OCS Report
MMS 2000-032

EXXON CORSAIR CANYON BLOCK 975 No. 1 WELL

Geological and Operational Summary

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ILLUSTRATIONS

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ABBREVIATIONS

API -- American Petroleum Institute
bbl -- barrels
BOP -- Blowout 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 Exxon Corsair Canyon (CO) Block 975 No. 1 well was the third to be spudded and second to be completed of the eight industry wildcat wells drilled on Georges Bank. Spudded on November 25, 1981, this is the northernmost of the wells drilled on Georges Bank. It is about 13.5 miles north-northwest of the Continental Offshore Stratigraphic Test (COST) G-2 well. The Exxon CO Block 975 No. 1 well was drilled by a semi-submersible rig in 209 feet of water on the continental shelf about 124 miles east-southeast of Nantucket Island and 40 miles from the shelf edge.

Exxon Corporation was the designated operator for the well, and the company's drilling target was a group of high-amplitude seismic reflectors ("bright spots") showing two-way closure, interpreted by the company to be a possible Bathonian carbonate hydrocarbon reservoir at about 13,730 to 14,080 feet. At 12,895 feet, the company drilled into anhydrite and at 13,820 feet, salt (halite). Limestone is the dominant rock type at these depths and, below the salt, dolomite and more anhydrite were encountered. No significant hydrocarbon shows were recorded and no well tests were attempted. The seismic high amplitudes were interpreted by Minerals Management Service (MMS) to be associated with anhydrite. The Exxon CO Block 975 No. 1 well bottomed in Upper Triassic (Norian?/Carnian) carbonates and anhydrite. Exxon plugged and abandoned the well as a dry hole on March 7, 1982.

This report relies on geologic and geophysical data provided to the MMS by Exxon, according to Outer Continental Shelf (OCS) regulations and lease stipulations. The data were released to the public after the Corsair Canyon Block 975 lease No. OCS-A-0153 was relinquished on December 10, 1984. Interpretations of the data contained in this report are those of MMS and may differ from those of Exxon. Well depths are measured from kelly bushing unless otherwise stated.

The material contained in this report is from unpublished, undated MMS, internal interpretations. 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 Exxon Corsair Canyon (CO) Block 975 No. 1 well (figure 1) was drilled by the North Star Drilling Company's *Alaskan Star* semisubmersible drilling vessel to a total depth of 14,605 feet, reached on February 24, 1982, with Exxon Corporation designated as operator. The well's location within the lease block is shown in figure 2. Drilling stipulations required the operator to provide MMS with well logs, lithologic samples, geologic information, and operational reports. The well was spudded on November 25, 1981, in 209 feet of water. Daily drilling progress is shown in figure 3. Well and drilling information are summarized in table 1. The casing program is shown in figure 4. Kelly bushing elevation is 83 feet.

The surface hole was drilled and the 30-inch casing (310 lbs/ft) was set on November 28 at 651 feet and cemented with 1,100 sacks of class H cement. The riser was connected after repairs to the latch pin assembly, and drilling resumed to 1,150 feet. The 16-inch casing (75 lbs/ft) was set at 1,101 feet and cemented using 600 sacks of class H cement plus 12 percent gel followed by 750 sacks of class H cement neat and 2 percent calcium chloride.

Seven days were spent on BOP repair and testing, then drilling resumed on December 14 and continued to 4,150 feet. The 13 3/8-inch casing (68 and 72 lbs/ft) was set in the 17 1/2-inch hole at 4,098 feet and cemented with 800 sacks of class H cement plus 12 percent gel followed by 550 sacks of class H cement neat. The casing was tested to 1,500 psi for 30 minutes and drilling resumed, reaching 12,513 feet on February 2, 1982.

The 9 5/8-inch casing (47 lbs/ft NK AC-90) was set in the 12 1/4-inch hole at 12,468 feet and cemented with 1,480 sacks of class H cement and tested to 3,300 psi for 30 minutes. Drilling resumed at 10.0 ppg mud weight and stopped at TD, 14,605 feet, using 12.4 ppg mud weight. The well was cored from 14,133 to 14,161 feet and logged. Well pressures are summarized in the **Formation Evaluation** chapter.

Figure 3 shows the abandonment program. The first plug was set at 14,095 to 14,510 feet with 100 sacks of cement. The second plug was set at 13,384 to 13,800 feet with 100 sacks of cement. The third plug as set at 13,038 to 13,350 feet with 75 sacks of cement. The fourth plug was set at 12,168 to 12,633 feet with 115 sacks of cement. A 9 5/8-inch retainer was set at 12,095 feet, and a pressure test was conducted. A 9 5/8-inch retainer was set at 3,833 feet, 148 sacks of cement were squeezed below the retainer, and 26 sacks were spotted on top (top of cement, 3,765 feet; bottom of cement, 4,348 feet). A pressure test was successful, and the 9 5/8-inch casing was cut at 1,250 feet and retrieved. A 150-sack plug was set and pressure tested at 1,125 to 1,400 feet. A retainer was set at

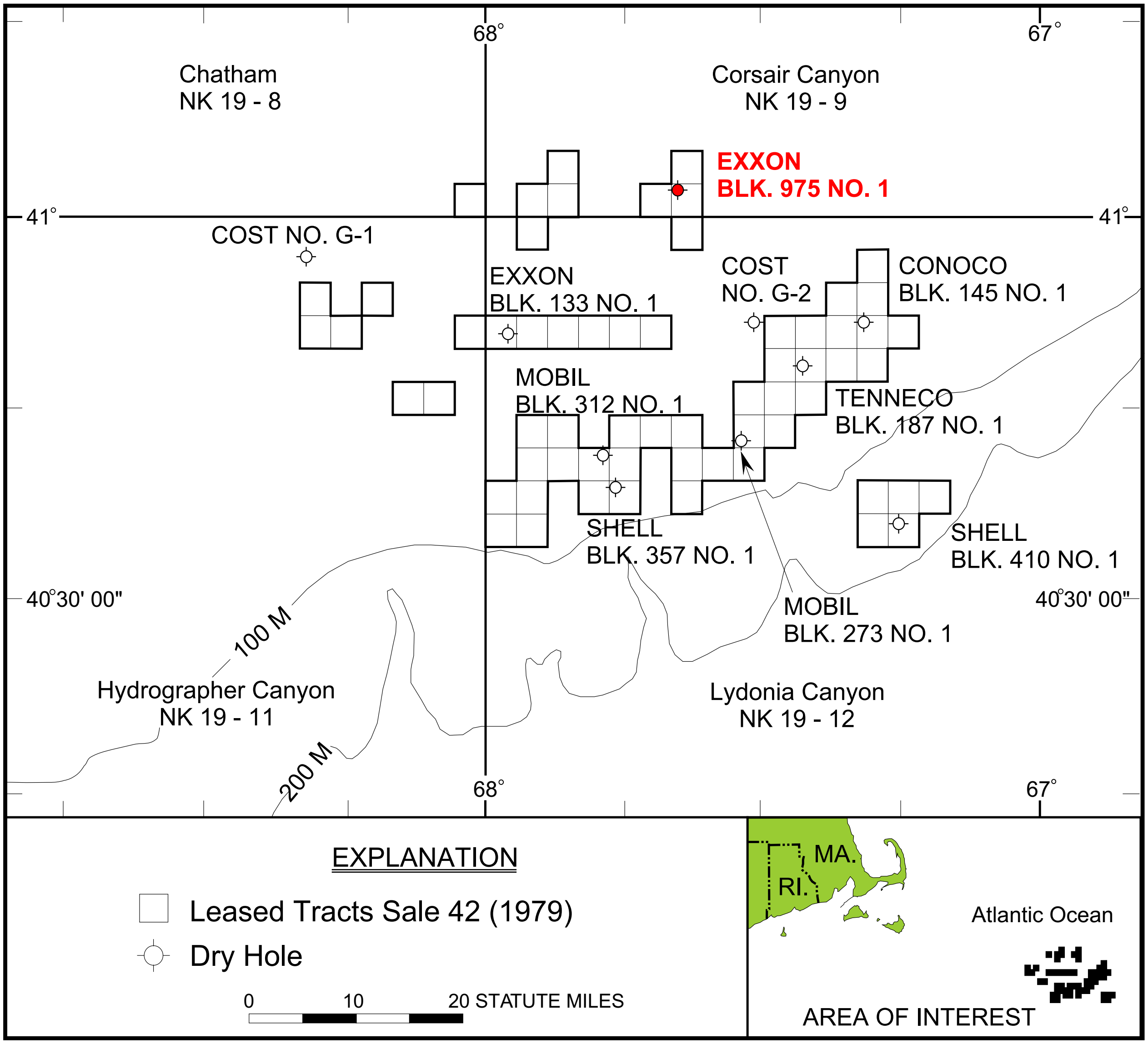

Figure 1. Map of the Atlantic offshore area showing well locations. The Exxon Corsair Canyon Block 975 No. 1 well is highlighted in red.. Bathymetry is in meters.

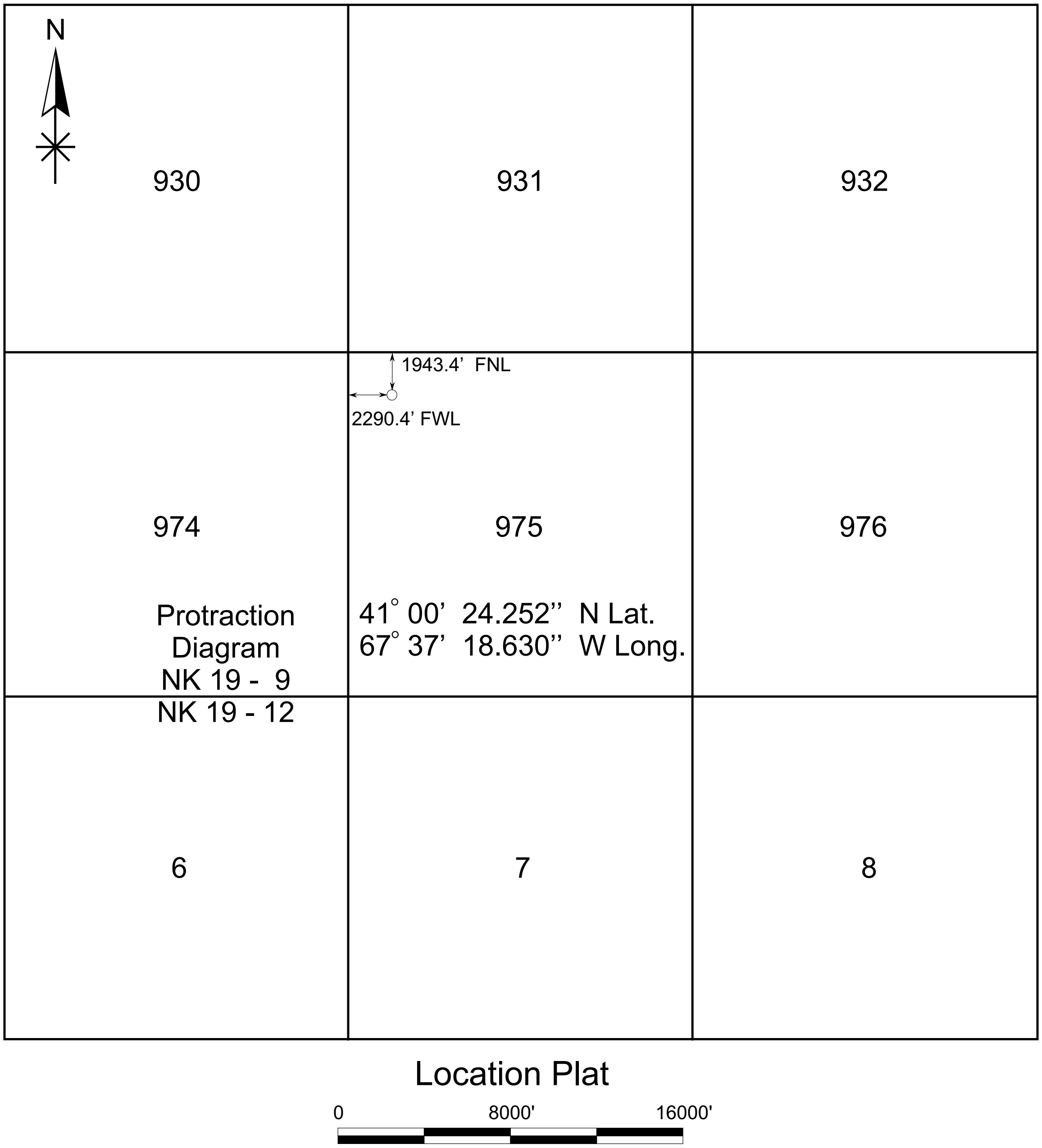

Figure 2. Location plat for the Exxon Block 975 No. 1 well on the OCS Corsair Canyon NK 19-9 protraction diagram.

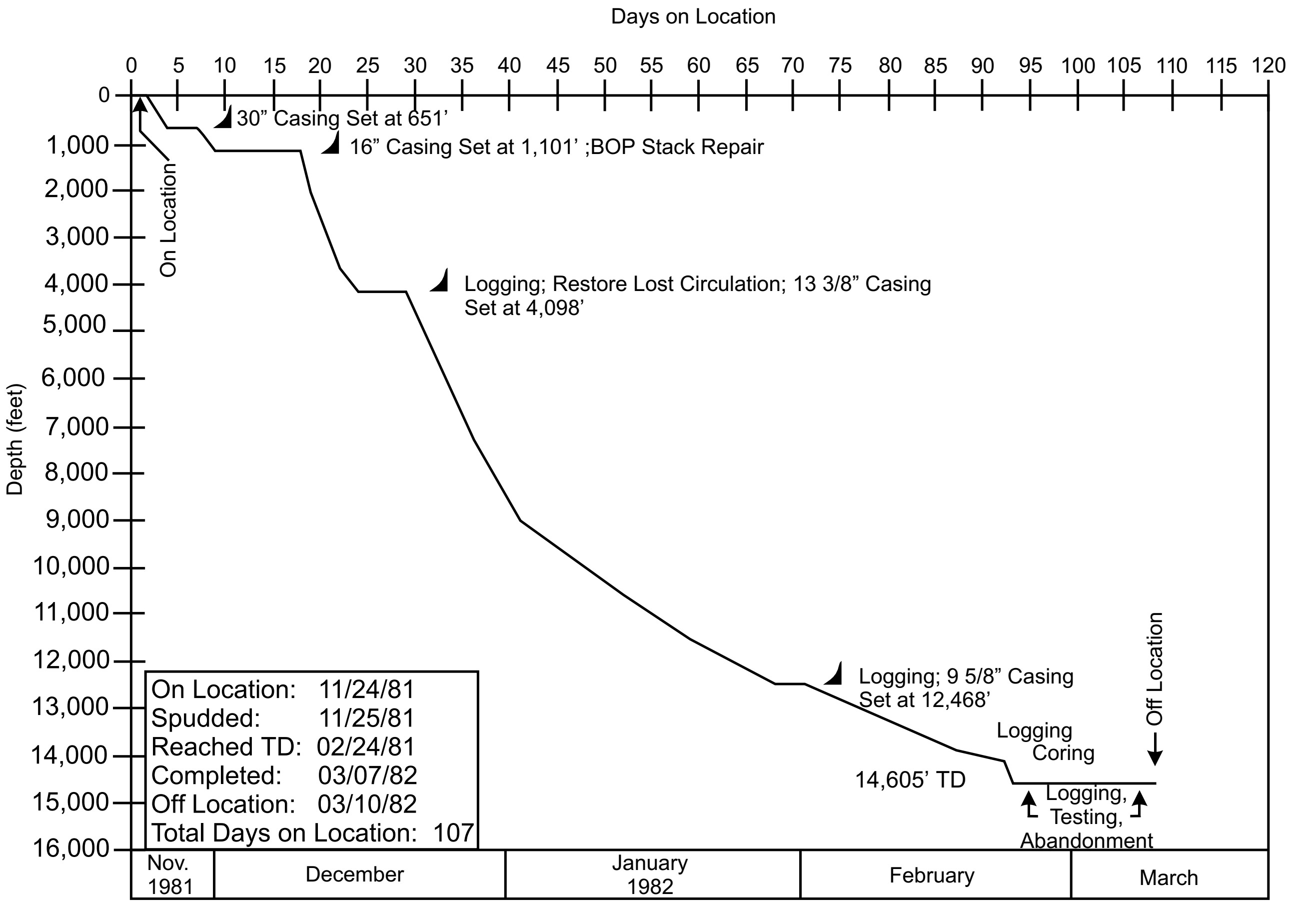

Figure 3. Daily drilling progress for the Exxon Corsair Canyon Block 975 No. 1 well.

Table 1. Well statistics

Well identification:	API No. 61-041-00001
	Lease No. OCS-A-0153
Surface location:	Corsair Canyon NK 19-9 CO Block 975 1,943.40 feet FNL 2,290.42 feet FWL Latitude: 41^O 00' 24.252" N Longitude: 67^O 37' 18.630" W UTM coordinates: X = 615,898.12 m Y = 4,540,207.65 m
Bottomhole location:	No information provided
Proposed total depth:	15,500
Measured depth:	14,605
True vertical depth:	14,605
Kelly bushing elevation:	83 feet
Water depth:	209 feet
Spud date:	November 25, 1981
Reached TD:	February 24, 1982
Off location:	March 10, 1982
Final well status:	Plugged and abandoned

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

840 feet, 190 sacks of cement were squeezed below the retainer, and 60 sacks were spotted on top (top of cement, 760 feet; bottom of cement, 1,275 feet). After a successful pressure test, the 13 3/8-inch casing was cut at 640 feet and pulled. The surface plug was set with 450 sacks of cement from 353 to 775 feet. The blowout preventer stack was pulled, and the 16- and 30-inch casings were cut 17 feet below mudline.

The *Alaskan Star* moved off location March 10, 1982. A post-abandonment seafloor site survey was conducted by John Chance and Associates.

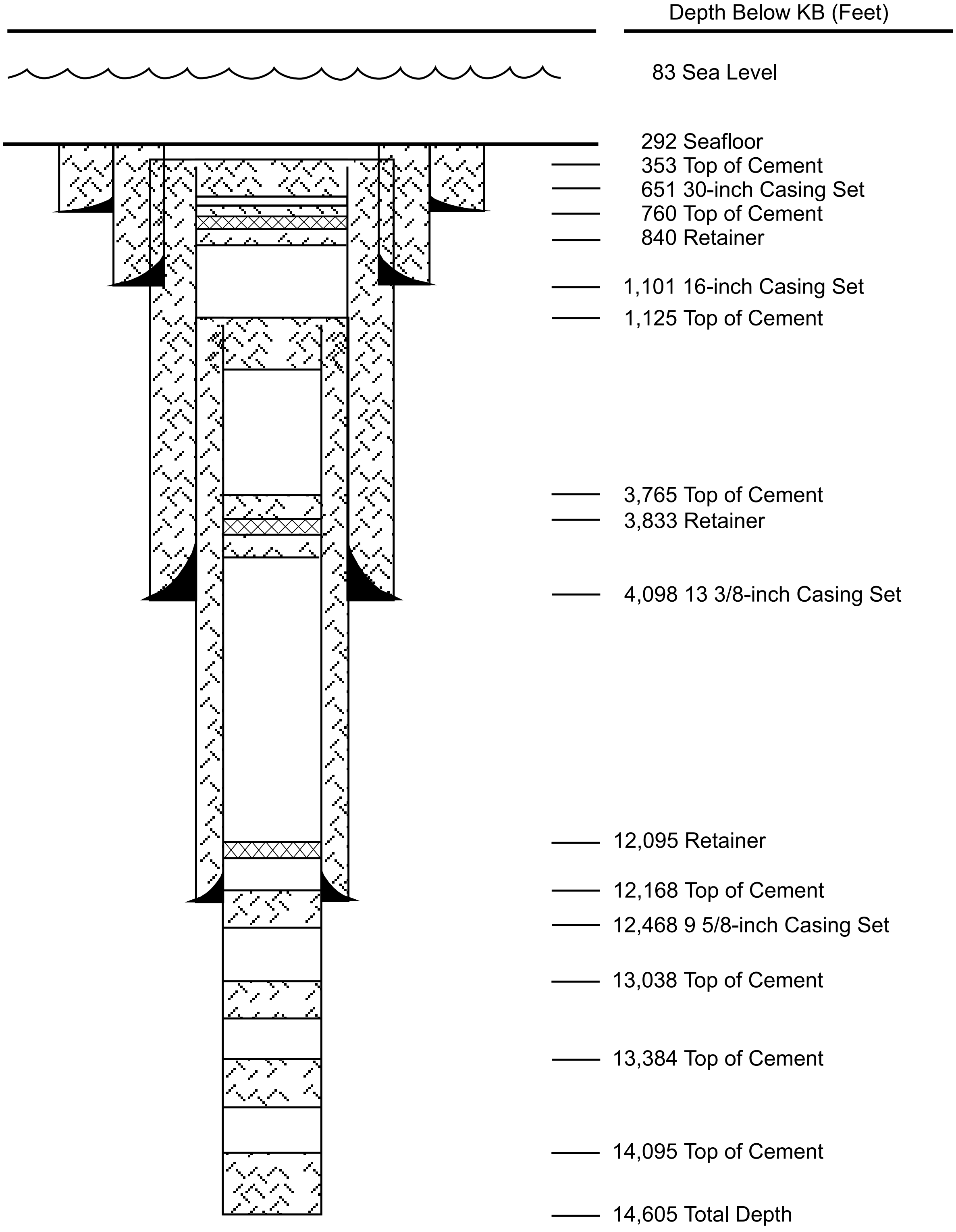

Figure 4. Casing diagram for the Exxon Corsair Canyon Block 975 No. 1 well.

WELL VELOCITY PROFILE

Schlumberger, Ltd. Wireline Testing ran a velocity checkshot survey between 2,317 and 14,517 feet in the Exxon CO Block 975 No. 1 well. The checkshot data, together with that for the other nine wells drilled on Georges Bank, were given 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 Exxon CO Block 975 No. 1 well. Figures 5 and 6 show interval velocity, average velocity, and RMS velocity plotted against depth and against two-way travel time. Well depths are subsea.

Table 2. Well velocity data

Depth (feet)	Two-way Travel Time (seconds)	Interval Velocity (feet/sec.)	Average Velocity (feet/sec.)	RMS Velocity (feet/sec.)
2,317	0.764	6,065	6,065	6,065
3,017	0.922	8,860	6,544	6,628
3,517	1.038	8,620	6,776	6,879
4,017	1.148	9,090	6,998	7,121
4,417	1.236	9,090	7,147	7,278
4,917	1.336	9,999	7,360	7,516
5,417	1.432	10,416	7,565	7,745
5,917	1.514	12,195	7,816	8,049
6,417	1.594	12,500	8,051	8,329
6,917	1.688	10,638	8,195	8,474
7,417	1.768	12,499	8,390	8,697
7,817	1.834	12,121	8,524	8,842
8,417	1.928	12,765	8,731	9,073
8,917	2.000	13,888	8,917	9,290
9,417	2.074	13,513	9,081	9,473
9,917	2.146	13,888	9,242	9,654
10,417	2.218	13,888	9,393	9,820
10,917	2.286	14,705	9,551	10,000
11,417	2.354	14,705	9,700	10,166
11,917	2.412	17,241	9,881	10,393
12,277	2.456	16,363	9,997	10,530
12,517	2.490	14,117	10,053	10,587
12,757	2.522	14,999	10,116	10,655
13,017	2.548	19,999	10,217	10,791
13,267	2.576	17,857	10,300	10,892
13,517	2.604	17,857	10,381	10,991
13,767	2.632	17,857	10,461	11,086
14,017	2.670	13,157	10,499	11,118
14,267	2.694	20,833	10,591	11,242
14,517	2.720	19,230	10,674	11,345

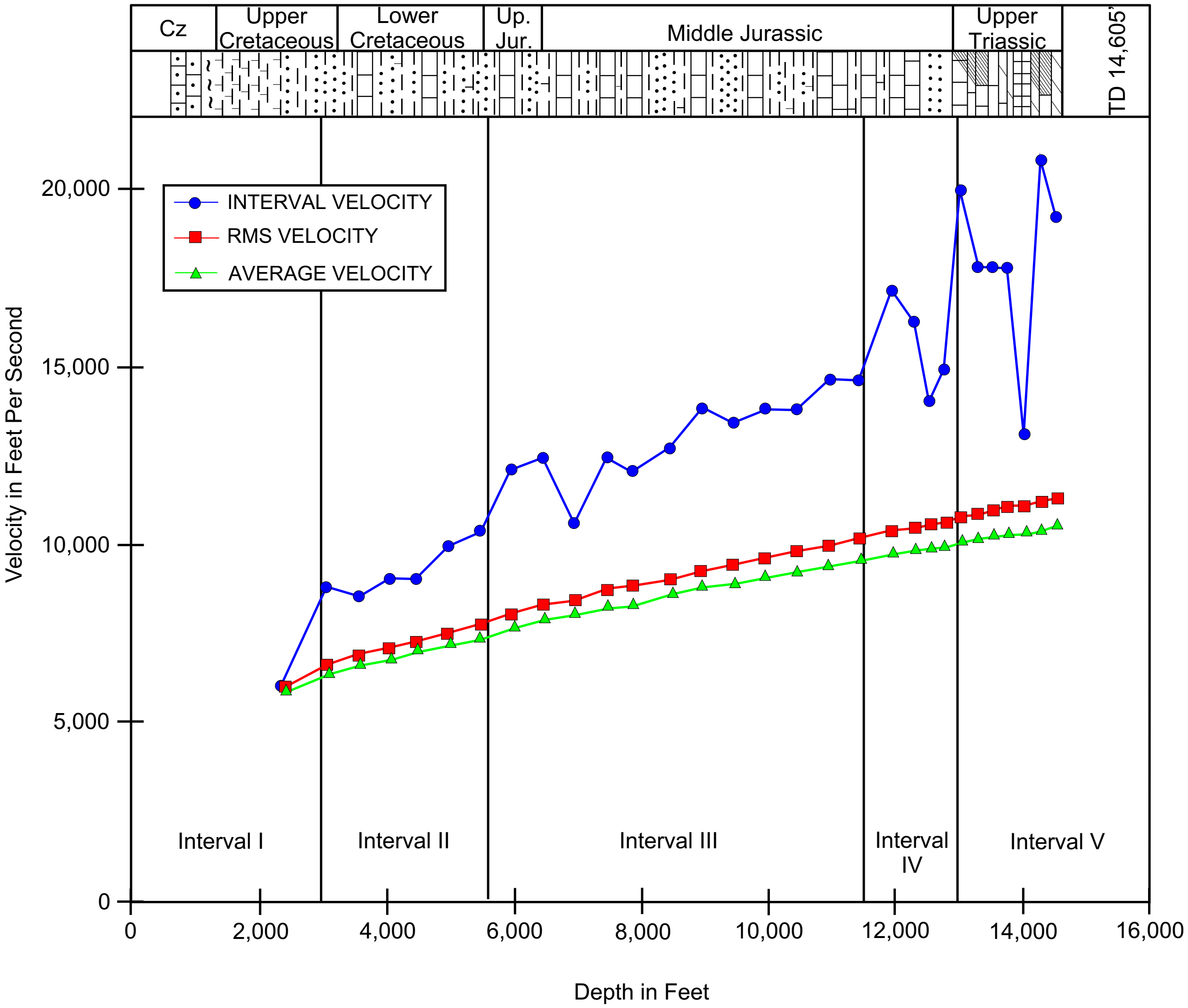

Figure 5. Well velocity profile for the Exxon Corsair Canyon Block 975 No. 1 well, plotted against depth, with biostratigraphic ages and generalized lithologies. Intervals are explained in text.

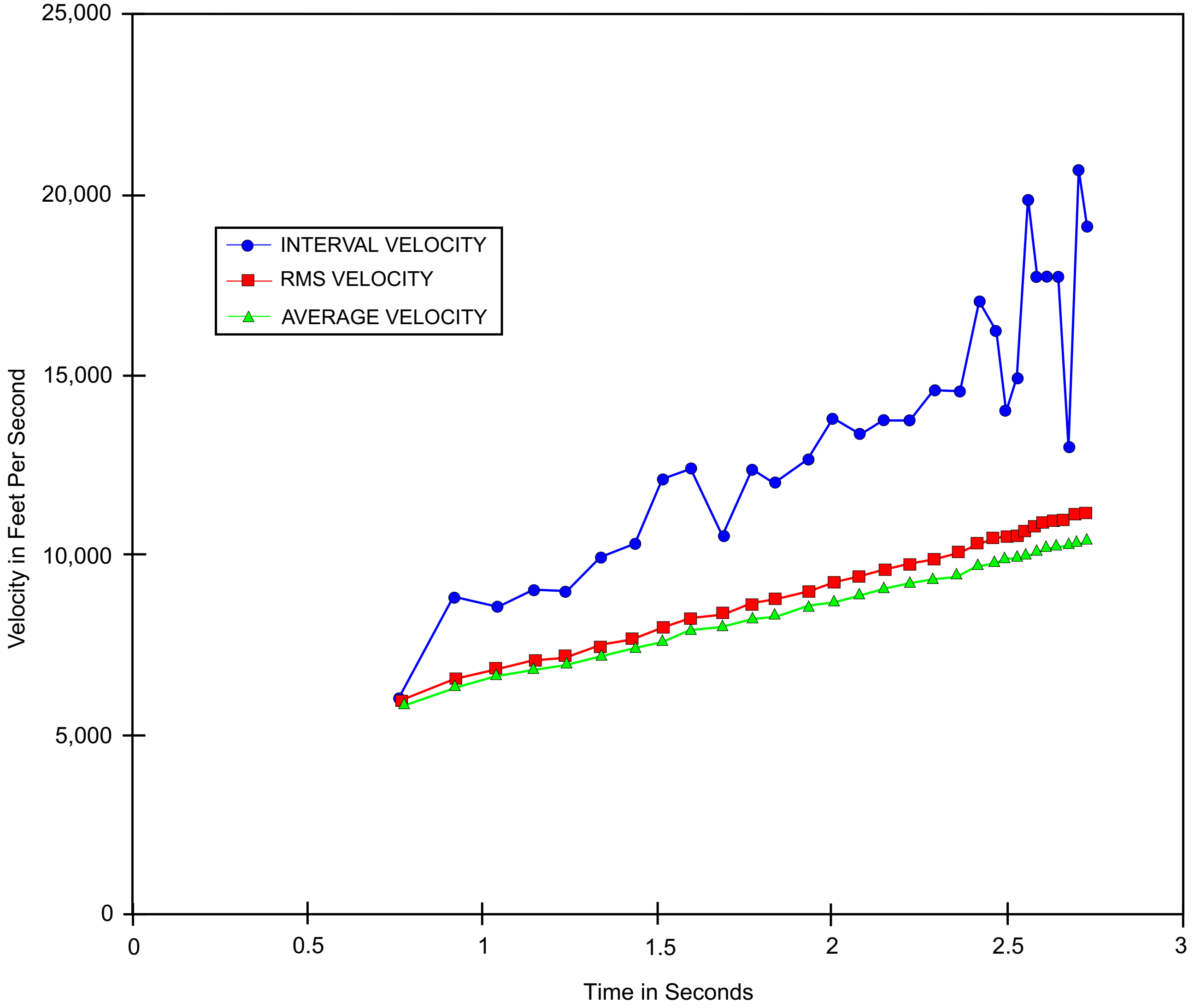

Figure 6. Well velocity profile for the Exxon Corsair Canyon Block 975 No. 1 well, plotted against two-way travel time. Averaged interval velocities explained in text.

A lithologic column is also shown in figure 5, and five velocity intervals are indicated, which generally correlate with five lithologic intervals penetrated by the well:

Table 3. Well velocity intervals

Interval	Depth Range (feet)	Interval velocity range (feet/second)	Average Interval velocity (feet/second)
I	0-3,000	6,065	6,065
II	3,000-5,500	8,620-10,416	9,346
III	5,500-11,500	10,638-14,705	13,109
IV	11,500-13,000	14,117-17,241	15,680
V	13,000-14,605	13,157-20,833	18,113

Interval I This interval contains only the first data point. The indicated interval velocity of 6,065 feet per second applies to the entire column of water, sediment, and rock to that depth.

Interval II This interval is identified on the basis of intermediate interval velocities, which increase with depth and correlate with interbedded shales, siltstones, sandstones, and marly limestones. Most of the interval is Lower Cretaceous.

Interval III This interval is identified on the basis of interval velocities that continue to increase with depth and are generally higher than in the previous interval, which is consistent with higher limestone abundance. This interval is Middle and Upper Jurassic.

Interval IV This Middle Jurassic interval is identified on the basis of alternating high and moderate interval velocities that correlate with limestones and siliciclastic rocks.

Interval V This Upper Triassic interval is identified on the basis of alternating very high and moderate interval velocities that correlate with limestones and dolomites interbedded with anhydrite and halite.

LITHOLOGIC INTERPRETATION

Taken and adapted from G. Carpenter, MMS internal report

Samples were collected at 30-foot intervals from 660 to 14,605 feet (TD). Additional lithologic control was provided by one conventional core at 14,133 to 14,161 feet and 22 successful side-wall cores.

The lithologic descriptions of this report are mainly based on examination of drill cuttings and are supplemented by thin sections. Depths of lithologic boundaries are adjusted with reference to electric and mud logs. All depths are from kelly bushing. Rocks penetrated are divided into gross lithologic-stratigraphic units, and a lithologic column appears as figure 7. The brief comments on paleobathymetry and environments of deposition are based on lithologic indicators (oolites, coal, etc.) and macrofossils.

From 660 to 1,350 feet the section consists of sandy limestone containing numerous fragments of thick-walled pelecypod shells. The limestone matrix is micritic and marly. Sand grains are angular to subangular and show iron staining.

A 40-foot thick bed of nearly pure glauconite is found from 1,190 to 1,230 feet. Grains are sand sized and rounded to subrounded. This unit marks an erosional unconformity at the Cretaceous-Tertiary boundary seen in other Georges Bank wells, notably the Mobil LC Block 312 No. 1 well.

From 1,350 to 2,240 feet the section consists of soft micritic, gray to grayish-tan marl. The marl is an unfossiliferous, very friable, poorly indurated mudstone. Between 2,240 and 4,980 feet the section consists of a near-shore to deltaic sequence of thin siltstones, sandstones, and limestones with coal, pyrite, mica and other minerals. The coal is limited to the sands and siltstones. The sand grains are subrounded to well rounded and are iron stained. The limestones are well consolidated to soft, calcareous mudstones (marl). The upper portion of the interval contains over 10 percent sand and aragonitic shell debris. The lower portion becomes progressively siltier, with traces of coal and pyrite. Siltstones are calcareous and generally separate the limestones from the sandstones. None of the beds is more than 100 feet thick.

The interval from 4,980 to 7,490 feet consists of limestones, calcareous shales, siltstones, and sandstones. The predominant lithology is a gray, shaly limestone with thin interbeds of sandstone and shale with abundant coal. The limestone is micritic to microcrystalline with rare unidentified fossil fragments. The sandstone beds are fine to coarse grained, moderately well sorted and become thicker with depth; sand grains are angular to subangular. Traces of mica, pyrite, and heavy minerals are found in the shales. The interval from 7,490 to 12,860 feet consists of sandstone with subordinate sandy limestone and shale and coal. Coal is less abundant than in the previous interval. At least four distinct transgressive-regressive facies sequences can be recognized within the interval. The sand grains are angular to subround, fine to coarse, and moderately sorted to well

Figure 7. Columnar chart of the lithology, biostratigraphy, and paleobathymetry of the Exxon Corsair Canyon Block 975 No. 1 well. Lithologic interpretations from examination of cuttings; lithologic breaks picked from well logs. Within columns, depths refer to uppermost occurrence of index fossils listed in Biostratigraphy chapter. Stage tops based on paleontology. Biostratigraphy and bathymetric interpretations become less reliable with increasing depth.

sorted. Iron staining of grains occurs near the tops of the sandstone units. The limestones are micritic to microcrystalline, buff to gray and contain up to 50 percent sand and silt. Shale beds are thin (less than two feet as measured on "electric" logs) and are reddish brown to black. The black shales are highly carbonaceous and the reddish shales are silty.

The interval from 12,860 to 14,605 feet (TD) is an interbedded sequence of limestone, salt, and anhydrite. Some replacement of limestone by dolomite (dolomite crust) has also occurred in a thin zone at 13,820 feet. The limestone is generally micritic and includes significant amounts (up to 20 percent) of thinly bedded sands and shales. Thin section examination shows that up to 15 percent of the micrite has been replaced by fibrous, bladed anhydrite. Rare, relict cubic structures suggest anhydritic replacement of halite as well.

A massive halite/anhydrite complex capped by a high velocity (21,600 feet/sec. from the sonic log) dolomite appears to be the source of the "bright spot," which was the Exxon target for this well. The complex is approximately 350 feet thick. The well bottomed in gray, sandy, micritic limestone and anhydrite at 14,605 feet.

POTENTIAL RESERVOIR ROCKS

The best reservoir characteristics are found in sandstones above 10,000 feet (see **Formation Evaluation** chapter). Average porosities are generally greater than 25 percent, based on log analysis, and permeability values exceed 100 md. The highest organic carbon values are also found above 10,000 feet. However, these rocks are thermally immature for petroleum production.

Reservoir characteristics below 10,000 feet are poor. The sandstones and limestones have average porosities of less than 10 percent and permeability values that rarely exceed 5 md. Analysis of a series of sidewall cores between 12,483 and 13,867 feet indicates porosity values averaging 10 percent in sandstones from 12,687 to 12,758 feet but with poor permeability. The conventional core taken between 14,133 and 14,161 feet shows a porosity of 25 percent at the top of the core, decreasing porosity downward, and 1 percent at the bottom. Porosity is vuggy, and permeabilities are negligible.

BIOSTRATIGRAPHY

Taken and adapted from R. Hall, W. Steinkraus, and H. Cousminer, MMS internal report

The biostratigraphic and paleoenvironmental interpretations for the Exxon CO Block 975 No. 1 well are based on fossil foraminifera, dinoflagellates, spores, pollen, and calcareous nannofossils from well cutting samples.

Microfossils were examined from 600 to 14,605 feet (TD). Palynological studies were made from 188 slides prepared from composited 90-foot intervals. Nannofossil studies were made from the examination of 110 slides representing 30-foot intervals. Foraminiferal studies were made from 202 samples at 30-foot intervals. No core samples were used from the Exxon CO Block 975 No. 1 well.

Two factors limit the reliability of the paleontologic data. (1) Analyses are made from drill cuttings, which are often heavily contaminated by cavings from higher in the drill hole. For this reason, only “tops”, or the uppermost appearances of species, are used. (2) Reworked, older fossil assemblages and individual specimens are commonly reincorporated in detrital sedimentary rocks. These fossils must be recognized so that intervals are not dated older than they really are. In addition, in U. S. offshore Atlantic wells, biostratigraphic control is poor in pre-Late Jurassic strata. Calcareous nannofossils and foraminifera are sparse. Palynomorphs are more common, but their biostratigraphic distribution is not fully documented with reference to the European type-stage localities.

The interpreted ages range from Eocene to Late Triassic (Norian?/Carnian). Unconformities were observed at 1,200 feet, 1,260 feet, 3,180 feet, 10,970 feet, and 12,870 feet.

CENOZOIC

TERTIARY

Eocene (1,200 feet-1,260 feet)

The highest occurrence of the nannofossil species Reticulofenestra hillae and Cyclococcolithus luminis at 1,200 feet indicates an Eocene age for this interval.

MESOZOIC

CRETACEOUS

Late Cretaceous

Campanian (1,260-1,350 feet)

A Campanian age for this interval is based on the highest occurrence of the nannofossil species Prediscosphaera cretacea at 1,260 feet and Broinsonia enormis at 1,320 feet. The planktonic foraminiferan Globotruncana lapparenti and nannofossil Archidelphia cretacea are also present. The environment of deposition is outer shelf.

Santonian/Coniacian (1,350-1,410 feet)

The highest occurrence of the planktonic foraminifera Dicarinella concavata at 1,350 feet and Marginotruncana sinuosa at 1,380 feet indicates a Santonian/Coniacian age for this interval. The nannofossil Marthasterites furcatus is present at 1,410 feet. The environment of deposition is outer shelf.

Turonian (1,410-2,130 feet)

The Turonian is based on the highest occurrence of the planktonic foraminifera Praeglobotruncana stephani at 1,410 feet and P. gibba and P. praehelvetica at 1,440 feet. The nannofossils Corollithion achylosum and Radiolithus planus are present at 1,860 feet. The environment of deposition is outer shelf, shallowing to middle shelf between 1,590 and 1,740 feet.

Cenomanian (2,130-3,180? feet)

The top of the Cenomanian at 2,130 feet is marked by the highest occurrence of the planktonic foraminiferan Rotalipora greenhornensis, the benthonic foraminiferan Gavelinopsis cenomanica, and the nannofossil Podorhabdus albianus.

Early Cretaceous

Aptian (3,180-3,940 feet)

The highest occurrence of the palynomorph Canningia attadalicum at 3,180 feet marks the top of the Aptian. Other important microfossils are the nannofossils Nannoconus bucheri at 3,570, N. globulus at 3,630, Nannoconus "ashgeloni" at 3,660, and the benthonic foraminiferan Lenticulina nodosa also at 3,660 feet.

Barremian/Hauterivian (3,940-4,080 feet)

The top of the Barremian/Hauterivian at 3,940 feet is marked by the highest occurrence of the palynomorph Aptea anaphrissa.

Early Valanginian (4,080-4,980 feet)

The early Valanginian age at 4,080 feet is based on the highest occurrence of the palynomorph Oligosphaeridium perforatum. The highest occurrence of the benthonic foraminferan Everticyclamina virguliana is at 4,140 feet. The environment of deposition is inner shelf.

Berriasian (4,980-5,490 feet)

The top of the Berriasian is identified by the palynomorph markers Bebout "138" and Bebout "140" (1982).

JURASSIC

Late Jurassic

Tithonian (5,490-5,880 feet)

The Tithonian is based on the highest occurrence of the benthonic foraminifera Epistomina uhligi and Epistomina. spp. 122 of Ascoli at 5,490 feet. The environment of deposition is possibly middle shelf.

Kimmeridgian (5,880-6,240 feet)

The top of the Kimmeridgian is marked by the highest occurrence of the palynomorph Gonyaulacysta cladophora at 5,880 feet. The environment of deposition is inner shelf.

Oxfordian (6,240-6,420 feet)

The top of the Oxfordian interval is based on the highest occurrence of the palynomorph Adnatosphaeridium aemulum at 6,240 feet.

The environment of deposition is inner shelf to nonmarine.

Middle Jurassic

Callovian (6,420-7,680 feet)

The highest occurrence of the palynomorph Valensiella ovulum at 6,420 feet marks the youngest identifiable Callovian material. The environment of deposition is inner shelf to nonmarine.

Bathonian (7,680-9,840 feet)

The top of the Bathonian at 7,680 feet is marked by the highest occurrence of the palynomorph Gonyaulacysta filapicata. The environment of deposition is nonmarine. (The foraminiferal Alveosepta jaccardi, having a mid-Kimmeridgian extinction point, is found to a depth below 8,000 feet.)

Bajocian (9,840 feet-12,870 feet)

The top of the Bajocian at 9,840 feet is defined by the highest occurrence of the palynomorph Mancodinium semitabulatum. The environment of deposition is nonmarine.

TRIASSIC

Late Triassic

Norian (12,870-13,950)

The top of the Norian at 12,870 feet is defined by the highest occurrence of the palynomorph genera Chordasporites, Camersporites, and Ovalipollis. The Norian palynomorph Hebecysta brevicornuta is present at 13,770 feet. Benthonic foraminifera indicate a marginal marine environment of deposition.

Norian?/Carnian (13,950-14,605? feet)

The highest occurrence of the palynomorphs Patinasporites densus and Lunatisporites sp. at 13,950 feet marks the Norian?/Carnian. The environment of deposition is nonmarine.

FORMATION EVALUATION

Taken and adapted from R. Nichols, MMS internal report

Schlumberger Ltd. ran the following geophysical "electric" logs in the Exxon CO Block 975 No. 1 well to provide information for stratigraphic correlation and for evaluation of formation fluids, porosity, and lithology:

Table 4. Well logs

Log Type	Depth Interval (feet) Below KB
DISFL/Sonic (dual induction spherically focused log/sonic)	1,055-13,881
DLL/MSFL (dual laterolog/micro-spherically focused log)	12,460-14,603
FDC (compensated formation density)	4,103-13,881
LSS (long spaced sonic)	12,460-14,603
CNL/FDC (compensated neutron log/compensated formation density)	4,103-14,603
Processed Dipmeter	4,103-14,603
RFT (repeat formation tester)	13,232-13,274

Exploration Logging, Inc. provided a Formation Evaluation Log ("mud log"), which included a rate of penetration curve, drilling exponent curve, sample description, and a graphic presentation of any hydrocarbon shows encountered (660 to 14,605 feet).

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 5.

Table 5. Well log interpretation summary

Series	Depth Interval (feet)	Potential Reservoir[1] (feet)	Ave ϕ (%)	SW (%)	Feet Hydrocarbon
UK	2,261-2,436	102	35	NC*	NC*
	2,442-2,483	41	35		
	2,526-2,584	32	35		
	2,624-2,664	40	35		
	2,678-2,688	10	35		

continued

Table 5. Well log interpretation summary--*continued*

Series	Depth Interval (feet)	Potential Reservoir[1] (feet)	Ave ϕ (%)	SW (%)	Feet Hydrocarbon
UK	2,692-2,704				
	2,720-2,740	12	35		
	2,758-2,772	14	34		
	2,828-2,994	122	35		
LK	3,170-3,243	69	35		
	3,294-3,427	81	35		
	3,766-3,781	12	34		
	3,893-3,924	26	32		
	3,938-3,954	16	32		
	4,004-4,030	26	32		
	4,175-4,194	16	35		
	4,310-4,321	11	33		
	4,330-4,377	47	29		
	4,404-4,070	57	27		
	4,542-4,554	12	25		
	4,564-4,940	325	23		
	5,064-5,077	13	23		
	5,106-5,116	10	26		
	5,122-5,138	16	28		
	5,183-5,314	129	27		
UJr	5,610-5,620	10	28		
	5,649-5,659	10	23		
MJr	6,534-6,550	16	25		
	6,618-6,658	36	26		
	6,694-6,708	14	23		
	6,728-6,762	34	26		
	6,810-6,824	14	22		
	6,955-6,967	12	25		
	6,994-7,009	15	23		
	7,040-7,056	16	22		
	7,198-7,232	34	23		
	7,344-7,354	10	18		
	7,508-7,526	18	23		
	7,562-7,572	10	20		
	7,604-7,636	32	22		

continued

Table 5. Well log interpretation summary--*continued*

Series	Feet Potential Reservoir[1]	Potential Reservoir[1] (feet)	Ave ϕ (%)	SW (%)	Feet Hydrocarbon
MJr	7,647-7,655	8	21		
	7,734-7,748	14	19		
	7,874-7,888	14	24		
	7,894-7,918	24	24		
	8,003-8,113	64	19		
	8,190-8,228	34	18		
	8,340-8,358	18	22		
	8,392-8,404	12	20		
	8,438-8,490	50	17		
	8,636-8,666	30	17		
	8,746-8,764	14	14		
	8,818-9,110	134	15	49 (8,873-8,880)	**
	9,299-9,488	128	15		
	9,603-9,728	73	14		
	10,113-10,124	11	13		

*Not calculated

**SWC indicates 9.9 % gas volume, but mud log recorded no total gas and only C_1 on the chromatograph.

[1] Generally in beds > 10 feet thick and ϕ > 5 percent.

The electric logs were of acceptable quality. However, numerous SP shifts can be seen at 2,810 feet, 3,050 feet, 11,790 feet, 12,190 feet, and 13,167 feet. The indicated depths for the upper repeat section (4,100 to 4,300 feet) are seven feet too shallow. Substantial hole enlargement occurs from 9,750 to 11,520 feet and impacted the quality of other log parameters, particularly the density-porosity.

Sidewall core porosities (table 6) compare favorably with CNL/FDC porosities in many cases. However, below 10,700 feet, the density log porosities are substantially lower than sidewall core porosities in those portions of the section not affected by hole enlargement.

Table 6. Sidewall core analysis summary

Depth Interval (feet)	Lithology	Porosity Range (%)	Permeability Range (md)
5,908	Limestone	15.6	0.2
6,627-11,594	Sandstone	15.2-22.9	0.2-9.0
11,996-12,462	Limestone/Sandstone	13.4-16.8	< 0.1
12,483-12,758*	Sandstone*	5-10*	None-poor*
12,758-13,812*	Limestone/Anhydrite*	0*	0*

*From operator description

One conventional core was taken in this well from 14,133 to 14,161 feet. A detailed petrologic examination was performed and the results are as follows:

Table 7. Conventional core summary

Core No.	Depth Interval (feet)	Lithology	Porosity Range (%)	Permeability Range (md)
1	14,133-14,161	Limestone	0.7-1.9	0.02-0.35

The entire core is described as micritic limestone with secondary vug porosity filled with silty salt. This assessment compares favorably with the porosity derived from the neutron, density, and sonic logs (0 to 4 percent).

<u>Dipmeter</u>

Results of the HDT survey were recorded on a dipmeter arrow plot from 4,103 feet to 14,603 feet. Possible structural anomalies can be observed at 4,930 feet, 6,540 feet, 9,050 feet, 9,300 feet, and 9,400 feet. From 11,330 to 12,450 feet, the dip is essentially westward at one to two degrees. Below 12,450 feet, the dips are variable until, at 13,000 feet, they again are primarily westward at one to eight degrees. At 13,820 feet, a salt section is encountered and the dips are very erratic for the remainder of the well to TD (14,605 feet).

Table 8 lists all shows of hydrocarbon encountered in this well. None of the shows listed was judged to be significant.

A normal pressure gradient (8.3 to 10.4 ppg eqmw) was encountered to a depth of 13,820 feet, at which point the mud chlorides increased to 92,000 ppm and the mud weight was raised to 12.5 ppg. At a total depth of 14,605 feet, the chlorides had increased to 154,000 ppm and the mud weight had been raised to 12.6 ppg.

Repeat formation tests were run on a selected interval with results as follows:

Table 9. Well tests

Depth (feet)	Flowing Pressure (psi)	Hydrostatic Pressure (psi)	Remarks
13,233.5	27	8,447	Tight-low perm.
13,239	8,448	8,448	Mud set
13,244	47	8,453	Low perm.
13,244.5	41	8,453	Low perm.
13,246.5	1,379	8,455	Pres. increase too slow to sample
13,246.5	22	8,454	Low perm.
13,255	25	8,459	Low perm.
13,271	23	8,466	Low perm.
13,272	25	8,469	Low perm.
13,273	26	8,471	Low perm.
13,274	26	8,471	Low perm.

GEOTHERMAL GRADIENT

Figure 8 shows bottomhole temperatures for four logging runs in the Exxon CO Block 975 No. 1 well plotted against depth. A temperature of 60 ^{0}F is assumed at the seafloor at an indicated depth of 292 feet (209-foot water depth plus 83-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.

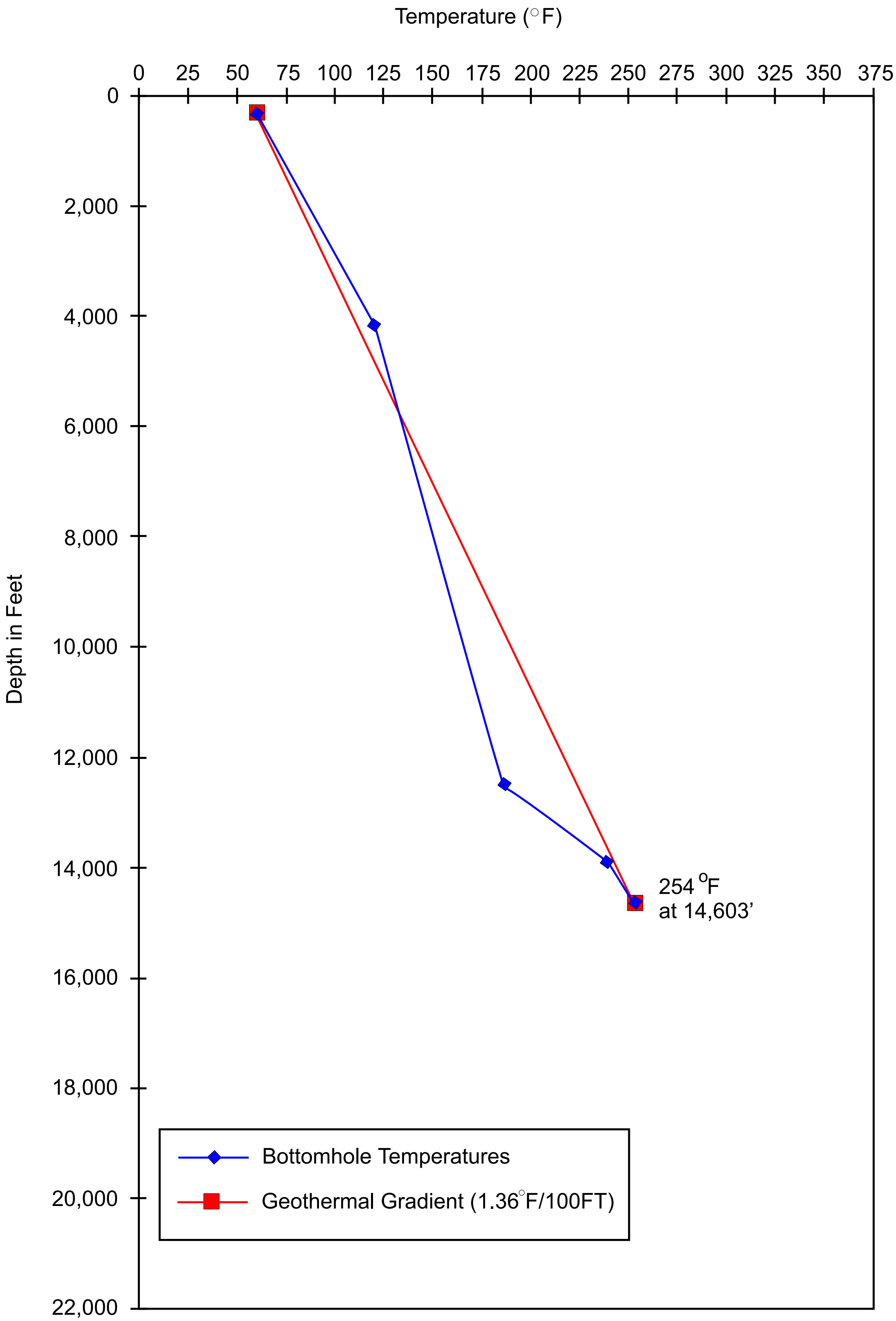

Figure 8. Well temperatures and geothermal gradient for the Exxon Corsair Canyon Block 975 No. 1 well. Well temperatures from bottom-hole temperatures of logging runs. Geothermal gradient based on bottomhole temperature of deepest logging run.

KEROGEN ANALYSIS

Taken and adapted from C. Fry, MMS internal report

METHOD

Kerogen types and thermal rank were determined by a microscopic examination of kerogen slides and palynology slides made from well cutting samples from the Exxon CO Block 975 No. 1 well.

In this analysis, organic material is classified as one of four major types: algal-amorphous, organic material of marine origin, either recognizable algae or the unstructured remains of algal material; herbaceous, leafy portions of plants, including spores and pollen; woody, plant detritus with a lignified, ribbed structure; coaly, black opaque material, thought to be chemically inert. Visual estimates are made for the percentage of each type, relative to the total abundance of kerogen, contained in each of the slides. Algal material is generally considered the best source for oil; structured terrestrial kerogen is primarily a gas source.

Thermal maturity of the organic material was estimated by comparing the color of various palynomorphs contained in the kerogen slides to the thermal alteration index (TAI) scale (figure 9) taken from Jones and Edison (1978). The colors displayed by the organic matter are an indication of the degree to which the kerogen has been thermally altered (Staplin, 1969).

Kerogen type and thermal alteration rank are used with TOC abundances to evaluate whether sediments in a well are prospective as petroleum source rocks.

KEROGEN TYPES

As with other Georges Bank wells, the Exxon CO Block 975 No. 1 well shows sparse organic matter with the greatest abundance of algal kerogens in Tertiary, Cretaceous, and Upper Jurassic rocks and the greatest abundance of coaly kerogens in Middle Jurassic through Upper Triassic rocks (figure 10). Relative abundances of herbaceous and woody organic material are only slightly greater in the Tertiary through Upper Jurassic part of the section, compared to the Middle Jurassic and lower.

Tertiary samples from 600 to 1,260 feet contain generally 10 to 35 percent algal, 20 to 40 percent herbaceous, 25 percent woody, and 20 to 30 percent coaly kerogens.

Cretaceous samples, from 1,260 to 5,490 feet, contain generally 10 to 25 percent algal, 20 to 25 percent herbaceous, 30 percent woody, and 20 to 35 percent coaly kerogens. At 1,550 feet coaly kerogen is especially abundant, amounting to 70 percent of total kerogens.

Upper Jurassic samples, from 5,490 to 6,420 feet, generally contain 10 to 20 percent algal, 20 to 30 percent herbaceous, 30 percent woody, and 35 percent coaly kerogens.

Middle Jurassic samples, from 6,420 to about 12,500 feet, have lower concentrations of algal organic material, generally ranging from 0 to 2 percent. Herbaceous kerogens generally decrease downward through the interval from 35 to 18 percent. Woody kerogens remain consistent at 35 percent. Coaly kerogens increase downward from 30 to 45 percent.

Well cutting samples appear to be heavily contaminated by uphole cavings from 12,500 to 12,870 feet.

Upper Triassic samples, from 12,870 to 14,605 (TD) feet, contain 5 percent or less algal, 10 to 35 percent herbaceous, 30 to 45 percent woody, and 30 to 45 percent coaly kerogens. At 14,150 feet algal and herbaceous abundance increases, together totaling 40 percent. With increasing depth in the well, kerogens are increasingly terrigenous in origin, humic in character, and gas prone in hydrocarbon potential.

MATURITY

Judging thermal maturity using samples from well cuttings must be done with great care to ensure that the material being analyzed is indigenous to the level sampled. Caved or reworked material both will give false indications of maturity. Oxidation caused by a high energy environment of deposition can also alter the appearance of the organic material.

The thermal maturity of the kerogen contained in the Exxon CO Block 975 No. 1 well was estimated by the visual observation of palynomorph color. The first indigenous palynomorphs observed to show borderline mature colors occur at 11,190 feet. The presence of both caved and reworked material throughout this Jurassic interval made thermal maturity difficult to judge. A TAI value of 2.6 indicates that kerogen found at this depth is being converted to petroleum, but not at significant reaction rates. At 13,950 feet, dinoflagellates have reddish-brown color (3.1 TAI or greater) indicating peak generation. No palynomorphs suitable for analysis were found below 13,950 feet.

CONCLUSION

Cretaceous and Upper Jurassic sediments of the Exxon CO Block 975 No. 1 well contain noticeable amounts of algal material and larger amounts of herbaceous material. However, the thermal maturity of these sediments is too low to expect significant generation of hydrocarbon.

Thermally mature kerogen is limited to the lower portion of the Middle Jurassic (11,190 to 12,870 feet) and the Upper Triassic, (12,870 to 14,605 feet), where about 80 percent of the kerogen is of woody-coaly types, suggesting a terrestrial, gas-prone source. Geochemical analyses are necessary to accurately define the limits and potential of the source beds penetrated by this well.

BURIAL HISTORY

The burial history model for the stratigraphic section penetrated by the Exxon CO Block 975 No. 1 well (figure 11) is based on the biostratigraphic determinations of the Minerals Management Service paleontological staff and others (figure 7) and the Cretaceous and Jurassic time scales of Van Hinte (1976a and 1976b). The burial model for this well shows fairly uniform subsidence and burial for Upper Jurassic through Tertiary rocks. Burial rates may have increased more recently than the Eocene Epoch. However, using sea level as the zero datum increases the aparent thickness and burial rate of the shallowest unit.

In constructing figure 11, no adjustments have been made for sedimentary compaction or for section removed by erosion.

If sufficient temperature is reached at about 11,000 feet for initiation of hydrocarbon generation, if peak generation is at about 13,000 to 14,000 feet (figure 10), and if basinal temperatures have remained relatively constant for the last 100 million years, only Triassic and perhaps some of the deepest Jurassic sedimentary rocks are thermally mature for producing hydrocarbons in the vicinity of the Exxon CO Block 975 No. 1 well.

MMS thermal alteration analysis places borderline maturity at a well depth of 11,190 feet (figure 10) with a TAI value of 2.6.

COMPANY-SUBMITTED DATA

Data and reports were submitted by Exxon Corporation to MMS when the Exxon Corsair Canyon (CO) Block 975 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 required submittals, such as the Exploration Plan, Application for Permit to Drill, and daily drilling reports, and detailed operations information, such as 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

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

Core analysis (sidewall and conventional cores), Erco Petroleum Services, Inc., Houston TX, undated.

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

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