OCS Report
MMS 86-0077

Tenneco Hudson Canyon 642-2 Well

Geological & Operational Summary

Edited By
LeRon E. Bielak

U.S. Department of the Interior
Minerals Management Service
Atlantic OCS Region

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ABSTRACT

Block 642 was leased to Tenneco Oil Company and Aminoil Resources, Inc. in Lease Sale No. 40 for a high bid $8,190,000. The No. 2 well on this block was spudded on January 20, 1979, in 445 feet of water and was plugged and abandoned on June 10, 1979, after drilling to a total depth of 18,400 feet. The lease was subsequently released despite the discovery of hydrocarbons.

Exploration objectives were Upper Cretaceous to Jurassic sandstone reservoirs with structural closure. Sediments in the well range from Pliocene to Middle Jurassic in age. Tertiary sediments are predominantly clays and shales reflecting environments of deposition ranging from nonmarine to lower slope regimes. Upper Cretaceous sediments are primarily calcareous, silty shales indicating outer shelf conditions. Lower Cretaceous and Upper Jurassic clastic sediments are characteristic of a deltaic complex. The Middle Jurassic section of the well consists of shallow platform and platform margin limestones.

Potential reservoir rocks were encountered throughout the well between 2,600 and 18,000 feet. A drill stem test (DST) in Albian age sandstones at 8,318 to 8,321 feet was reported to have a flow of 630 barrels of oil per day (BOPD) of 48.4° API gravity oil. The DST at 12,675 to 12,698 feet reported one million cubic feet of gas per day (MMCFGPD), while at 12,730 to 12,764 feet 20 thousand cubic feet of gas per day was estimated. From the deepest test in the interval, between 13,180 to 13,194 feet, flows of 12 MMCFGPD and 100 barrels of condensate per day were reported. All of the zones tested sandstones of Jurassic in age.

Kerogen analysis indicated that a significant amount of marine (oil prone) organic material is found in sediments above 12,780 feet, while more terrestrial (gas prone) kerogen is found below 12,780 feet. Sediments above 13,860 feet appear to be thermally immature, however, and are not expected to have generated hydrocarbons. The oil recovered from the tested Albian reservoir was probably generated, expulsed and migrated from Jurassic source beds.

ABBREVIATIONS

API	--	American Petroleum Institute
BCPD	--	barrels of condensate per day
BOPD	--	barrels of oil per day
BWPD	--	barrels of water per day
CNL	--	compensated neutron log
DST	--	drill stem test
FDC	--	formation density compensated log
FEL	--	from east line
FNL	--	from north line
FT	--	formation test
HDT	--	high resolution dipmeter
HW	--	hot wire
K.B.	--	Kelly bushing
MCFGPD	--	thousand cubic feet of gas per day
md	--	millidarcy
MMCFGPD	--	million cubic feet of gas per day
OCS	--	Outer Continental Shelf
PBTD	--	plug back total depth
ppg	--	pounds per gallon
PSI	--	pounds per square inch
SFL	--	spherically focused log
S_W	--	water saturation
TAI	--	thermal alteration index
UTM	--	universal transverse mercator
W.D.	--	water depth
WST	--	well seismic tool
%Ro	--	percentage vitrinite reflectance

OPERATIONAL SUMMARY
by
Ray Vincent

Statistical Summary

Block 642 in Mid Atlantic official protraction diagram NJ 18-3, Hudson Canyon was leased to the Tenneco Oil Company and its bidding partner Aminoil Resources, Inc. in OCS Lease Sale No. 40, held on August 17, 1976 (For block and map locations of the well see figs. 1 and 2). Their high bid for this block was $8,190,000. Although two drill stem tests produced significant amounts of oil and gas, this well, which was Tenneco's second well on this lease, was nevertheless plugged and abandoned on June 10, 1979. Pertinent well information is summarized in table 1.

Tenneco and Aminoil Resources were joint operators for the well which was drilled using the semisubmersible rig the Zapata Ugland. Bethlehem Steel Corporation built this drilling vessel for Zapata in their Beaumont, Texas yard in 1974. The drilling vessel is a twin-hulled, sea barge catamaran with six stabilizing columns, a ten-point mooring system, and an elevated water-tight working platform. The vessel has a severe storm wave clearance of 100 feet, a minimum operating water depth of 150 feet and maximum operating depth of 600 feet (which could be increased to 1,000 feet by additions to the anchor chains, marine risers, and control system). The drilling vessel's classification and certification is: American Bureau of Shipping (ABS) Column Stabilized Drilling Unit, Maltese Cross A1, Circle M, Maltese Cross AMS for unrestricted ocean service. It also has a United Kingdom Certificate of Fitness for Offshore Installations. Zapata initially registered the vessel under the Norwegian Flag, but the rig is now registered in Panama.

Zapata used Davisville, Rhode Island (approximately 160 miles north-northeast of the well location) as an operational and supply base. Normally, drilling contractors use two seagoing supply vessels as support to transport the necessary drilling materials and supplies. During the drilling operations, Zapata utilized one standby vessel, normally stationed within a one-half mile radius of the well location.

Zapata spudded the well at 0630 hours (EST) on January 20, 1979. Although the rig was on location a total of 142 days, drilling was completed in 115 days, on May 14, 1979, at a total depth of 18,400 feet. Tenneco did extensive logging and testing of potential hydrocarbon zones between 8,318 to 8,638 feet and between 12,675 to 13,194 feet. The well was plugged and abandoned in accordance with Federal regulations as certified in the Sundry Notice dated June 7, 1979.

Drilling Program

Zapata used one 36-inch bit, two 26-inch bits, three 17 1/2-inch bits, twenty five 12 1/4-inch bits, and thirteen 8 3/8-inch bits. Between 1,000 and 11,000 feet, penetration rates were approximately 443 feet per day. Below 11,000 feet to total depth, the average rate of penetration dropped to 127 feet per day. Figure 3 portrays a curve of the daily drilling progress.

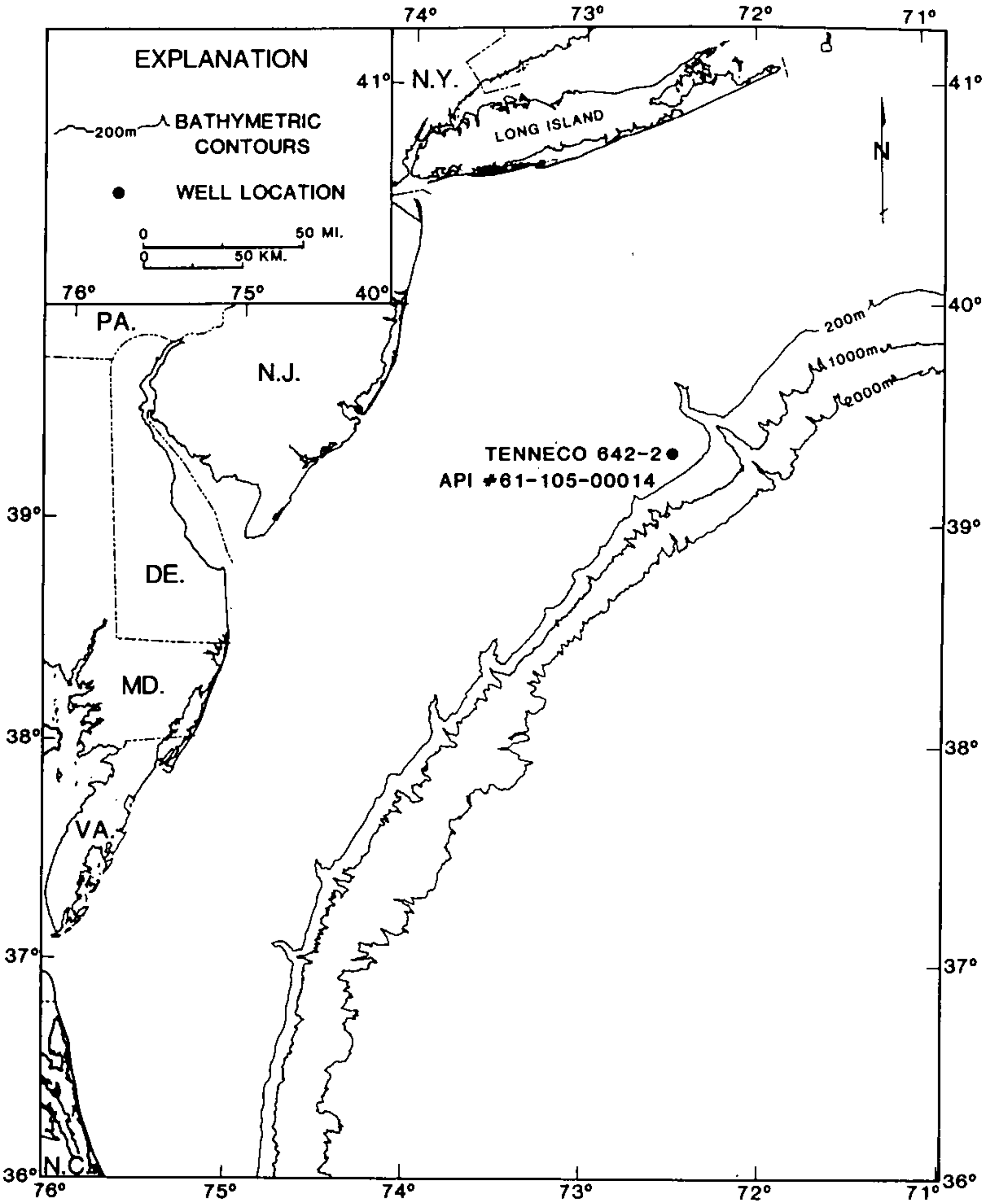

Figure 1.--Map of a portion of the Mid-Atlantic offshore area showing the location of the Tenneco 642-2 well.

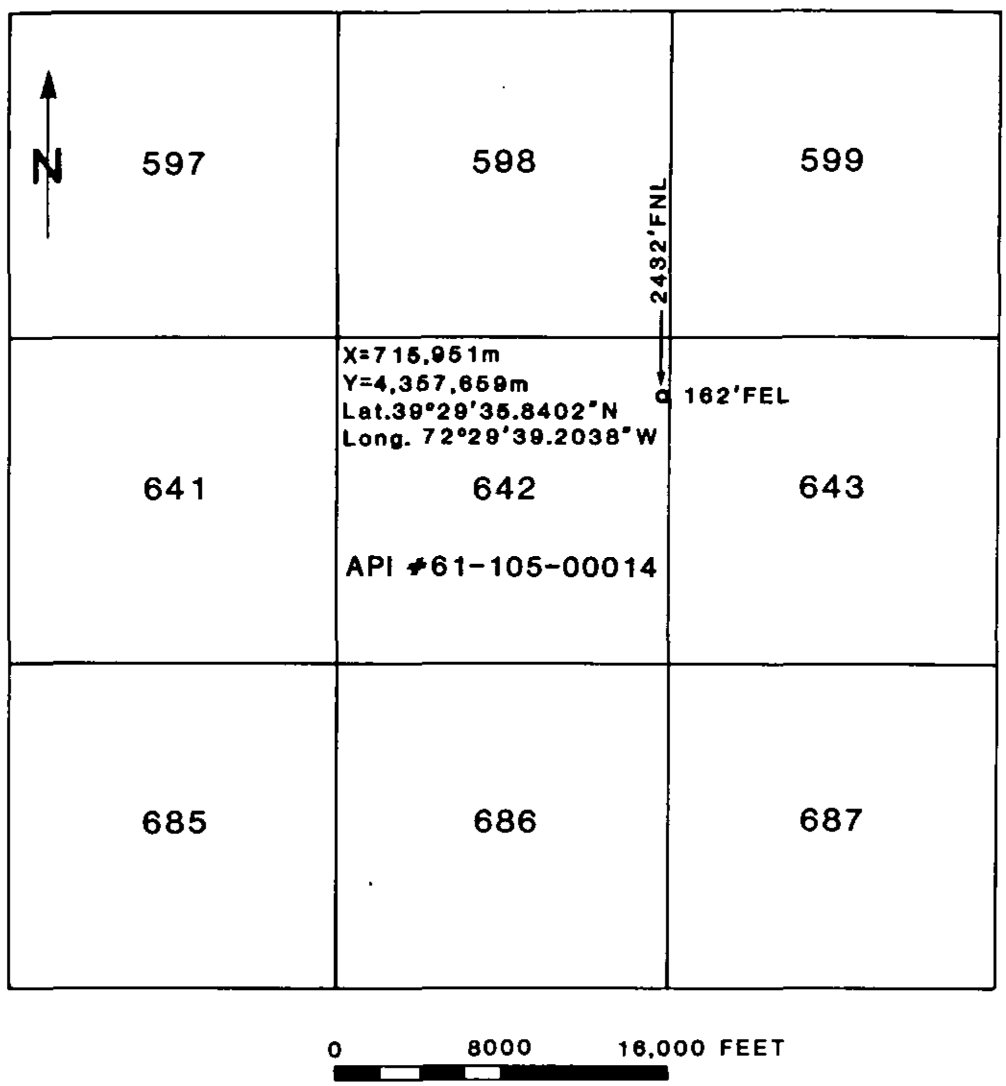

Figure 2.--Plat showing the final location of the Tenneco 642-2 well in OCS Protraction Diagram NJ18-3.

Table 1 -- Pertinent well information for the Tenneco 642-2 well

Well identification	API # 61-105-0014
Lease number	OCS-A-0038
Protraction diagram	NJ 18-3 (Hudson Canyon)
Actual surface location	UTM Coordinates: x = 715,591 m y = 4,357,659 m Latitude: 39° 29'35.8402" N Longitude: 72° 29'39.2038" W
Distance from block lines	2,432 feet FNL 162 feet FEL
Actual bottom hole location	Same as surface location
Proposed total depth	19,000 feet
Actual total depth	18,400 feet
Total measured depth	18,400 feet
Spud date	January 20, 1979
Completion date	June 10, 1979
Kelly bushing elevation	88 feet above mean sea level (all depths in this report measured from K.B. unless otherwise indicated)
Water depth	445 feet (135.7 m)
Final well status	Plugged and abandoned

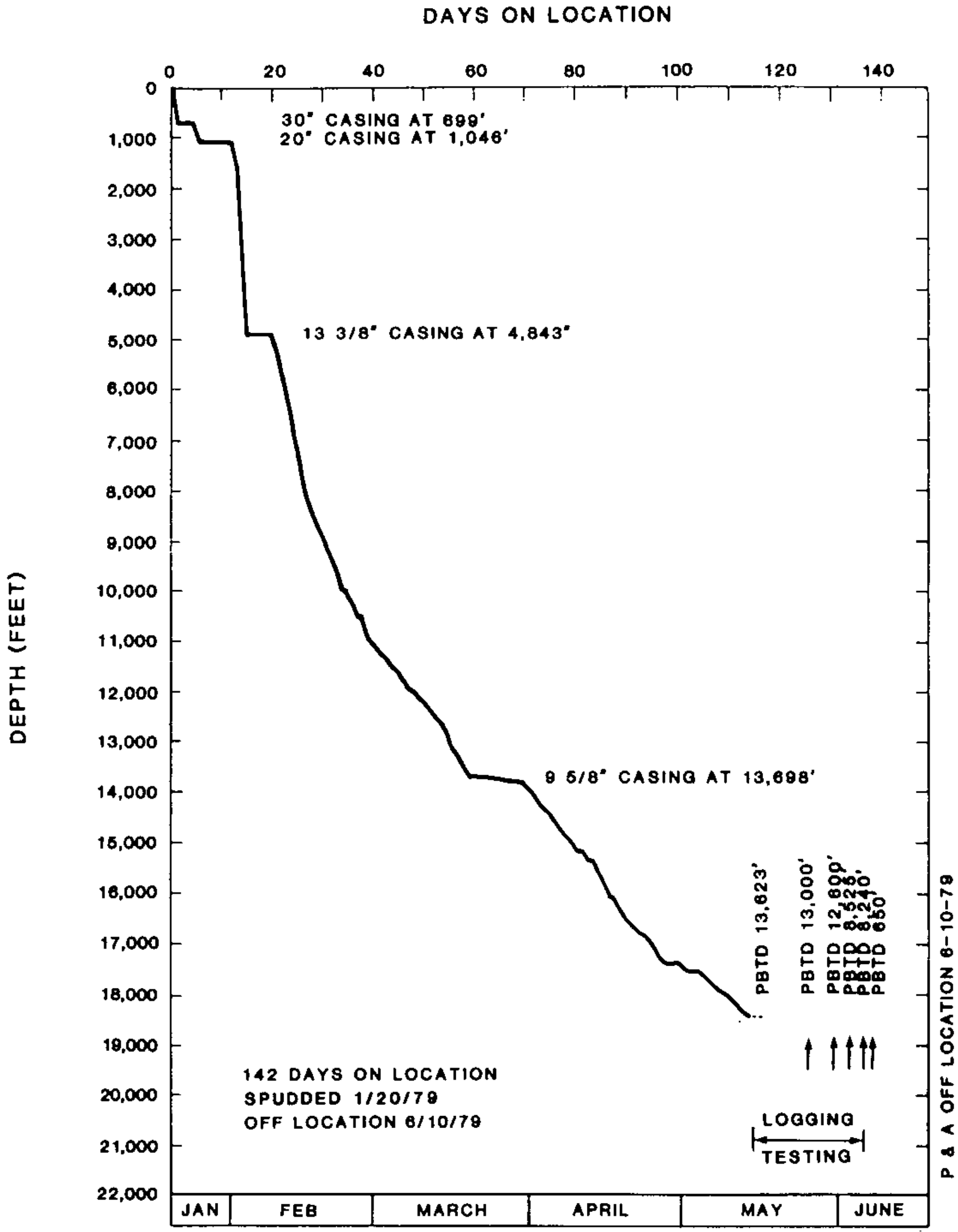

Figure 3.--Graph showing the daily drilling progress for the Tenneco 642-2 well.

Tenneco ran and set four strings of casing as shown on figure 4. The 30-inch casing was set at 698 feet with 1,170 sacks of cement; the 20-inch casing was set at 1,046 feet with 1,500 sacks of cement; the 13 3/8-inch casing was set at 4,843 feet with 2,900 sacks of Class H cement, and the 9 5/8-inch casing was set at 13,698 feet with 1,600 sacks of Class H cement. Figure 4 also depicts the abandonment procedure. Tenneco's numerous tests necessitated the setting of a number of retainers and squeeze jobs to properly isolate the tested zones before plugging and abandoning the well.

Tenneco planned to use a modified polymer system with Drispac in fresh water and gradually change it to a Uni-Cal system for the deeper part of the well. After drilling commenced, offset drilling data indicated the potential for problems from expandable clays, hydrogen sulfide gas, massive carbonate sections, higher temperatures below 16,000 feet, and pressures requiring a mud weight of 13 ppg (pounds per gallon) below 16,000 feet. Tenneco altered their original mud program to one using seawater for their mud system and Drispac for a modified polymer. Tenneco used Soltex for shale control and Uni-Cal to control viscosity and water loss. Tenneco also used a variety of mud additives to inhibit corrosion, provide mud stability and increase mud weight.

Mud performance and hole conditions were very good down to 13,700 feet. After logging with 9.6 ppg mud, the driller recentered the hole, ran to bottom, and found that the section between 13,630 and 13,700 feet was unstable and would not remain open. After the mud weight was increased to 10 ppg and then 10.6 ppg, the hole stabilized and 9 5/8-inch casing was set and cemented at 13,698 feet. From 13,700 to 16,000 feet, mud weights were increased to 10.6 ppg. Below 16,000 feet the mud weight was again increased to 11 ppg and then to 12.5 ppg at 17,030 feet. At a depth of 17,304 feet the drill pipe became stuck after a trip in the hole with a diamond core barrel. According to the stretch chart, the pipe was stuck below 14,000 feet. A mixture of Lubri-Sal and Mil-Free was spotted in the annulus from 15,000 to 16,500 feet and the solution moved up to 14,000 to 15,500 feet in approximately four hours. The pipe came free about ten hours after initial placement. The Lubri-Sal solution was circulated out and incorporated into the mud system. Although influxes of carbon dioxide gas and frequent foaming problems were encountered while drilling the carbonate section, the mud program avoided or solved all related hole problems. The program provided good hole conditions, minimum hole enlargement, and reasonable drilling time.

Samples and Tests

Cuttings samples were collected from 1,100 to 18,400 feet in the well, and aliquots were provided for analyses. The cuttings were collected as 30 foot composited samples above 8,000 feet and as 10-foot composited samples below 8,000 feet. In addition Tenneco recovered 174 sidewall cores between 6,968 and 18,318 feet and cut two conventional cores using a diamond core head. The conventional cores were recovered from 17,602 to 17,604 feet (Core No. 1) and between 17,874 and 17,932 feet (Core No. 2).

The Department of Interior was provided with reports of core analyses completed by Tenneco and Core Laboratoriés, Inc. Cuttings samples were utilized for lithologic studies, and fractions between 1,100 feet and

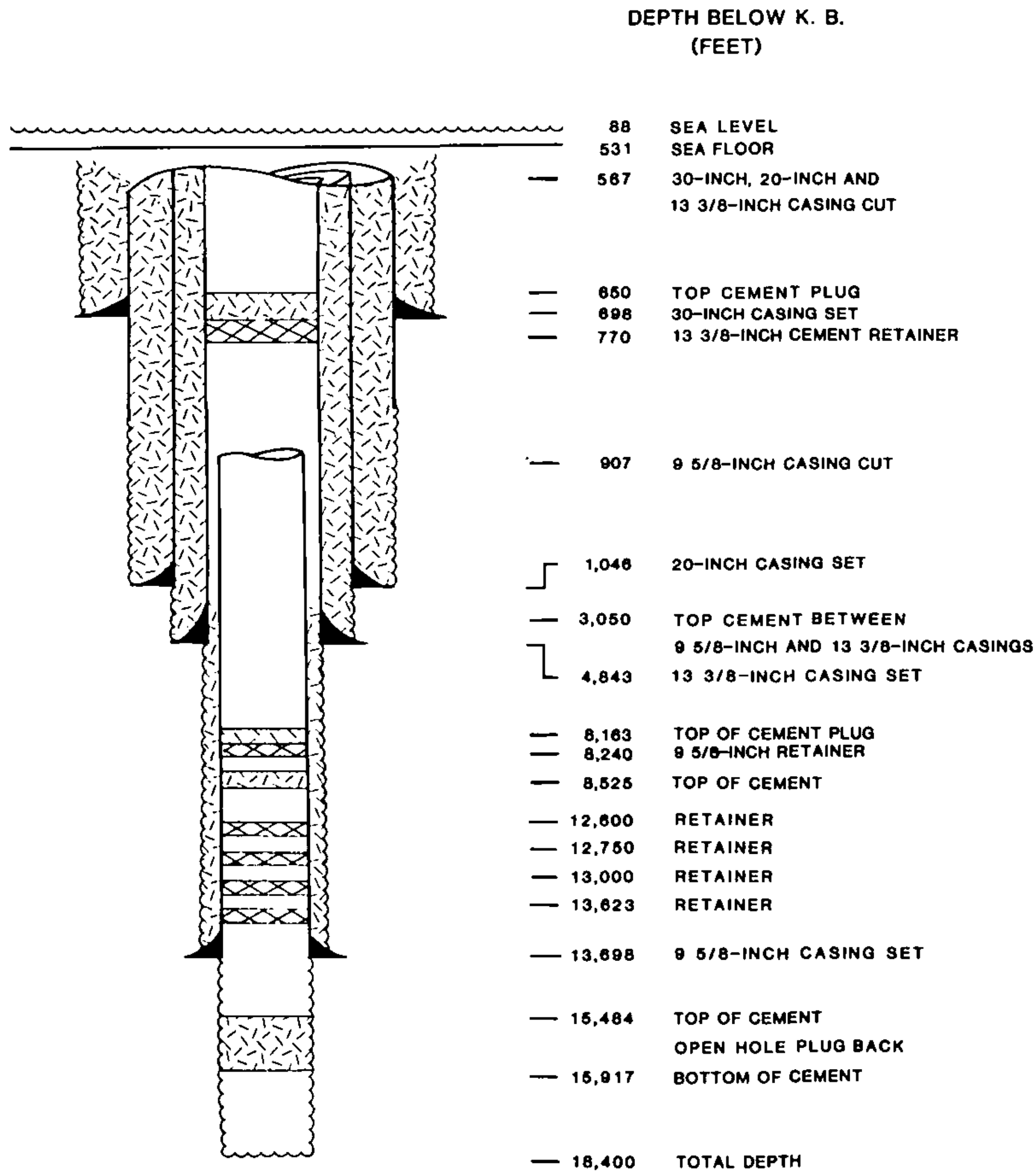

Figure 4.--Schematic diagram showing the casing and cement program for the Tenneco 642-2 well.

the total well depth were processed and utilized for paleontologic examination and interpretations. Thin sections were also prepared from cuttings for selected intervals between 3,560 and 18,400 feet.

Schlumberger Limited ran electric log suites to provide information for stratigraphic correlation, lithologic analysis, and the evaluation of potential hydrocarbon bearing zones (a listing of log runs and types can be found in the Formation Evaluation section of this report). The Analysts Inc. provided a physical formation log (mud log) from 900 to 18,400 feet. Tenneco also ran 12 formation interval tests and five drill stem tests, two of which failed. Results of the drill stem tests are given in table 2.

Weather

Zapata was delayed approximately one day in spudding the well because of high winds of 40-60 knots and rough seas. After spudding, Zapata's operations were only delayed or affected by weather conditions for approximately one and one half days.

Table 2 — Tenneco 642-2 drill stem test results

Test No.	Interval Tested (Shots/ft.)	Length of of Test (hours)	Choke Size (inches)	Final Flow Press. (psi)	Final Shut-in Press. (psi)	Results/Recovery
1	13,180-13,194 ft. (8)	-	-	-	-	Test failed downhole plugging
1A	13,180-13,194 ft. (8)	11	26/64	5,517	5,187	Flow 12 MMCFGPD, 100 BCPD, Water Cushion, Condens. Grav.= 49.1° API
2	12,730-12,764 ft. (8)	12	16/64	4,167	5,670	Flow 3 1/2 BWPD, Est. 20 MCFGPD, Water Cushion
3	12,675-12,698 ft.	-	-	-	-	Tool failed
3A	12,675-12,698 ft. (8)	5	30/64	3,384	5,593	Average flow rate 1 MMCFGPD, 500 BWPD, Water Cush.
4	8,318-8,321 ft. (4)	11.5	10/64	3,700	3,792	Average oil rate flow: 630 BOPD No gas; oil grav. 48.4° API; nitrogen cushion

WELL VELOCITY PROFILE
by
F. W. Lishman

A Schlumberger Well Seismic Tool (WST) survey was run in addition to the sonic log in the Tenneco 642-2 well. The WST provides a check of the integrated time and establishes a reference time between the beginning of the sonic log and the top of the well. An interval velocity profile, which was plotted from the WST data, is shown in figure 5. Five depth intervals are identified on the basis of relative interval velocities between 445 feet (sea floor) and 18,295 feet, the deepest data. The lower velocities of intervals I, II, and III are consistent with predominantly clastic lithologies, while the higher velocities of intervals IV and V suggest an increasing percentage of carbonates. These five depth intervals and their inferred lithologies generally agree with the facies units identified in the lithologic log.

Intervals I-V are defined on the basis of abrupt and persistent shifts in velocity. The velocity range within each interval does not (with one minor exception) overlap any other interval velocity range.

Interval I: The velocities in this interval suggest clastic lithologies, with shale predominating.

DEPTH RANGE:	445 - 5,612 feet
INTERVAL VELOCITY RANGE:	5,488 - 9,016 feet/second
AVERAGE INTERVAL VELOCITY:	6,710 feet/second

Interval II: Predominantly clastic lithologies are indicated by the velocities in this zone. An anomalous velocity of 12,000 feet per second occurs between 5,612 and 5,912 feet and may represent an increase in carbonate material.

DEPTH RANGE:	5,612 - 8,518 feet
INTERVAL VELOCITY RANGE:	9,761 - 12,000 feet/second
AVERAGE INTERVAL VELOCITY:	10,723 feet/second

Interval III: The velocities within this interval suggest clastic lithologies with sandstone predominating. An anomalous velocity of 15,250 feet per second ocurs between 10,390 and 10,512 feet and may represent an increase in carbonate material.

DEPTH RANGE:	8,518 - 14,565 feet
INTERVAL VELOCITY RANGE:	11,826 - 15,250 feet/second
AVERAGE INTERVAL VELOCITY:	12,976 feet/second

Interval IV: The increased velocities in this zone are consistent with mixed clastic and carbonate lithologies with sandstone predominating.

DEPTH RANGE:	14,565 - 16,280 feet
INTERVAL VELOCITY RANGE:	15,546 - 16,151 feet/second
AVERAGE INTERVAL VELOCITY:	15,734 feet/second

Interval V: The very high velocities in the final interval of the well suggest carbonate lithologies containing insignificant amounts of clastic material.

DEPTH RANGE:	16,280 - 18,295 feet
INTERVAL VELOCITY RANGE:	19,476 - 23,325 feet/second
AVERAGE INTERVAL VELOCITY:	21,436 feet/second

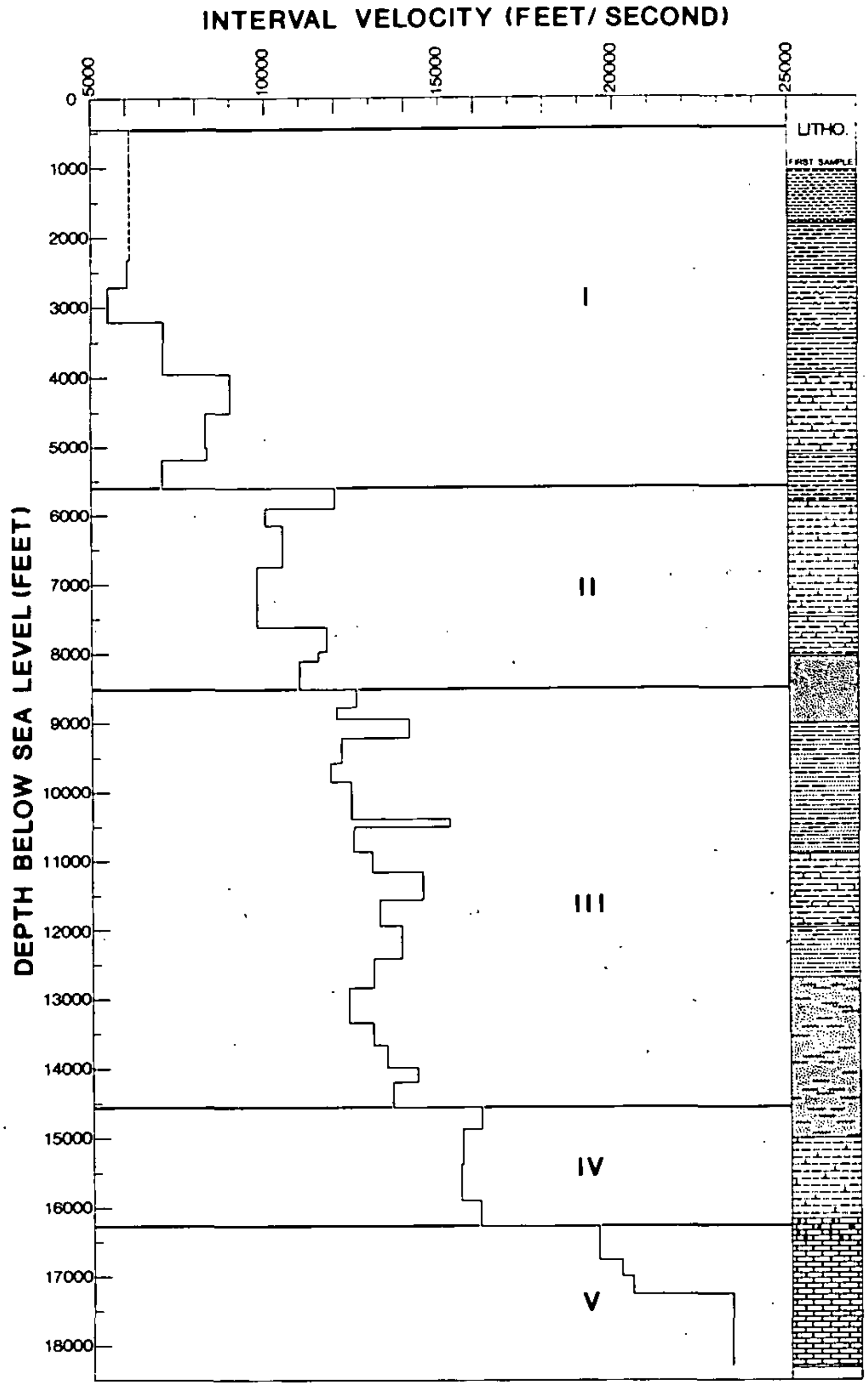

Figure 5.--Interval velocity profile for the Tenneco 642-2 well.

LITHOLOGIC ANALYSIS
by
Anthony C. Giordano

Geologic data used as the basis of this report consisted of drill cuttings, sidewall core and conventional core reports, thin sections, well logs and, to a limited extent, geophysical record sections. Intervals for which these data were collected are described in the Operational Summary section of this publication. Overall, the sample quality is fair to good. The lithologic units are described below beginning with the uppermost (youngest) section and are shown in figure 6 (p. 14).

1,100 to 4,040 feet

The uppermost part of this interval consists of a gray, soft, sticky clay with scattered shell fragments and loose quartz grains. The unit becomes progressively more indurated with depth. Below 1,900 feet, the clay changes to a gray, slightly silty shale. Sand units infrequently interrupt the shale sequence below 2,400 feet. These sand units consist of clear to milky quartz grains which vary from angular to well rounded in degree of abrasion and from medium to fine grained in size. The units are unconsolidated or weakly cemented with silica. Glauconite is abundant in places and is associated with the lower sand and shale units. Sediments in this interval range from Pliocene to Oligocene in age. An unconformity is recognized just above the base of the Pliocene. This interval contains no evidence of oil staining or fluorescence.

4,040 to 5,180 feet

This section of Eocene to Paleocene age is overlain unconformably by late Oligocene sediments. The sediments consist of calcareous shales and fossiliferous limestone. The shales are soft, gray, and very calcareous. Trace amounts of sand and shell fragments (primarily planktonic foraminifera) increase in abundance with depth and are found associated with the shale. The first indication of limestone is seen at 4,280 feet. Thin stringers of tan fossiliferous, micritic limestone persist sporadically to about 4,900 feet. Late Paleocene age sediments are represented by a thin 30-foot section of calcareous shale from 5,150 to 5,180 feet which terminates at the Tertiary-Cretaceous unconformity surface. This entire interval contains no evidence of oil staining or fluorescence. Visual porosity is fair to poor and is limited to intraparticle porosity in the limestone section.

5,180 to 7,940 feet

This interval of Upper Cretaceous sediments consists of calcareous shales and sands. The quartz sand is clear to white, fine grained, subrounded, and slightly cemented by calcite. The dominant lithology in this section is a light gray to brown, slightly to very calcareous, silty shale. Streaks of limestone and minor amounts of pyrite, coal, anhydrite, fossil fragments, and glauconite are also observed. The limestone is primarily a micrite with some secondary alteration to chickenwire anhydrite. This section contains no evidence of oil staining or fluorescence. Visual porosity in the individual sand units is excellent.

7,940 to 16,110 feet

This Early Cretaceous and Jurassic age section consists of sandstone, shale, and a minor amount of limestone. The sandstone units consist primarily of clear, white or gray, coarse to finegrained, subrounded sand. A small percent of this sand is cemented by calcite. The shales range from light to dark gray and dark brown, soft to hard, very silty to sandy and are micaceous and calcareous in places. A glossy, black, blocky lignite is seen at the top of the "Albian Sand" and is associated with shales deeper in the section. The limestones in the section are white, tan, and chalky and in places slightly dolomitic. In thin section, the limestones exhibit mudstone to packstone textures and have some secondary quartz and anhydrite replacement. Trace amounts of pyrite, mica, glauconite, biotite, fossil fragments, and feldspar are seen throughout this interval. There was no reported evidence of oil staining or fluorescence in these sediments; however, several successful drill stem tests were taken in sands in this interval between 8,318 and 13,178 feet. The results of these tests are described in table 2. Visual porosity in the individual sand units is excellent.

16,110 to 18,400 feet

This interval contains limestone of Jurassic age which varies in texture from mudstones to wackestones, packstones, and some grainstones. The limestone is light to dark gray or brown, firm to hard, pelleted, oolitic and fossiliferous or skeletal in places with minor calcite inclusions. Thin section analysis indicates that the majority of the limestones are either oomicritic or biomicritic, including a diverse assemblage of fossils (foraminifera, pelecypods, bryozoa, echinoid fragments, tubiphytes, sponges and algal material). The intra- and interparticle porosity in the oolitic section varies from excellent to poor (where secondary quartz and calcite replacement and infilling have occurred). A minor amount of anhydrite and dolomite replacement is also present. Fluorescence was observed in this limestone at a depth of nearly 17,800 feet.

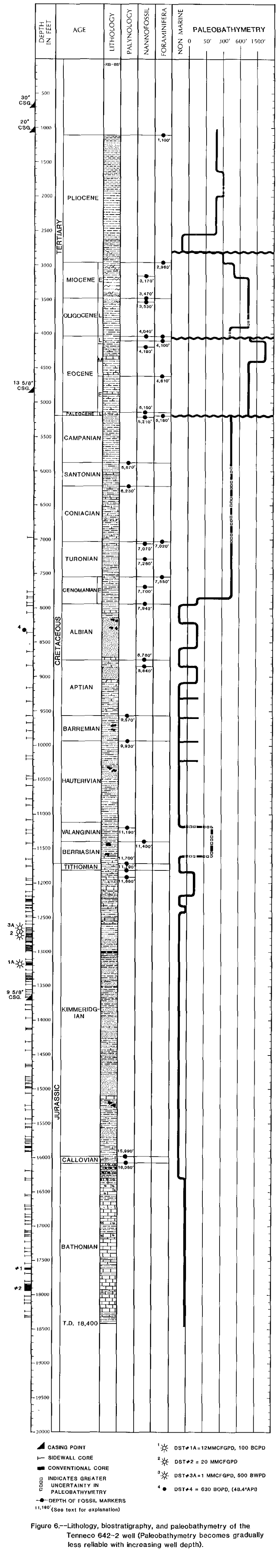

Figure 6.--Lithology, biostratigraphy, and paleobathymetry of the Tenneco 642-2 well (Paleobathymetry becomes gradually less reliable with increasing well depth).

BIOSTRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS

by
LeRon E. Bielak, William E. Steinkraus,
Harold L. Cousminer and Anthony C. Giordano

Three factors limit the reliability of paleontologic data from offshore Atlantic wells: (1) Most analyses are made from drill cuttings samples, which are often heavily contaminated by cavings from higher in the drill hole. For this reason, only "tops" or the uppermost species appearances are recorded. (2) Reworked, older fossil assemblages and individual specimens are commonly reincorporated in detrital sedimentary rocks. The reworked nature of these fossils must be recognized so that misdating can be avoided. (3) Biostratigraphic control is poor in pre-Late Jurassic strata. Calcareous nannofossils and foraminifera are rare to nonexistent. Palynomorphs are more common, but their biostratigraphic distribution is not fully documented with reference to the European type stage localities. The Jurassic palynostratigraphy of offshore eastern Canada (Bujak and Williams, 1977) has been relied upon for this investigation because many of the palynomorph marker species observed in Canada's Atlantic offshore sediments are also present in the Atlantic offshore sediments of the United States. Although the European stage equivalence of several species is not fully resolved, some species have recently been documented in European type sections (Woollam and Riding, 1983; Woollam 1983; Davies, 1985).

Figure 6 (p. 14) provides graphic reference to the biostratigraphic and paleoenvironmental discussions that follow.

CENOZOIC

Cenozoic sediments range from Pliocene to late (or possibly mid) Paleocene in age and are interrupted by two recognizable hiatuses. Environments of deposition range from nonmarine to lower slope regimes.

Pliocene (1,100 to 2,960 feet)

No samples were collected above 1,100 feet. The interval between 1,100 and 2,960 feet was examined for calcareous nannofossils but was found to be devoid of specimens. Foraminiferal species were observed throughout most of this section with the occurrence of *Turborotalia puncticulata* at 1,100 feet and below establishing the section as Pliocene in age. Environments of deposition reflect middle to outer shelf conditions with the exception of rare regressive prodeltaic pulses. Characteristic and persistent benthonic foraminifera in this interval include *Quinqueloculina seminulina*, *Cassidulina crassa*, *Elphidium* spp., *Bolivina anariensis*, *Bulimina aculeata*, *B. pupoides*, and *Nonion alabamensis*. Spruce pollen (*Picea*) is also present throughout this interval indicating boreal climates. This lithostratigraphic unit rests unconformably on sediments of early Miocene age.

Early Miocene (2,960 to 3,470 feet)

The age of the top of this section is based on the highest occurrence of Globigerina dissimilis (= Catapsadrax unicavus). Globorotalia siakensis is associated with G. dissimilis as is Globorotalia fohsi (though deeper in the section). The occurrence of the nannofossil species Discoaster druggi at 3,170 feet supports the first occurrence of pre-Pliocene sediments. Depositional environments are deeper in this interval than in the overlying Pliocene section although there is no discrete lithologic break. Outer shelf to upper slope conditions are reflected in a notable increase in the diversity of benthonic foraminiferal assemblages, including common occurrences of species of Bolivina, Pullenia, Gyroidina, Uvigerina and Siphogenerina. Cold water depositional conditions are indicated by common occurrences of diatoms and radiolarians throughout this interval.

Late Oligocene (3,470 to 4,040 feet)

The top of this stage is based on the highest occurrence of the nannofossil species Discoaster obtusus. Helicopontosphaera recta is encountered slightly lower in the section at 3,530 feet, and Globigerina ouachatensis is recorded at 3,560 feet. Outer shelf to upper slope environments prevailed in this zone. Foraminiferal assemblages are common and diverse. Common benthonic forms include species of the genera Siphogenerina, Lenticulina, Schenkiella, Gyroidina, Sphaeroidina and Planulina. Persistently occurring planktonic foraminifera include Globoquadrina dehiscens, G. venezuelana, Globorotalia siakensis and Globigerina praebulloides.

Late Eocene (4,040 to 4,100 feet)

The joint occurrence of the planktonic foraminifer Gloigerinatheka index and the nannofossil species Isthmolithus recurvus mark the top of this brief late Eocene section. Globorotalia cerroazulensis, another late Eocene planktonic foraminiferal marker, also occurs in this interval. Assemblages observed represent an upper slope paleoenvironment.

Middle Eocene (4,100 to 4,610 feet)

The upper limit of the middle Eocene is determined by the highest occurrence of the planktonic foraminifer Globorotalia crassata (= G. spinulosa) and G. spinuloinflata. Associated planktonics within this interval include Globigerina eoceana, Truncorotaloides topilensis, T. rohri, Pseudohastigerina micra, Globigerinatheka index, Globoquadrina venezuelana and Globorotalia pentacamerata. The nannofossil Chiasmolithus grandis occurs just below the top of this zone at 4,190 feet. The depositional regime represents primarily lower slope environments although the bottom of this interval reflects the continuation of a slightly shallower Early Eocene stage of sedimentation. Foraminiferal assemblages are diverse and abundant. Planktonic/benthonic foraminiferal ratios in some samples range as high as 9 to 1.

Early Eocene (4,610 to 5,150)

The section is interpreted as early Eocene because of the presence of the foraminifer Globorotalia caucasica to 4,610 feet. The nannofossil species Discoaster multiradiatus also occurs within this zone at 5,120 feet. Upper slope foraminiferal assemblages observed in the overlying section are a continuation of the depositional setting found in this stage.

Late Paleocene (5,150 to 5,180 feet)

The Paleocene age sediments are represented by a thin 30-foot interval in which the nannofossil marker species Heliolithus kleinpelli and the planktonic foraminifera Globorotalia pseudomenardii and Globigerina triloculinoides occur. A single specimen of Globigerina compressa was recovered suggesting that the mid/late Paleocene boundary may have been encountered in this composited sample.

MESOZOIC

Late Cretaceous

Maastrichtian sediments are absent but fossil recoveries indicate the presence of Campanian to Cenomanian sediments. Outer shelf depositional environments prevailed throughout most of the Late Cretaceous period.

Campanian (5,180 to 5,870 feet)

This section is unconformably overlain by Paleocene sediments. The youngest Cretaceous sediments are interpreted to be Campanian in age based on the highest occurrence of Globotruncana linneiana. Associated foraminiferal fauna at the top of this interval includes Globotruncana ventricosa, G. cretacea, G. marginata, Ammodiscus glabratus, Gyroidina soldanii and Dorothia retusa. Deeper in this section Globotruncana arca, G. stuarti, G. elevata, G. fornicata, and G. angusticarinata make their highest appearance. Planktonics comprise up to half of some of the foraminiferal samples in this interval. Other benthonics prevalent deeper in this zone and reflecting outer shelf environmental conditions include Anomalina complanata, A. vulgaris, A. ammonoides, Clavulinoides disjunctus, Bolivina decorata, B. incrassata, Gaudryina pyrimidata, Cibicides excolatus, C. stephensoni, C. subcarinatus, Gyroidina micheliniana, Ammodiscus cretaceous, Marginulina austiniana, Anomalinoides acuta, Gavelinella sp. and Lenticulina spp. Kyphopyxa christneri has its highest occurrence at 5,690 feet.

Nannofossil species of Campanian age which occur just below the top of this section are Broinsonia parca at 5,210 feet and Tetralithus pyramidus at 5,240 feet. The palynomorph Xenascus ceratoides also has its highest occurrence at 5,240 feet and further supports the Campanian age delineation for this interval.

Santonian (5,870 to 6,230 feet)

The Santonian is marked by the highest occurrence of the dinocyst Calliosphaeridium asymmetricus at 5,870 feet. A decrease in faunal abundances in this zone coupled with an increase in sand and carbonate content in the sediments points to a more regressive, possibly prodeltaic, regime than that encountered in the overlying zone.

Coniacian (6,230 to 7,020 feet)

The upper limit of Coniacian sediments is placed at 6,230 feet because of the highest occurrence of the palynomorph Cicatricosisporites perforatus. Paleoenvironmental conditions are equivalent to those in the overlying zone.

Turonian (7,020 to 7,550 feet)

The occurrence of Praeglobotruncana stephani establishes the top of this interval as Turonian in age. Globotruncana helvetica, a basal Coniacian marker, is found in association with P. stephani. The nannofossil Radiolithus planus, another Turonian index species, has its highest occurrence at 7,070 feet, while Corallithion achylosum is found no higher than 7,280 feet. Faunal assemblages and abundances suggest the predominance of an outer shelf setting throughout most of this stage of sedimentation.

Cenomanian (7,550 to 7,940 feet)

The highest occurrence of Cenomanian sediments is placed at 7,550 feet because the presence of the index foraminifer Rotalipora appenninica. Rotalipora cushmani also occurs with R. appenninica lower in this zone at 7,700 feet. The Cenomanian nannofossil markers identified in this interval include Corollithion kennedyi at 7,700 feet and Lithaphidites alatus at 7,880 feet. Outer shelf depositional conditions continue to within 50 feet of the base of this interval at which point a prominent deltaic sandstone unit is encountered.

Early Cretaceous

Early Cretaceous sediments are very characteristic of a delta setting because they are highly variable and consist of a complex stratigraphic section of interfingering marine and nonmarine strata. The presence of lignite associated with sands and shales indicates that restricted delta plain marine subenvironments exist within this sequence. The few limestones occurring in this section are packstones or wackestones and have some secondary quartz and anhydrite replacement. Ground water leaching by fresh water partly dolomitized some of the limestones. Trace amounts of pyrite, mica, glauconite, biotite, fossil fragments and feldspar are seen throughout this interval. Diagnostic electric log curves reflect delta system patterns in sharp contrast to the flatter curves of the overlying marine transgressive sequence. Resistivity curves display very active patterns and spontaneous potential responses exhibit very blocky, funnel, and serrated shapes depending on the delta facies position encountered.

Albian (7,940 to 8,780 feet)

The top of the Early Cretaceous section is determined by the highest occurrence of the nannofossil indicator Braarudosphaera africana. This zone is predominantly sandstone deposited in a distributary channel system. The electic log spontaneous potential curve portrays a typical serrated cyclindrical response. Silty shale or claystone streaks provide sufficient marine conditions to support Albian nannofossil occurrences; foraminiferal assemblages are virtually nonexistent.

Aptian (8,780 to 9,570 feet)

The Aptian age for this interval is indicated by the highest occurrence of the nannofossil species Nannoconus florus at 8,780 feet. Nannoconus globulus occurs at 8,840 feet and N. "ashqeloni" at 8,870 feet. The upper part of this section includes the lower segment of the distributary channel system which persisted into Albian time. The lower part of the Aptian section is characterized by interdistributary deposits and marginal marine conditions that persisted through most of Early Cretaceous time at this well site.

Barremian (9,570 to 9,930 feet)

The Barremian top is marked by the highest occurrence of the dinoflagellate Muderongia simplex.

Hauterivian (9,930 to 11,190 feet)

The top of the Hauterivian section is defined on the basis of the highest occurrence of the palynomorphs Trilobosporites bernissartensis and T. domitus.

Valanginian (11,190 to 11,400 feet)

At 11,190 feet the Valanginian age determination is based on the upper limit of the foraminifer Epistomina caracolla.

Berriasian (11,400 to 11,700 feet)

The upper limit of the nannofossil marker Polycostella senaria places the top of this stage at 11,400 feet. Below this level Nannoconus bronnimanni is identified at 11,460 feet and Polycostella beckmannii, which does not range above the Early Berriasian, is present at 11,590 feet. Palynomorph index species Muderongia staurota is found at 11,610 feet.

Jurassic

The Jurassic section is separated into two depositional components. The younger component is a deltaic section which persisted from Bathonian to Aptian time. The older component is a thick carbonate section of Callovian to Bathonian age. The limestones that occur in this interval are mudstones, wackestones, packstones, and some grainstones. Analysis of thin sections indicates that the limestone is primarily biomicritic with a diverse assemblage of fossil material consisting of foraminifera, pelecypods, bryozoa, echinoid spines and plates, tubiphytes, sponges, and algal remains. The presence of this biogenic debris coincides with the occurrence of a prograding sequence recognizable on seismic record sections as continuous, inclined, high amplitude reflectors. Electric log responses indicate the increasing calcareous content of the sediments by displaying short, high resistivity peaks and weak spontaneous potential responses.

Tithonian (11,700 to 11,790 feet)

The upper limit of Jurassic sediments is placed at 11,700 feet on the basis of the uppermost occurrence of the dinocyst *Ctenidodinium panneum*.

Kimmeridgian (11,790 to 15,990 feet)

The Kimmeridgian top is marked by the highest occurrence of the dinocyst *Gonyaulacysta globata*. *Senoniasphaera jurassica* and *Gonyalacysta cladophora* were identified slightly lower in the section at 11,880 feet. Both of these species have peak occurrences in the Kimmeridgian. No palynomorphs known to represent Oxfordian sediments have been noted.

Callovian (15,990 to 16,080 feet)

The Middle Jurassic, Callovian section is recognized on the basis of the occurrence of the palynomorph *Valensiella* sp. at 15,990 feet.

Bathonian (16,080 to 18,400 feet)

The Bathonian dinocyst marker species *Gonyaulacysta filapicata* has its uppermost occurrence in the well at 16,080 feet. This marker occurs intermittently down to 17,340 feet. No fossils older in age than the Bathonian have been identified in samples from this well.

FORMATION EVALUATION
by
Renny R. Nichols

Schlumberger Limited ran the following logs in the Tenneco 642-2 well to provide information for stratigraphic correlation and for evaluation of formation fluids, porosity, and lithology:

Table 3 -- Schlumberger logs

Log Type	Depth Interval (feet) below KB
Sonic Log	698 - 18,395
Dual Induction - Spherically Focused Log (SFL)	698 - 18,395
Compensated Neutron Log (CNL) / Formation Density Compensated Log (FDC)	4,844 - 18,395
High-Resolution Dipmeter (HDT)	4,844 - 18,395
Repeat Formation Tester Log	9,650 - 18,674

The Analysts, Inc. provided a Physical Formation Log ("Mud Log") which included a rate of penetration curve, sample description, and a graphic presentation (not including a chromatograph) of any hydrocarbon shows encountered between 900 and 18,400 feet.

The electric logs, 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 summary of well log data is shown in table 4. Although a combination of these logs were analyzed, efforts were made to substantiate the estimates shown in table 4. A detailed lithologic and reservoir property determination was made from samples, conventional cores, and sidewall cores in addition to fully considering the results of any tests performed.

The electric logs were of acceptable quality. Shifts of the spontaneous potential curve occur at 3,400, 4,870, 13,700, and 15,950 feet. The caliper curve deployed with the compensated neutron and formation density compensated logs is offscale from 4,850 to 4,925 feet and exhibits an unusual cyclical response from 15,710 to 15,910 feet. Also, the high resolution dipmeter is missing responses for the interval from 13,647 to 13,725 feet.

Table 4 -- Well log interpretation summary

Depth Interval (feet)	Feet of Potential Reservoir (a)	Average Porosity (%)	Water Saturation (%) (b)	Feet of Hydrocarbon (c)	
2,607-2,654	47	35	-	0	
3,381-3,526	125	35	-	0	
4,898-4,909	11	32	-	0	
5,898-5,940	31	31	-	0	
5,955-5,996	39	31	-	0	
7,428-7,445	14	30	-	0	
7,886-8,134	211	22	-	0	
8,186-8,200	14	26	59?	4(?)	(d)
8,200-8,282	80	26(?)	-	0	
8,316-8,324	8	28	33	8	(e)
8,324-8,586	248	26	-	0	
8,586-8,610	24	21	-	0	
8,691-8,712	19	25	-	0	
8,867-9,190	269	18	-	0	
9,230-9,336	92	14	-	0	
9,412-9,470	56	15	-	0	
9,491-9,579	81	17	-	0	
9,628-9,638	10	23	-	0	
9,670-9,748	71	22	-	0	
9,774-9,946	169	18	-	0	
9,994-10,013	19	20	-	0	
10,046-10,090	41	22	-	0	
10,112-10,330	207	18	-	0	
10,342-10,356	10	19	-	0	
10,384-10,398	11	19	-	0	
10,433-10,478	33	23	-	0	
10,603-10,660	49	23	-	0	
10,717-10,767	50	21	-	0	
10,803-10,863	55	24	-	0	
11,074-11,092	15	21	-	0	
11,217-11,226	9	13	-	0	
11,324-11,334	10	13	-	0	
11,403-11,412	9	16	-	0	
11,526-11,548	19	14	-	0	
12,221-12,236	15	16	47	13	
12,302-12,308	6	15	43	6	
12,328-12,336	8	13	71	0	
12,636-12,648	20	16	66	0	
12,672-12,708	32	17	59	32	(f)
12,732-12,766	34	18	43	0	(g)
12,784-12,792	8	15	50	0	(h)
12,832-12,843	11	16	51	0	(i)
12,898-12,930	28	16	43	28	(j)
13,078-13,088	8	16	47	10(?)	(k)
13,176-13,192	14	17	37	14	
13,300-13,336	32	14	57	0	
13,386-13,398	7	11	65	0	
13,398-13,432	31	9	64	0	

Table 4 -- Well log interpretation summary--continued

Depth Interval (feet)	Feet of Potential Reservoir	Average Porosity (%)	Water Saturation (%)	Feet of Hydrocarbon
13,604-13,614	10	15	-	0
13,632-13,656	24	11	-	0
13,719-13,730	11	9	-	0
13,754-13,765	11	10	-	0
13,832-13,848	16	16	-	0
13,938-13,951	13	10	-	0
14,034-14,056	22	8	67	0
14,106-14,140	34	5	-	0
14,164-14,192	26	6	-	0
14,236-14,304	59	7	-	0
14,483-14,508	25	10	-	0
14,552-14,562	10	8	-	0
14,642-14,673	31	8	-	0
14,763-14,785	20	7	-	0
14,866-14,920	48	6	-	0
14,948-14,977	26	6	-	0
15,291-15,314	25	5	-	0
15,344-15,366	20	9	-	0
15,502-15,514	10	9	-	0
15,548-15,564	16	11	-	0
15,578-15,599	21	10	-	0
15,650-15,672	22	7	-	0
15,714-15,746	32	15	-	0
15,778-15,810	32	9	-	0
15,850-15,859	9	10	47	0 (1)
15,859-15,878	19	10	58	0
15,878-15,904	24	14	58	0
15,938-15,960	22	9	-	0
15,983-15,998	13	12	68	0
16,040-16,062	22	8	-	0
16,094-16,106	10	8	-	0
16,673-16,678	5	5	70	0
17,776-16,690	14	7	94	0
17,856-16,872	16	9	100	0
17,908-16,922	14	10	100	0

(a) Generally in beds > 10 ft. thick and Ø > 5%
(b) A dash (-) indicates that the water saturation was not calculated
(c) Generally in beds > 10 ft. thick, Ø > 5%, and S_W< 50%
(d) Only 4 ft. at 33% S_W(which appears beneath higher S_W zone)
(e) Hotwire (HW) registered only 10 units, but DST of 8,318-8,321 ft. = 630 BOPD (48.4° API)
(f) S_W>50, but HW = 200 units and, DST of 12,675-12,698 ft. = 1.0 MMCFGPD
(g) S_W<50, but DST of 12,730-12,764 ft. = only 20 MCFGPD
(h) Same characteristics as zone above
(i) Same characteristics as zone in footnote e) above
(j) Hotwire registered 200 units
(k) Hotwire registered 70 units
(l) S_W<50, but the formation test at 15,855 ft. recovered water

In selected zones, sidewall core porosities compare favorably with log derived porosities and generally fall between sonic and density porosity values down to 12,300 feet. From 12,600 to 13,200 feet, the sidewall core and log derived porosity values are very close (± 2%) with sidewall core values being slightly lower. In zones between 13,300 to 13,400 feet, the sidewall core porosities exceed log derived values. From 15,800 to just below 15,900 feet, there is close agreement of values. However, in limestone from 17,862 to 17,922 feet, the log derived porosities generally exceed the sidewall core porosities by several percentage points. (See table 5)

Table 5 -- Sidewall core analysis (summary)

Depth Interval	Lith.	Porosity Range (%)	Permeability Range (md)	Oil Pore (%)	Gas Bulk (%)
6,968-8,326	ss	10.3-24.7	<.1 to 560	-	1.9-4.7
8,630	ss	23.8	110	10.8	8.2
9,160-10,138	ss	13.1-25.8	<.1 to 450	-	1.3-5.7
10,192-10,850	ss	16.9-20.6	2.7 to 125	-	1.8-4.6
11,088-12,644	ss	8.7-19.3	<.1 to 13	-	.8-4.2
12,676-13,126	ss	14.6-18.3	<.1 to 3.3	-	1.3-4.3
13,182-15,906	ss	4.9-20.3	<.1 to 24	-	.6-5.9
16,304-18,266	ls	1.8-11.6	<.1 to .4	-	.1-2.1

For core No. 1, the porosity values compare well with log derived values (sonic = 3% and FDC = 1%). For core No. 2, the porosity range is somewhat higher than log derived porosity, but the intervals and general level correlate well (sonic = 2-10% and density = 2-10%). (See table 6)

Table 6 -- Conventional core analysis (summary)

No.	Depth Interval	Lith.	Porosity Range (%)	Permeability Range (md)	Oil Pore (%)
1	17,602-17,604	ls	1.7- 3.3	.26-.46	-
2	17,874-17,932	ls	1.7-18.2	.01-27	0-1.1

Significant Shows

Table 7 lists all shows of hydrocarbon encountered in this well. Shows occurring over the following intervals were judged to be significant:

12,221-12,236 feet	12,832-12,843 feet
12,302-12,308 feet	12,898-12,930 feet
12,672-12,708 feet	13,078-13,088 feet
12,732-12,766 feet	13,176-13,192 feet
12,784-12,792 feet	15,850-15,904 feet

Table 7 -- Summary chart, shows of hydrocarbon

Depth Interval	Drilling Time ft./hr.	Sample Description (Mud Log)	Total Gas b.g.		Chroma-tograph	Cutt. Gas	Conventional Cores						Sidewall Cores						Well Log Interpretation			Tests
							Interv.	Ø	K	O_p	O_b	G_b		Ø	K*	O_p	O_b	G_b	Interval-ft.	Ø	S_w	
8,110-8,170	50-100	sand, sl cmt.	2	45	-	-							8,174	20	1	-	-	4.7	8,186-8,200	26	59	
8,320-8,330	15-120	sand, lsly consol.	2	10	-	-							8,326	14	.7	-	-	2.7	8,316-8,324	28	53	8,318-21 ft.
																						=630 BOPD
8,610-8,625	20-45	ss/ls, chlky, xln	2	2	-	-																(48° API)
9,665-9,685	15-140	ss, lsly consol.	2	5	-	-							8,630	24	110	10.8	2.6	8.2	8,612-8,654	8	76	
9,760-9,795	10-100	sd, unconcol.	2	2	-	-							9,674	22	50	-	-	5.4	-			
12,220-12,235	8-45	sd, unconsol.	2	160	-	-							9,782	21	200	-	-	5.7	-			
12,295-12,315	13-45	ss, well cmt.	5	80	-	-							12,223-12,237	18	7	-	-	4	12,221-12,236	16	47	
12,320-12,335	14-45	ss, well cmt.	15	150	-	-							12,304-12,306	15	.9	-	-	2	12,302-12,308	15	43	
12,620-12,640	8-30	ss, sl cmt, sm lig.	5	40	-	-							-						12,328-12,336	13	71	
12,655-12,705	11-140	ss, consol.	5	200	-	-							12,644	17	1	-	-	2.6	12,636-12,648	16	66	
													12,676-12,692	17	.3	-	-	3	12,672-12,708	17	59	12,675-698 ft.
12,720-12,760	13-80	ss, consol.	15	220	-	-																= 1.0 MMCFGPD
													12,727-12,759	16	.6	-	-	3	12,732-12,766	18	43	12,730-764 ft.
12,775-12,785	13-75	ss, consol.	25	220	-	-																= 20 MCFGPD
12,820-12,840	14-45	ss, calc, sm mica	15	80	-	-							12,785-12,788	17	1.5	-	-	3	12,784-12,792	15	50	
12,890-12,930	5-55	ss, calc, sm mica	5	200	-	-							12,820-12,838	16	1	-	-	3	12,832-12,843	16	51	
13,060-13,080	8-60	ss, silic., well	5	70	-	-							12,906-12,928	16	1	-	-	3.5	12,898-12,930	16	43	
		cmt.											-	-	-	-	-	-	13,078-13,088	16	47	
13,170-13,190	6-22	ss, silic., well	5	190	-	-																
		cmt.											13,182-13,190	18	7	-	-	3	13,176-13,192	17	37	13,164-78 ft.
13,290-13,330	10-28	ss, calc	8	20	-	-																= 12 MMCFGPD
13,375-13,385	6-40	ss, silic. calc vy	5	5	-	-							13,306-13,327	20	16	-	-	3.3	13,300-13,336	14	57	
		slow dull yel											13,369-13,385	17	4	-	-	3	13,386-13,398	11	65	
		stmm cut																				
13,390-13,430	6-25	ss	5	5	-	-																
14,030-14,085	8-35	ss, scat flu, sl	3	30	-	-							13,388-13,433	19	13	-	-	5.2	13,398-13,432	9	64	
		brt yel cut																				
14,645-14,650	6-16	ss, sm glauc, mica	3	3	-	-							-						14,034-14,056	8	67	
15,730-15,765	16-70	ss, calc, sm mica	2	20	-	-							14,658	16	5	-	-	5.2	-			
15,865-15,920	16-70	ss, silic, no flu,	3	400	-	-							15,734-15,740	15	6	-	-	5.8	-			
		no heavies											15,854-15,906	16	13	-	-	3.5-	15,850-15,904	12	55	FT @ 15,855 ft.
15,960-15,975	10-38	ls, xln, sl arg.	2	10	tr hvy	-												5.3				= 270cc water
		ool, no flu, tr			(?)								-	-	-	-	-	-	15,983-15,998	12	68	
		hvy																				
16,680-16,685	9-20	ss, well cmt., arg.	3	100	-	-																
17,781-17,800	5-20	ls, chlky, scat.	3	60	-	-							-	-	-	-	-	-	16,673-16,678	5	70	
		flu, sl slow milky											-	-	-	-	-	-	17,776-17,790	7	94	
		cut						Ø	K	O_p												
17,865-17,885	6-28	ls, chlky	5	130	-	-	17,874-	3.8-	.01-	0-												
							17,885	12.4	1.7	.4												
17,910-17,930	7-22	ls, chlky	5	160	-	-	17,885-	1.7-	.01-	0-			17,866-15,870	5	<.1	-	-	1.1	17,856-17,872	9	100	
							17,932	12.6	27	1.1			17,900-15,922	7	<.1	-	-	1.1	17,908-17,922	10	100	

arg. = argillaceous
chlky = chalky
cmt. = cemented
flu = fluorescence

glauc = glauconite
lig. = lignite
lsly = loosely
ool = oolitic

scat. = scattered
sl = slightly
sm = small
tr = trace

xln = crystalline
yel = yellow
* = derived empirically

Ø = porosity
K = permeability
O_p = oil saturation
b.g.= background gas

O_b = Oil (Bulk), weight % of oil relative to bulk sample weight
G_b = Gas (Bulk), weight % of gas relative to bulk sample weight

KEROGEN ANALYSIS
by
Charles Fry

Palynology slides were microscopically analyzed to determine the type and thermal rank of the kerogen contained in the cuttings samples of the Tenneco 642-2 well. For this analysis, the insoluble organic material dispersed in sedimentary rock was classified into four major types: algal, herbaceous, woody, and coaly (Adapted from Bayliss, 1980 and Hunt, 1979). Estimates were made for the percentage of each of these types that are contained in the palynology slides.

The maturity of the organic material was estimated by comparing the color of various palynomorphs in the palynology slides to a thermal alteration index (TAI) scale (see fig. 7a, after Jones and Edison, 1978). The colors displayed by the organic matter indicate the degree to which the kerogen has been thermally altered (Staplin, 1969).

Kerogen Type

Figure 7b summarizes the results of the kerogen analysis for the Tenneco 642-2 well. Tertiary samples above 2,720 feet are sparse in kerogen content and have a mixed kerogen distribution: 10-20 percent algal kerogen, 30-40 percent herbaceous material, 35-40 percent woody material and 5-10 percent coaly. Below 2,720 feet, the kerogen observed in Tertiary samples is mostly marine in nature being 75-80 percent algal and herbaceous kerogen.

Late Cretaceous samples from 5,180 to 7,940 feet represent a transition from marine kerogen distribution (50% algal kerogen, 25% herbaceous, 15% woody, and 10% coaly) to a mixed distribution (5-10% algal kerogen, 25-35% herbaceous, 40% woody, and 20% coaly). Early Cretaceous samples from 7,940 to 11,700 feet are similar to those examined in the lower section of Late Cretaceous age sediments. Jurassic samples above 12,780 feet have a mostly terrestrial kerogen distribution with noteworthy amounts of algal material present (5% algal kerogen, 25-30% herbaceous, 45% woody, and 20-25% coaly). Jurassic samples below 12,780 feet contain 75-90% woody and coaly kerogen with algal material visable only in trace amounts.

In summary, there are measurable amounts of marine oil prone kerogen observed in all samples above 12,780 feet. The interval between 2,720 and 5,180 feet is rich in this material. Samples below 12,780 feet are dominated by the terrestrial kerogen types with only small amounts of algal material observed.

Maturity

Judging thermal maturity from well cuttings must be done with great care to insure that the material being analyzed is indigenous to the level sampled. Caved or reworked material will give false indications of maturity. Oxidation

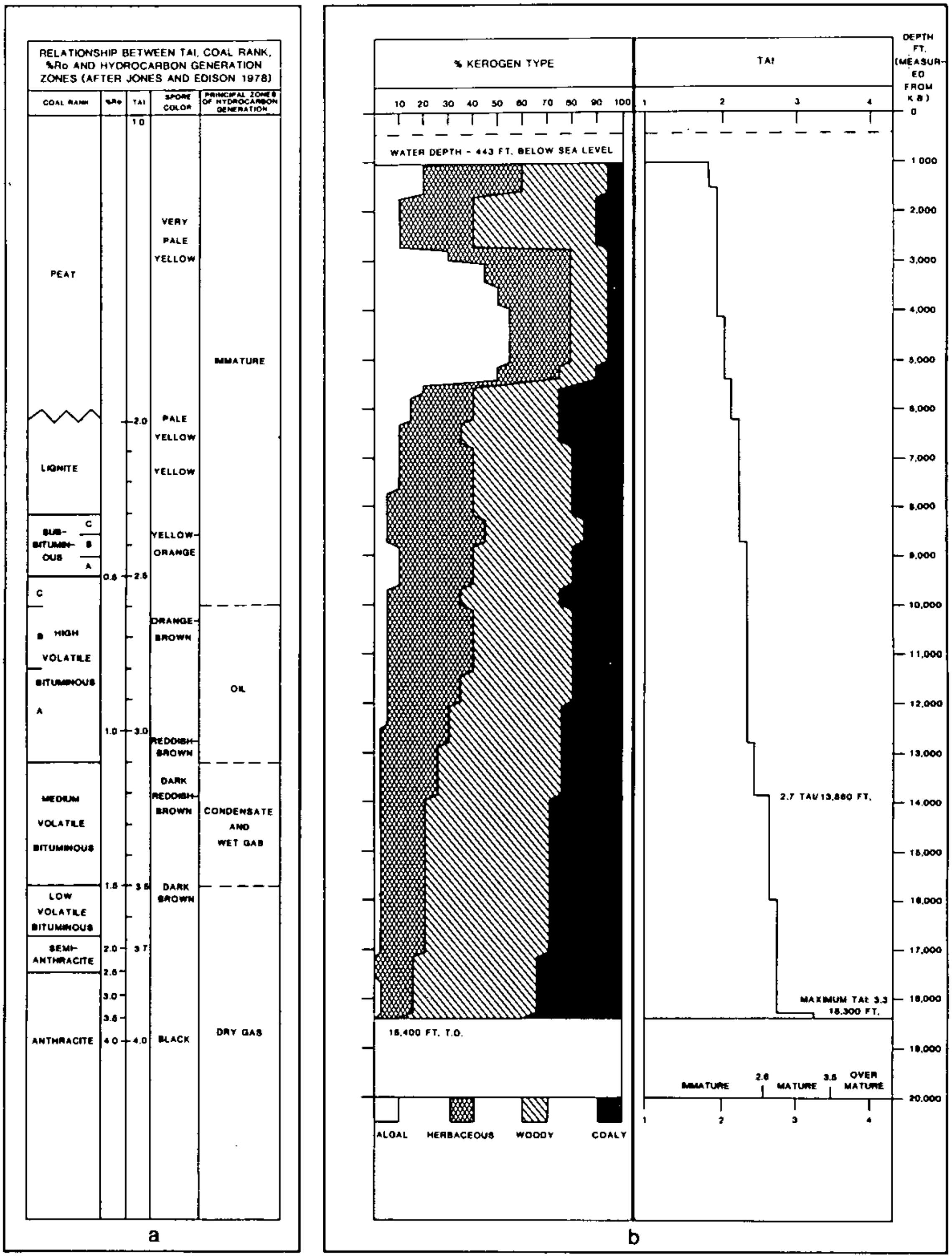

Figure 7.--Graph of kerogen types and thermal maturity of sediments in the Tenneco 642-2 well.

caused by a high energy depositional environment can also alter the appearance of the kerogen. TAI values were recorded using palynomorphs considered to be in situ. The TAI curve for the well is illustrated in figure 7b.

Palynomorphs observed in Jurassic samples above 13,860 feet were orange in color indicating that alteration has taken place, but this color does not usually indicate a thermally mature flora. The first occurrence of fully mature colors is observed in the 13,860 foot sample. Orange-brown palynomorphs correspond to a TAI value of 2.7. Evidence of increased alteration is observed in samples below 15,990 feet (2.8 TAI) and 16,980 feet (2.9 TAI). The lowest sample examined contained dark reddish brown pollen grains indicating alteration beyond peak maturity (3.3 TAI). Preliminary geochemical fingerprinting of oil recovered from a tested Albian sand with possible Jurassic source rocks suggests, but does not unequivocally prove, that the oil may have migrated from Jurassic algal carbonates (R.E. Miller, verbal communication, 1986).

Conclusions

Marine (oil prone) kerogen is present in notable amounts in all samples above 12,780 feet. The interval from 2,720 to 5,180 feet is rich in this material. Tertiary and Late Cretaceous samples have TAI values less than 2.4 and would be unlikely to generate hydrocarbons by catagenesis. Early Cretaceous and Late Jurassic age samples above 13,860 feet also appear to be in the immature range (2.4 to 2.5 TAI) but show signs of alteration. Thermally mature palynomorphs are observed in samples from 13,860 to 18,400 feet (the total well depth). The actual onset of hydrocarbon generation is best defined by geochemical method; however, the colors observed in samples below 13,860 feet suggest that generation is possible in this section of the well. The mainly terrestrial composition of the kerogen below 12,780 feet suggests potential generation of gas hydrocarbons. The source potential of the sediments containing algal material above 12,780 feet is uncertain. The kerogen in this upper section has been altered, but does not display colors indicative of thermal maturity.

REFERENCES

Bayliss, Geoffrey S., 1980, Source Rock Evaluation Reference Manual: Geochem Laboratories Inc., Houston, Texas.

Bujak, J. P., and Williams, G. L., 1978, Cretaceous Palynostratigraphy of Offshore Southeastern Canada: Geological Survey of Canada Bulletin 297; pp. 1-19.

Davies, E. H., 1985, Microspore and Dinoflagellate cyst Oppel-zonation of the Lias of Portugal: Palynology Volume 9; pp. 105-132.

Hunt, John M., 1979, Petroleum Geochemistry and Geology: W. H. Freeman Co., San Francisco, California; pp. 273-350.

Jones, R. W. and Edison, T. A., 1978, Microscopic Observations of Kerogen Related to Geochemical Parameters with Emphasis on Thermal Maturation. in D.F. Olitz, editor, Symp. in Geochemistry: Low Temperature Metamorphism of Kerogen and Clay Minerals.

Miller, Robert E., Geochemical Report on the Tenneco 642-2 well: on file at Minerals Managerment Service, Atlantic Region Office; Unpublished.

Riding, J. B., Dinoflagellate cyst Range-Top Biostratigraphy of the Uppermost Triassic to Lowermost Cretaceous of Northwest Europe. Palynology Volume 8; pp. 185-210

Staplin, Frank L., 1969, Sedimentary Organic Matter, Organic Metamorphism, and Oil and Gas Occurrence: Bulletin of Canadian Petroleum Geology vol. 17, no. 1.; pp. 47-66.

Woollam, R. and Riding J. B., 1983, Dinoflagellate cyst Zonation of the English Jurassic: Report-Natural Environment Research Council, Institute of Geological Sciences Volume 83, no. 2; pp. 1-42.