4-33-38W
15-189-21756

FIGURE 5

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2481.8 feet

Average Grain Size: 0.065 mm (Lower Very Fine Sand)
Sorting: Very Well Sorted
Porosity: 17.6%
Permeability: 10.1 md
Stratigraphic Unit: Herington
Dep. Facies: Tidal Flat

Very well sorted, very fine sand and silt are the main framework constituents in this sandstone. In addition, dolomitized peloids (dark grains) were also observed. The main pore-filling constituent is very finely crystalline dolomite. It is unclear if this dolomite is altered matrix material or a directly precipitated cement. Only a minor amount of clay was identified. Primary intergranular pores and scattered secondary pores (from leached grains) account for most of the pore volume. In addition, there appears to be some microporosity associated with the finely crystalline dolomite.

A - 40X

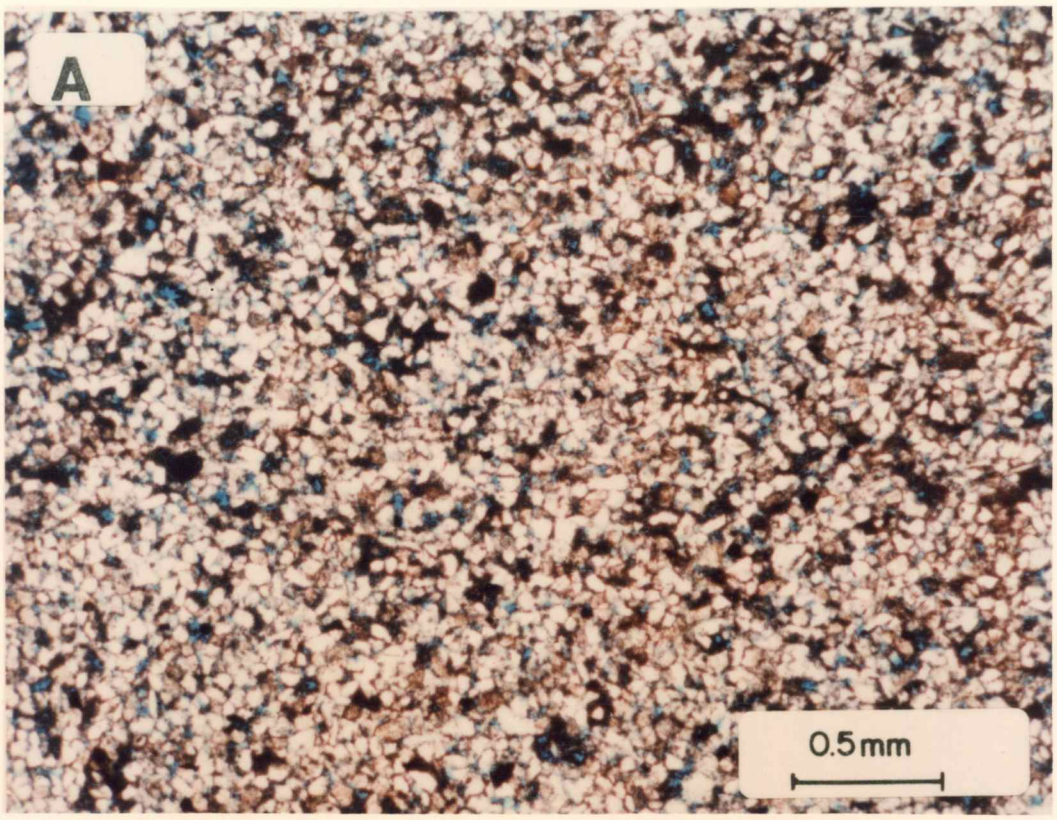
B - 160X

X-ray Diffraction Data

Quartz	46%
Potassium Feldspar	35%
Plagioclase Feldspar	8%
Dolomite	9%
Clay	2%

Petrophysical Data

Cementation Exponent (m): 1.92
Saturation Exponent (n): 1.69


A
0.5mm

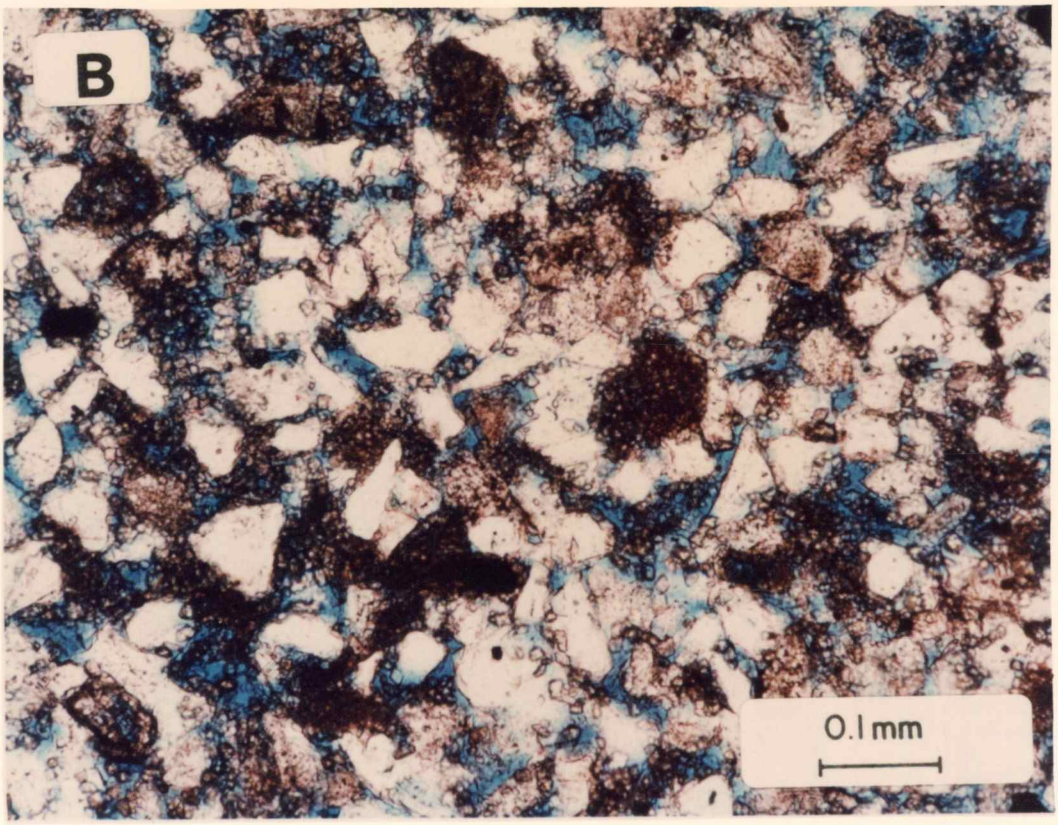

B
0.1mm

FIGURE 6

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2515.3 feet

Rock Type: Dolomite
Depositional Texture: Grainstone(?)
Porosity: 11.4%
Permeability: 1.61 md
Stratigraphic Unit: Krider
Dep. Facies: Carbonate Shoal

Although dolomitization has partially obscured the depositional texture of this rock, relict fabrics suggest a grainstone texture. Based on the sizes and shapes of the framework grains, it appears that a combination of oncoids, peloids and skeletal debris are present. In addition to relatively large moldic pores, smaller intercrystalline pores, possible relict intergranular pores, and some intragranular microporosity are present. In view B the white filter helps to reveal the presence of intercrystalline pore space within a framework grain (outlined in black). Note how these pores are relatively isolated from other pores by the dolomite cement crystals (D) that fill the interstitial areas. These types of pores, along with poorly interconnected moldic pores, may help to explain the relatively low permeability, compared to the measured porosity. A few stylolites (arrows in view B) crosscut the sample.

A – 40X

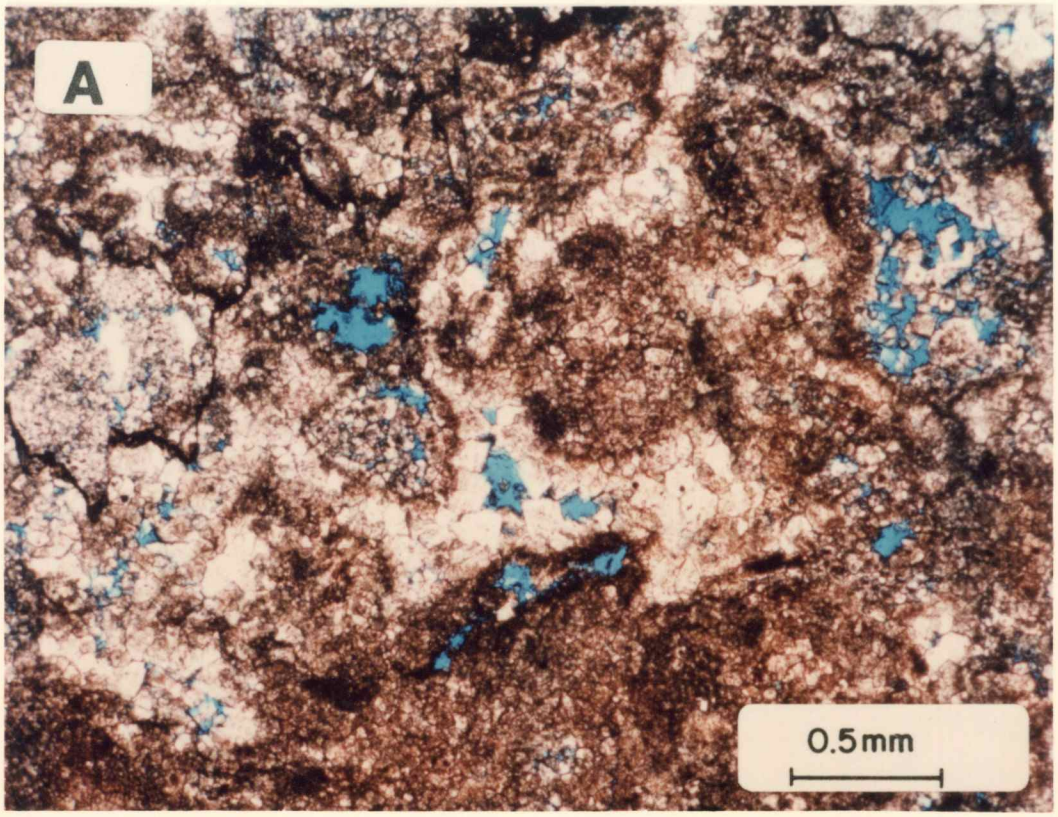
B – 160X, White Filter

X-ray Diffraction Data

Quartz	2%
Potassium Feldspar	1%
Dolomite	92%
Clay	5%

Petrophysical Data

Cementation Exponent (m): 2.00
Saturation Exponent (n): 1.88


A
0.5mm

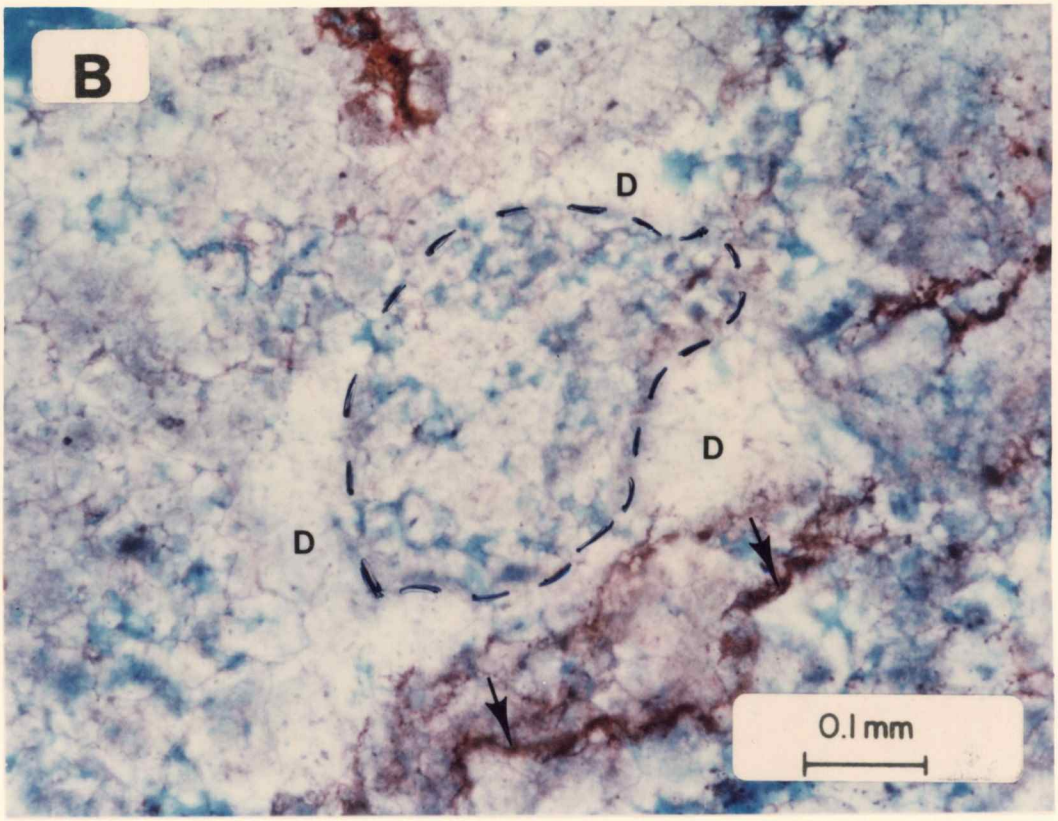

B
D
D
D
0.1mm

FIGURE 7

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2518.2 feet

Rock Type: Dolomite
Depositional Texture: Grainstone/Packstone
Porosity: 15.1%
Permeability: 31.4 md
Stratigraphic Unit: Krider
Dep. Facies: Carbonate Shoal to Shoal Flank

Large moldic (M) pores are common in this dolomite. The size and shape of the moldic pores suggest they are leached fossil fragments and oncoids. In addition to these relatively large pores, smaller intercrystalline (Ic) pores are rather homogeneously distributed throughout the rock. These intercrystalline pores help to increase the interconnectivity of the larger moldic pores, combining to yield a rather effective pore network and relatively high permeability. A minor amount of late-stage anhydrite cement (not shown here) has occluded some of the larger moldic pores. Compare this sample to the sample shown in Figure 6; the higher m value in this sample probably reflects a greater abundance of moldic porosity.

A - 40X

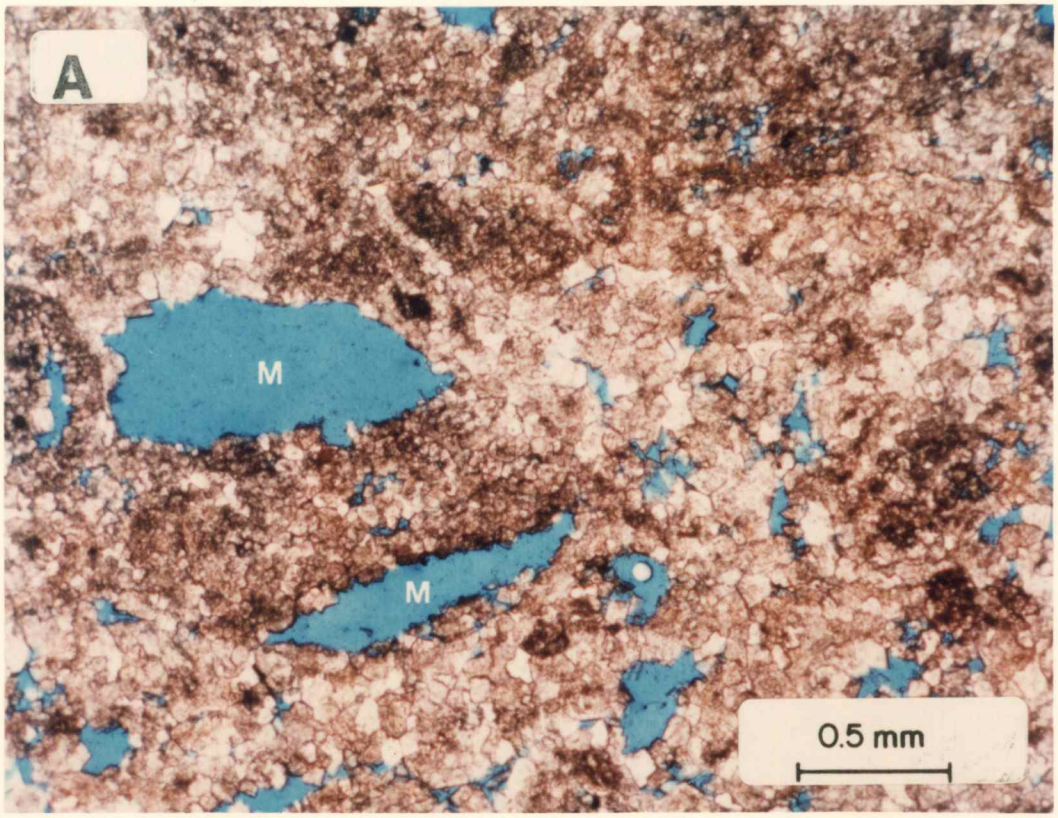
B - 160X

X-ray Diffraction Data

Quartz	2%
Dolomite	95%
Clay	3%

Petrophysical Data

Cementation Exponent (m): 2.20
Saturation Exponent (n): 1.78


A
M
M
0.5 mm

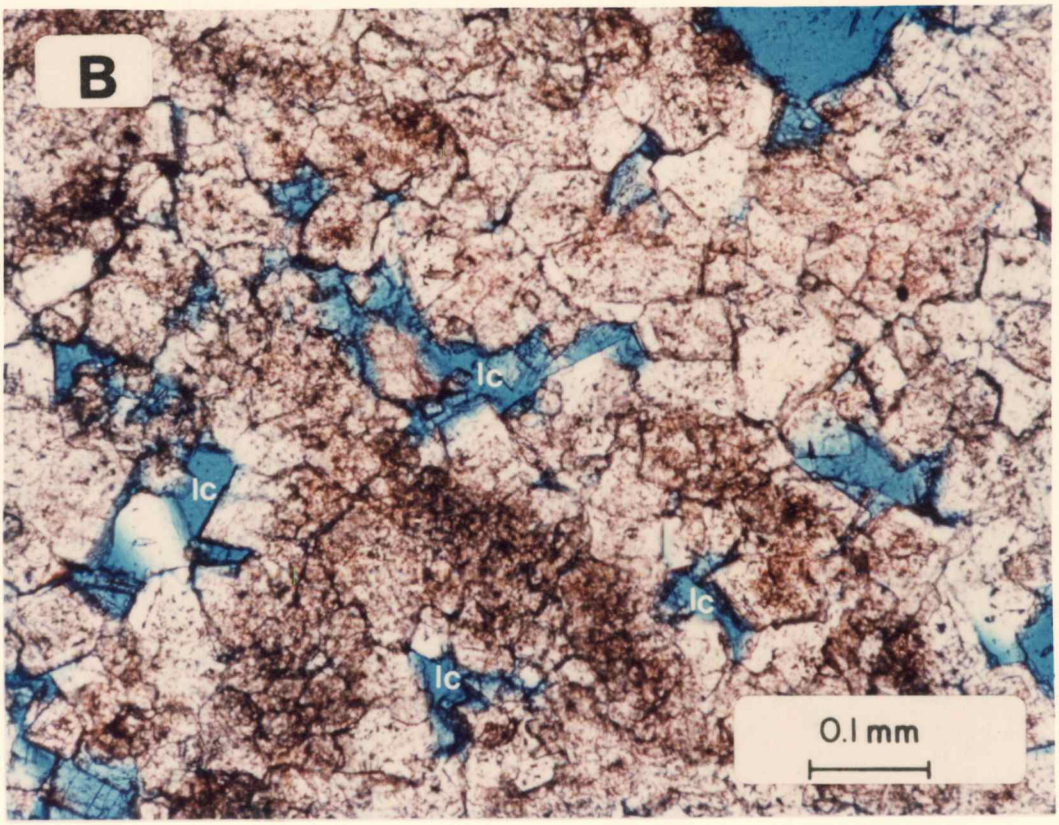

B
lc
lc
lc
lc
0.1 mm

FIGURE 8

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2526.4 feet

Rock Type: Dolomite
Depositional Texture: Grainstone/Packstone
Porosity: 19.3%
Permeability: 63.0 md
Stratigraphic Unit: Krider
Dep. Facies: Carbonate Shoal to Shoal Flank

Intercrystalline pore space is very common throughout this dolomite. In addition, scattered moldic pores are also present. Compare view A in this sample with Figure 7,A. The relative abundance and homogeneous distribution of intercrystalline pore space in this sample yields a much more efficient pore system, and correspondingly higher permeability.

A - 40X

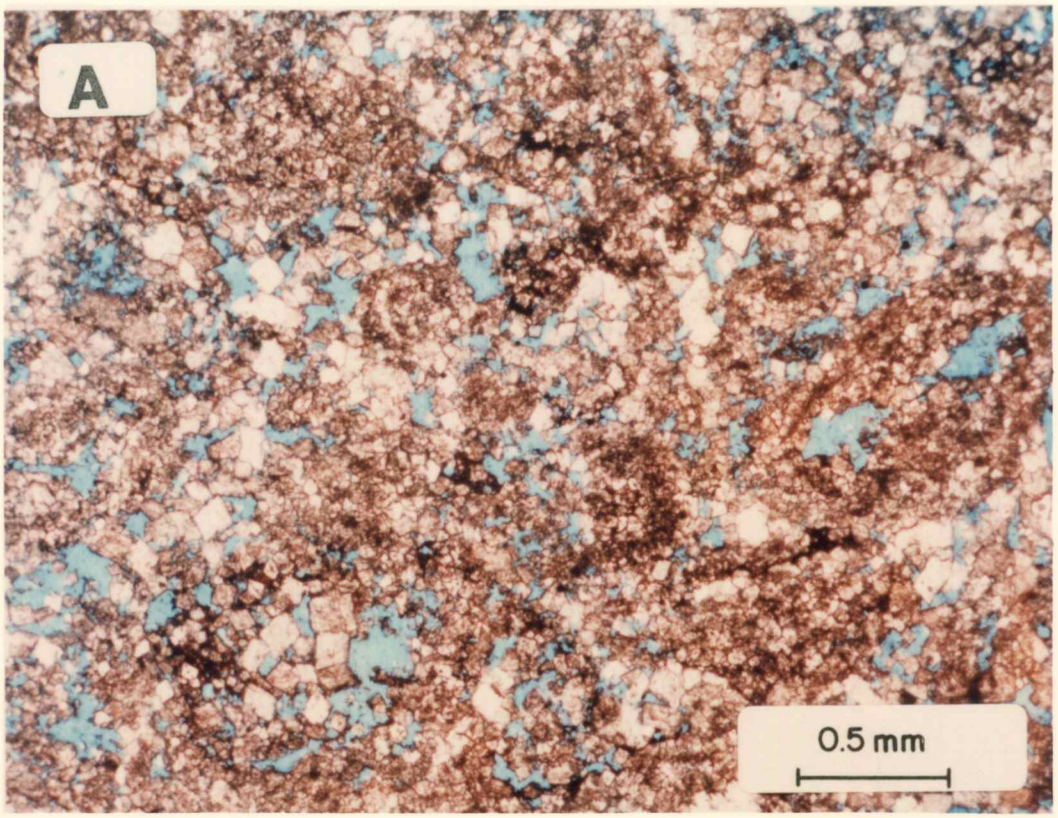
B - 160X

X-ray Diffraction Data

Quartz	4%
Dolomite	93%
Clay	3%

Petrophysical Data

Cementation Exponent (m): 2.10
Saturation Exponent (n): 1.64


A
0.5 mm

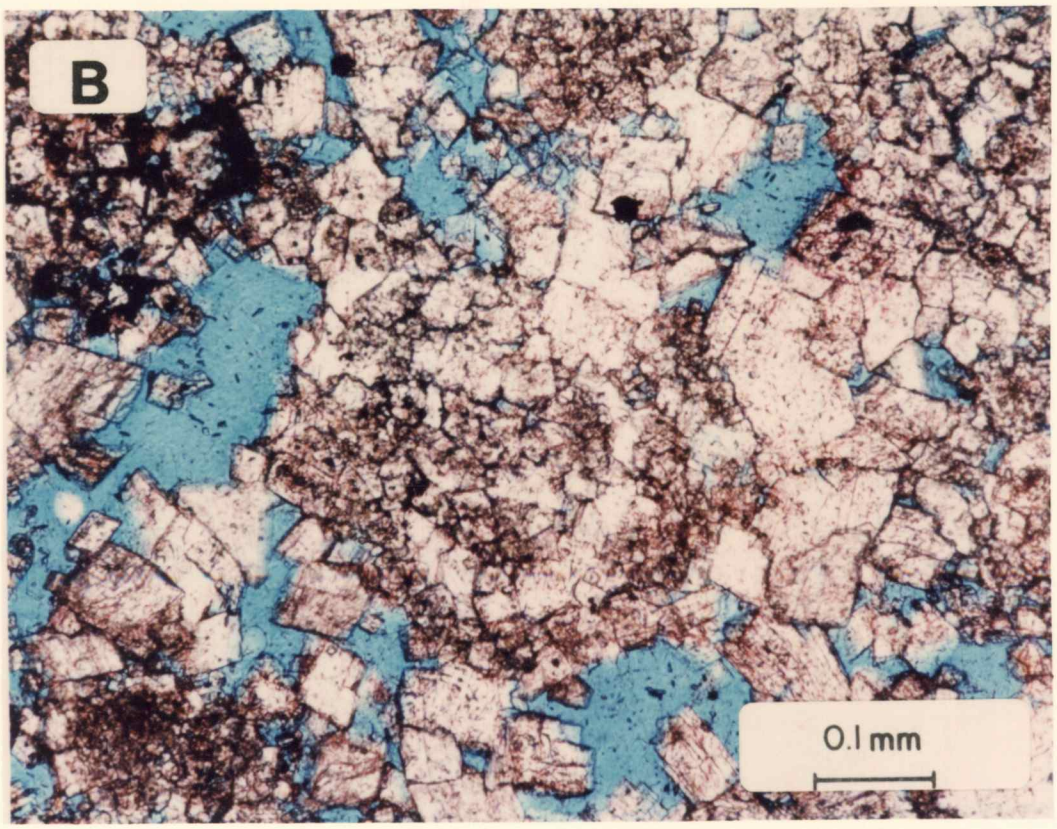

B
0.1 mm

FIGURE 9

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2532.3 feet

Rock Type: Dolomite
Depositional Texture: Packstone/Grainstone(?)
Porosity: 14.0%
Permeability: 8.74 md
Stratigraphic Unit: Krider
Dep. Facies: Carbonate Shoal to Shoal Flank

Subequal amounts of moldic (M) pores and intercrystalline (black arrows in view B) pores are present in this dolomite. Portions of the sample consist of dense, tightly interlocking dolomite rhombs with conspicuously less intercrystalline pore space. Note that the depositional texture has been obstructed by dolomitization.

A - 40X

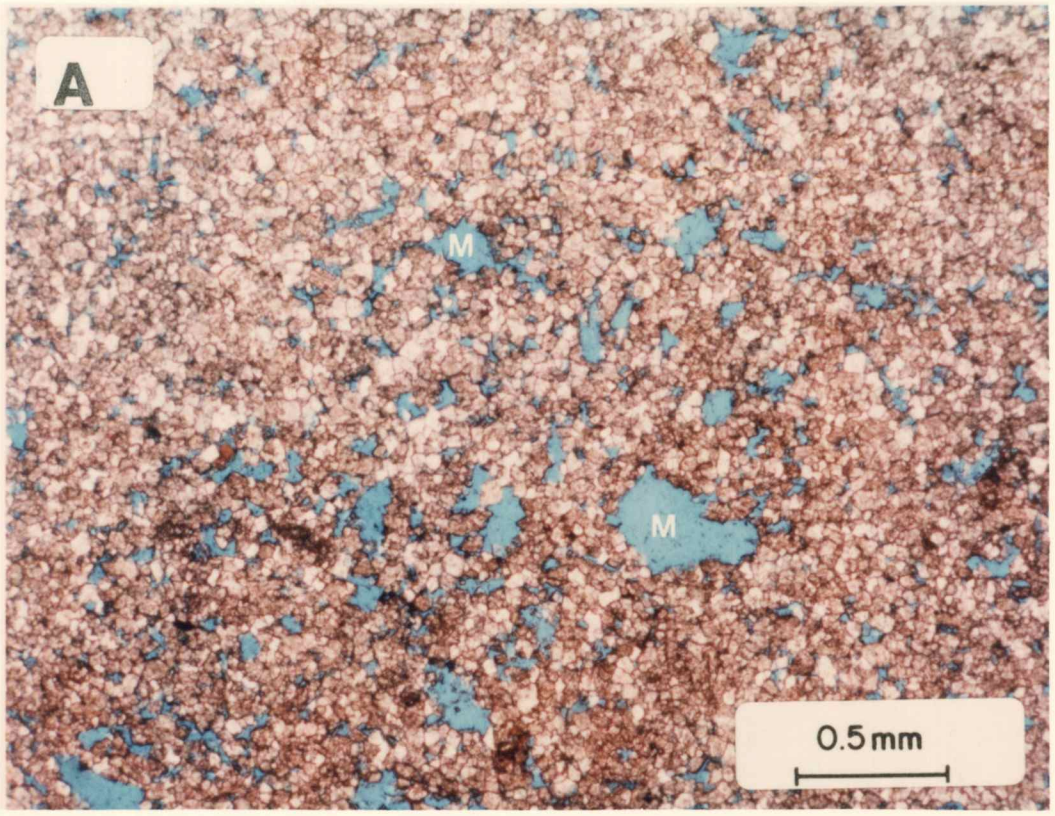
B - 160X

X-ray Diffraction Data

Quartz	1%
Dolomite	92%
Anhydrite	3%
Clay	4%

Petrophysical Data

Cementation Exponent (m): 2.05
Saturation Exponent (n): 1.32


A
M
M
0.5 mm

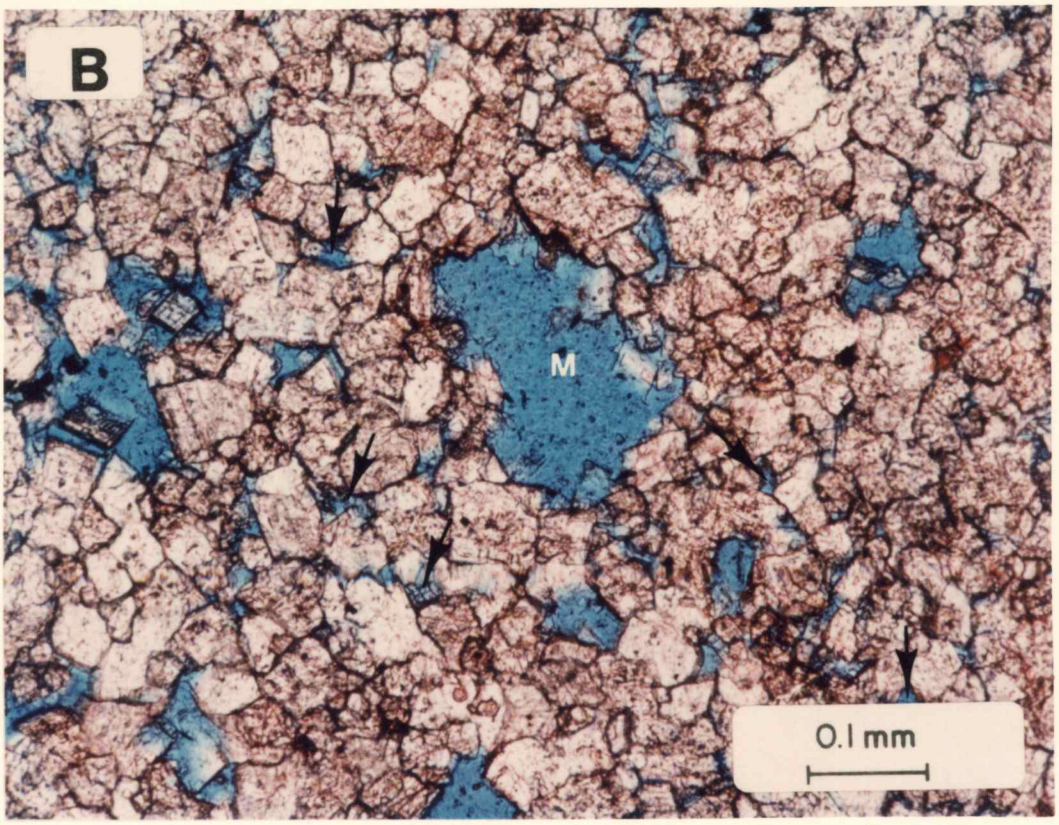

B
M
0.1 mm

FIGURE 10

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2552.9 feet

Average Grain Size: 0.077 mm (Lower Very Fine Sand) Porosity: 26.0%
Sorting: Well Sorted Permeability: 144 md
Stratigraphic Unit: Winfield Sandstone
Dep. Facies: Tidal Flat

Hematite-stained clay (dark material) is the main pore-filling constituent in this sample. Minor amounts of anhydrite cement and silica cement also plays roles in porosity reduction. Primary intergranular pores account for most of the measured pore volume, although secondary pores from leached and partially leached grains were also identified. The relatively high measured permeability reflects a pore system dominated by homogeneously distributed, generally well interconnected primary pores.

A - 40X

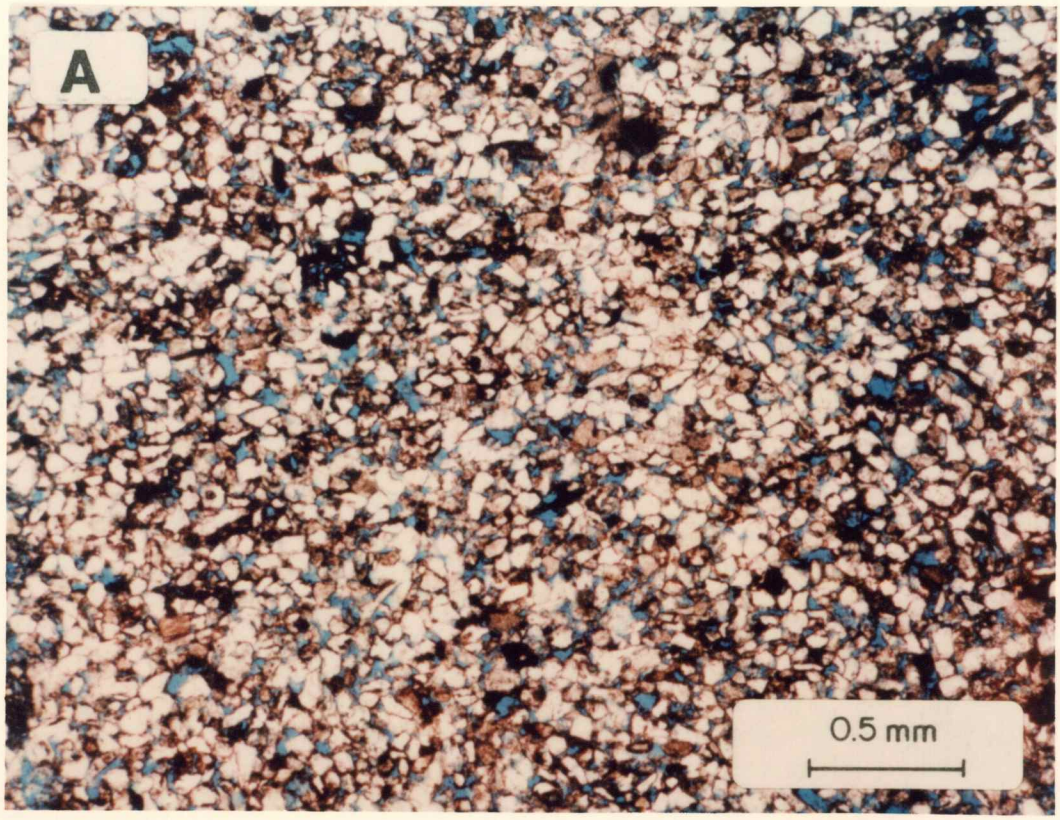
B - 160X

X-ray Diffraction Data

Quartz	74%
Potassium Feldspar	11%
Plagioclase Feldspar	12%
Clay	3%

Petrophysical Data

Cementation Exponent (m): 1.79
Saturation Exponent (n): 1.68


A
0.5 mm

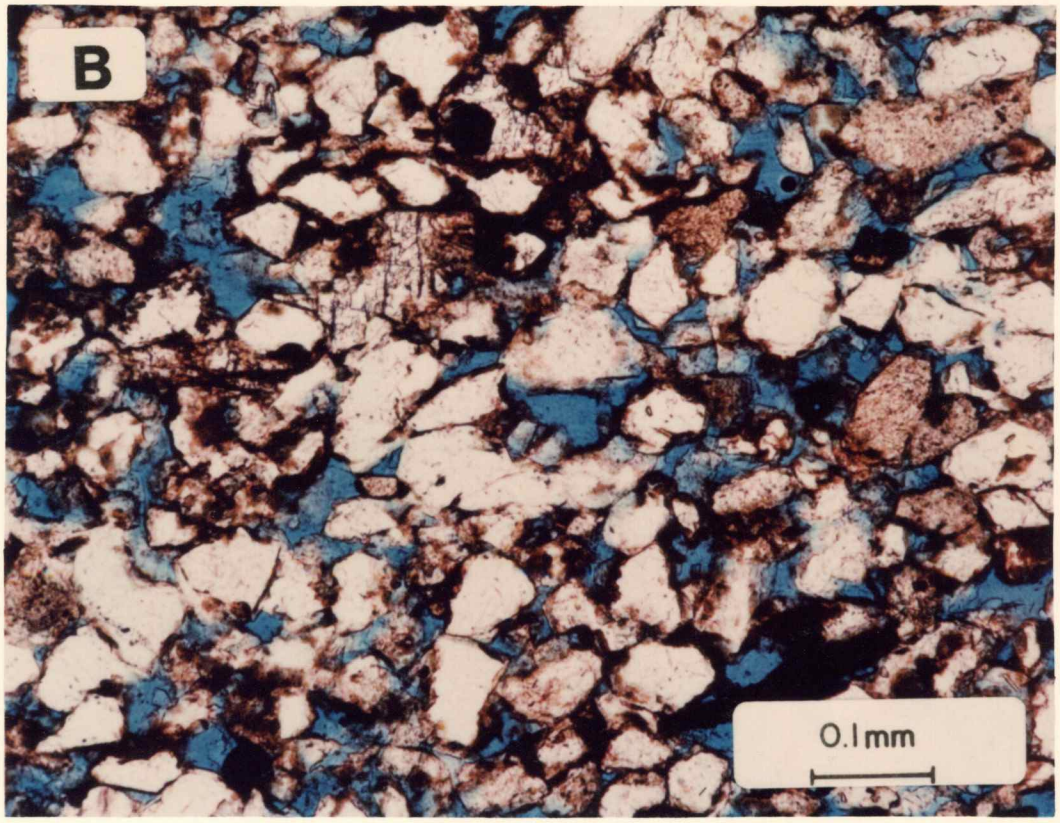

B
0.1 mm

FIGURE 11

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2573.5 feet

Rock Type: Calcareous Dolomite
Depositional Texture: Packstone
Porosity: 19.1%
Permeability: 7.64 md
Stratigraphic Unit: Winfield Dolomitic Lime
Dep. Facies: Shoal Flank

The finely crystalline, inclusion-rich dolomite that accounts for most of the sample probably developed from alteration of micrite matrix. Some of the framework grains were also dolomitized. Calcite cement and remnant calcite framework grains (stained pink) can also be distinguished. Patchy anhydrite cement has filled some of the larger moldic pores. The remnant pore system consists of scattered moldic pores (M) and intercrystalline pores that are heterogeneously distributed within the dolomitized matrix. In this rock, it appears that dolomitization enhanced porosity by creating intercrystalline pores in what was presumably low porosity lime matrix (micrite). A minor amount of dark-colored solid hydrocarbon(?) coats some of the pores.

A - 40X

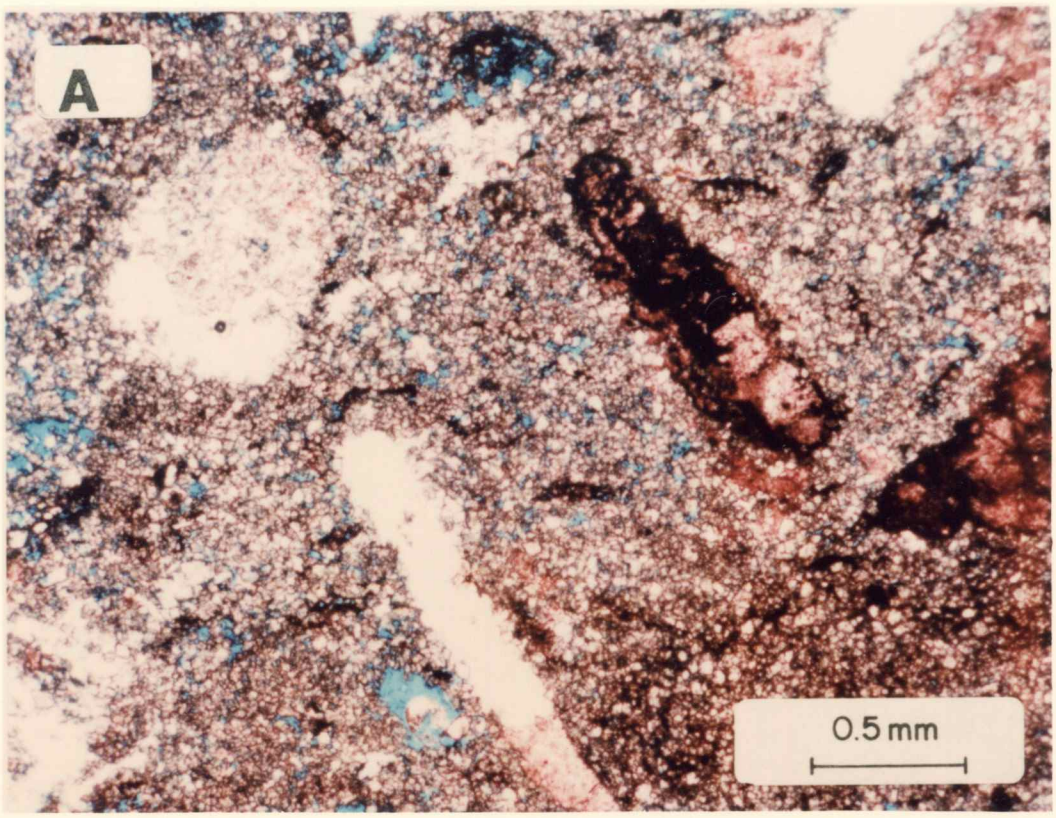
B - 160X

X-ray Diffraction Data

Quartz	5%
Plagioclase Feldspar	1%
Calcite	11%
Dolomite	68%
Anhydrite	11%
Clay	4%

Petrophysical Data

Cementation Exponent (m): 2.09
Saturation Exponent (n): 1.50


A
0.5 mm

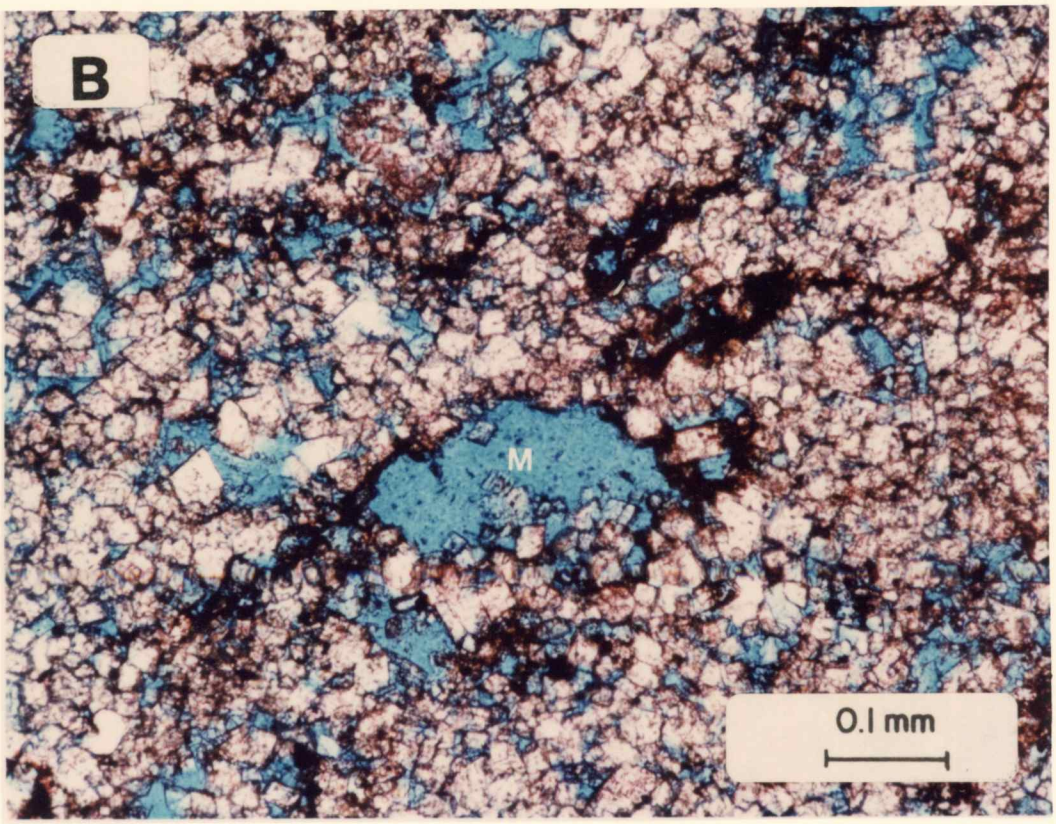

B
M
0.1 mm

FIGURE 12

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2578.7 feet

Rock Type: Slightly Dolomitic Limestone
Depositional Texture: Packstone/Grainstone
Porosity: 12.6%
Permeability: 0.779 md
Stratigraphic Unit: Winfield Dolomitic Lime
Dep. Facies: Shoal Flank

Bryozoans, foraminifera, echinoderms, other skeletal debris and oncoids account for most of the framework grains in this rock. Although there are scattered macropores (moldic pores, interparticle pores and intraparticle pores), a portion of the total measured pore volume is in the form of microporosity. This microporosity occurs in association with altered micritic grains and micrite matrix. Most of the macropores appear to be rather isolated from one another by the interstitial micrite. There has been a minor amount of matrix-selective dolomitization.

A - 40X

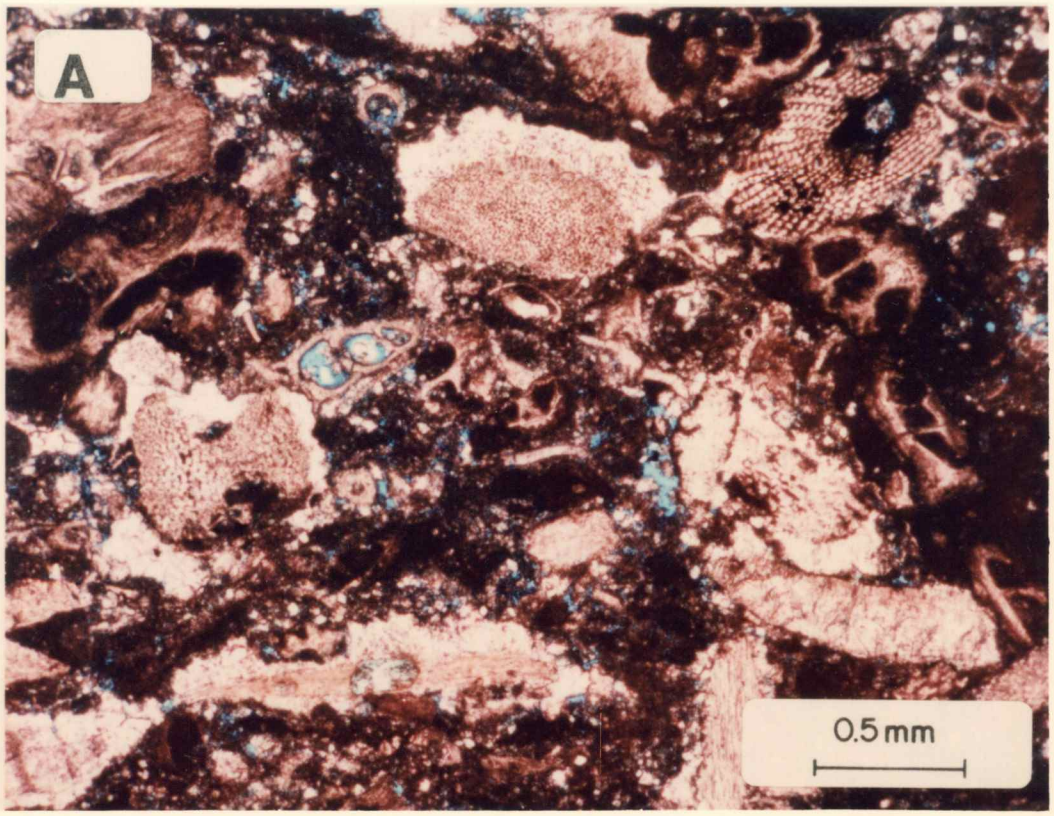
B - 160X

X-ray Diffraction Data

Quartz	1%
Calcite	94%
Dolomite	5%

Petrophysical Data

Cementation Exponent (m): 2.01
Saturation Exponent (n): 2.03


A
0.5 mm

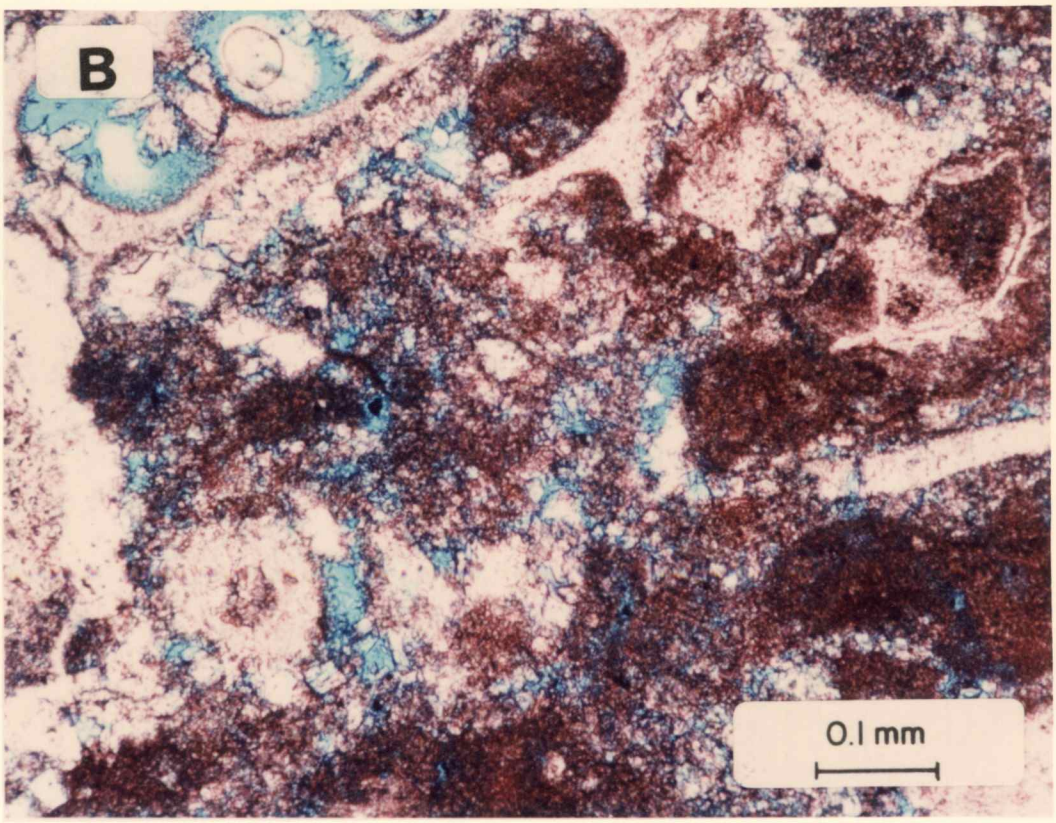

B
0.1 mm

FIGURE 13

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2613.2 feet

Average Grain Size: 0.048 mm (Coarse Silt)
Sorting: Very Well Sorted
Porosity: 20.7%
Permeability: 35.7 md
Stratigraphic Unit: Towanda Sand
Dep. Facies: Tidal Flat

Note the fine, uniform grain size in this siltstone. Pore-filling constituents are rather sparse, and intergranular pore space is well preserved. Small patches and single crystals of dolomite (D) and anhydrite cements are scattered throughout the rock, there is some carbonate matrix material; however, the relatively high measured permeability suggests that the intergranular areas are well interconnected.

A - 40X

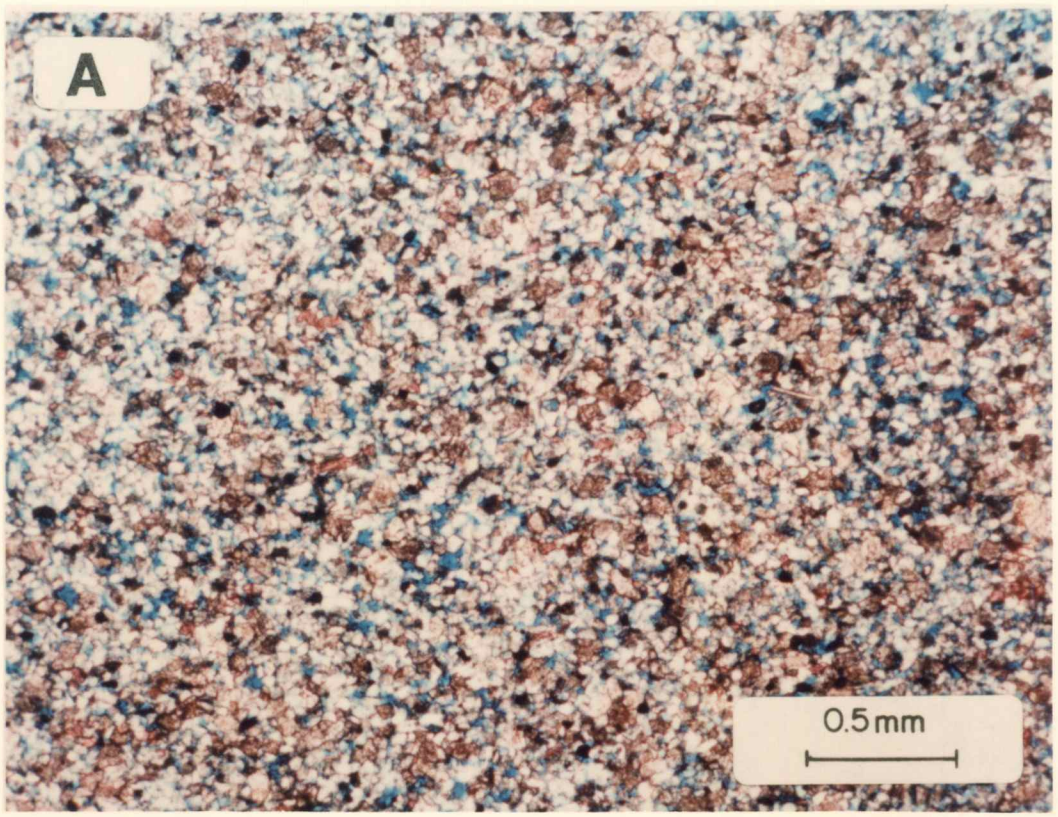
B - 160X

X-ray Diffraction Data

Quartz	74%
Plagioclase Feldspar	7%
Calcite	2%
Dolomite	9%
Anhydrite	5%
Clay	3%

Petrophysical Data

Cementation Exponent (m): 1.89
Saturation Exponent (n): 1.54


A
0.5mm

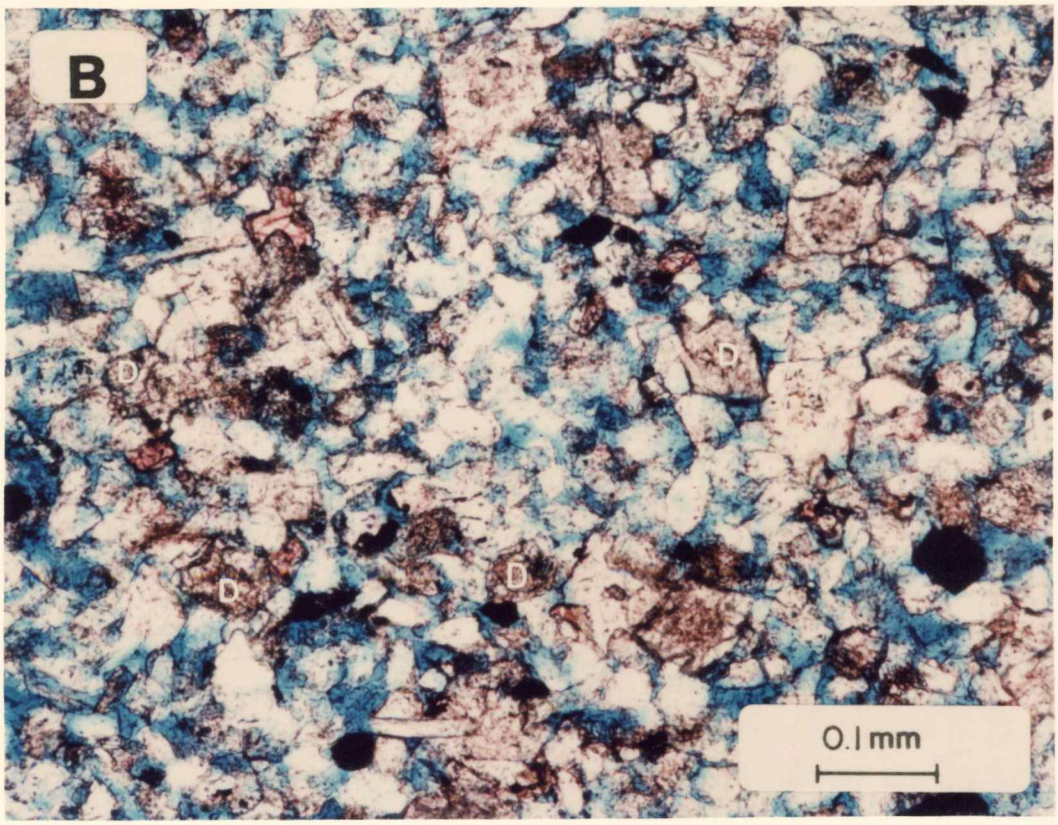

B
D
D
D
D
0.1mm

FIGURE 14

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2625.9 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 14.4%
Permeability: 1.69 md
Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shoal

Ooids, oncoids and scattered skeletal grains are present in this rather coarse-grained, lime grainstone. Patchy calcite (C) cement, some of which occurs as syntaxial overgrowths around echinoderm (E) fragments, and some of which is in the form of more finely crystalline spar, has occluded some of the intergranular pore space. The remnant pore system consists of a combination of moldic (M) pores, partially reduced intergranular pores (arrows in view B) and microporosity within micritic grains such as oncoids, micritized skeletal fragments and micritic intraclasts. There is also indication of very minor fracture development; however, these fractures do not appear to significantly enhance reservoir potential. Patchy anhydrite and dolomite replacement (lower left corner of view A) yields areas of low porosity.

A - 40X

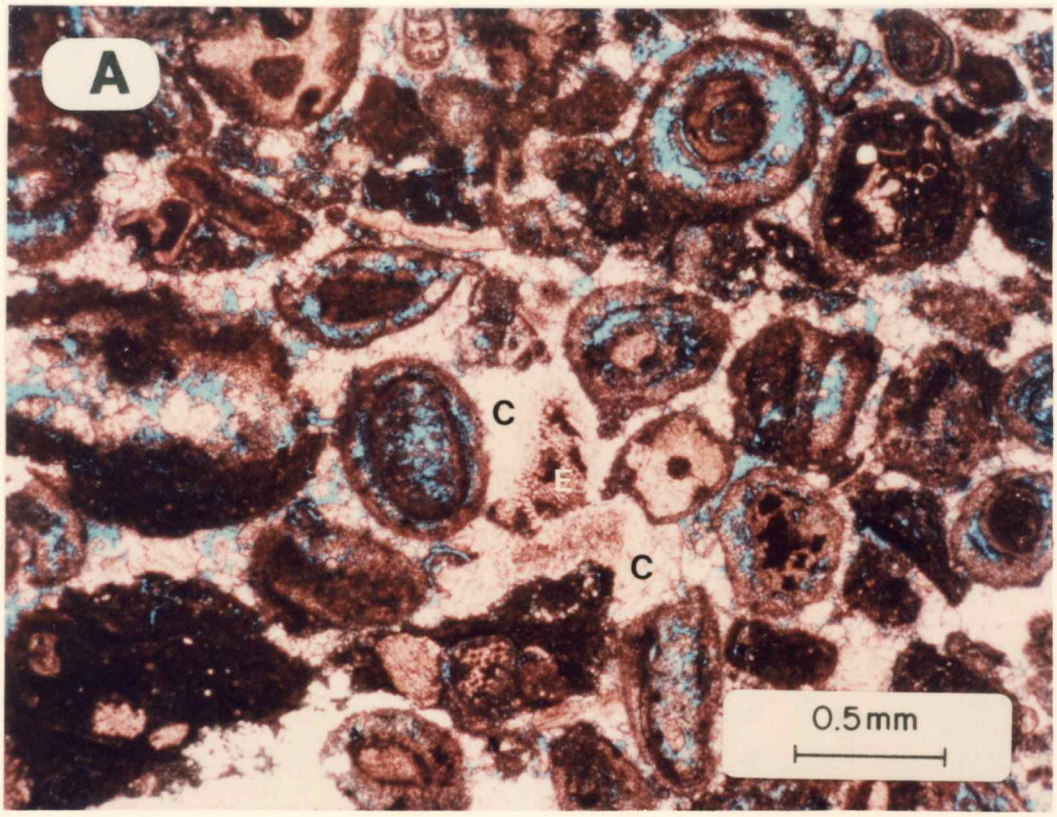
B - 160X

X-ray Diffraction Data

Quartz	2%
Calcite	83%
Dolomite	1%
Anhydrite	14%

Petrophysical Data

Cementation Exponent (m): 2.15
Saturation Exponent (n): 1.84


A
C
C
0.5mm

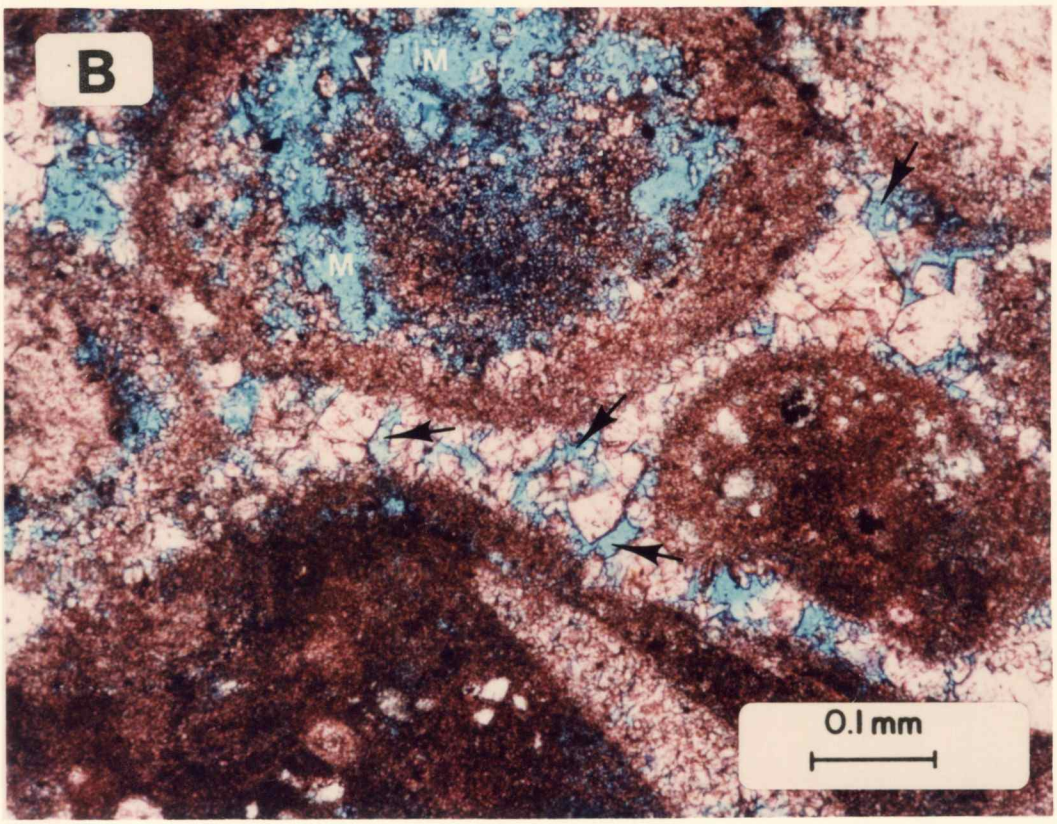

B
IM
M
0.1mm

FIGURE 15

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2637.8 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 27.1%
Permeability: 0.856 md
Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shoal

Relatively well sorted ooids are the dominant framework constituent in this limestone. In addition, scattered skeletal grains and micritic intraclasts are also present. The pore system is dominated by moldic pores within leached and partially leached framework grains. In view A, note how some grains have been extensively leached, leaving relatively large, "clean" moldic pores; other grains (such as the one highlighted near the top of view B) has been only partially leached, leaving micrite-sized crystals within the altered grain. There appears to be microporosity associated with these grain remnants. A large portion of the primary intergranular pore space has been occluded by calcite cement. Many of the moldic pores are isolated from one another by this interstitial calcite cement, although some remain partially open (arrows in view B). The large volume of poorly interconnected moldic pores yields a rock with a very high m value.

A - 40X

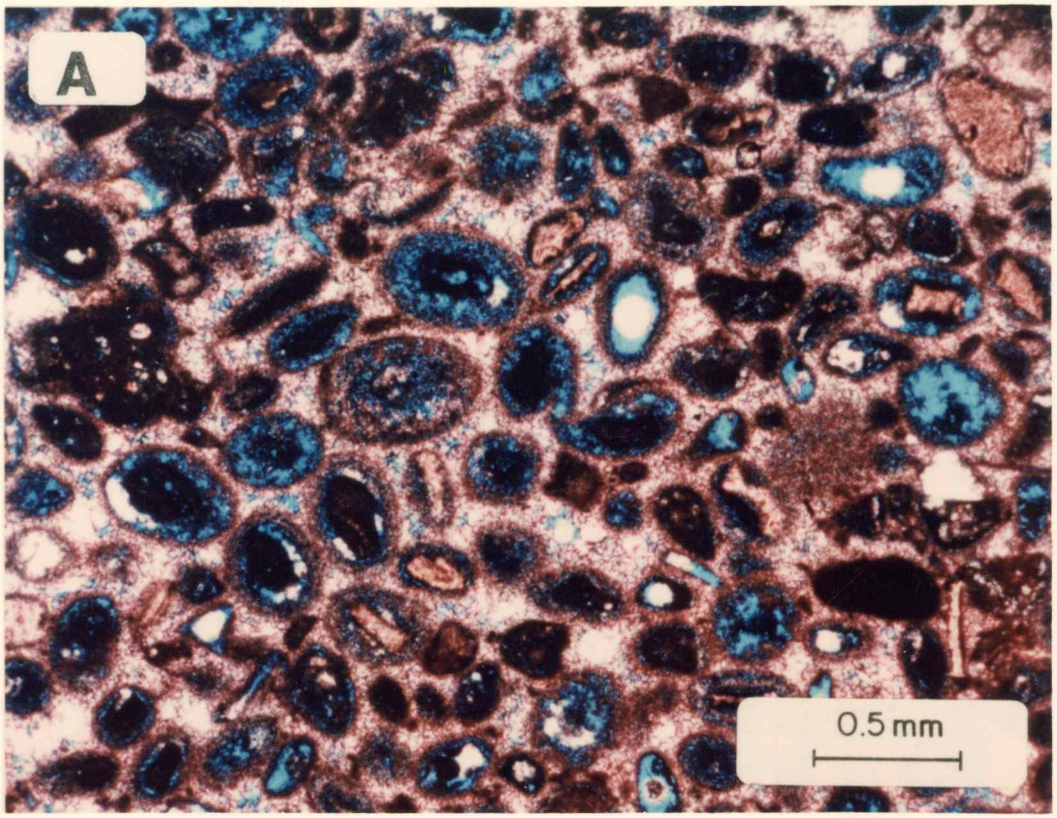
B - 160X

X-ray Diffraction Data

Quartz	2%
Calcite	96%
Anhydrite	2%

Petrophysical Data

Cementation Exponent (m): 3.45
Saturation Exponent (n): 1.94


A
0.5 mm

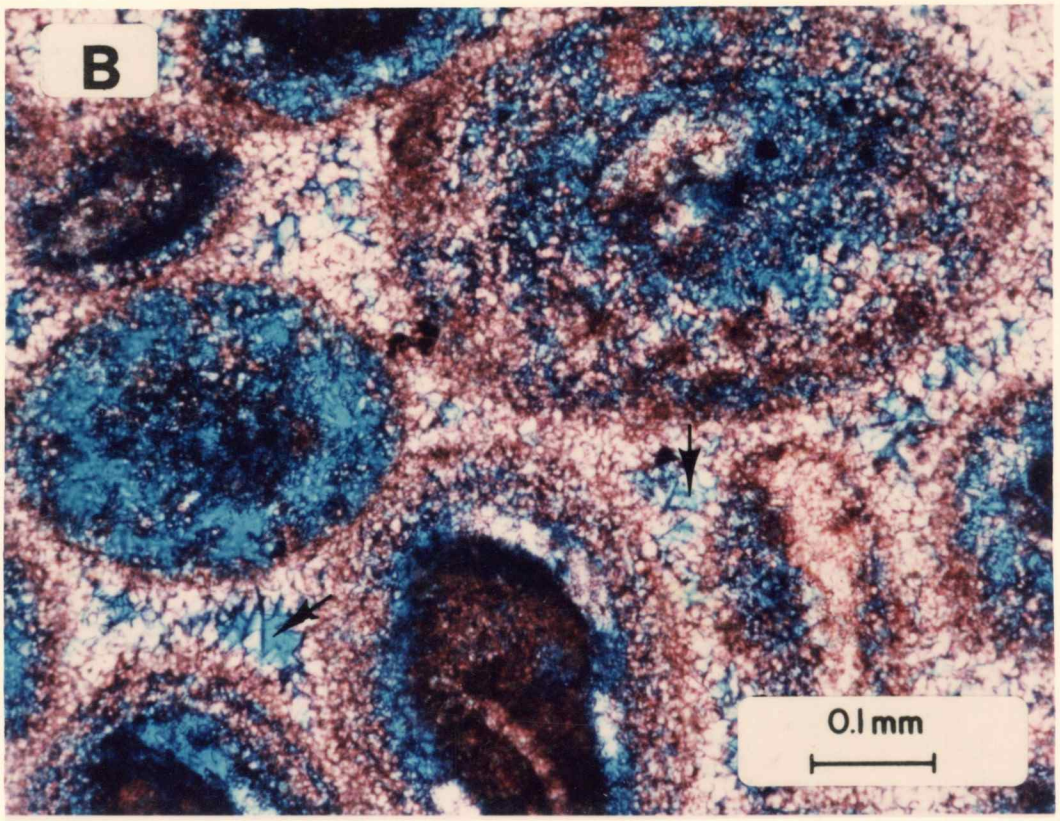

B
0.1 mm

FIGURE 16

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2638.2 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 22.9%
Permeability: 4.52 md
Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shoal

Ooids and skeletal debris account for most of the framework constituents in this grainstone. In view A, open moldic pores are conspicuous in the upper half of the photomicrograph, but compaction has reduced pore space in the lower half of the photomicrograph. View B shows a close-up view of the boundary between the "less compacted" (top) and more compacted (bottom) parts of this sample. This type of local heterogeneity may have reduced permeability in this sample. Where compaction is less extensive, moldic pores and some remnant intergranular pores can be distinguished. Where compaction is more extensive these same pore types are present, although they are less well preserved. In addition to the macropores, there is some microporosity that occurs in association with partially leached framework grains and in minor amounts of altered detrital micrite matrix.

A - 20X

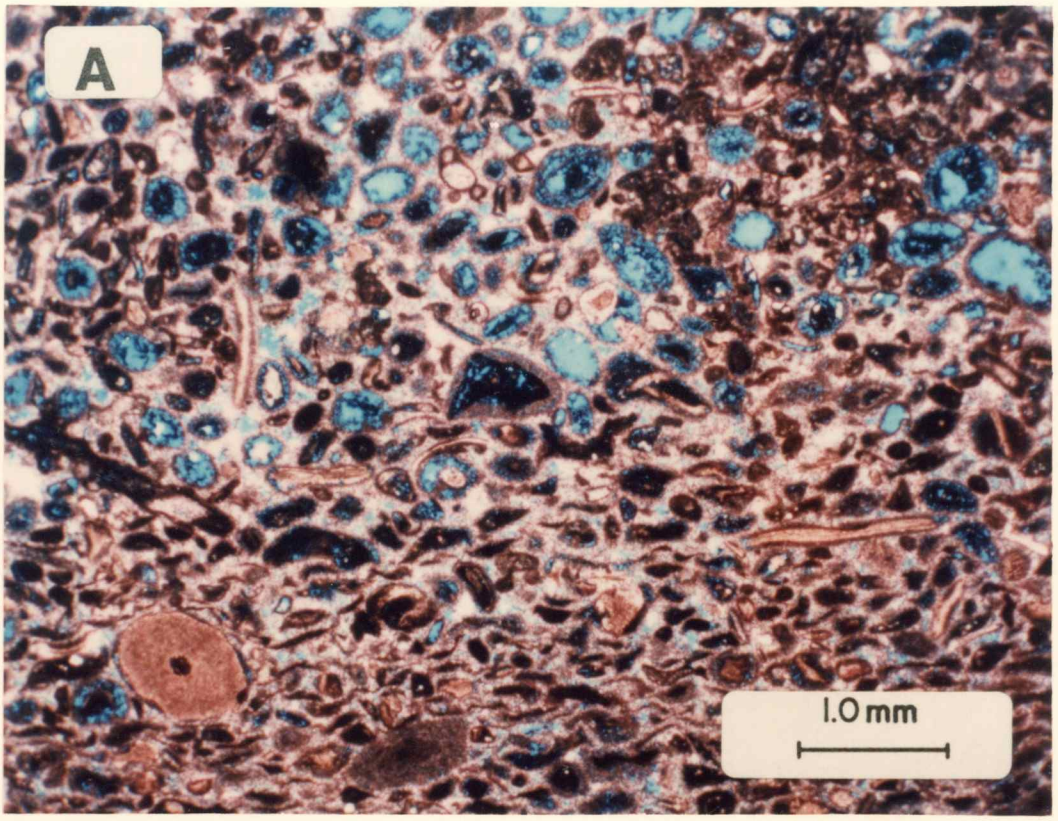
B - 40X

X-ray Diffraction Data

Quartz	2%
Calcite	92%
Anhydrite	6%

Petrophysical Data

Cementation Exponent (m): 2.72
Saturation Exponent (n): 1.67


A
1.0 mm

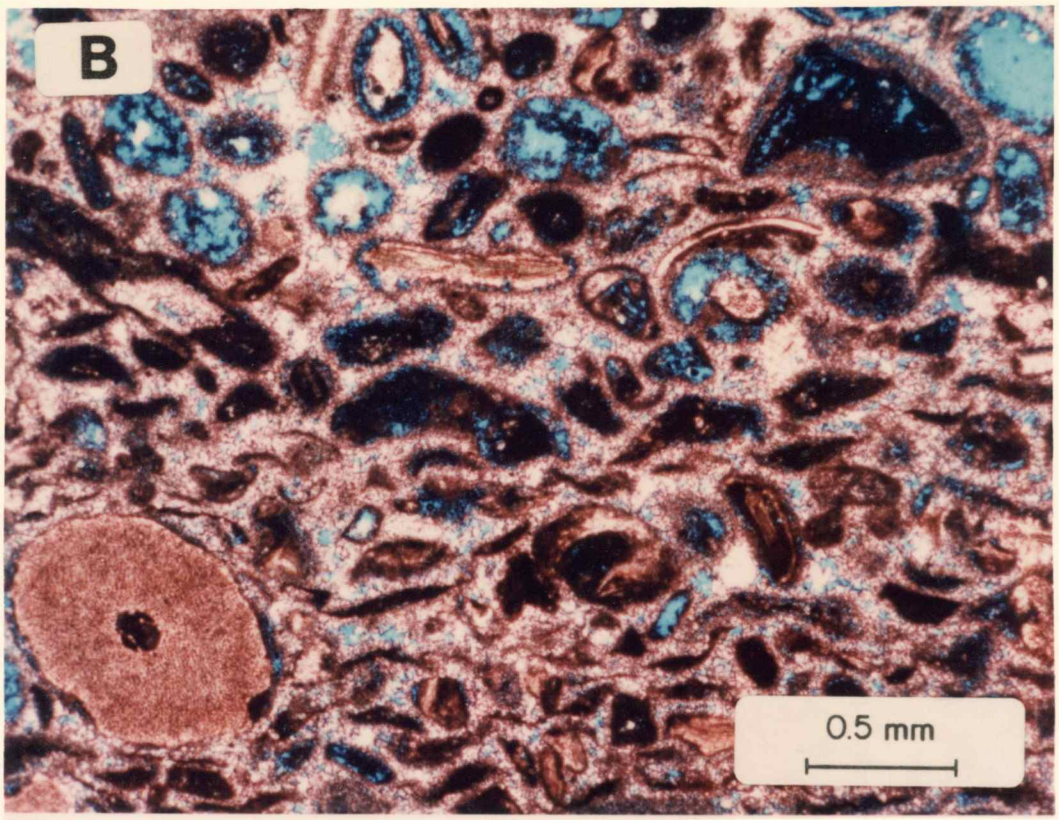

B
0.5 mm

FIGURE 17

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2647.6 feet

Rock Type: Dolomitic, Silty Limestone
Depositional Texture: Packstone
Porosity: 17.5%
Permeability: 3.39 md
Stratigraphic Unit: Towanda Lime
Dep. Facies: Carbonate Shoal to Shoal Flank

This rock appears to have undergone partial "matrix-selective" dolomitization. That is, a portion of the interstitial micrite has been replaced by finely crystalline dolomite, while the framework grains are still composed of calcite. Oncoids (On) and skeletal grains account for most of the framework constituents. Quartz (q) silt/very fine-grained sand is also present. In addition to relatively large moldic (M) pores that developed due to partial dissolution of carbonate grains, dolomitization of the matrix resulted in the development of intercrystalline pores throughout the matrix.

A - 40X

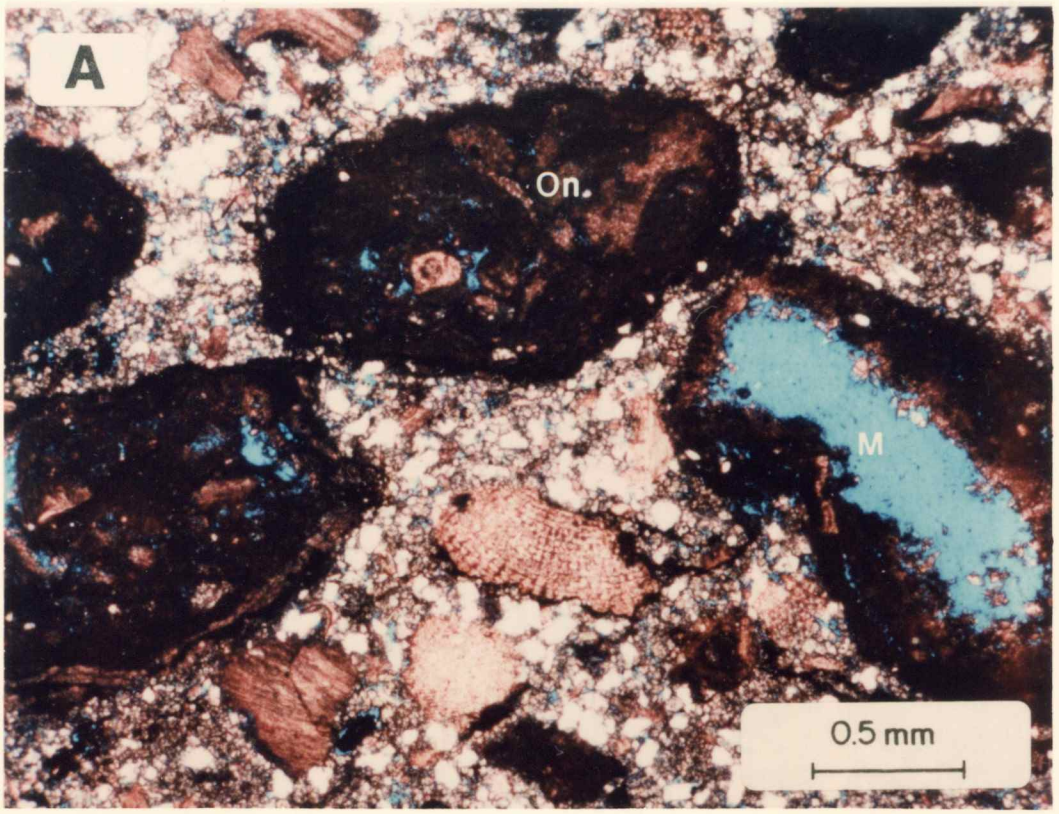
B - 160X

X-ray Diffraction Data

Quartz	18%
Plagioclase Feldspar	6%
Calcite	47%
Dolomite	23%
Anhydrite	2%
Clay	4%

Petrophysical Data

Cementation Exponent (m): 2.04
Saturation Exponent (n): 1.69


A
On.
M
0.5 mm

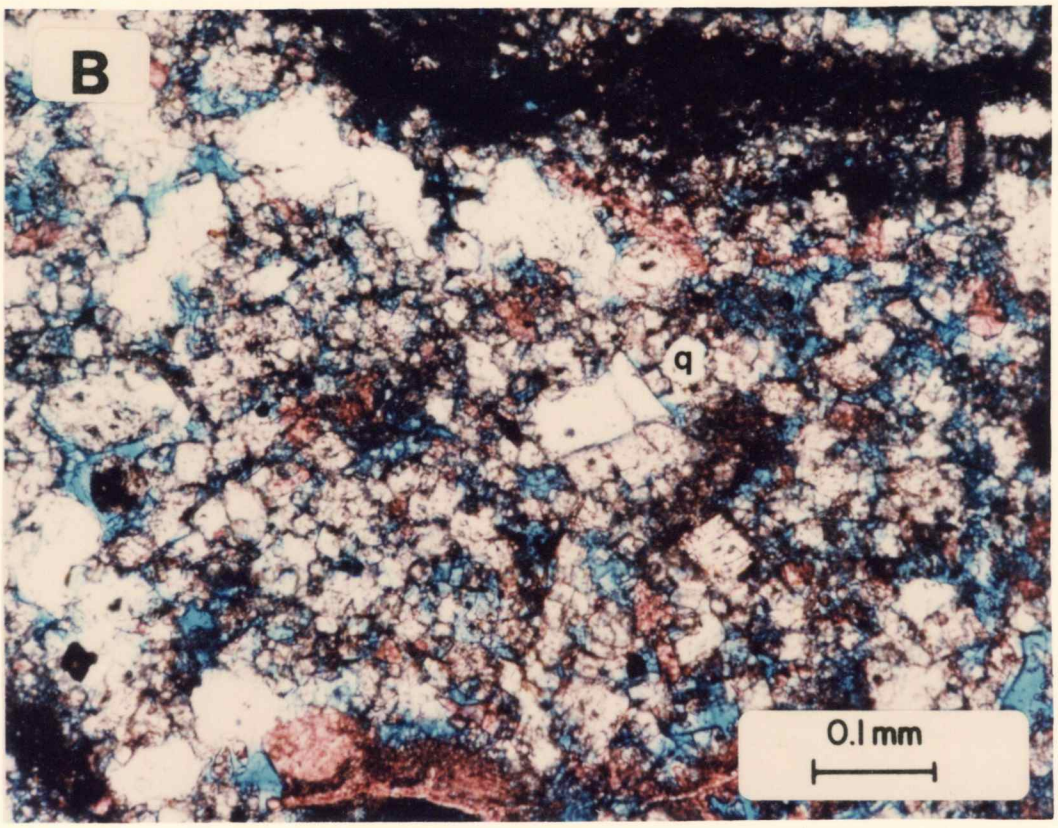

B
q
0.1 mm

FIGURE 18

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2682.6 feet

Rock Type: Dolomitic Limestone
Depositional Texture: Packstone
Porosity: 15.9%
Permeability: 0.532 md
Stratigraphic Unit: Upper Fort Riley
Dep. Facies: Shoal to Shoal Flank

Most of the pore space in this dolomitic limestone occurs as very fine intercrystalline pores within the partially dolomitized micrite matrix. A portion of this matrix porosity may be classified as microporosity. Some scattered macropores were also observed, such as moldic pores and intraskeletal pores. This type of pore structure yields relatively high porosity, but low permeability due to the small pore throat apertures. Echinoderm fragments, oncoids, bryozoans and peloids are the principal framework constituents. A minor amount of quartz and feldspar silt is scattered throughout the sample. Some of the skeletal grains have been partially silicified.

A - 40X

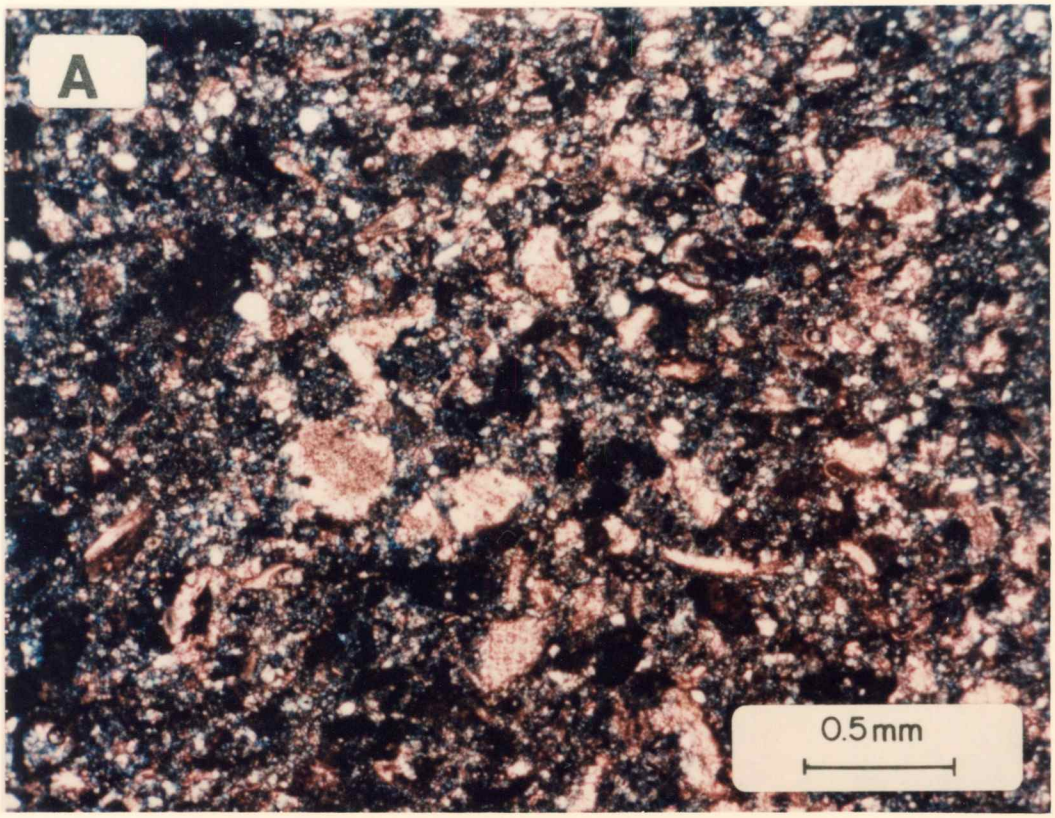
B - 160X

X-ray Diffraction Data

Quartz	10%
Plagioclase Feldspar	10%
Calcite	59%
Dolomite	19%
Clay	2%

Petrophysical Data

Cementation Exponent (m): 1.90
Saturation Exponent (n): 1.61


A
0.5 mm

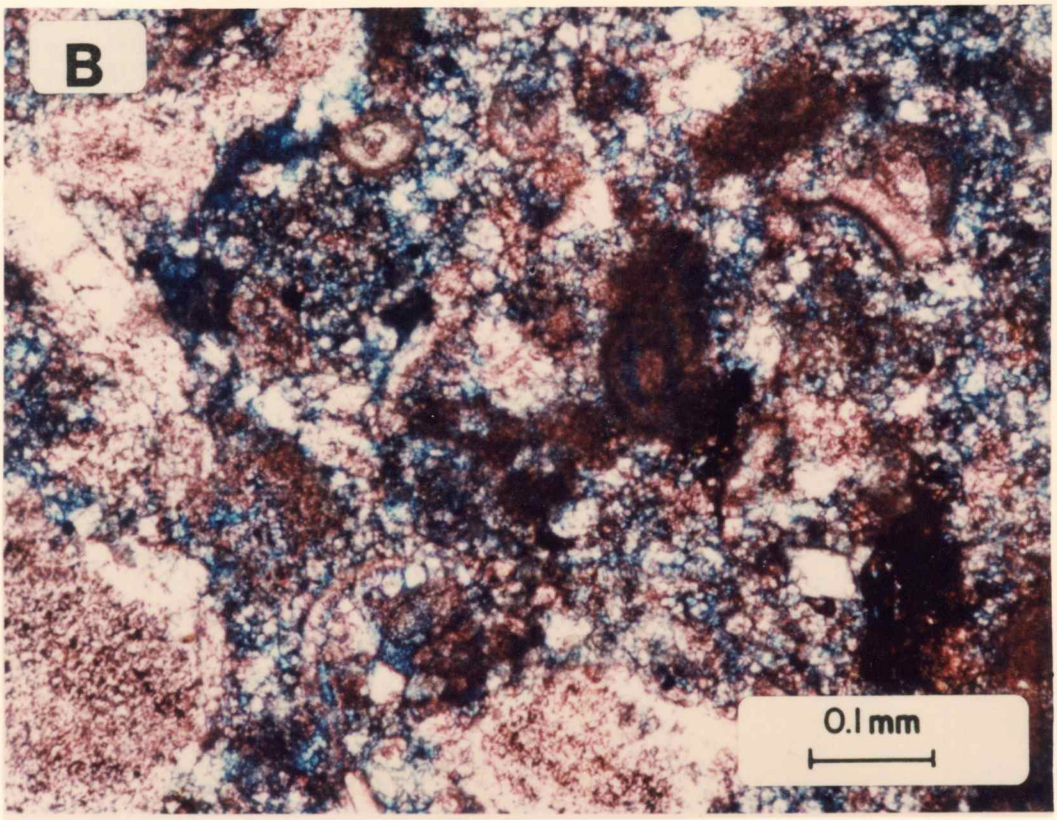

B
0.1 mm

FIGURE 19

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2704.7 feet

Rock Type: Silty, Dolomitic Limestone
Depositional Texture: Packstone
Porosity: 10.5%
Permeability: 0.159 md
Stratigraphic Unit: Upper Fort Riley
Dep. Facies: Carbonate Shoal to Shoal Flank

Detrital micrite (brown material) has occluded nearly all of the intergranular pore space in this skeletal packstone. Subtle diagenetic alteration (neomorphism) of this matrix led to the development of microporosity. In addition, some intragranular pores have been preserved within bryozoan fragments and other skeletal grains. Overall, the pore system in this rock is dominated by microporosity. This yields a rock with relatively high porosity, but rather low permeability. The large bivalve that crosscuts view B has been partially silicified. An anhydrite nodule (not shown here) was observed near the perimeter of this sample.

A - 40X

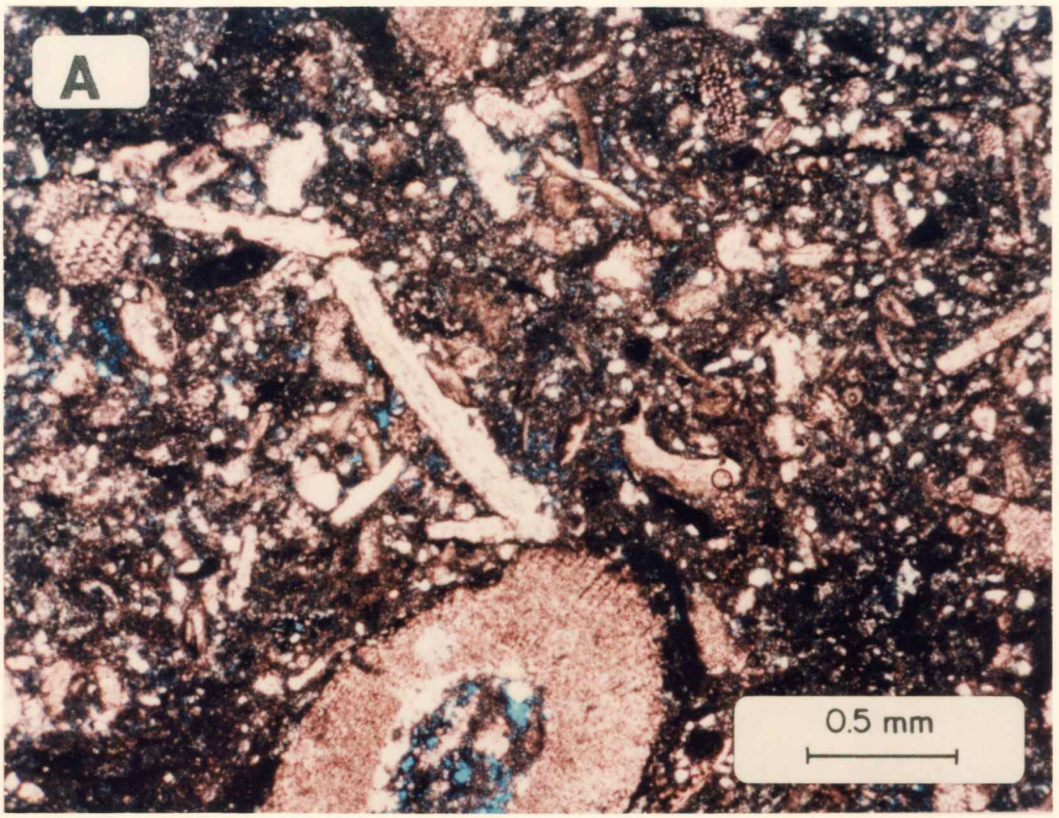
B - 160X

X-ray Diffraction Data

Quartz	8%
Potassium Feldspar	1%
Plagioclase Feldspar	1%
Calcite	62%
Dolomite	8%
Anhydrite	18%
Clay	2%

Petrophysical Data

Cementation Exponent (m): 1.88
Saturation Exponent (n): 1.41


A
0.5 mm

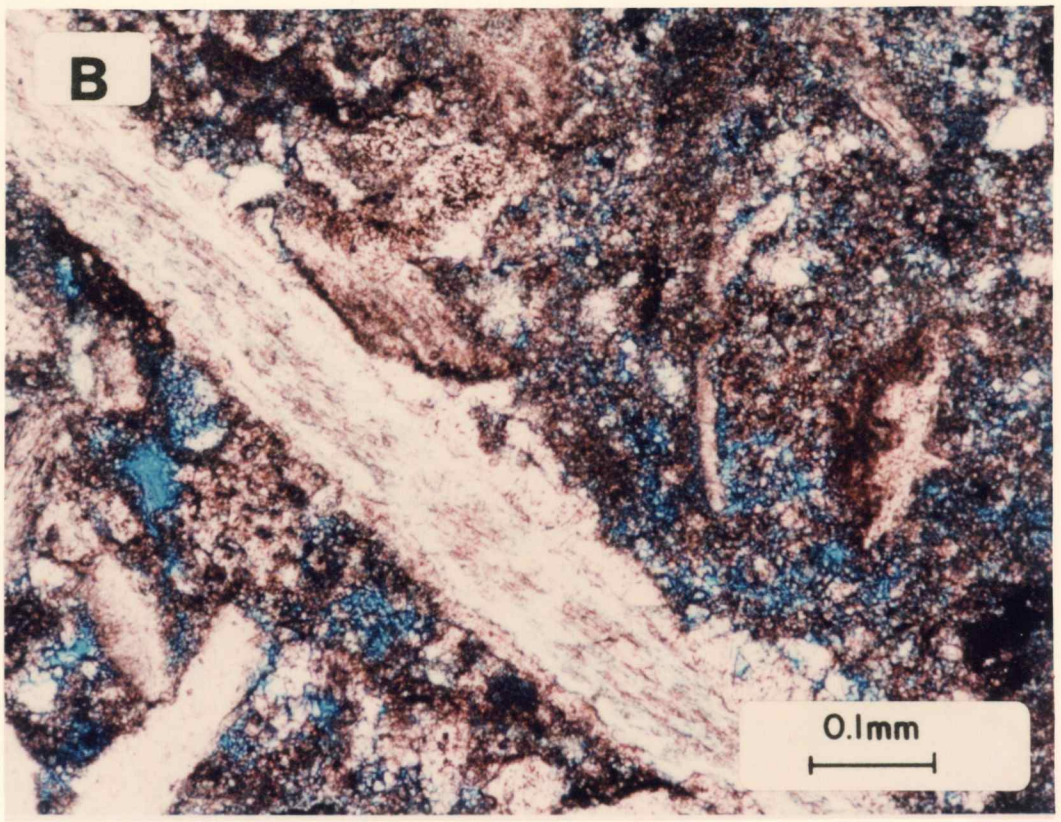

B
0.1mm

FIGURE 20

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2740.1 feet

Average Grain Size: 0.058 mm (Coarse Silt) Porosity: 10.1%
Sorting: Well Sorted Permeability: 0.126 md
Stratigraphic Unit: Upper Florence
Dep. Facies: Tidal Flat

Recrystallized carbonate matrix, calcite cement and dolomite cement are the main pore-filling constituents in this siltstone. In view A, note the subtle grain size variations that reflect bedding. In parts of this sample, intergranular pores have been relatively well preserved; in other parts, matrix material and cement have infilled nearly all of the intergranular areas. In the high magnification view (view B) close examination is required to identify the small remnant intergranular pores.

A - 40X

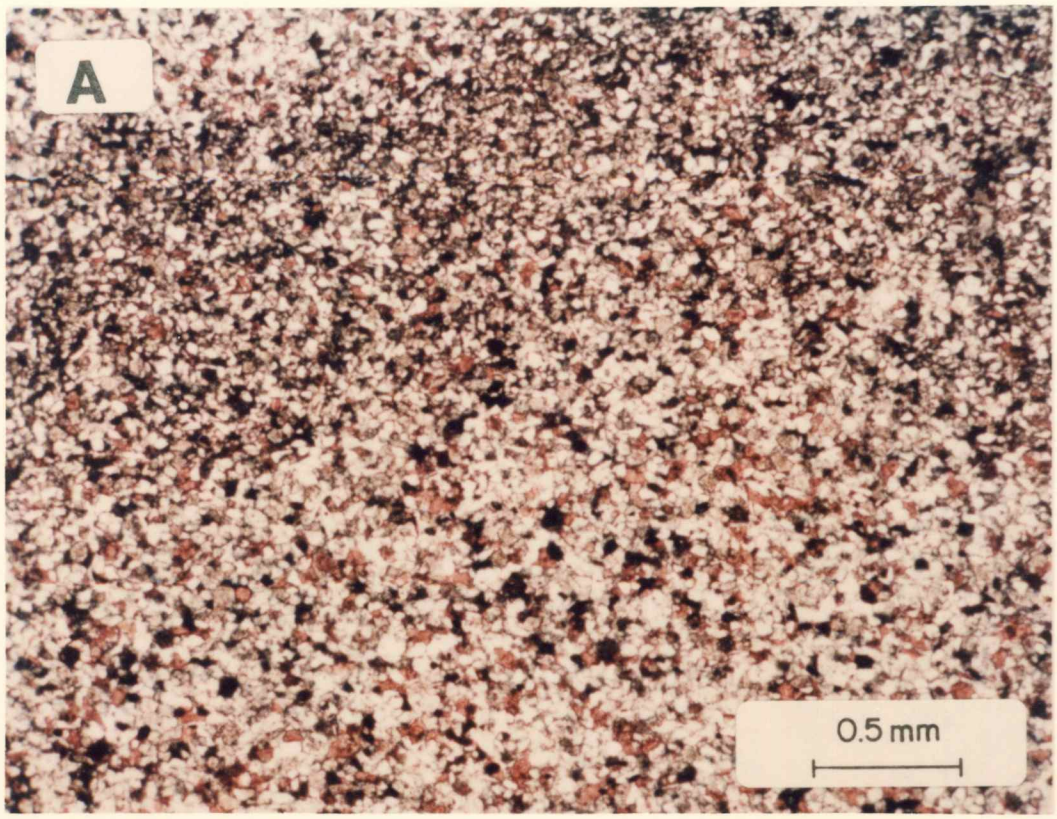
B - 160X

X-ray Diffraction Data

Quartz	74%
Plagioclase Feldspar	4%
Calcite	14%
Dolomite	2%
Clay	6%

Petrophysical Data

Cementation Exponent (m): 1.83
Saturation Exponent (n): 1.57


A
0.5 mm

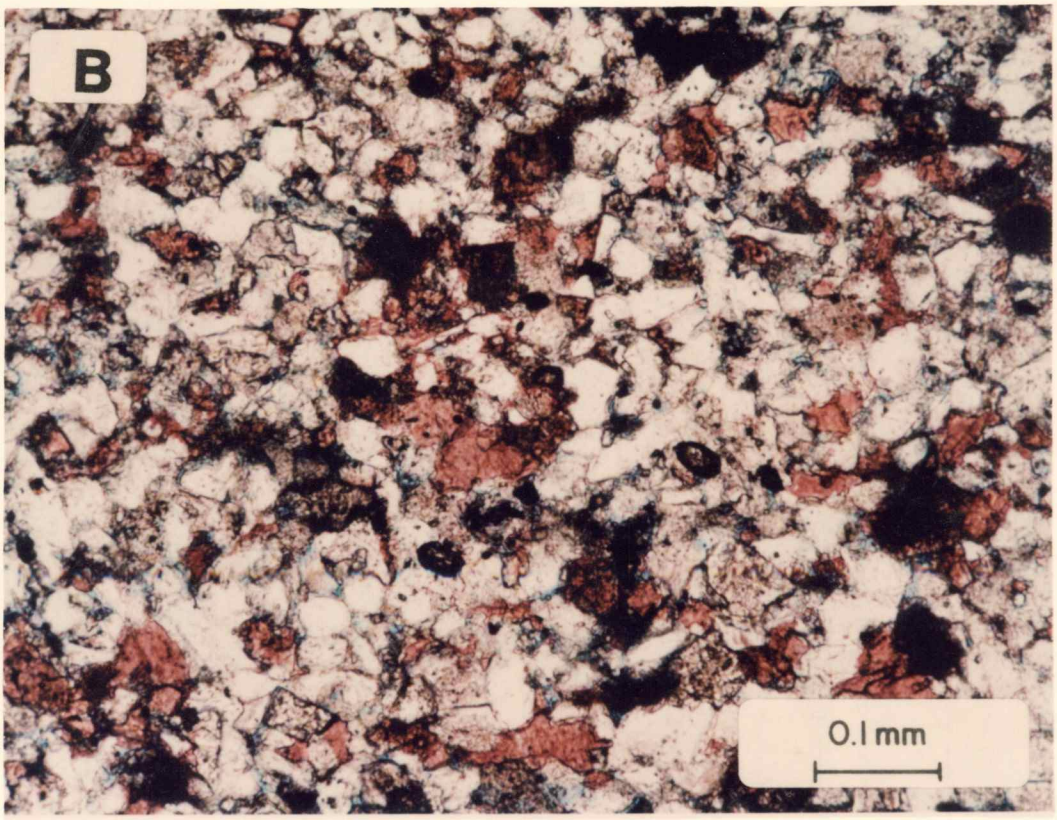

B
0.1 mm

FIGURE 21

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2743.1 feet

Average Grain Size: 0.056 mm (Coarse Silt) Porosity: 9.0%
Sorting: Well Sorted Permeability: 0.020 md
Stratigraphic Unit: Lower Florence
Dep. Facies: Tidal Flat

Visible pore space is uncommon in this siltstone. This reflects the presence of calcite cement, dolomite cement and clay minerals. A large portion of the total pore volume must be contained within microporosity associated with the clay minerals. This pore structure yields rock with low permeability and rather poor reservoir potential. Quartz, feldspar, argillaceous rock fragments, small fossil fragments and heavy minerals account for most of the framework grains.

A - 40X

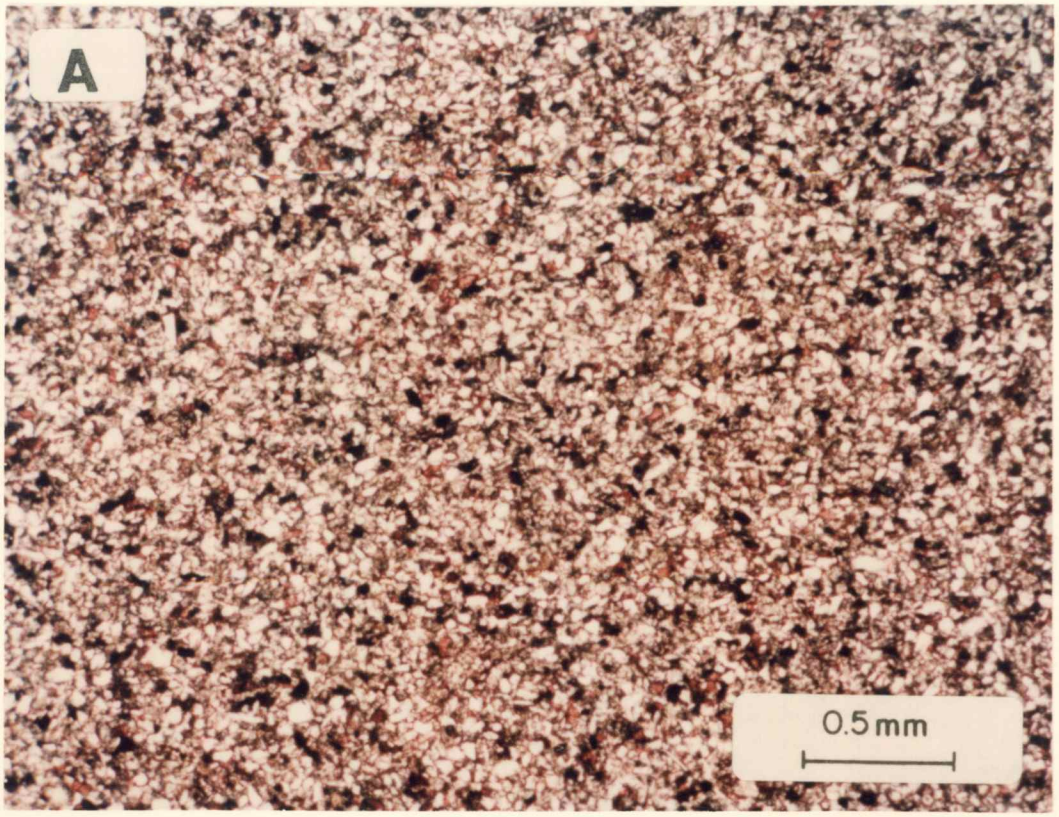
B - 160X

X-ray Diffraction Data

Quartz	71%
Potassium Feldspar	3%
Plagioclase Feldspar	8%
Calcite	9%
Dolomite	2%
Clay	7%

Petrophysical Data

Cementation Exponent (m): 1.88
Saturation Exponent (n): Not Available


A
0.5 mm

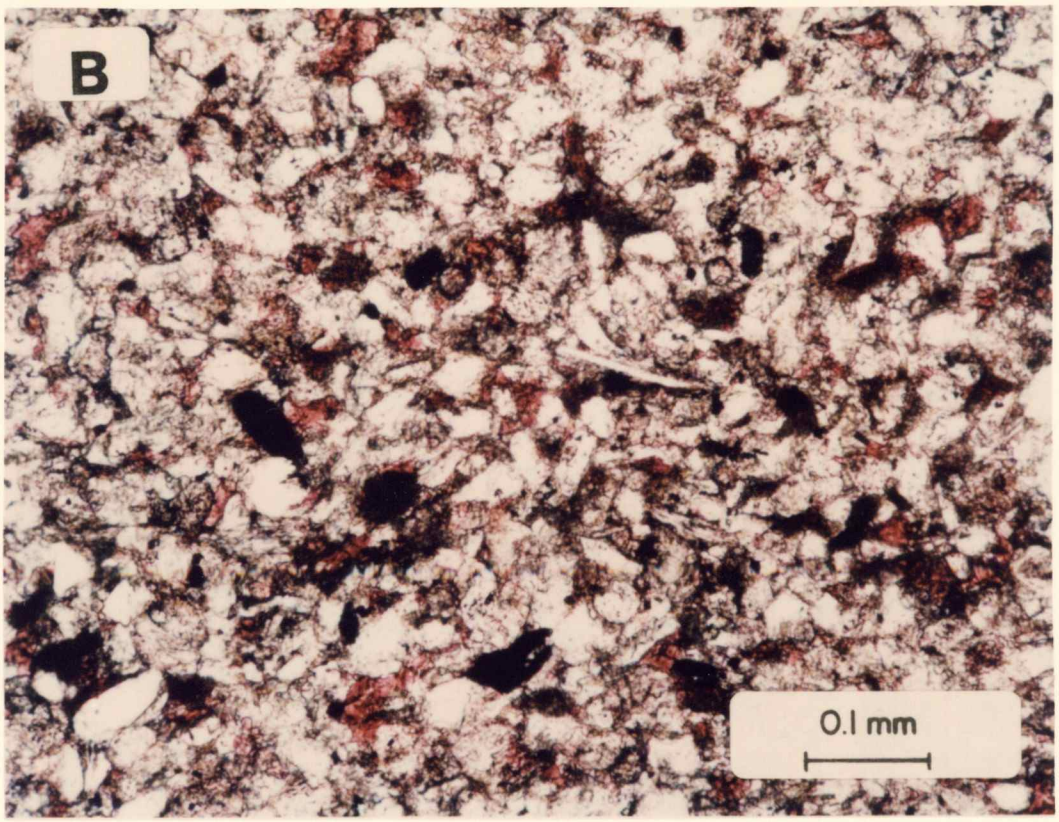

B
0.1 mm

FIGURE 22

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2768.8 feet

Rock Type: Limestone
Depositional Texture: Grainstone

Porosity: 7.0%
Permeability: 0.014 md

Stratigraphic Unit: Wreford
Dep. Facies: Carbonate Shoal

Oncoids and skeletal grains are the predominant framework constituents in this grainstone. Nearly all of the framework grains show some indications of algal coatings. Calcite cement (C) has occluded most of the intergranular pores and intraparticle macropores. A large portion of the remnant pore volume is in the form of microporosity and small macropores within altered/leached micritic grains (view B). These intraparticle pores are isolated from one another by the calcite cement that occludes the intergranular areas. This is reflected in the low measured permeability.

A – 40X

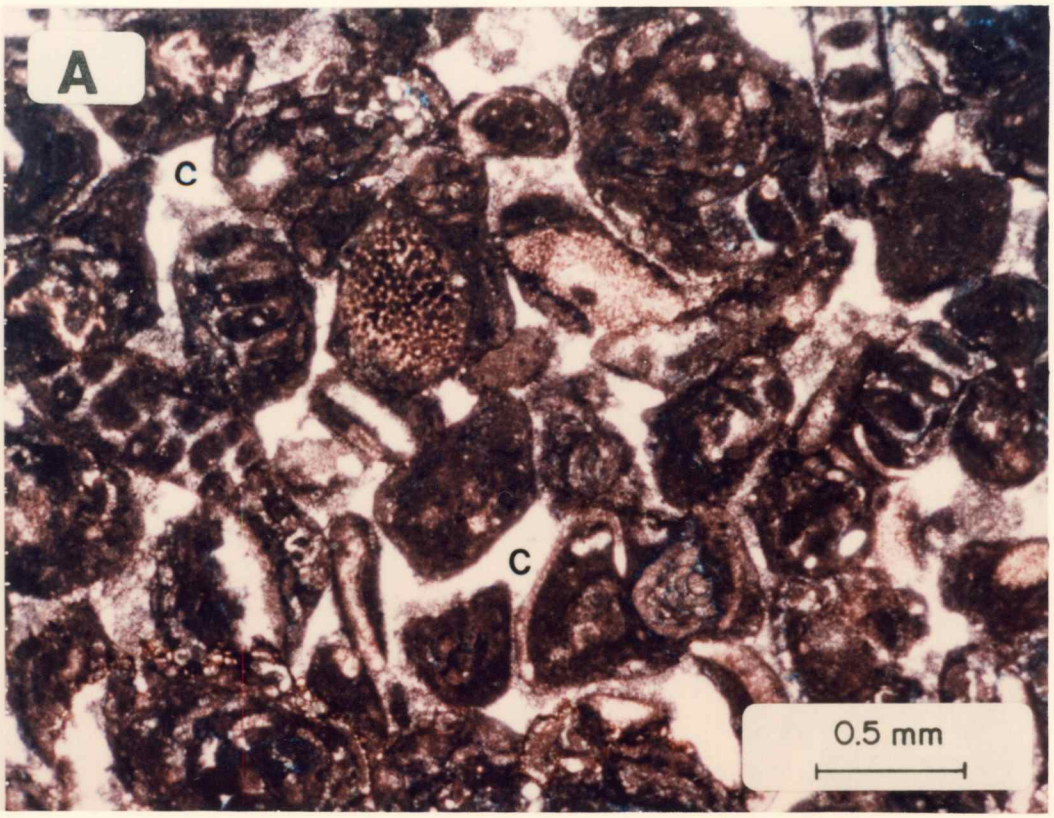
B – 160X

X-ray Diffraction Data

Quartz	5%
Calcite	95%

Petrophysical Data

Cementation Exponent (m): 1.84
Saturation Exponent (n): 1.46


A
C
C
0.5 mm

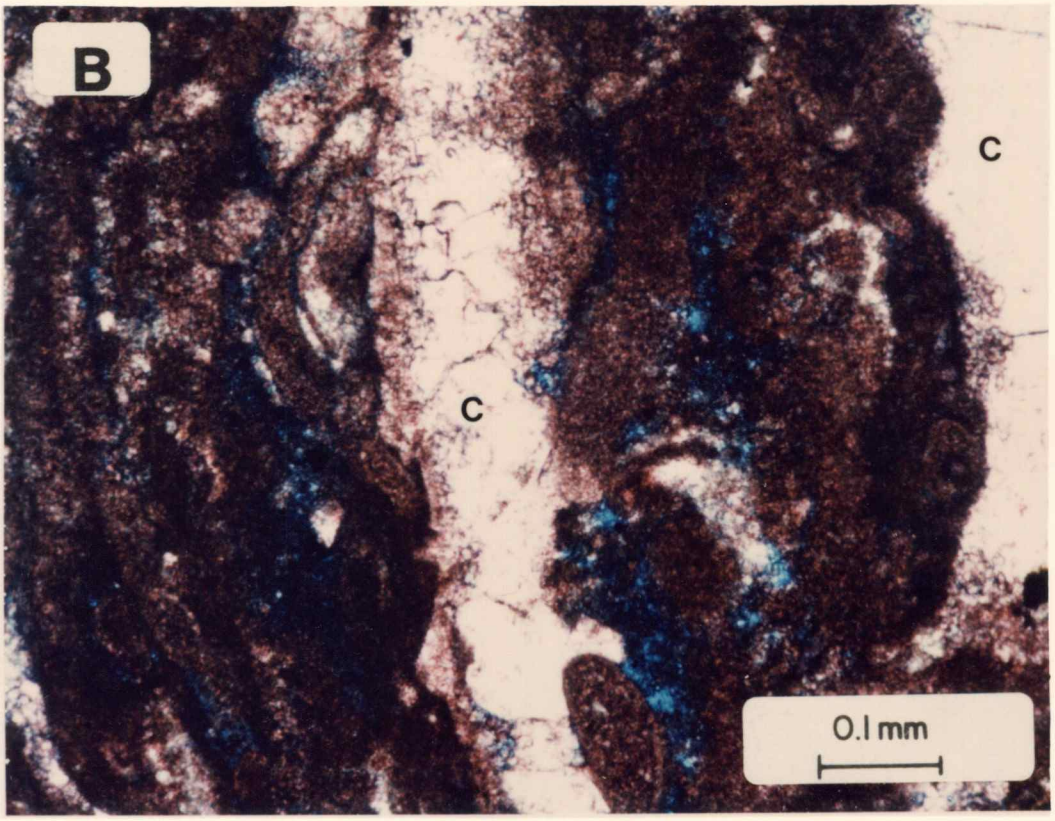

B
C
C
0.1 mm

FIGURE 23

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2793.5 feet

Average Grain Size: 0.080 mm (Lower Very Fine Sand) Porosity: 9.5%
Sorting: Well Sorted Permeability: 4.73 md

Stratigraphic Unit: Council Grove A
Dep. Facies: Eolian Dune

This cross-stratified sandstone has heterogeneously distributed pore space. In view B, parts of the sample have conspicuous intergranular pore space, while other parts have little visible pore space due to streaky anhydrite cementation. In view A, some of the anhydrite cement appears to follow bedding planes, while in other areas the cement crosscuts bedding surfaces. This type of erratic, patchy cementation could lead to variations in directional permeability. Calcite cement, quartz overgrowths and clay minerals also play a role in porosity reduction. In addition to quartz grains, feldspar grains and heavy minerals were identified.

A - 20X

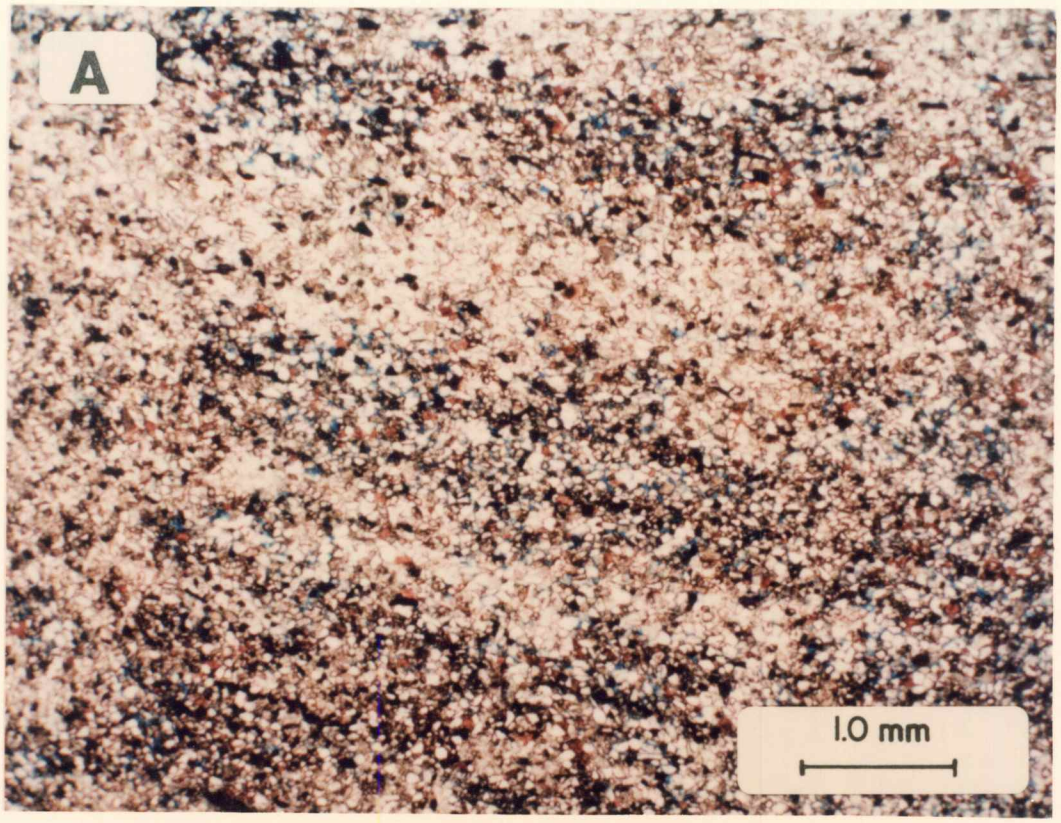
B - 40X

X-ray Diffraction Data

Quartz	59%
Potassium Feldspar	20%
Plagioclase Feldspar	7%
Calcite	4%
Anhydrite	6%
Clay	4%

Petrophysical Data

Cementation Exponent (m): 1.81
Saturation Exponent (n): 1.55


A
1.0 mm

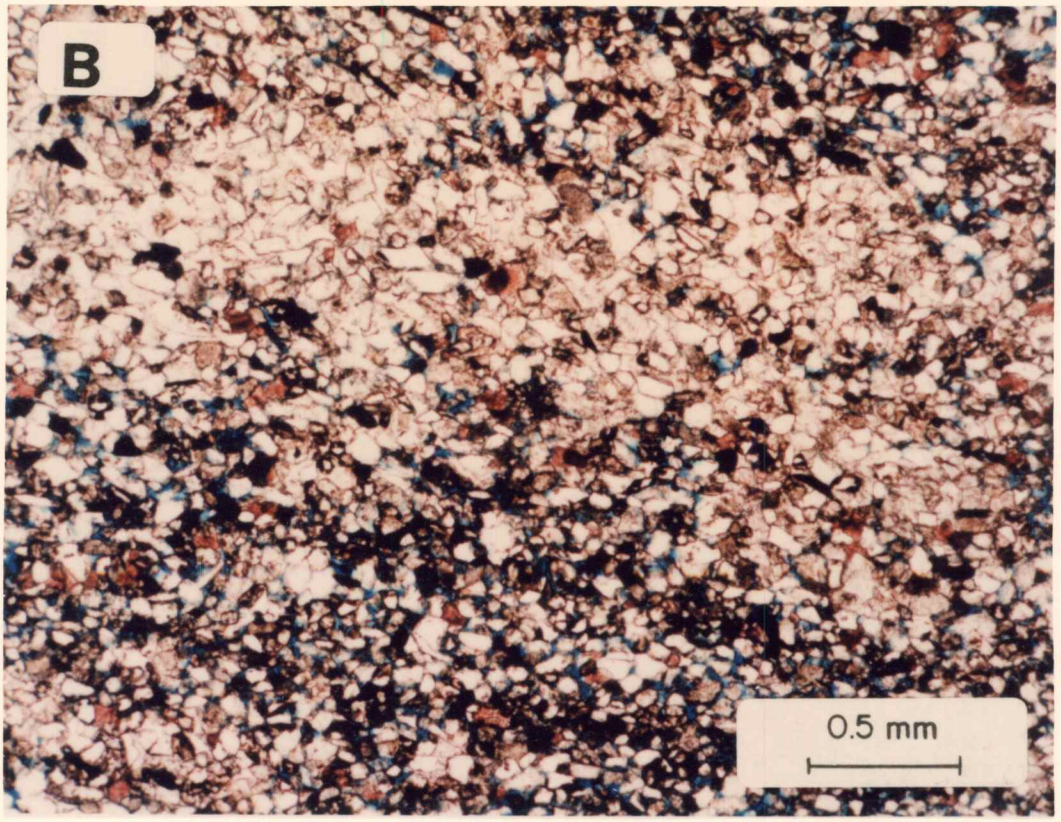

B
0.5 mm

FIGURE 24

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2793.9 feet

Average Grain Size: 0.098 mm (Upper Very Fine Sand) Porosity: 8.3%
Sorting: Well Sorted Permeability: 1.68 md
Stratigraphic Unit: Council Grove A
Dep. Facies: Eolian Dune

This sample comes from a cross-stratified fine-grained sandstone that appears to be of eolian origin. Quartz and feldspar grains account for nearly all of the framework constituents. Although average grain size is in the range of very fine sand, this sample has among the coarsest grain size of any siliciclastic deposits identified throughout the core. In both of these photomicrographs, note the heterogeneous distribution of intergranular pore space. This reflects the presence of patchy anhydrite cement, as well as subordinate amounts of calcite (stained pink) cement and interstitial clay. The loose grain packing suggests that the anhydrite cement probably precipitated relatively early in the diagenetic history of this rock, prior to significant compaction.

A - 40X

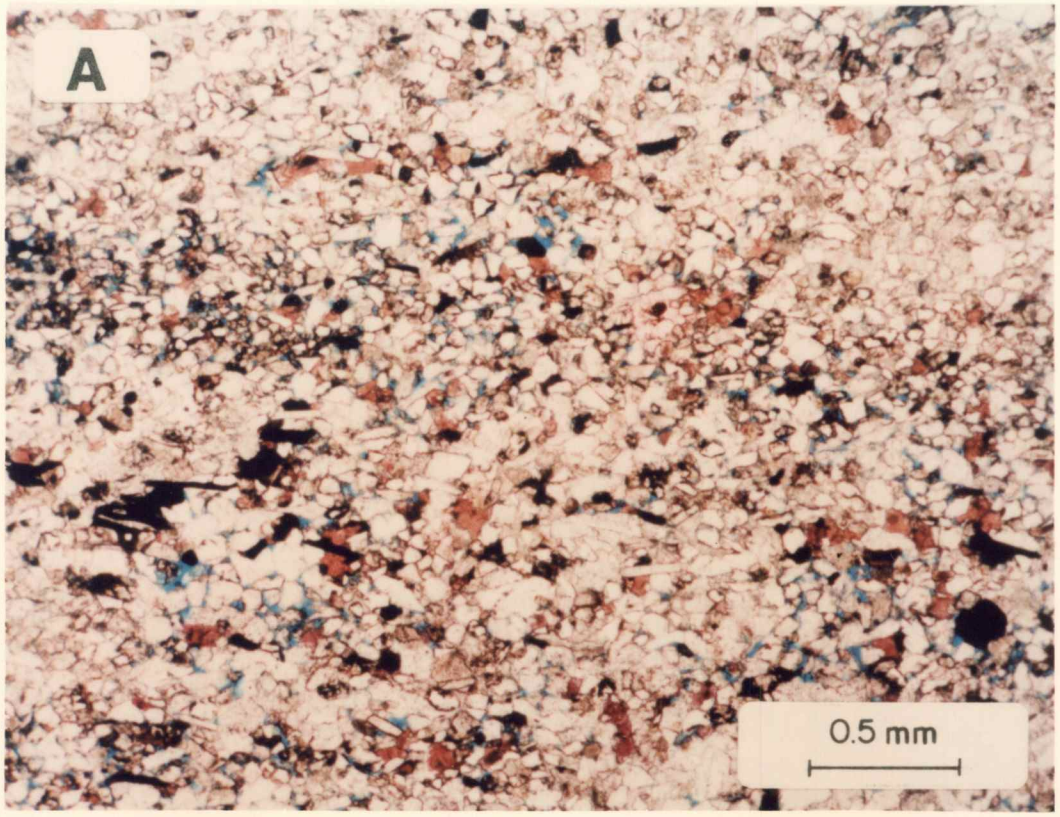
B - 160X

X-ray Diffraction Data

Quartz	61%
Potassium Feldspar	8%
Plagioclase Feldspar	6%
Calcite	8%
Anhydrite	14%
Clay	3%

Petrophysical Data

Cementation Exponent (m): 1.82
Saturation Exponent (n): 1.81


A
0.5 mm

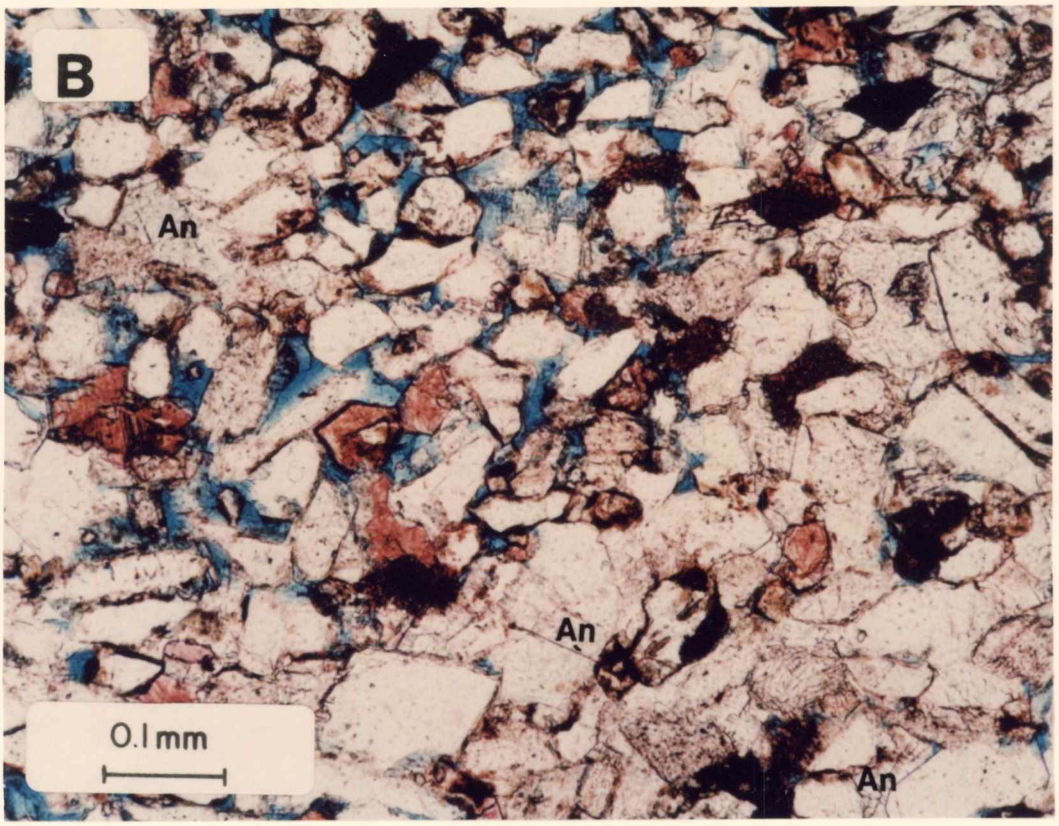

B
An
An
An
0.1 mm

FIGURE 25

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2802.6 feet

Average Grain Size: 0.058 mm (Coarse Silt) Porosity: 8.8%
Sorting: Well Sorted Permeability: 0.010 md
Stratigraphic Unit: Council Grove A
Dep. Facies: Paleosol/Coastal Plain

This argillaceous, calcite (stained pink)-cemented siltstone is from one of the oxidized paleosol/coastal plain horizons. Visible pore space in lacking. Most of the measured pore volume must be in the form of microporosity. The low permeability reflects a rock with rather extensive calcite cementation and interstitial detrital clay. Quartz, feldspar and mica grains account for nearly all of the framework constituents.

A - 40X

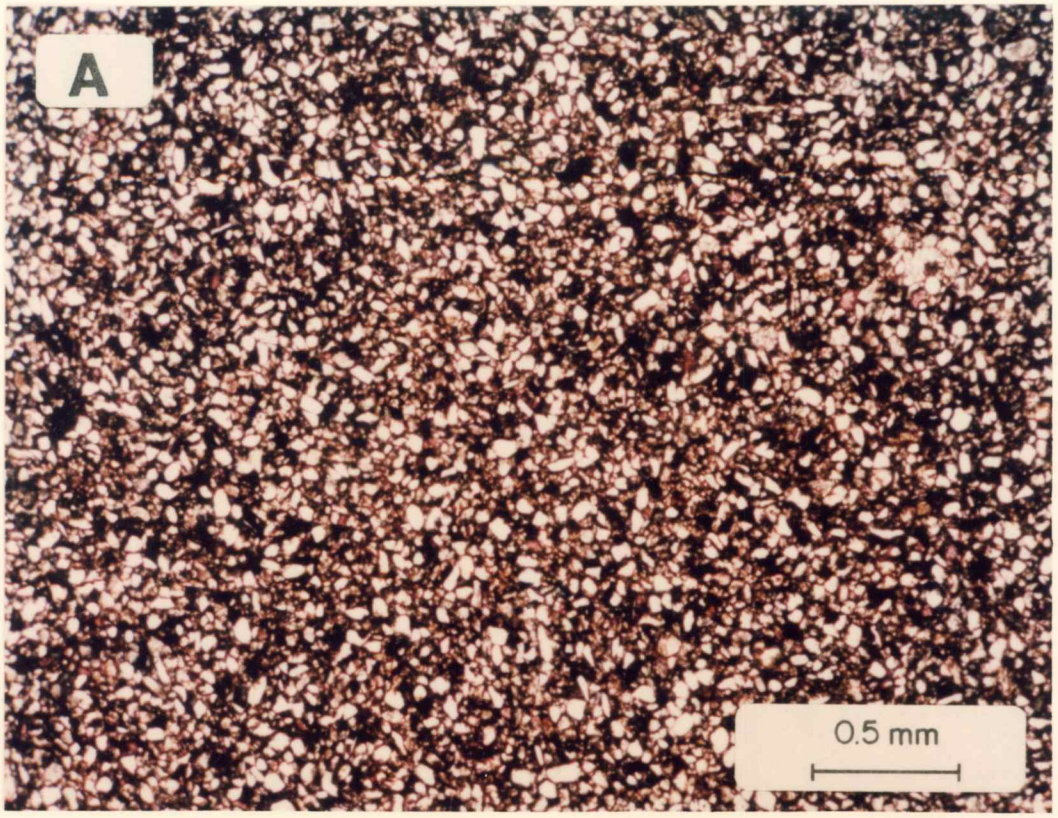
B - 160X

X-ray Diffraction Data

Quartz	64%
Potassium Feldspar	8%
Plagioclase Feldspar	7%
Calcite	13%
Dolomite	2%
Clay	6%

Petrophysical Data

Cementation Exponent (m): 1.78
Saturation Exponent (n): 1.21


A
0.5 mm

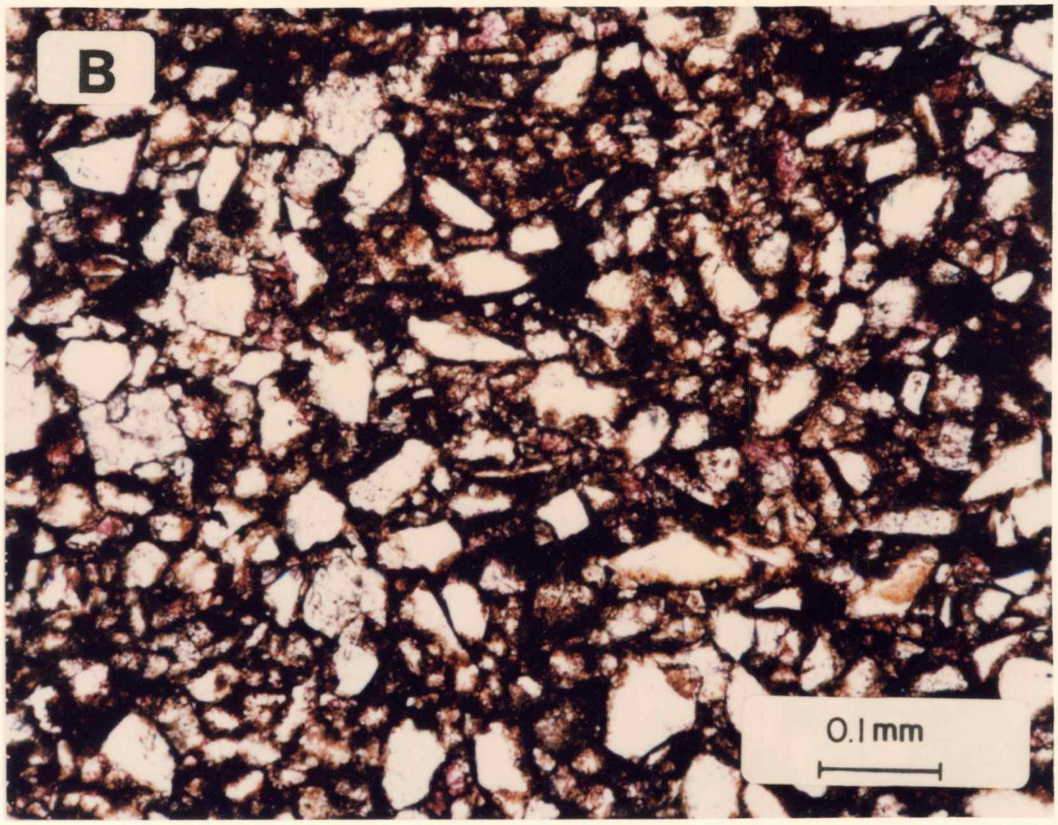

B
0.1 mm

FIGURE 26

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2805.2 feet

Average Grain Size: 0.060 mm (Coarse Silt) Porosity: 9.3%
Sorting: Well Sorted Permeability: 0.012 md
Stratigraphic Unit: Council Grove A
Dep. Facies: Paleosol/Coastal Plain

Note the lack of visible pore space in this argillaceous siltstone. Calcite cement and clay minerals have occluded nearly all of the macropores. Therefore, most of the measured pore volume must be in the form of microporosity. The low permeability is consistent with this observation. Quartz grains, feldspar and mica account for most of the framework constituents. Opaque grains and heavy minerals were also identified.

A – 40X

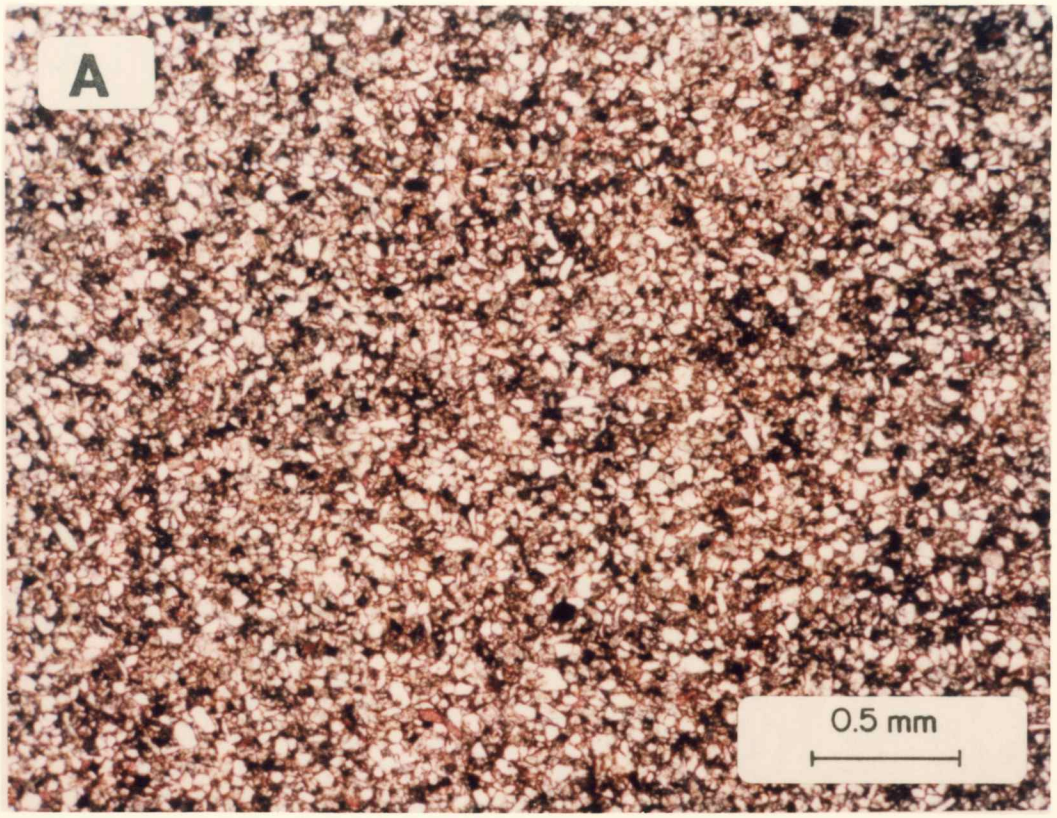
B – 160X

X-ray Diffraction Data

Quartz	73%
Plagioclase Feldspar	8%
Calcite	7%
Dolomite	3%
Clay	9%

Petrophysical Data

Cementation Exponent (m): 1.77
Saturation Exponent (n): Not Available


A
0.5 mm

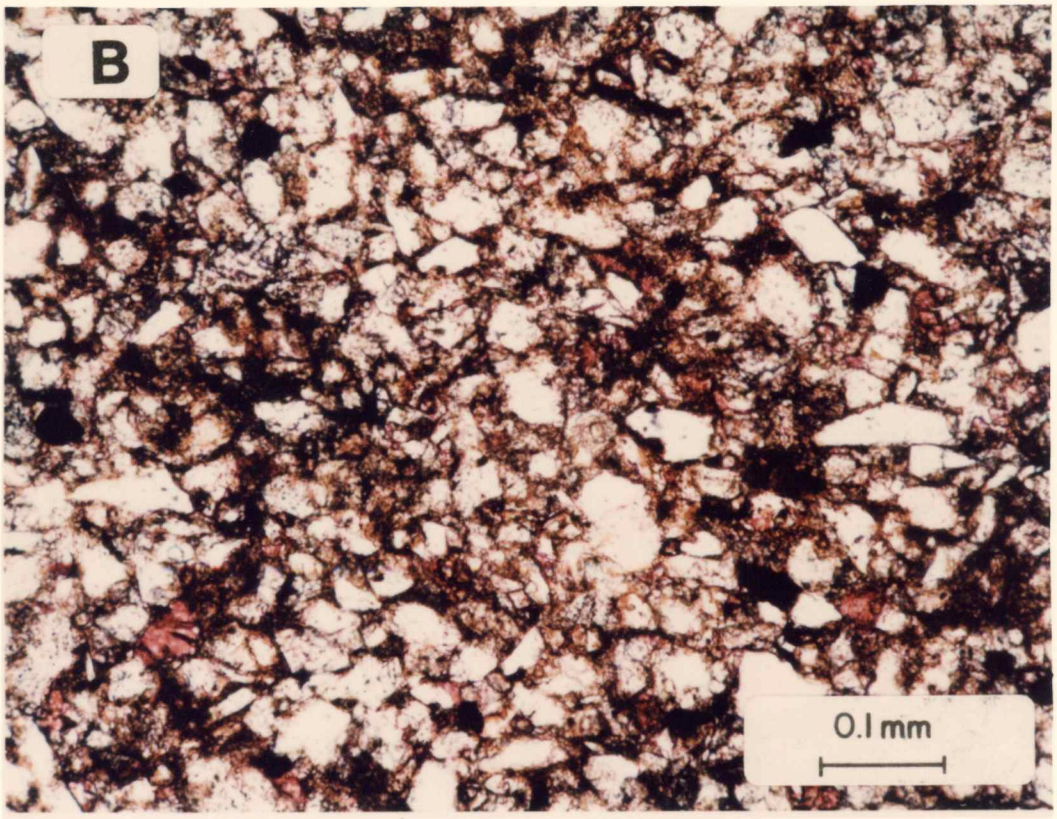

B
0.1 mm

FIGURE 27

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2870.3 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 11.9%
Permeability: 10.6 md
Stratigraphic Unit: Council Grove B1
Dep. Facies: Carbonate Shoal

Oncoids, peloids, calcareous algae, foraminifera, bryozoans and echinoderms are present in this skeletal-oncoid-peloid grainstone. Patchy calcite cement (most of the white areas in view A) has locally occluded both intergranular and intragranular pores. However, throughout most of the sample a relatively well preserved network of intergranular pores is accompanied by secondary moldic pores, intraskeletal pores and intragranular microporosity (within micritic grains such as oncoids and peloids). In view B, a close-up view of a coated grain reveals microporosity (faint blue areas - white arrows) within some of the micritic algal coatings. Although the intragranular pores, moldic pores and microporosity contribute to the total pore volume, the intergranular (In) pores probably account for most of the effective pore space.

A - 40X

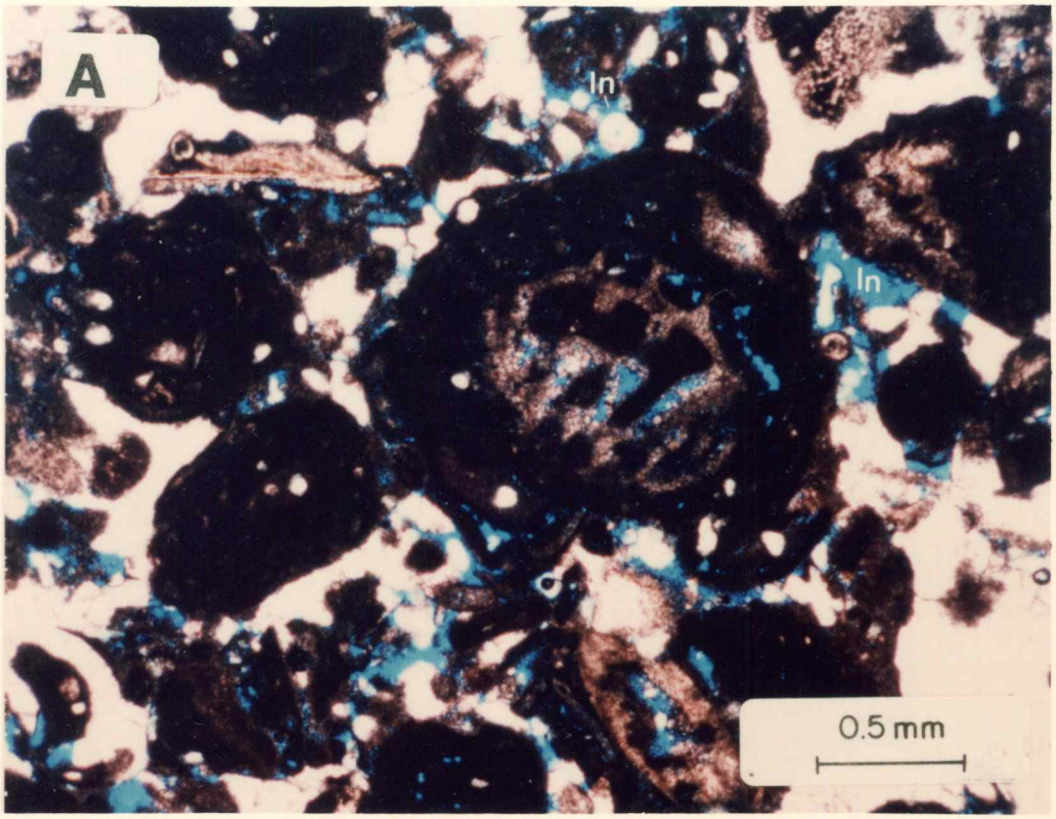
B - 160X

X-ray Diffraction Data

Quartz	3%
Calcite	74%
Anhydrite	23%

Petrophysical Data

Cementation Exponent (m): 2.22
Saturation Exponent (n): 2.03


A
In
In
0.5 mm

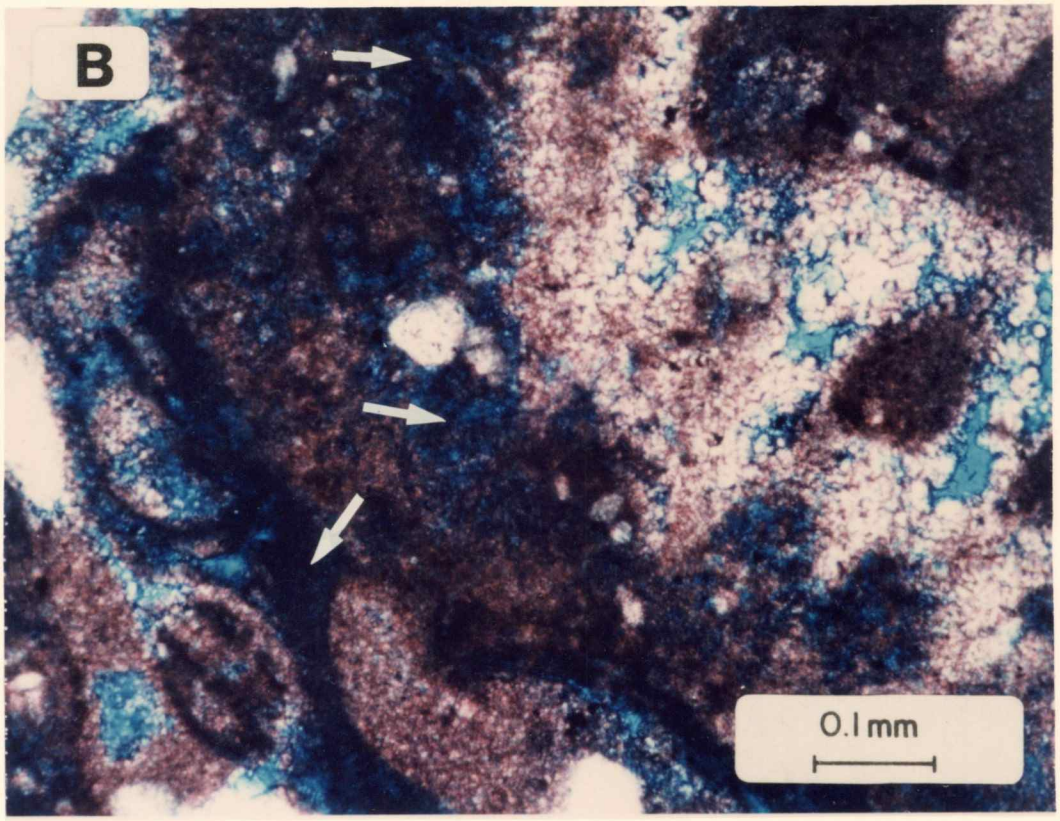

B
0.1 mm

FIGURE 28

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2878.9 feet

Rock Type: Limestone
Depositional Texture: Packstone/Grainstone
Porosity: 6.5%
Permeability: 0.291 md
Stratigraphic Unit: Council Grove B1
Dep. Facies: Carbonate Shoal to Shoal Flank

Intergranular pore space in this limestone is limited by: 1) calcite (C) cement, 2) depositional micrite, and 3) compaction (which locally deformed micritic peloids into pseudomatrix). View A shows a portion of the sample with some remnant intergranular pores and moldic pores. View B shows a partially healed natural fracture (arrow). Some other fractures are completely occluded with calcite cement. In addition to the filled fractures, it appears that some vuggy pores (not shown here) were also occluded with calcite cement. The low permeability suggests that the fractures have only a marginal impact on permeability through this rock. Peloids and fine-grained skeletal debris such as foraminifera and calcareous algae are common.

A - 40X

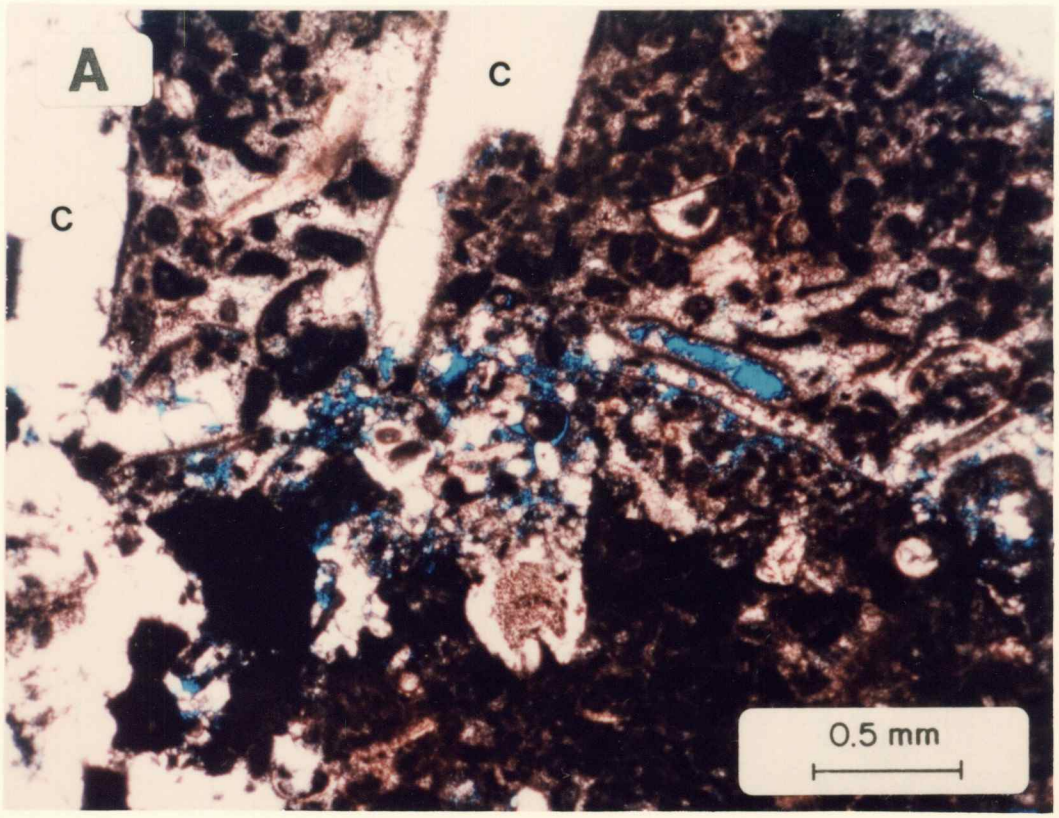
B - 40X

X-ray Diffraction Data

Quartz	1%
Calcite	99%

Petrophysical Data

Cementation Exponent (m): 2.11
Saturation Exponent (n): 1.99


A
C
C
0.5 mm

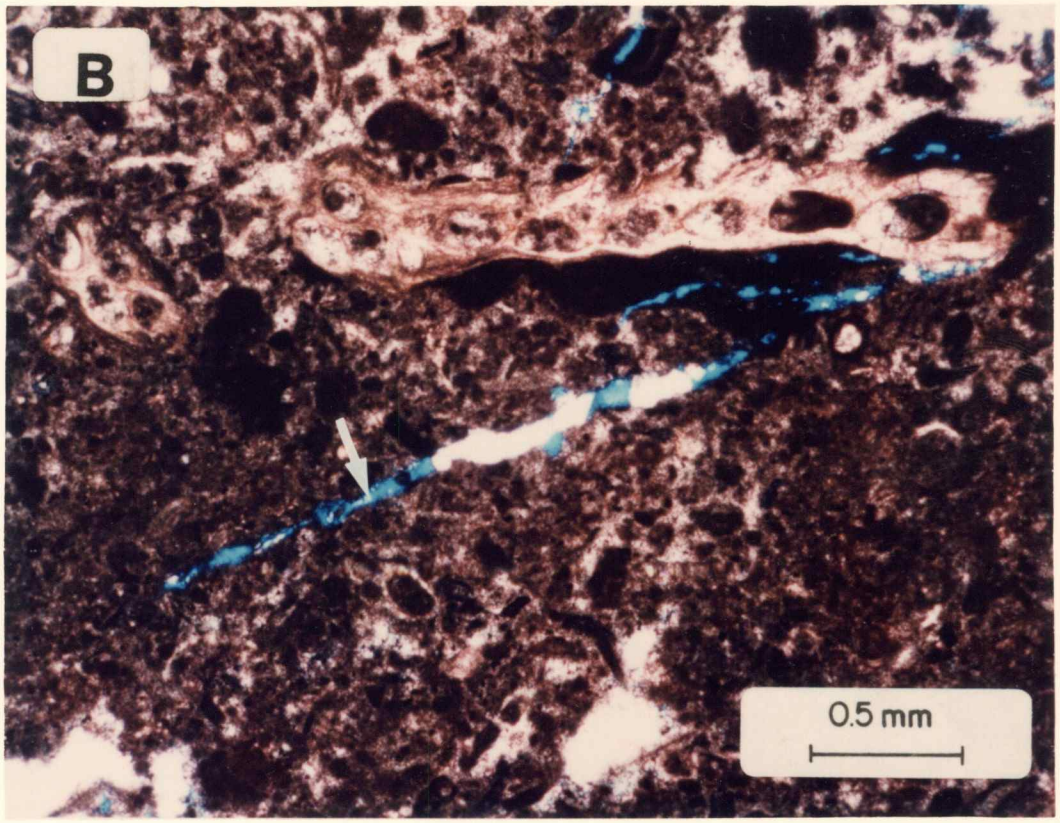

B
0.5 mm

FIGURE 29

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2896.3 feet

Rock Type: Limestone
Depositional Texture: Grainstone/Packstone
Porosity: 6.9%
Permeability: 0.014 md
Stratigraphic Unit: Council Grove B2
Dep. Facies: Carbonate Shoal to Shoal Flank

Note the general paucity of visible pore space in this limestone (view A). Calcite cement and detrital micrite have combined to occlude nearly all of the intergranular areas. A minor amount of secondary pore space occurs in association with partial dissolution of framework grains. In addition, some of the micritic framework grains, such as oncoids, peloids and micritized skeletal fragments, show indications of microporosity. This rock is judged to have poor reservoir potential.

A - 40X

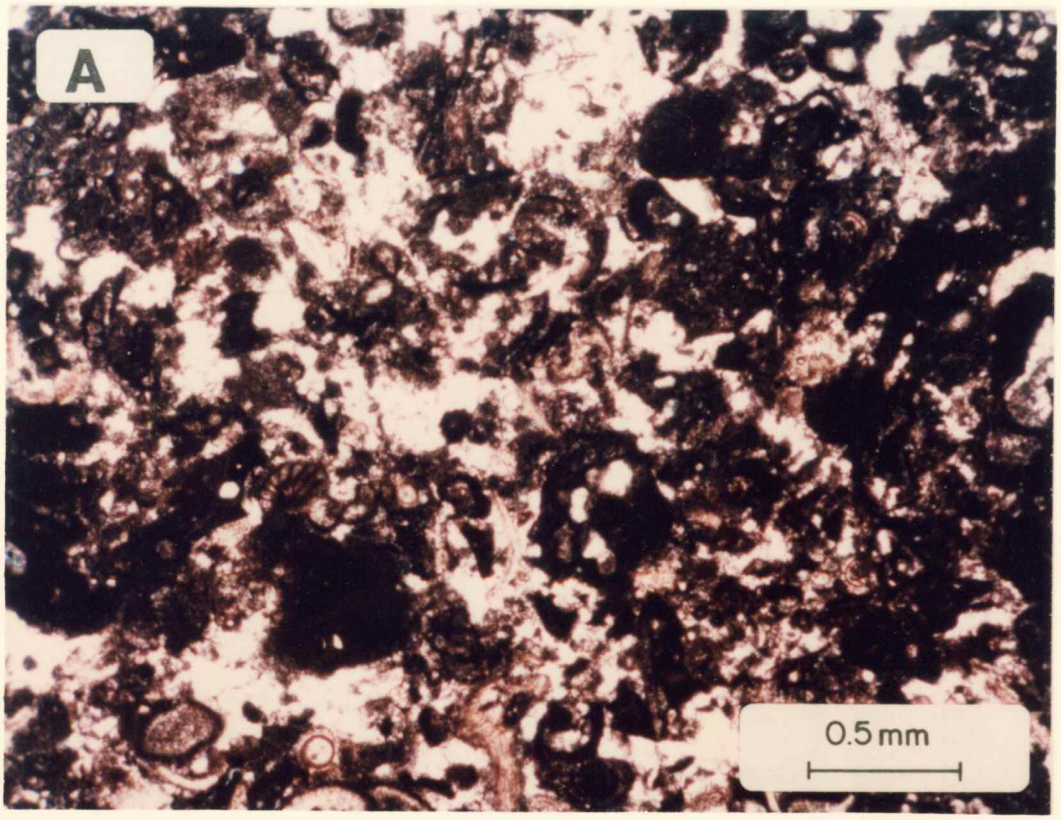
B - 160X

X-ray Diffraction Data

Quartz	3%
Calcite	97%

Petrophysical Data

Cementation Exponent (m): 1.81
Saturation Exponent (n): 1.44


A
0.5 mm

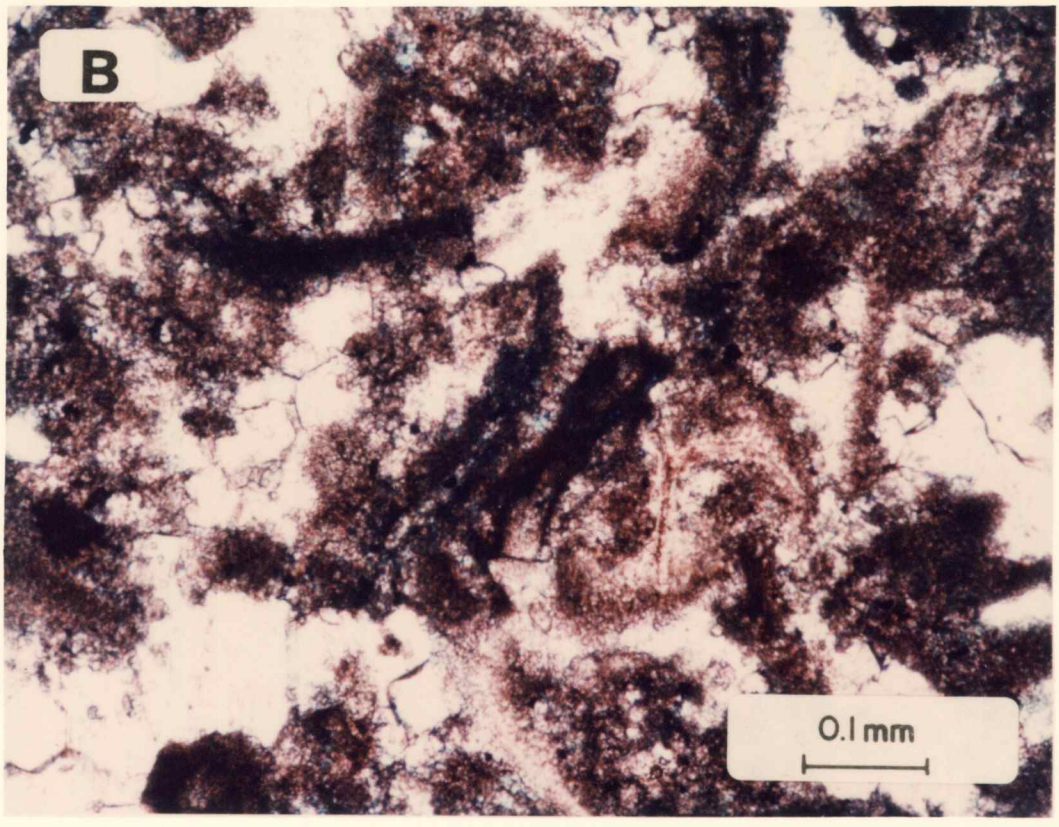

B
0.1 mm

FIGURE 30

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2897.6 feet

Rock Type: Limestone
Depositional Texture: Packstone
Porosity: 9.2%
Permeability: 0.065 md
Stratigraphic Unit: Council Grove B2
Dep. Facies: Carbonate Shoal to Shoal Flank

View A illustrates the general paucity of macropore space in this packstone. View B shows the same area of the sample through a white filter. The faint blue color that can be distinguished in many of the framework grains (white arrows). This reflects the presence of intragranular microporosity. In addition, some microporosity can be distinguished within the micrite matrix. This pore structure is consistent with the relatively high measured porosity, but low permeability.

A – 40X,

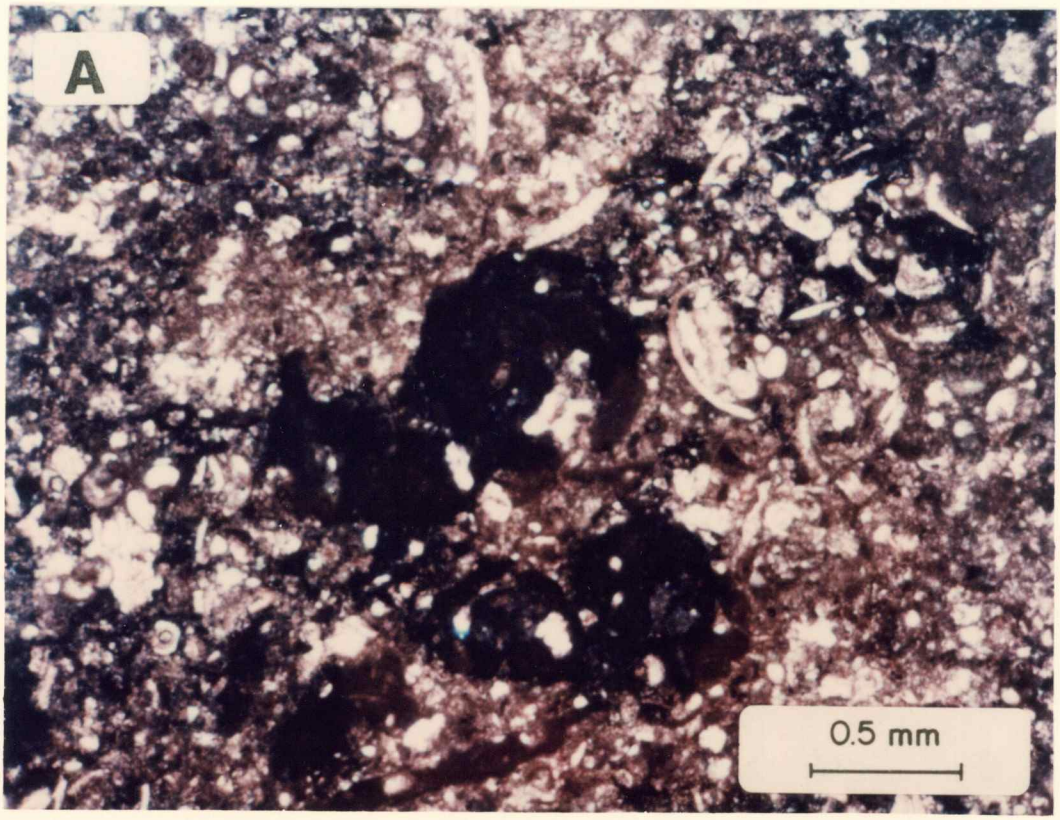
B – 40X, White Filter

X-ray Diffraction Data

Quartz	12%
Calcite	88%

Petrophysical Data

Cementation Exponent (m): 1.87
Saturation Exponent (n): 1.67


A
0.5 mm

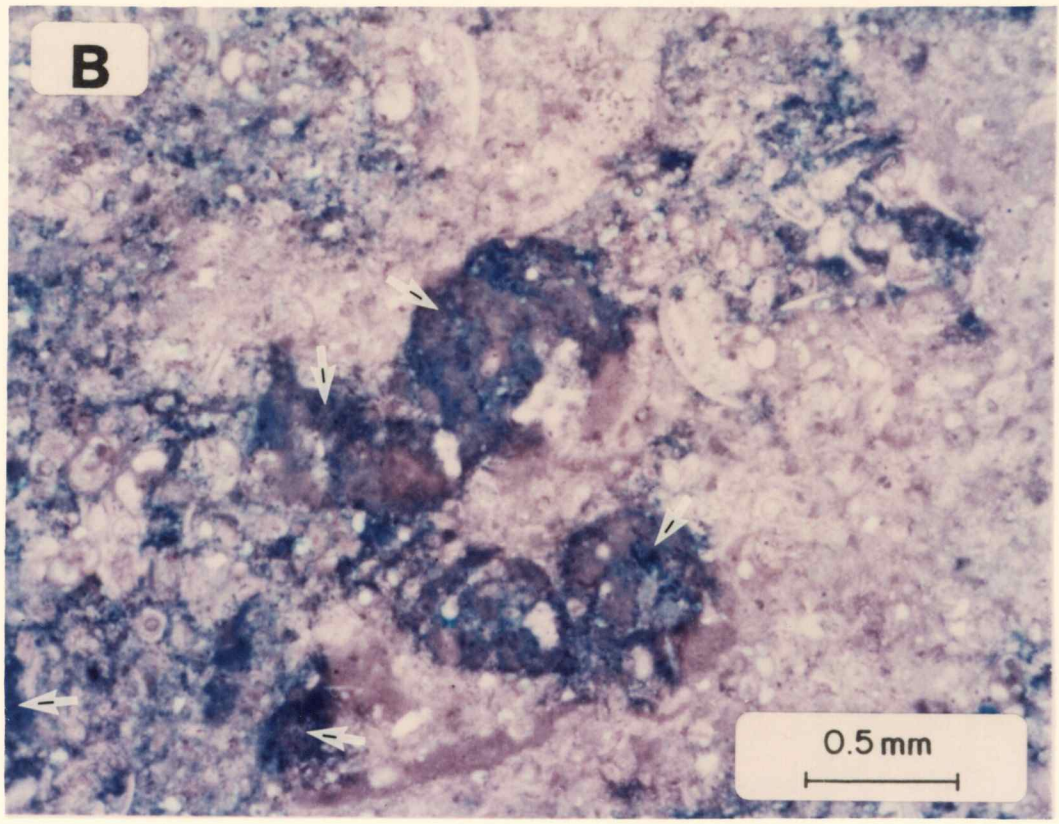

B
0.5 mm

FIGURE 31

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2917.3 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 14.2%
Permeability: 9.30 md
Stratigraphic Unit: Council Grove B3
Dep. Facies: Carbonate Shoal

Peloids and fine-grained, micritized skeletal fragments account for most of the framework constituents in this rather uniformly sorted grainstone. Although calcite cement (most of the white areas) has occluded a portion of the intergranular pore network, well preserved intergranular pores are present in other parts of the sample (view B). In addition to the intergranular pores, some intragranular pores are present within foraminifera and calcareous algae, and many of the micritic grains appear to have some intragranular microporosity. The relatively high permeability in this sample, compared to other samples from near this depth range, reflect the present of rather well preserved intergranular pores.

A - 40X

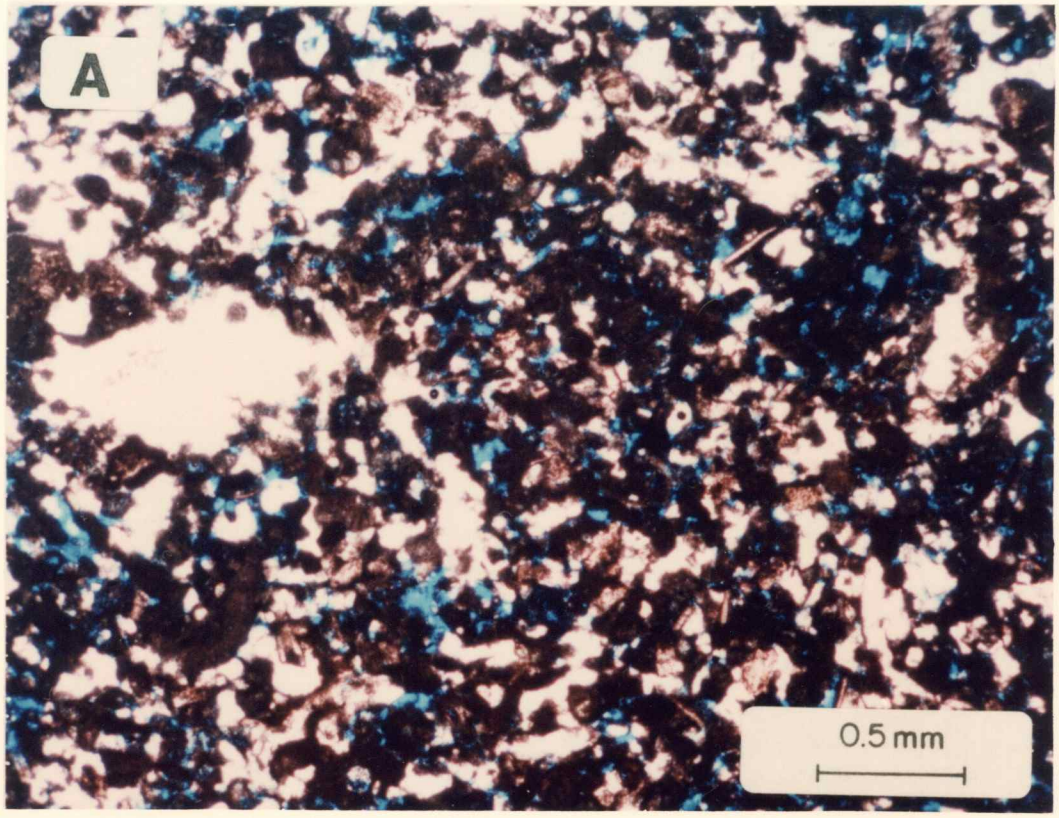
B - 160X

X-ray Diffraction Data

Quartz	3%
Calcite	97%

Petrophysical Data

Cementation Exponent (m): 2.11
Saturation Exponent (n): 1.55


A
0.5 mm

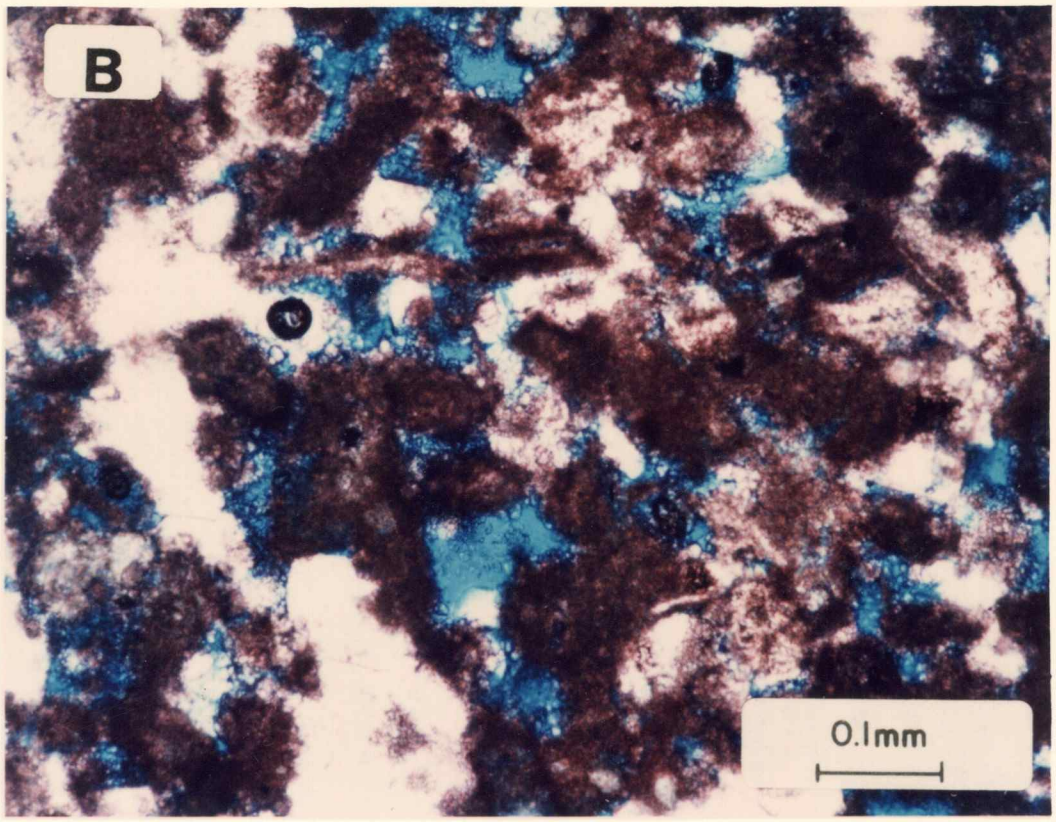

B
0.1mm

FIGURE 32

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2918.1 feet

Rock Type: Limestone
Depositional Texture: Packstone/Grainstone
Porosity: 13.1%
Permeability: 0.576 md
Stratigraphic Unit: Council Grove B3
Dep. Facies: Carbonate Shoal to Shoal Flank

Close examination of this limestone reveals that it is dominated by peloids, micritized skeletal fragments and other micritic grains. Although parts of the sample have detrital micrite between the grains, calcite cement and pseudomatrix (compacted grains) appear to be the principal pore-filling constituents. The pore system consists of a combination of remnant intergranular pores, intraskeletal pores within foraminifera and calcareous algae, and microporosity within micritic grains. In view A, the upper half of the photomicrograph has very little conspicuous intergranular pore space; by comparison, the lower half of view A shows scattered intergranular macropores. Patchy anhydrite replacement (not shown here) was noted.

A - 40X

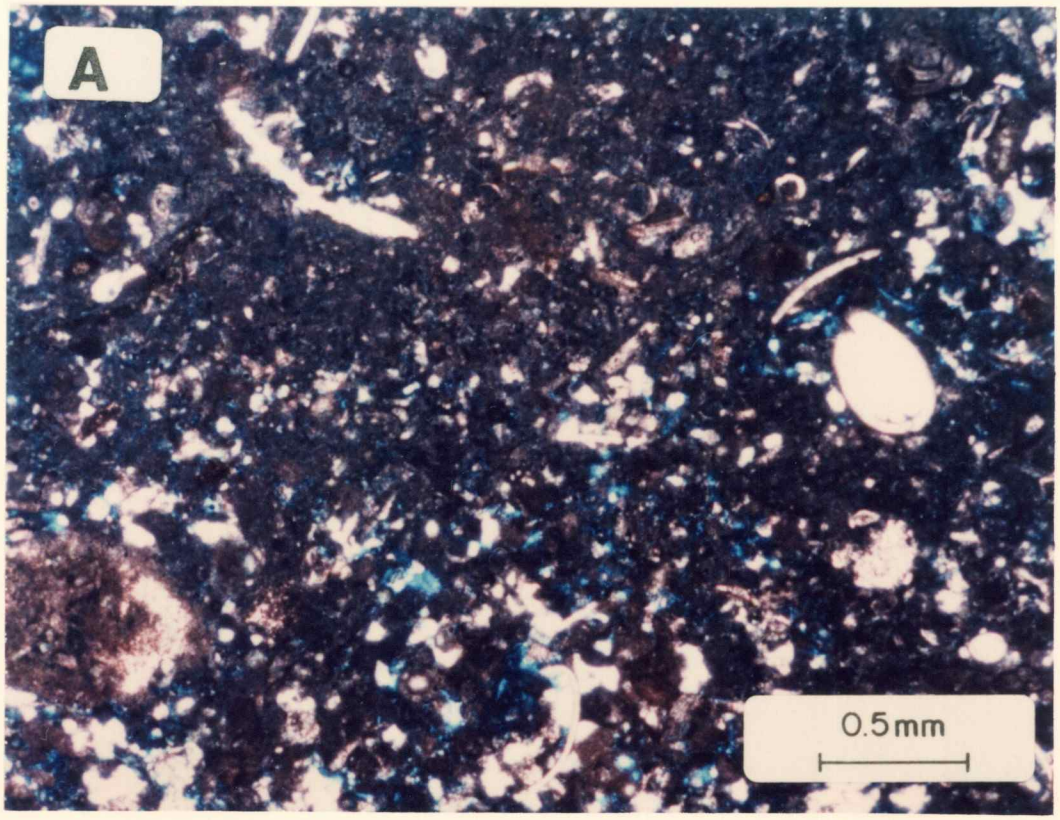
B - 160X

X-ray Diffraction Data

Quartz	7%
Calcite	90%
Anhydrite	3%

Petrophysical Data

Cementation Exponent (m): 2.00
Saturation Exponent (n): 1.67


A
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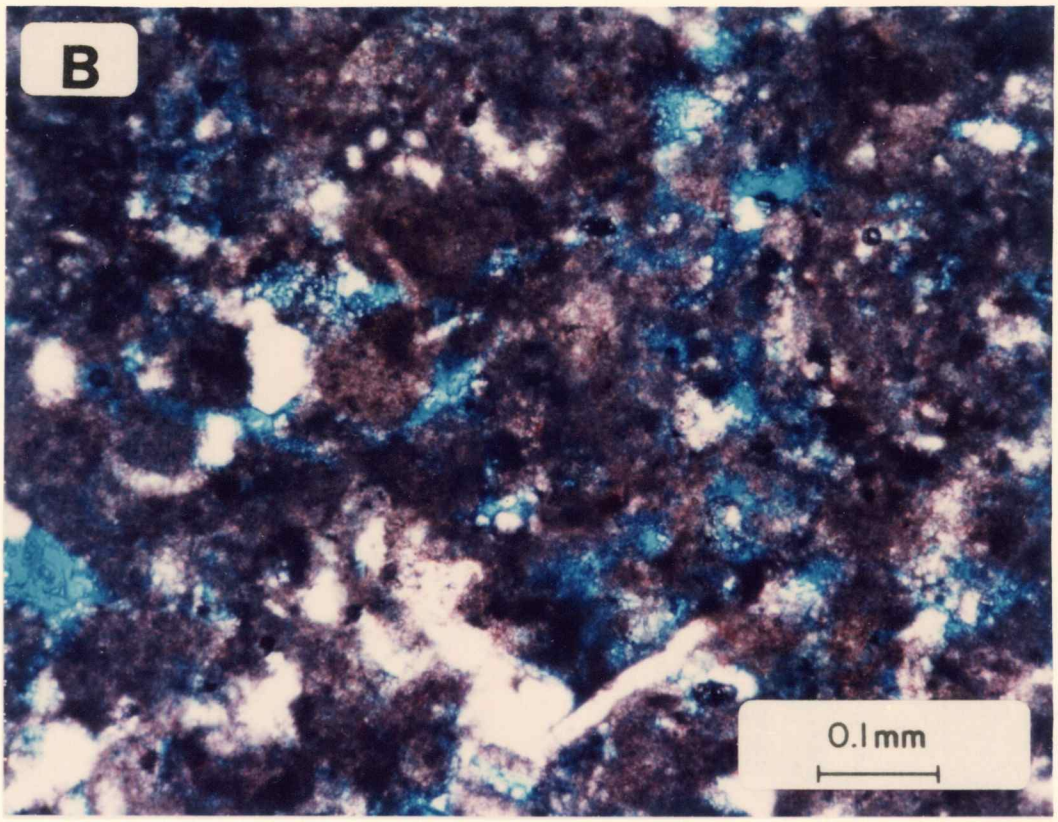

B
0.1mm

FIGURE 33

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2925.5 feet

Average Grain Size: 0.058 mm (Coarse Silt) Porosity: 13.2%
Sorting: Well Sorted Permeability: 0.035 md
Stratigraphic Unit: Council Grove B3
Dep. Facies: Paleosol/Coastal Plain

This argillaceous siltstone has very little visible pore space due to a combination of detrital clay, dolomite cement, and iron-oxide cement. Nearly all of the measured pore space must be in the form of microporosity associated with the clay minerals. Rocks with this type of pore structure can have relatively high porosity, but invariably have low permeability.

A - 40X

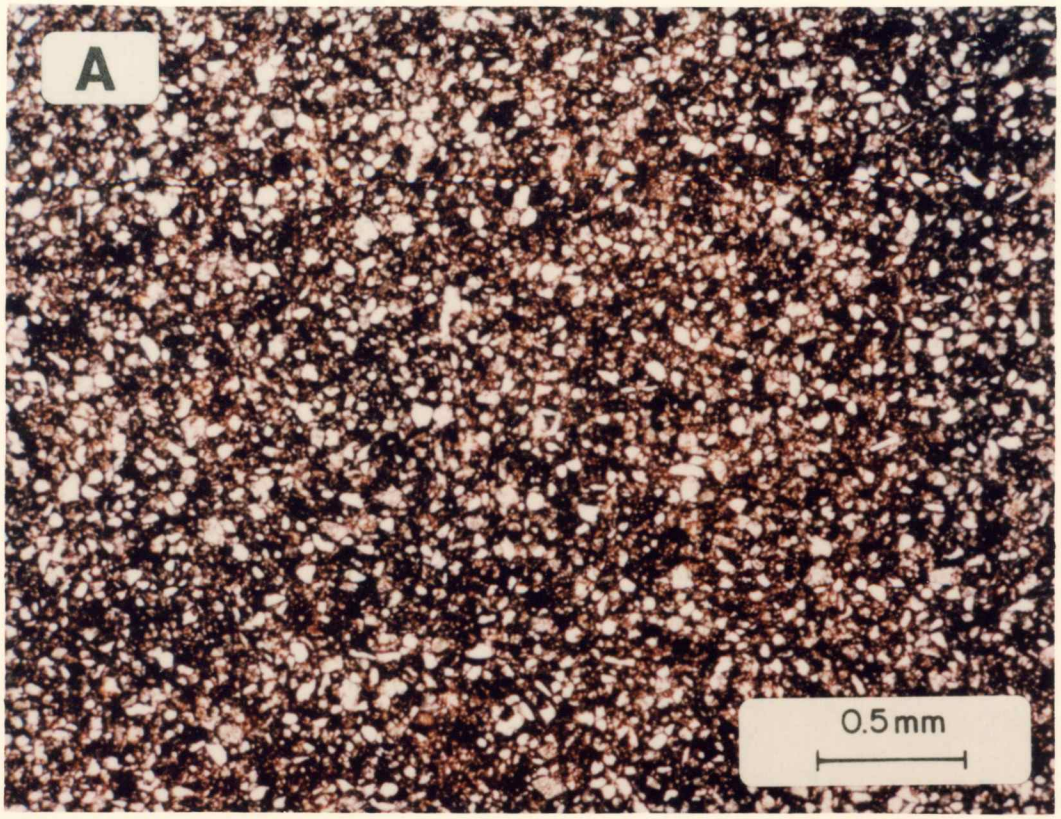
B - 160X

X-ray Diffraction Data

Quartz	74%
Plagioclase Feldspar	5%
Dolomite	14%
Clay	7%

Petrophysical Data

Cementation Exponent (m): 1.89
Saturation Exponent (n): 1.91


A
0.5 mm

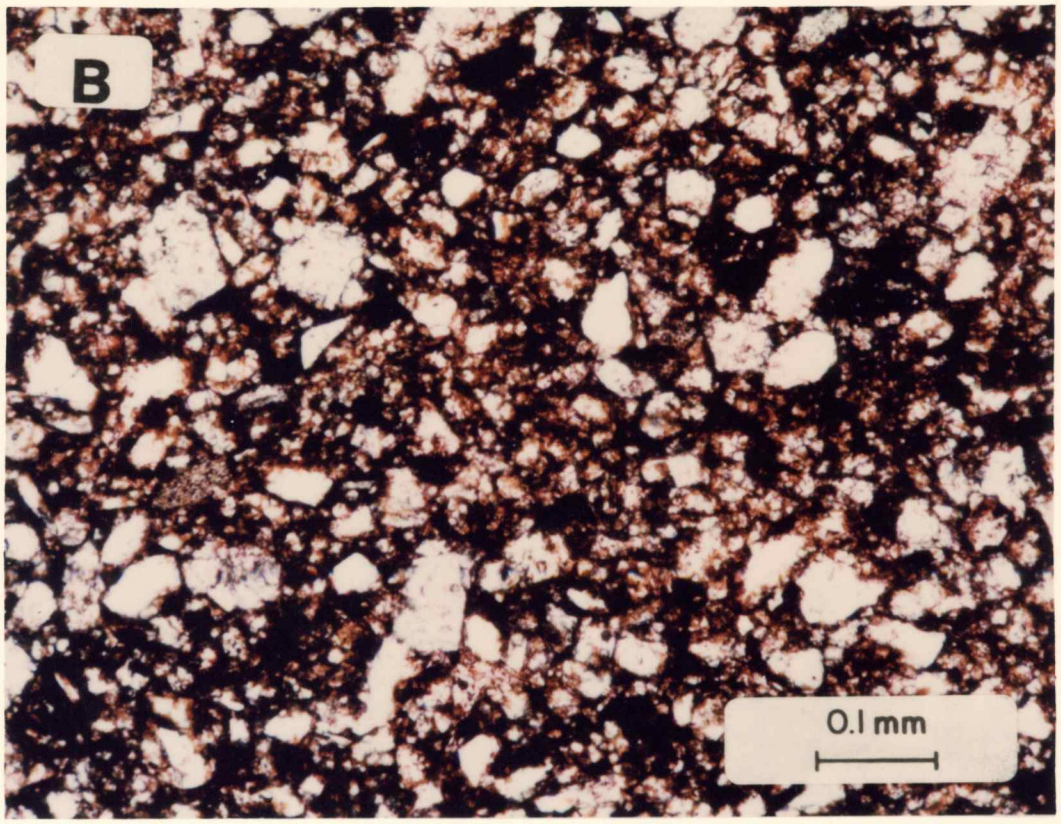

B
0.1 mm

FIGURE 34

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2932.3 feet

Rock Type: Limestone
Depositional Texture: Grainstone
Porosity: 6.6%
Permeability: 0.142 md
Stratigraphic Unit: Council Grove B4
Dep. Facies: Carbonate Shoal

Most of this grainstone has little visible pore space due to extensive calcite cementation (lower half of view A). The upper half of view A shows a lamination with relatively well preserved intergranular pore space. View B shows a close-up view of an oncoid; the faint blue color that can be distinguished reflects the presence of microporosity within this micritic grain. In addition to oncoids, peloids, micritized skeletal fragments and small intraclasts were observed. Prior to calcite cementation, this rock may have had porosity in excess of 25%.

A - 20X

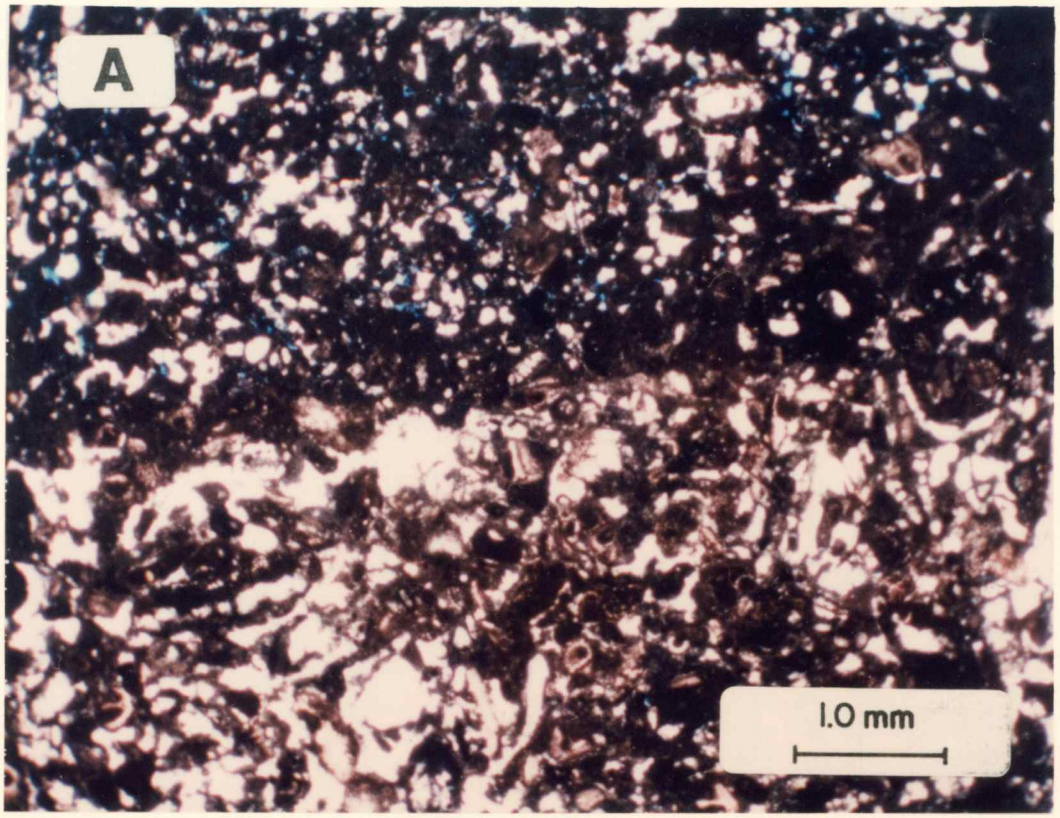
B - 160X, White Filter

X-ray Diffraction Data

Quartz	2%
Calcite	95%
Anhydrite	3%

Petrophysical Data

Cementation Exponent (m): 1.99
Saturation Exponent (n): 1.65


A
1.0 mm

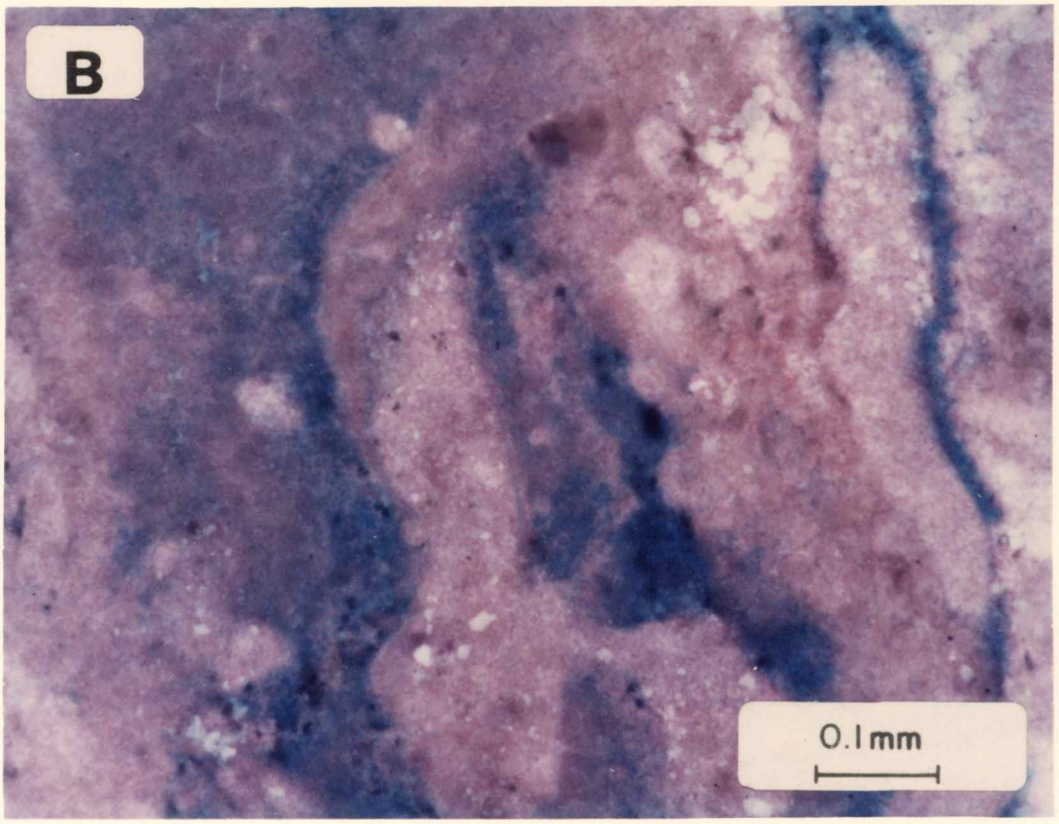

B
0.1 mm

FIGURE 35

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2951.5 feet

Rock Type: Dolomitic Limestone
Depositional Texture: Wackestone
Porosity: 9.7%
Permeability: 0.122 md
Stratigraphic Unit: Council Grove B5
Dep. Facies: Shoal Flank to Shallow Shelf

Note the micritic texture of this limestone. Framework grains include skeletal debris (echinoderms, bryozoans, ostracodes and brachiopods), oncoids and peloids. Visible pore space is uncommon due to the abundance of detrital micrite matrix. View B shows the same area of the sample through a white filter. Note the microporosity that occurs within a micritic grain (white arrow), as well as the faint blue cast that reflects microporosity throughout the micrite matrix. Nearly all of the measured pore volume is in the form of microporosity. The low permeability is consistent with this observation. The depositional texture and assemblage of framework grains support a shoal flank and/or shallow shelf depositional environment.

A - 40X

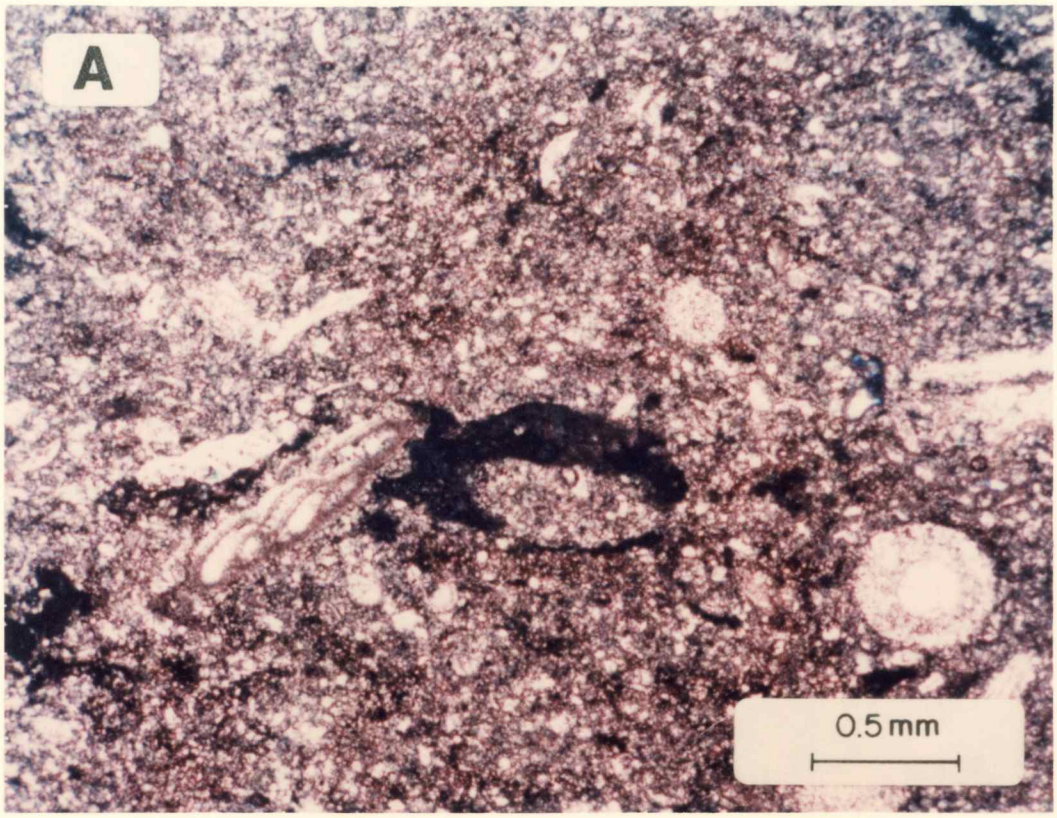
B - 40X, White Filter

X-ray Diffraction Data

Quartz	6%
Calcite	78%
Dolomite	16%

Petrophysical Data

Cementation Exponent (m): 1.83
Saturation Exponent (n): 1.49


A
0.5 mm

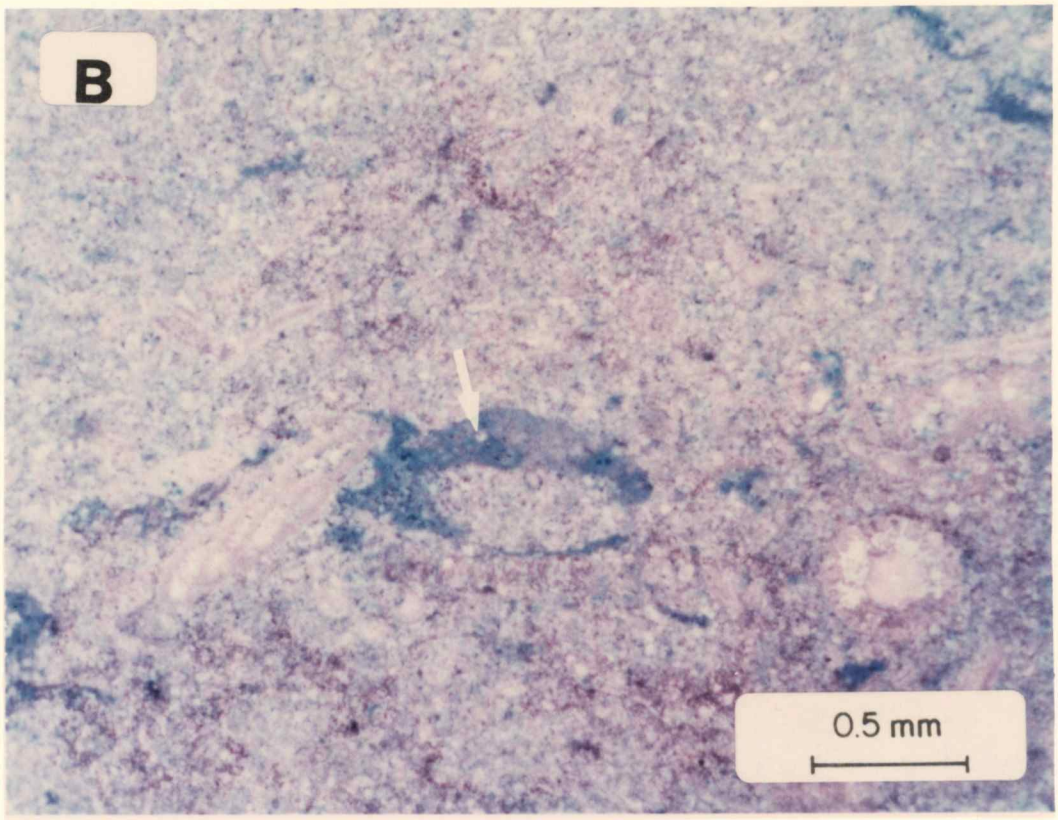

B
0.5 mm

FIGURE 36

THIN SECTION PHOTOMICROGRAPHS

ANADARKO PETROLEUM CORPORATION YOUNGREN "J" 1-H WELL

Depth: 2952.3 feet

Rock Type: Limestone
Depositional Texture: Packstone
Porosity: 13.7%
Permeability: 1.84 md
Stratigraphic Unit: Council Grove B5
Dep. Facies: Shoal Flank to Shallow Shelf

Throughout most of this sample, detrital micrite has infilled the intergranular areas. However, some parts of the sample, where compaction is less extensive, have small intergranular pores (view B). In addition to these patches of intergranular pore space, thin fractures (white arrows in view A) crosscut the sample. These fractures are clearly a natural part of the rock fabric, as they are partially occluded with calcite cement. Patchy dolomitization (white areas in view A) appears to be nonfabric-selective, replacing both matrix and grains.

A - 40X

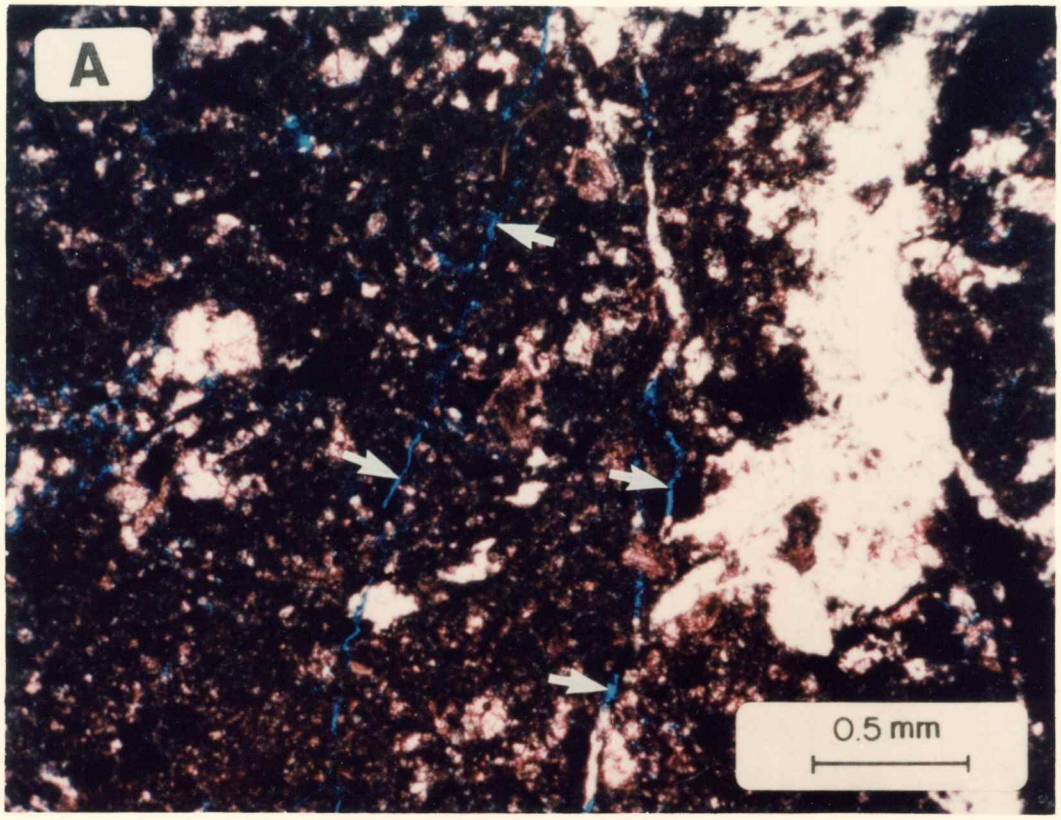
B - 160X

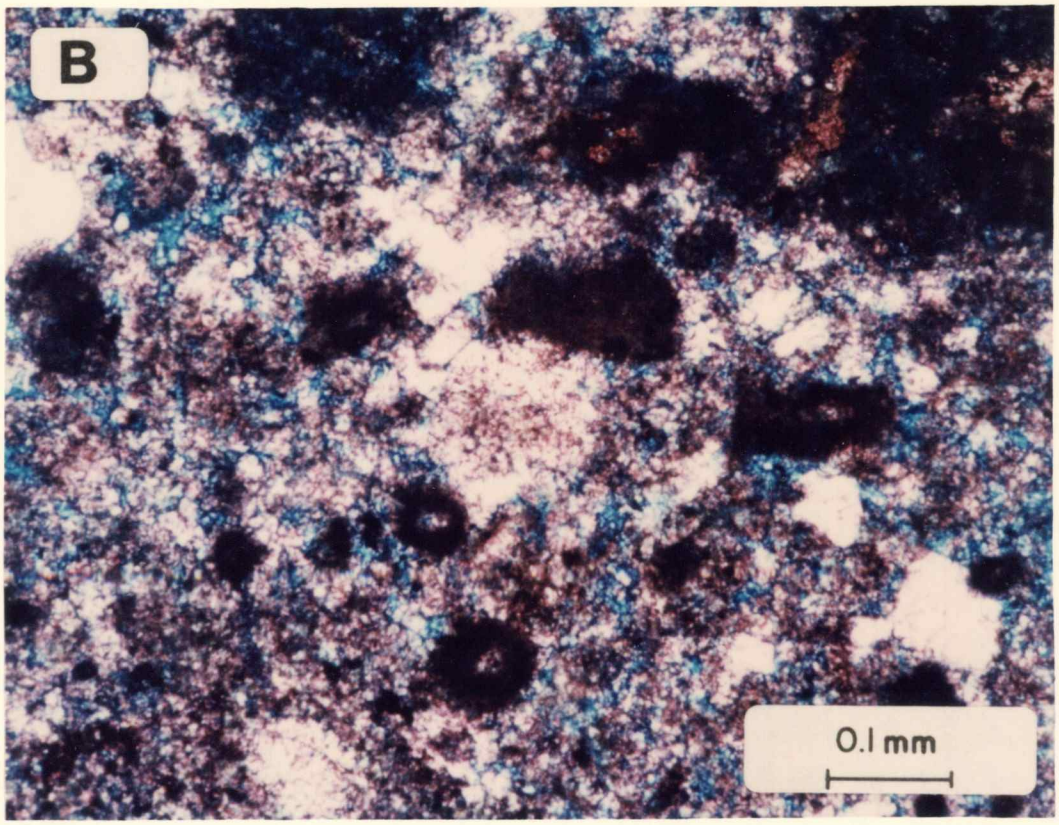
X-ray Diffraction Data

Quartz	1%
Calcite	98%
Dolomite	1%

Petrophysical Data

Cementation Exponent (m): 2.01
Saturation Exponent (n): 1.92


A
0.5 mm


B
0.1 mm