L-11

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Final Geological Report

Well: 9/4-1
Province: North Sea
Location: 57°35'02" N
04°01'13" E

Concession: Block 9/4
Country: Norway
Elevation: K.B. to Seafloor , 317'

Near Seismic s.p. 2462½
line 5735

Reference Datum: (KB) 95' abv MSL

Date spudded: 31 March 1968
Status: Junked and abandoned

Date Completed: 19 May 1968
Total Depth: 9720'

Objectives

Primary

Mid Jurassic Sandstone
Bunter Sandstone

Secondary

Basal Tertiary Sandstones
Upper Cretaceous Chalk
Lower Cretaceous Sandstones
Upper Triassic Sandstones

Shows: 1650'-3000' Tertiary shale - gas (methane only)
6480'-6530' Jurassic shale - gas
7150'-7440' Jurassic shale - oil and gas
7507'-7608' Mid-Jurassic sand - oil

Tests: None

Cores: Cut 73 sidewall cores. Recovered 69 sidewall cores.

Drilling Contractor and Rig: Zapata offshore Endeavour (Cont.Emsco 20-R)

Hole size	interval	casing	shoe depth
48"	317' to 380'	36"	475'
26"	380' to 1230'	20"	1097'
17½"	1230' to 3629'	13-3/8"	3584'
12¼"	3629' to 9720'		

Drilling fluid:	Interval:
Sea water - gel	317' to 3629'
Spersene XP-20	3629' to 9720'
(saturated w/salt at 9720')	

Well costs:

Total well cost:	$ 1,460,000	estimated
Evaluation cost:	$ 45,000	estimated

Personnel:

The following Amoseas personnel were involved in wellsite operations while drilling the subject well;

J.C. Bayless	-	Drilling Superintendent
J.J. Bruns	-	Wellsite Geologist
J. Clarke	-	Wellsite Geologist

Enclosures:

1. Amoseas Composite Well Log
2. Exploration Logging - Robertson Mud Log

Appendices:

1. Clay Mineralogy Analysis (Robertson Research)

2. Hydrocarbon Analysis (Robertson Research)

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SUMMARY AND CONCLUSIONS

The 9/4-1 well was drilled at a unique location whereby multiple prospects (Tertiary to Mesozoic) could be tested in structurally high positions on the largest Mesozoic closure on the Fisher Bank Arch high.

The primary objective in the well was an estimated 200 feet of Jurassic sandstone. Eighty three net feet of Jurassic sandstone was penetrated in a sand body from 7507 to 7608 feet. Fair shows were logged in the upper 15 feet of the sand. The remainder had very scattered poor shows. Porosity averages 25 percent and examination of sidewall cores indicates a clean-permeable sandstone reservoir. Unfortunately, logs as well as all other data combine to condemn the sand as 100 percent water saturated. An updip accumulation of hydrocarbons may be present but the limited areal extent and thickness of the reservoir render the prospect uneconomic.

The second primary objective, the Bunter Sandstone, is represented by an estimated 200 feet of thin interbedded sands and sandstones scattered throughout a thick Triassic section composed predominantly of silty red brown to pastel claystones. There were no shows in the Triassic.

Basal Tertiary sandstones, Upper Cretaceous Chalk and Lower Cretaceous sandstones were secondary objectives, but were non productive due to either the absence of the predicted lithologies or the non development of reservoir properties in the sediments present.

No economic accumulations of hydrocarbons were found in the 9/4-1 well. Nevertheless an excellent sandstone reservoir with slight traces of hydrocarbons was discovered.

This fact, when combined with a large structure, salt piercement and major faulting suggest that several exploratory wells may be needed to evaluate the Fisher Bank Arch.

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Table of Stratigraphic Units

Unit	Depth	Thk.penetrated
Quaternary	317'(-222')	831'
Tertiary	1148'(-1053')	3232'
Pliocene	1148'(-1053')	112' Pli
U.Miocene	1260'(-1165')	215'
M.Miocene	1475'(-1380')	220' } 860 Mi
L.Miocene	1695'(-1600')	425'
Burdigalian	1695'(-1600')	385'
Aquitanian	2080'(-1985')	40'
Oligocene	2120'(-2025')	800' Ol
U.-M.Eocene	2920'(-2825')	600' } 763 Eo
L.Eocene	3520'(-3425')	163'
Paleocene	3683'(-3588')	697' } 1057 Pc
Danian	4020'(-3925')	360'
U.Cretaceous Reworking?	4380'(-4285')	1539' UK
?Danian-Maastrichtian	4380'(-4285')	60' } 585(-) Ma
Maastrichtian	4440'(-4345')	495'
U.Campanian	4935'(-4840')	145' } Ca 455
L.Campanian	5080'(-4985')	310'
Santonian	5390'(-5295')	150' Sa
Coniacian	5540'(-5445')	379' Co
L.Cretaceous	5919'(-5824')	491'
Albian	5919'(-5824')	29' Al
Aptian	5948'(-5853')	29' Ap
Barremian	5977'(-5882')	101' Ba(+) } 433
L.Barremian-Hauterivian	6078'(-5983')	62' Ha(-)
Hauterivian-Valanginian	6140'(-6045')	100'
Valanginian	6240'(-6145')	170'
Jurassic	6410'(-6315')	1237' ok
Kimmeridgian	6410'(-6315')	976 ~~1237'~~
Mid-Jurassic Ls. (pink seismic pick)	7386'(-7291')	121 ~~84'~~ } 185 M.Ju
Mid-Jurassic ss.	7507'(-7412')	140 ~~101'~~
Triassic	7647'(-7552')	1995'
Permian (?) evaporites	9642'(-9547')	78'

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Stratigraphy

Quaternary

Recent and Pleistocene 317' to 1148' KB thickness 831'

Predominantly sand with some interbedded clay. The lithology is inferred from the few cuttings recovered and the drilling rate curve as almost all of the section was drilled with complete mud loss. The sands are very fine to fine grained, white to clear, sub angular to rounded with abundant shell debris.

-1053 -4285

Tertiary 1148' to 4380' KB thickness 3232'

The top of the Tertiary is arbitrarily picked at 1148' on the basis of a gamma ray deflection. Below 1148' clay predominates, while above 1148' the gamma ray curve indicates sands which are assumed to be Pleistocene in age.

-1053 -1165

Pliocene 1148' to 1260' KB thickness 112'

Clay: gray, soft, generally very carbonaceous, strong H_2S odor with HCL.

-1165 -1600

U. and M. Miocene 1260' to 1695' KB thickness 435'

Clay: gray, soft, generally non calcareous, finely micaceous grading to argillaceous gray siltstone with rare thin interbeds of pink marly limestone.

-1600 -2025

L. Miocene 1695' to 2120' KB thickness 425'

Clay: gray to gray brown, soft, very micaceous, generally non calcareous, slightly glauconitic with thin interbeds of light gray to light tan clay, very calcareous, flaky, grading in part to pink argillaceous marly limestone; occasional shell debris and pyritized fossils.

-2025 -2825

Oligocene 2120' to 2920' KB thickness 800'

Clay-claystone: gray to gray brown, micaceous, generally non calcareous but occasionally slightly calcareous, slightly silty and grading to siltstone and silty sandstone; traces of pelecypod shell fragments and pyrite.

-2825 -3425

U. to M. Eocene 2920' to 3520' KB thickness 600'

Clay: gray to gray brown, with a slight reddish tint, micaceous, calcareous, generally very silty and commonly grading to siltstone and sandy siltstone; traces of limestone, brown, hard, argillaceous and occasional shell fragments.

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-3425 -3588

L. Eocene 3520' to 3683' KB thickness 163'

Siltstone: greenish gray, soft, very calcareous, coarsely micaceous, glauconitic, argillaceous grading to clay, gray to green gray, soft, micaceous, silty, glauconitic, finely pyritic; rare shell fragments.

A distinguishing feature is the predominant siltstone lithology.

-3588 -4285

Paleocene 3683' to 4380' KB thickness 697'

Claystone-shale: generally gray to gray green but occasionally salmon to light tan gray, soft to firm fissile, calcareous to very calcareous-marly, very micaceous, finely glauconitic and pyritic (some pyritic plant remains); sandstone, quartz, hard, poorly sorted (silty to very coarse grained), sub-angular to well rounded, argillaceous grading to siltstone, dark purple brown, hard, angular, micaceous gritty, pyritized.

The distinguished feature of the Paleocene is the very calcareous nature of the sediments.

-4285 -5824

Upper Cretaceous 4380' to 5919' KB thickness 1539'

Limestone: white to off white, firm to hard, fossiliferous, chalky grading to chalk, white to buff tan to gray, soft, argillaceous; chert, brittle, colorless, gray and rose translucent, commonly milky white opaque. The chert is not very abundant. The distinguishing feature is the predominant chalk lithology.

-5824 -6045

Lower Cretaceous (Albian to Valanginian) 5919' to 6140' KB thickness 221'

Claystone: varicoloured yellow green, green yellow, red gray, dull brick red, and gray black, soft, calcareous, sticky.

The distinguishing characteristic is the common yellow hue of some of the claystones.

-6045 -6315

Lower Cretaceous (Valanginian) 6140' to 6410' KB thickness 270'

Claystone: gray to gray brown, soft, calcareous, pyritic with thin argillaceous pyritic siltstone interbeds which occasionally grade into sandstone, brown, very fine grained, silty and dirty.

-6315 -7552

Jurassic 6410' to 7647' KB thickness 1237'

Kimmeridgian undifferentiated 6410'-7386' KB thickness 976'

Claystone; gray to gray brown, soft to firm and subfissile, pyritic, fossiliferous, silty grading to common gray siltstone and rare silty sandstone; shale, firm to brittle, gray, calcareous, silty, fossiliferous near the base of the interval.

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-7294 -7412

Jurassic limestone and shale 7386' to 7507' KB thickness 121'

Predominantly shale as described above with thin interbeds of limestone, gray to light brown to tan, hard, microcrystalline grading to and becoming in part dolomite, light brown, hard, finely crystalline sucrosic.

7412 7552

Jurassic Sandstone Interval(incl. Mid-Jurassic sand) 7507' to 7647' KB thickness 140'

The Jurassic sandstone interval is extended to include all the section from the top of the first sandstone at 7507' to the top of the Triassic red beds at 7647'. Although the massive sandstone occurs from 7507' to 7608', the logs and cuttings data indicate that the remainder of the section is sandy and silty enough to permits its being included as part of a more general sandstone interval.

The sandstone is white to clear, soft, friable, clean, very fine to fine grained with rarer medium to coarse grained laminae, fair sorted, subround to round, slightly calcareous and silty with interbeds of dark brown lignitic micaceous claystone.

Below the main sandstone the interval is predominantly siltstone, green to light green, soft, micaceous and slightly calcareous with pale green, micaceous, pyritic claystone.

-7552 -9547

Triassic 7647' to 9642' KB thickness 1995'

Interbedded claystone and sandstone: claystone, red brown, but also very commonly white, gray white, pale green to green gray, generally soft but occasionally firm to hard, muscovitic and chloritic, rarely anhydritic, kaolinitic, calcareous, silty to sandy and commonly grading to varicoloured siltstones. The pastel claystones are usually very silty to sandy and are associated with the sand and sandstone intervals. The sands and sandstones are white to clear to occasionally pink, quartz, very fine to fine to rarely coarse grained and conglomeratic, subrounded to rounded, loose to firm and friable, commonly glauconitic and pyritic, slightly calcareous (cement), relatively clean but becoming in part very micaceous and argillaceous. The sands appear to be thinly interbedded with the light coloured clays, the thickest individual sandbeds probably not exceeding 15 to 20 feet. It is possible that much of the loose quartz occurs as free quartz grains in the soluble clay and is concentrated as a residue after the cuttings are washed. As a result of the unrecovered drill pipe the Triassic section of the hole was not logged and therefore an accurate sand count is impossible. Using the combined drill rate and cuttings data a very approximate 200 feet of sand is estimated to occur in the Triassic.

<u>Permian(?) Evaporites</u> 9642' to 9720' KB thickness 78'

<u>Halite</u>: translucent to clear with intermixed and interbedded anhydrite and carnallite. Anhydrite generally white to light gray, hard, amorphous and occurs as whispy inclusions and as thin interbeds in the halite; carnallite, blood red opaque, bitter taste, occurs as thin interbeds and as finely disseminated crystals in a predominant halite matrix. Combined paleontological and palynological investigations do not confirm a precise Permian age but the presence of potassium minerals at the top of the salt strongly suggests that the evaporites are Permian. Potassium mineralization is common in the Permian evaporites drilled in the English and Danish parts of the Zechstein salt basin.

Paleontology

The paleontology and palynology were done by Robertson Research Laboratories, Llandudno, North-Wales. A final report will be submitted separately.

In most instances the tops used in the report and on the composite log have been picked from paleo data and occasionally adjusted to clear cut lithologic breaks. In a few cases the tops are purely lithologic as for example the top of the Permian(?) evaporites at 9642'.

Six sidewall cores from the interval 7610' to 7922' were examined for age determination.

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Well Data, Drill cuttings and Sidewall core Distribution

Cuttings

Two sets of washed cuttings, 10'-20' intervals, are stored in the Amoseas warehouse, Pernis, Holland. A set of washed and dried cuttings will also remain in the Amoseas office, the Hague, Netherlands and a set of cuttings has been stored in CandT's office, Oslo, Norway. Also, a set of cuttings has been sent to the Ministry of Industry and Handicrafts(Petroleum Section) Oslo, Norway.Five sample splits, for trade purposes, will be stored in Amoseas Pernis,Netherlands warehouse.

Sidewall cores

Sidewall cores are to be stored in the Amoseas warehouse, Pernis, Holland.

Well Data

Originals of all well data are kept in Amoseas The Hague office. Duplicates of all pertinent well data have been forwarded to Amoseas New-York, London and Oslo offices. Duplicates have also been sent to the Ministry of Industry and Handicrafts (Petroleum Section) Oslo, Norway.

Wireline Surveys:

(All logs were run by Schlumberger)

Survey	Run No.	Interval
IES	1	1093-3628
IES	2	3583-7937
BHC-Sonic	1	1093-3300
BHC-Sonic	2	3583-7935
GR	1	300-3300
GR	2	3200-7935
CDM	1	1093-3275
FDC	1	3583-7935

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Drilling Problems.

Lost Circulation

After driving and cementing the 36" conductor pipe to 400 feet, drilled out with 17½" bit and lost partial returns. Drilled ahead to 610 feet and lost complete returns, drilled to 1400 feet without returns and reamed 26" hole to 924 feet when bad weather forced a 12 hour operations delay. When returned to reaming found unable to ream below 890 feet due to a collapsed and caving hole. Set six cement plugs around the bottom of the 36" pipe in an effort to stop the lost circulation outside the 36" pipe. Placed 1000 sacks of cement in the 35 foot wide crater which had formed around the 36" pipe at the seafloor. Attempted to ream ahead and the hole continued to fall in below 430 feet. Redrove 36" pipe to 438 feet to effect a circulation seal but upon drilling out lost complete returns. Redrove 36" pipe to 475' but lost complete returns at 470 feet when attempted to drill out. Washed and reamed to 1230 feet, spotted gel mud and ran 20" casing to 1097 feet.

The problem was a direct result of having to leave the hole standing for 12 hours during the storm delay. There is no way to avoid a similar occurrence in future wells but this time loss emphasized the importance of a good conductor pipe seal as well as rapidly run surface casing.

No further lost circulation was encountered throughout the hole.

Stuck Drill Pipe

While drilling a 12¼" hole at 7391 feet with 10.1 lb/gal. mud the drill pipe became stuck. The mud weight was increased to 10.3 lb/gal. and the drill string was quickly freed. The wireline logs indicate a low velocity - low density shale zone from 7230' to 7370' which may be slightly overpressured. The mud and hole behavior before the actual sticking suggests an overpressured condition with the resultant shale sloughing and drilling difficulties.
In future wells we can avoid this problem by an immediate mud weight increase as soon as the indications become evident.

Again, while drilling a 12¼" hole at 9720 feet with 10.5 lb/gal. mud, the pipe became stuck in salt while making a connection. Fishing operations were basically involved with increasing mud weight (i.e. hydrostatic pressure) to combat salt flowage while, at the same time, placing fresh water and detergent slugs opposite the lower drill collars in an effort to dissolve the salt and free the pipe. All efforts to free the pipe

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failed and after 5 days of fishing it was decided to abandon the hole.

In this case the cause of the stuck drill string was evident. Returns from the salt bed, particularly after the various wash jobs, consisted of halite with abundant intermixed and interbedded red carnallite (a low density 1.57 sp.gr. hydrous potassium magnesium chloride). The low density salt is especially subject to flow and as soon as circulation (and dissolution) was slowed prior to making the connection the salt quickly extruded into the bore hole and stuck the drill pipe. Furthermore, the dome is probably an area of active stresses and salt flowage may have been a problem throughout the salt core regardless of salt composition.

If future wells are drilled in the same or similar areas this problem can be handled only by increased mud weights. As a result, casing programs should be designed accordingly. It is possible that 17 or 18 lb/gal. muds might have to be used to control salt flowage.

Logging Problems

Considerable tool difficulties occurred during logging job no.2 on May 2, 1968. Equipment failures were found in the microlog-microlaterolog combination tool, the continuous dipmeter tool and the sidewall core guns. Malfunction of sidewall core gun no.1 through misfiring resulted in 17 recovered cores of indeterminate depths. Also depths of cores from the remaining guns could not be accurately determined until all cores were recovered. This explains why some intervals were double shot and core spacing was not more even.

Formation Evaluation

Pleistocene - Tertiary

The Pleistocene occurs above the 20" casing shoe at 1097 feet where there were no returns. An evaluation of the section is therefore not possible. The gamma ray curve indicates the section to be predominantly sands or silts with interbedded clays.

The top of the Tertiary probably occurs slightly below the 20" casing shoe (1097 feet). There are no significant reservoirs developed in the Tertiary. A few thin silty sands or siltstone beds occur from approximately 1100 to 2190 feet. They were not identified in the cuttings. The beds calculate 100 percent saltwater assuming a 30 percent porosity and an Rmf/Rw ratio equal to one (no sp.).
From 2190 feet to the top of the Chalk at 4380 feet the Tertiary is clay except for some thin pyritic silty sandstones in the interval 3710 to 3780'.

From 1650' to 3000' very high methane shale gas readings were recorded. The high readings were due to the naturally carbonaceous and gassy nature of the clays as well as the low viscosity-low density drilling fluid (sea water) employed. Note the gas decrease when the sea water was displaced with mud at 3000 feet.

Cretaceous Chalk

There were no shows in the chalk and no evidence of permeability as visible open fractures or lost circulation etc.

The chalk has the normally high porosities, 30 to 35 percent, at the top which decreases with depth and compaction to 10 to 15 percent range. Below 5500 feet some low velocity zones are evident and are due to a slight clay content in the chalk. A Magnolia Plot (see fig.1) yields a matrix velocity of about 21,000 ft/sec. and indicates a 100 percent water saturation. Point 1, which appears to have a 75 percent water saturation, occurs at the very top of the chalk in a washed out unconsolidated and slightly argillaceous zone.

An Rw of .08 ohm meters, calculated from the SP, yields Ro's equal to the measured RT's, indicating a 100 percent water saturation.

Jurassic Shale

In the Jurassic shales, slightly above the Mid-Jurassic sandstone, gas shows of methane through iso-butane were recorded from 7150' to 7435'.

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Methane reached a maximum of 1020 ppm while the heavier components were present in quantities less than 100 ppm. Total gas was not high, averaging about 13 to 15 units over the interval.

The zone is characterized by a high gamma ray activity, low density and low velocity in comparison to surrounding beds, increased resistivity and the presence of the gas mentioned above. While drilling through the zone progressively deteriorating mud properties, cuttings quality and general hole conditions were experienced culminating in stuck drill pipe at 7391 feet. These conditions suggest a slightly overpressured state in the shale. The cuttings are described as siltstone and shale which is commonly hard and brittle with calcite filled veinlets. The gas detected is felt to be primarily fracture gas. If it were normal interstitial shale gas the cuttings gas readings would be considerably higher.

It is interesting to note that there is a similar Jurassic interval from 8430 to 8920 feet in the Dansk Nord B-1 well. Log and gas curve responses from the two zones are practically identical. At the time of drilling the DNB-1 well, this office felt that the 500 feet of gassy fractured shale should have been more fully evaluated. In the present well the interval is of insufficient thickness to have warranted further evaluation. The better gas readings occur over an interval of only 100 feet.

Although the show interval has no reservoir characteristics the shows are very significant in the fact that they prove the shale section to be highly oil and gas generative.

Mid-Jurassic Sandstone

The sandstone, which was the primary well objective, occurs from 7507 to 7608 feet and includes 83 feet net of sand. Poor to fair shows of oil occurred in the upper 15 feet of the sand while the remainder contained a few scattered traces of oil. Gas shows were very weak throughout the sand with the best readings corresponding to thin interbeds of black lignitic shale. Methane reached a maximum of 230 ppm with traces of ethane. Total gas read only 5 to 6 units over the entire sand body.

The results of a Magnolia Plot (see fig.2) using density vs 16" normal resistivity (conductivily could not be used due to an insufficient log scale) indicates the sand to be 85 to 100 percent water wet. The small oil saturations calculated are probably due to either a slight residual oil saturation as evidenced from the shows detected or to subtle minor invasion effects. In calculating saltwater saturations an Ro of .54 ohm meters was calculated using an Rw of .045 ohm meters (estimated from the SP) and a

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porosity of 25 percent (formation factor = 12). Normally Rt is taken from the conductivity curve but in this instance the resistivities of the sand were so low that the log scale was insufficient to measure the maximum conductivities. The reason for the abnormally low induction log resistivity value is likely a combination of the reciprocator not functioning correctly in the 1 ohm or less range as well as the tendency of the 6FF40 induction tool to record unnaturally high values when conductivities are above 1000 millimhos. The induction log resistivities are between .10 and .20 ohm meters and these Rt's result in saltwater saturations which are much greater than 100 percent as well as calculated Rw's in the supersaturated region. If the resistivities from the 16" normal are used as Rt then saltwater saturations of near 100 percent result. In this case the 16" normal is probably giving a reliable Rt value as clean sands in the 25 to 30% porosity range are generally not seriously effected by invasion under reasonably normal drilling conditions which existed at the time this interval was penetrated.

Considering all information it is concluded that the mid-Jurassic sandstone does not contain any significant hydrocarbon accumulation, although a minor show was recorded in the upper part of the sand.

Triassic

The only logs available, over all but the top 200 feet of the Triassic, are the cuttings and mud logs. No wireline logs were run over the remainder of the interval as a result of the drill pipe fish left in the hole. An estimated 200 feet of thinly bedded sandstones occurs in the predominantly claystone and shale section. There were no shows detected in the cuttings or by the mud logging equipment. It is assumed that the Triassic contains no commercial hydrocarbons.

Permian(?) Evaporites

The interval is composed entirely of evaporites and there are no potential reservoir rocks within the section.

Analyses

Grain densities on seven shale sidewall cores from above, in and below the Mid-Jurassic Sandstone were determined by Robertson Research Ltd. and the results are presented below:

Core depth(feet)	Specific gravity
7258	2.39
7437	2.62
7540	2.50
7610	2.79
7718	2.69
7820	2.66
7922	2.72

Mineralogical content of the above samples was also carried out by Robertson Research and the results are attached as appendix No.1.

Hydrocarbon analyses of these sidewall core samples from above and in the Mid-Jurassic Sandstone were done by Robertson Research and the results are included as appendix No.2.
These analyses were done in an effort to gain some insight into percentages and compositions of any hydrocarbons present in the samples. The results indicate that the shales are hydrocarbon bearing and that they could be classed as oil and gas generative.

J.J. Bruns
Wellsite Geologist 9/4-1

JJBr/ms

BIT RECORD

Bit No.	1-RR	2	1-HO-RR	2-RR	2-HO-RR
Size	26	17½	48	17½	26
Make	HTC	SEC	SEC	SEC	SEC
Type	OSC	S3T	Hole Opener	S3T	Hole Opener
Serial No.	260130	945248	Custom	945248	Custom
Jets	REG	3 x 24	-	3 x 24	-
Depth Out	368	380	380	1400	924
Footage	51	12	-	1020	-
Hours	1.5	1.0	2.0	13.5	4.5
ROP Ft./Hr.	34.0	12.0	-	75.6	-
Cum. Hours	1.5	2.5	2.5	16.0	16.0
Weight Kip	0.5	0.5	0.5	10	5-10
Rotary RPM	50	50	50	140	90
Rotary Ft-Lbs.	100	100	100	140A	200A
Pump PSI	600	600	600	1600	600
Pump GPM	970	970	970	1150	1150
Ann. Vel.	-	-	-	100	-
DP Bit	-	-	-	600	-
Bit HHd	-	-	-	403	-
Liner	7½	7½	7½	7½	7½
SPM	84	84	84	100	100
Deviation	½°-317	1°-380	-	0°-1400	-
Dull BTG	4-2-0	1-1-0	-	1-I-0	-
Mud Type	SW	SW	SW	SW	SW
Wt./Vis.	-	-	-	-	-
Remarks	Cones locked.		17½ YT3A-RR Pilot Bit.	Drilling with no circulation.	Storm stopped progress.
Jet. Vel.		235		275	

BIT RECORD

Bit No.	3	2-HO-RR	3-RR	4	5
Size	17½	26	17½	17½	26
Make	HTC	SEC	HTC	HTC	HTC
Type	OSC-3	Hole opener	OSC-3	OSC-3	OSC-3
Serial No.	471208	Custom	471208	47772	XJ048
Jets	-	-	-	3x24	REG
Depth Out	1400	842	456	625	1230
Footage	ReDrill	ReDrill	ReDrill	ReDrill	ReDrill
Hours	14.5	2.5	10.5	4.0	12.5
ROP Ft./Hr.	-	-	-	-	-
Cum. Hours	16.0	16.0	16.0	16.0	16.0
Weight Kip	10-20	10-20	10-20	5-10	15-20
Rotary RPM	80	90	80	60	140
Rotary Ft-Lbs.	150A	200A	150A	100A	-
Pump PSI	900	1000	900	1000	1200
Pump GPM	1280	1280	1280	1150	1380
Ann. Vel.	-	-	-	-	-
DP Bit	-	-	-	-	-
Bit HHd	-	-	-	-	-
Liner	7½	7½	7½	7½	7½
SPM	110	110	110	100	120
Deviation	-	-	-	-	-
Dull BTG	1-1-0	-	4-1-0	1-1-0	1-1-0
Mud Type	SW	SW	-	SWGel	SW
Wt./Vis.	-	-	-	9.0/43	-
Remarks	Redrill caving hole NC.	Rotary table failed.	Redrill caving hole NC.	Redrill lost circ at 625.	Redrill no circ.

BIT RECORD

Bit No.	4-RR	6	7
Size	17½	17½	12-1/4
Make	HTC	HTC	SEC
Type	OSC-3	OSC-3	S3S
Serial No.	47772	49092	102298
Jets	3 x 24	3 x 24	3 x 13
Depth Out	3000	3629	4412
Footage	1600	629	783
Hours	19.5	14.5	9.0
ROP Ft./Hr.	82.2	43.4	87.0
Cum. Hours	35.5	50.0	59.0
Weight Kip.	15-20	15-20	20-35
Rotary RPM	180	180	90-160
Rotary Ft-Lbs.	250A	200A	200A
Pump PSI	1900	1900	2800
Pump GPM	1150	1150	630
Ann. Vel.	100	100	120
DP Bit	600	600	2200
Bit HHd	403	403	795
Liner	7½	7½	6-1/4
SPM	100	100	82
Deviation	½°-3000	1-1/4°-3629	½°-4412
Dull BTG	2-2-0	1-2-0	2-2-0
Mud Type	SW	SW Gel	Spersene
Wt./Vis.	-	9.3/38	9.7/37
Remarks	Drill gumbo shales	Gumbo plugging flowline	Gumbo to top Chalk at 4380.
Jet Vel.	275	275	520

BIT RECORD

Bit No.	4-RR	6	7	8	9
Size	17½	17½	12-1/4	12-1/4	12-1/4
Make	HTC	HTC	SEC	SEC	SEC
Type	OSC-3	OSC-3	S3S	S4TG	S6G
Serial No.	47772	49092	102298	98819	104095
Jets	3 x 24	3 x 24	3 x 13	3 x 14	3 x 14
Depth Out	3000	3629	4412	4741	4977
Footage	1600	629	783	329	236
Hours	19.5	14.5	9.0	13.0	10.0
ROP Ft./Hr.	82.2	43.4	87.0	25.3	23.6
Cum. Hours	35.5	50.0	59.0	72.0	82.0
Weight Kip	15-20	15-20	20-35	40	30/40
Rotary RPM	180	180	90-160	90	90/140
Rotary Ft-Lbs.	250A	200A	200A	200A	175A
Pump PSI	1900	1900	2800	2800	2800
Pump GPM	1150	1150	630	690	670
Ann. Vel.	100	100	120	130	125
DP Bit	600	600	2200	2150	2050
Bit HHd	403	403	795	865	800
Liner	7½	7½	6-1/4	6-1/4	6-1/4
SPM	100	100	82	90	88
Deviation	½°-3000	1-1/4°-3629	½°-4412	2°-4741	1°-4977
Dull BTG	2-2-0	1-2-0	2-2-0	4-4-0	3-2-0
Mud Type	SW	SW Gel	Spersene	Spersene	Spersene
Wt./Vis.	-	9.3/38	9.7/37	10.0/52	10.0/52
Remarks	Drill gumbo shales	Gumbo plugging flowline	Gumbo to top Chalk at 4380.	Chalk w/chert	Chalk w/chert
Jet Vel.	275	275	520	490	480

BIT RECORD

Bit No.	20	21
Size	12-1/4	12-1/4
Make	SEC	SEC
Type	S4TG	S4TG
Serial No.	111775	116334
Jets	3 x 16	3 x 16
Depth Out	8265	8709
Footage	326	444
Hours	14.0	17.0
ROP Ft./Hr.	23.3	26.1
Cum. Hours	230.0	247.0
Weight Kip	45	30/45
Rotary RPM	150	150
Rotary Ft-Lbs.	200A	220A
Pump PSI	2800	2800
Pump GPM	650	650
Ann. Vel.	125	125
DP Bit	1170	1170
Bit HHd	445	445
Liner	6-1/4	6-1/4
SPM	84	84
Deviation	1-3/4° -8265	2°- 8709
Dull BTG	3-4-0	4-4-0
Mud Type	Spersene XP-20	
Wt./Vis.	10.5/48	10.5/48
Remarks	Triassic	Triassic
	clay/sand	clay/sand
Jet Vel	355	355

BIT RECORD

Bit No.	10	11	12	13	14
Size	12-1/4	12-1/4	12-1/4	12-1/4	12-1/4
Make	SEC	SEC	SEC	SEC	SEC
Type	M4NG	M4NG	S6G	M4NG	S4TG
Serial No.	102216	102217	945918	99602	103208
Jets	3 x 14	3 x 14	3 x 14	3 x 14	3 x 14
Depth Out	5212	5526	5600	5783	6039
Footage	235	314	74	183	256
Hours	15.0	15.0	7.0	16	15
ROP Ft./Hr.	15.7	20.9	10.6	11.4	17.1
Cum. Hours	97.0	112.0	119	135	150
Weight Kip	40145	55	45/55	55/60	35/45
Rotary RPM	140	100/140	80/140	80/140	145/170
Rotary Ft-Lbs.	200A	200A	200A	200	200
Pump PSI	2800	2800	2800	2800	2800
Pump GPM	675	675	675	630	630
Ann. Vel.	125	125	125	120	120
DP Bit	2100	2100	2100	1800	1800
Bit HHd	825	825	825	660	660
Liner	6-1/4	6-1/4	6-1/4	6-1/4	6-1/4
SPM	88	88	88	82	82
Deviation	1°-5212	-	-	1°-5783	-
Dull BTG	4-2-0	3-2-0	1-1-0	3-2-0	3-3-0
Mud Type	XP-20 Spersene →				
Wt./Vis.	9.8/42	10.1/47	10.1/47	10.1/45	10.1/45
Remarks	Chalk	Limestone	Limestone	Limestone	Limestone
	Ls w/chert	chalk w/	chalk w/	chalk w/	chalk w/
		chert	chert	chert	chert
					5913 top lr. cret. clay.
Jet Vel.	480	480	480	450	450

BIT RECORD

Bit No.	15	16	17	18	19
Size	12-1/4	12-1/4	12-1/4	12-1/4	12-1/4
Make	SEC	SEC	SEC	SEC	SEC
Type	S3S	S3S	S3S	S3S	S4TG
Serial No.	110980	102284	103146	946629	103119
Jets	3 x 14	3 x 14	3 x 14	3 x 14	3 x 16
Depth Out	6380	6883	7446	7877	7939
Footage	341	503	563	431	62
Hours	13	17.5	16.5	16.0	3.0
ROP Ft./Hr.	26.2	28.8	34.1	27.0	20.7
Cum. Hours	163	180.5	197.0	213.0	216.0
Weight Kip	35/40	35	35	45	45
Rotary RPM	165	170	170	150	150
Rotary Ft-Lbs.	200	200A	200A	200A	200A
Pump PSI	2800	2800	2800	2800	2800
Pump GPM	630	600	600	585	710
Ann. Vel.	120	115	115	112	135
DP Bit	1800	1650	1650	1600	1400
Bit HHd	660	575	575	545	580
Liner	6-1/4	6-1/4	6-1/4	6-1/4	6-1/4
SPM	82	78	78	76	92
Deviation	3-1/4°-6380	4½°-6883	5-1/4°-7446	3°-7877	2½°-7939
Dull BTG	2-2-0	2-2-0	2-2-0	3-2-0	1-1-0
Mud Type	XP-20-Spersene →				
Wt./Vis.	10.1/46	10.3/50	10.3/50	10.4/49	10.4/49
Remarks	Cret/Jur clays	Cret/Jur clays	Top mid Jur LS-7386	Top mid Jur SS-7507 top triassic clay 7646	Pulled green to log due to drilling break
Jet Vel	450	430	430	415	385

BIT RECORD

Bit No.	20	21	22	23	24
Size	12-1/4	12-1/4	12-1/4	12-1/4	12-1/4
Make	SEC	SEC	SEC	SEC	SEC
Type	S4TG	S4TG	S4TG	M4NG	M4NG
Serial No.	111775	116334	102337	99643	102200
Jets	3 x 16	3 x 16	16x16x18	16x16x18	16x16x18
Depth Out	8265	8709	9036	9200	9417
Footage	326	444	327	164	217
Hours	14.0	17.0	12.0	10.5	12.0
ROP Ft./Hr.	23.3	26.1	27.2	15.6	18.1
Cum. Hours	230.0	247.0	257.5	268.0	280.0
Weight Kip	45	30/45	30/45	45/55	40/50
Rotary RPM	150	150	150	90/140	90
Rotary Ft-Lbs.	200A	220A	250A	200A	200A
Pump PSI	2800	2800	2800	2800	2800
Pump GPM	650	650	650	630	630
Ann. Vel.	125	125	125	120	120
DP Bit	1170	1170	990	940	940
Bit HHd	445	445	376	345	345
Liner	6-1/4	6-1/4	6-1/4	6-1/4	6-1/4
SPM	84	84	84	82	82
Deviation	1-3/4° -8265	2°- 8709	2° -9036	2-1/2° -9200	-
Dull BTG	3-4-0	4-4-0	3-3-0	3-3-0	4-3-0
Mud Type	Spersene XP-20		Spersene XP-20		Spersene XP-20
Wt./Vis.	10.5/48	10.5/48	10.6/43	10.6/43	10.5/40
Remarks	Triassic clay/sand	Triassic clay/sand	Triassic	Triassic	Triassic clay/sand locked cone
Jet Vel	355	355	325	315	315

BIT RECORD

Bit No.	25	26
Size	12-1/4	12-1/4
Make	HTC	Reed
Type	XV	YS-1
Serial No.	59044	NDB118
Jets	3 x 18	3 x 14
Depth Out	9606	9720
Footage	189	114
Hours	12.5	6.0
ROP Ft./Hr.	14.6	19.0
Cum. Hours	292.5	298.5
Weight Kip	40/50	30/45
Rotary RPM	90/150	80
Rotary Ft-Lbs.	250A	200A
Pump PSI	2800	2800
Pump GPM	680	546
Ann. Vel.	125	104
DP Bit	800	1400
Bit HHd	320	515
Liner	6-1/4	6-1/4
SPM	88	70
Deviation	-	-
Dull BTG	4-3-0	-
Mud Type	Spersene XP-20	-
Wt./Vis.	10.5/40	10.5/40
Remarks	Triassic clay/sand locked cone.	Top Salt 9642. Stuck Pipe
Jet Vel.	295	385

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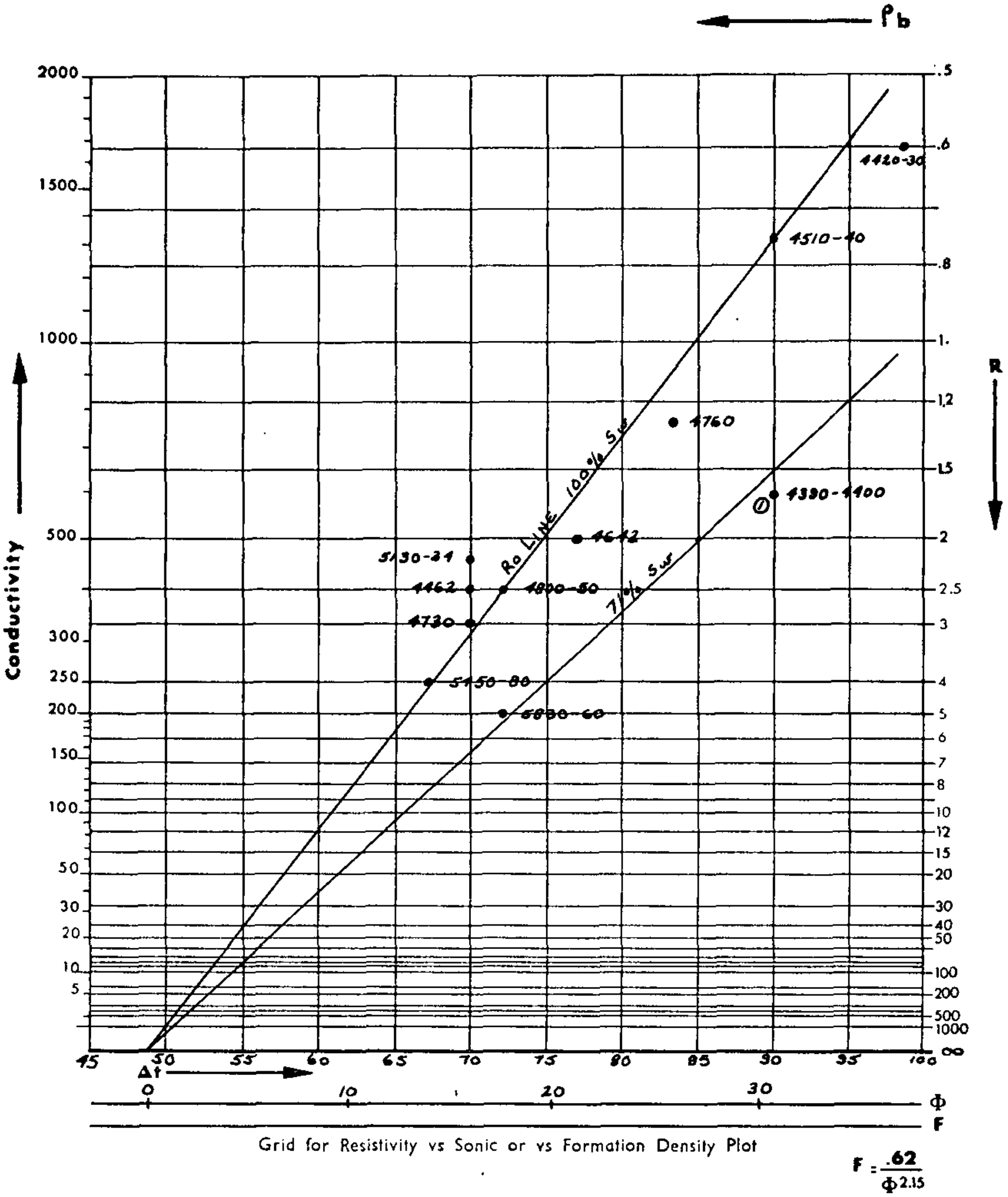
FIG. 1

GRID FOR SONIC — RESISTIVITY OR FD — RESISTIVITY PLOTS

AMOSEAS 9/4-1 CRETACEOUS CHALK



Grid for Resistivity vs Sonic or vs Formation Density Plot

$F = \frac{.62}{\Phi^{2.15}}$

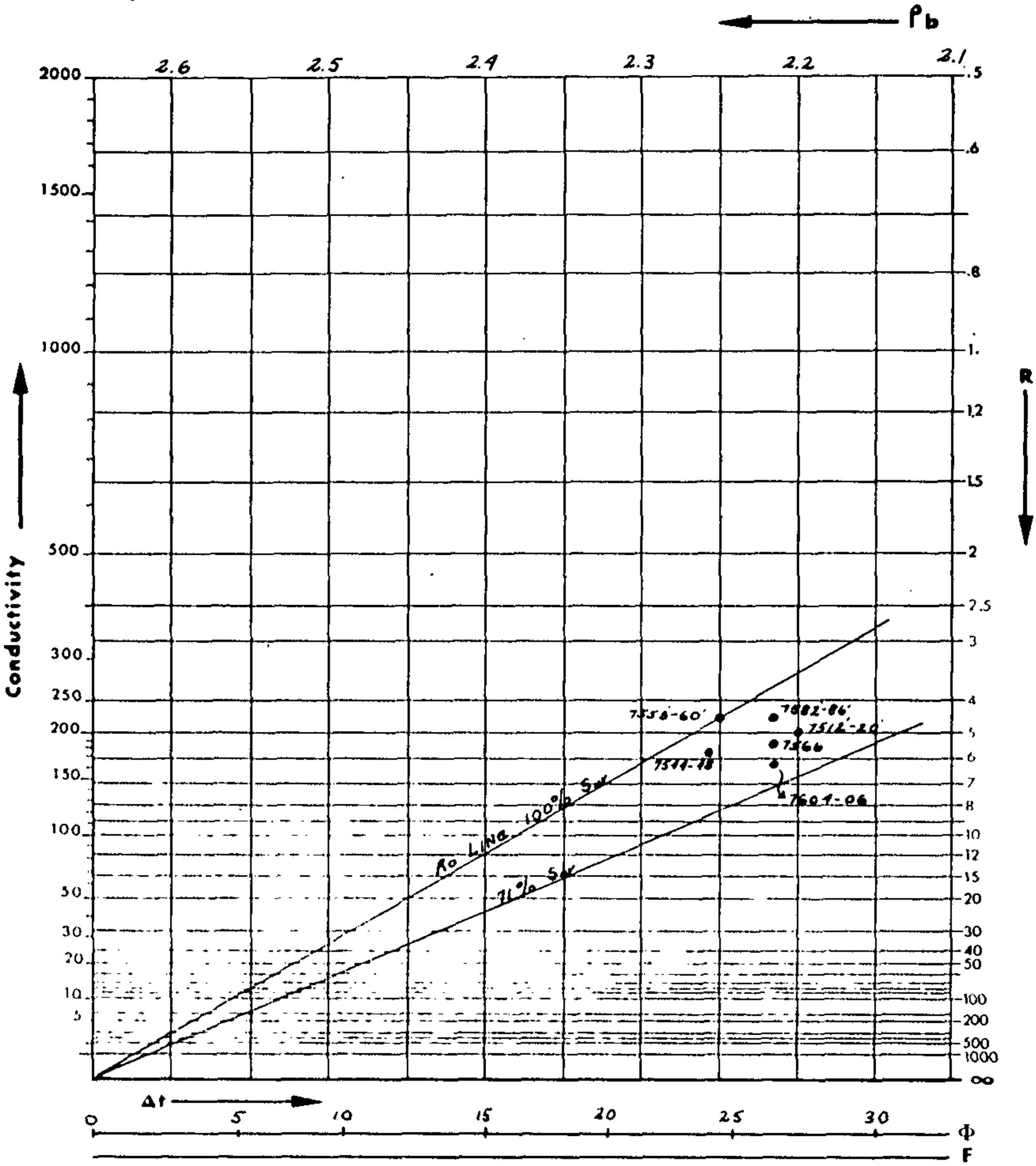
TAUSHETSPLIKT

FIG. 2

GRID FOR SONIC — RESISTIVITY OR FD — RESISTIVITY PLOTS

AMOSEAS 9/4-1

MID JURASSIC SAND



Grid for Resistivity vs Sonic or vs Formation Density Plot

$F = \frac{.62}{\Phi^{2.15}}$

ROBERTSON RESEARCH COMPANY LIMITED

MEMORANDUM NO. 578

CLAY MINERALOGY OF SHALE SAMPLES

This report describes the clay mineralogy of seven samples of shale submitted by American Overseas Petroleum Limited from their Norwegian North Sea Well 9/4-1.

Each of the shale samples was prepared by dispersing in water with ultrasonic treatment, and the $<5\mu$ fraction was then separated by sedimentation. Aliquots were pipetted onto glass slides and infra-red dried.

The semi-quantitative composition of the clay mineral fraction of the shales is shown in table 1. This table shows that illite is present in all the samples. Mixed-layer clay minerals comprise about half the percentage given for illite in samples 7718', 7820' and 7922'. Kaolinite is present in all the samples. Kaolinite and chlorite are present in samples 7718', 7820' and 7922' but cannot be separated without more detailed work.

TABLE 1 Semi-quantitative composition of the clay mineral fraction of seven shales submitted by American Overseas Petroleum Ltd.

Sample	Illite	Kaolinite	Other Minerals
7258	85%	15	quartz, calcite.
7437	23%	77	quartz.
7540	37%	63	quartz, possible apatite.
7610	46%	54	quartz.
7718	63%^{x}	37^{xx}	quartz, possible apatite.
7820	77%^{x}	23^{xx}	quartz, alkali feldspar, possible apatite.
7922	58%^{x}	42^{xx}	quartz, calcite

^{x} Mixed-layer minerals comprise about half the percentage given for illite in these samples.

^{xx} The figure given for kaolinite in these samples, is actually kaolinite plus chlorite, but the two samples cannot be separated without some detailed tests.

APPENDIX - 2

LLANDDULAS
ABERGELE
DENBIGHSHIRE

TELEPHONE: LLANDDULAS 424
(049-266 424)

Telex: 61216
Cable: Research Abergele

ROBERTSON RESEARCH COMPANY LIMITED

CERTIFICATE OF ANALYSIS

(comprising 2 sheets)

TAUSHET SPLIKT

Certificate Number: 689/68.
Project Number: ARP 689/144.
Your Reference:
Date: 29th May 1968.

Client: American Overseas Petroleum Ltd.,
Conradkade 178,
The Hague,
Netherlands.
For the attention of:

HYDROCARBON ANALYSES

Sample numbers 7437, 7525 and 7540 were extracted first with Di-ethyl Ether, to obtain lower Molecular Weight Hydrocarbons which were examined by Gas/Liquid Chromatography. The samples were then extracted with Trichloroethylene to obtain high Molecular Weight Hydrocarbons which were also examined by Gas/Liquid Chromatography. In each case Gravimetric Analysis was also conducted.

The Gas/Liquid Chromatography of all three samples was extremely complex, and contained a few hundred Isomers and Homologues, hence an adequate determination of chain lengths and relative abundances was not feasible in the time. Beyond C_{30}, the results given are Tentative since the column was operating at its thermal limit (360°C), at which temperature bleeding caused considerable Base-Line drift. An approximate correction for this drift was made by running a number of Chromatographs without samples, and determining the average drift rate due to bleeding.

RESULTS:

Percentage Hydrocarbons present.

Sample No. 7437	0.15%
Sample No. 7525	0.37%
Sample No. 7540	0.22%

Cont'd..../

for and on behalf of
ROBERTSON RESEARCH COMPANY LIMITED

P. E. Croft
Chief Analyst

Telexed on	
Cabled on	

Certificate of Analysis No. 689/68.

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Percentage composition of Hydrocarbons contained.

	Sample No. 7437	Sample No. 7525	Sample No. 7540
Up to C_{14}	4%	11%	7%
C_{14} to C_{16}	8%	17%	10%
C_{16} to C_{18}	38%	31%	27%
C_{18} to C_{28}	9%	11%	14%
C_{28} to C_{30}	32%	19%	32%
Above C_{30}	9%	11%	10%

In the case of C_{16} to C_{18} range, there was in fact one major constituent corresponding to either C_{16}, C_{17} or C_{18}. In order to determine precisely which this is, it would be necessary to spend further time.

29.5.68.