Library

CONOCO

These Data were received from Conoco in September 1981 Please File with 2/1-1 W28.

Interoffice Communication

To Tony Doré

From L.C. Bellis

Date 2 September 1981

Subject Brief review Block 2/1-1 Well File

30" Conductor set at 485' (148m)
20" Surface set at 1325' (404m)
13 3/8" Casing set at 3785' (1154m)
9 5/8" Casing set at 9997' (3047m)
7" Liner 9806-12,747' (3885m)

Drilled 5 7/8" hole to 13,707' (4,179m). Well flowed back 5 bbls of drilling mud. Drill pipe shut in pressure 1000 psig, casing pressure 940 psig w/16.1 ppg. mud. Killed well with 18 ppg mud. Stuck pipe, hole packed off could not circulate. Backed off at 12,580' (3,834m) circulated and conditioned mud. Set 7" retainer at 12,554 and squeezed w/225 sx cement, reversed out at 12,430' (3,789m). Engineers estimate that 5 bbl gain at 13,707 was probably due to salt water influx from an overpressured sand lens, based on slight salinity increase in mud (from 25,000 ppm to 35,000 ppm) and insufficient volume of gas released at surface for it to be equivalent to 5 bbls of gas at 13,707!

Estimated pressure at 13,707 = 13,707 (0.8365) = 11,466 psig

Perforated 7" liner 11,876-941'; 12160-202'; 12,234-279' and tested. Azidized well. Well flowed at estimated rate of 400 Mcf/D F.T.P 100 psi.

L.C. Bellis

BP NORWAY LTD - FORUS
CENTRAL LIBRARY
EXPLORED REPORTS COLLECTION
AC: NOCS 2/1-1 W28
VOLUME: 36541

19.06 ✠
13960 conos n
conoco london

no 8932
to conoco stamford
attn morris/grivetti/ marshall/ ryman

gulf london- r a house

conoco olslo- m lesser

u r g e n t
well 2/1-1 roger neves reports lowest sample at 13,640 is kimmeridgian. section is less marine below 13,550, and ihn his opinion we would not have far to drill to reach main jurassic sands- either lower kimmeridge sands overlying bathonian sands, or kimmer- idge shales overlying bathonian sands. possibly we have already entered the main sands in ''no-sample'' interval 13,640 to 13,707. we agree with engineers that t e 5bbl gain at 13,707 is irobably salt aaer influx from overpressured sand lense, based in slight calinity increase of mudk(from 25,000 ppm to 35,400 ppm) and insufficient volume of gas released at surface for it to be equivalent to 5 bbls agas at 13,707.
drill pipe was backed-off at 10,680. just reported we have freed pipe to 12,580 whilst attempting second back-off at 13,300. possibly twisted off in tool joint since have been unable with 3 passes to get back in. will proceed very catiously to get more pipe out while waiting on offloading of sufficient barite and mud but do not want to leave more pipe in hole since are now clear of lowest chalk perforating interval. is mechanically impossible for us to drill deeper, or log interval 12,750 to 13,707 in time available.
we are consulting with gulf and conocos production dept. have norwegian permission to start testing programme. if no luck during night and prior to getting mud aboard we recommend plugging off fish and starting perforating and testing the cretaceous. casing shoe is at 12,747. repeat top of fish is below lowest perforation zone and can be cemented off

brandorff

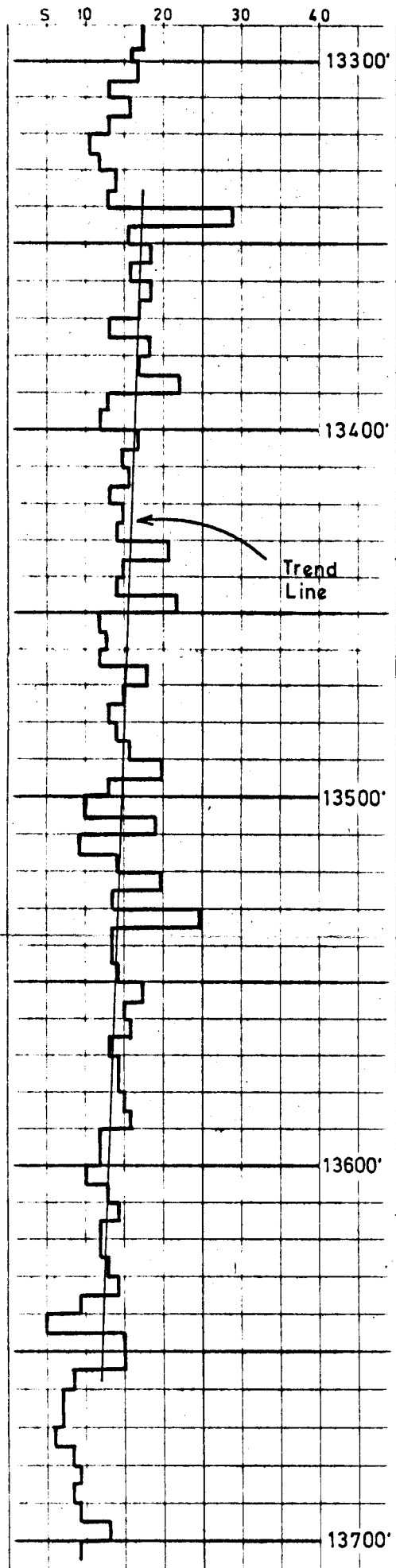
30.10.72 h 1812 gfl
✠
13960 conos n
conoco london

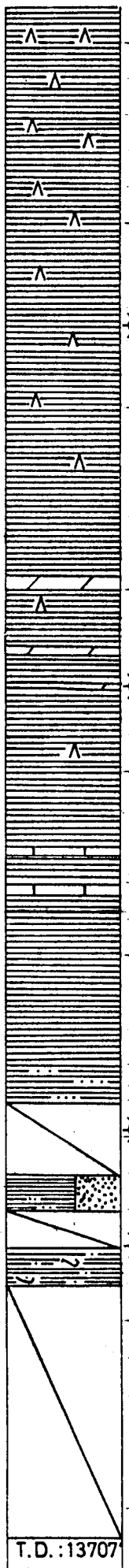
conoco oslo
ase

13960 conos n✠
[illegible]

CONOCO 2/1 - 1

R.O.P. and Cuttings Sample Log





Background Gas between 13,300' and T.D. varies as follows:-
1475 - 9200 C_1
228 - 1970 C_2
Tr - 1280 C_3
Tr - 408 C_4
with peaks as indicated

Peak { 32,200 C_1, 7,240 C_2, 576 C_3, 147 C_4

SHALE, grey - black, silty. with 30% - 60% GYPSUM, medium to coarse loose grains (possibly contamination of, or reprecipitation from, mud system)

As above, but 20% - 30% GYPSUM

Peak { 24,600 C_1, 6,840 C_2, 5,120 C_3, 510 C_4

Bands of DOLOMITE, white to light grey brown, tight with no shows

SHALE / CLAYSTONE, grey - black, silty, calcareous, with thin bands of dense micritic LIMESTONE.

Peak { 12,300 C_1, 2,280 C_2, 1,830 C_3, 510 C_4

Peak { 12,300 C_1, 3,800 C_2, 2,560 C_3, 510 C_4

As above with traces SAND, translucent, loose, medium to coarse, sub-rounded, no shows.
SAND, loose, fine to medium, trace glauconite.
CLAYSTONE, medium - dark grey, silty, occasional carbonaceous flecks and glauconite, abundant coarse white shell fragments.

I.A.D.S.
1 Sept. '77

GEOLOGICAL LIBRARY

2/1-1 W28

LIST OF CONTENTS

			Page
A.	Well location plat		1
B.	Geological reports		
	I	Summary	2
	II	Formation tops	3
	III	Stratigraphy	4
	IV	Hydrocarbon indications and geological notes on primary targets	7
	V	Electrophysical logging & Evaluation	8
	VI	Microfossil age determination	10
C.	Engineering reports		
	I	Well history	11
	II	Drilling curves and time distribution	23
	III	Bit record	26
	IV	Mud records	27
	V	Casing and cementing records	45
	VI	Production test	46
	VII	Suspension	54
D.	Enclosures		
	I	Composite log	
	II	Schlumberger logs	
	III	Palaeontological reports	
		(a) Roveda: Interval 1: 8,652'-10,008, and interval 2: 10,008'-10,610'	
		(b) McDaniel: Coccolith zonation for intervals 1: 9,630'-10,500' and 2: 10,520'-12,500'; Erilog for interval 9,950'-12,500'; summary of results	
		(c) Downie and Neves: Palynological report on the interval 12,230'-13,640'	
	IV	Flopetrol drill stem test report	
	V	Survey Report	
	VI	Core Analysis Report	

(1) TP
(2) Library
File in 2/1-1
W. 28.

Seq. file

File Note: 2/1-4 and 5 Part 1 **11-8-81**

Gary Bergman of Conoco called back today with information available in Conoco on the Well 2/1-1 kick. He only had limited further data:-

He confirmed that the kick occurred at 13707 ft with a 16 ppg mud in the hole and that a shut in drill pipe pressure of 1000 psi and a casing pressure of 940 psi occurred. Pit gain was 5 bbl.

The new information was that Conoco were fairly sure that it was a salt water influx as the mud salinity had increased from 25,000 to 35,000 ppm NaCl and that there was insufficient gas at surface to account for a 5 bbl gain.

There is no need to alter our earlier calculations. { Ref TNDH 6/7/81 see file 700/019

T.N.D. Hares

c.t. K.S. Dunne
N.R. Booth
File 2/1-4 Part 1 Drilling
File 2/1-5 Part 1 Drilling

B.G. Williams
A.M. Spencer
C.C. Bailey

Note paragraph 3 where Conoco feel that the 2/1-1 influx was most likely caused by a salt water influx.

A. LOCATION PLAT

CONOCO NORWAY INC.

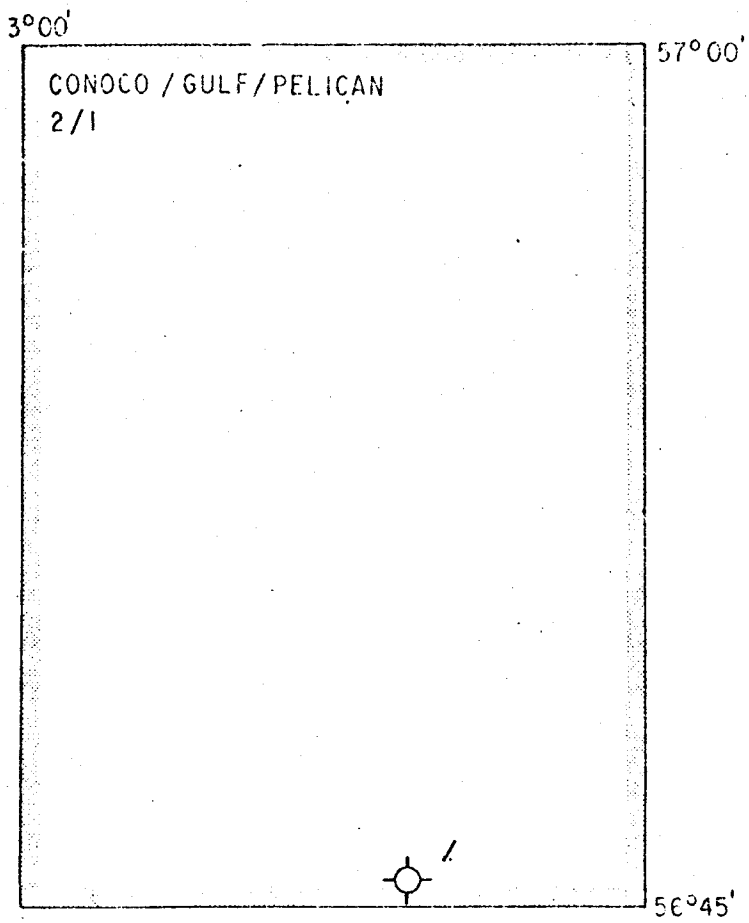
GULF OIL (GREAT BRITAIN) LIMITED

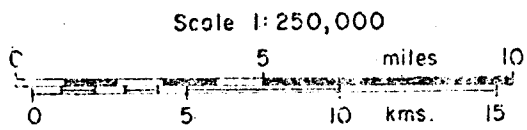
K/S A/S PELICAN ET COMPANY

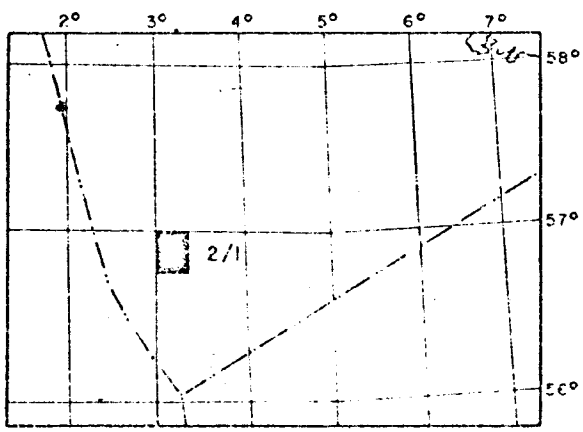
WELL LOCATION PLAT 2/1-1

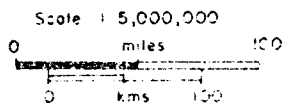
Country :- Norway
Area :- North Sea
Water depth :- 216'

Location Lat. : 56° 45' 26·2" N
Long. : 03° 12' 18·8" E
K.B. elevation :- 112'
T.D. 13,707'









B. GEOLOGICAL REPORT

I SUMMARY

The well 2/1-1 was drilled by the consortium Conoco Norway Inc., Norwegian Gulf Oil Production Co. and K/S A/S Pelican et Co. at 56° 45' 26.2"N, 03° 12' 18.8"E in Norwegian waters. The rig "Ocean Tide" was jacked up in 216' of water and spudded on 28th August, 1972.

A 36" hole was drilled to 520' K.B. (with 192' of penetration) and 30" casing was set with the shoe at 485'. A 26" hole was drilled to 1,360' K.B. and 20" casing was set with the shoe at 1,324'. A 17½" hole was drilled to 3,825'. This was logged and 13⅜" casing was set with the shoe at 3,785'. A 12¼" hole was then drilled to 10,008' at which depth logs were run; 9⅝" casing was then set with the shoe at 9,983' (Schlumberger).

The 8½" hole was then drilled to 10,385'. Core No. 1 was taken between 10,385' and 10,430' and the 8½" hole was continued to 12,750'. After logging a 7" liner was run from 9,806' - 12,747'.

A 5⅞" hole was drilled to 13,707' and at this depth the well "kicked" and the pipe stuck. During the "killing" operation, returns were lost and the surface mud volume dropped to a point such that circulation had to be stopped. After re-building the surface volume, circulation could not be re-established. While trying to back off, the drill pipe twisted off, leaving 1,117' of fish in the hole. A cement retainer was set and the well plugged back to 12,430'.

Three intervals between 11,876' and 12,279', totalling 152' of section, were perforated and acidized with 25,000 gallons. The well was then tested and a final flow rate of about 400 MCFD of gas was established.

While pulling the test tools, a drill collar pin parted, leaving 530' of collars and test tools in the hole. The well was then plugged and suspended.

Suspension operations were completed on 17th November, 1972. After waiting on weather, the rig was jacked down on 26th November and began the move to Dutch waters. On 29th November, the rig was caught in a severe storm and subsequently had to be towed to safety on the east coast of Denmark. The rig remained in Danish waters until 15th December when the move to Dutch waters was continued. Two days later, Petroland took over operation of the rig.

II FORMATION TOPS K.B. Elevations = + 112' to M.S.L.

	Drilled Depth	Subsea Depth	Thickness
QUATERNARY/TERTIARY			
Undifferentiated	328'	(-216')	8,322'
Oligocene - Top not determined but present at	8,650'	(-8,538')	197'
Lower Eocene	8,847'	(-8,735')	693'
Middle - Upper Palaeocene	9,540'	(-9,428')	722'
Lower Palaeocene (Danian)	10,262'	(-10,150')	385'
UPPER CRETACEOUS			
Maastrichtian	10,647'	(-10,535')	1,520'
Santonian-Campanian	12,167'	(-12,055')	113'
LOWER CRETACEOUS			
Albian-Aptian	12,280'	(-12,168')	109'
Barremian	12,389'	(-12,277')	101'
Berriasian-Valanginian	12,490'	(-12,378')	260'
UPPER JURASSIC			
Portlandian	12,750'	(-12,638')	250'
Kimmeridgian	13,000±'	(-12,888±)	717'
Total Depth (in Jurassic).	13,707'	(-13,595')	

III STRATIGRAPHY

No palaeontological age determinations were carried out for the upper portion of this well; the Quaternary and Tertiary above 8,650' K.B. are thus undifferentiated. Palaeontological age determinations were carried out on ditch cuttings from 8,652' - 10,610' K.B. (foraminifera), 9,620' - 12,500' K.B. (coccoliths) and 12,230' - 13,640' (palynomorphs) and are discussed below (p.10). Correlations based upon lithological and electro-physical log data are incorporated in the accompanying composite log.

1. Quaternary and Tertiary (328' - 10,647' K.B.)

(a) From the sea floor at 328' to 520', the well was drilled without sample returns. Below this, soft and sticky grey clays with abundant shell fragments were encountered. Lignite and pyrite are present in trace amounts and the formation is frequently silty; a single 15' unit of sand, composed of very fine to fine, loose, sub-angular to sub-rounded grains, occurs at 670' and minor interbeds of similar sand are present between 1,450' and 2,080'. Rare argillaceous limestone stringers occur at 3,520' and also between 4,950' and 8,650'. Thicker limestone horizons occur at 5,620' and 6,830' and between 7,130' and 8,450'; they are generally micritic or microcrystalline. This part of the succession also contains rare sand stringers and occasional horizons of very hard microcrystalline dolomite. Between 7,850' and 8,000', traces of foraminifera and worm tubes are preserved but the next 600', consisting of shaly claystones and rare interbedded limestones, are generally unfossiliferous.

(b) Oligocene (8,650±' - 8,847' K.B.)

This Stage is represented by soft and slightly silty grey claystones, often slightly calcareous, interbedded with brown to dark brown, micritic to microcrystalline, argillaceous limestones. Remains of serpulid worms, shell fragments and arenaceous foraminifera are locally abundant and indicate a moderately deep marine environment.

(c) Lower Eocene (8,847' - 9,540' K.B.)

The Lower Eocene differs little from the overlying Oligocene. However, the claystones are less calcareous and less silty although occasional interbeds of limestone (which occurs as thin stringers in three distinct zones, 9,100'-9,210', 9,285' - 9,355' and 9,500' - 9,540') and dolomite. The limestones are rarely glauconitic but contain chert nodules as well as shell fragments, arenaceous foraminifera and rare diatoms except between 9,200' and 9,350' where both the claystones and the limestones are tuffaceous.

(d) Upper Palaeocene (9,540' - 9,788' K.B.)

Brown silty claystones and shales with rare thin calcareous and occasional carbonaceous horizons are present throughout this relatively unfossiliferous formation. At 9,615' a 10' thick very calcareous and slightly pyritic siltstone occurs.

(e) Middle Palaeocene (9,788' - 10,262' K.B.)

The Middle Palaeocene may be subdivided into three distinct units. The uppermost consists of silty grey claystones and marls which are rarely dolomitic but which contain thin sandstone streaks between 9,800' and 9,820'; the middle unit consists of light cream cryptocrystalline limestone, containing abundant microfossils and occasional nodules of milky chert, interbedded with minor red-brown claystones and grey marls; the lowest unit (10,190' - 10,262') comprises red-brown to grey, calcareous to very calcareous claystones.

(f) Lower Palaeocene (10,262' - 10,647' K.B.)

The Danian is represented by light brown to creamy white, compact and hard, cryptocrystalline limestone which is occasionally soft and chalky or argillaceous in its upper part. The limestone is locally cherty and is stylolitic between 10,385' and 10,405'; an abundant microfauna is present throughout.

2. Cretaceous (10,647' - 12,750' K.B.)

Lithologically, no break is discernible between the Danian and the uppermost Cretaceous and electrophysical logs have been used for this and other inter-Stage correlations.

(a) Maastrichtian (10,647' - 12,167' K.B.)

The succession is characterized by pale grey to brown chalk which contains many bands of milky chert down to 11,400'. Apart from three prominent lignite bands which occur between 11,575' and 11,905', the Maastrichtian is extremely uniform.

(b) Santonian - Campanian (12,167' - 12,280' K.B.)

This chalk is lithologically similar to that of the overlying Maastrichtian and has only been distinguished by means of electrophysical logs (which indicated the existence of a thin shale bed, the "Log Top" of the Santonian-Campanian). However, there is a small amount of grey and red-brown silty claystone towards the base.

(c) Albian-Aptian (12,280' - 12,389' K.B.)

At the top there is an abrupt change from the chalk fancies of the Upper Cretaceous to the gray marls and interbedded limestone horizons typical of the Lower Cretaceous and Upper Jurassic. Within this Stage, grey and grey-brown limestones are locally prominent although they become thinner and more marly with depth. Molluscan and microplanktonic remains are abundant while disaccate pollen and spores are also present.

(d) Barremian (12,389' - 12,490' K.B.) and Valanginian-Berriasian (12,490' - 12,750' K.B.)

The base of the Cretaceous is represented by an uninterrupted series of very calcareous dark grey shales and marls. These are occasionally micromicaceous and silty and contain traces of pyrite and glauconite.

3. Jurassic (12,750 - T.D. (13,707'))

(a) Portlandian (12,750' - 13,000' K.B.)

The top of the Jurassic can not be accurately defined in this well although there is a gradational change from the grey shales and marls of the basal Cretaceous to grey and grey-black, bituminous and non-calcareous shales interbedded with rare coals and increasing amounts of crystalline limestone. The limestone is colourless to white but the contained calcite fragments become red- or brown-coated with depth. Within the crystalline limestone formation, two 7'-thick sandstone units, fine - to very fine-grained and slightly calcareous, occur at 12,890' and 12,930'.

(b) Kimmeridgian (13,000' - T.D. at 13,707' K.B.)

A marked facies change occurs at or near the top of the Kimmeridgian. Grey-black, calcareous and occasionally silty bituminous shales of typical Kimmeridge clay facies persists down to 13,570'; rare and thin calcareous bands are present throughout but are commoner between 13,000' and 13,100' although a prominent grey-brown micritic limestone bed occurs at 13,530'. Dolomite beds are developed in two intervals: 13,130' - 13,270' and 13,445' - 13,475'. The dolomite is of two types, grey-brown and micritic and the more common crystalline variety which is white to pale grey, fine- to medium-grained and contains occasional pyrite and fossil casts.

From 13,580' to 13,645', medium-grained colourless to white sandstone is interbedded with silty grey shale. Both lithologies are glauconitic while the shale is carbonaceous and contains abundant white shell fragments. No cuttings were recovered from the interval 13,645' and T.D. at 13,707'.

IV Hydrocarbon Indications and Geological Notes on Primary Targets

The Core Lab gas detector recorded no gas in the unconsolidated Quaternary and Tertiary sediments above 1,300' K.B. but between 1,300' and 3,500', background methane averaged 25-1000 p.p.m. with peaks ranging from 13,000 p.p.m. at 1,900' to 65,000 - 130,000 p.p.m. at 3,450'. Within the Tertiary silty claystones (3,500' - 7,500'), background methane ranged from 350 - 10,000 p.p.m. (with a mean of 4,000) while peaks were less pronounced at 16,000 - 32,500 p.p.m. methane. In the lower parts of the Tertiary and the uppermost Cretaceous (7,500' - 11,800'), background gas decreased to a mean of 500 p.p.m. and there were no gas peaks greater than 2,500 p.p.m. methane. However, oil shows (dull gold fluorescence with slow straw-yellow cut) were observed in the shales at the base of the Middle Palaeocene and at the top of the Danian limestone (10,250 - 10,425'), especially at 10,370' where there was a good straw-yellow streaming cut (faster than the upper intervals) accompanied by a minor gas peak (6,000 p.p.m. total gas).

Higher members of the paraffin series appeared in the lower parts of the Maestrichtian limestones and throughout the Santonian-Campanian (11,800' - 12,280'), particularly in the lignite bands. Gas peaks of 50,000 - 175,000 p.p.m. methane, 7,600 - 15,800 p.p.m. ethane, 3,300 - 6,600 p.p.m. propane, 2,000 - 5,000 p.p.m. butane, and up to 400 p.p.m. hexane were obtained although the limestone porosity was only 7-12%. Below 12,200', at the base of the Cretaceous limestones, total gas readings dropped sharply from 70,000 p.p.m. to less than 10,000 p.p.m. in the Lower Cretaceous shales (the sandstone facies being absent at this locality).

A 1% pale yellow fluorescence, sometimes accompanied by a straw-yellow streaming crush cut in the limestone horizons, confirmed the presence of oil in the dark brown tarry spots at the top of the Campanian and within the Berriasian (12,500'). Weak fluorescence with a milky yellowish white cut fluorescence indicated oil within the gas-bearing (60,000 - 70,000 p.p.m. total gas) sandstone horizons at the base of the Portlandian but no such staining or fluorescence was observed in the Kimmeridgian. However, background gas readings in the bituminous shales, claystones and thin dolomite beds in the middle parts of the Kimmeridgian ranged from 2,000 - 8,000 p.p.m. methane, 200 - 2,000 p.p.m. ethane, trace to 1,200 p.p.m. propane and trace to 400 p.p.m. butane with peak readings 2-8 times these figures; gas concentrations were increasing when the well was shut in at 13,707'.

The test intervals 11,876' - 11,941', 12,160' - 12,202' and 12,234' - 12,279' were perforated through casing. After acidizing the formation, gas came to the surface within one hour, flowing in surges with acid water and thick emulsion. Production was 400 MCFD with a very little liquid but the zone tested is extremely tight.

Analyses of the gas samples varied considerably with time. Methane decreasing from 79% to 50%, ethane + propane increasing from 11% to 31% while hexanes and higher homologues increased marginally from 0.67% to 1.38%.

V Electro-Physical Logging & Evaluation

i) All Electro Physical Logging was carried out by Schlumberger Well Surveying Corporation. The following logs were run over the intervals shown:

BHC	Sonic/Gamma	1	1,324'-3,822'	(Sonic)
			175'-3,822'	(Gamma Ray)
		2	3,785'-9,364'	
		3	9,364'-10,011'	
		4	9,998'-12,740'	
IES		1	1,324'-3,825'	
		2	3,785'-10,014'	
		3	9,991'-12,748'	
MLL/ML		1	9,997'-12,470'	
Dual Laterlog		1	9,990'-12,470'	
Compensated Neutron				
(FDC/CNL)		1	9,980'-12,470'	
(CNL/CCL)		2	9,750'-12,400'	
Cement Bond		1	9,750'-12,400'	
Perforation Record		1	11,800'-12,350'	
C. P. I.		1	10,000'-12,450'	

ii) Evaluation

Results from a Schlumberger Computer Processed Interpretation are as follows:-

3481 3545

Upper Limestone Unit (Middle Palaeocene) Interval 10,004'-10,186' KB

The main zone of interest in this unit is interval 10,004'-10,064' KB where ϕAV = 19%, ϕ max = 22%, and Sw AV = 55%, using an Rw = 0.025 Ω m^2/m and Ph = 0.8. The relatively low average water saturation value is, however, surprising as no significant hydrocarbon shows were observed while drilling this unit. The probable answer is that an incorrect (too low) value of Rw has been used for this limestone unit i.e. the formation water is fresher than in the underlying Danian - Maastrictian limestones.

3571 3771

Danian - Maastrichtian Limestones. Interval 10,262'-10,837' KB

The main zones of interest are as follows:- Rw = 0.025Rm^2/m, PL = 0.8

Interval (KB depths)	ϕ AV	ϕ max	Sw AV	Sw min
10,262'-10,300'	12.5%	16%	76%	40%
10,364'-10,390'	17%	20.5%	61%	42%
10,408'-10,431'	17%	21%	70%	54%
10,444'-10,474'	14.3%	16%	79%	68%
10,512'-10,562'	16.5%	20%	76%	65%
10,718'-10,837'	14%	19%	96%	77%

$\bar{\phi}$ = 15% ϕ_{max} = 21%

The most likely zone to produce oil is the Danian interval 10364' - 10390' KB(26ft.). However, by comparison with surrounding wells, the flow rate would not be expected to exceed 1000 BOPD, which from this thin an interval would undoubtedly be non-commercial.

4132 4273

Basal Maastrichtian/Santonian-Companion Limestones. Interval 11874'-12280' KB

In this basal Chalk interval the following zones are of interest:-

RW = 0.02 ohms. ph = 0.25

Interval (KB depth)	ØAV	ØMAX	SWAV	SWMIN
11874'-11898'	9.5%	13%	40%	22%
11902'-11938'	7.7%	10%	59%	30%
12158'-12171'	12%	14%	31%	12%
12185'-12198'	10%	13%	48%	32%
12232'-12277'	10.6%	13%	52%	37%

$\bar{\phi}$ = 10%

As suggested by the log analysis, a production test of selected zones proved the interval to be gas or gas condensate bearing but tight.

VI Microfossile Age Determinations

No palaeontological age determinations were carried out above 8,650'.

Palaeontological evidence (Roveda and McDaniel) suggests that the Upper and Middle Eocene is absent, the "Palaeontological Top" for the Lower Eocene agreeing very well with the "Log Top". The interval 9,970'-10,260' is somewhat problematical. All methods indicate that the top of the Danian is at or about 10,260' but McDaniel recognises "Selandian" flora in the interval 9,980'-10,230', together with abundant "reworked" Maastrichtian coccoliths, and suggests a correlation with similar rocks in Denmark. However, Roveda postulates that the unit 10,000'-10,190' is an allochthonous element (composed of slumped Danian, 10,000'-10,150' and Maastrichtian, 10,150'-10,190') within Palaeocene clays. Preference is given to McDaniel's hypothesis since this unit can be correlated with several other wells in the area.

Minor discrepancies occur between electrophysical and palaeontological interpretations in the interval, 12,150'-12,500'. The Composite Log shows the electrophysical log based correlation with neighbouring wells since the palaeontological deductions have been based upon heavily caved samples.

The top of the Jurassic (Portlandian) has been based upon the palnological work of Downie and Neves and has been arbitrarily picked mid-way between two sampling depths. There is a possibility that the top of the Kimmeridgian is repeated as a consequence of faulting since there is much calcite present and the whole Kimmeridgian section is considerably thicker than that of neighbouring wells.

C. ENGINEERING REPORT

Lee Graphics

Lee Graphics Instruments, Inc.

Model 1000 Series Recorder

Serial No. 1000-1-1-1

Chart Speed: 1 Inch per Hour

Chart Range: 0 to 100

Pen Range: 0 to 100

Pen Range: 0 to 100

Pen