PRELIMINARY GEOLOGIC DESCRIPTION

S. A. HOLDITCH & ASSOCIATES
HOWELL NO. 5

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INTRODUCTION

Two intervals of the Travis Peak Formation were cored in the S. A. Holditch & Associates Howell No. 5 well, Waskom field, Harrison County, Texas. Core was recovered from 5,950.0 to 6,311.0 ft and from 7,395.3 to 7,562.8 ft. The top of the Travis Peak is at 5,860 ft (log depth), so the core begins about 90 ft below the top of the formation.

MACROSCOPIC CORE DESCRIPTION

The Travis Peak cores were described using a hand lens and binocular microscope, and graphic logs of the cores were made at a scale of 1 inch = 5 ft (fig. 1). The following features of the cores were noted on the descriptive logs: depth; rock type; accessories such as pyrite, organic matter, and burrows; sedimentary structures; texture (sorting); induration; grain size; relative amount of carbonate cement; color; and special features such as reservoir bitumen (solid hydrocarbons) and calcareous nodules (fig. 1). Porosity and permeability values reported by Core Laboratories, Inc. are noted on the graphic logs, as are the depths from which thin sections have been made. Porosity and permeability values that are reported were measured under in situ overburden pressures; the permeability is K_{oo}, permeability adjusted by the Klinkenberg correction factor. Correction factors between core and log depths are noted for each cored interval (fig. 1). The cores consist of fine- to very fine-grained sandstone, mudstone, and limestone (fig. 1).

The lower cores, from 7,395.3 to 7,562.8 ft, contain sandstone beds up to 28 ft thick, interbedded with red and gray mudstones (fig. 1). Most mudstones in this interval are thin, but a 15-ft-thick mudstone occurs at 7,474.5 to 7,490.0 ft. This red mudstone has a burrowed, disturbed texture and contains abundant carbonate nodules. The sandstones exhibit multiple fining-upward cycles, the upper sections of which are commonly truncated. The sandstones generally have scoured lower contacts with high-angle cross-beds and planar laminations at the base, and they are capped by rippled and burrowed muddy sandstone at the top (fig. 1).

The rocks in the lower section of core are interpreted to have been deposited in a fluvial environment. The crossbedded and planar-laminated sandstones may be longitudinal and transverse-bar deposits and channel fills from a sand-rich, low-sinuosity braided stream system. The tops of many of the sandstones are burrowed, which probably took place after the waning of floods. The mudstones interbedded with these sandstones are interpreted as overbank floodplain deposits. Floodplain deposits are not commonly preserved in braided streams, which would explain why most mud-stones in this section of the core are thin.

The upper section of core (5,950.0 to 6,311.0 ft) contains sandstones interbedded with thicker red and gray mudstones than in the lower core. The sandstones in the lower part of this cored interval have sharp bases, and the highest energy sedimentary structures (crossbeds and parallel to slightly inclined laminae) occur in the lower part of the sandstones. The sandstones fine upward, and the upper parts are extensively burrowed. An example is the B-1 sandstone at 6,125 to 6,110 ft (fig. 1). Many of the burrows are highlighted by reservoir bitumen. Calcareous nodules are common in the mudstones and at the base of sandstones. Most mudstones are red, but some mudstones are gray and contain pyrite associated with organic matter.

Above 6,010 ft in the upper cored interval, all mudstones are gray. Sandstones are thin, extensively burrowed, and cemented by carbonate. At the top of the cored interval, limestones are interbedded with siliciclastic mudstones. The limestones are packstones; that is, they are composed of skeletal fragments and carbonate mud. Oyster, pelecypod, and gastropod shell fragments are the most common skeletal grains. Thin stringers of terrigenous clastic mud are common within limestone beds.

The upper cored interval records the transition from terrigenous-clastic to shallow-marine deposition. The lower part of this interval lacks evidence of marine deposition, and the rocks probably represent small fluvial channels or crevasse splays deposited in the adjacent floodplain. This environment represents a more distal fluvial setting compared with the rocks of the lower core. The red and gray mudstones are interpreted as overbank floodplain deposits. Mudstones are relatively thick in this core, suggesting that the streams carried mixed bedload and suspended load, and overbank floodplain deposits were preserved in the system. The gray color of some of the mudstones is probably caused by a high water table, abundant organic matter, and reducing fluids that moved through overlying sandstones. The upper part of the upper cored interval is interpreted as having been deposited in a proximal-deltaic to marginal-marine position, such as a lower delta plain to interdistributary bay environment. Periodic marine incursions in the upper Travis Peak are recorded by the limestones near the top of the formation.

PETROGRAPHIC DESCRIPTION

Detailed study of the core is being conducted with a standard petrographic microscope and with a scanning electron microscope (SEM) that includes an energy dispersive x-ray system (EDX).

Grain Size

Analysis of grain size was accomplished by making grain-size point counts of thin sections. Fifty grains per slide were measured along their long dimensions, excluding cement overgrowths, in order to determine the size of the detrital grains. Mean diameter of sand- and silt-sized grains was calculated for each sample (tables 1, 2); detrital and authigenic clays were not included in the calculation of mean grain diameter.

Most sandstones in the Holditch Howell No. 5 well are fine or very fine grained (0.06 to 0.25 mm), but in the lower cored interval several sandstones are medium grained (0.25 to 0.5 mm). Most silt is coarse silt, between 0.031 and 0.063 mm, and clay particles are smaller than 0.004 mm. The samples are classified texturally as sandstone, silty sandstone, muddy sandstone, mudstone, and claystone. Fine-grained deposits in this well contain more clay and less sand- and silt-sized grains than do mudstones from other parts of the Travis Peak. Claystones contain as much as 86% clay-size particles (tables 1, 2).

Mineral Composition

Thirty-one thin sections have been point counted for a preliminary description of mineral composition (tables 3, 4). The sandstones are mineralogically mature and are classified as quartzarenite or subarkose. Quartz comprises 87.4% to 100% of the essential framework constituents (quartz, feldspar, and rock fragments). Plagioclase feldspar is more abundant than orthoclase, and total feldspar volume varies from 0% to 11.5%. Rock fragments, mainly low-rank metamorphic rock fragments and chert, constitute between 0% and 2.7% of the framework grains.

Authigenic cements constitute between 0% and 41.5% of the rock volume in these 31 samples (tables 3, 4). Authigenic quartz, illite, chlorite, kaolinite, dolomite, ankerite, anhydrite, and reservoir bitumen have all been observed in Holditch Howell No. 5 thin sections.

Quartz cement (fig. 2) is the most abundant authigenic mineral in the Holditch Howell No. 5 cores. Quartz overgrowths fill as much as 29.5% of the sandstone volume (tables 3, 4), and precipitation of authigenic quartz occluded much of the primary porosity. However, compared with other parts of the Travis Peak in East Texas, such as in Nacogdoches County, the volume of quartz overgrowths in the Holditch Howell No. 5 samples is lower, and significant primary porosity has been retained. The sandstone at 7,416.6 to 7,425 ft (fig. 1) has porosity as high as 10.8% and permeability as high as 19 md (fig. 1). Primary porosity in a sample from 7,419.5 ft can easily be seen in SEM (fig. 2); the volume of quartz overgrowths in this sample is only 12% (table 3).

Authigenic illite and chlorite occur as pore-filling cements (fig. 3) in secondary pores that formed by dissolution of feldspars. These cements formed relatively late in the burial history of the Travis Peak. Kaolinite cement was observed in primary pores in the Holditch Howell No. 5 samples. Petrographic evidence is equivocal, but the kaolinite appears to have precipitated at about the same time as, or somewhat later than, the quartz overgrowths.

Dolomite and ankerite occur in cores from both the upper and lower part of the Travis Peak in the Holditch Howell No. 5 well, but they are most abundant in the upper part of the formation. Ankerite is a late cement that commonly precipitated on a nucleus of earlier dolomite cement (fig. 4). Ankerite cement has a maximum volume of 11.5% in the sample from 6,296.0 ft (tables 3, 4), and it could cause completion problems (formation of an iron-hydroxide gel) if it is treated with acid.

Minor amounts of late anhydrite cement were observed in a sample from 7,442.4 ft (table 3). The anhydrite cement is a late, diagenetic feature and did not precipitate in the depositional environment.

Reservoir bitumen (a solid hydrocarbon residue) occurs only in the upper cores. In the East Texas study area, most reservoir bitumen occurs within the upper 300 ft of the top of the Travis Peak, and this pattern holds true for Waskom field. Where the bitumen is abundant, it fills primary and secondary porosity. Petrographic evidence suggests it entered the sandstones after precipitation of quartz overgrowths and ankerite. Geochemical studies of the reservoir bitumen indicate it formed by deasphalting of pooled oil after solution of gas into the oil (Rogers and others, 1974). The bitumen in samples from the Holditch Howell No. 5 cores does not appear as dark in thin section as does bitumen in samples from Chapel Hill field, Smith County. The reservoir bitumen in Waskom field may not be composed of as high molecular weight hydrocarbons as bitumen in Chapel Hill field, perhaps because the Travis Peak is not buried as deep in Waskom field.

Porosity

Porosity observed in thin section varies from 0 to 16% (tables 1, 2). Both primary and secondary pores are present (figs. 2, 5). Secondary pores are formed by the dissolution of framework grains, so they are approximately the same size as detrital grains. The large secondary pore in figure 5 has a diameter of 0.16 mm and may have formed when two adjacent feldspar grains dissolved. Secondary pores commonly are partially filled by authigenic clays (figs. 2, 3) and remnants of detrital feldspar. Porosity measured by point counting thin sections is usually lower than porosity measured by porosimeter on adjacent samples because of the presence of abundant microporosity (compare fig. 1 to tables 1, 2). Microporosity occurs in detrital and authigenic clays (fig. 3); such porosity generally cannot be seen in thin section, but it can be observed by SEM and is measured by porosimeter.

Table 1. Grain-size distribution in deeper Holditch Howell No. 5 cores.

Depth (ft)	Mean (mm)	Sand (%)	Silt (%)	Detrital clay (%)	Authigenic clay (%)	Textural class
7419.8	.261	97.0	0	0	3.0	Sandstone
7421.5	.212	96.0	0	0	4.0	Sandstone
7423.9	.253	97.5	0	0	2.5	Sandstone
7439.2	.338	97.0	0	0	3.0	Sandstone
7442.4	.315	98.0	0	0	2.0	Sandstone
7458.0	.260	98.0	0	0	2.0	Sandstone
7459.3	.236	97.0	0	0	3.0	Sandstone
7464.2	.221	99.5	0	0	0.5	Sandstone
7471.9	.233	99.0	0	0	1.0	Sandstone
7482.0	.063	9.5	4.5	86.0	0	Claystone
7499.5	.288	99.0	0	0	1.0	Sandstone
7506.4	.225	98.0	0	0	2.0	Sandstone

Table 2. Grain-size distribution in shallower Holditch Howell No. 5 cores.

Depth (ft)	Mean (mm)	Sand (%)	Silt (%)	Detrital clay (%)	Authigenic clay (%)	Textural class
5953.5	.077	64.8	22.8	6.5	6.0	Silty sandstone
5964.3	.111	91.5	8.0	0	0.5	Sandstone
5987.6	.110	93.3	4.0	1.0	1.8	Sandstone
6037.5	.087	82.1	9.1	0	8.8	Silty sandstone
6117.2	.103	73.5	8	13	5.5	Muddy sandstone
6117.9	.106	81.0	9.0	3.5	6.5	Silty sandstone
6123.0	.121	85.0	3.5	3.8	7.8	Muddy sandstone
6129.7	.041	3.6	21.9	74.5	0	Claystone
6160.2	.043	9.1	19.4	71.5	0	Claystone
6161.5	.023	0.5	22.0	77.0	0.5	Claystone
6188.3	.122	93.0	4.0	1.0	2.0	Sandstone
6189.3	.102	97.0	2.0	0	1.0	Sandstone
6191.6	.114	96.5	2.0	0	1.5	Sandstone
6201.3	.121	96.5	2.0	0.5	1.0	Sandstone
6206.1	.103	84	13.5	1.0	1.5	Silty sandstone
6215.2	.044	7.5	39.5	53.0	0	Mudstone
6236.6	.034	1.5	23.0	75.5	0	Claystone
6253.3	.114	92	4.0	0.5	3.5	Sandstone
6296.0	.103	89.0	10.0	0	1.0	Silty sandstone

Table 3. Petrographic analyses of deeper Holditch Howell No. 5 cores.

	Framework grains								Matrix
Depth (ft)	Quartz	Plagioclase	Orthoclase	MRF	Chert	Clay clasts	Mica	Other	Clay-sized fines
7419.8	77.5	0	0	0.5	0	3.0	0	0	0
7421.5	78.0	0.5	0	0	0.5	2.0	0	0.5[1]	0
7423.9	74.5	1.0	0	0	0.5	0.5	0	0	0
7439.2	68.5	1.5	0.5	0.5	0.5	0.5	0	0	0
7442.4	63.0	0.5	0	0	1.5	14.0	0	0	0
7458.0	82.5	1.0	0.5	0	0.5	4.0	1.0	0	0
7459.3	75.0	0	0	0	0.5	1.0	0	0.5[2]	0
7464.2	72.5	1.5	0	0	0	1.0	0	0.5[1]	0
7471.9	78.0	1.0	0	0.5	1.0	2.0	0	0	0
7482.0	14.0	0	0	0	0	0	0	0	86.0
7499.5	67.0	0.5	0	1.0	0	2.0	0	0	0
7506.4	74.0	0.5	0	0	0	1.5	0	0	0

[1]Zircon

[2]Tourmaline

Table 3 (cont.)

Depth (ft)	Cements							Porosity	
	Quartz	Dolomite	Ankerite	Illite	Chlorite	Kaolinite	Anhydrite	Primary	Secondary
7419.8	12.0	0	0	0.5	0.5	2.0	0	1.5	2.5
7421.5	12.5	0	0	1.5	1.5	1.0	0	1.0	1.0
7423.9	16.0	0	0	2.0	0.5	0	0	1.0	4.0
7439.2	21.0	0	0	1.0	0.5	1.5	0.5	1.5	2.0
7442.4	13.5	0	0	1.5	0	0.5	1.0	1.0	3.5
7458.0	6.0	0	0	2.0	0	0	0	0	2.5
7459.3	17.0	0	0	0	2.0	0	0	1.5	2.5
7464.2	13.5	0.5	1.0	0.5	0	0	0	2.0	7.0
7471.9	11.5	0	0.5	1.0	0	0	0	2.0	2.5
7482.0	0	0	0	0	0	0	0	0	0
7499.5	23.0	0	1.0	0	0	1.0	0	1.0	3.5
7506.4	20.5	0	0	0	1.0	1.0	0	1.0	0.5

Table 4. Petrographic analyses of shallower Holditch Howell No. 5 cores.

	Framework grains								Matrix
Depth (ft)	Quartz	Plagioclase	Orthoclase	MRF	Chert	Clay clasts	Mica	Other	Clay-sized fines
5953.5	57.0	2.0	1.0	0	0	0	1.0	0	6.5
5964.3	57.5	0.5	0.5	0	0	0	0	0	0
5987.6	49.5	3.5	0	0	0.5	0	0	0.5[1]	1.0
6037.5	48.5	1.5	0	0	0.5	0	0	0	0
6117.2	52.0	1.5	0	0	0.5	0	0	0	13.0
6117.9	58.0	2.5	0	0	0	0	0	0	4.5
6123.0	47.5	0.5	0	0	0	0	0	0	3.8
6129.7	22.0	0	0	0	0	3.0	0.5	0	74.5
6160.2	20.0	0	0	0	0	4.0	0	0	71.5
6161.5	18.0	0	0	0	0	0	0	0	77.0
6188.3	57.0	7.5	0	0	0.5	1.0	0	0	1.0
6189.3	69.0	1.5	1.0	0	1.0	2.0	0	0	0
6191.6	54.5	4.5	0.5	0	0	0	0	0	0
6201.3	60.0	1.5	3.0	0.5	0.5	0	0	0.5[2]	0.5
6206.1	52.0	5.0	1.5	1.0	0	1.0	0	0	1.0
6215.2	38.0	1.0	0	0	0	1.0	0	0	53.0
6236.6	23.0	0	0	0	0	0	0	1.0[3]	75.5
6253.3	50.5	5.5	0.5	0	0.5	0	0	0	0
6296.0	52.0	0	1.5	0	1.5	0	0	0	0

[1]Authigenic feldspar

[2]Augite

[3]Plant fragments

Table 4 (cont.)

Depth (ft)	Cements							Porosity	
	Quartz	Dolomite	Ankerite	Illite	Chlorite	Kaolinite	Reservoir bitumen	Primary	Secondary
5953.5	12.5	0	0	6.0	0	0	4.5	3.5	6.0
5964.3	22.5	2.0	9.5	0	0.5	0	0.5	3.0	3.5
5987.6	22.5	0.5	3.0	1.8	0	0	2.8	6.0	8.5
6037.5	24.0	0	0	8.8	0	0	8.8	4.5	3.5
6117.2	19.0	0	0.5	5.5	0	0	5.0	1.5	1.5
6117.9	13.5	0	0	4.5	0	0	10.0	1.5	5.5
6123.0	18.5	0	0	1.5	6.8	0	0.0	3.5	8.0
6129.7	0	0	0	0	0	0	0	0	0
6160.2	0	4.0	0.5	0	0	0	0	0	0
6161.5	1.5	0	0	0.5	0	0	0	2.0	1.0
6188.3	18.5	0	0	1.5	0	0.5	0	7.0	5.5
6189.3	18.0	0	0	0	1.0	0	0	3.0	3.5
6191.6	25.5	0	0	1.5	0	0	0.5	4.5	8.5
6201.3	18.5	1.0	1.0	1.0	0	0	1.5	5.0	6.0
6206.1	29.5	0	1.5	0.5	1.0	0	0	3.0	2.5
6215.2	0	1.0	5.5	0	0	0	0	0	0
6236.6	0	0	0.5	0	0	0	0	0	0
6253.3	22.0	0	1.0	4.0	0	0	0	4.0	12.0
6296.0	19.0	6.5	11.5	1.0	0	0	0	4.0	3.0

REFERENCE

Rogers, M. A., McAlary, J. D., and Bailey, N. J. L., 1974, Significance of reservoir bitumens to thermal-maturation studies, western Canada Basin: American Association of Petroleum Geologists, v. 58, no. 9, p. 1806-1824.

FIGURE CAPTION

Figure 1. Descriptive log of core of the Travis Peak Formation from the S. A. Holditch & Associates Howell No. 5 well, Harrison County, Texas. Core depths are 5,950.0 to 6,311.0 ft and 7,395.3 to 7,562.8 ft.

See separate files for Figure 1, descriptive log cores 1-9

EXPLANATION OF SYMBOLS

CONTACT

Gradational G

Upward fining

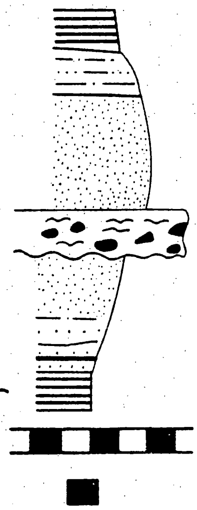
Planar

Erosive E

Upward coarsening

Slightly irregular

ROCK TYPE (%)



Mudstone

Siltstone and sandy siltstone (—···—)

Sandstone

Mud clast and mud flake (~~) conglomerate

Interbedded sandstone (····), siltstone (—···—), and

Mudstone

Coal

Porosity

ACCESSORIES

Vertical and horizontal burrows

Organic fragments

Rootlets

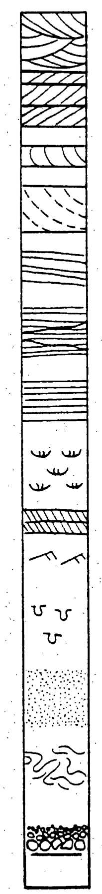
Shells

Mica flakes

P Pyrite

Callianassa burrows

STRUCTURES



Trough crossbedding

Planar crossbedding

Crossbeds with oversteepened foresets

Indistinct cross-stratification

Gently inclined lamination = GI

Gently inclined lamination separated by low-angle discordances

Horizontal lamination

Ripple trough lamination

Planar ripple lamination

Climbing-ripple lamination

Heavily bioturbated sandstone

"Massive" sandstone = M

Contorted bedding

Graded bedding

TEXTURE

Sorting	Rounding
vp-s Very poor	a Angular
p-s Poor	s-a Subangular
m-s Moderately well	s-r Subrounded
w-s Well	r Rounded

INDURATION

WI	Well indurated
I	Indurated
IF	Indurated but friable
IS	Indurated but shaly

RELATIVE CALCITE CONTENT

1	Slight effervescence
3	Moderate effervescence
5	Strong effervescence
10	Very strong effervescence

COLOR

Abbreviations from Rock-Color Chart, Geological Society of America

Abbreviations from Geological Society of America
Rock-Color Chart Used on Core Descriptions

HUE N

N8	very light gray
N7	light gray
N6	medium light gray
N5	medium gray
N4	medium dark gray
N3	dark gray

HUE YR

5YR 8/1	pinkish gray
5YR 7/2	grayish orange pink
5YR 6/1	light brownish gray
5YR 5/2	pale brown
5YR 4/1	brownish gray
10YR 6/2	pale yellowish brown

HUE 7

5Y 8/1	yellowish gray
5Y 6/1	light olive gray
5Y 5/2	light olive gray
5Y 4/1	olive gray
5Y 3/2	olive gray

HUE G

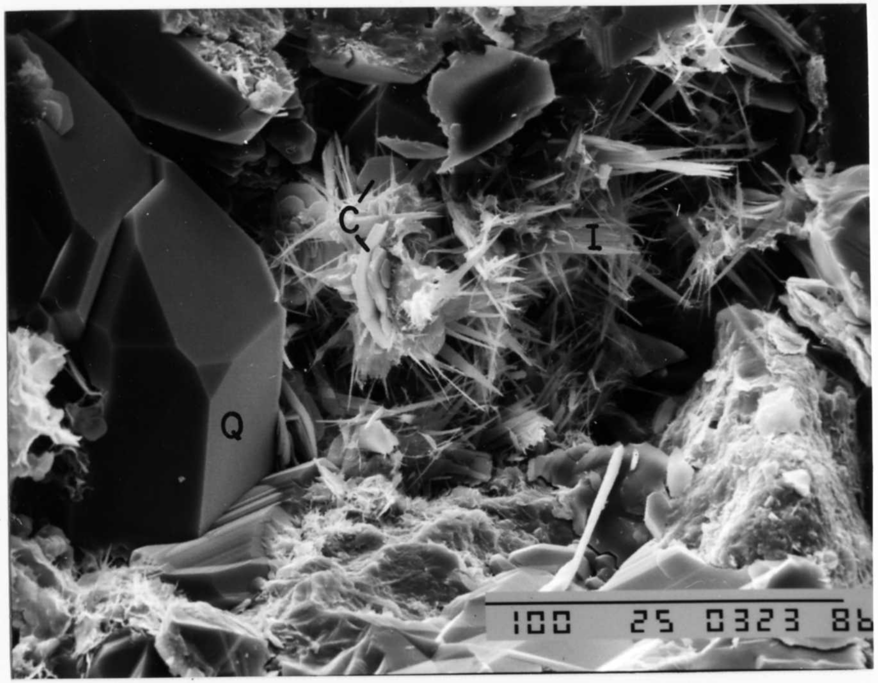
5G 6/1	greenish gray
5G 4/1	dark greenish gray
5G 2/1	greenish black

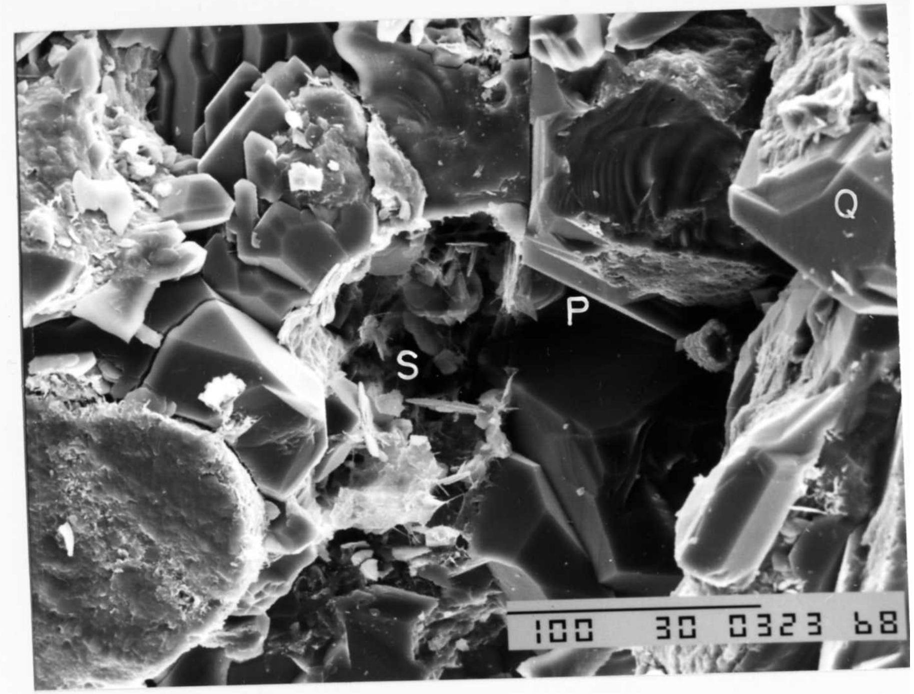
HUE R

5R 8/2	grayish pink
5R 6/2	pale red
5R 4/2	grayish red
5R 2/2	blackish red
10R 6/2	pale red

HUE GY

5GY 6/1	greenish gray
5GY 4/1	dark greenish gray
5GY 2/1	greenish black


Q
C
I
100 25 0323 86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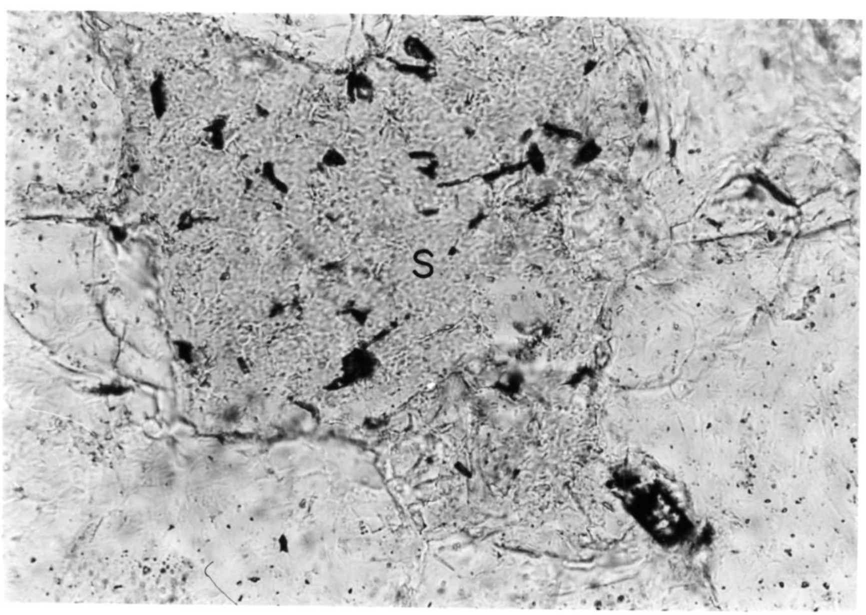
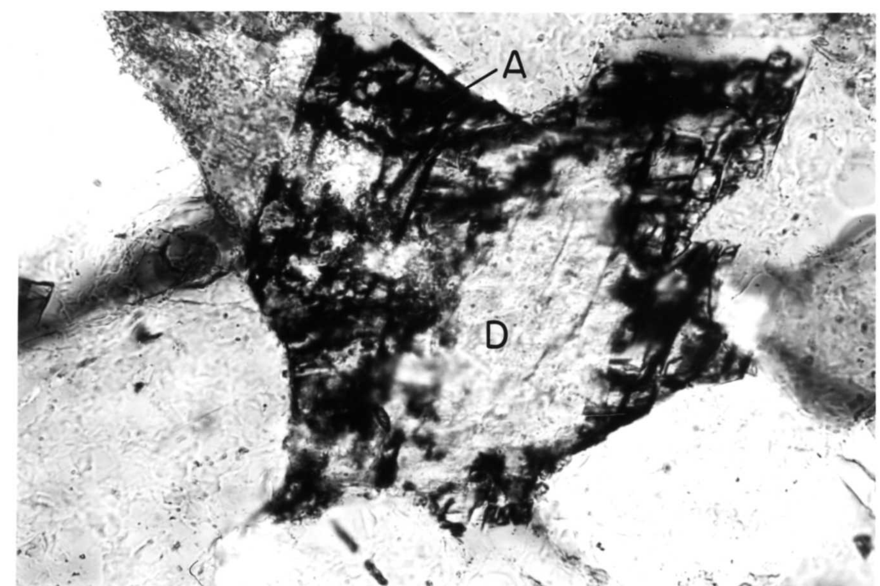

S


A
D

F I G U R E 2. SEM photograph of primary (P) and secondary (S) pores and quartz overgrowths (Q). The secondary pore is partly outlined by an illite rim. Depth is 7,419.5 ft. Bar length is 100 μm; magnification is 350x.	F I G U R E 3. SEM photograph of authigenic illite fibers (I) and chlorite plates (C) within a secondary pore. Euhedral quartz overgrowths (Q) cover a detrital quartz grain. Depth is 7,419.5 ft. Bar length is 100 μm; magnification is 500x.
F I G U R E 4. Photomicrograph of ankerite cement (A) that precipitated on a nucleus of early dolomite cement (D) from 6,201.3 ft. Long dimension of photo is 0.26 mm. Plane-polarized light with gypsum plate inserted.	F I G U R E 5. Photomicrograph of large secondary pore (S) from 6,201.3 ft. Long dimension of photo is 0.26 mm. Plane-polarized light.