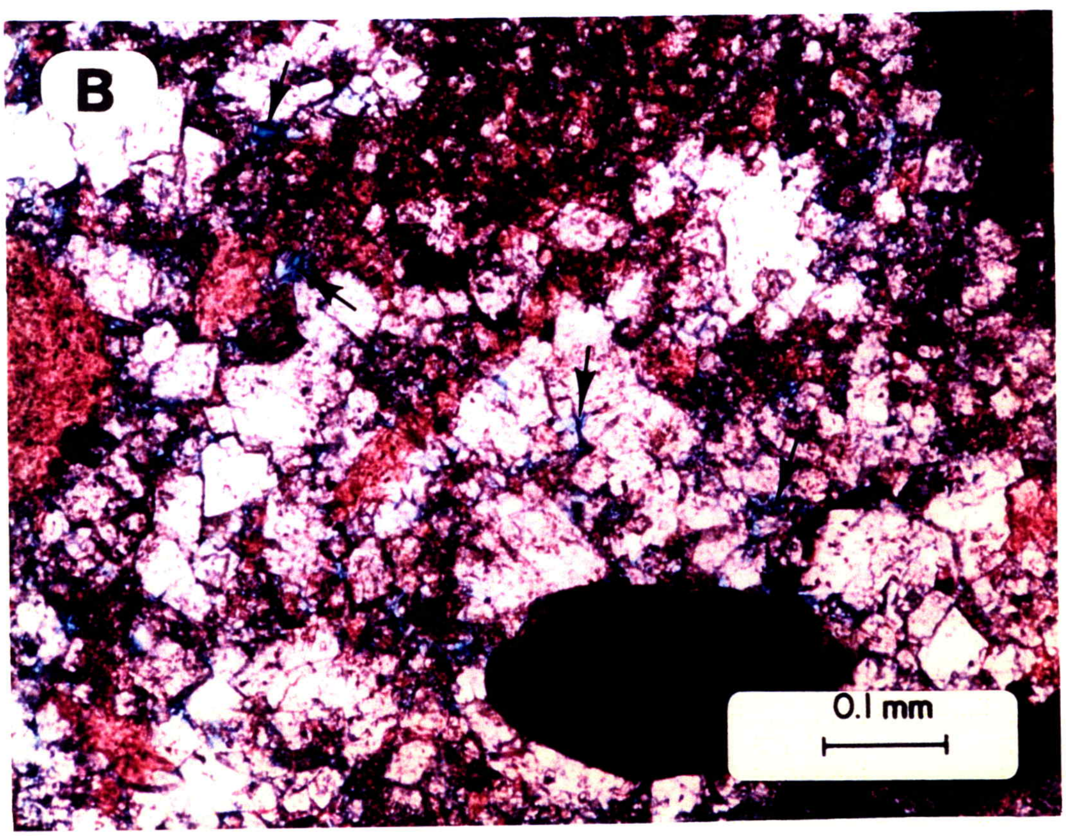

B
0.1 mm

FIGURE 6

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2356.3 feet

Rock Type: Limestone
Porosity: 12.8%
Depositional Texture: Grainstone
Permeability: 0.613 md
Stratigraphic Unit: Krider Lime (Lower)
Dep. Facies: Carbonate Shoal

The pore system in this lime grainstone consists of 1) moldic (Mo) pores where grains and oncoid nuclei have been leached, 2) highly reduced intergranular pores, and 3) microporosity within the micritic oncoids. Calcite cement (Ca) has occluded a large portion of the intergranular pore volume. Only small remnants of the intergranular pore network have been preserved. The low permeability (compared to the measured porosity) suggests that a relatively large portion of the total pore volume is in the form of microporosity and poorly interconnected secondary pores. In view B, the darker, more micritic areas have a faint blue cast, reflecting the presence of microporosity.

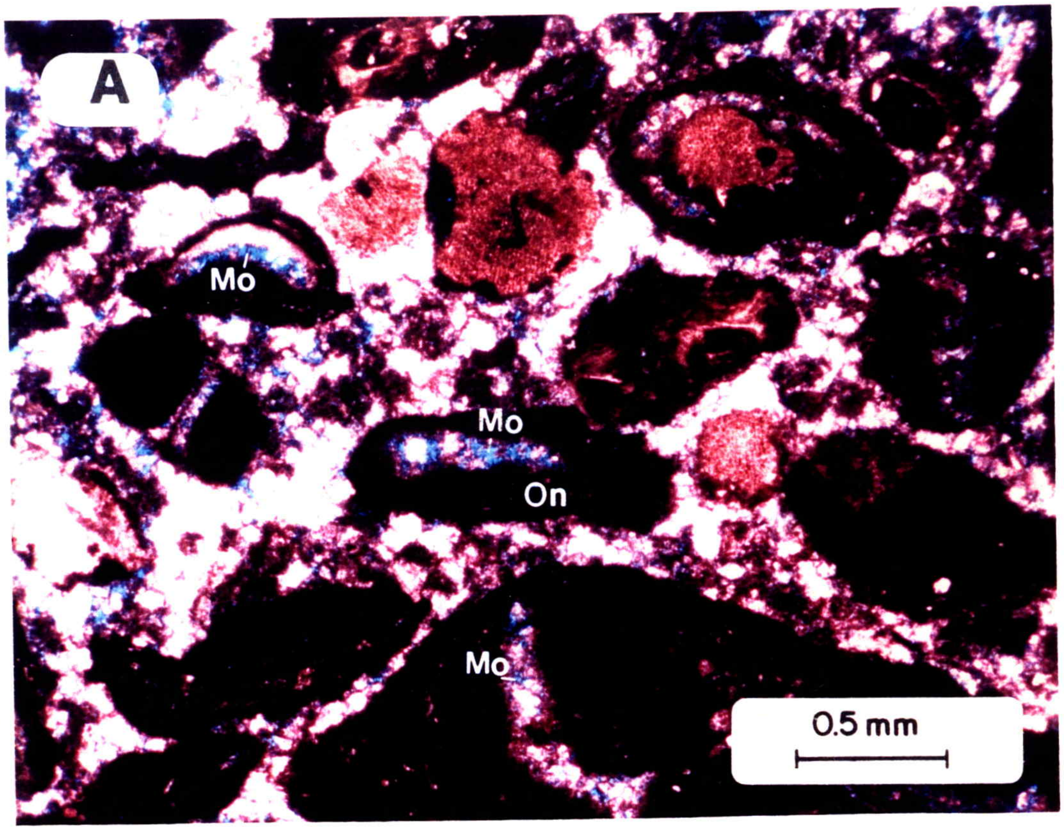
A - 40X

B - 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	5%
Calcite	82%
Dolomite	6%
Anhydrite	7%


A
Mo
Mo
On
Mo
0.5 mm

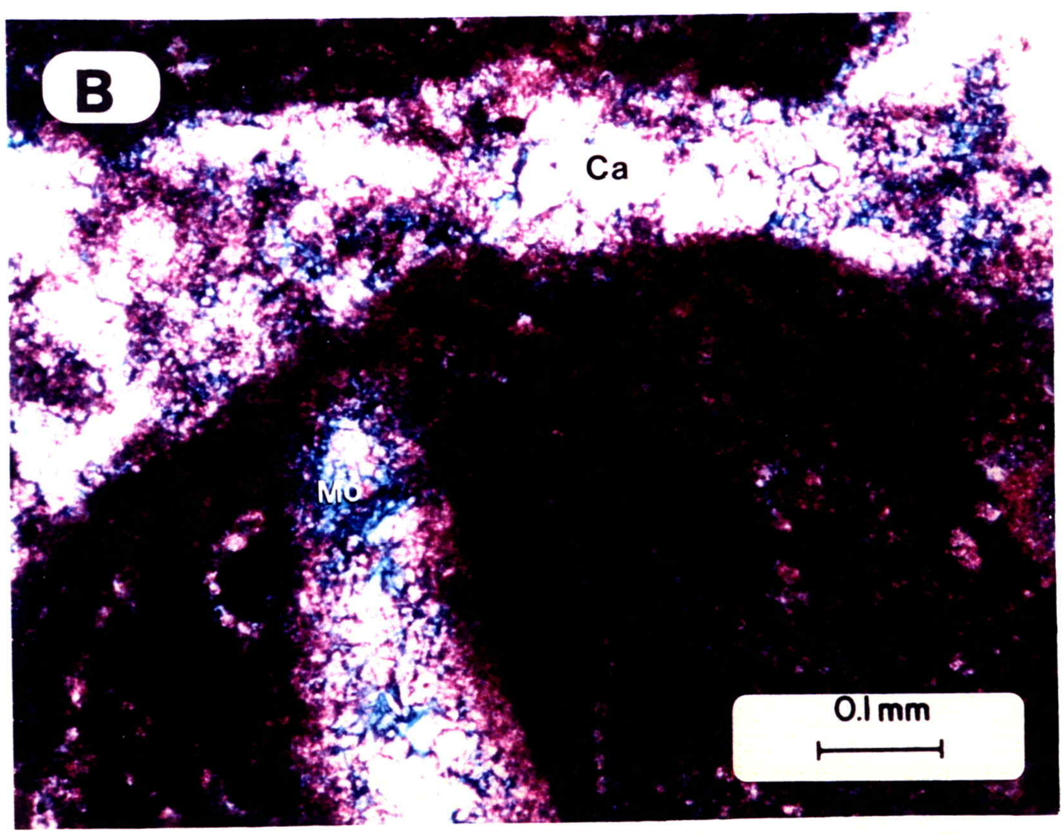

B
Ca
Mo
0.1 mm

FIGURE 7

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2389.3 feet

Average Grain Size: 0.073 mm (LVF Sand)
Sorting: Very Well Sorted
Porosity: 15.3%
Permeability: 4.070 md
Stratigraphic Unit: Winfield Sand
Dep. Facies: Tidal Flat

Pore space in this very fine-grained sandstone has been reduced by a combination of dolomite (both matrix and cement), calcite (both matrix and cement), authigenic clay and anhydrite cement. Close examination (view B) indicates that there are parts of the sample that have very few open intergranular pores. There is heterogeneity in the rock, apparently reflecting bedding, bioturbation and/or root mottling. For example, near the bottom of view A, a relative abundance of intergranular pore space is apparent. Near the top of view A, intergranular pore space is uncommon. Most of the fluid flow capacity is probably confined to the "clean" laminations.

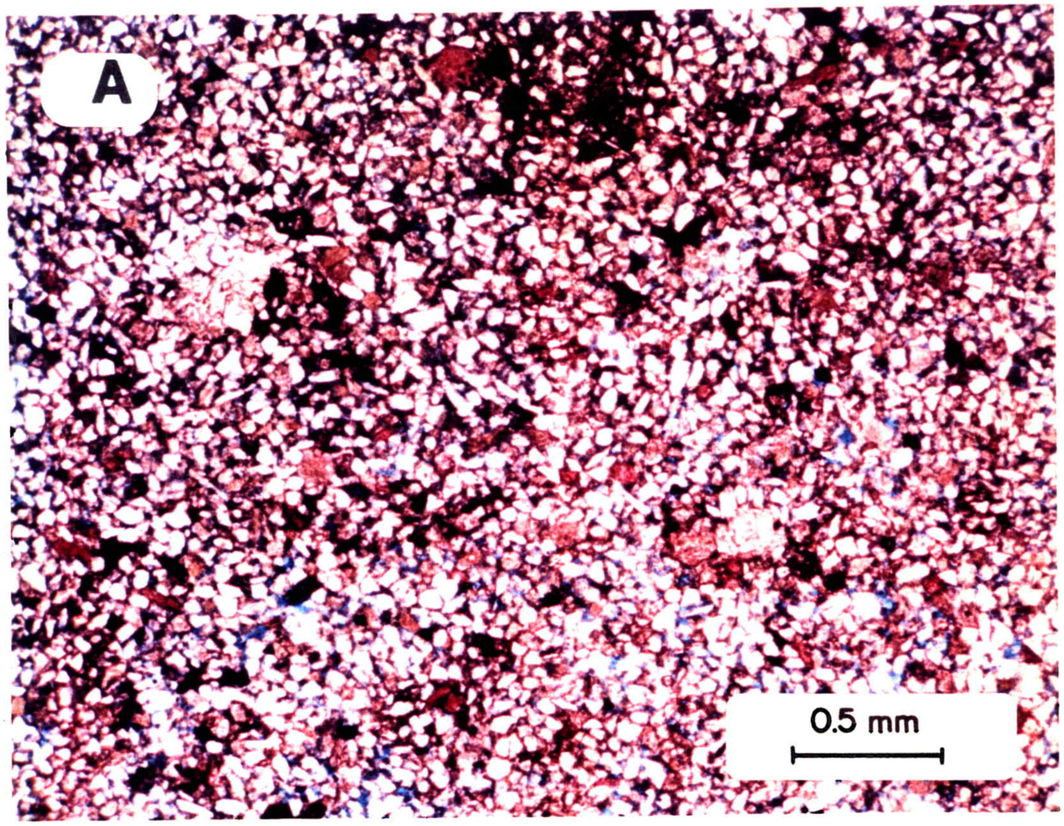
A - 40X

B - 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	49%
Potassium Feldspar	17%
Plagioclase Feldspar	12%
Calcite	7%
Dolomite	11%
Clay	4%


A
0.5 mm

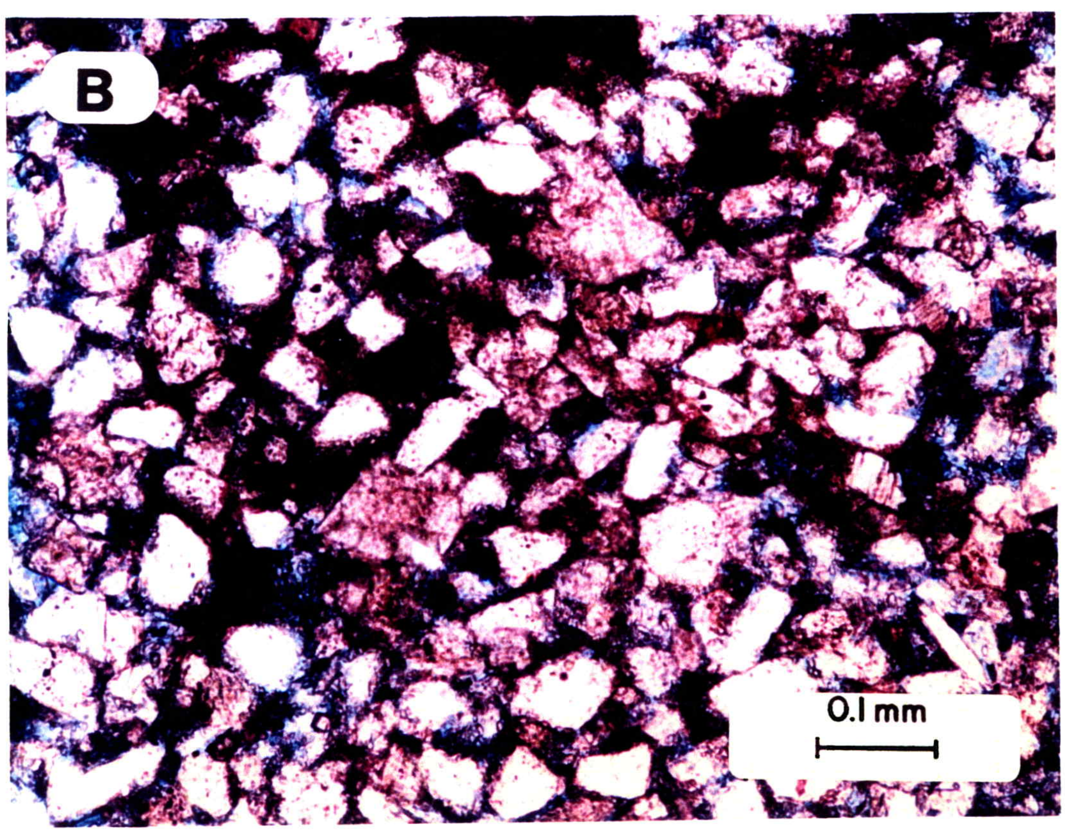

B
0.1 mm

FIGURE 8

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2391.7 feet

Average Grain Size: 0.074 mm (LVF Sand)
Sorting: Very Well Sorted

Porosity: 12.7%
Permeability: 0.556 md

Stratigraphic Unit: Winfield Sand
Dep. Facies: Tidal Flat

Compare this sandstone to the sample from 2389.3 feet (Figure 7). Although these rocks have relatively similar texture and composition, the sample from 2391.7 feet has somewhat lower porosity and significantly lower permeability. The main differences between these two rocks are 1) the amount of finely crystalline calcite cement, and 2) the relative lack of "clean" laminations with preserved intergranular pore space. Only a few minor areas (such as shown near the bottom of view B) have preserved pore space. Calcite matrix, dolomite matrix and calcite and dolomite cements, along with authigenic clay, are the main pore-filling constituents. Quartz, plagioclase feldspar, potassium feldspar and carbonate grains account for nearly all the framework constituents in this well sorted very fine-grained sandstone.

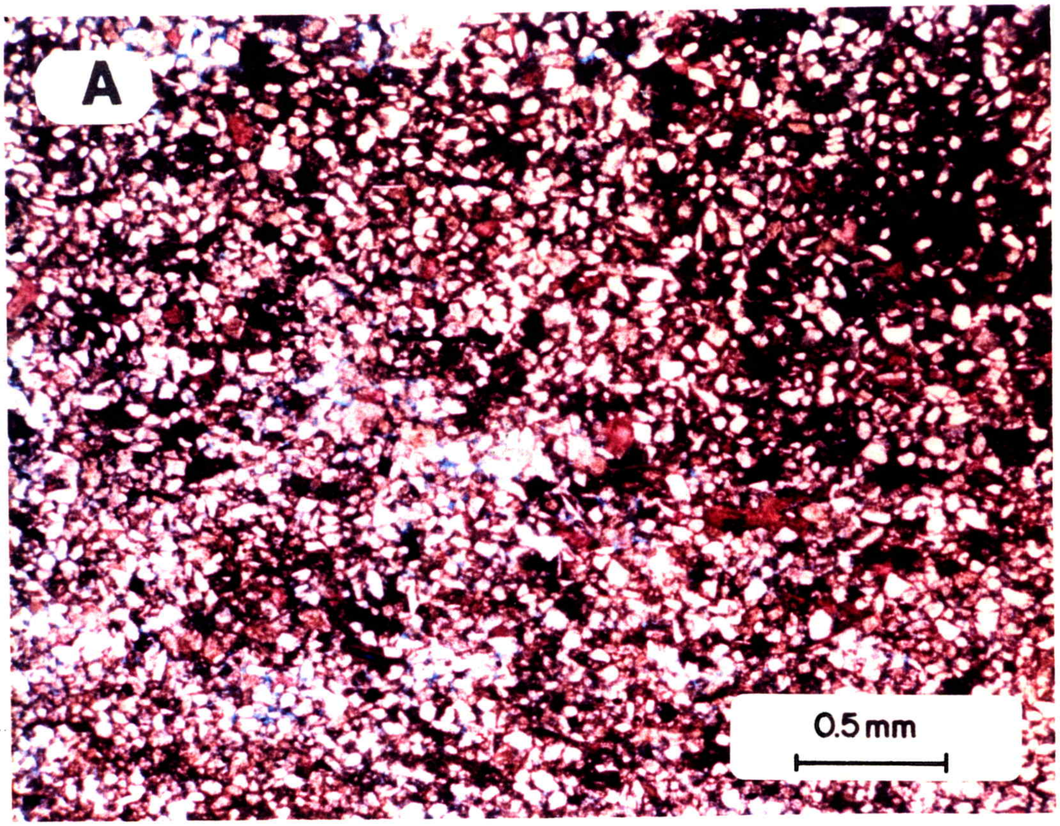
A - 40X

B - 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	54%
Potassium Feldspar	11%
Plagioclase Feldspar	7%
Calcite	11%
Dolomite	8%
Anhydrite	6%
Clay	3%


A
0.5 mm

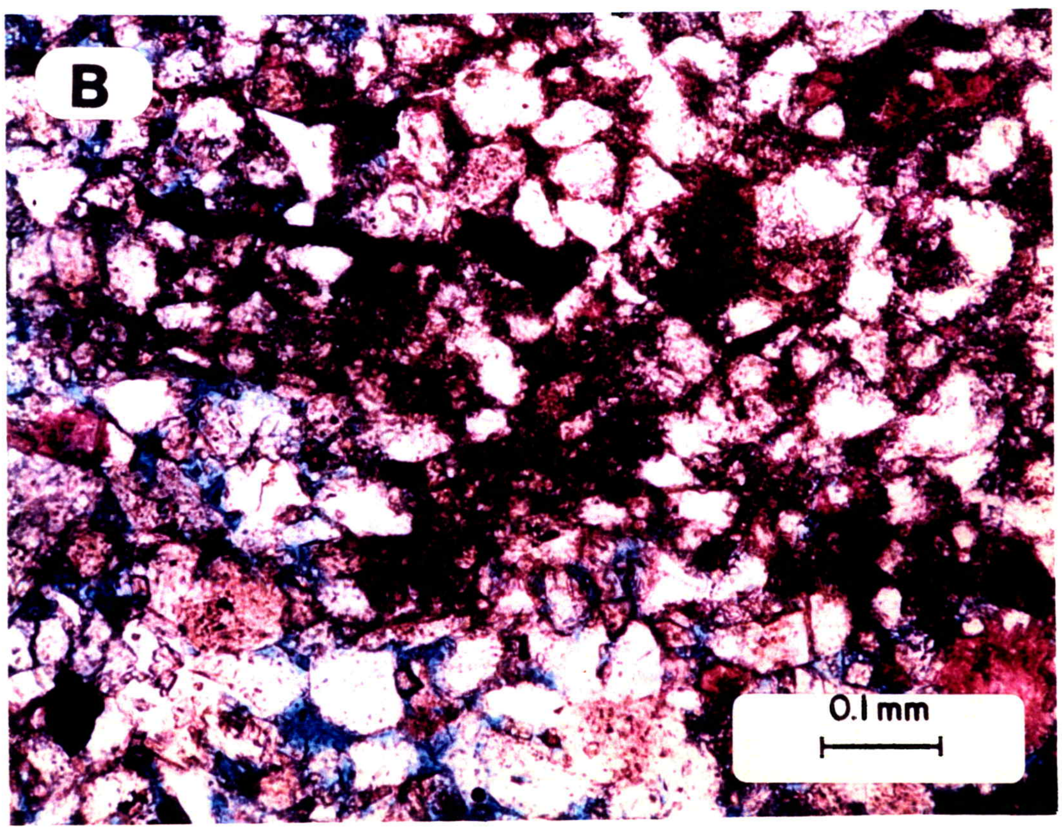

B
0.1 mm

FIGURE 9

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2405.2 feet

Rock Type: Anhydritic Dolomite
Depositional Texture: Grainstone

Porosity: 15.8%
Permeability: 10.983 md

Stratigraphic Unit: Winfield Dolomitic Lime
Dep. Facies: Carbonate Shoal

This rock was deposited as a skeletal-peloid grainstone. Bivalves, echinoderms and other fossil fragments can be distinguished. The rock has undergone a complex diagenetic history that includes 1) minor calcite cementation, 2) extensive grain dissolution, 3) partial dolomitization (leaving only a minor amount of original calcite - stained pink) and 4) anhydrite (An) cementation. Although the rock had and retained some primary intergranular pore space, early porosity enhancement occurred during grain dissolution. Remnants of the original grains can still be distinguished (white arrows in view B). In places, these moldic pores collapsed. This brittle deformation allows for the interconnection of primary and secondary pores. The relatively high measured permeability probably reflects contributions from both pore types.

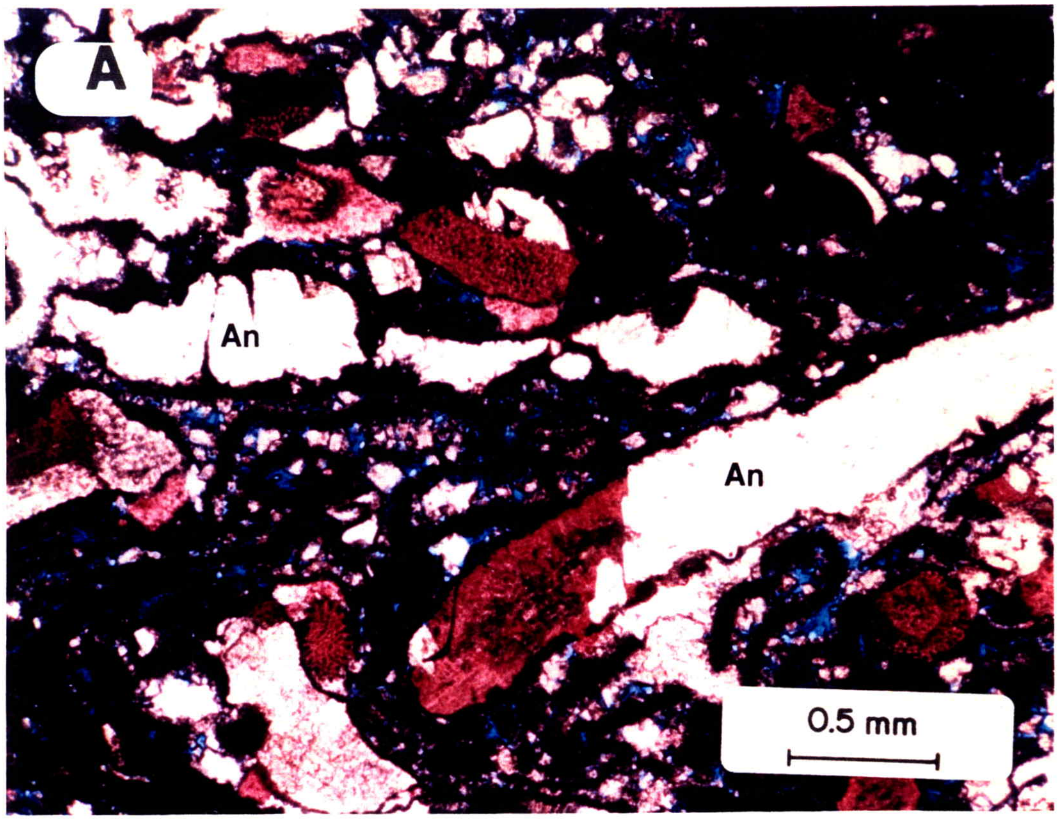
A - 40X

B - 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	2%
Calcite	17%
Dolomite	42%
Anhydrite	39%


A
An
An
0.5 mm

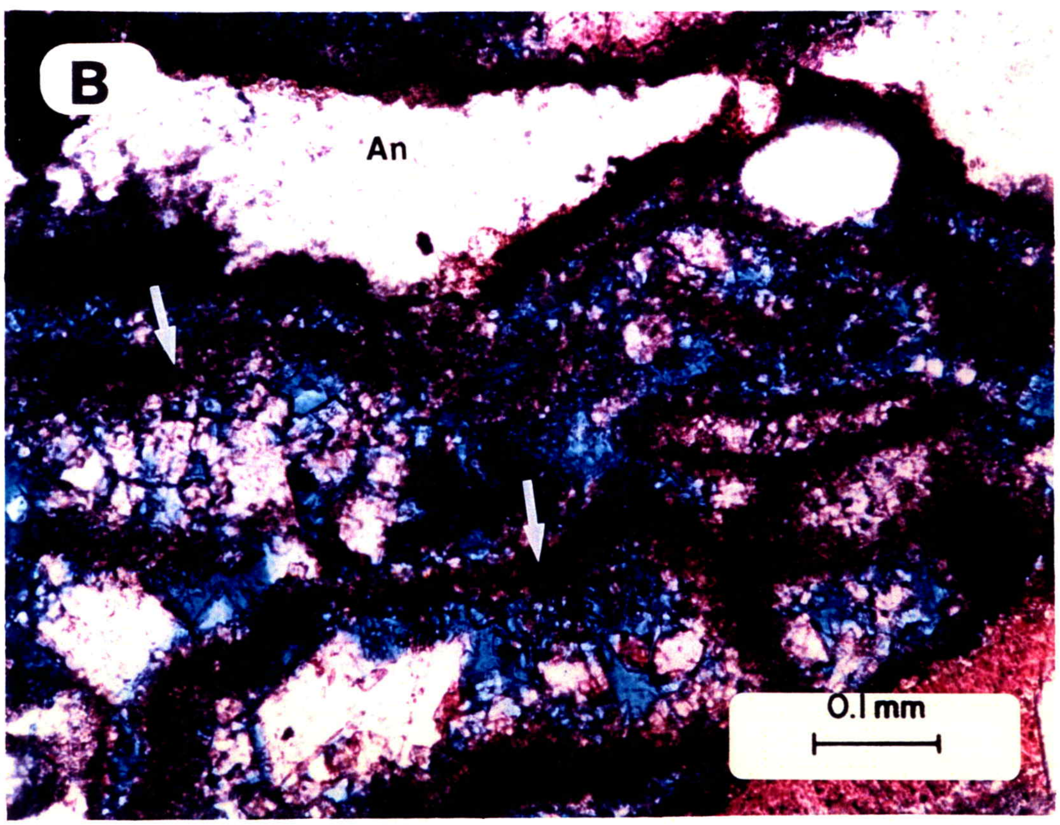

B
An
0.1mm

FIGURE 10

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2461.2 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 11.1%
Permeability: 0.577 md
Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shale

Extensive calcite (Ca) cementation has occluded most of the intergranular pore space in this rock. Nearly all of the remnant pore volume is in the form of 1) moldic pores from partially leached grains, and 2) microporosity within neomorphosed micritic particles such as peloids, oncoids and micritized skeletal fragments. These secondary pore types generally yield rather ineffective pore networks, as reflected in the relatively low permeability.

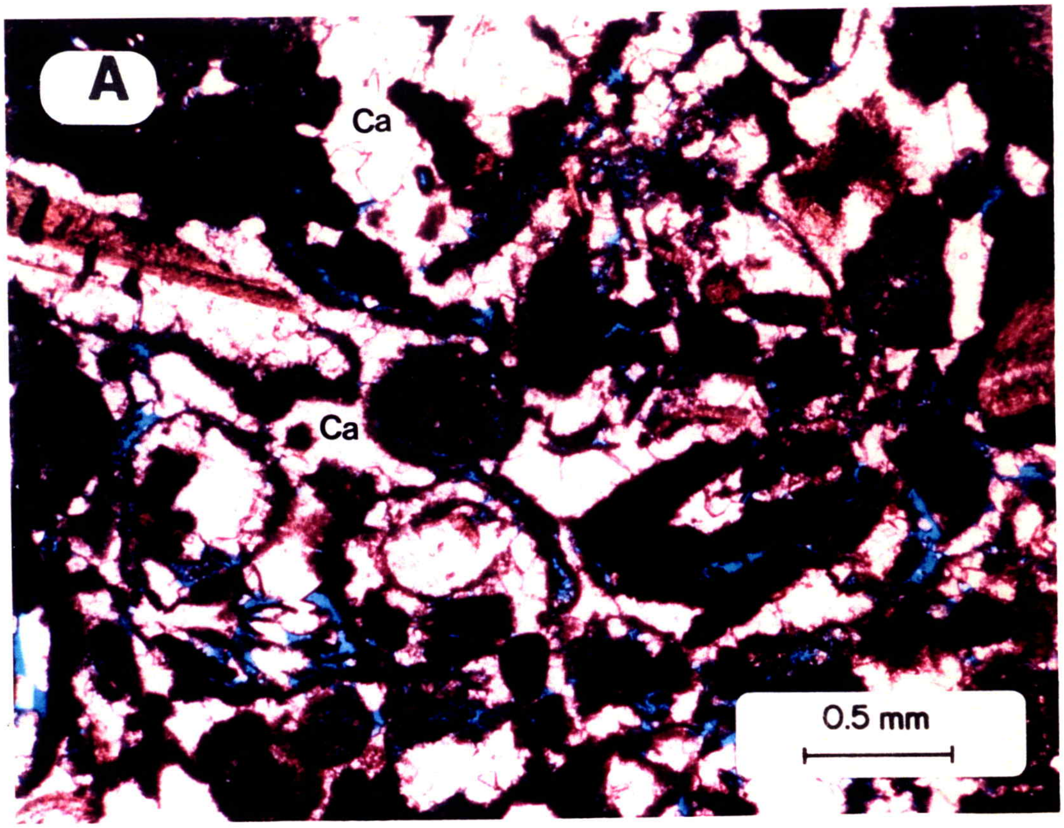
A – 40X

B – 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	4%
Calcite	94%
Dolomite	1%
Anhydrite	1%


A
Ca
Ca
0.5 mm

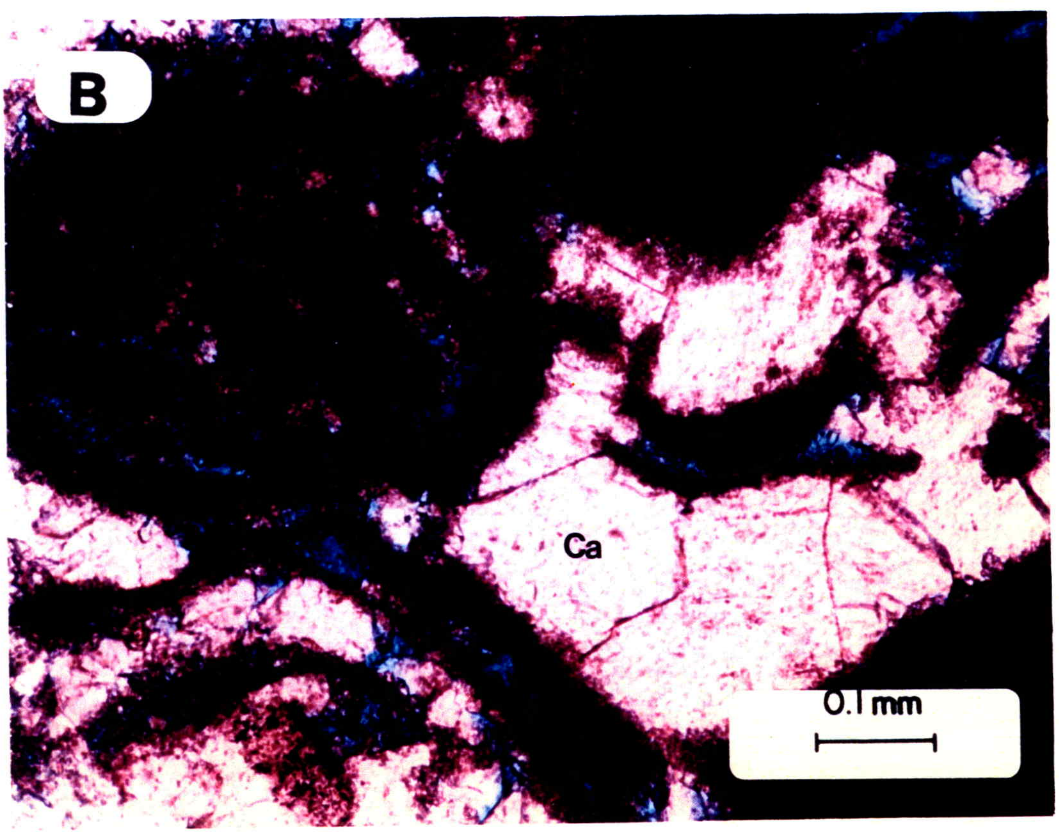

B
Ca
0.1mm

FIGURE 11

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2463.5 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shoal

Porosity: 26.8%
Permeability: 52.351 md

This grainstone has one of the highest measured permeability values encountered in the cored interval (excluding fractured plugs). The pore system contains a combination of primary (1) intergranular pores and secondary (2) moldic pores from leached and partially leached ooids. In addition, a portion of the total pore volume is in the form of microporosity in altered micritic grains. Evidently, the network of primary intergranular pores is rather well interconnected, as indicated by the high measured permeability. Bladed calcite cement is the principal pore-filling phase, with minor amounts of dolomite and anhydrite cements also observed. In most cases, it appears that the secondary pores are rather poorly interconnected with the primary pores, suggesting that the moldic pores are a rather ineffective component of the pore system.

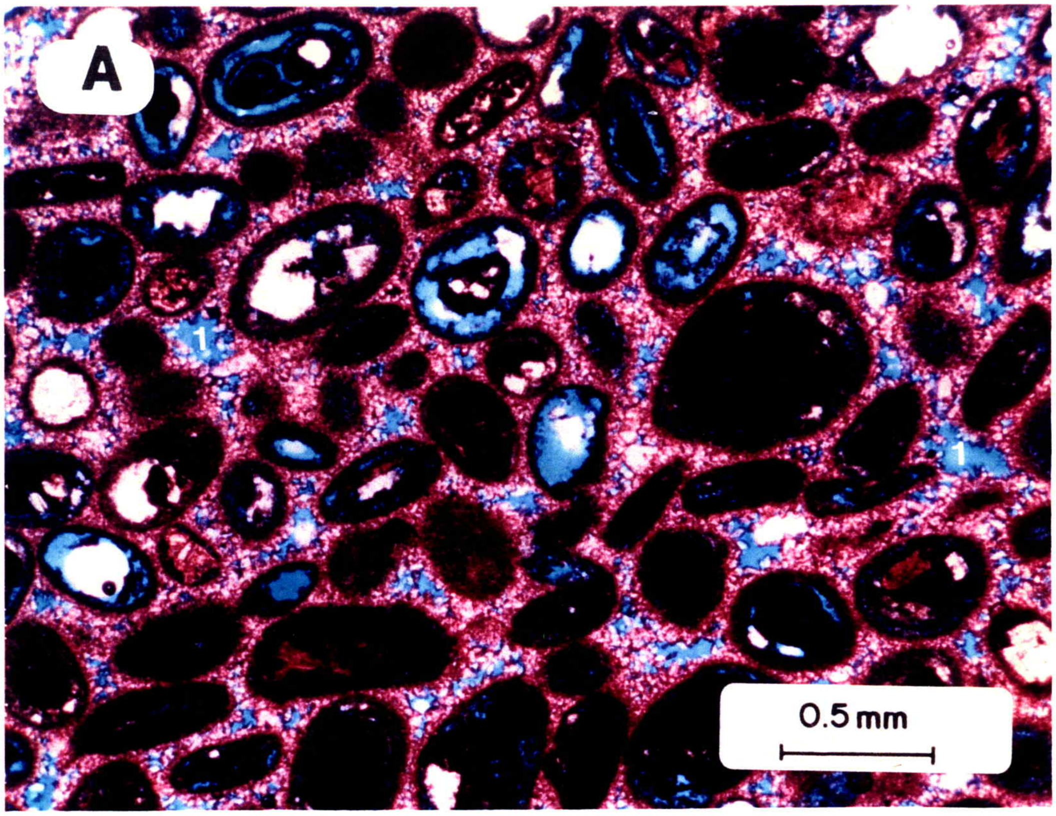
A - 32X

B - 128X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	9%
Calcite	77%
Dolomite	4%
Anhydrite	10%


A
1
1
0.5 mm

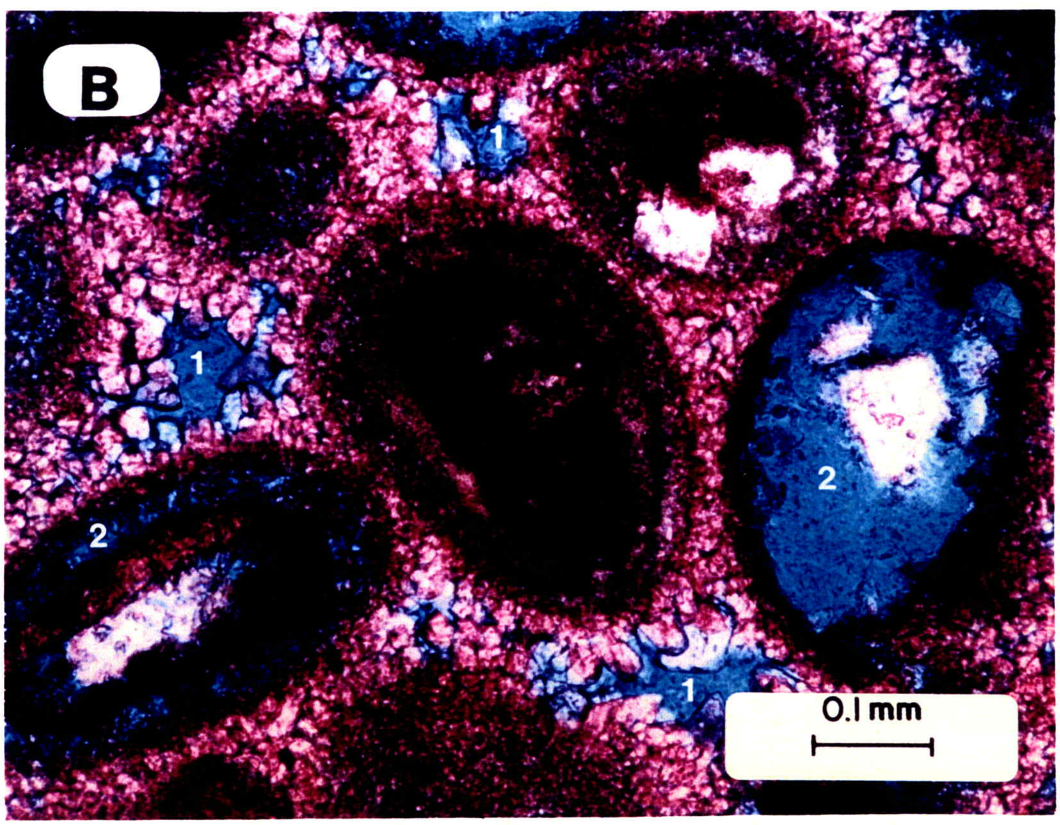

B
1
1
2
2
1
0.1 mm

FIGURE 12

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2465.4 feet

Rock Type: Limestone
Depositional Texture: Grainstone

Porosity: 23.4%
Permeability: 15.443 md

Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shoal

Compare this ooid grainstone to the ooid grainstone from 2463.5 feet (Figure 11). Although these rocks are very similar, this sample has areas with somewhat more extensive calcite cementation (upper half of view A); this results in a less well developed network of primary (1) intergranular pores. In addition, secondary (2) pores from leached grains appear to be marginally less abundant. Here again, the secondary pores from leached ooids appear to be largely disconnected from the network of primary pores. Microporous framework grains (upper center of view B) were also observed. This microporosity is probably a relatively ineffective component of the pore network.

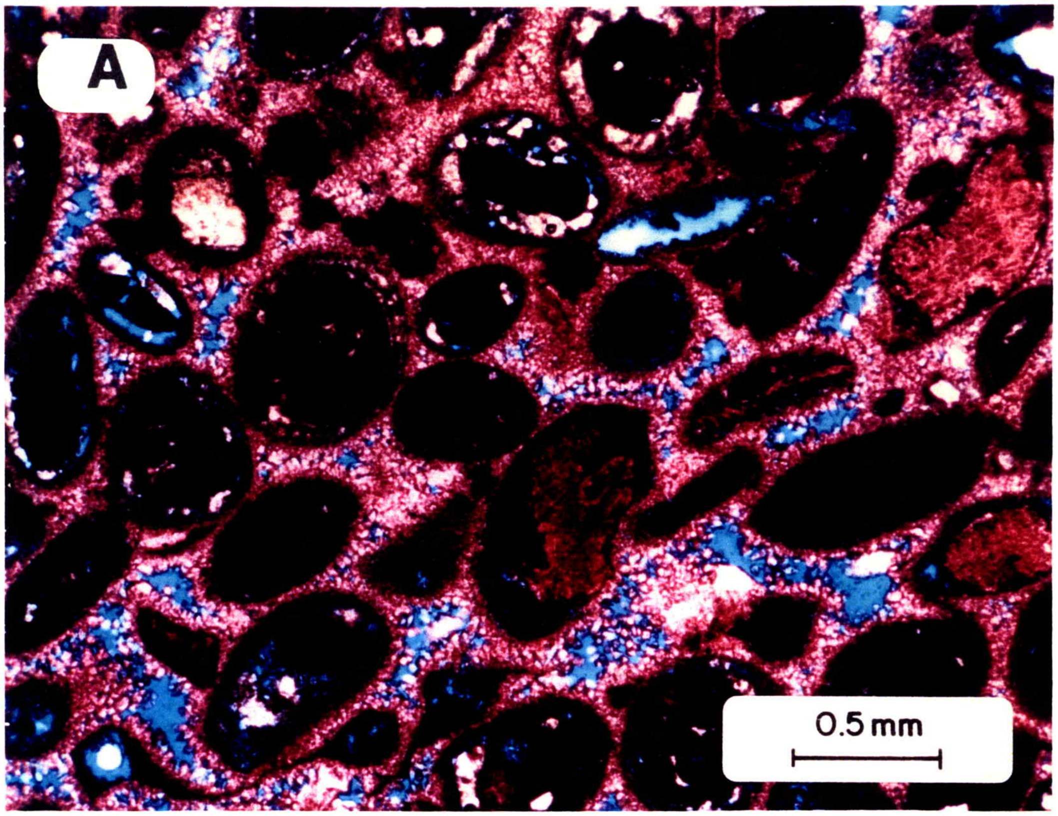
A - 40X

B - 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	1%
Calcite	55%
Dolomite	1%
Anhydrite	43%


A
0.5 mm

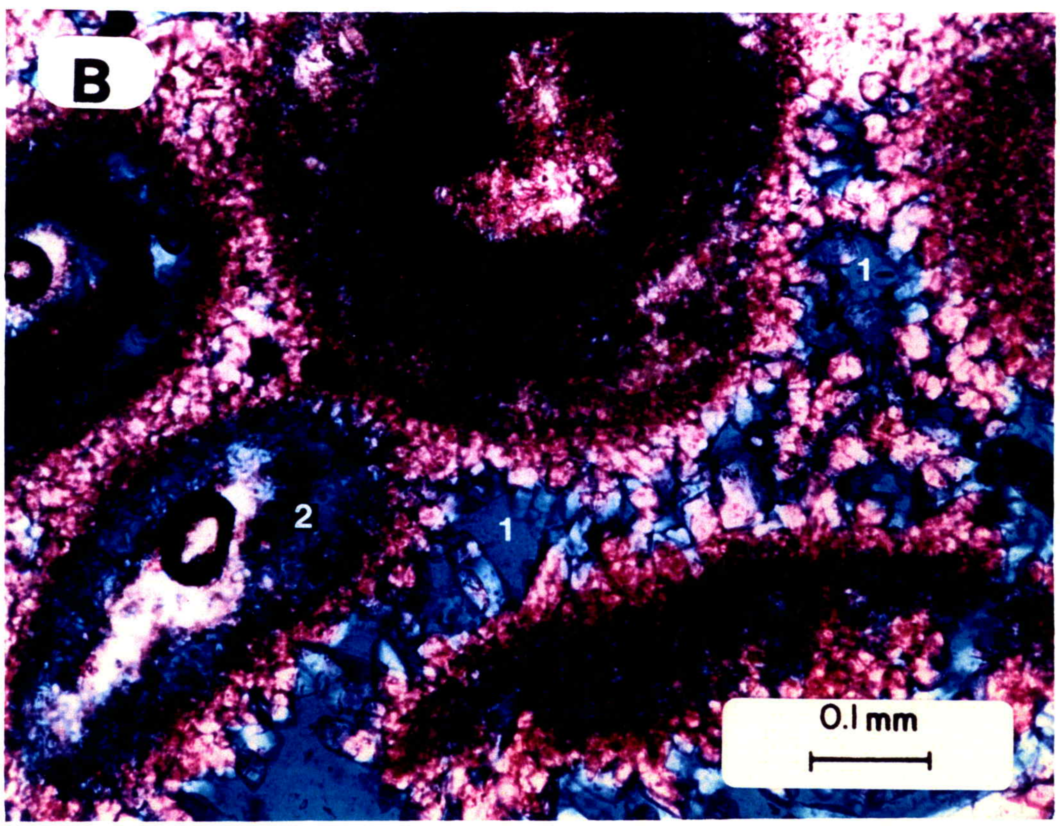

B
1
2
1
0.1 mm

FIGURE 13

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2514.6 feet

Average Grain Size: 0.087 mm (LVF Sand)
Sorting: Very Well Sorted

Porosity: 18.8%
Permeability: 34.668 md

Stratigraphic Unit: Homeville Sand
Dep. Facies: Tidal Flat

Primary intergranular pores are well preserved in this very well sorted, very fine-grained sandstone (view B). Compared to similar siltstones and sandstones from this core, calcite and dolomite pore-filling constituents are less common. A few patches of anhydrite (lower half of view A) were observed, but overall this rock is judged to have very good reservoir potential. Quartz grains, potassium feldspar and plagioclase feldspar are the principal framework constituents.

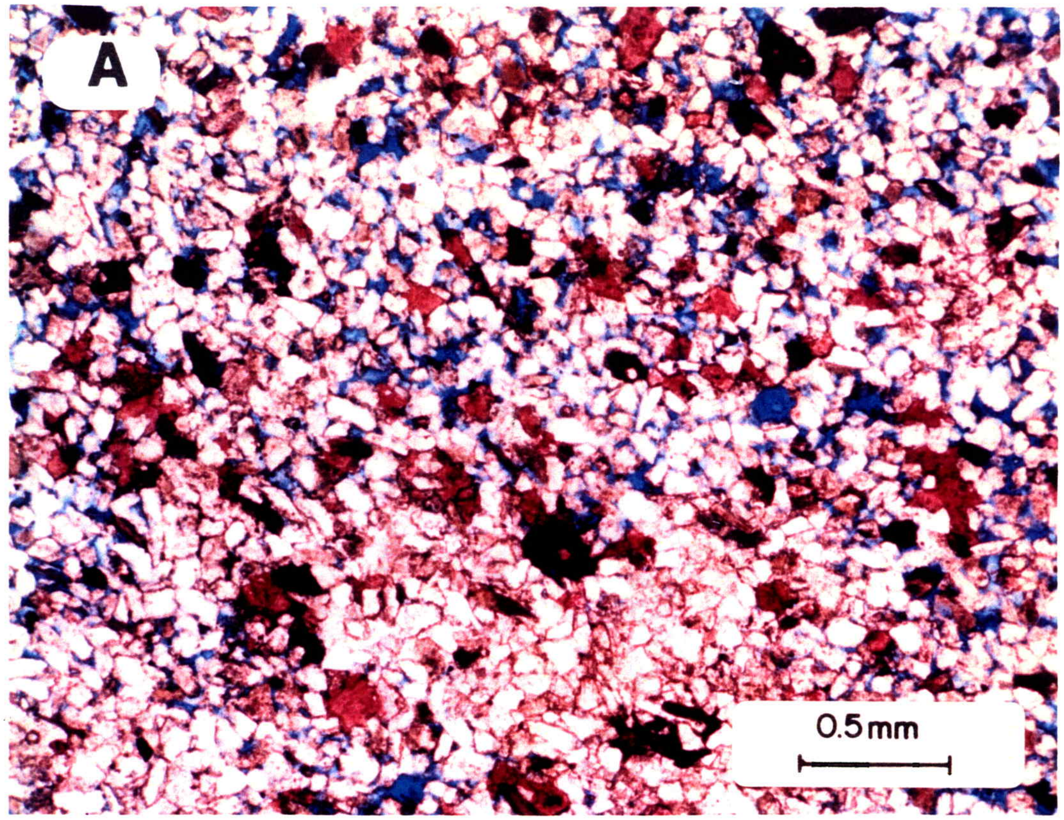
A – 40X

B – 160X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	59%
Potassium Feldspar	12%
Plagioclase Feldspar	13%
Calcite	6%
Dolomite	1%
Anhydrite	4%
Clay	5%


A
0.5 mm

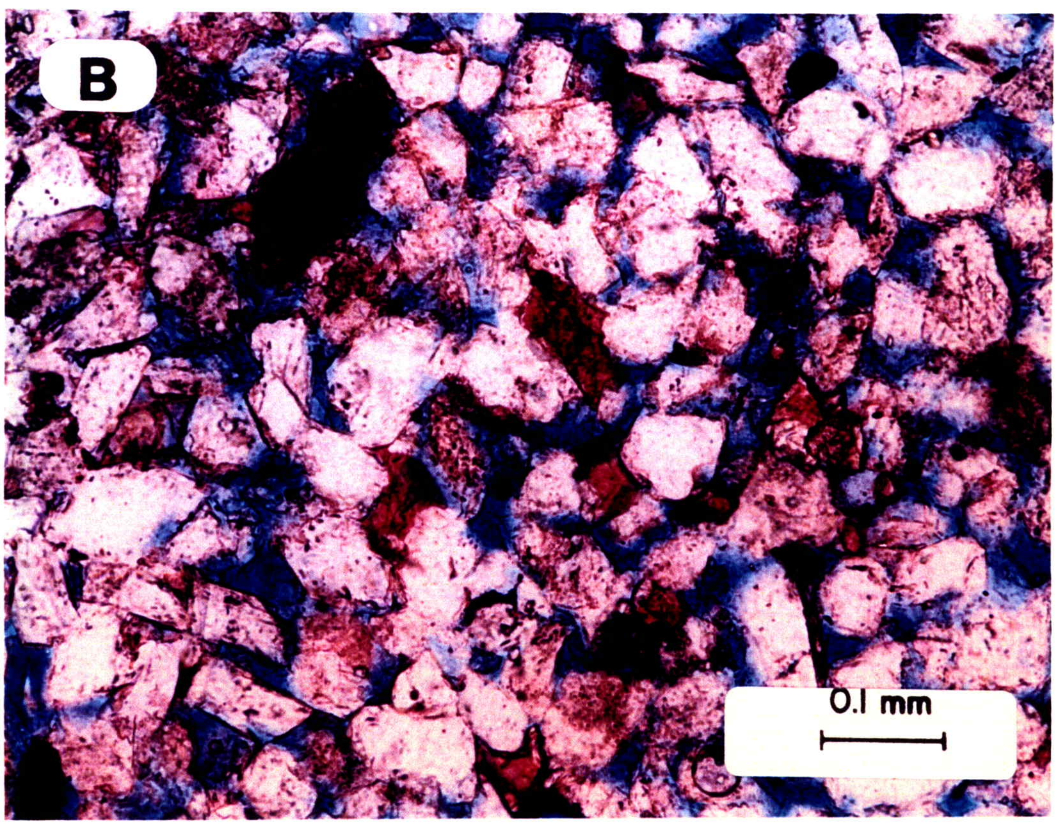

B
0.1 mm

FIGURE 14

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2532.8 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 14.6%
Permeability: 2.950 md
Stratigraphic Unit: Fort Riley Lime
Dep. Facies: Carbonate Shoal

This skeletal-peloid grainstone has a partially preserved network of intergranular pores. However, calcite cement, micrite matrix and patchy anhydrite cement have reduced the volume of primary pores, attenuated pore throats, and limited permeability. The remnant primary intergranular pore system probably accounts for most of the effective pore space. Less effective components of the pore system include the microporosity within micritic grains, and a minor amount of secondary pore space from grain dissolution.

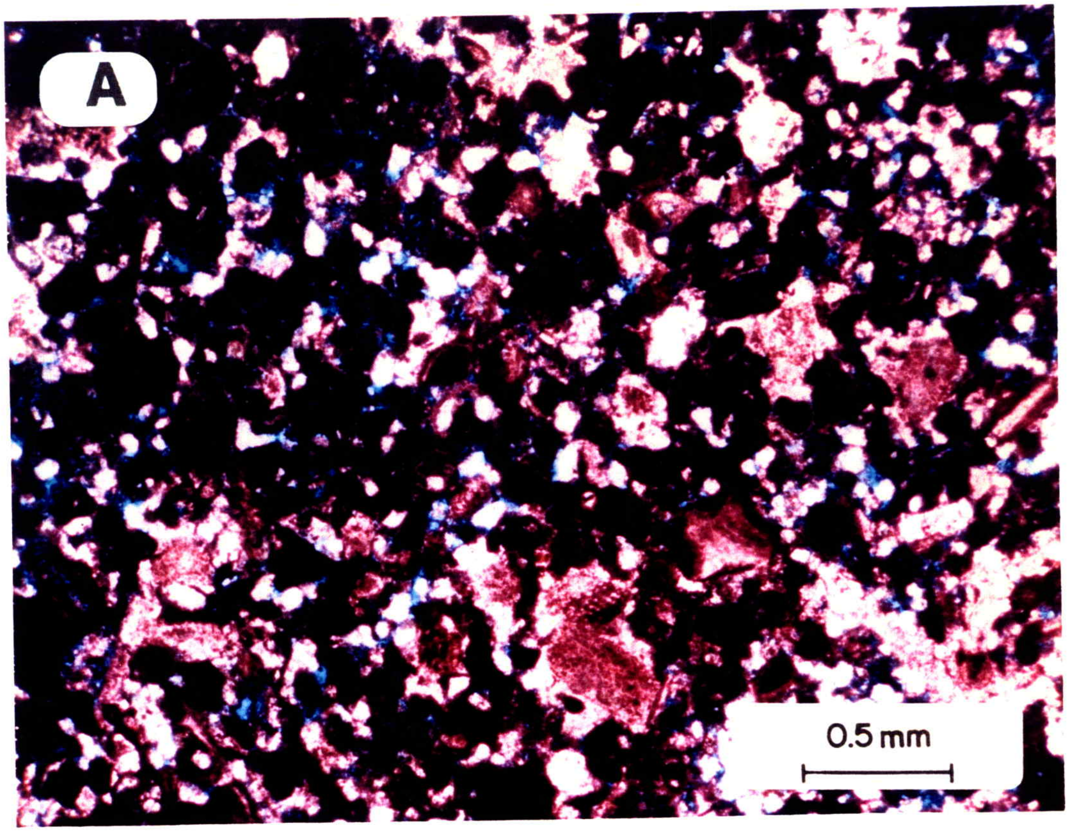
A - 32X

B - 128X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	10%
Plagioclase Feldspar	8%
Calcite	74%
Dolomite	1%
Anhydrite	6%
Clay	1%


A
0.5 mm

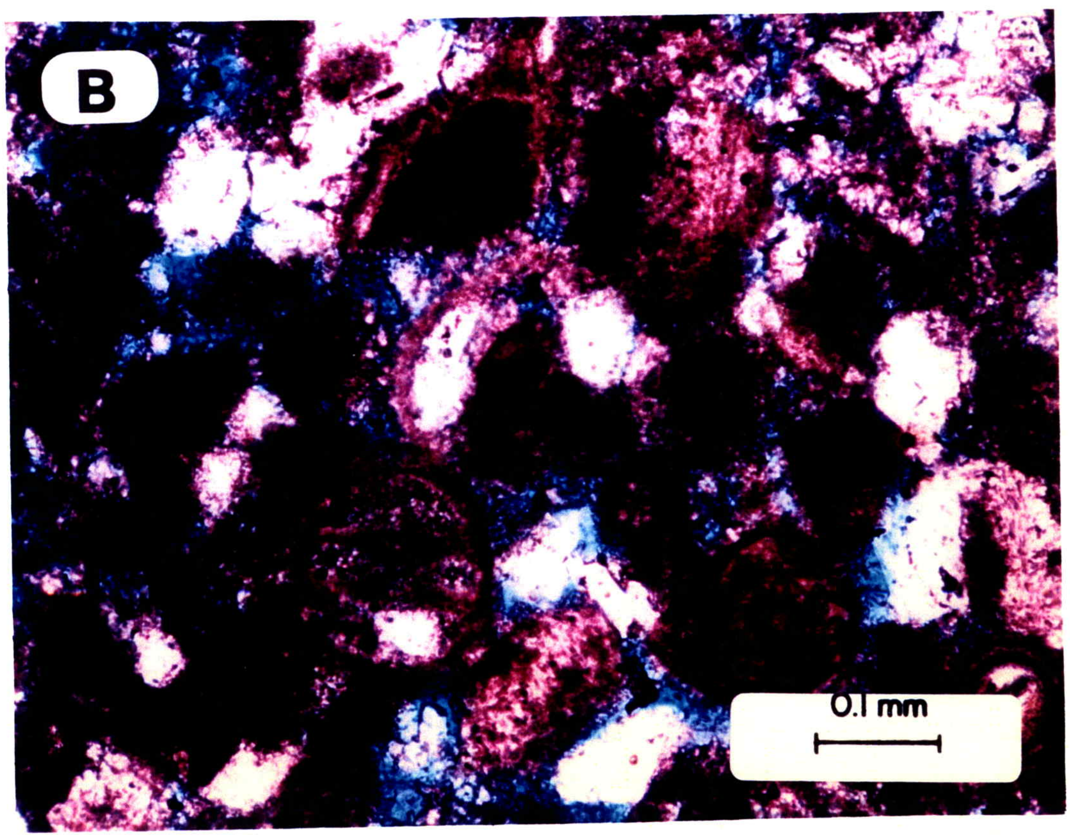

B
0.1 mm

FIGURE 15

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION

CORNELL UNIVERSITY "C" 1-H WELL

Depth: 2573.2 feet

Average Grain Size: 0.053 mm (Coarse Silt)
Sorting: Very Well Sorted

Porosity: 11.1%
Permeability: 14.842 md

Stratigraphic Unit: Florence Sand
Dep. Facies: Tidal Flat

This siltstone has rather "streaky" porosity preservation. Throughout view A, a combination of calcite cement, dolomite cement, calcite matrix, and dolomite matrix have occluded most of the pore space. In the lower half of view A, and in the left half of view B, these pore-filling constituents are less common, and intergranular pores have been preserved. This suggests that most of the effective pore space is confined to thin "clean" laminations that have relatively unobstructed intergranular pores. Overall, the measured permeability appears to be somewhat high compared to observed pore structure.

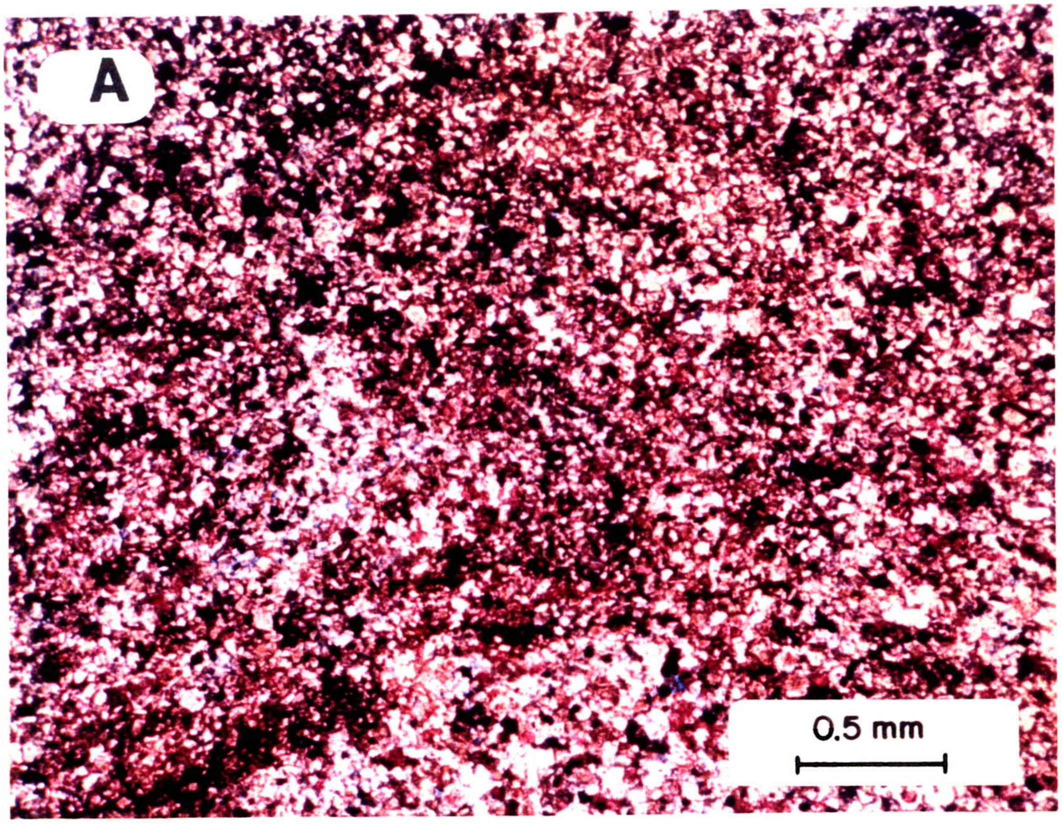
A - 32X

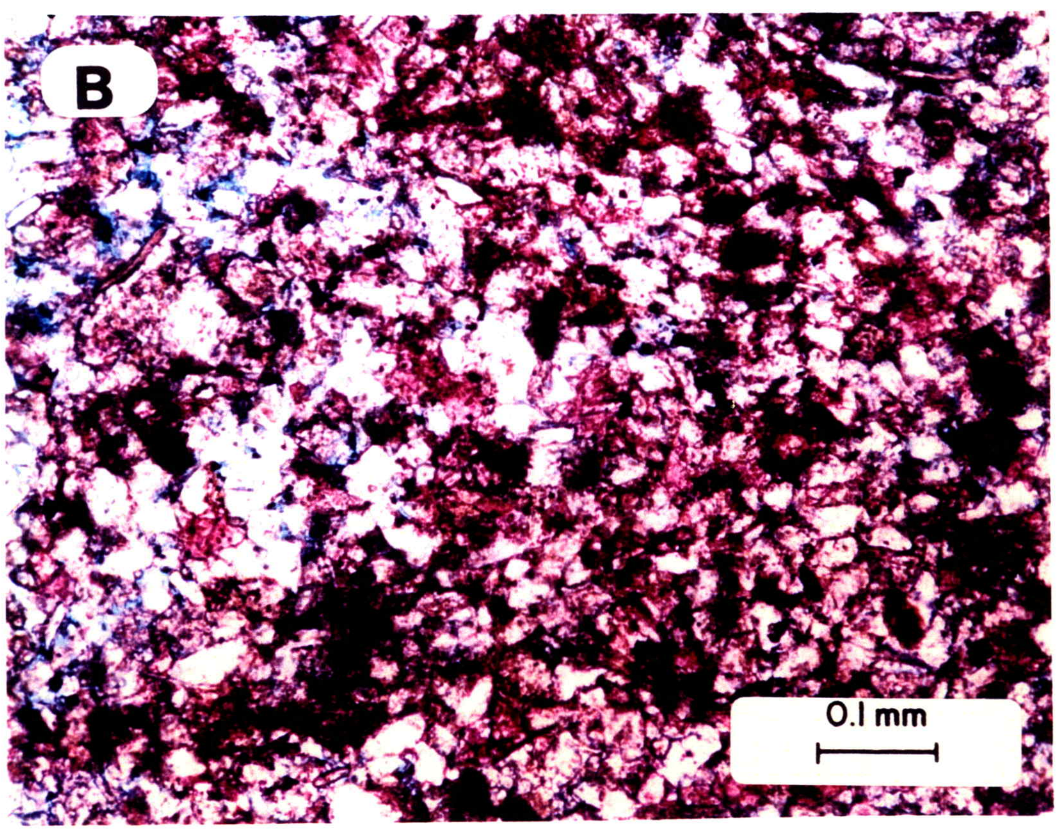
B - 128X

X-ray Diffraction Data

Bulk Mineralogy

Quartz	66%
Potassium Feldspar	8%
Plagioclase Feldspar	6%
Calcite	12%
Dolomite	4%
Clay	4%


A
0.5 mm


B
0.1 mm