OCS Report
MMS 2000-038

SHELL LYDONIA CANYON BLOCK 357 No. 1 WELL

Geological and Operational Summary

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ABBREVIATIONS

API -- American Petroleum Institute
bbl -- barrels
BOP -- Blow out preventer
CNL -- Compensated neutron log
CPI -- Carbon Preference Index
COST -- Continental Offshore Stratigraphic Test
DST -- drill stem test
EQMW -- equivalent mud weight
FDC -- compensated formation density log
FEL -- from east line
FNL -- from north line
FSL -- from south line
FWL -- from west line
k -- permeability
KB -- kelly bushing
LS -- limestone
m -- meter (s)
md -- millidarcy
MYBP -- million years before present
OCS -- Outer Continental Shelf
ppf -- pounds per foot
ppg -- pounds per gallon
ppm -- parts per million
psi -- pounds per square inch
R_O -- vitrinite reflectance
SS -- sandstone
Sw -- water saturation
TAI -- thermal alteration index
TD -- total depth
TIOG -- threshold of intense oil generation
TOC -- total organic carbon
UTM -- Universal Transverse Mercator
ϕ -- porosity

INTRODUCTION

The Shell Lydonia Canyon (LC) Block 357 No. 1 well was the sixth to be spudded and last to be completed of the eight industry wildcat wells drilled on Georges Bank. Spudded on April 14, 1982, this well is the southwesternmost of the group of wells drilled on Georges Bank. It is about 20 miles southwest of the Continental Offshore Stratigraphic Test (COST) G-2 well. The Shell LC Block 357 No. 1 well was drilled by a semi-submersible rig in 265 feet of water on the continental shelf about 124 miles east-southeast of Nantucket Island and 18 miles from the shelf edge.

Shell Offshore Inc. (Shell) was the designated operator for the well, and the company's primary drilling target was a simple structural closure on Jurassic horizons in the northwest part of the block. In the Exploration Plan, Shell identified three horizons on seismic data, JII, JIII, and JIV, between 1.8 and 3.6 seconds, two-way travel time. Inferred depths range from 16,000 to 22,000 feet in limestone, dolomite, and anhydrite. Shell said that the anticlinal closure at and below 2.8 seconds might be an expression of a deeper geologic structure, such as a salt swell. Although the well was permitted to 22,000 feet, total depth reached was 19,427 feet. Within the target zone, Shell encountered tight micritic limestones with oolites, pellets, and fossil fragments, as well as minor anhydrite and dolomite. There was a significant gas show of about 1,300 units at 18,760 feet in limestone. Petrophysical tests done on two conventional cores, between 18,800 feet and total depth, yielded porosities of up to 3.1 percent and permeabilities mostly below one millidarcy. No well tests were attempted. The Shell 357 No. 1 well was plugged and abandoned as a dry hole on September 27, 1982.

This report relies on geologic and geophysical data provided to the Minerals Management Service (MMS) by Shell, according to Outer Continental Shelf (OCS) regulations and lease stipulations. The data were released to the public after the LC Block 357 lease No. OCS-A-0210 expired on January 31, 1985. Interpretations of the data contained in this report are those of MMS and may differ from those of Shell. Well depths are measured from kelly bushing (measured depths) unless otherwise stated.

The material contained in this report is from unpublished, undated MMS, internal interpretations. No petroleum geochemical or kerogen analysis was done for this well by MMS. No attempt has been made to provide more recent geologic, geochemical, or geophysical interpretations or data, published or unpublished.

This report is initially released on the Minerals Management Service Internet site **http://www.gomr.mms.gov**, and, together with the other Georges Bank well reports, on a single compact disk (CD). At a later date, additional technical data, including well "electric" logs will be added to the CD.

OPERATIONAL SUMMARY

The Shell Lydonia Canyon (LC) Block 357 No. 1 well (figures 1 and 2) was drilled by the Zapata Offshore Company's *Saratoga* semisubmersible drilling rig to a total measured depth of 19,427 feet. The well was spudded on April 14, 1982, in 265 feet of water. Daily drilling progress for the well is shown in figure 3 and well statistics are presented in table 1. Geologic exploration objectives were Jurassic carbonate rocks between 2.8 and 3.4 seconds two-way travel time, identified on seismic record sections and interpreted to be at depths of 16,000 to 22,000 feet. At the well location, the target strata form a simple structural closure over an inferred salt pillow at greater depth.

The surface hole was drilled with 8.9-ppg mud and opened to 36 inches to a depth of 514 feet. The 30-inch surface casing was set at 495 feet with 2,000 sacks of class H cement. A casing diagram is shown in figure 4. Re-cement jobs were attempted after testing because of leakage around the outside of the surface casing. The marine riser was connected, the cement plug was drilled out, and drilling continued with a 17 1/2-inch bit to 1,219 feet and with mud weights from 9.0 to 10.0 ppg. The hole was logged and then opened to 26 inches to a depth of 1,181 feet. In two attempts, the 20-inch casing could not be run into the hole because of bridging. After repeated reaming, washing, and re-cementing the surface casing, the 20-inch casing was run and set at 1,169 feet with 1,030 sacks of class H cement. The blowout preventer and riser were run and tested and the 20-inch casing was tested to 200 psi for 30 minutes. The cement plug was drilled out and drilling continued with a 17 1/2-inch bit and 9.0- to 9.1-ppg mud to 4,465 feet depth. The hole was logged and the 13 3/8-inch casing was run and set at 4,417 feet with 255 sacks of class H cement.

The casing was tested at 1,000 psi for 30 minutes. Drilling resumed to 12,060 feet with a 12 1/2-inch bit and 9.0 to 9.1 ppg mud. Repeated reaming was required to maintain hole gauge. The hole was logged, and the 9 5/8-inch casing was run and set at 12,011 feet with 2,760 sacks of class H cement. The casing and plug were tested at 2,700 psi, the ball joint repaired, and the BOP tested. The plug was drilled out, drilling and reaming resumed to 17,988 feet with an 8 1/2-inch bit and mud weights from 9.5 to 12.0 ppg, and the hole was logged. Drilling resumed to 18,845 feet with an 8 1/2-inch bit and 12.8- to 12.9-ppg mud. A gas show was encountered at 18,765 feet.

The hole was logged, cleaned, and sidewall cores run. A 7-inch liner was run and cemented with 800 sacks of class H cement to 18,630 feet. Pressure testing was done by bumping the plug to 2,000 psi, but the setting sleeve failed. The top of the liner was cemented and tested to 4,145 psi for 30 minutes. With the use of a 5 7/8-inch bit, the cement plugs were drilled out, but the drill pipe stuck at 18,752 feet. After backing off, the bit, sub, and drill collar were left in the hole. Fishing was partly successful, and the bit was milled and the hole cleaned.

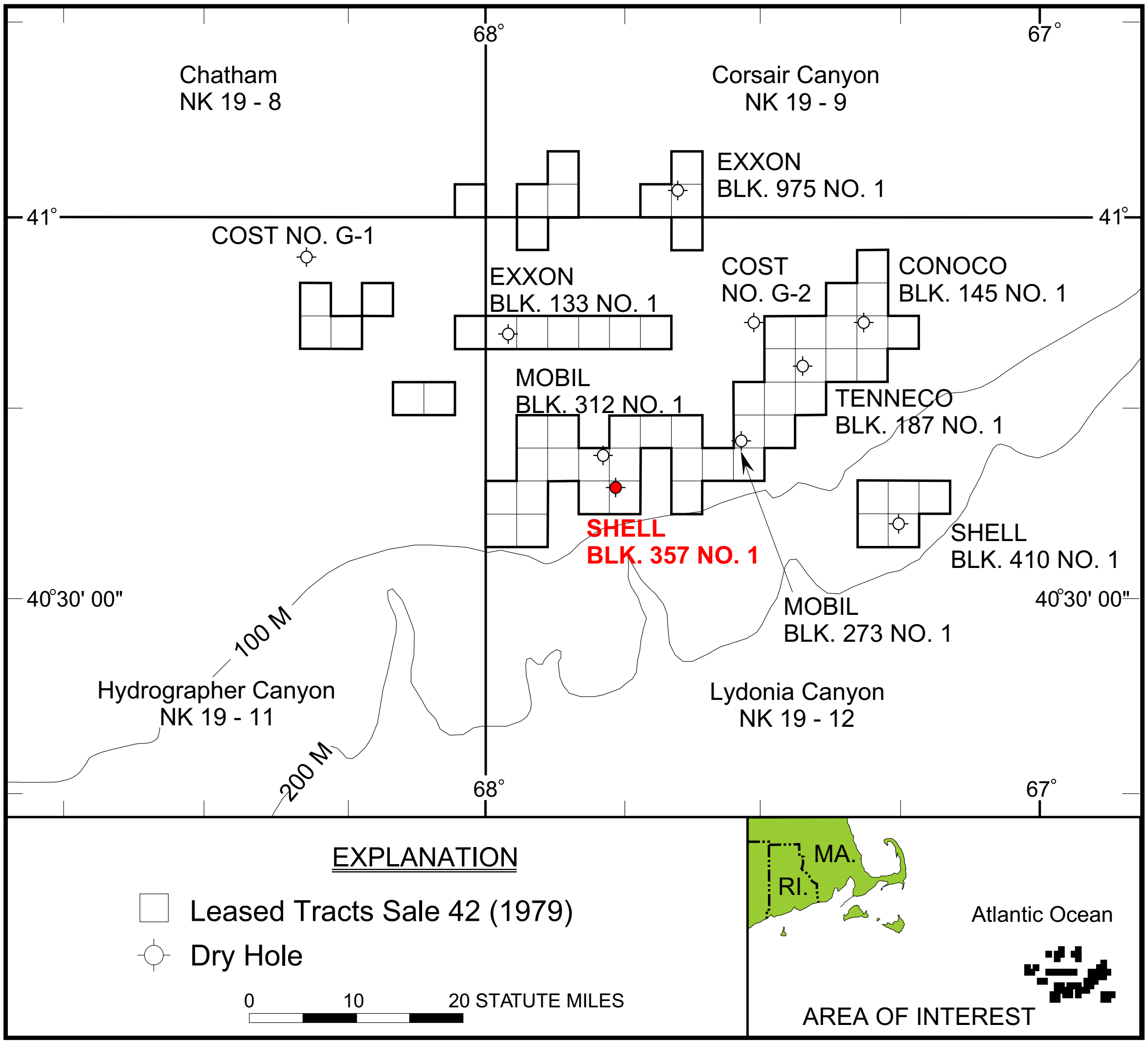

Figure 1. Map of the North Atlantic offshore area showing well locations. The Shell Lydonia Canyon Block 357 No. 1 well is highlighted in red. Bathymetry is in meters.

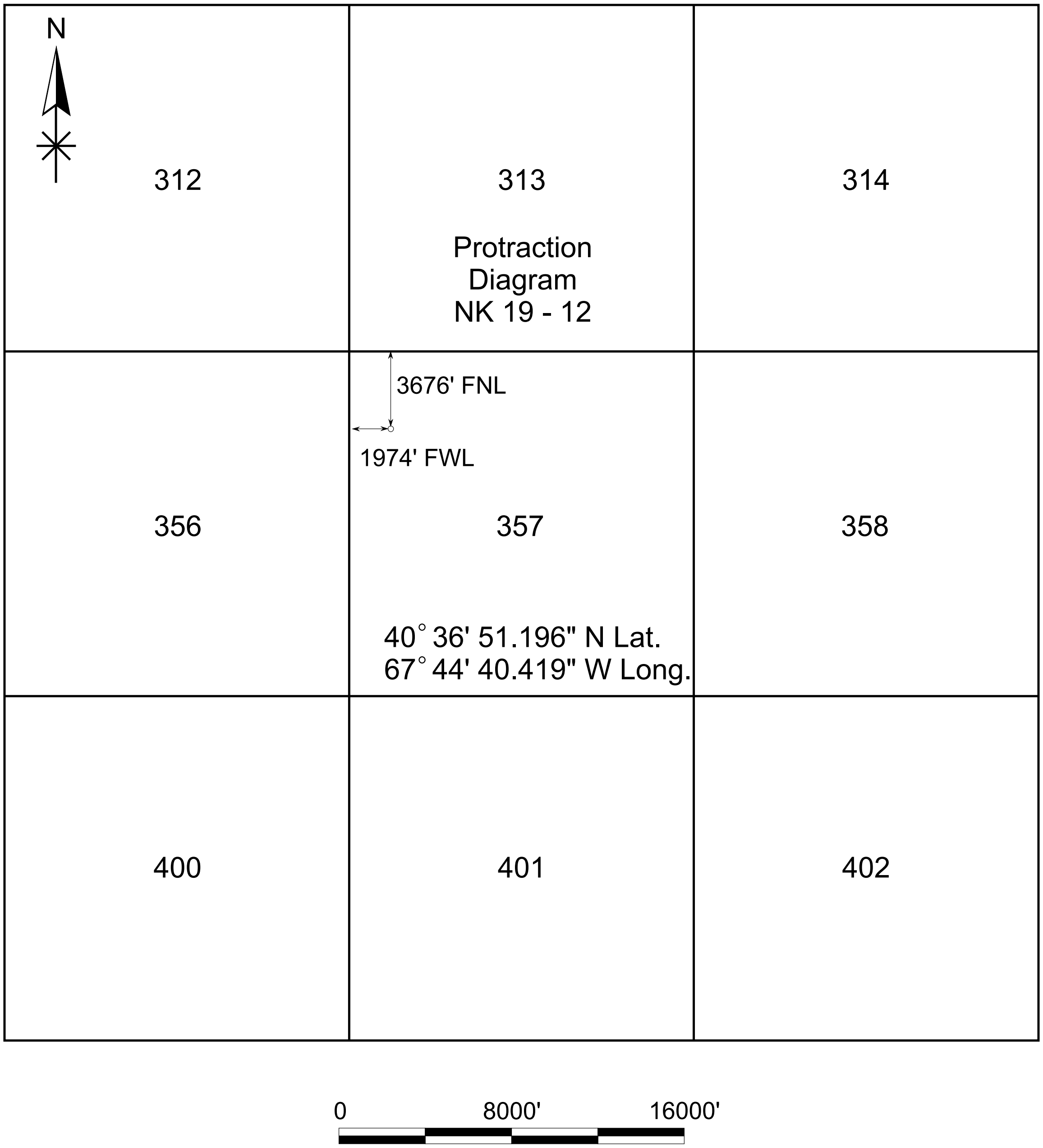

Figure 2. Location plat for the Shell Block 357 No. 1 well on the OCS Lydonia Canyon NK 19-12 protraction diagram.

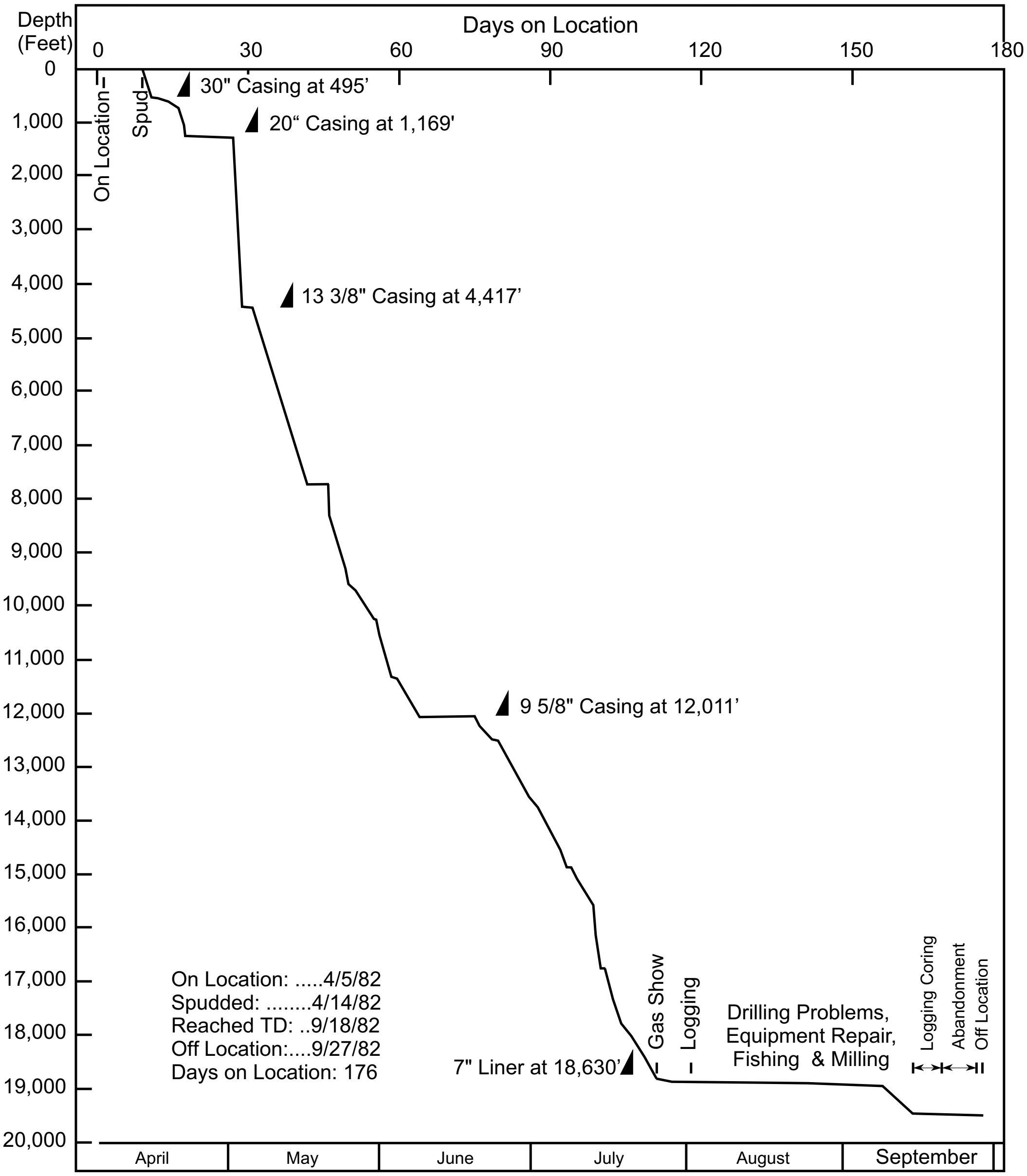

Figure 3. Daily drilling progress for the Shell Lydonia Canyon Block 357 No. 1 well.

Drilling resumed to 19,427 feet with mud weights of 12.8 to 12.9 ppg, where the rate of penetration became negligible. The hole was reamed to TD and attempts to resume drilling were not successful. The hole was logged, the conventional core was cut, and sidewall cores were shot.

Table 1. Well statistics

Well identification:	API #61-040-00006 Lease No. OCS-A-0210
Surface location:	Lydonia Canyon NK 19-12 LC Block 357 3,676 feet FNL 1,974 feet FWL Latitude 40° 36' 51.196" N Longitude 67° 44' 40.419" W UTM coordinates: X = 606,201.7m Y = 4,496,479.7m
Bottomhole location:	18 feet S and 53.9 feet W of surface location
Proposed total depth:	22,000 feet
Measured depth:	19,427 feet
True vertical depth:	19,398.5 feet
Kelly bushing elevation:	72 feet
Water depth:	265 feet
Spud date:	April 14, 1982
Reached TD:	September 18, 1982
Off location:	September 27, 1982
Final well status:	Plugged and abandoned

Note: All well depths indicated in this report are measured from the kelly bushing (measured depth), unless otherwise indicated. Mean sea level is the datum for the water depth.

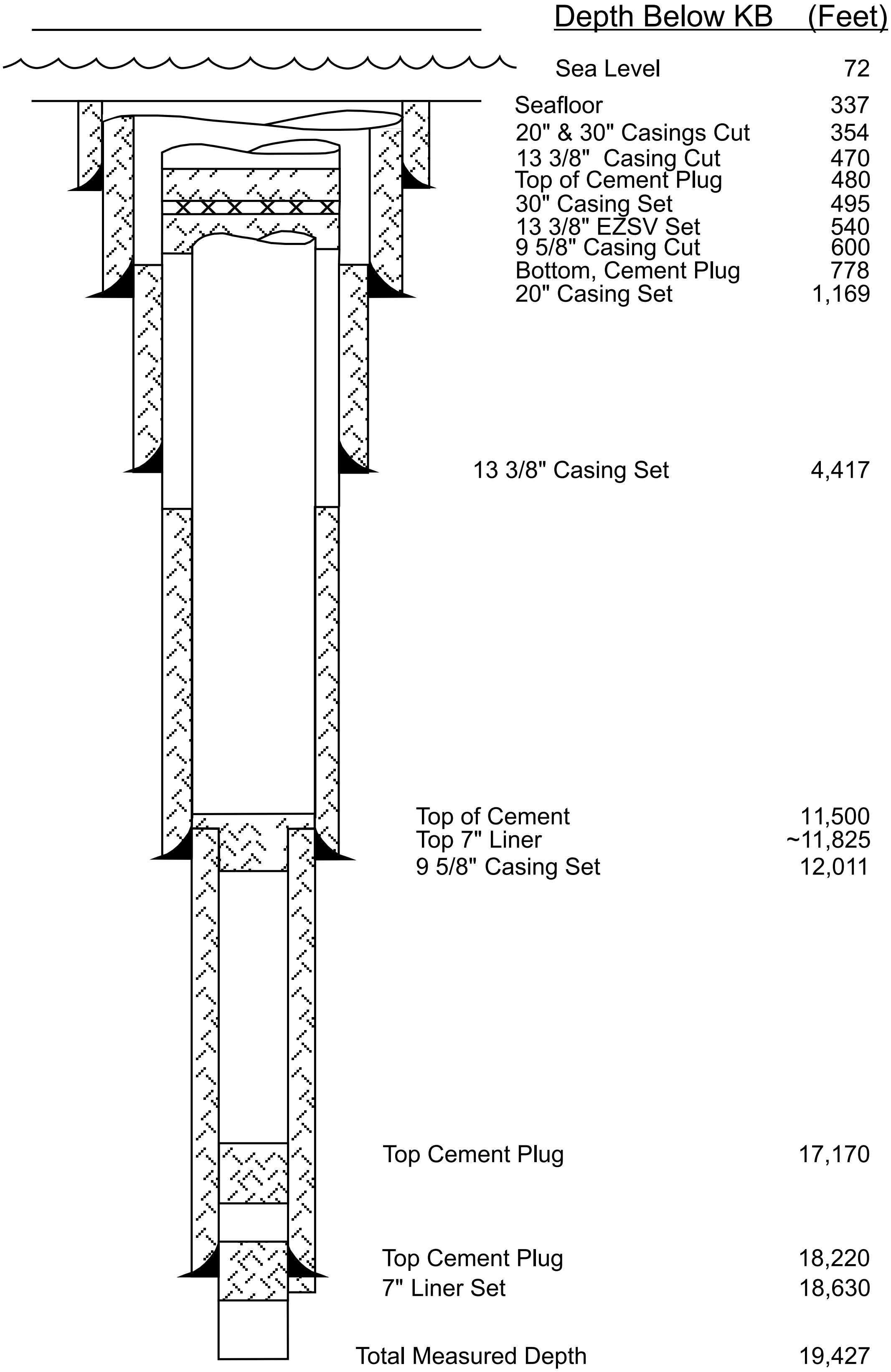

Figure 4. Casing diagram for the Shell Lydonia Canyon Block 357 No. 1 well.

Abandonment procedures (figure 4) included setting cement plugs at 18,220, 17,170, and 11,500 feet (tops of cement) with 100 sacks of class H cement for each plug. A pressure test was conducted at 11,500 feet with 1,000 psi, and the 9 5/8-inch casing was cut at 600 feet and pulled. A packer was set and tested at 540 feet and 100 sacks were squeezed below the retainer (bottom of cement, 778 feet), and 75 sacks were spotted on top (top of cement, 480 feet). The plug was tested at 1,000 psi and the 13 3/8-inch casing was cut at 470 feet and pulled. The 13 3/8-inch annulus was tested at 400 psi, and the 20- and 30-inch casings were cut and pulled at 354 feet. All wellhead equipment and anchors were retrieved. The site was cleaned by divers and surveyed by sidescan sonar, and the rig was released on September 27, 1982.

WELL VELOCITY PROFILE

Schlumberger Ltd. ran a velocity checkshot survey between 12,407 and 17,907 feet in the Shell LC Block 357 No. 1 well. The checkshot data, together with that for the other nine wells drilled on Georges Bank, were given by MMS to Velocity Databank, Inc. at their request after all leases had been relinquished or had expired. Velocity Databank calculated interval, average, and RMS velocities, plotted time-depth curves, and tabulated the data. Table 2 presents well depth, two-way travel time, and the calculated velocities for the Shell LC Block 357 No. 1 well. Figures 5 and 6 show interval velocity, average velocity, and RMS velocity plotted against depth and against two-way travel time, respectively. Well depths are subsea.

Table 2. Well velocity data

Depth (feet)	Two-Way Time (seconds)	Interval Velocity (feet/sec.)	RMS Velocity (feet/sec.)	Average Velocity (feet/sec.)
12,407	2.530	9,807	9,807	9,807
12,925	2.592	16,709	10,027	9,972
13,427	2.646	18,592	10,274	10,148
13,927	2.700	18,518	10,502	10,316
14,389	2.752	17,769	10,685	10,457
14,927	2.804	20,692	10,954	10,646
15,427	2.856	19,230	11,160	10,803
15,927	2.906	20,000	11,370	10,961
16,252	2.940	19,117	11,490	11,055
16,877	3.002	20,161	11,734	11,243
17,427	3.054	21,153	11,956	11,412
17,907	3.102	19,999	12,122	11,545

A lithologic column is also shown in figure 5. Because check shots were done in only the bottom portion of the well, only two interval-velocity intervals are apparent on figure 5. These are listed in table 3.

Table 3. Well velocity intervals

Interval	Depth Range (feet)	Interval Velocity range (feet/second)	Average Interval Velocity (feet/second)
I	0-14,500 (12,925-14,500*)	9,807-18,592 (16,709-18,592*)	16,279 (17,897*)
II	14,500-17,907	19,117-21,153	20,050

*Shallowest data point omitted

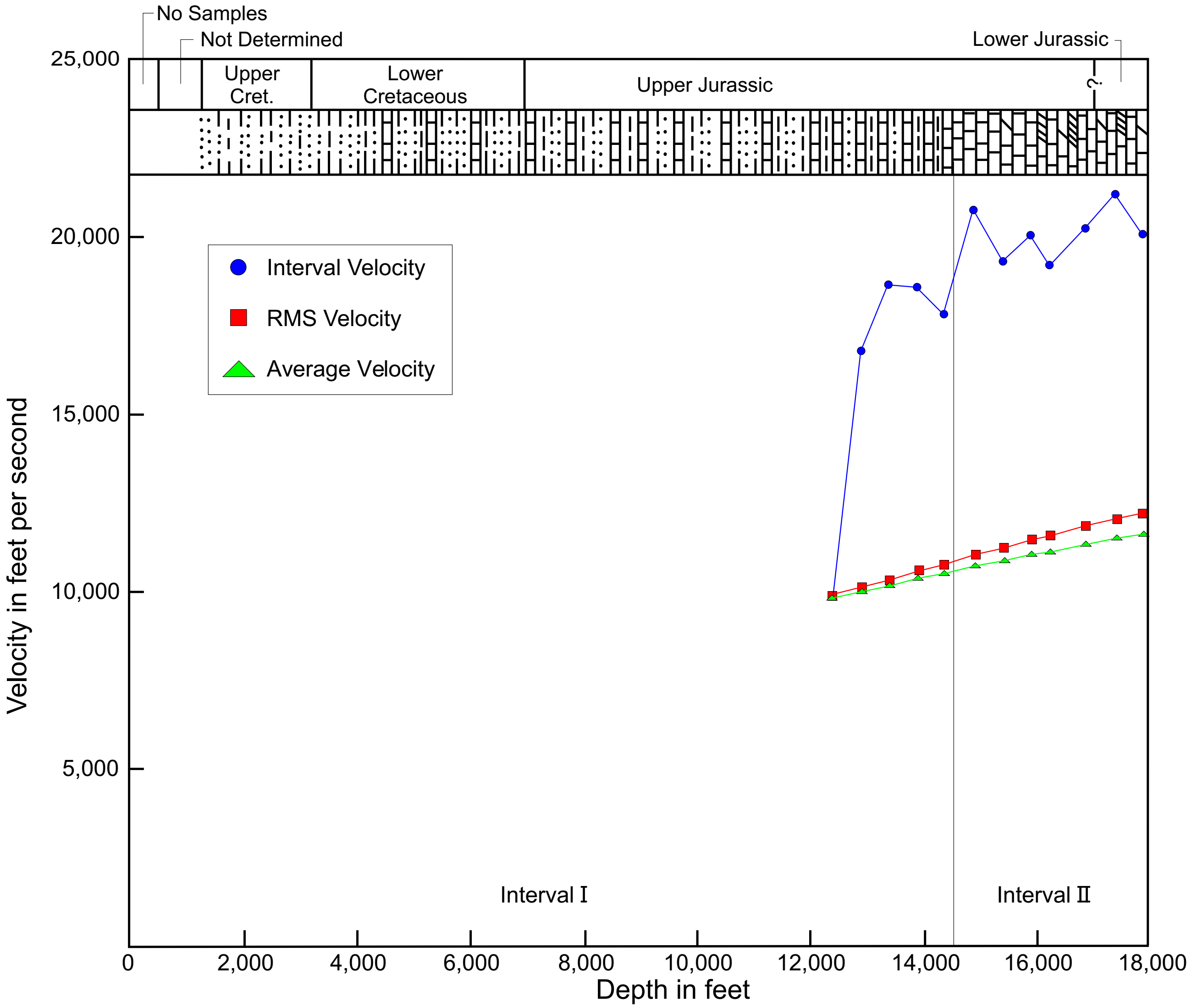

Figure 5. Well velocity profile for the Shell Lydonia Canyon Block 357 No. 1 well, plotted against depth, with biostratigraphic ages and generalized lithologies. Intervals are explained in text.

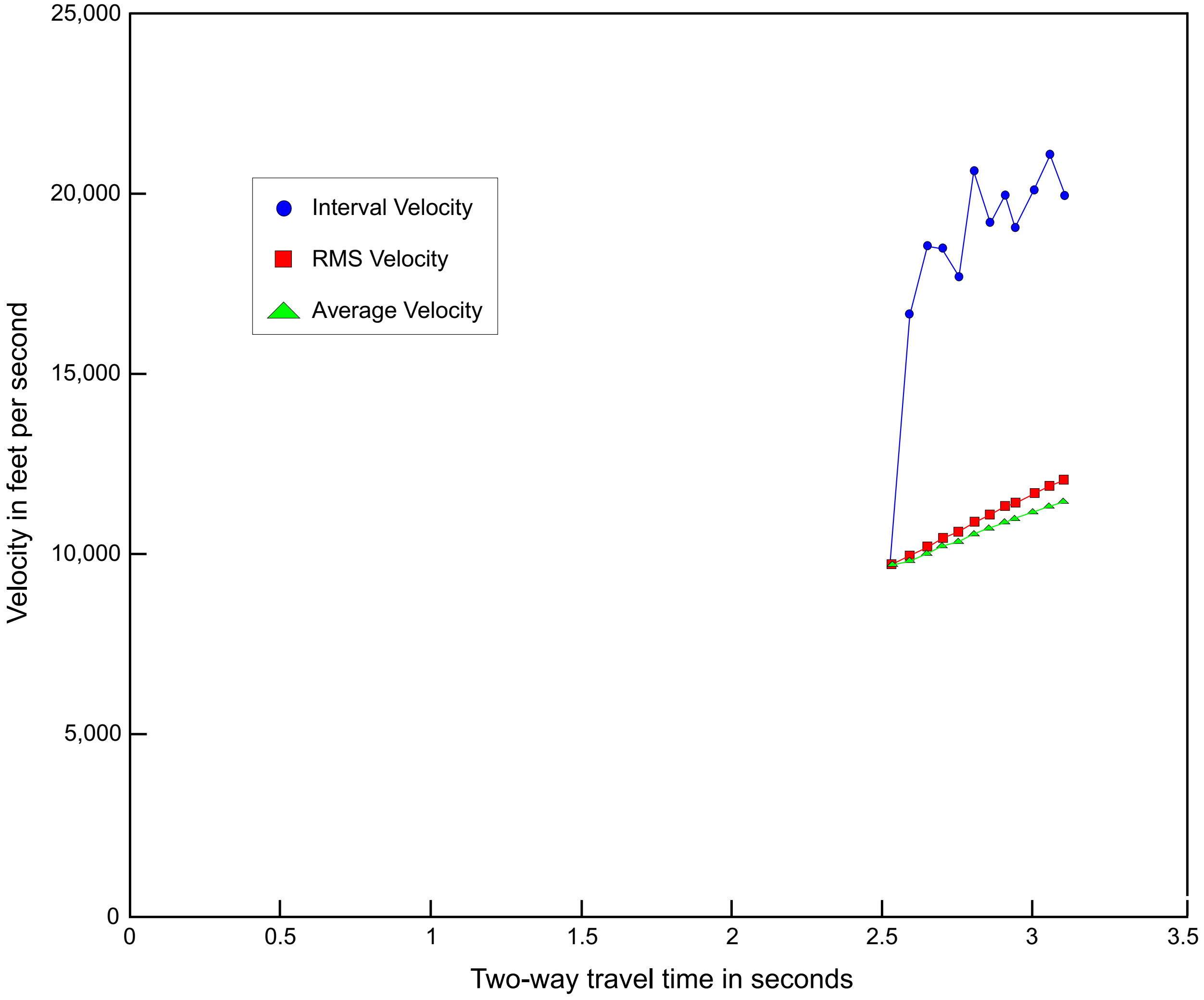

Figure 6. Well velocity profile for the Shell Lydonia Canyon Block 357 No. 1 well, plotted against two-way travel time.

Interval I This interval contains the first five data points and includes the entire column of water and rock to 14,389 feet. With regard to interval velocities, the first value, 9,807 feet per second, at 12,407 feet, has little practical value, since it also applies to the entire column of water and rock to that depth. In Table 3, the values in parentheses for Interval I omit the shallowest data point and are representative of the interval velocities at 12,925 to 14,500 feet. These moderately high velocities correlate with limestone with siliciclastic interbeds. According to Shell Offshore, Inc. biostratigraphic analysis, this part of the section is Oxfordian (Late Jurassic).

Interval II This interval is identified on the basis of high interval velocities, which correlate with limestones. The lower portion of the interval also contains some dolomite and anhydrite. This interval is Early(?) to Late Jurassic, according to Shell's biostratigraphy.

LITHOLOGIC INTERPRETATION

Taken and adapted from A. Rampertaap, MMS internal report

Well cuttings were collected at 30-foot intervals from 540 to 13,020 feet and then 10-foot intervals to total depth, 19,427 feet in the Shell LC Block 357 No. 1 well. Sample quality ranged from fair to good, based on amounts of cavings and degree of washing. Conventional cores from 18,815 to 18,845 feet and 19,399 to 19,407 feet, together with 46 sidewall cores taken from 15,189 to 18,782 feet, provided additional lithologic control.

The lithologic descriptions of this report are based on examination of drill cuttings, supplemented by mud log sample descriptions. Depths of lithologic boundaries are adjusted with reference to electric logs. All depths are from kelly bushing. Rocks penetrated are divided into gross lithologic-stratigraphic units, shown in figure 7.

From 540 to 580 feet, the section consists of unconsolidated quartz sand, with red siltstone fragments and traces of shell debris and glauconite. From 580 to 1,200 feet, there are no cutting samples. From 1,200 to 1,300 feet, the interval consists of coarse sand with subrounded to rounded grains and traces of shell fragments.

From 1,300 to 1,450 feet, the section consists of coarse-grained quartz sand with subrounded to rounded grains, silty clay, glauconitic sandstone fragments, and traces of shell fragments. From 1,450 to 2,400 feet, the section consists of dark gray clay with lesser amounts of sandy siltstone, and sandstone. There are trace quantities of shell fragments, and lignite is abundant at about 2,000 feet.

From 2,400 to 3,150 feet, the section consists of gray to black, calcareous, clayey siltstone or mudstone with traces of sand, lignite (which may be cavings), and shell fragments.

From 3,150 to 3,510 feet, the section consists of dark-gray to black calcareous mudstone with traces of sand, lignite, and fossil fragments. From 3,510 to 3,775 feet, the section consists of medium to coarse grained quartz sand with subangular to subrounded grains and traces of fossil fragments.

From 3,775 to 3,910 feet, the section consists of dark-gray, calcareous mudstone with traces of sand, glauconite, and fossil fragments. From 3,910 to 4,300 feet, the section consists of brown to gray calcareous, sandy siltstone with traces of shell fragments and glauconite pellets.

From 4,300 to 4,500 feet, the section consists of brown to gray, calcareous siltstone, limestone, and traces of fossil fragments and glauconite pellets. From 4,500 to 4,775 feet, the section consists of dark-gray, sandy siltstone with traces of limestone, lignite, glauconite, and fossil fragments. From 4,775 to 5,350 feet, the section consists of light-gray to gray limestone, coarse-grained sandstone, gray shale, calcareous siltstone, and clay. From 5,350 to 6,450 feet, the section consists of sandstone, shale, and calcareous sandy siltstone. The sandstone is very fine to coarse, moderately sorted, and clear to light gray with angular to subangular grains and traces of pyrite, glauconite, and coal. Most of the shale is light to medium

Figure 7. Columnar chart of the lithology and biostratigraphy of the Shell Lydonia Canyon Block 357 No. 1 well. Lithologic interpretations from examination of cuttings; lithologic breaks picked from well logs. Stage tops from Shell. No paleobathymetry available.

gray; a small proportion is red. The sandy siltstone is light to dark gray with traces of pyrite, glauconite, and coal.

From 6,450 to 7,075 feet, the section consists of limestone, calcareous sandstone, and calcareous sandy siltstone. The limestone is light to dark gray with traces of pyrite, shale, and quartz. The sandstone has clear, angular to subangular grains and traces of pyrite. The sandy siltstone is light to dark gray with traces of pyrite. Silty clay occurs between 6,900 and 6,920 feet. From 7,075 to 7,275 feet, the section is predominantly light-gray limestone and shale.

From 7,275 to 7,525 feet, the section consists of white to gray, calcareous siltstone with traces of shale. From 7,525 to 7,900 feet, the section consists of calcareous siltstone that is light to dark gray, moderately well indurated, and has traces of limestone. Light-gray, calcareous clay with traces of limestone occurs between 7,810 to 7,900 feet. From 7,900 to 8,875 feet, light-gray limestone grades into dark-gray siltstone and light- to dark-gray shale. Traces of pyrite, siltstone, shale, and limestone also occur. Chalky limestone occurs between 8,550 and 8,650 feet.

From 8,875 to 9,520 feet, the section consists of calcareous, sandy shale, shale, limestone, and sandstone. The sandy shale contains fine, rounded sand grains. The shale is dark gray. The limestone is light to dark gray with traces of lignite. The sandstone is well sorted and fine grained with rounded quartz grains.

From 9,520 to 12,100 feet, the section consists of limestone, sandstone, siltstone, and shale. The limestone is white to dark gray with small amounts of pyrite. The sandstone is dominantly light gray, fine grained, and moderately sorted with angular to subangular quartz grains. Traces of glauconite occur at 9,950 and 10,200 feet. The siltstone is reddish brown, gray, and light gray. The shale is dark gray.

From 12,100 to 13,110 feet, the section consists of microcrystalline limestone with lesser amounts of sandstone, chalk, and siltstone. The limestone is white to medium gray with scattered oolites from 12,900 to 13,100 feet. The dominant lithology from 13,110 to 13,510 feet is white to gray, microcrystalline limestone, in part oolitic, with traces of pyrite, anhydrite, sandstone, and siltstone. From 13,510 to 13,750 feet, the section consists of light- to medium-gray limestone with minor gray shale and traces of siltstone. From 13,750 to 14,400 feet, the section consists of limestone with traces of siltstone. From 13,825 to 14,275 feet, the limestone is oolitic with traces of anhydrite at 13,910 feet.

At 14,040 feet a thin bed of chalky limestone is present. From 14,400 to 14,740 feet, the section consists of white to medium gray oolitic limestone. From 14,740 to 19,427 feet, the section consists entirely of limestone and dolomite with limestone predominant in the upper section to 19,110 feet and dolomite predominant below 19,110 feet. Through the overall interval, the limestone grades downward from oolite to micrite. Small amounts of anhydrite occur at 16,000, 16,300, 16,430, 16,690, 16,910, 17,500, and 19,400 feet.

BIOSTRATIGRAPHY

This biostratigraphic summary is taken from a report submitted by Shell to MMS for the Shell LC Block 357 No. 1 well. No MMS paleontological interpretations are available. This biostratigraphic summary also appears in figure 7.

Table 4. Biostratigraphy

Series	Age	Depth Interval (feet)
	Not examined	0-514
	Not determined	514-1,330
Late Cretaceous	at/in Campanian	1,300
	at/in late Santonian	1,630
	Coniacian - Turonian	2,560
	in Turonian	2,660
	at/in late Cenomanian	2,740
Early Cretaceous	at/in Albian	3,250
	at/in Aptian	3,940
	in Barremian	5,080
	at/in Hauterivian	5,650
	at/in Valanginian	6,400
Late Jurassic (?)		7,060
Late Jurassic	at/in Kimmeridgian	7,360
	at/in Oxfordian	9,460
Early Jurassic (?)		17,010
Total sample depth		19,395

FORMATION EVALUATION

Taken and adapted from R. Nichols, MMS internal report

Schlumberger Ltd. ran the following geophysical "electric" logs in the Shell LC Block 357 No. 1 well to provide information for stratigraphic correlation and for evaluation of formation fluids, porosity, and lithology:

Table 5. Well logs

Log Type	Depth Interval (feet) Below KB
DISFL/Sonic (dual induction spherically focused log/sonic)	497-19,391
BHC/Sonic (borehole compensated/sonic)	4,419-19,389
FDC (compensated formation density)	1,172-19,392
CNL/FDC (compensated neutron log/compensated formation density)	1,172-19,392
LDT/GR (lithodensity tool/gamma ray)	4,419-12,038
GR/Spectrometry (gamma ray/spectrometry)	4,419-19,392
Caliper	4,419-18,840
HDT (high-resolution dipmeter)	4,419-19,395
FIL (fracture identification log)	12,013-18,840

Exploration Logging, Inc. (EXLOG) provided a formation evaluation "mud" log, which included a rate of penetration curve, sample description, and a graphic presentation of any hydrocarbon shows encountered (515 to 19,434 feet). In addition, a pressure analysis log (500 to 19,400 feet) and a drilling data pressure log (520 to 19,430 feet) were provided. EXLOG's deepest well depths are not consistent with the operator's measured TD's.

The "electric" logs, together with the "mud" log and other available data, were analyzed in detail to determine the thickness of potential reservoirs, average porosities, and feet of hydrocarbon present. Reservoir rocks with porosities less than 5 percent were disregarded. A combination of logs was used in the analysis, but a detailed lithologic and reservoir property determination from samples, conventional cores, and sidewall cores, in addition to full consideration of any test results, is necessary to substantiate the following estimates as shown in table 6.

Table 6. Well log interpretation summary

Series*	Depth Interval (feet)	Potential Reservoir[1] (feet)	Ave ϕ (%)	SW (%)	Feet of Hydrocarbon
EK	3,358-3,400	42	34	**NC	NC
	3,412-3,424	12	35	-	-
	3,528-3,578	50	28	-	-
	3,654-3,712	44	34	-	-
	4,134-4,158	24	35	-	-
	4,436-4,452	16	(35)	-	-
	4,734-4,804	19	33	-	-
	4,854-4,864	10	29	-	-
	5,036-5,044	8	29	-	-
	5,356-5,384	28	29	-	-
	5,428-5,448	16	29	-	-
	5,490-5,673	83	29	-	-
	5,718-5,760	38	32	-	-
	5,882-5,908	24	30	-	-
	5,938-5,958	20	32	-	-
	6,066-6,128	58	29	-	-
	6,144-6,182	38	28	-	-
	6,210-6,250	40	32	-	-
	6,302-6,322	20	30	-	-
	6,572-6,593	13	23	-	-
	6,673-6,720	24	23	-	-
	6,822-6,833	11	26	-	-
UJ	7,726-7,736	8	28	67	-
	8,252-8,269	15	18	-	-
	8,818-8,848	30	19	-	-
	8,862-8,874	12	19	-	-
	9,196-9,218	12	22	-	-
	9,293-9,332	35	18	-	-
	9,384-9,396	12	16	-	-
	10,255-10,266	11	15	-	-
	10,374-10,389	15	15	-	-
	10,466-10,480	14	16	-	-
	10,912-10,924	9	13	-	-
	14,108-14,122	12(?)	6	54+	-[2]

Continued

Table 6. Well log interpretation summary--*continued*

Series*	Depth Interval (feet)	Potential Reservoir[1] (feet)	Ave ϕ (%)	SW (%)	Feet of Hydrocarbon
UJ	14,575-14,586	11	5	-	
	15,450-15,470	18	5	-	-
	15,688-15,774	41	10	-	-
	16,148-16,192	26	9	-	-
EJ(?)	18,755-18,772	6	6	17	6(?)[3]
	19,274-19,284	(5)	($\leq$ 5)	-	-

*Biostratigraphy from company-submitted report
**Not calculated
[1] Generally in beds > 10 feet thick and > 5%
[2] Mud log response = 3 units (C_{1-2})
[3] Mud log response = 1,300 units (C_{1-2})

The electric logs were of acceptable quality. However, SP shifts were reported at 9,715, 13,950, 15,200, and 15,280 feet. Additional SP shifts may be present at 4,430, 17,800, 18,235, and 18,875 feet. The CNL/FDC tool stuck at 14,225 feet and the readings from 14,168 to 14,248 feet appear to be in error. From 6,900 to 19,391 feet, washouts indicated by the caliper log appear to affect the density porosity reading severely and cause false annulus responses by the medium reading induction log.

Sidewall core porosities (table 7) compare favorably to "electric" log porosities, particularly the values calculated from the sonic log. The sidewall coring process may have induced fractures in the harder limestone sections.

Table 7. Sidewall core analysis summary

Depth Interval (feet)	Lithology	Porosity Range (%)	Permeability Range (md)
15,189-18,782	Limestone, fine xln	1-3[1]	NC*

*Not calculated
[1] Described as leached and vuggy with some open fractures

Two conventional cores were taken in this well with results as follows:

Table 8. Conventional core summary

Core No.	Depth Interval (feet)	Recov. (feet)	Lith.	ϕ Range (%)	Permeability Range (md)	Grain Density (g/cc)
1	18,815-18,845	27	LS	0.2-1.7	0.009-0.02	2.70-2.75
2	19,399-19,407	7	LS/Dol	1.2-3.1	0.02-61.6	2.71-2.82

Core No. 1 does not compare well with the CNL/FDC because of severe washouts, indicated by the caliper log. The FDC reads much too high because of the enlarged hole and the CNL tracks at zero. The sonic log is not functional below 18,810 feet because of tool placement. Core No. 2 compares favorably with the CNL porosity; however, the FDC and sonic logs were not recorded over this interval.

Results of the HDT survey were recorded on a dipmeter arrow plot from 4,420 to 18,845 feet and 19,182 to 19,395 feet. Possible structural anomalies may be present at 7,010, 9,190, 12,030, 13,030, 13,190, 15,500, 17,110, and 17,650 feet (table 9).

Table 9. Dipmeter analysis summary

Depth Interval (feet)	Magnitude (degrees)	Direction
4,420-8,250	1-12	Erratic
8,250-9,775	1-6	W
9,975-11,675	2-11	Erratic
11,675-12,025	1-4	W
12,025-13,025	1-6	W
13,025-15,200	1-2	W
15,200-15,700	20	W
15,700-17,650	40	Erratic
17,650-18,100	1-7	Erratic
18,100-19,395 (TD)	10	E

Table 10 lists all shows of hydrocarbon encountered in this well. The show encountered at 18,760 to 18,770 feet was judged to be significant.

A normal pressure gradient (approx. 9.0 eqmw) was encountered to a depth of 12,100 feet, and at that point the mud weight increased to 9.5 ppg. At 14,100 feet, the mud weight had increased to 10.0 ppg, and at 14,800 feet to 11.0 ppg. At 18,000 feet, a mud weight of 12.0 ppg was reached, and the formation pressure estimated by Exploration Logging on their pressure analysis log was 11.6 ppg eqmw. From 18,900 to 19,400 feet, the mud weight was 12.9 ppg and the formation pressure was estimated to be 12.2 ppg eqmw.

No well tests were performed in this well.

Table 10. Hydrocarbon shows

Depth (Feet)	Drilling Break (ft/hr)	Sample Description (Mud Log)	Total Gas		Chromatograph	Cuttings Gas	Conventional Cores			Sidewall Cores		Well Log Interpretation			Well Tests
			bk. grd.				depth (ft)	ϕ (%)	k (md)	o (%)	k (md)	depth (feet)	ϕ(%)	sw(%)	
7,726 - 7,736	20 - 25	Sltstone; trace faint yellow mineral fluorescene, no cut	1	3	C_l, 2,3,4	-	-	-	-	-	-	7,726 - 7,736	18	67	none
8,130 - 8,680	20 - 40	Sltstone, hard; trace light yellow fluorescence, no cut	1	2	C_l, 2,3,	-	-	-	-	-	-	-	-	-	none
12,120 - 12,130	6	Limestone, hard; no fluorescence	1	10	C_l, 2,3,	-	-	-	-	-	-	-	-	-	none
14,100 - 14,110	13 - 14	Limestone, micritic; mineral fluorescence, no cut	1	3	C_l, 2,	-	-	-	-	-	-	14,108 - 14,122	6	54	none
18,760 - 18,770	13 - 18	Limestone, hard; light yellow mineral fluorescence, no cut	2	1,300	C_l, 2,	-	18,815 - 18,842	0.2 - 1.7	0.007 - 0.02	18,760 18,762 18,765 18,771	some 3 some some	18,755 - 18,772	6	17	none

GEOTHERMAL GRADIENT

Figure 8 shows bottomhole temperatures for seven logging runs in the Shell LC Block 357 No. 1 well plotted against depth. A temperature of 60 ^{0}F is assumed at the seafloor at an indicated depth of 337 feet (265-foot water depth plus 72-foot kelly bushing elevation). Shown also is a straight-line graph between the seafloor and total-depth temperatures in order to represent an overall geothermal gradient for the well, which is 1.36 ^{0}F/100 ft. Calculated geothermal gradients for all Georges Bank wells range from 1.06 to 1.40 ^{o}F/100 ft.

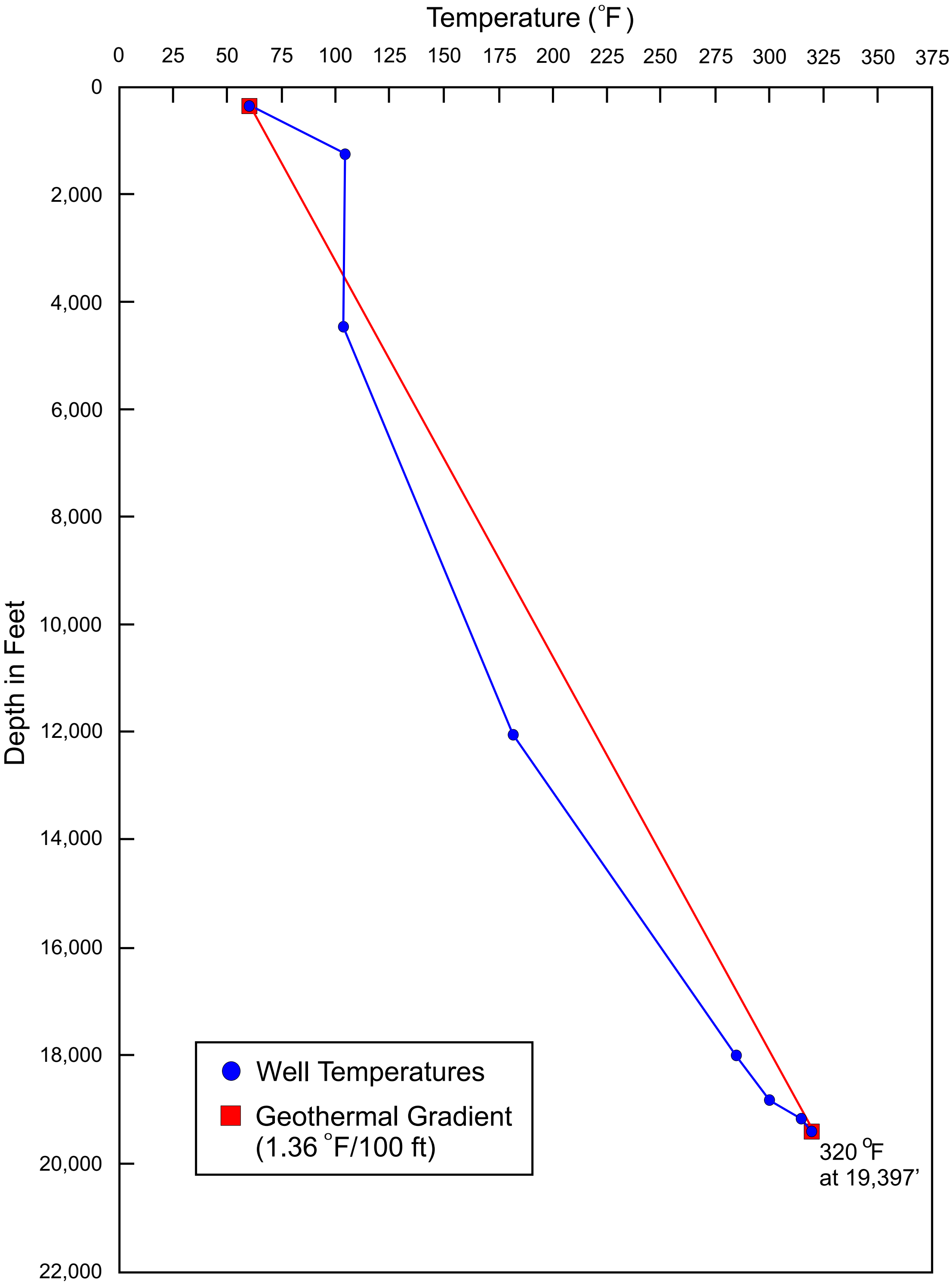

Figure 8. Well temperatures and geothermal gradient for the Shell Lydonia Canyon Block 357 No. 1 well. Well temperatures from bottomhole temperatures of logging runs. Geothermal gradient based on bottomhole temperature of deepest logging run.

BURIAL HISTORY

The burial history model for the stratigraphic section penetrated by the Shell LC Block 357 No. 1 well (figure 9) is based on biostratigraphic determinations contained in a report submitted by Shell to MMS (figure 7; table 4) and the Cretaceous and Jurassic time scales of Van Hinte (1976a and 1976b). In general, burial diagrams for Georges Bank wells show rapid Lower and Middle Jurassic subsidence followed by moderate and then low burial rates through the rest of the Mesozoic and Cenozoic Eras. The Shell LC Block 357 No. 1 profile is consistent with those of the other Georges Bank wells in which Early Jurassic marker fossils were identified, the Mobil LC Block 312 No. 1 and the Tenneco LC Block 187 No. 1 wells.

In constructing figure 9, no adjustments have been made for sedimentary compaction or for section removed by erosion. In their report, Shell applied "at/in" to most age designations; see the **Biostratigraphy** chapter of this report.

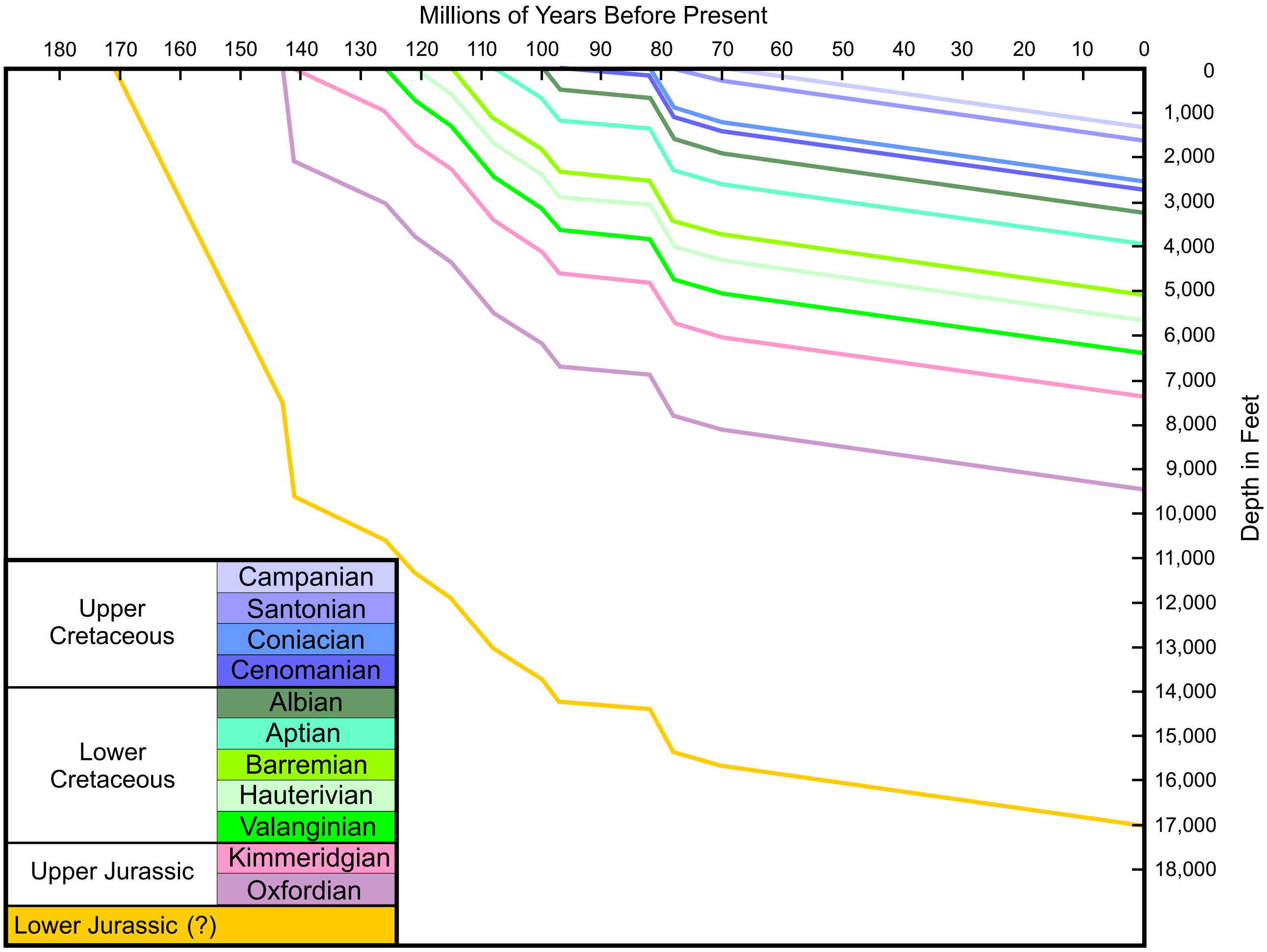

Figure 9. Burial diagram for the Shell Lydonia Canyon Block 357 No. 1 well. Based on stage tops from Shell (see figure 7).

COMPANY-SUBMITTED DATA

Data and reports were submitted by Shell Offshore, Inc., to MMS when the Shell LC Block 357 No. 1 well was drilled, as required by Federal regulations and lease stipulations. Items of general geological, geophysical, and engineering usefulness are listed below. Items not listed include routine submittals required by regulation and detailed operations information, such as the Exploration Plan, Application for Permit to Drill, daily drilling reports, monthly reports, well location survey, and drilling pressure and temperature data logs. Well "electric" logs are listed in the **Formation Evaluation** chapter. Listed and unlisted company reports and data are available through the Public Information Unit, Minerals Management Service, Gulf of Mexico OCS Region, 1201 Elmwood Park Boulevard, New Orleans, Louisiana 70123-2394; telephone (504)736-2519 or 1-800-200-GULF, FAX (504)736-2620. Well logs are available on microfilm from the National Geophysical Data Center, 325 Broadway Street, Boulder CO 80303-3337, attn. Ms Robin Warnken; telephone (303)497-6338, FAX (303)497-6513; e-mail rwarnken@NGDC.NOAA.GOV.

At a later date, additional original technical data, including well logs, will be added to the compact disk (CD) version of the Georges Bank well reports. The CD will be available from the Gulf of Mexico OCS Region Public Information Unit.

SELECTED COMPANY-SUBMITTED DATA

Velocity survey computation (well velocity and well seismic tool data), Schlumberger Ltd., Wireline Testing, Houston TX, undated.

Physical formation (mud) log, Exploration Logging of U.S.A., Inc., undated.

Core analysis data (conventional core No. 1; porosity, air permeability, and grain density), Shell Development Co., Petrophysical Services Laboratory, Houston TX, 08/27/82.

Core analysis data (conventional core No. 2; porosity, air permeability, and grain density), Shell Development Co., Petrophysical Services Laboratory, Houston TX, 10/06/82.

Sidewall cores (lithologic descriptions), Shell Offshore, Inc., New Orleans LA, undated.

Paleontological summary (stage tops), Shell Offshore, New Orleans LA, 10/05/82.

Source rock study (lithologic descriptions, kerogen analysis, vitrinite reflectance, molecular geochemical analysis), Shell Development Co., Geochemical Services, Houston TX, 08/18/82.

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