ELF AQUITAINE NORGE A/S
Exploration Division
Ref.no.: 311D/82/79-R
FV/ån

Dispatching:

| | |
|---|---|
| Norsk Hydro, Oslo | (1) |
| Total, Aberdeen | (1) |
| Total, Paris | (1) |
| Statoil, Svg. | (1) |
| NPD, Svg. | (2) |
| DEX.PROG.EUROPE | (1) |
| SID, Paris | (2) |
| Dig.Europe, Dir. Techn. | (3) |
| Dept.Gisement | (1) |
| Labo. Boussens | (1) |
| **EAN** | |
| Production Div. | (1) |
| Reservoir Dept. | (1) |
| Exlo.Div. (JJ/JD) | (1) |
| Southern District | (1) |
| File | (1) |
| **For Trade** | |
| Chevron, The Hague | (1) |

# GEOLOGICAL COMPLETION REPORT
## WELL 3/7-3



Approved by:
J. Dupuy
Geological Dept. Manager

Author: F. Verrolles

Stavanger, April 1982

## L I S T  O F  C O N T E N T S:

## L I S T   O F   F I G U R E S:

## L I S T  O F  A P P E N D I C E S:

1. Bore card 1/5000
2. Core description, K1
3. " " , K2
4. " " , K3
5. Side wall core description, Run 1
6. Well history summary

## L I S T  O F  P L A T E S:

1. Composite log, 1/500
2. Seismic line ANO 7380
3. Seismic line NS 40
4. Isobath map C1 horizon, Top of Tuff
5. " " C2 " , Top of Chalk
6. " " D1 " , Base of Chalk
7. " " J " , Possible Top of Jurassic sandstones
8. Calibrated sonic and impedance log, line ANO 7380
9. Chromatolog
10. Lower Cretaceous - Jurassic correlations

# POSITION MAP

BLOCK : 3/7

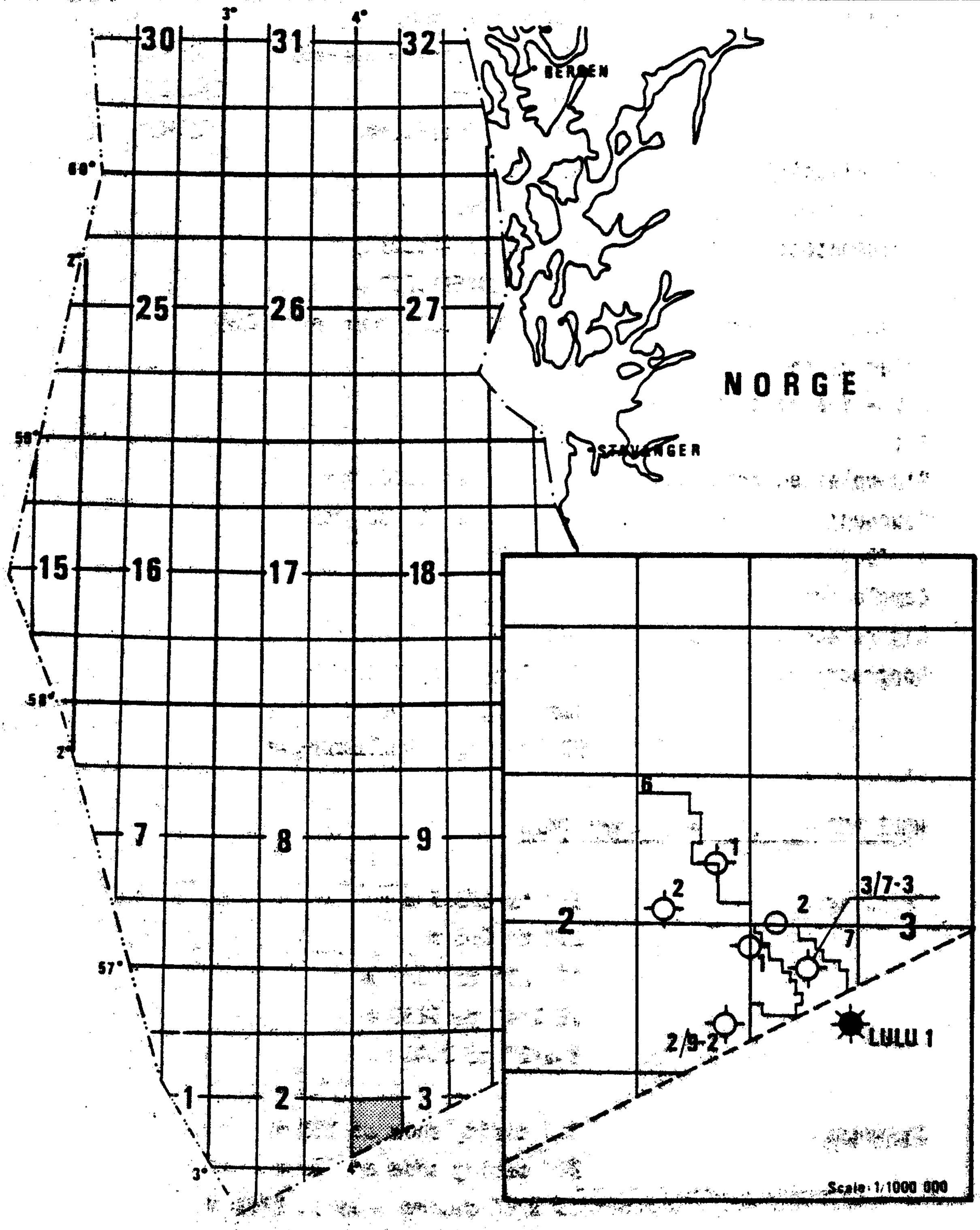
WELL : 3/7-3

OWNER : PETRONORD

X: 04 ° 10' 54.33"
Y: 56 ° 24' 54.77"

Scale: 1/2500 000

Date: 1981




EXPLORATION DIVISION

FIG. 1

## S U M M A R Y

The 3/7-3 well was drilled between June 21st and August 24th 1981.

The targets of 3/7-3 well were the Danian/Upper Cretaceous limestones found hydrocarbon bearing on the Danish well LULU 1 and the Middle Jurassic sandstones.

The "chalk" has been found water bearing. The Middle Jurassic sandstones are missing as the Upper Jurassic directly overlay the Permian Salt.

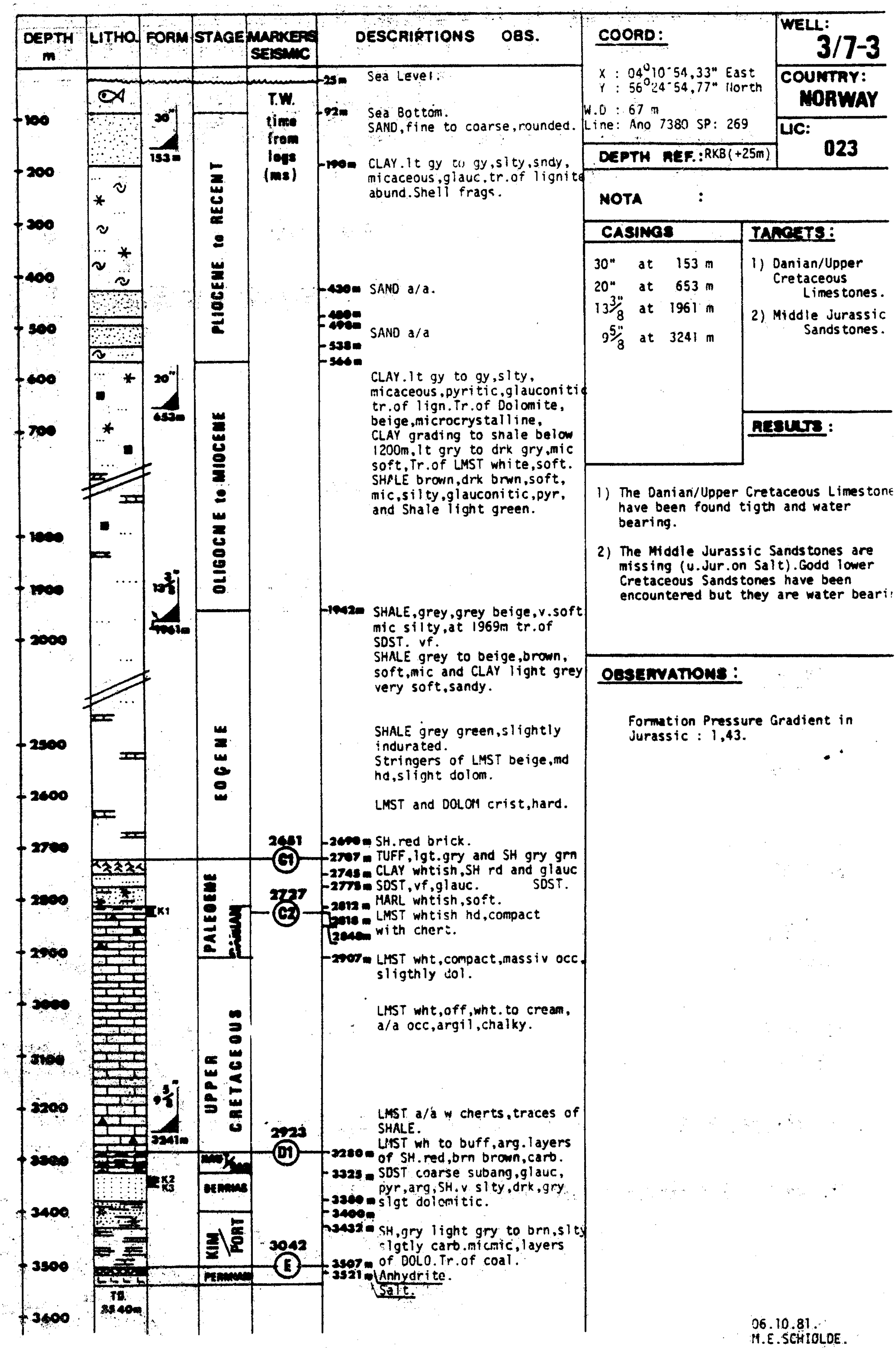
Good Lower Cretaceous/Upper Jurassic sandstones have been encountered but they are water bearing.

## 1 G E N E R A L  D A T A (see fig. 1 and 2)

| | |
|---|---|
| Country: | Norway offshore |
| Area: | Block 3/7 |
| Operator: | Elf Aquitaine Norge A/S |
| Owners: | Petronord Group |
| | Elf Aquitaine Norge A/S 43.60% |
| | Norsk Hydro 34.60% |
| | Total Marine Norsk 21.80% |
| Well classification: | Wildcat |
| Drilling Rig: | Dyvi Alpha |
| Coordinates: | X = 04°10'54".33 E |
| | Y = 56°24'54".77 N |
| Seismic location: | Line ANO 7380, Shot point 269 |
| Water depth: | 67 m |
| RKB - Sea bottom: | 92 m |
| TD: | 3540 m |
| Rig released from 3/7-2: | 20.06.82 at 16.00 hrs |
| Spudded: | 21.06.82 at 15.00 hrs |
| At TD: | 24.08.82 |
| Completed: | 31.08.82 |
| Rig released from 3/7-3: | 01.09.82 at 07.00 hrs |
| Contractors: | Drilling: Dyvi Drilling |
| | Mud logging: Geoservices |
| | El logging: Schlumberger |

HOLE RECORD (all depths are RKB)

| | |
|---|---|
| Drilling: | 36" to 153.5 m |
| | 26" to 666 m |
| | 17 1/2" to 1970 m |
| | 12 1/4" to 3253 m |
| | 8 1/2" to 3540 m |
| Casings: | 30" casing shoe at 153 m |
| | 20" casing shoe at 653 m |
| | 13 3/8" casing shoe at 1961 m |
| | 9 5/8" casing shoe at 3241 m |



DEPTH m
LITHO.
FORM
STAGE
MARKERS SEISMIC
DESCRIPTIONS OBS.
WELL: 3/7-3
COUNTRY: NORWAY
LIC: 023
COORD:
X : 04°10'54,33" East
Y : 56°24'54,77" North
W.D : 67 m
Line: Ano 7380 SP: 269
DEPTH REF.: RKB(+25m)
NOTA :
CASINGS
30" at 153 m
20" at 653 m
13 3/8" at 1961 m
9 5/8" at 3241 m
TARGETS :
1) Danian/Upper Cretaceous Limestones.
2) Middle Jurassic Sandstones.
RESULTS :
1) The Danian/Upper Cretaceous Limestone have been found tigth and water bearing.
2) The Middle Jurassic Sandstones are missing (u.Jur.on Salt).Godd lower Cretaceous Sandstones have been encountered but they are water beari
OBSERVATIONS :
Formation Pressure Gradient in Jurassic : 1,43.
T.W. time from logs (ms)
PLIOCENE to RECENT
OLIGOCNE to MIOCENE
EOCENE
PALEOENE
DANIAN
UPPER CRETACEOUS
BERRIAS
KIM PORT
PERMIAN
25m Sea Level.
92m Sea Bottom. SAND,fine to coarse,rounded.
190m CLAY.lt gy to gy,slty,sndy, micaceous,glauc,tr.of lignite abund.Shell frags.
430m SAND a/a.
480m
490m SAND a/a
538m
566m
CLAY.lt gy to gy,slty, micaceous,pyritic,glauconitic tr.of lign.Tr.of Dolomite, beige,microcrystalline, CLAY grading to shale below 1200m,lt gry to drk gry,mic soft,Tr.of LMST white,soft. SHALE brown,drk brwn,soft, mic,silty,glauconitic,pyr, and Shale light green.
1942m SHALE,grey,grey beige,v.soft mic silty,at 1969m tr.of SDST. vf. SHALE grey to beige,brown, soft,mic and CLAY light grey very soft,sandy.
SHALE grey green,slightly indurated. Stringers of LMST beige,md hd,slight dolom.
LMST and DOLOM crist,hard.
2690m SH.red brick.
2707m TUFF,lgt.gry and SH gry grn
2745m CLAY whtish,SH rd and glauc
2775m SDST,vf,glauc. SDST.
MARL whtish,soft.
2812m LMST whtish hd,compact
2818m
2848m with chert.
2907m LMST wht,compact,massiv occ. sligthly dol.
LMST wht,off,wht.to cream, a/a occ,argil,chalky.
LMST a/a w cherts,traces of SHALE.
LMST wh to buff,arg.layers
3280m of SH.red,brn brown,carb.
3325m SDST coarse subang,glauc, pyr,arg,SH.v slty,drk,gry
3380m slgt dolomitic.
3400m
3432m SH,gry light gry to brn,slty slgtly carb.micmic,layers
3507m of DOLO.Tr.of coal.
3521m Anhydrite.
Salt.
2651 G1
2727 G2
2923 D1
3042 E
K1
K2 K3
30" 153m
20" 653m
13 3/8" 1961m
9 5/8" 3241m
TD 3540m
100
200
300
400
500
600
700
1800
1900
2000
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
3600
06.10.81.
M.E.SCHIOLDE.

Fig.2

The TD (3540 m) was reached in 67 days, including 1 day for moving from the 3/7-2 location. Six days were spent for abandonment. The total duration of the 3/7-3 well was 72.6 days.

A summary of the well history is found in appendix 6.

All depths quoted in this report are in RKB unless other wise stated. Interval RKB-Sea level is 25 m.

# 2 O B J E C T I V E S   A N D   M A I N   R E S U L T S (see bore card, appendix 1)

## 2.1 OBJECTIVES

The 3/7-3 well was a wildcat designed to test possible hydrocarbon accumulation in:

- Danian/Upper Cretaceous chalk, hydrocarbon bearing in the Ekofisk area and in the Danish well Lulu 1.

- The Middle Jurassic sandstones which are hydrocarbon bearing in well 2/6-2.

The TD was planned below the top of the Zechstein salt in order to test possible lower Jurassic and/or Triassic sandstones if present.

## 2.2 MAIN RESULTS

Tertiary sands were encountered in the Paleocene with a thickness of 37.5 m. They are water bearing.

The chalk, which was the main target, is relatively tight and water bearing.

Good lower Cretaceous sandstones were encountered. They are 75 m thick and water bearing.

32 meters of sandstone were found at the Top of Jurassic. They are water bearing.

The Kimmeridgian shales rest directly on the Zechstein anhydrite.

The well was bottomed at 3540 m in Zechstein salt.

### 2.2.1 Post Cretaceous series (sea bottom to 2907 m)

The Recent to Pliocene series consist of sand fine to coarse with clay stringers.

The Miocene, Oliogocene and Eocene are dominantly clay and shale with stringers of limestone and dolomite.

The Upper Paleocene consist of series of shale with layers of tuffaceous material and minor stringers of sand. The last 37.5 m are sands with stringers of limestone.

The Lower Paleocene includes 6 meters of marl followed by the Danian limestone (2818 - 2907 m), compact, chalky, with abundant chert.

### 2.2.2 Cretaceous series

Upper Cretaceous (2907 - 3280 m):

The Upper Cretaceous consists of limestone, hard, slightly dolomitic in place with rare layers of shale grey-green to gre-brown, occasionally red brown.

Towards the base (below 3235 m) the limestone become more argillaceous with abundant chert. Intercalations of red brown and marl are common.

Lower Cretaceous (3280 - 3400 m):

The upper part (Hauterivian - Barremian) consists of interbedding of limestone, shale dark grey to red brown, calcareous and sandstone coarse to very coarse, glauconitic.

Below 3325 m, the Berriasian is dominantly sandstone, coarse to very coarse, more or less silica cemented.

Below 3380 m, the sandstone is grading to a finer sandstone, glauconitic pyritic, dolomitic cemented, radioactive (from electric logs).

### 2.2.3 Jurassic series (3400 - 3507 m):

The first 32 m (Portlandian - Kimmeridgian) consists of the same type of sandstone as found at the base of Lower Cretaceous.

Below 3432 m the Middle and Lower Kimmeridgian are dominantly shale grey to brown, silty, micromicaceous with layers of dolomite. Occasionally particles of coal are encountered.

### 2.2.4 Permian series (3507 - 3540 m TD):

The Upper Jurassic shale rests directly on 14 meters of Anhydrite. Top of Salt is at 3521 m.

## 3 L I T H O L O G Y (see composite log pl. 1)

The 3/7-3 lithology is summarized below (RKB depths).

| | |
|---|---|
| 92 (sea bottom) - 566 m: | Sand, poorly sorted, fine to coarse and clay light grey to grey, silty, micaceous with lignite and shell fragments. |
| 566 - 1371 m: | Clay, light grey to grey, soft, silty, micaceous with pyrite, lignite, glauconite and shell fragments with rare stringers of dolomite, beige microcrystalline. |
| 1371 - 1454 m: | Clay to shale, dark grey, grey brown, soft slightly silty, micaceous. Stringers of limestone, white, very soft. Traces of siltstone light grey, friable, calcareous. |
| 1454 - 1942 m: | Shale brown to dark brown, soft micaceous, glauconitic with organic matter. Traces of shale light grey-green, soft. Stringers of limestone grey to grey beige, microcrystalline, slightly dolomite. |
| 1942 - 2011 m: | Shale grey to grey beige, very soft, micaceous, silty. Traces of very fine sand. |
| 2011 - 2329 m: | Shale, grey to dark grey brown, very soft, micaceous, occasionally moderately indurated. Stringers of shale light grey, limestone and sands. |
| 2329 - 2697 m: | Shale grey green, soft to moderately indurated with traces of pyrite, mica and forams. Stringers of limestone, tan to dark tan, compact and dolomite. |

Paleocene:

| | |
|---|---|
| 2697 - 2726 m: | Shale, brown, red brik, indurated, micromicaceous and shale whitish to light grey, soft, pasty. Stringers of sandstone, fine friable. Volcanic Tuff, light grey. |

| | |
|---|---|
| 2726 - 2741 m: | Shale, grey green, micromicaceous, soft with Tuff. |
| 2741 - 2753 m: | Shale, light grey, pasty with thin beds of sandstone, fine, glauconitic and with limestone. |
| 2753  2761 m: | Shale red brik, soft pasty. |
| 2761 - 2774.5 m: | Shale whitish grading to marl. |
| 2774.5 - 2812 m: | Sandstone, very fine, white, friable, glauconitic. |
| 2812 - 2818 m: | Marl white to greyish. |
| 2818 - 2907 m: | Limestone, white, compact, chalky with abundant chert, occasionally slightly dolomitic, becoming slightly argillaceous with depth. |

Upper Cretaceous:

| | |
|---|---|
| 2907 - 3152 m: | Limestone, white to buff, slightly dolomitic in places, traces of pyrite and quartz inclusions. |
| 3152 - 3217 m: | Limestone, white to cream, moderately hard, occasionally argillaceous with rare layers of shale grey green to red brown. |
| 3217 - 3235 m: | Limestone, white, hard. |
| 3235 - 3280 m: | Limestone, white, occasionally soft and argillaceous with chert grading locally to red brown marl. |

Lower Cretaceous:

Hauterivian to Barremian:

| | |
|---|---|
| 3280 - 3325 m: | Limestone white, more or less argillaceous with layers of shale dark grey to light brown and red brown, soft, calcareous and sandstone coarse to very coarse, relatively well sorted, glauconitic. |

## Berriasian:

| | |
|---|---|
| 3325 - 3380 m: | Sandstone, coarse to very coarse, light brown to medium brown, subangular to subrounded, slightly calcareous, friable to slightly consolidated, silica cemented with traces of kaolinite and glauconite. Occasionally quartz pebbles up to 5 mm. Rare traces of coal. |
| 3380 - 3400 m: | Sandstone, white to grey, coarse to medium, glauconitic, pyritic, occasionally dolomitic cemented, sometimes argillaceous with stringers of shale dark grey, very silty. |

## Jurassic:

### Portlandian:

| | |
|---|---|
| 3400 - 3407 m: | Same lithology as below. |

### Upper Kimmeridgian:

| | |
|---|---|
| 3407 - 3432 m: | Sandstone, coarse to medium, dolomitic, glauconitic, pyritic with interbeds of:<br>- siltstone dark grey, argillaceous, hard<br>- shale, dark grey, very silty, glauconitic, trace of shale red brown and green.<br>(The high Gamma Ray log reading in this interval is due to Uranium, as shown by the NGT log). |

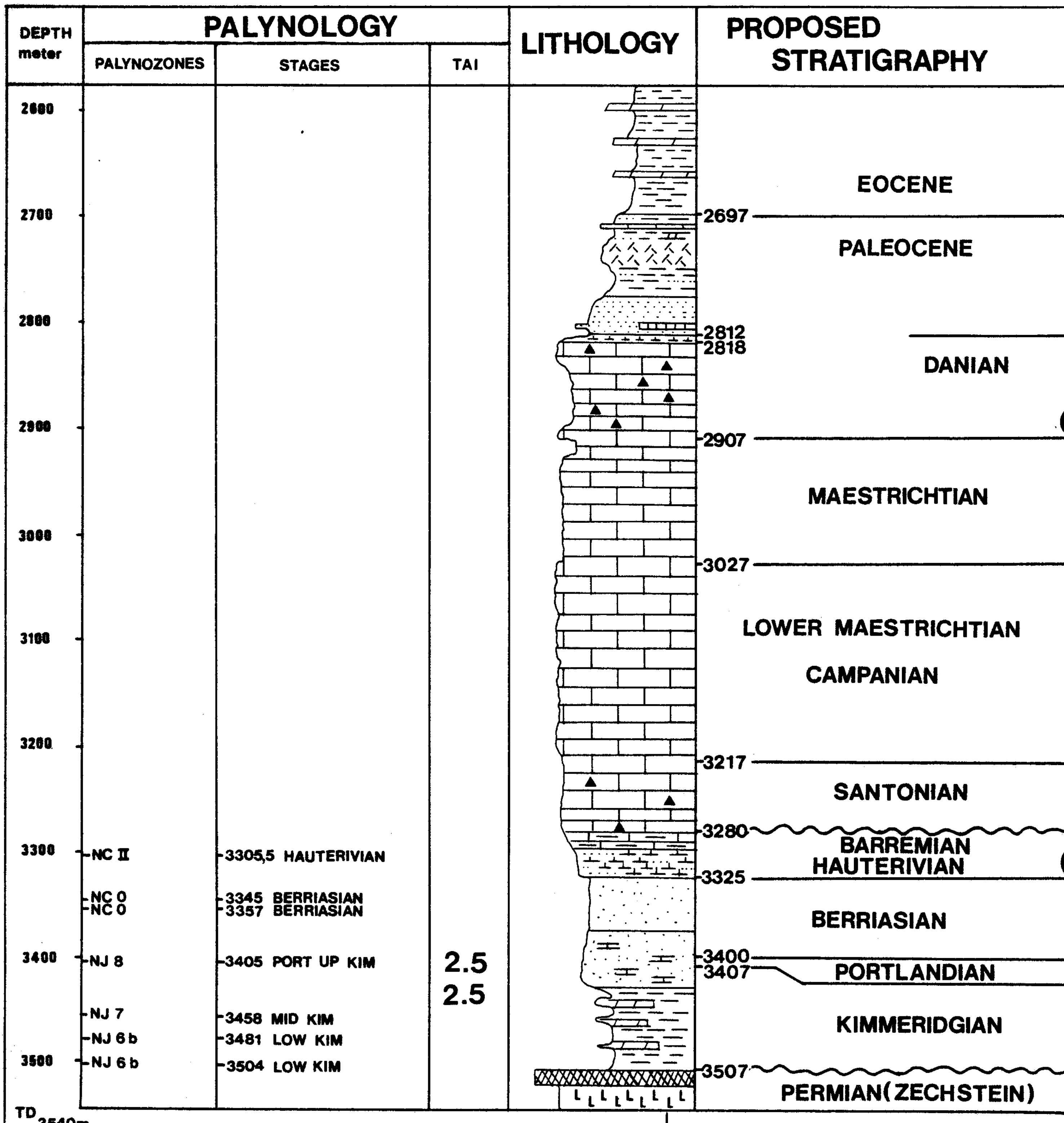
### Middle to Lower Kimmeridgian:

| | |
|---|---|
| 3432 - 3507 m: | Shale, grey, light grey to brown, silty, slightly carbonaceous, micromicaceous with stringers of dolomite, grey to dark brown, microcrystalline, pyritic.<br>Traces of coal or/and lignite. |

Permian (Zechstein):

| | |
|---|---|
| 3507 - 3521 m: | Anhydrite, white to cream, occasionally translucent. |
| 3521 - 3540 m (TD): | Salt (Halite). |

# 3/7-3 STRATIGRAFICAL CONCLUSIONS




3/7-3

PALEOCENE TO PERMIAN

Palynology from Labo Geology Boussens.

Depth datum RKB(-+25m)

F.Verrolles, April 82

Fig.3

# 4 S T R A T I G R A P H Y (see fig. 3, appendix 1)

The main formation tops are:

| | DEPTH (M) | |
|---|---|---|
| | RKB | MSL |
| Paleocene | 2697 | -2672 |
| Danian | 2812 | -2787 |
| Upper Cretaceous (Maastrichtian) | 2907 | -2882 |
| Lower Cretaceous | 3280 | -3255 |
| Berriasian sandstone | 3325 | -3300 |
| Upper Jurassic sandstone | 3400 | -3375 |
| Upper Jurassic shale | 3432 | -3407 |
| Permian | 3507 | -3482 |

(a comparison between prognosed and actual depths is found in chapter 7, STRUCTURAL DATA).

Above the Lower Cretaceous, formation tops are derived from electric logs interpretation and correlations with the nearby wells 3/7-2 and Lulu 1. Below, formation tops are partly from logs and partly from biostratigraphic analyses performed by SNEA(P) laboratories.

The main biostratigraphical results and inferred stratigraphy below the Paleocene are found in fig. 3 "3/7-3 Stratigraphical conclusions".

Two major stratigraphical breaks can be noticed:

- Santonian to Barremian
- Kimmeridgian to Permian

A minor one may exist between Hauterivian and Berriasian because no Valanginian has been noticed. This could be due to a concentration of the sequence and not to a stratigraphical break.

# 5 SEDIMENTOLOGY

## Tertiary (566 - 2907 m)

No special sedimentological features are noticed in this interval. The shale/clay associated with pyrite and fine mica indicate a calm, relatively deep, marine environment. The zone of deposition is far away from the shore line at the time of deposition.

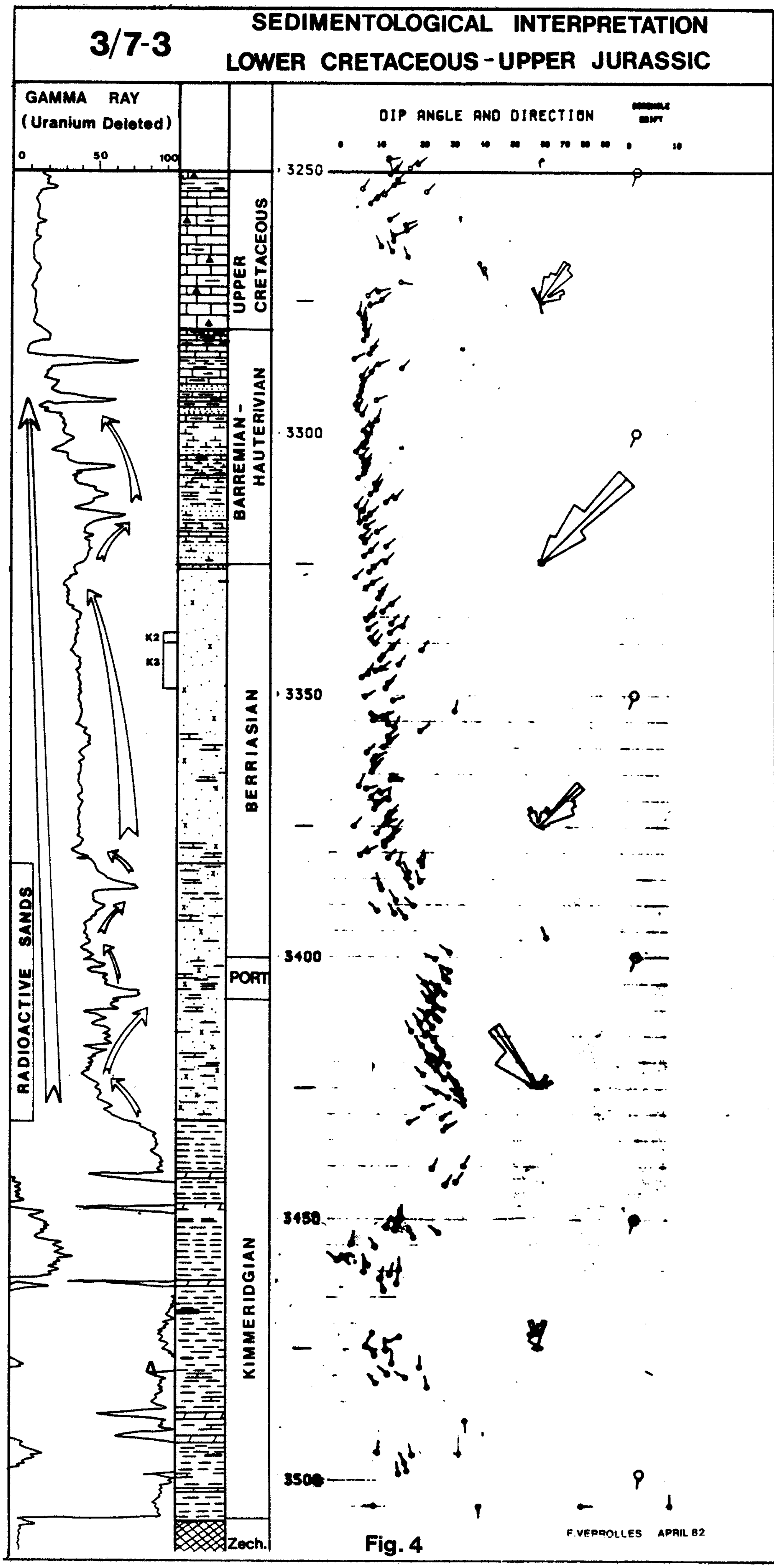
The tuffitic zone (2702 - 2740 m) is still marine but even more calm than the overlaying interval. The sandstone encountered between 2774.5 and 2812 m are very fine and glauconitic. They represent the distal part of Paleocene sands with their source located most probably in the North Eastern direction. The glauconite shows that they have been laid down in a marine environment. Such sands have been encountered on wells 3/7-2 and also 2/6-1 where they grade to siltstone.

One core has been cut in the Danian Chalk. No special features are noticed except for slicken side, stylolites which are the result of the chalk structuration by the salt. But the dipmeter (see chapter 7.2) indicates that at least the upper part of the Danian chalk has been probably reworked. The environment of deposition is still marine but relatively shallow. The lower part of the Danian chalk was laid down in a relatively deeper sea.

## Upper Cretaceous (2907 - 3280 m)

At the end of the Maastrichtian times the sea was again relatively shallow as it seems from the dipmeter that the upper part of the Maastrictian has been also reworked.

Below 2960 m, for the Lower Maastrichtian, the Campanian and the Santorian, the deposition occures in a rather shallow, quiet marine environment.



3/7-3
SEDIMENTOLOGICAL INTERPRETATION
LOWER CRETACEOUS - UPPER JURASSIC
GAMMA RAY
(Uranium Deleted)
0
50
100
DIP ANGLE AND DIRECTION
3250
3300
3350
3400
3450
3500
UPPER CRETACEOUS
BARREMIAN-HAUTERIVIAN
BERRIASIAN
PORT
KIMMERIDGIAN
Zech.
K2
K3
RADIOACTIVE SANDS
F.VERROLLES APRIL 82

Fig. 4

## Lower Cretaceous (3280 - 3400 m, see fig. 4)

The interval 3280 - 3325 m exhibits a thinning upwards sequence due to the presence of marl and carbonates. Coarse to very coarse sandstones, glauconitic, are noticed which indicates an extern marine littoral open marine environment. Some lignitic debris indicates a relatively shallow deposition at the base of the slope of the platform. These sediments are the lateral extension of a coarse clastic body.

The top part of the sequence is caracterized by red brown shale with abundant echinoderous and forams. These sediments are to be compared with the Lower Cretaceous limestones which have been encountered on the 2/6-2 well. The source is most probably a higher Jurassic platform which has still to be located.

The marine sands encountered between 3325 and 3380 m have been deposited in a relatively shallow (100 to 200 m deep) marine environment and rather close from a continental platform which can be the Mandal High to the west of the 3/7-3 location. This high was emerged during the Lower Cretaceous and earlier as proved by the 3/7-1 well where the Upper Cretaceous chalk rests directly on the Ordovician-Silurian basement.

The lowest part of the Lower Cretaceous (3380 - 3400 m) is still marine. The glauconite is very abundant, up to 25%. The high Gamma Ray log reading is due to Uranium as shown by the NGT log and not due to an increase of the clay content. Here also the environment is shallow. It looks like a "dumping" without any sorting of the sediments at the base of the slope but very close from the platform.

## Upper Jurassic (3400 - 3507 m, see fig. 4)

The upper sands between 3400 and 3432 m have the same environment of deposition than the lowest part of the Lower Cretaceous.

Below 3432 m, the lithology is typical of a marine, relatively shallow, restricted environment. They rests directly on the Zechstein anhydrite.

## 6 O R G A N I C G E O C H E M I S T R Y (see fig. 3)

Most of the organic matter noticed in the Lower Cretaceous/Upper Jurassic interval are lignitic debris (humic). Sapropelic material is present in the Upper Jurassic shale.

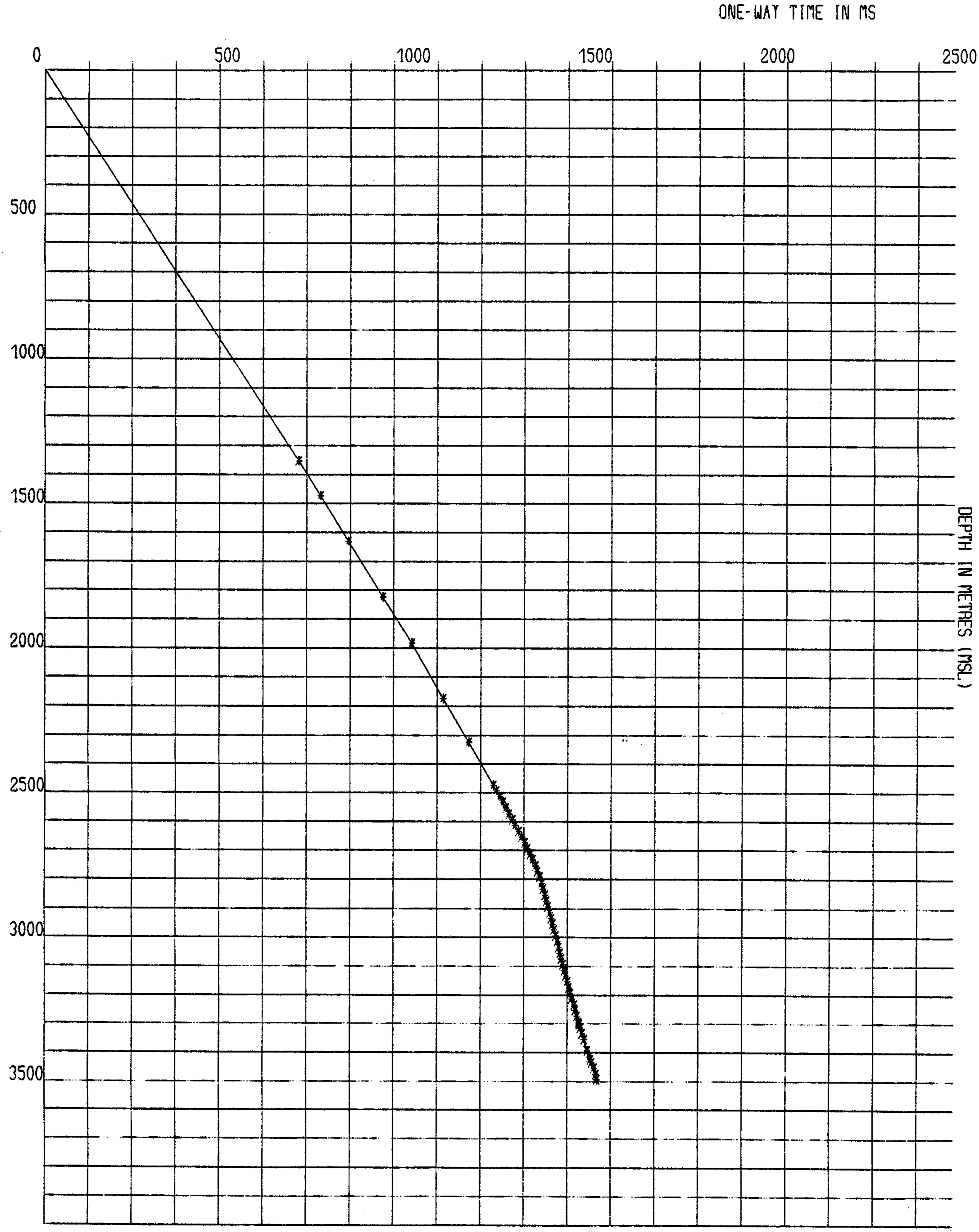
For both kind of material, the TAI values noticed between 3400 and 3450m show that the organic matter has reached the oil generating maturation zone.

It is believed that in the area the Jurassic organic matter has reached the beginning of genesis of hydrocarbons at the end of the Upper Cretaceous or Danian times.

The richness in organic matter of the Upper Jurassic shale is not yet known. It is possible that it is not high enough as no hydrocarbons has been found in the 3/7-3 well.

# CURVE T = F (D)

WELL : 3/7-3




ELF AQUITAINE NORGE A/S , EXPLORATION

**Fig.5**

# 7 S T R U C T U R A L   D A T A

## 7.1 GEOPHYSICAL RESULTS

### 7.1.1 Well Velocity Survey and Calibrated Sonic Log:

A vertical seismic profile (VSP) has been made on this well (50 shots between 3520 and 2500 m).

A calibrated sonic has been produced. Fig. 5 shows the curve T = f(D).

### 7.1.2 Comparison Prognosis Versus Results:

The 3/7-3 well is located at shot point 269, seismic line ANO 7380 (see fig. 6 and pl. 2).

The table below compares prognosis to calibrated results.

| HORIZON | DEPTH MSL (m) | | DISCREPANCY |
|---|---|---|---|
| | Prognosis * | Results | |
| C1 Top of Tuffitic zone | -2695 | -2682 | -13 |
| C2 Top of Chalk | -2810 | -2793 | -17 |
| D1 Base of U.Cret lmst. | -3200 | -3255 | -55 |
| Base of Lower Cret.sands** | -3380 | -3300 | -80 |
| E Top of Permian | -3545 | -3482 | -63 |
| TD | -3595 | -3515 | -80 |

* Depths prognosed using the 3/7-2 results. They do not correspond to the depths given in the geological prognosis which used wells 2/6-1, 2/9-2, 3/7-1 and Lulu 1.

** This marker correspond to the marker called J in the prognosis.

The discrepancies between prognosed depths and well data begin to be rather important from the base of chalk and below.

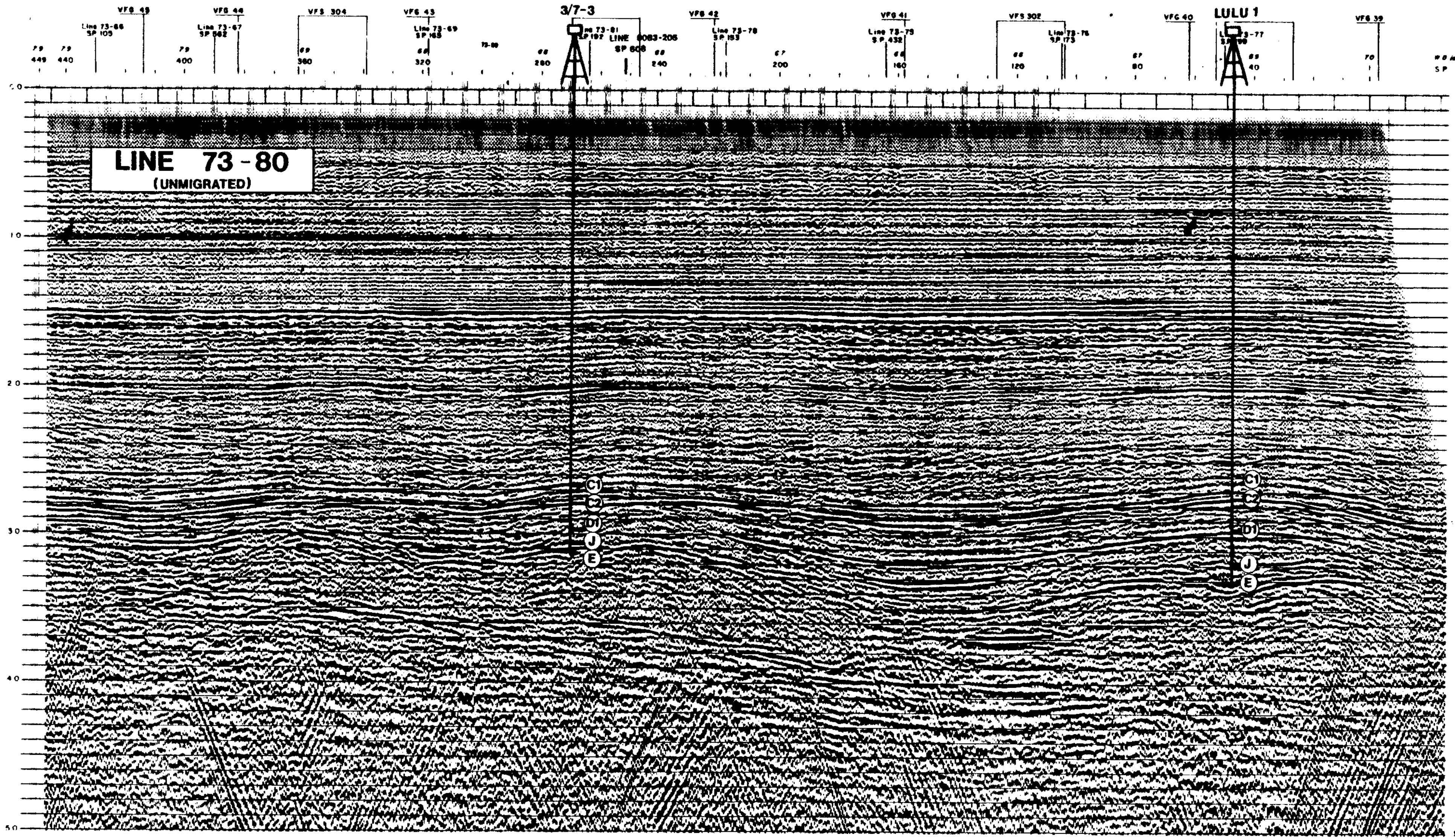
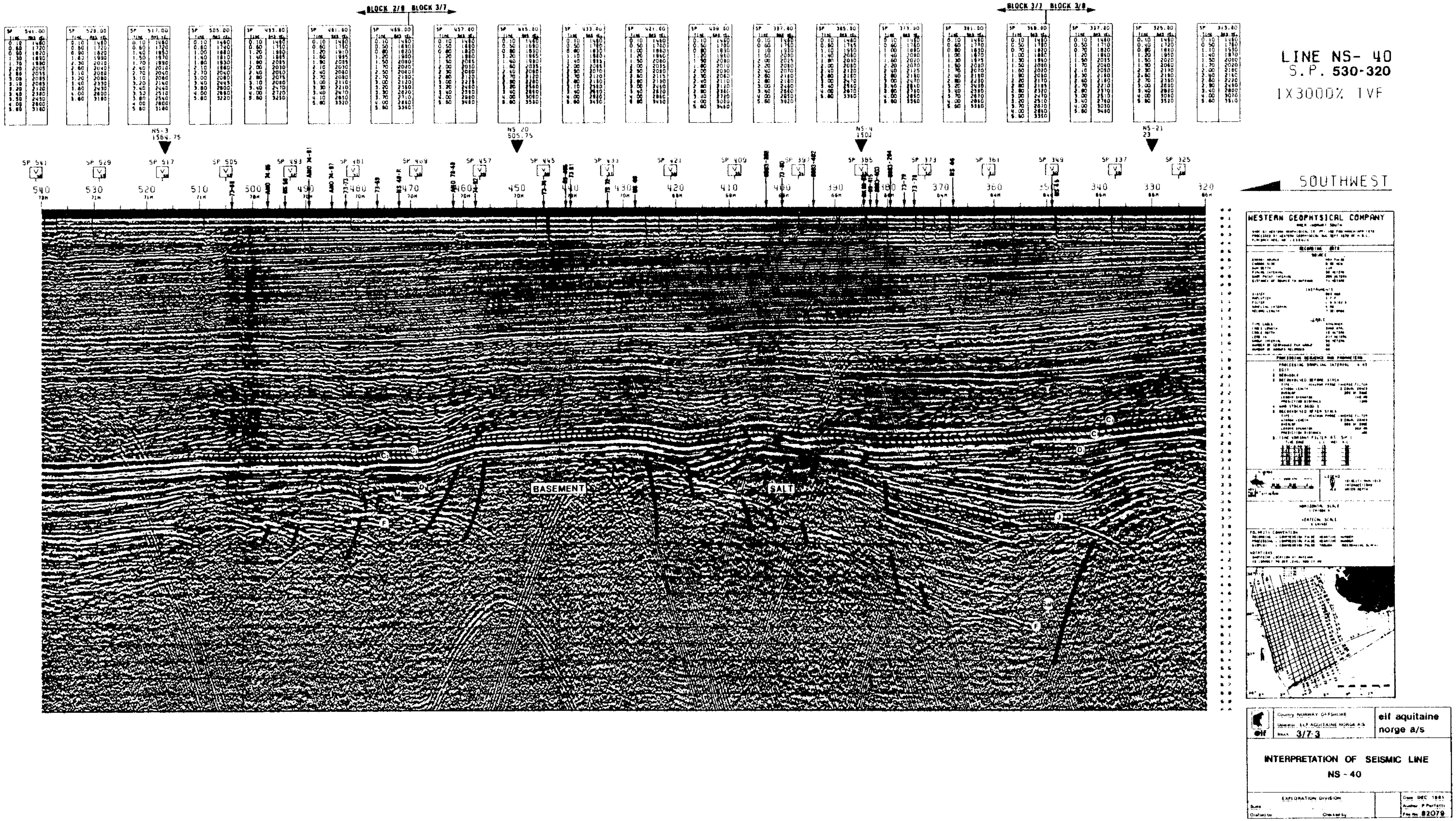



FIG.6

Fig.7


BLOCK 2/8 BLOCK 3/7
BLOCK 3/7 BLOCK 3/8
LINE NS- 40
S.P. 530-320
1X3000% TVF
SOUTHWEST
WESTERN GEOPHYSICAL COMPANY
BASEMENT
SALT
Country NORWAY OFFSHORE
Operator ELF AQUITAINE NORGE A/S
Block 3/7-3
elf aquitaine
norge a/s
INTERPRETATION OF SEISMIC LINE
NS - 40
EXPLORATION DIVISION
Scale
Drafted by
Checked by
Date DEC 1981
Author P Perfetti
File No 82079

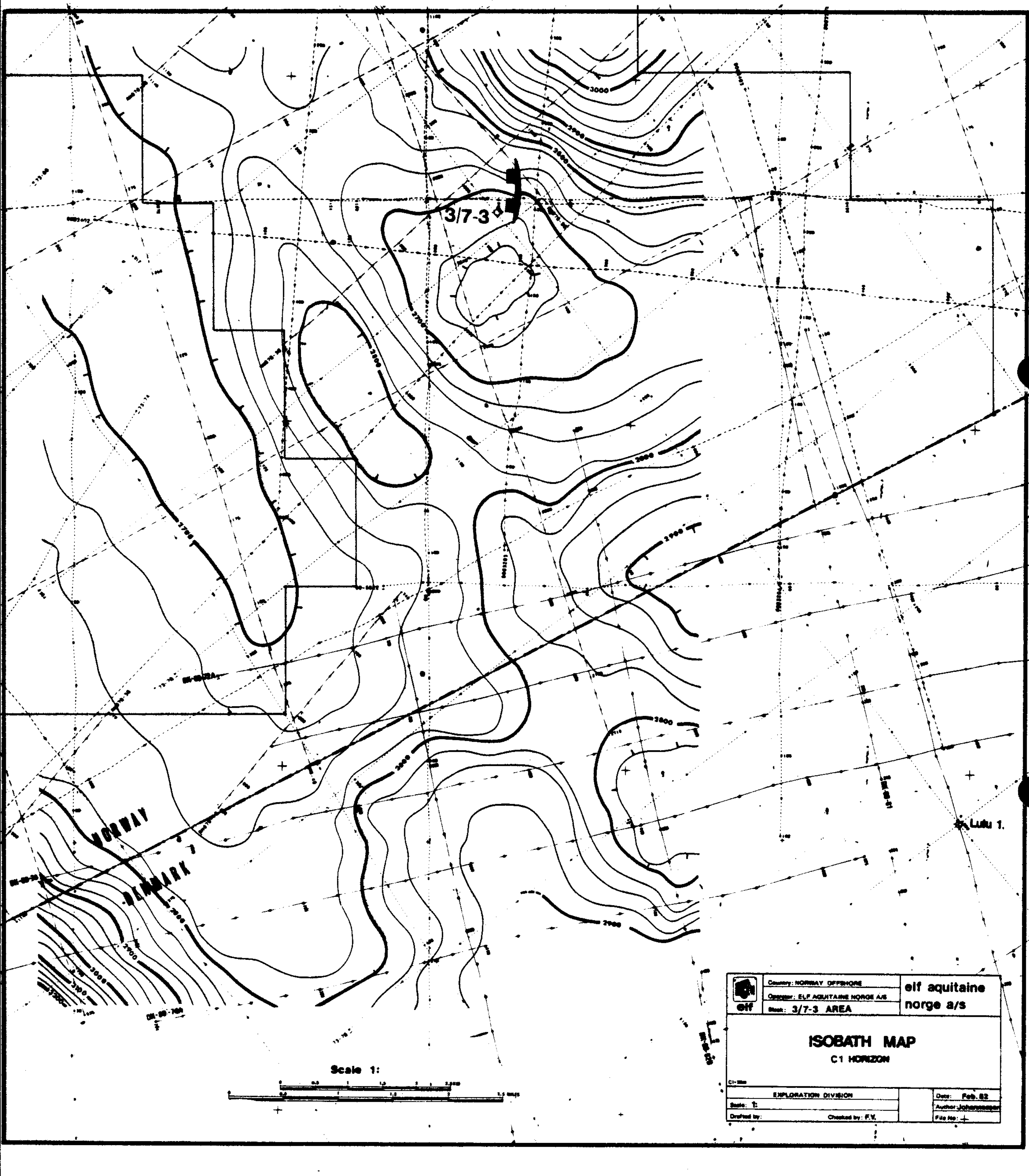
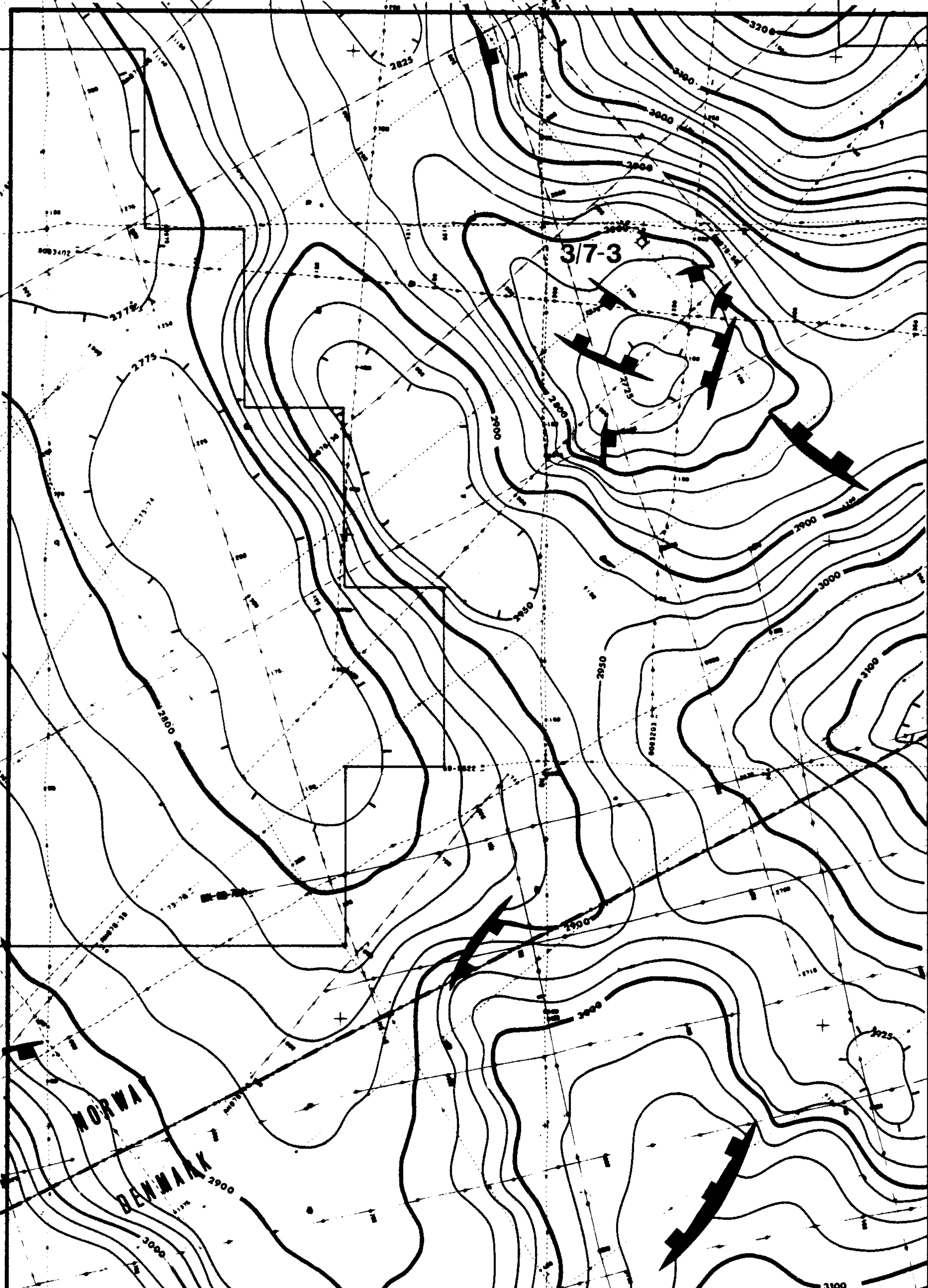

3/7-3
3000
2900
2800
2700
NORWAY
DENMARK
Lulu 1.
Scale 1:
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA
elf aquitaine
norge a/s
ISOBATH MAP
C1 HORIZON
EXPLORATION DIVISION
Scale: 1:
Drafted by:
Checked by: F.Y.
Date: Feb. 82
Author: Johannessen
File No:

Fig.8




Scale 1:

0 0.5 1 1.5 2 2.5 KM

0 0.5 1 1.5 2 2.5 MILES

| | |
|---|---|
| Country: NORWAY OFFSHORE<br>Operator: ELF AQUITAINE NORGE A/S<br>Block: 3/7-3 AREA | elf aquitaine norge a/s |

**ISOBATH MAP**

C2 HORIZON

CI=25m

EXPLORATION DIVISION

Scale: 1:

Drafted by:

Checked by: F.V.

Date: Feb 82

Author: R.Jo

File No:

Fig. 9

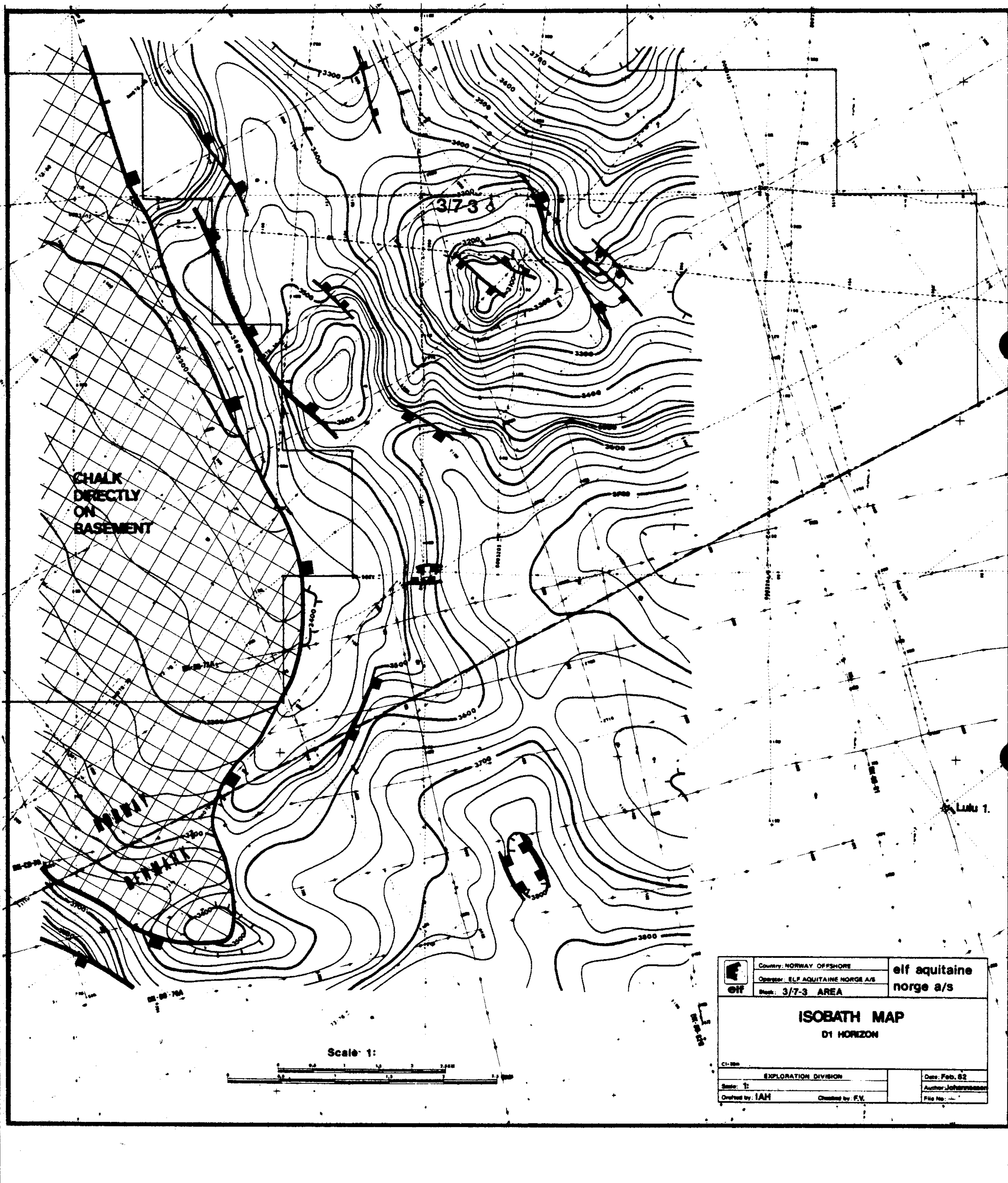

3/7-3
CHALK
DIRECTLY
ON
BASEMENT
Lulu 1.
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA
elf aquitaine
norge a/s
ISOBATH MAP
D1 HORIZON
EXPLORATION DIVISION
Scale: 1:
Drafted by: IAH
Checked by: F.V.
Date: Feb. 82
Scale 1:

Fig. 10

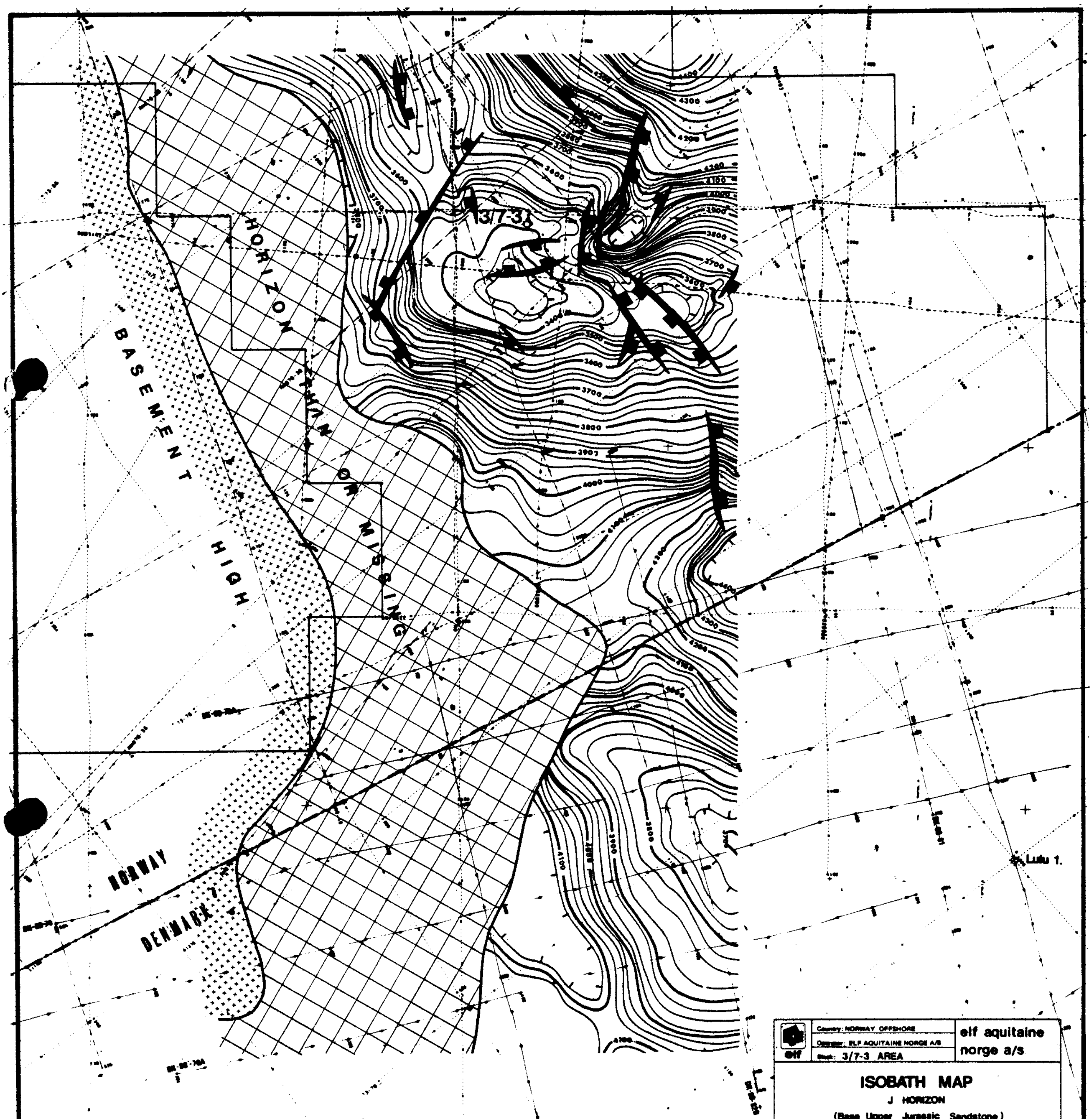
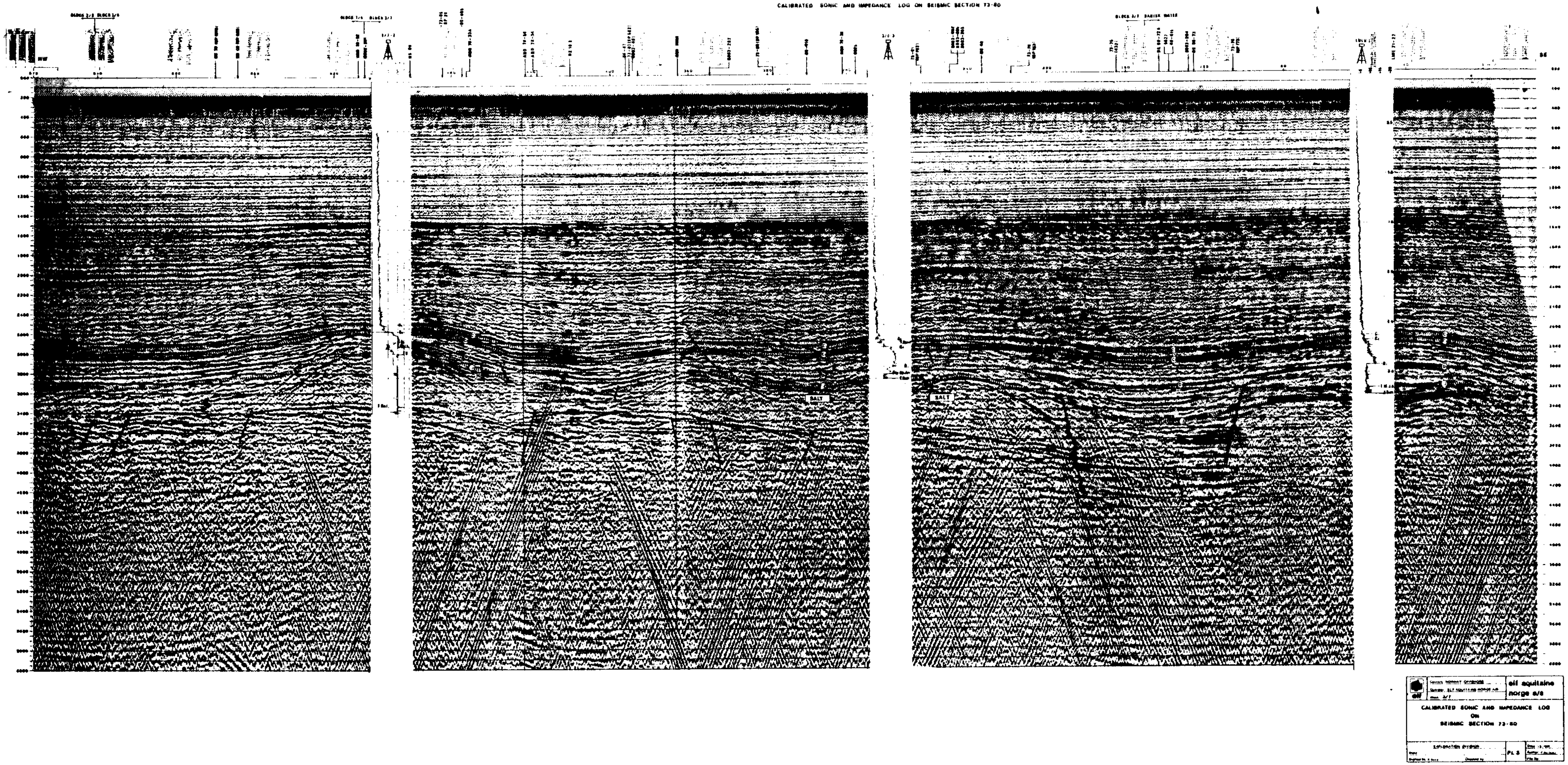

3/7-3
HORIZON ERODED OR MISSING
BASEMENT HIGH
NORWAY
DENMARK
Lulu 1.
Scale
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA
elf aquitaine norge a/s
ISOBATH MAP
J HORIZON
(Base Upper Jurassic Sandstone)
EXPLORATION DIVISION
Date Feb. 82
Drafted by: IAH
Checked by: F.V.

Fig. 11

Fig. 12


CALIBRATED SONIC AND IMPEDANCE LOG ON SEISMIC SECTION 73-80
SALT
SALT
elf aquitaine
norge a/s
CALIBRATED SONIC AND IMPEDANCE LOG
ON
SEISMIC SECTION 73-80
PL 3

Seismic sections were calibrated to wells 2/6-1, 3/7-1, Lulu 1 and 2/9-2 (see line NS 40, fig. 7, pl. 3). Later the 3/7-2 well results were used.

The interval velocities used for the depth prognosis were incorrect because the 2/9-2 well, on the other side of the Mandal high, was included in the computation of the average interval velocity. Using only 3/7-2 and Lulu 1 wells (see line ANO 7380, fig. 6, pl. 2), the accuracy is much more better.

The D1 horizon (base of Upper Cretaceous Limestone), is very weak, therefore the picking of the horizon is rather uncertain. The J horizon which was supposed to be the top of the Upper Jurassic sandstone may correspond to the top of Portlandian/Kimmeridgian sandstone as there is a positive contrast on the sonic log.

Revised isobath maps are presented for:

- C1, Top of Tuffitic zone (fig. 8, pl. 4)
- C2, Top of Chalk (fig. 9, pl. 5)
- D1, Base of Upper Cretaceous limestone (fig. 10, pl. 6)
- J, Top of Jurassic sandstones (fig. 11, pl. 7)

### 7.1.3 Comments:

The results of the VSP has shown that the interpretation of the different horizons was off for the bottom of the chalk and below.

The interval velocities used for the depth prognosis (using the 3/7-2 data) were confirmed by the VSP data. The slighthly erroneous picking of the seismic sections can be explained from the poor reflections at Lower Cretaceous and below. The Lower Cretaceous contains a lot of marl and limestone stringers. The top of Lower Cretaceous sandstones corresponds in fact to a negative sonic break. The next positive sonic sonic break occures at the top of the radioactive sands, while the top of Kimmeridgian shale is a negative break. The interval between these last two sonic breaks is too short to develop any reflection which therefore accounts for the discrepancy in the picking (see calibrated sonic and impedance log, seismic line ANO 7380, fig. 12, pl. 8).

## 7.2 DIPMETER INTERPRETATION

The dipmeter has been run below 1971 m.

### 7.2.1 Tertiary (down to 2907 m):

In the Eocene and Upper Paleocene sequence, down to 2717 m, scattered dipmeter readings in the 5 to 25° range with a general northern azimuth (320° to 40°) are seen. No major structural features are inferred. Structural dips range from 20° north at the top of sequence to about 10° north and less around 2700 m. This exhibits the slight displacement towards the south of the top of the salt which was still rising very gently during the Eocene.

The top of Tuffitic zone (2707 m) is very well seen on the dipmeter. Down to 2741 m, dipmeter readings are in the 6 to 8° range with an almost unique azimuth of 315°. This is the structural dip for the interval.

Down to the top of the Danian chalk (2818 m) no structural dip is noticable. The dips are scattered between 3 and 40° with no main direction. This may represent a slumping of fine clastic on the general southerly paleoslope which has been restructured by the salt movement. This match perfectly well with the observation made on the same Paleocene sands on well 3/7-2.

While most of the Danian chalk (2818 - 2907 m) has a low dip around 5°, the direction is turning gently from about 340° to 30°. With a so low dip angle it is difficult to infer anything. Locally this general shape is interrupted by scattered dip (up to 20°) and azimuth (mainly southwards). This is most probably the result of erosion of Upper Cretaceous chalk redeposited during Danian times with from time to time some slumping.

Some of the figures noticed on the dipmeter can also be linked with the fracturation of the chalk when the salt was rising up during the Eocene times.

### 7.2.2 Upper Cretaceous (2907 - 3280 m)

The upper part of the Maastrichtian (2907 - 2963 m) is highly disturbed. Dips up to 50° are noticed with azimuths in the north to east quadrant. This represents most probably faulted blocks associated with slumping.

Below 2963 m, the chalk is affected by a gentle structural dip which passes gradually from about 5° to 20° with an almost constant azimuth of about 20 to 25°. From place to place fractured zones are noticed.

The Santonian (3217 - 3280 m) is a little disturbed as the dips vary in angle from 10 to 25° and in azimuth from north west to north east.

### 7.2.3 Lower Cretaceous (3280 - 3400 m)

Between the base of the chalk (3280 m) and the top of the radioactive sands (3380 m) the structural dip increases slowly from 6 to 7° at the top up to 15° at the bottom of the interval. Dip directions is north-North east. No main patterns are noticeable showing a deposition on an almost flat surface (the base of the slope, as already stated in the chapter 5). The structural dip is the result of the rising salt.

On the contray the radioactive sands between 3380 and 3400 m exhibit an azimuth which is north-north west. The dip angle is between 10 and 20°. This does not describe well the sedimentological picture in chapter 5.

### 7.2.4 Upper Jurassic (3400 - 3507 m)

There is a very clear break in the dip angle between the Lower Cretaceous radioactive sands and the Upper Jurassic radioactive sands. While the aximuth remains the same (north-north west) the dip angle is in the 20 to 35° range.

Below 3400 m, in the Kimmeridgian shale the structural dip is around 15° north which is most probably the result of the hallokynetic activity which will take place later.

## 7.~~5~~3 CONCLUSION

The 3/7-3 well is not located at the top of the salt structure, but slightly on the northern flank of the diapir. In the area, after correction for the salt pull up effect, the F Horizon, which represents the surface on which the salt has been deposited is dipping partly in a general north-eastern direction, towards the center of the syncline located between the Mandal High and the edge of the Westland platform on block 3/5 and 3/8 (see fig. 17).

This direction is almost the same that the one given by the rising salt, changes in azimuth being only the result of the displacement of the top of the salt.

The change in dip angle, and the thinning of some intervals noticed on the seismic lines, show that the 3/7-3 diapir did not rise till the end of Lower Cretaceous/beginning of Upper Cretaceous (see fig. 16).

During Triassic and Lower/Middle Jurassic times, only very thin sediments must have been deposited on the top of the salt which was a flat area.

These sediments have been eroded at the beginning of the Upper Jurassic then the sea level rise fast enough to allow the deposition and the preservation of the Kimmeridgian and Berriasian to Barremian sediments. Then the salt started to move which explain the stratigraphicl break notice between the Barremian and the Santonian.

During the Upper Cretaceous and Paleocene times the halokinetic activity almost stopped. If not it has been very gentle. The possible reworking of some Maastrichtian/Danian chalk is due most probably to changes in the sea level.

It is during the Eocene that the salt activity resumes, mainly during the Lower Eocene. The top of the salt may have changed slightly its position as notice in paragraph 7.2.1.

The salt activity stopped completely during the Oligocene/Miocene times.

It should be noted that on the 3/7-3 structure the salt has never moved as much as on the two other nearby structures 3/7-2 and Lulu.

## 8 HYDROCARBON SHOWS

### 8.1 GAS SHOWS (see chromatolog pl. 9)

The most important shows have been encountered in the Tertiary section down to 1970 m where the mud weight had to be increased from 1.31 to 1.55 sq in order to keep the well stable. Traces of C2 and C3 where noticed.

Below 1970 m, the amount of gas is generally lower than 1% for C1 with traces of C2 and C3.

In the upper Jurassic shale the maxiumum reached is 7% of C1 with traces of C2, C3 and C4.

These gas shows are listed below:

| | |
|---|---|
| 430 - 534 m | 2 to 8% C1 |
| 534 - 625 m | 2 to 5% C1 |
| 625 - 700 m | 1 to 2% C1 |
| 700 - 755 m | 0.1 to 5% C1 |
| 755 - 760 m | 5.8% C1 |
| 760 - 890 m | 0.3 to 0.9% C1 |
| 890 - 1000 m | 1 to 3% C1 |
| 1000 - 1400 m | 0.5 to 3% C1 |
| 1400 - 1505 m | 1.5 to 6% C1 |
| 1505 - 1550 m | 0.5 to 3% C1 |
| 1550 - 1590 m | 2 to 6% C1 |
| 1590 - 1635 m | 0.8 to 1.5% C1 |
| 1635 - 1690 m | 1 to 3% C1 |
| 1690 - 1770 m | 2 to 5% C1 |
| 1770 - 1775 m | 8% C1 |
| 1775 - 1942 m | 1.5 to 5% C1, Traces C2 and C3 |
| 1942 - 1970 m | Up to 76% C1, Traces C2 and C3 |
| 1970 - 2030 m | 0.4 to 1.5% C1 |
| 2030 - 2340 m | 0.5 to 1% C1, Traces C2 and C3 |

| | |
|---|---|
| 2340 - 2460 m | 0.3 to 0.6% C1 |
| 2460 - 2650 m | Max 1% C1, Traces C2 and C3 |
| 2650 - 2700 m | 0.4 to 1% C1 |
| 2700 - 2720 m | Max 0.9% C1, Traces C2 and C3 |
| 2720 - 2810 m | Up to 2.5% C1, Traces C2 and C3 |
| 2810 - 2850 m | Up to 0.5% C1, Traces C2, C3 and C4 |
| 2850 - 2900 m | Max 0.2% C1, Traces C2 |
| 2900 - 3000 m | Max 0.2% C1 |
| 3000 - 3430 m | No Gas |
| 3430 - 3460 m | Max 0.2% C1 |
| 3460 - 3465 m | 7% C1, Traces C2, C3 and C4 |
| 3465 - 3507 m | Max 0.3% C1, Traces C2 and C3 |
| 3507 - 3540 m (T) | No Gas |

## 8.2 OIL SHOWS

No oil shows have been noticed during the drilling of the 3/7-3 well.

# 9 C O R I N G

## 9.1 CONVENTIONAL CORING

Three cores have been cut: K1 in the Danian chalk and K2 and K3 in the Lower Cretaceous sandstones.

K1: 2830 - 2848 m, cut 18 m, recovered 10,6 m, 60%
Limestone, white, off white, hard, compact, with microfractures filled with calcite and dark grey shale. Occasionally abundant chert.

K2: 3357.5 - 3339 m, cut 1.5, recovered 1 m, 67%
K3: 3339 - 3348 m, cut 9 m, recovered 9 m, 100%
Sandstone coarse to very coarse, light brown to medium brown with irregular dark brown areas, subangular to subrounded slightly calcareous, friable to slightly consolidated, silica cemented with traces of Kaolinite and glauconite.

Core descriptions are found in appendices 2, 3 and 4.

## 9.2 SIDEWALL CORING

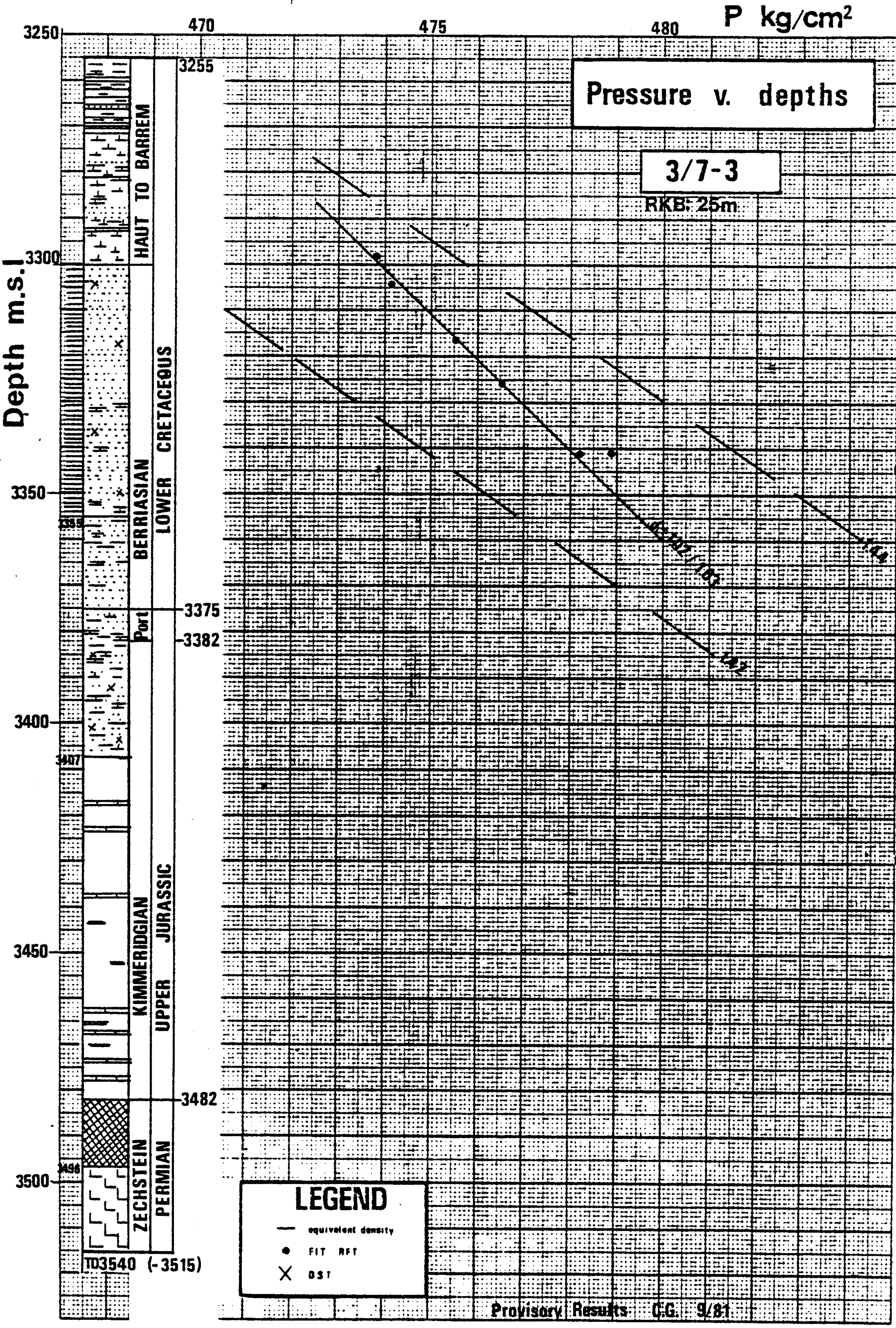
One gun of sidewall cores has been shot from 3285.5 to 3504 m. 30 cores were shot and 28 recovered. Sidewall core description is found in appendix 5.

## 10 LOGGING

Electrical logging was performed by Schlumberger.

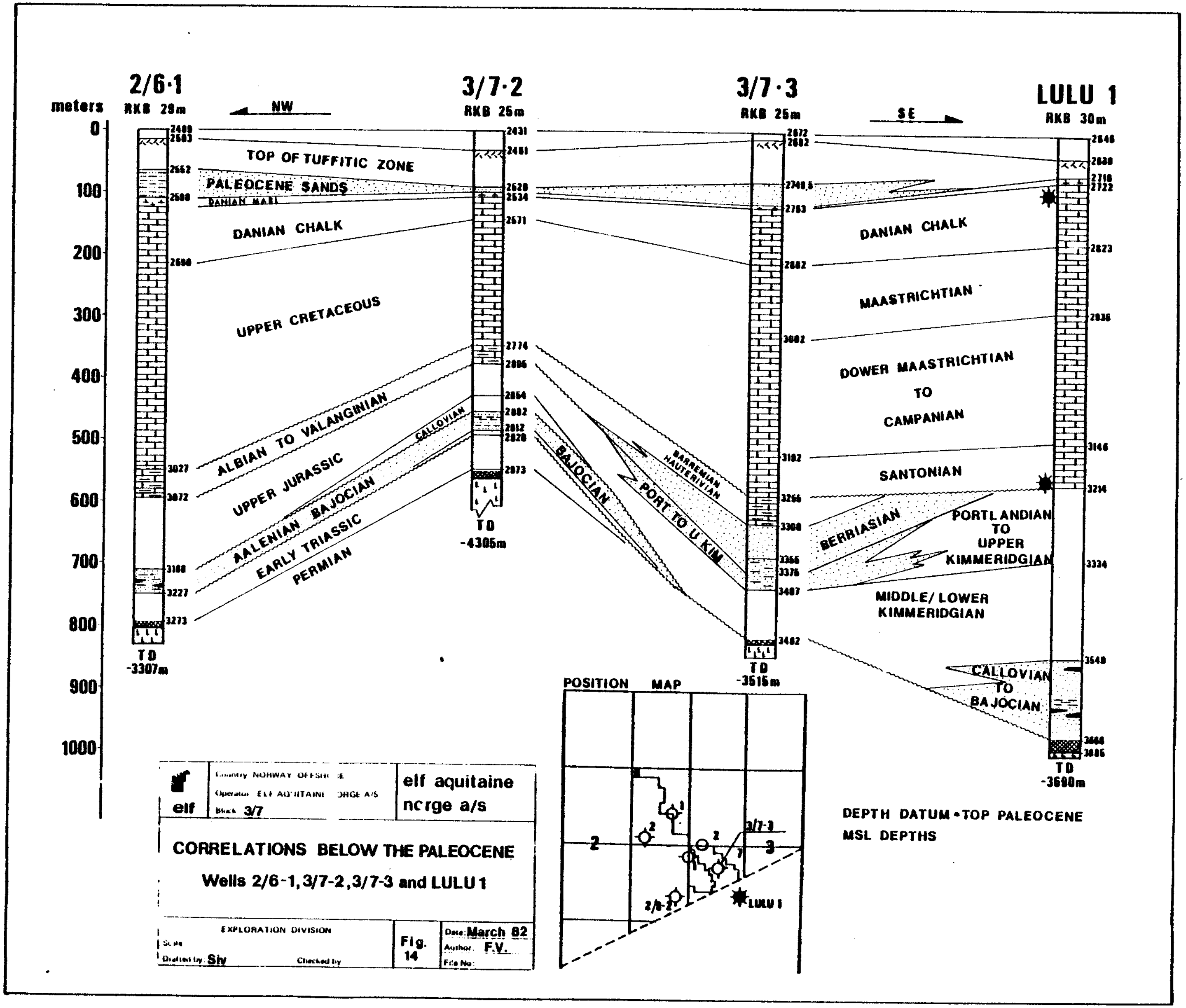
| | |
|---|---|
| - ISF-SONIC-GR | 663 - 153 m V |
| - ISF-SONIC-GR | 1969 - 653 m |
| - ISF-SONIC-GR | 2906 - 1961 m |
| - ISF-SONIC-NGT | 3542 - 3244 m |
| - LDL-GR | 666 - 153 m V |
| - LDL-CNL-GR | 3253 - 1961 m |
| - LDL-CNL-GR | 3542 - 3244 m |
| - HDT | 3253 - 1971 m |
| - HDT | 3505 - 3240 m |
| - CBL-VDL | 1935 - 500 m |
| - CBL-VDL | 3242.5 - 1700 m |
| - Temp Log | 1800 - 378 m |
| - Temp Log | 1500 - 100 m |
| - Velocity survey (VSP) | 3520 - 2500 m (50 shots) |

In the intercal 1961 - 653 m only the ISF SONIC GR has been run because of hole problems.



P kg/cm²
470
475
480
3250
3255
3300
3350
3359
3375
3382
3400
3407
3450
3482
3496
3500
Depth m.s.l
HAUT TO BARREM
BERRIASIAN
LOWER CRETACEOUS
Port
KIMMERIDGIAN
UPPER JURASSIC
ZECHSTEIN
PERMIAN
TD3540 (-3515)
Pressure v. depths
3/7-3
RKB: 25m
1.44
1.42
LEGEND
equivalent density
FIT RFT
DST
Provisory Results C.G. 9/81


Fig. 13



2/6·1
RKB 29m
3/7·2
RKB 25m
3/7·3
RKB 25m
LULU 1
RKB 30m
meters
NW
SE
0
100
200
300
400
500
600
700
800
900
1000
TOP OF TUFFITIC ZONE
PALEOCENE SANDS
DANIAN MARL
DANIAN CHALK
UPPER CRETACEOUS
ALBIAN TO VALANGINIAN
UPPER JURASSIC
CALLOVIAN
AALENIAN BAJOCIAN
EARLY TRIASSIC
PERMIAN
BAJOCIAN
PORT TO U KIM
BARREMIAN HAUTERIVIAN
DANIAN CHALK
MAASTRICHTIAN
DOWER MAASTRICHTIAN
TO
CAMPANIAN
SANTONIAN
BERRIASIAN
PORTLANDIAN
TO
UPPER
KIMMERIDGIAN
MIDDLE/ LOWER
KIMMERIDGIAN
CALLOVIAN
TO
BAJOCIAN
TD
-3307m
TD
-4305m
TD
-3516m
TD
-3690m
DEPTH DATUM - TOP PALEOCENE
MSL DEPTHS
POSITION MAP
2
3
3/7-3
2/6-2
LULU 1
elf
elf aquitaine
norge a/s
Block 3/7
CORRELATIONS BELOW THE PALEOCENE
Wells 2/6-1, 3/7-2, 3/7-3 and LULU 1
EXPLORATION DIVISION
Drafted by: Siv
Checked by
Fig. 14
Date: March 82
Author: F.V.
File No:

## 11 T E S T I N G

No drill stem test has been performed. 6 pressure tests by RFT were performed at the following depths: 3323.5; 3329; 3341; 3351; 3366 and 3372 m.

The formation pressure gradien is 1.43 in the Lower Cretaceous sandstones. The RFT indicates a water pressure gradient of 1.02 - 1.03 into these sandstones.

## 12 F O R M A T I O N   P R E S S U R E S

As expected the formation pressure started to build up in the Tertiary. At 1968 m a drilling break was experienced and the well started to flow. The flow was killed with a mud weight of 1.55 gr/cc. After setting the 13 3/8" casing shoe at 1961 m, the well was controlled after gains and losses with a mud weight of 1.58 gr/cc.

No other problems have been encountered while drilling. It is reasonable to think that the formation pressure started to build up below 1000 m to reach a gradient of about 1.55 around 1970 m.

The Paleocene sands, the chalk and the Lower Cretaceous/Upper Jurassic sands have most probably the same gradien. RFT performed in the Lower Cretaceous sandstone (see above chapter 11) indicate a formation pressure of 473.32 kg/cm$^2$ at 3323 m (-3298 m MSL) giving a formation pressure gradient of 1.43 gr/cc. (see fig. 13).

This is slightly lower than the gradient observed into the Jurassic nearby wells:

2/6-1 = 1.55
3/7-2 = 1.50
Lulu 1 = 1.50

## 13 C O R R E L A T I O N S

(see fig. 14 and 15, pl. 10 and table 1).

Correlations are made to the Petronord wells 2/6-1 and 3/7-2 and to the Chevron well Lulu 1 in Danish water.

- 2/6-1 is 27 km away in the North West
- 3/7-2 is 11 km away in the North West
- Lulu 1 is 12 km away in the South East

Only the 3/7-2 well has reached the Rotliegendes formation. Volcanics were encountered while the nearby 3/5-1 has been drilled through 300 m of Rotliegendes sandstones.

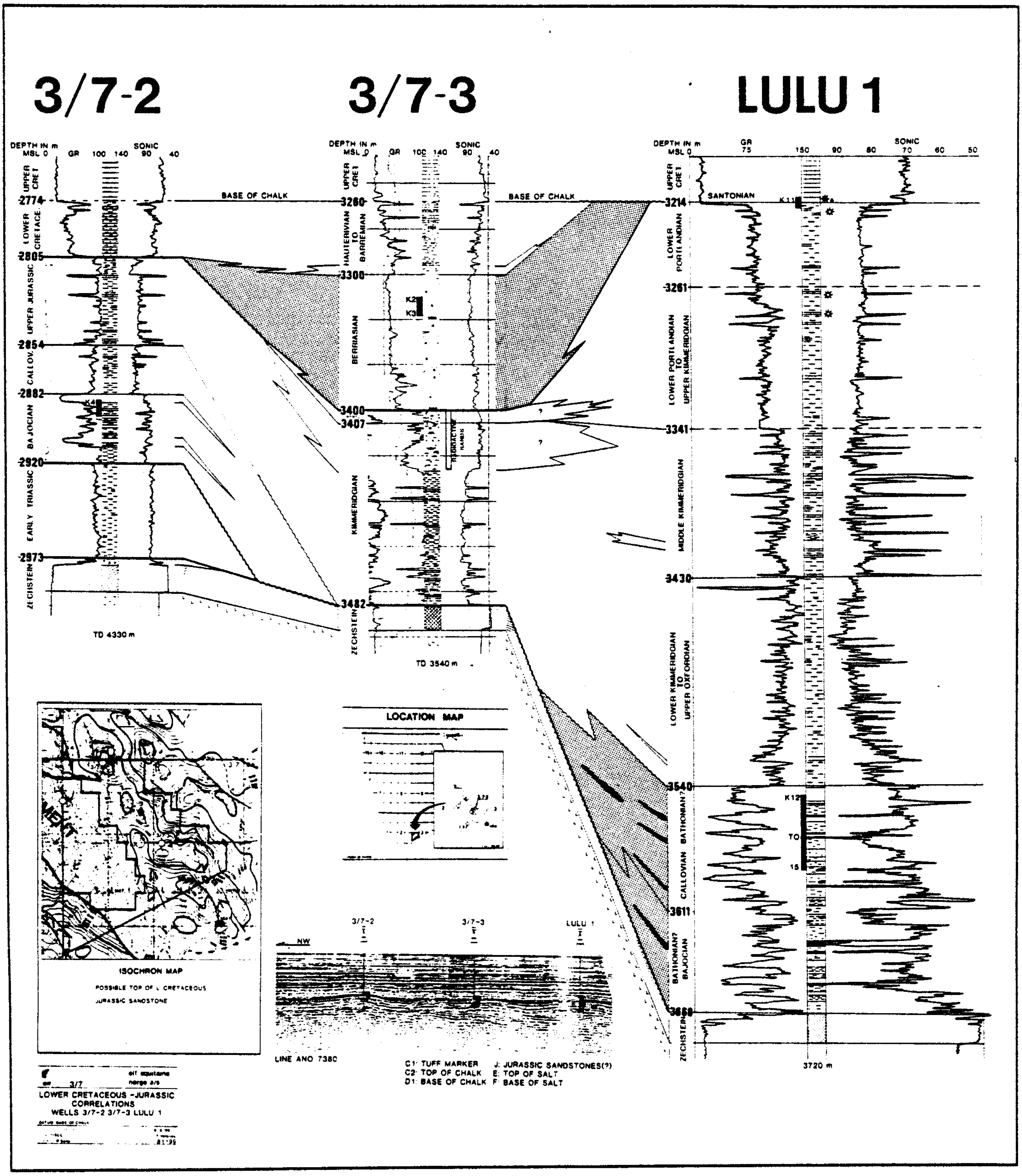
The 2/6-1, 3/7-3 and Lulu 1 have been bottom at the top of the Zechstein salt.

Early Triassic is found on 2/6-1 and 3/7-2 with about the same thickness.

No Lower Jurassic was encountered on any of these wells while Middle Jurassic sands were found except on 3/7-3. On 2/6-1 and Lulu 1 these sands are typical of deltaic series with presence of coal. The 3/7-2 the Middle Jurassic sandstones are still in a deltaic environment but they represent feeder channels. The thickness of the interval is 128 m on Lulu 1 and it is a lot thinner on 2/6-1 (39 m) and 3/7-2 (38 m). The general trend is a thickening towards Lulu 1. In age the sandstones are older on 2/6-1 (Aalenian) than on 3/7-2 (Bajocian) and than on Lulu 1 where they are Bajocian to Callovian.

The Upper Jurassic shale are thinner on 3/7-2 but the general trend is a thickening towards Lulu 1 deeper into the basin. On 3/7-3, the upper part of the Upper Jurassic consists of radioactive sands (32 m).

For the Lower Cretaceous the thickness is in the same range on 2/6-1 (45 m) and 3/7-2 (31 m) while it is missing on Lulu 1, where the chalk rests directly on the Upper Jurassic. On 3/7-3, 75 m of sands are found and the total thickness of the interval is 120 m.



3/7-2
3/7-3
LULU 1
DEPTH IN m MSL 0
GR
SONIC
BASE OF CHALK
UPPER CRET
LOWER CRETACE.
UPPER JURASSIC
CALLOV.
BAJOCIAN
EARLY TRIASSIC
ZECHSTEIN
2774
2805
2854
2882
2920
2973
TD 4330 m
HAUTERIVIAN TO BARREMIAN
BERRIASIAN
KIMMERIDGIAN
3260
3300
3400
3407
3482
TD 3540 m
SANTONIAN
LOWER PORTLANDIAN
LOWER PORTLANDIAN TO UPPER KIMMERIDGIAN
MIDDLE KIMMERIDGIAN
LOWER KIMMERIDGIAN TO UPPER OXFORDIAN
CALLOVIAN BATHONIAN?
BATHONIAN? BAJOCIAN
3214
3261
3341
3430
3540
3611
3668
3720 m
ISOCHRON MAP
POSSIBLE TOP OF L. CRETACEOUS JURASSIC SANDSTONE
LOCATION MAP
NW
LINE ANO 7380
C1: TUFF MARKER
C2: TOP OF CHALK
D1: BASE OF CHALK
J: JURASSIC SANDSTONES(?)
E: TOP OF SALT
F: BASE OF SALT
elf aquitaine norge a/s
3/7
LOWER CRETACEOUS -JURASSIC CORRELATIONS
WELLS 3/7-2 3/7-3 LULU 1


FIG.15

# CORRELATIONS 2/6-1, 3/7-2, 3/7-3, LULU 1

| TOPS (Depths in metres) | 2/6-1 | | 3/7-2 | | 3/7-3 | | LULU 1 | |
|---|---|---|---|---|---|---|---|---|
| | Depth MSL | Thickness | Depth MSL | Thickness | Depth MSL | Thickness | Depth MSL | Thickness |
| Paleocene | -2489 | 14 | -2431 | 30 | -2672 | 10 | -2646 | 34 |
| Tuffitic Zone | -2503 | 49 | -2461 | 59 | -2682 | 67.5 | -2680 | 30 |
| Paleocene Sand | -2552 | 46 | -2520 | 8 | -2749.5 | 37.5 | ---- | |
| Danian Marl | -2598 | 10 | -2528 | 6 | -2787 | 6 | -2710 | 12 |
| Danian Chalk | -2608 | 82 | -2534 | 37 | -2793 | 89 | -2722 | 101 |
| Upper Cretaceous Chalk | -2690 | 337 | -2571 | 203 | -2882 | 373 | -2823 | 391 |
| Lower Cretaceous | -3027 | 45 | -2774 | 31 | -3255 | 45 | -3214 | 0 |
| Lower Cretaceous Sand | ---- | | ---- | | -3300 | 75 | ---- | |
| Upper Jurassic Sand | ---- | | ---- | | -3375 | 32 | ---- | |
| Upper Jurassic Shale | -3072 | 116 | -2805 | 77 | -3407 | 75 | -3214 | 326 |
| Middle Jurassic Sand | -3188 | 155 | -2882 | 38 | ---- | | -3540 | 128 |
| Early Triassic | -3227 | 46 | -2920 | 53 | ---- | | ---- | |
| Permian | -3273 | | -2973 | | -3482 | | -3668 | |
| RKB - SEA LEVEL = (m) | 29 | | 25 | | 25 | | 30 | |

There is a major break between Upper and Lower Cretaceous. The Upper Cretaceous is thickening from 2/6-1 to Lulu 1. The interval is thinner on 3/7-2 because of the salt risi g.

The same observation can be applied to the Danian chalk, while the Danian marl has an almost constant thickness (6 to 12 m).

The Paleocene is thicker on 2/6-1 (109 m) and 3/7-3 (115 m). On 3/7-2 it is 97 m thick a d only 64 m on Lulu 1. Where it is the thickest (2/6-1 and 3/7-3) Paleocene sands are rather well developped (46 and 37.5 m) while on 3/7-2 they are only 8 m thick and missing on Lulu 1.

The interval between Top of Tuffitic zone and Top of Paleocene is thicker on 3/7-2 and Lulu 1 than on the two other wells. Salt activity accounts for that.

The four wells are located on the Eastern flank of the Mandal high. To the East, the syncline which lays between the Mandal high and the Vestland Platform/Ring Købing Fynn high is deeper in the vicinity of Lulu.

Major stratigraphic breaks can be noticed on the four wells:

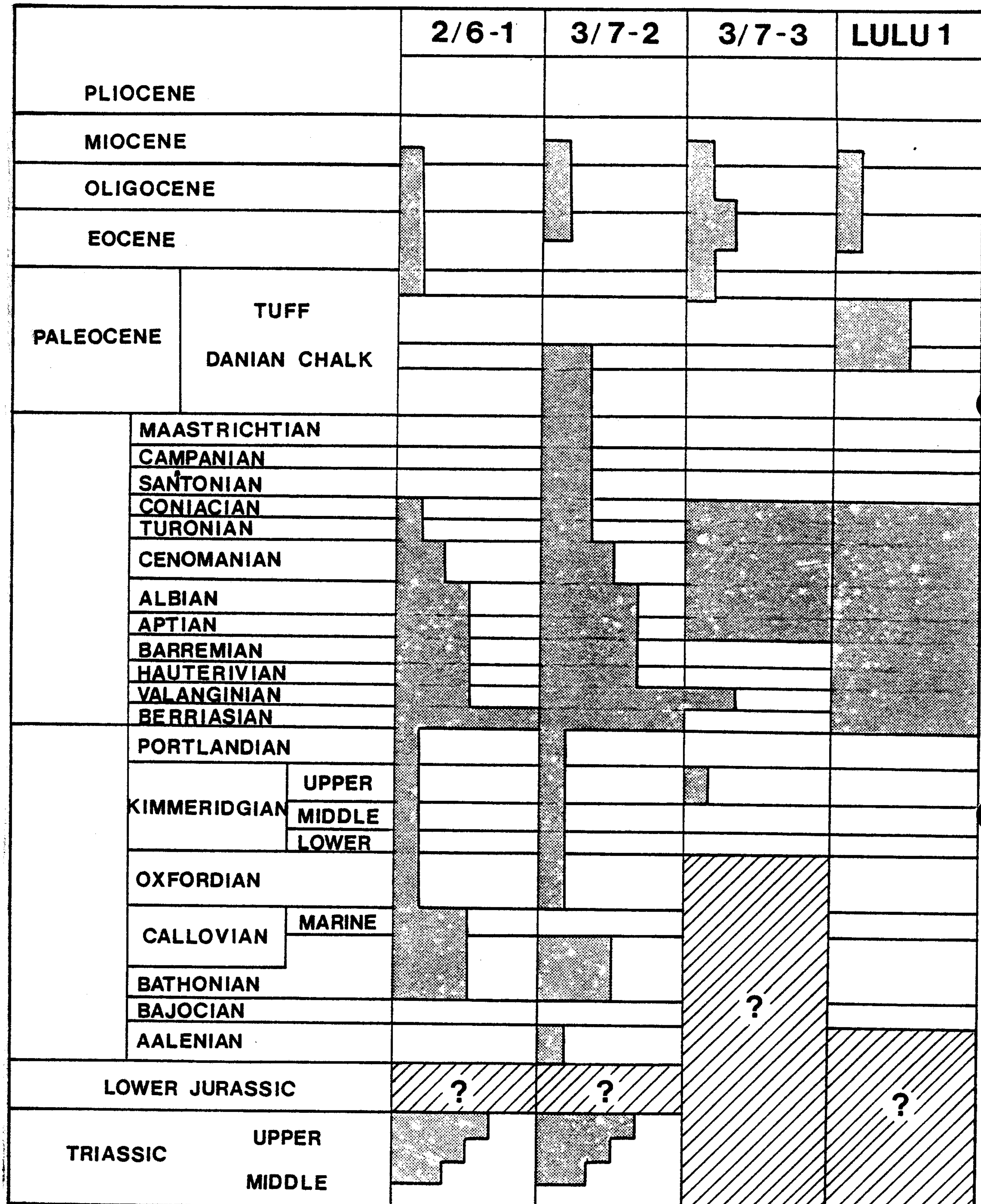
2/6-1: Early Triassic to Aalenian
Aalenian/Bajocian to Kimmeridgian
Kimmeridgian/Portlandian to Volanginian
Albian to Santonian

3/7-2: Early Triassic to Bajocian
Bajocian to Upper Callovian (marine)
Kimmeridgian to Valanginian
Albian to Maastrichtian (?)

3/7-3: Permian to Kimmeridgian
Barremian to Santonian

Lullu 1: Permian to Bajocian
Portlandian to Santonian

# SALT ACTIVITY IN 3/7 AREA




F.Verrolles APRIL 1982

Fig.16

These breaks are most probably the result of the salt activity as the four wells are located in the same type of environment. Therefore it is possible to determine the main phases of salt activity in the area (see fig. 16).

On 2/6-1, the hallokynetic activity started during the Triassic. It slows down during the early Middle Jurassic to start again in the late Middle Jurassic. The Upper Jurassic was most probably a period of slow rising. The salt activity resumes during the Lower Cretaceous to decrease again during the Upper Cretaceous. It is only after the deposition of the Tuff that the activity resumed.

On 3/7-2 the salt started to rise during also the Triassic. The early Middle Jurassic was a period of calm. By the end of the Upper Jurassic, till Early Paleocene the salt was very active. It slows down from Middle Paleocene to about Middle Eocene,then resumes its moving till the Oligo-Miocene.

On 3/7-3, the area was probably a high till the transgression of the Kimmerian sea. The salt started to move during Ablo-Aptian times till the Santonian. The Upper Cretaceous, Danain and Early Paleocene were very calm. It is only after the deposition of the Tuff that the rising resumed, but gently and with a displacement of the top of the Salt in a south-eastwards direction to come to a stop during the Oligo-Miocene.

On Lulu 1, the area was high till the Bajocian times. The salt has moved during all the Lower Cretaceous. The Upper Cretaceous was very quiet. The activity resumes after the deposition of the Danian Marl and slows down after the sedimentation of the Tuff. During Eocene to Miocene the salt resumes a gentle rise.

# 14 C O N C L U S I O N S

## 14.1 PETROLEUM RESULTS

The 3/7-3 well turned out to be dry. Despite the Thermal Alteration Index of 2.5 noticed in the Jurassic, which indicates a maturation stage at the beginning of the oil window, only minor gas shows have been encountered.

This is to be compared with the TAI noticed on wells 2/6-1 (2 to 2.5 in the Jurassic). The TAI is not known for Lulu 1. The slightly higher TAI values in well 3/7-2 are probably the results of a larger salt activity.

Maturation study of organic matter contained in the Upper Jurassic has been performed with DIAGEN. The results indicates that the oil migration may have started during the Late Maastrichtian and Danian times.

The source potential of the area seem to be rather good. Hydrocarbons have been found in Lulu 1. Even if the organic matter content of the Upper Jurassic shale is not exactly known, these shales are believed to thicken eastward in the syncline and also southward. In the 3/7-2 well the kerogene varies from humic in the Triassic to ligneous and amorphous in the Jurassic and ligneous only in the Lower Cretaceous.

Possible source rocks, even if we consider that the ligneous Kerogen is not as good as the humic one, are widely spread from the Triassic to the Barremian. These have been burried deep enough to generate hydrocarbons except on the Mandal high to the west, where these series are missing.

Therefore it is believed that the main problem is not one of source rocks but it is a problem of trapping the hydrocarbons.

On the 3/7-3 well the main phase of structuration occured from Aptian to Coniacian (It may have started slowly during the Upper Kimmeridgian and the Valanginian). Then the salt remained quiet till the end of Paleocene when it resumed gently to more and it was still active during Eocene, Oligocene and beginning of Miocene.

This means that the Upper Jurassic/Lower Cretaceous sandstones were already structured before the beginning of migration of the hydrocarbons. The Upper Cretaceous/Danian chalk were structured only quite some time after their deposition, which leave enough time for the diagenesis to start in the chalk (see fig. 16).

There is also a problem of caprock. It is reasonable to assume that the Lower Cretaceous strata (Valanginian to Albian) are not a good cover because they consist of many layers of carbonates. It is also very likely that, in some area on the 3/7 block, the Lower Cretaceous/Upper Jurassic sandstones have been truncated and are in direct contact with the chalk (see fig. 14, 15 and pl. 10). The chalk, fractured by hallokinesis, could have been a good path of dismigration.

On 3/7-3, the Upper Cretaceous/Danian chalk is overlain by only 6 meters of marl. The well being not located at the top of the structure, these marls may be missing towards the top. If the chalk was hydrocarbon bearing, it has been in contact with the Paleocene sands. But the chalk has been structured only later. These two reasons account for the fairlure in finding hydrocarbon in the chalk.

The seismic "anomaly" noticed at the top of the chalk may be the result from a composite reflection of the reworked Maastrictian/Danian and fracture chalk (see chapter 5, SEDIMENTOLOGY).

From well data it seem that the pressure regime is constant from Paleocene to Jurassic (see chapter 12, FORMATION PRESSURES). The pressure gradient is higher in the Tertiary. The formation pressure gradient is higher in the 2/6-1, 3/7-2 and Lulu 1. This lower pressure gradient in the 3/7-3 may also account for the absence of hydrocarbons.

At 1968 m, a drilling break was encountered and the well started to flow. The flow was killed with a mud weight of 1.55. After setting the 13 3/8" casing (shoe at 1961 m) the well was controlled after gain and losses with a mud weight of 1.58.

During these troubles the gas reading on chromatograph and gas detector reached often 76% of C1 with only traces of C2 and C3. Because of the circulation in closed circuit to kill the well, no sands were noticed in the cuttings.

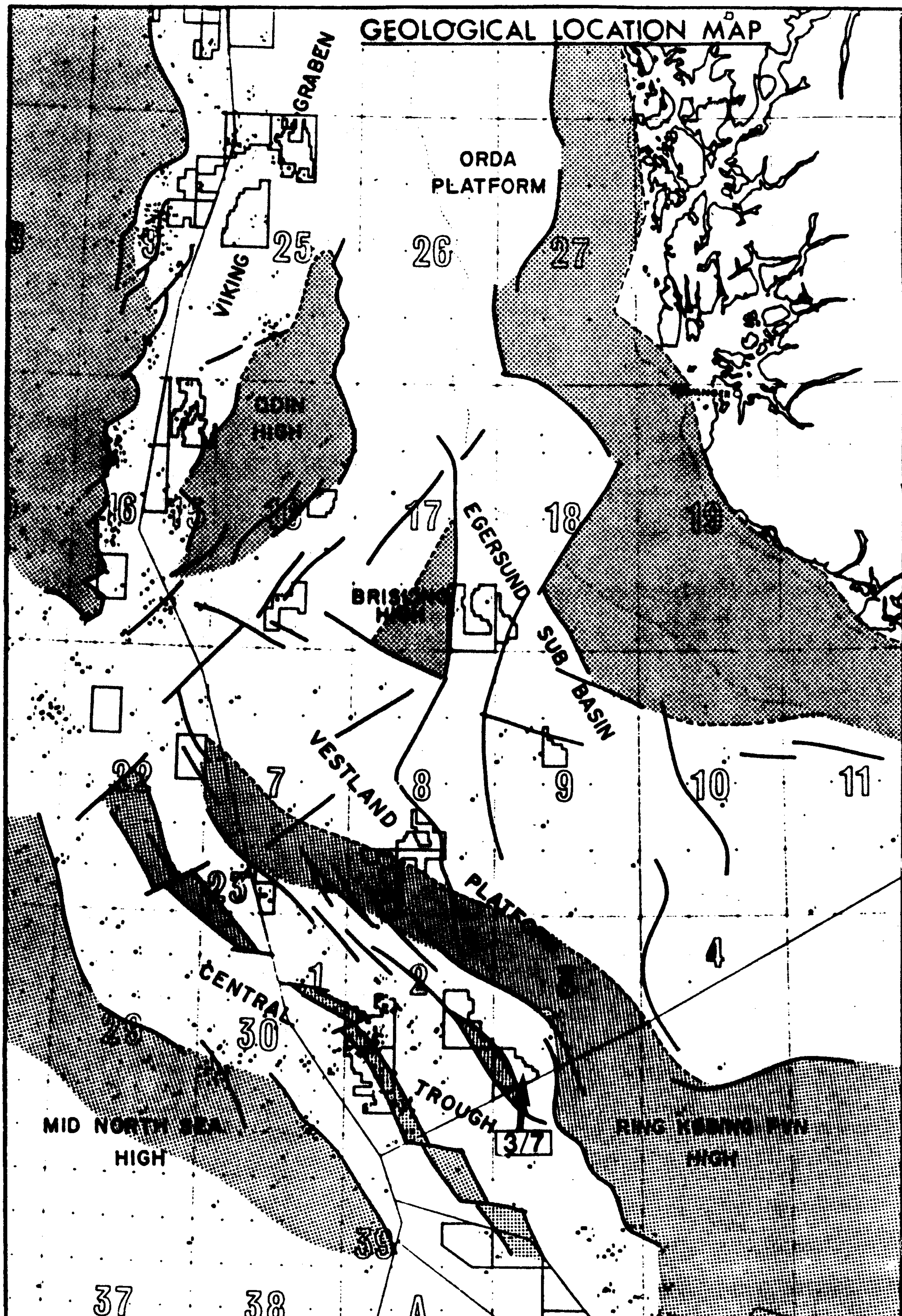

GEOLOGICAL LOCATION MAP
VIKING GRABEN
ORDA PLATFORM
25
26
27
ODIN HIGH
16
17
18
19
EGERSUND SUB BASIN
BRISING HIGH
VESTLAND PLATEAU
7
8
9
10
11
4
CENTRAL TROUGH
1
2
30
3/7
MID NORTH SEA HIGH
37
38
39
A
SCALE: 1/2 000 000

Fig.17

Nor on the electric logs it is possible to see any sand. The gas is a dry gas and may be a biogenic gas as the one encountered on well 2/3-1 in the Oligocene sands. The over pressure noticed in this interval is most probably the result of both the absence of good permeability and extensions of possible sand stringers and the rising of the salt during Eocene.

The mud weight used for killing the well may have also "loaded" the formation and have created more pressure problem than what would normally have happened. Later, no further pressure problems have been encountered.

## 14.2 REGIONAL IMPLICATION (see fig. 17)

The 3/7 block is located along the eastern flank of the Mandal high which lies on blocks 2/6, 2/9 and 3/7, marking the edge of the Central Trough. A wide syncline streches over the North-Eastern part of the block.

The other side of the syncline is bordered by the Vestland Platform/Ring Købing Fyn High in blocks 3/5 and 3/8. The syncline is dipping southward towards the Danish zone of the Central Troug. The syncline also opens northward in the direction of the septentional Permian basin which lies symmetrically to the south Permian basin already subsiding at the Westphalian times.

The Mandal High was a non depositional area untill the beginning of the Upper Cretaceous time, as confirmed by the 3/7-1 well where the chalk is ~~resting~~ rests directly on the Ordovician/Silurian gneiss (Dated by the Potassium-Argon method).

Two ages were found for the micas and feldspars: 435   10 millions years and 330   14 millions years. The first datation corresponds to a Caledonian age (Taconian phase) at the Ordovician/Silurian boundary. The second datation gives an Hercynian (Sudetian phase) at the Visean/Namurian boundary. This age does not fit with a major orogenic phase but to a re-heating. That is the time of the moscovian transgression. The abnormal behaviour of the Argon can be explained by the presence of a caprock overlaying the gneiss at the beginning of the Hercynian period. This caprock has probably been eroded at the beginning of the Carboniferous times.

The subsiding basin on the eastern flank of the basement high exhibits thick continuous deposits which started during Carboniferous and lasted untill Quaternary times. All the series older than the Upper Cretaceous pinching out against the flank of the Mandal High. In addition the hallokinetic activity has generated numerous structures at various times.

The subsidence of the syncline has allowed the burying of the Carboniferous and Jurassic rocks allowing them to generate hydrocarbons (cf. Lulu 1).

On the eastern flank of the syncline very few wells have been drilled. The well 3/5-1 has proved 300 m of Rotliegendes sandstones overlain by a relatively thin salt and thin Upper Jurassic which contains some Kimmeridgian sandstones.

Both the Mandal High and the Vestland Platform could have been good clastic sources.

In the light of 3/7-3 results and also considering the regional frame and history already quoted in chapters 13 and 14, the potential for the various formations on block 3/7 is summarized below.

Tertiary:

The Eocene/Oligocene sands found gas bearing of 2/3-1 well are probably missing. If they exist they are very thin, have very bad reservoir qualities and their extension may be expected to be very local. They may also represent a drilling hazard as they appear to be overpressured. They are certainly not a target for a new well on the 3/7 block.

The Paleocene sands (37.5 m thick) were more developped than expected. They cover a large area at least in the vicinity of the Mandal high (eastern side). Their thickness varies because of the hallokinesis. These sands have the same pressure gradient as the chalk and the other reservoirs below. They can be also in contact with the chalk as the Dan marls are very thin.

They may have created stratigraphic traps on the eastern flank of the Mandal High, although they have not been encountered there yet (well 3/7-1), provided they can be found in a position higher than their position at the time of the oil migration. It has been already explained that they have been structured later at the locations already drilled.

Cretaceous Chalk:

Well data in the area condemn more or less completely the reservoir potential of the chalk in the area. On wells 2/6-1, 3/7-3 and Lulu 1 the chalk was not yet structured at the beginning of the oil migration. The oil therefore could not be trapped. On Lulu 1 the structuration went on just after the deposition of the Danian chalk. It could be the reason why wet gas and condensate have been trapped in the chalk because in the syncline the "oil window" had been passed already.

Later, on 2/6-1 and 3/7-3, when the chalk was structured, the diagenesis had already deleted the reservoir qualities of the chalk. On 3/7-3 the porosity in Danian (K1) is always below 15% and the permeability generally below 0.2 md. From electric log there are indications that the porosity can be slightly better for some levels in the chalk. On 3/7-2 the salt was still moving during the hydrocarbon migration, thus creating ways for dismigration.

Only a careful study of all the remaining salt structures may lead to a chalk discovery in the 3/7 block. If the history of the structure to the Lulu 1 history possibilities still exist. But as the main salt structures have already been drilled (3/7-2 and 3/7-3) only a very minor discovery may be expected.

Lower Cretaceous:

Lower Cretaceous sands have only been encountered in the 3/7-3 well. They were already found once in the area, in the 25/5-1 well, where they are siltstones, exhibiting distal facies. These sands were the main target of the well 2/6-2 where they were not encountered. The Mandal High can be a good source for these sands but may have produced only a relatively small amount of clastic.

A total of 72 m of sandstones with good reservoir qualities (K2 and K3, porosity from 20 to 28%, permeability 0.5 to 10 darcies) have been drilled through on 3/7-3. The base of the sand is highly radioactive. Analyses of heavy minerals have been requested to try to make a comparison with the basal gneiss cored on 3/7-1.

These sands are probably troncated towards the South/South-East by the Upper Cretaceous limestone.

In area where the chalk has not been fractured by the salt activity it may provide very good traps, provided the sand pich out before the Mandal High.

Jurassic:

Upper Jurassic sandstones have been encountered in 3/7-3. They are Portlandian/Kimmeridgian in age and have probably the same source and distribution as the Lower Cretaceous sands. In the area, Kimmeridgian sands have been encountered in well 3/5-1.

As far as traps only are concerned, the same remarks apply to these Upper Jurassic sands as for the Lower Cretaceous ones.

Middle Jurassic sands are missing in 3/7-3. They have been encountered in the whole area (2/5-6, 2/6-1, 2/6-2, 3/7-2, Lulu 1) with different thicknesses due to the salt movements. They have generally good reservoir qualities. They may still be searched for as pinchouts against the flanks of salts diapirs (where they are missing at the top) and also against the Mandal High.

Permian:

Even if the Rotliegendes sandstones have not been encountered in 3/7-2 they exist in this area (see 3/5-1 well). They may provide traps against the flank of the Mandal High where the seismic data exhibit closures at the F horizon level (base of salt) in area where the salt is expected to be thin, and some deeper horizons truncated by the F. The main problem here is the possible presence of possible volcanism in the vicinity of the Mandal High.

Even after the failure of the two wells 3/7-2 and 3/7-3, there remains some possibilities of finding a prospect on the 3/7 block. The vicinity of the Lulu 1 discovery (even if not very important), the good maturation level of the organic matter in the area, show a fair potential hydrocarbon source in the area.

It remains to locate possible reservoirs and traps in the:

1) Lower Cretaceous/Upper Jurassic
2) Middle Jurassic
3) Rotliegendes (found either from carboniferous source rock or from Jurassic source rock if high enough on the flank of the Mandal High, (see Auk and Argyll in UK waters)
4) Paleocene
5) Danian/Upper Cretaceous chalk
(The numbers indicate the rank of interest of these targets).

New seismic with regular grid (1 x 1 km) has been shot in February 1982. The interpretation of this new seismic should lead either to the discovery of one or more new prospects, or to a well founded relinquishment of the remainder of the block.

## Appendix.1

| | | | |
|---|---|---|---|
| Coord X: 04° 10' 54.33" | Z ground: -67m | Spudded: 21.06.81. | Well **3/7-3** |
| Y: 56° 24' 54.77" | Z RKB: +25m | Started drilling: 21.06.81. | |
| Line: ANO 7380 | SP: 269 | 92m | At T.D: 24.08.81 | Country **NORWAY off-shore** |
| Depths datum: RKB | | Completed: 01.09.81 | |
| Rig: Dyvi Alpha | | TD Driller: 3540 m | T.D. Logger: 3542 m |
| Stopped in: Zechstein | | | |
| OPERATOR EAN | | LICENCE 023 | OWNED BY PETRONORD |

**TARGETS**

1) Danian/Upper Cretaceous Limestones.
2) Middle Jurassic Sandstones.

**RESULTS**

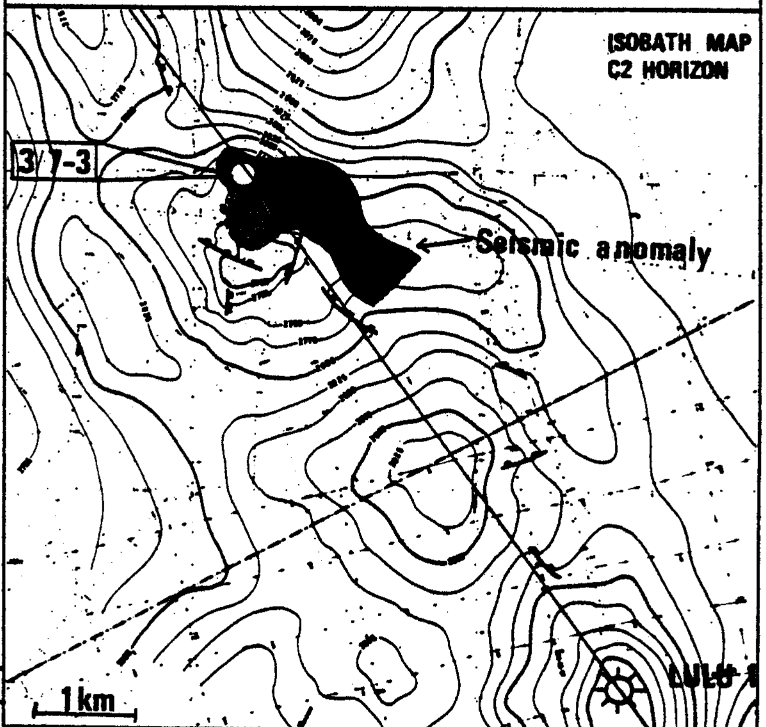
1) The Danian/Upper Cretaceous Limestones have been found tigth and water bearing.
2) The Middle Jurassic Sandstones are missing (U.Jur. on Salt). Good lower Cretaceous Sandstones have been encountered but they are water bearing.

**CASINGS**

| | | |
|---|---|---|
| 30" | at | 153m |
| 20" | at | 653m |
| $13^{3}/8$" | at | 1961m |
| $9^{5}/8$" | at | 3241m |

**CORES**

| | | |
|---|---|---|
| K1 | 2830-2848 | 60% |
| K2 | 3337,5-3339 | 67% |
| K3 | 3339 -3348 | 100 |
| SWC | 3285,5-3504 | 28/30 |




**SHOWS**

C1, traces of C2, C3 noticed in the Tertiary above 2700m.
Below no shows.

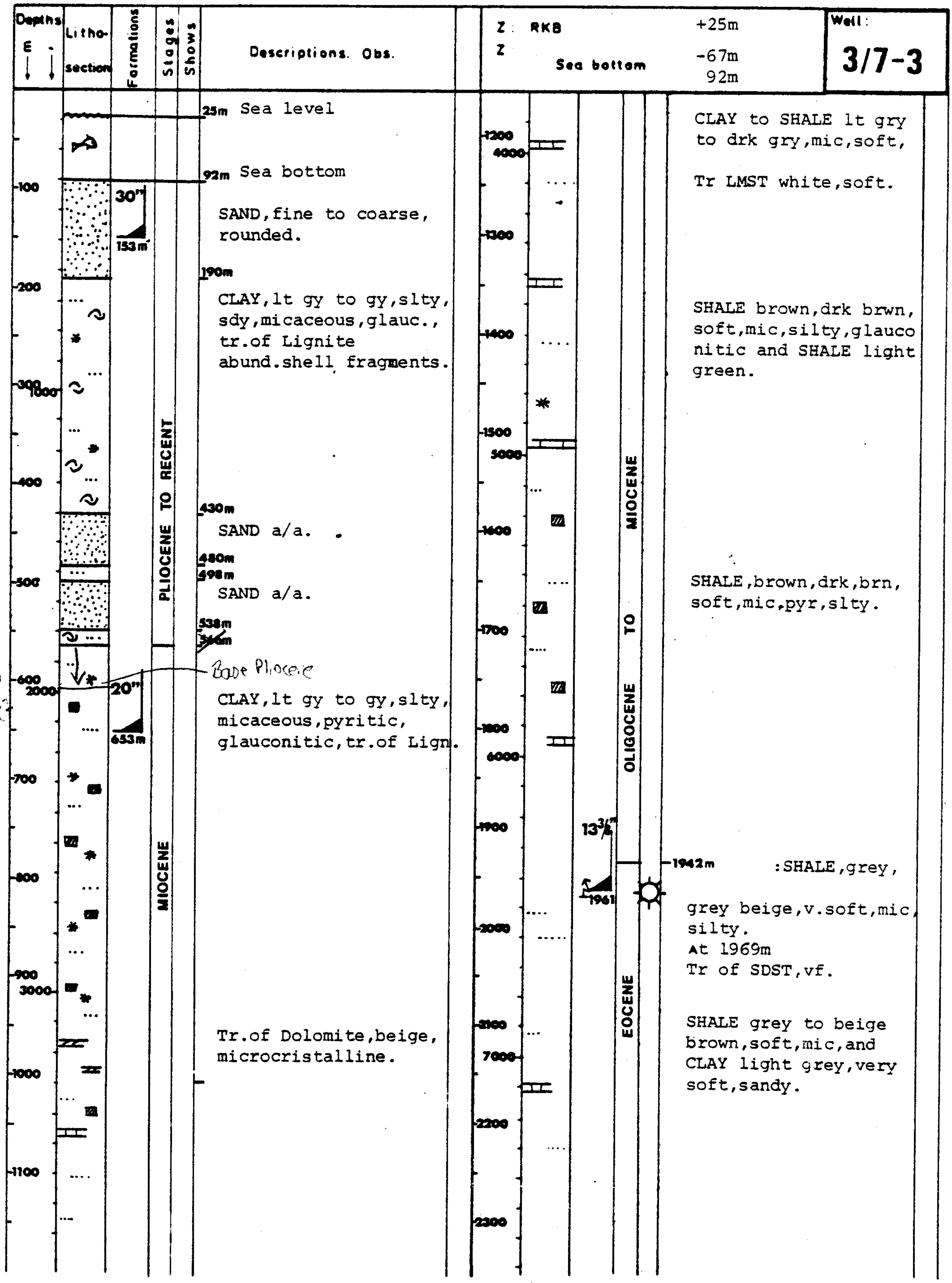
**LOGS**

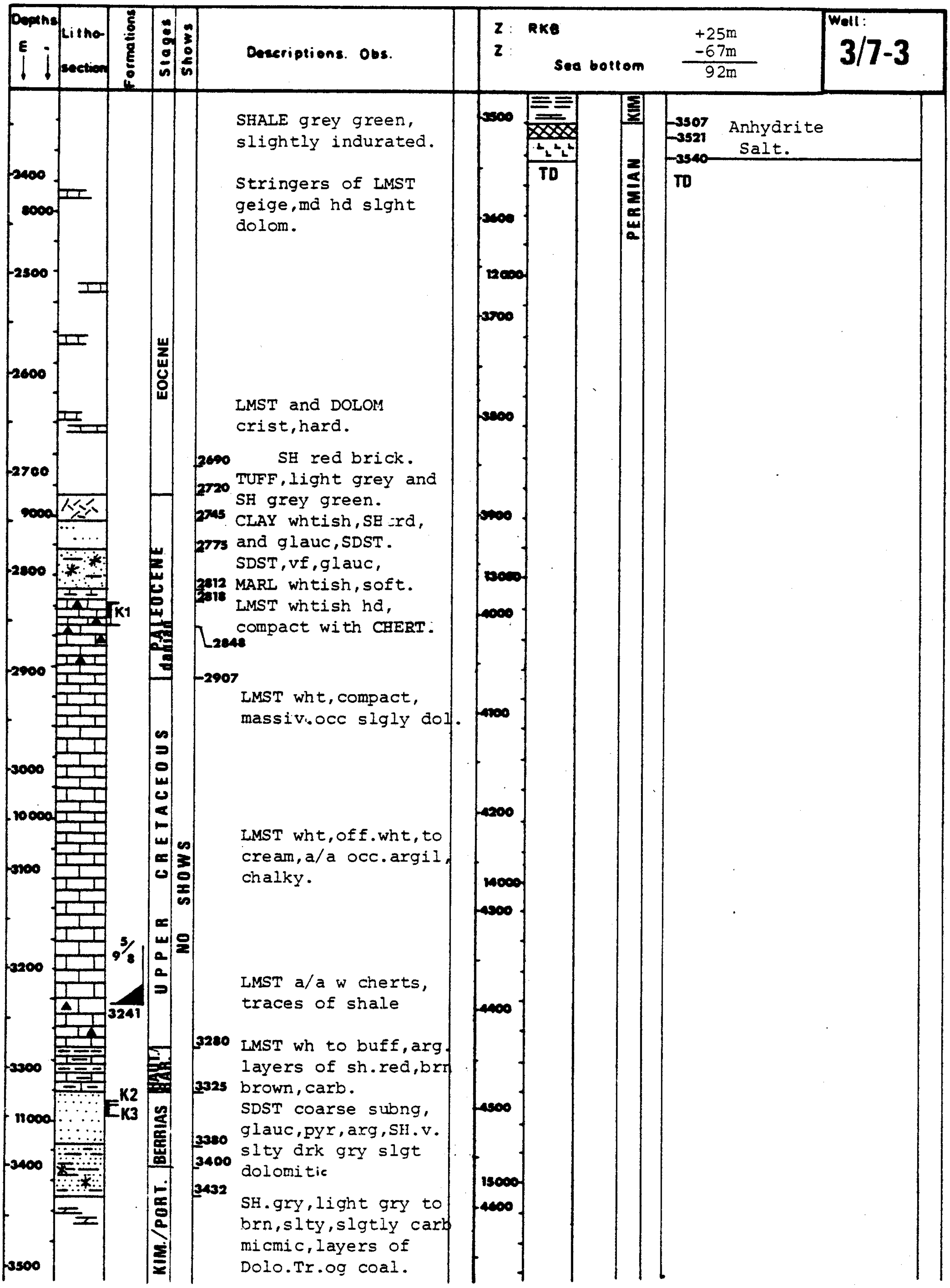
| | | | | | |
|---|---|---|---|---|---|
| ISF/BHC/GR | 666 - 153 | 1 | LDL/CNL/GR | 3542-3244 | 2 |
| LDL/GR CAL | 666 - 153 GR up to mud line | 1 | HDT | 3253-1961 | 1 |
| ISF/GR BHC | 1969 -653 | 2 | HDT | 3505-3240 | 2 |
| ISF/GR BHC | 2906-1961 | 3 | Velocity | 3520-2500 (50 shots) | |
| ISF/BHC/GR | 3251-1961 | 3 | Temp | 1500-100m | 2 |
| ISF/NGS/BHC | 3542-3244 | 5 | CBL | 1935-500m | 1 |
| LDL CNL GR | 3253-1961 | 1 | CBL | 3242.5-1700m | 2 |

**TESTS**

| | |
|---|---|
| RFT | 6 pressure tests 3323.5, 3329, 3341, 3351, 3366, 3372m<br>6803 psi at 3372m<br>Pressure gradient=1,42 |

Checked M.E.SCHIØLDE
Date 30.09.81.


Depths m
Litho-section
Formations
Stages
Shows
Descriptions. Obs.
Z: RKB +25m
Z Sea bottom -67m
92m
Well: 3/7-3
25m Sea level
92m Sea bottom
SAND, fine to coarse, rounded.
30"
153m
190m
CLAY, lt gy to gy, slty, sdy, micaceous, glauc., tr. of Lignite abund. shell fragments.
PLIOCENE TO RECENT
430m
SAND a/a.
480m
498m
SAND a/a.
538m
566m
Base Pliocene
R.P.J
20"
653m
CLAY, lt gy to gy, slty, micaceous, pyritic, glauconitic, tr. of Lign.
MIOCENE
Tr. of Dolomite, beige, microcristalline.
CLAY to SHALE lt gry to drk gry, mic, soft,
Tr LMST white, soft.
SHALE brown, drk brwn, soft, mic, silty, glauconitic and SHALE light green.
SHALE, brown, drk, brn, soft, mic, pyr, slty.
OLIGOCENE TO MIOCENE
13 3/8"
1961
1942m
: SHALE, grey, grey beige, v.soft, mic, silty.
At 1969m
Tr of SDST, vf.
SHALE grey to beige brown, soft, mic, and CLAY light grey, very soft, sandy.
EOCENE



Depths m
Litho-section
Formations
Stages
Shows
Descriptions. Obs.
Z : RKB +25m
Z : Sea bottom -67m
92m
Well:
3/7-3
SHALE grey green, slightly indurated.
Stringers of LMST geige,md hd slght dolom.
LMST and DOLOM crist,hard.
2690 SH red brick.
2720 TUFF,light grey and SH grey green.
2745 CLAY whtish,SH rd, and glauc,SDST.
2775 SDST,vf,glauc,
2812 MARL whtish,soft.
2818 LMST whtish hd, compact with CHERT.
2848
2907
LMST wht,compact, massiv.occ slgly dol.
LMST wht,off.wht,to cream,a/a occ.argil, chalky.
LMST a/a w cherts, traces of shale
3280 LMST wh to buff,arg. layers of sh.red,brn brown,carb.
3325 SDST coarse subng, glauc,pyr,arg,SH.v.
3380 slty drk gry slgt
3400 dolomitic
3432 SH.gry,light gry to brn,slty,slgtly carb micmic,layers of Dolo.Tr.og coal.
EOCENE
PALEOCENE
danian
UPPER CRETACEOUS
HAUT./BAR.
BERRIAS
KIM./PORT.
NO SHOWS
K1
K2
K3
5/8
9
3241
2400
8000
2500
2600
2700
9000
2800
2900
3000
10000
3100
3200
3300
11000
3400
3500
3500
3600
12000
3700
3800
3900
13000
4000
4100
4200
14000
4300
4400
4500
15000
4600
TD
KIM
PERMIAN
3507 Anhydrite
3521 Salt.
3540
TD

# CORE DESCRIPTION

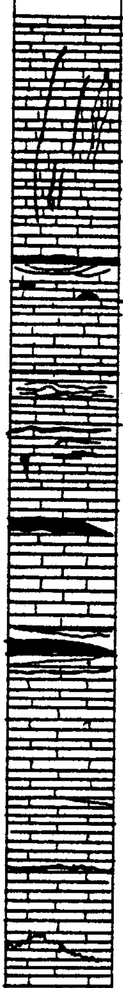
Sheet 1/5

CUT: 18 m
RECOVERED: 10.6 m   59.5 %
LOSS: 7.4 m

COMPANY: EAN
WELL N°: 3/7-3
CORE N°: 1

DATE: 31.07.81.
DEPTHS: 2830-2832

| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | BOX | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 2830,00 | | | | | | CAVING ? | 1 | LIMESTONE whitish, light grey-tan, moderatly hard, compact. Horizontal laminations of SHALE: 0,1mm-1cm. Vertical-oblique fractures filled with Calcite. (1cmx10cm) or with dark grey SHALE with traces of Calcite (0,1cmx20cm). |
| | | | | | | | | (2cm)thick laminatons of SHALE, dark grey-dark green, brittle. soft to firm, grading to very thin laminations ( 0,1mm ) of SHALE. |
| 2831,00 | | No | No | No | | | | LIMESTONE light grey-grey, moderatly, hard compact, slight argillaceous. With very thin laminations of SHALE. |
| | | | | | | | | Flake of pyrite on possible bitume(?) black, soft (to be confirmed) |
| | 78% | | | | | | 2 | Laminations of SHALE, dark grey-black, brittle (2cm to 0.1cm) |
| | | | | | | | | Very thin Stylolites with trace of SHALE inside. |
| 2832,00 | | | | | | | | |



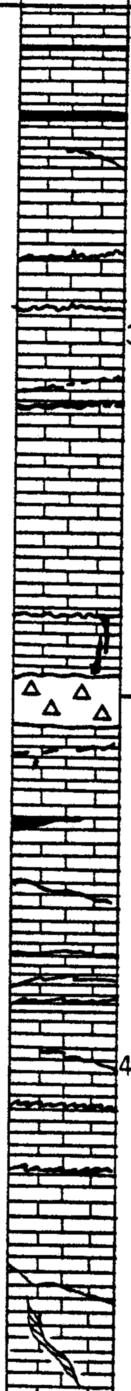
# CORE DESCRIPTION

Sheet 2/5

CUT: 18 m
RECOVERED: 10.6 m 59.5 %
LOSS: 7.4 m

COMPANY: EAN
WELL N°: 3/7-3
CORE N°: 1

DATE: 31.07.81.
DEPTHS: 2832-2834

| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | BOX | DESCIPTION |
|---|---|---|---|---|---|---|---|---|
| 2832,00 | | | | | |  | | Thin SHALE layer = 1mm<br>SHALE layer = 2cm thick } SHALE as above |
| | | | | | | | | Thin stylolites <0,1 mm |
| | | | | | | | 3 | LIMESTONE as above. |
| | | | | | | | | Vertical fractures with pyrite and SHALE, trace DOLOMITE. ( 1mm x 2 cm ) |
| 2833,00 | 0 | No | No | No | | | | CHERT light grey-bluish, very hard, microcristalline. |
| | | | | | | | | LIMESTONE beige-light brown. |
| | | | | | | | | LIMESTONE, light green-grey, argillaceous, firm-moderatly hard. |
| | 72/86 | | | | | | 4 | Abondant stylolites with trace of SHALE. |
| | | | | | | | | Slikenside with trace of SHALE dark green, soft. |
| 2934,00 | | | | | | | | LIMESTONE light grey-beige, hard, compact small oblique fracture with Calcite and Pyrite. ( 1 mm to 5 mm wide, 10 cm long ). |

# CORE DESCRIPTION

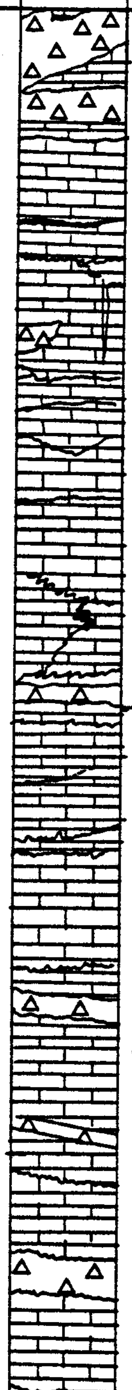
Sheet 3/5

CUT: 18 m
RECOVERED: 10.6 m 59.5 %
LOSS: 7.4 m

COMPANY: EAN
WELL Nº: 3/7-3
CORE Nº: 1

DATE: 31.07.81.
DEPTHS: 2830-2832

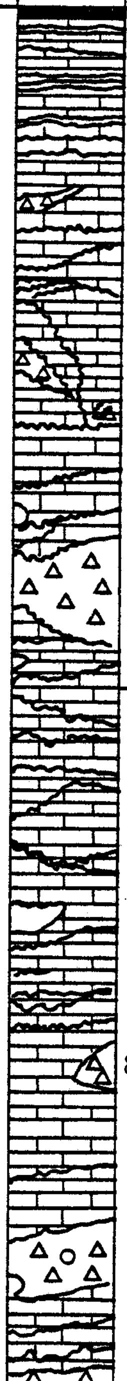
| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | BOX | DESCIPTION |
|---|---|---|---|---|---|---|---|---|
| 2834,00 | 0 | No | No | No | | | | CHERT: dark grey-bluish, very hard. |
| | | | | | | | | LIMESTONE: beige, hard-very hard, compact. |
| | | | | | | | | Stylolites filled with SHALE dark green grey, soft-firm. Very thin stylolites. |
| | | | | | | | 5 | Vertical fracture filled with Calcite (2mmx10cm) |
| | | | | | | | | LIMESTONE cream-ligth grey, moderatly hard to hard. |
| | 79/ 83 | | | | | | | Stylolites filled in parts with Càlcite. |
| 2835,00 | | No | No | No | | | | LIMESTONE dark grey, hard, compact thin stylolites. |
| | | | | | | | | LIMESTONE whitish-ligth grey, tan. |
| | | | | | | | 6 | CHERT dark grey-bluish, very hard. |
| | | | | | | | | LIMESTONE whitish-grey, hard, compact. |
| 2836,00 | | | | | | | | |



# CORE DESCRIPTION

Sheet 4/5

| | | |
|---|---|---|
| CUT: 18m | COMPANY: EAN | DATE: 31.07.81. |
| RECOVERED: 10.6m 59.5 % | WELL N°: 3/7-3 | DEPTHS: 2836-2838 |
| LOSS: 7.4m | CORE N°: 1 | |

| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | BOX | DESCIPTION |
|---|---|---|---|---|---|---|---|---|
| 2836,00 | 88 | | | | |  | | 1cm SHALE,dark grey-dark green,brittle,firm, slight calcareousAbondant stylolites filled with SHALE a/a (0,1mm - 1mm)<br>LIMESTONE light grey,argillaceous,moderatly hard. |
| | | | | | | | 7 | LIMESTONE,beige cream,very hard,with fossils and trace of CHERT a/a. |
| | | | | | | | | Abondant thin Stylolites,sometimes filled with SHALE.<br>Layer of CHERT (10cm -15cm ) a/a<br>Traces of CHALK white-whitish,soft. |
| 2837,00 | | No | No | No | | | | LIMESTONE light grey-tan with trace of CHALK a/a |
| | 84 | | | | | | | LIMESTONE,beige,hard,trace fossils, oblique slikensides with SHALE dark green. |
| | | | | | | | 8 | |
| | 0 | | | | | | | |
| 2838,00 | | | | | | | | |

elf norge - EXPLORATION

# CORE DESCRIPTION

Sheet 5/5

CUT: 18 m
RECOVERED: 10.6 m 59.5 %
LOSS: 7.4m

COMPANY: EAN
WELL N°: 3/7-3
CORE N°: 1

DATE: 31.07.81.
DEPTHS: 2838-2839,6

| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | BOX | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| 2838 | 84 | | No | | | | 9 | LIMESTONE whitish-cream,hard,compact,xlin traces of pockets filled with Calcite and SHALE. |
| | | | | | | | | No Stylolite |
| | | | | | | | | Trace fossils. |
| | 0 | | No | | | | | CHERT dark grey-bluish,very hard,with trace CHALK. |
| | | | | | | | | core fragments: CHERT - argillaceous LIMESTONE. |
| 2839,00 | | | Poor | | | | 10 | Core fragments: CHALK,witish-ligth grey,soft, SHALE,dark green (in place?) |
| | | | | | | | | LIMESTONE grey-dark grey,hard,compact, with abondant lamination of stylolites with SHALE. |
| | | | | | | | | Core fragments CHERT,CHALK very soft-whitish. |
| | | | Poor. | | | | | Core fragments CHALK a/a,trace of SHALE. |

PROVISIONAL

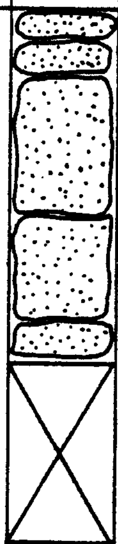
**Appendix.3**

# CORE DESCRIPTION

CUT: 1.5 m
RECOVERED: 1 m  67 %
LOSS: 0.5 m

COMPANY: E.A.N
WELL N°: 3/7-3
CORE N°: 2

DATE: 24-08-81
DEPTHS: 3337.5-3339 m
Page 1 of 1

| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | DESCIPTION |
|---|---|---|---|---|---|---|---|
| 3337.5 – 3338.5 | TR. of $CaCo_3$ | GOOD PERMEABILITY (Deep mud invasion) | GOOD VIS.POROSITY | NO FLUORSCENCE | |  | SANDSTONE: light brown to tan with irregular bands of dark brown,friable,coarse to very coarse, subangular to subrounded locally angular,slightly calcareous and argillaceous,local aggregates of kaolinite,silica cement,traces of glauconite, scattered quartz pebbles. |
| 3339.0 | | | | | | | |

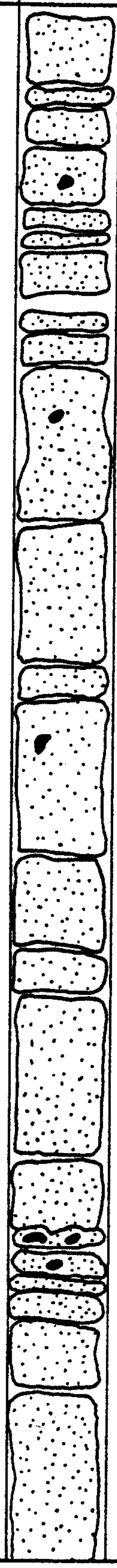
elf norge - EXPLORATION

PROVISIONAL

**Appendix.4**

# CORE DESCRIPTION

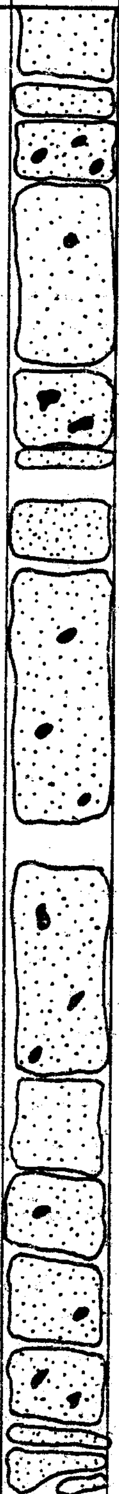
| | | |
|---|---|---|
| CUT: 9 m | COMPANY: E.A.N. | DATE: 24-08-81. |
| RECOVERED: 9 m    100 % | WELL N°: 3/7-3 | DEPTHS: 3339.0-3348.0 m |
| LOSS: 0 | CORE N°: 3 | Page 1 of 2 |

| DEPTHS | % $CO_3Ca$ | PERM | POROS | SHOWS | DIPS | LOG | DESCIPTION |
|---|---|---|---|---|---|---|---|
| 3339.0 | TRACES OF CARBONATE | GOOD APPARENT PERMEABILITY ( Deep mud invasion ). | GOOD VISUAL POROSITY | NO FLUORSCENCE | |  | SANDSTONE: light brown to medium brown with irregular bands of dark brown, friable, coarse to very coarse, subangular to subrounded well sorted, slightly calcareous, silica cemented traces of kaolinite and glauconite, locally quartz pebbles, milky to bluish. |
| 3340.0 | | | | | | | SANDSTONE: light brown as above, motteled with dark brown patches, local coarse grains of bluish quartz (2mm) traces of mica. |
| 3341 | | | | | | | SANDSTONE: light brown as above pebble(5mm) milky bluish, traces of coal and glauconite. |
| | | | | | | | SANDSTONE: medium brown as above. |
| 3342 | | | | | | | SANDSTONE: dark brown, less well cemented than the lighter sandstone. |
| | | | | | | | SANDSTONE: light brown as above. |
| | | | | | | | SANDSTONE: dark brown, very coarse, pebbly (up to 10mm), friable. |
| 3343 | | | | | | | SANDSTONE: light brown to tan, as above slightly less cemented, more friable, pebbles up to 5mm, traces of coal. |
| 3343.7 | | | | | | | |

PROVISIONAL

# CORE DESCRIPTION

| | | |
|---|---|---|
| CUT: 9 m | COMPANY: E.A.N. | DATE: 24-08-81. |
| RECOVERED: 9 m  100 % | WELL Nº: 3/7-3 | DEPTHS: 3339.0-3348.0 m |
| LOSS: 0 | CORE Nº: 3 | Page 2 of 2. |

| DEPTHS | % $CaCO_3$ | PERM | POROS | SHOWS | DIPS | LOG | DESCIPTION |
|---|---|---|---|---|---|---|---|
| 3343.7 | TRACES OF CARBONATE | GOOD APPARENT POROSITY ( Deep mud invasion ) | GOOD VISUAL POROSITY | NO FLUORSCENCE | |  | SANDSTONE: light grey to tan as above. |
| 3344 | | | | | | | SANDSTONE: light grey to tan as above with darker, sublinear patches, 0.5 to 1 cm wide and up to 5 cm long, possibly with finely diseminated carbonaceous material, randomlyoriented, quartz pebbles (up to 10 mm). |
| | | | | | | | Scattered rock fragments, dark grey Claystone and medium brown, quartzitic(?), both types angular. |
| 3345 | | | | | | | |
| 3346 | | | | | | | |
| 3347 | | | | | | | |
| 3348 | | | | | | | SANDSTONE: dark brown, quartz grains becoming greyish and brownish, less cemented than before. |

elf norge - EXPLORATION

Appendix.5

# SIDE WALL CORES DESCRIPTION

| | | |
|---|---|---|
| WELL : 3/7-3 | RUN N° : 1 | SERVICE COMPANY: SPE |
| LICENCE : | PAGE N°: 1 | ASKED: 30 |
| | DATE : 26/8/81 | RECOVERED : 29 |
| EAN | | SHOT : 30 |
| | | LOST : 1 |
| | | FULL BULLET : 28 |
| | | CAILLET G |

tr : trace - M : medium - G : good

| N° | DEPTHS | REC | LITHOLOGY | Fluorescence | CUT |
|---|---|---|---|---|---|
| 1 | 3504 | 100 | SHALE dark-grey | None | |
| 2 | 3491 | 40 | SHALE dark-grey, slightly silty | / | |
| 3 | 3488 | 30 | SHALE A/A with dolomite grey. | / | |
| 4 | 3481 | 60 | SHALE dark-grey, slightly carb. | / | |
| 5 | 3475 | 60 | SHALE dark-grey, slightly carb, micromicaceous | / | |
| 6 | 3466 | 0 | LOST | | |
| 7 | 3458 | 40 | SHALE dark-grey, slightly carb. | / | |
| 8 | 3453 | 40 | SHALE A/A | / | |
| 9 | 3444 | 50 | SHALE A/A | / | |
| 10 | 3438 | 60 | SHALE A/A | / | |
| 11 | 3434 | 80 | SHALE grey, slightly silty | / | |
| 12 | 3426 | 60 | SHALE grey, sandy, glauconitic, slightly carb. | / | |
| 13 | 3420 | 50 | SANDSTONE, coarse, glauconitic, very argilaceous and dolomitic. | / | |
| 14 | 3418 | 50 | SANDSTONE A/A , soft, very argilaceous | / | |
| 15 | 3415 | 70 | SHALE very sandy, coarse grain, carb. | / | |
| 16 | 3412,7 | 50 | SANDSTONE coarse to medium, grey, argil.-dolom. | / | |
| 17 | 3409 | 60 | SANDSTONE A/A, glauconitic, dolomitic, cement | / | |
| 18 | 3405 | 60 | SHALE grey, very sandy, slightly carb. (to sandstone very argilaceous) | / | |

# SIDE WALL CORES DESCRIPTION

| | | | |
|---|---|---|---|
| WELL : 3/7-3 | RUN N° : 1 | SERVICE COMPANY: SPE | |
| LICENCE : | PAGE N°: 2 | ASKED: 30 | |
| | DATE : 26/8/81 | RECOVERED: 29 | |
| EAN | | SHOT : 30 | |
| | | LOST : 1 | |
| | | FULL BULLET : 28 | |
| | | CAILLET G. | |

tr : trace - M : medium - G : good

| N° | DEPTHS | REC | LITHOLOGY | Fluorescence | CUT |
|---|---|---|---|---|---|
| 19 | 3409 | 40 | SHALE grey, very sandy, with white inclusions of sandstone, carb. | None | |
| 20 | 3396 | 60 | SANDSTONE light grey, medium to coarse, poor sorted, slightly dolomitic, glauconitic | / | |
| 21 | 3390 | 40 | SANDSTONE light grey A/A | / | |
| 22 | 3385 | 50 | SANDSTONE light grey, argil.-dolimitic, coarse, soft | / | |
| 23 | 3381 | 30 | SANDSTONE white, carb., medium to coarse, with glauconite and pyrite | / | |
| 24 | 3357 | 60 | Limestone off-white, pasty, argilaceous, soft sandy | / | |
| 25 | 3322,5 | 50 | SANDSTONE light-grey, coarse, slightly carb. | / | |
| 26 | 3314,5 | 50 | SANDSTONE white, coarse, slightly carb. | / | |
| 27 | 3311 | 60 | LIMESTONE off-white, argilaceous and slightly sandy | / | |
| 28 | 3305,5 | 50 | SHALE grey to light grey, silty, carb. | / | |
| 29 | 3293 | 0 | EMPTY | | |
| 30 | 3285,5 | 70 | LIMESTONE white, soft | / | |

# WELL HISTORY SUMMARY

## MOVING IN

The well 3/7-3 started June 20, 1981 at 16.00 hrs. With all anchors racked up and the semi-submersible "Dyvi Alpha" ready for two on well location 3/7-2.

Thw S.S. DYVI ALPHA arrived on location June 20, 1981 at 18.00 hrs. and dropped the first anchor at 18.25 hrs.

Well coordinates: 04°10' 54.33" E
56°24' 54.77" N

Water depth on location 67 m distance RKB/mud line: 92 m

## DRILLING

The well was spudded the 21.06.81 at 15.00 hrs. and the drilling was finished the 26.08.81 at 19.30 hrs., which gives 66.2 days of drilling. The following operations were performed:

- Drilled 36" hole and set 30 inch casing at 153 m
- Drilled 17 1/2 hole log and underreamed 26" to 666 m
- Set 20" casing at 653 m
- Drilled 17 1/2 hole to 1968 m. At 1968 m increased mud weight from 1.31 to 1.55 to keep the well stable. Drilled 17 1/2 hole to 1970 m
- Ran logs and set 13 3/8 inch casing at 1961 m

After cemented 13 3/8 inch casing, well started to flow. 17.5 $m^3$ cement plug. The well was stabilised by help of heavy mud and cement plugs pumped down the annules or squeezed through perforation in the casing.

- Drilled 12 1/4" hole to 2830 m
- Cut core #1 from 2830 m to 2848 m
- Drilled 12 1/4" hole from 2848 to 3253 m
- Ran logs and sat 9 5/8" casing at 3241 m
- Drilled 8 1/2" hole 3291 to 3337.5 m
- Cut core #2 and #3 from 3337.5 to 3348 m
- 8 1/2" hole was drilled from 3348 m to total depth 3540 m and logged.

Abandonment

The abandonment phase was 5.48 days long and the last anchors were on bolster September 1st at 07.00 hrs. S.S. DYVI ALPHA went to SAGA.

Total well duration: 72.6 days.

| YEAR | LICENCE | OWNER | OPERATOR | BLOCK |
|---|---|---|---|---|
| 1981 | 023 | PETRONORD | EAN | 3/7 |

| OWNER | WELL | OPERATOR |
|---|---|---|
| PETRONORD | 3/7-3 | EAN |

# COMPOSITE LOG

1981 | 3/7-3 | EAN

AREA : NORWAY off-shore

## scale 1/500

| | | | |
|---|---|---|---|
| Coordinates | x : 04° 10′ 54.33″ E | Date spudded : | 1981 June 6th |
| | y : 56° 24′ 54.77″ N | Started drilling : | 1981 June 6th |
| Water depth : 67m | RKB : 25m | At T.D. : | 1981 August 24 th |
| Rig : | Dyvi Alphà | T.D. (driller) : | 3540 m |
| Contractor : | Dyvi drilling | T.D. (logger) : | 3542 m |
| Mud logging : | Geoservices | COMPLETED | 1981 September 1st. |

Well-site geologists : G. Caillet J. Marion

Approved by : F. Verrolles date : Sept. 1981

Status : Plugged and Abandoned, dry hole.

PL. 1

## LEGEND

CASING SHOE Ø depth

K1 (CORE) depth

SIDE WALL CORE

ON CORES & CUTTINGS: Gas show; Oil; Direct fluo; "Cut"

G (GAS) depth; O (OIL) depth; TZ (TRANZITION ZONE) depth; W (WATER)

F.I.T RESULTS: Gas; Oil; Form.water or filtr.w/salinity; Dry; Meconical failure

SAND, fine grained; SAND, coarse; CLAY / SHALE; calcareous Shale to Marl; SANDSTONE; LIMESTONE

Siltstone; TUFF, volcanics; COAL, LIGNITE; ANHYDRITE; ROCK SALT

Pyrite; Calcite; Bitumen; Glauconite; Dolomite; Mica


3/7-3 : LOGGING.

| | ISF/SONIC/GR | | LDL/CNL/GR | | HDT | | CBL/VDL |
|---|---|---|---|---|---|---|---|
| 1 | 666 - 153 | 1 | 666 - 153(no CNL) | 1 | 3253 - 1961 | 1 | 1935 - 500 |
| 2 | 1969 - 653 | 1 | 3253 - 1961 | 2 | 3505 - 3240 | 2 | 3242.5 - 1700 |
| 3 | 2906 - 1961 | 2 | 3542 - 3244 | | | | |
| 4 | 3253 - 1961 | | | | Temp.log. | | VSL |
| 1 | 3542 - 3244 (a) | | | 1 | 1880 - 378 | 1 | 3520 - 2500 |
| (a) | NGT instead of GR | | | 2 | 1500 - 100 | | CST |
| | | | | | | 1 | 3504 - 3285.5 |
| | | | | | | | RFT 6 shots. |

RFT : 6 shots were attempted.

| DEPTH | HYDROSTATIC PRESSURE | FORMATION PRESSURE | GRADIENT |
|---|---|---|---|
| 3323.5 m | 7810 PSI | 6732 PSI | 1.43 |
| 3329 m | 7818 " | 6737 " | 1.43 |
| 3341 m | 7844 " | 6755 " | 1.43 |
| 3351 m | 7859 " | 6770 " | 1.43 |
| 3366 m | 7897 " | 6793 " | 1.43 |
| 3372 m | 7900 " | 6803 " | 1.43 |

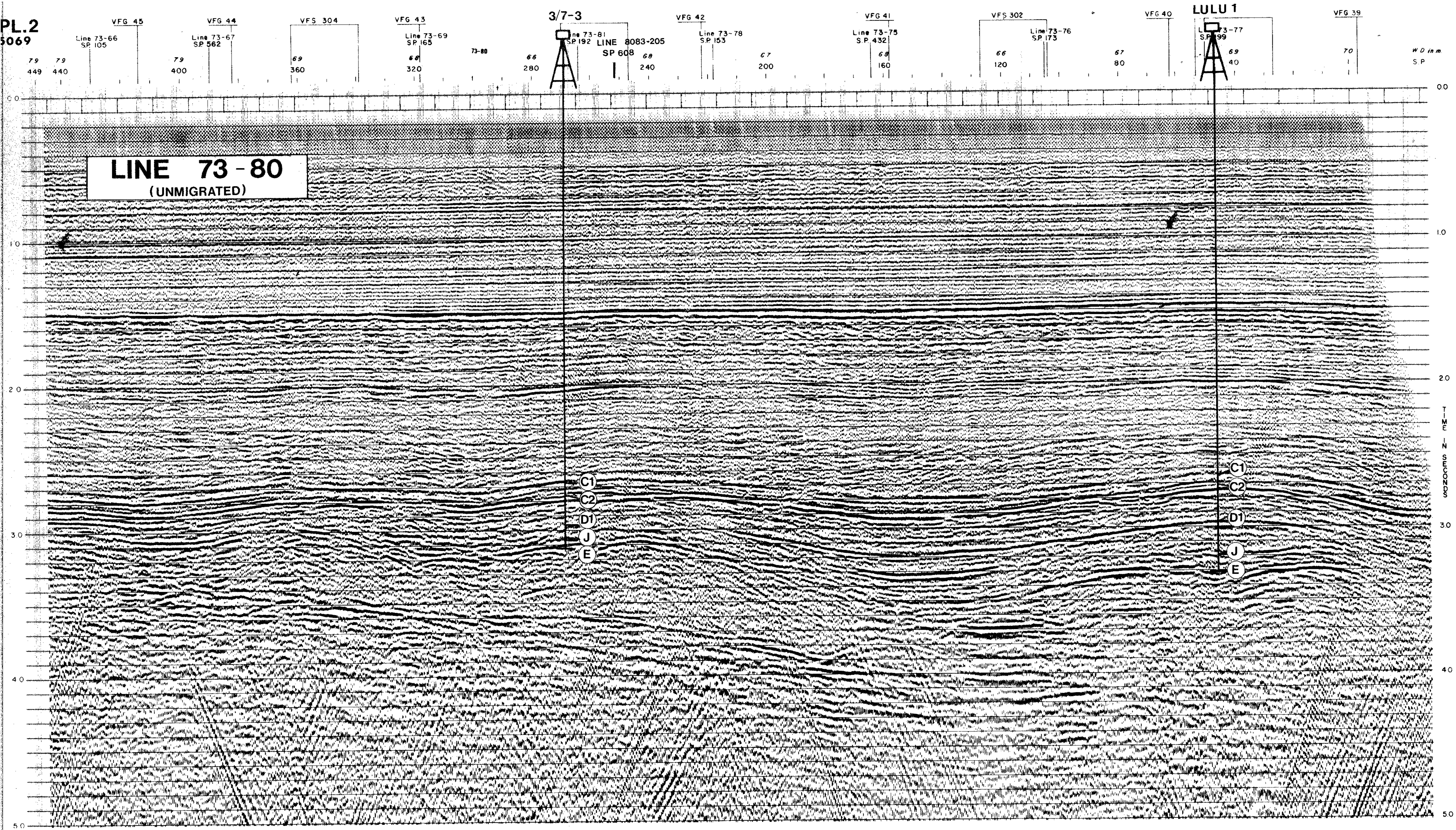
CORING :

CORE 1 2830 - 2848 m 10.6 m of 18 m (60%) LIMESTONE, white off white, hard compact, with microfractures filled with CALCITE and dark grey SHALE. Occasionally abundant chert.

CORE 2 3337.5 - 3339 m 1 m of 1.5 m (67%) Same description as core no 3.

CORE 3 3339 - 3348 m 9 m of 9 m (100%) SANDSTONE coarse to very coarse, light brown to medium brown with irregular dark brown areas, subangular to subrounded, slightly calcareous, friable to slightly consolidated, silica cemented, with traces of KOOLINITE and GLAUCONITE. Occasionally quartz pebbles up to 5mm. Rare traces of COAL.

PL.2
5069


LINE 73-80
(UNMIGRATED)
3/7-3
LULU 1
VFG 45
VFG 44
VFS 304
VFG 43
VFG 42
VFG 41
VFS 302
VFG 40
VFG 39
Line 73-66
S.P. 105
Line 73-67
S.P. 562
Line 73-69
S.P. 165
Line 73-81
S.P. 192
LINE 8083-205
SP 608
Line 73-78
S.P. 153
Line 73-75
S.P. 432
Line 73-76
S.P. 173
Line 73-77
S.P. 99
73-80
W.D. in m.
S.P.
449
440
400
360
320
280
240
200
160
120
80
40
C1
C2
D1
J
E
TIME IN SECONDS
0.0
1.0
2.0
3.0
4.0
5.0

| SP 541.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1720 |
| 0.90 | 1820 |
| 1.30 | 1890 |
| 1.70 | 1990 |
| 2.20 | 2005 |
| 2.60 | 2055 |
| 3.00 | 2065 |
| 3.10 | 2085 |
| 3.20 | 2120 |
| 3.40 | 2380 |
| 3.50 | 2450 |
| 4.00 | 2600 |
| 5.60 | 3180 |

| SP 529.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1720 |
| 0.90 | 1820 |
| 1.60 | 1990 |
| 2.30 | 2010 |
| 2.60 | 2040 |
| 3.10 | 2060 |
| 3.20 | 2090 |
| 3.40 | 2330 |
| 3.60 | 2430 |
| 4.00 | 2600 |
| 5.60 | 3180 |

| SP 517.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1720 |
| 1.40 | 1950 |
| 1.50 | 1970 |
| 1.70 | 1990 |
| 2.40 | 2010 |
| 2.70 | 2040 |
| 3.10 | 2060 |
| 3.20 | 2140 |
| 3.40 | 2440 |
| 3.50 | 2510 |
| 3.80 | 2540 |
| 4.00 | 2600 |
| 5.60 | 3180 |

| SP 505.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1740 |
| 1.00 | 1860 |
| 1.40 | 1910 |
| 1.80 | 1930 |
| 2.10 | 1960 |
| 2.70 | 2040 |
| 3.00 | 2060 |
| 3.40 | 2445 |
| 3.80 | 2600 |
| 4.00 | 2660 |
| 5.60 | 3220 |

| SP 493.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1750 |
| 1.20 | 1900 |
| 1.40 | 1995 |
| 1.80 | 2005 |
| 2.00 | 2030 |
| 2.40 | 2040 |
| 2.80 | 2075 |
| 3.10 | 2090 |
| 3.40 | 2470 |
| 4.00 | 2720 |
| 5.60 | 3250 |

| SP 481.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1750 |
| 1.20 | 1910 |
| 1.60 | 1995 |
| 1.90 | 2005 |
| 2.10 | 2030 |
| 2.40 | 2060 |
| 2.70 | 2080 |
| 3.00 | 2110 |
| 3.30 | 2210 |
| 3.40 | 2470 |
| 4.10 | 2850 |
| 5.80 | 3320 |

BLOCK 2/9 BLOCK 3/7

| SP 469.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1690 |
| 0.80 | 1820 |
| 1.20 | 1900 |
| 1.50 | 2000 |
| 1.70 | 2020 |
| 2.50 | 2060 |
| 2.70 | 2100 |
| 3.00 | 2120 |
| 3.20 | 2380 |
| 3.30 | 2620 |
| 3.70 | 2710 |
| 4.00 | 2860 |
| 5.60 | 3360 |

| SP 457.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1680 |
| 0.80 | 1820 |
| 1.20 | 1900 |
| 1.50 | 2005 |
| 2.00 | 2030 |
| 2.30 | 2060 |
| 2.80 | 2120 |
| 3.00 | 2225 |
| 3.20 | 2480 |
| 3.40 | 2590 |
| 4.00 | 2900 |
| 5.60 | 3400 |

| SP 445.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1690 |
| 0.80 | 1830 |
| 1.20 | 1905 |
| 1.40 | 1980 |
| 1.60 | 2035 |
| 2.40 | 2060 |
| 2.70 | 2120 |
| 2.90 | 2200 |
| 3.20 | 2580 |
| 3.40 | 2680 |
| 4.00 | 3060 |
| 5.60 | 3500 |

| SP 433.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1700 |
| 0.80 | 1830 |
| 1.10 | 1900 |
| 1.40 | 1995 |
| 2.00 | 2005 |
| 2.50 | 2070 |
| 2.70 | 2120 |
| 2.80 | 2190 |
| 3.10 | 2500 |
| 3.40 | 2690 |
| 4.00 | 2980 |
| 5.60 | 3450 |

| SP 421.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1700 |
| 1.00 | 1880 |
| 1.20 | 1940 |
| 1.50 | 2000 |
| 2.00 | 2035 |
| 2.50 | 2090 |
| 2.60 | 2115 |
| 2.80 | 2130 |
| 3.00 | 2440 |
| 3.40 | 2620 |
| 4.00 | 2960 |
| 5.60 | 3430 |

| SP 409.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1700 |
| 0.80 | 1830 |
| 1.20 | 1940 |
| 1.50 | 2000 |
| 1.80 | 2010 |
| 2.00 | 2030 |
| 2.30 | 2060 |
| 2.40 | 2110 |
| 2.80 | 2120 |
| 2.90 | 2360 |
| 3.40 | 2720 |
| 4.00 | 3000 |
| 5.60 | 3460 |

| SP 397.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1750 |
| 1.10 | 1930 |
| 1.50 | 2000 |
| 2.00 | 2025 |
| 2.20 | 2060 |
| 2.40 | 2070 |
| 2.60 | 2160 |
| 2.80 | 2180 |
| 3.00 | 2480 |
| 3.40 | 2660 |
| 4.00 | 2950 |
| 5.60 | 3420 |

| SP 385.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1745 |
| 1.10 | 1950 |
| 1.40 | 2000 |
| 1.80 | 2030 |
| 2.00 | 2060 |
| 2.40 | 2120 |
| 2.80 | 2180 |
| 3.00 | 2470 |
| 3.40 | 2560 |
| 4.00 | 2870 |
| 5.60 | 3360 |

| SP 373.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1780 |
| 1.00 | 1880 |
| 1.40 | 2000 |
| 1.60 | 2020 |
| 2.20 | 2070 |
| 2.40 | 2125 |
| 2.80 | 2190 |
| 3.00 | 2470 |
| 3.40 | 2640 |
| 3.80 | 2760 |
| 4.00 | 2860 |
| 5.60 | 3360 |

| SP 361.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.60 | 1770 |
| 0.80 | 1830 |
| 1.00 | 1870 |
| 1.30 | 1975 |
| 1.50 | 2030 |
| 1.70 | 2070 |
| 2.40 | 2190 |
| 2.80 | 2230 |
| 3.20 | 2430 |
| 3.40 | 2580 |
| 3.70 | 2670 |
| 4.00 | 2860 |
| 5.60 | 3360 |

BLOCK 3/7 BLOCK 3/8

| SP 349.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1700 |
| 0.70 | 1820 |
| 1.00 | 1880 |
| 1.30 | 1940 |
| 1.50 | 2000 |
| 1.60 | 2020 |
| 1.90 | 2060 |
| 2.20 | 2170 |
| 2.80 | 2185 |
| 2.90 | 2320 |
| 3.00 | 2470 |
| 3.20 | 2510 |
| 3.70 | 2670 |
| 4.00 | 2840 |
| 5.60 | 3350 |

| SP 337.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1710 |
| 0.70 | 1820 |
| 1.20 | 1940 |
| 1.50 | 2035 |
| 1.70 | 2060 |
| 2.10 | 2090 |
| 2.30 | 2160 |
| 2.40 | 2180 |
| 2.70 | 2210 |
| 2.80 | 2370 |
| 3.00 | 2510 |
| 3.40 | 2760 |
| 4.00 | 3030 |
| 5.60 | 3480 |

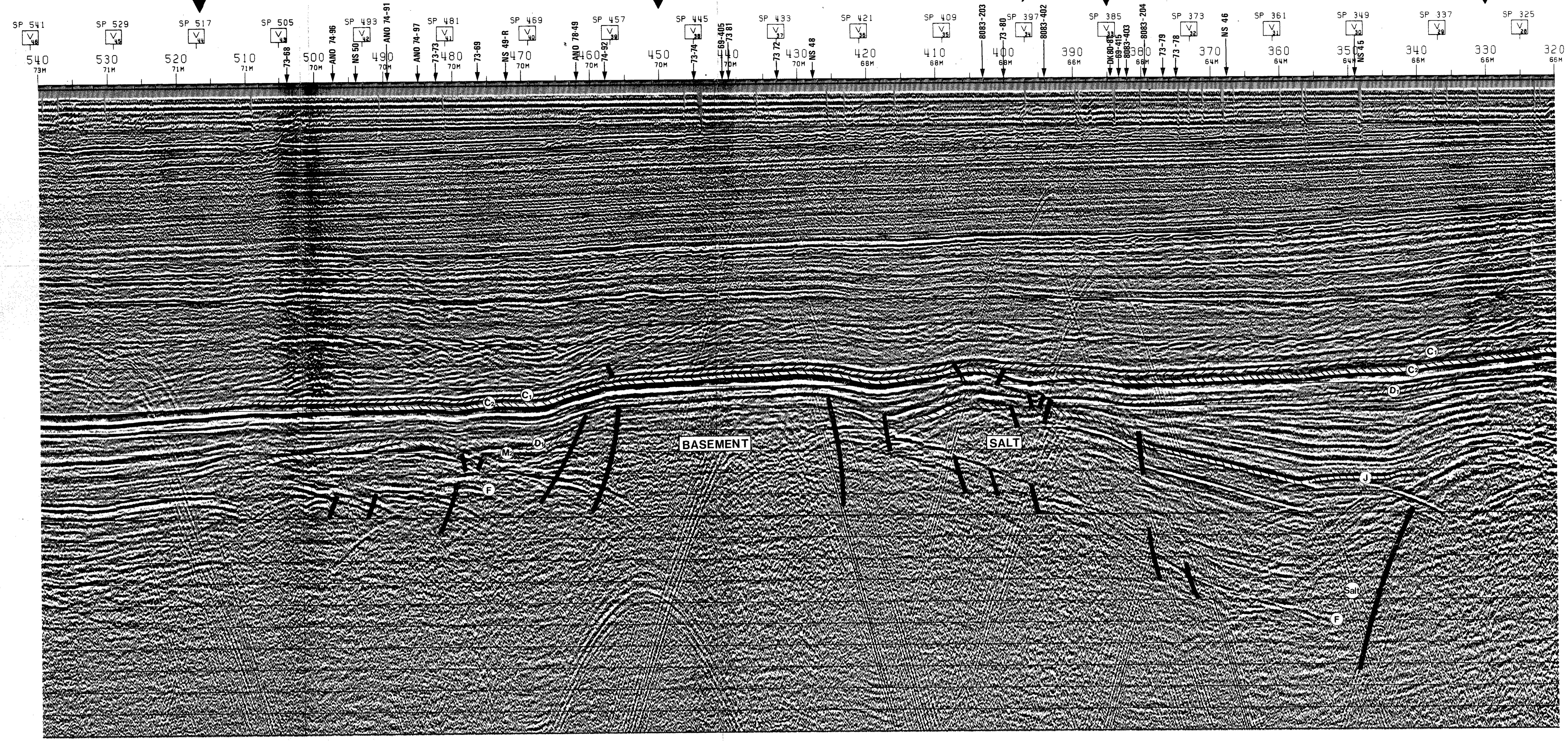
| SP 325.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.40 | 1720 |
| 0.80 | 1840 |
| 1.20 | 1950 |
| 1.50 | 2020 |
| 1.90 | 2060 |
| 2.30 | 2170 |
| 2.60 | 2190 |
| 2.70 | 2390 |
| 3.00 | 2600 |
| 3.40 | 2820 |
| 4.00 | 3090 |
| 5.60 | 3520 |

| SP 313.00 | |
|---|---|
| TIME | RMS VEL |
| 0.10 | 1460 |
| 0.50 | 1760 |
| 1.10 | 1930 |
| 1.40 | 1970 |
| 1.50 | 2000 |
| 1.70 | 2020 |
| 2.00 | 2100 |
| 2.40 | 2140 |
| 2.60 | 2220 |
| 2.90 | 2490 |
| 3.40 | 2800 |
| 4.00 | 3070 |
| 5.60 | 3510 |

# LINE NS- 40

S.P. 530-320

1X3000% TVF




# SOUTHWEST

## WESTERN GEOPHYSICAL COMPANY

AREA :NORWAY SOUTH

SHOT BY WESTERN GEOPHYSICAL CO. PTY. 102 FEB/MARCH/APR 1978
PROCESSED BY WESTERN GEOPHYSICAL AUG/SEPT 1978 AT H.D.C.
PLAYBACK REEL NO. : 253404

### RECORDING DATA

SOURCE

| | |
|---|---|
| ENERGY SOURCE | MAXIPULSE |
| CHARGE SIZE | 8 OZ NCN |
| GUN DEPTH | 11M |
| FIRING INTERVAL | 50 METERS |
| SHOT POINT INTERVAL | 200 METERS |
| DISTANCE OF SOURCE TO ANTENNA | 71 METERS |

INSTRUMENTS

| | |
|---|---|
| SYSTEM | DDS 888 |
| AMPLIFIER | I.F.P. |
| FILTER | L/8 H/62.5 |
| SAMPLING INTERVAL | 4 MS |
| RECORD LENGTH | 7 SECONDS |

CABLE

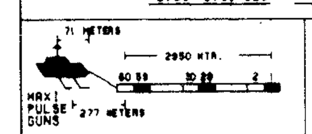
| | |
|---|---|
| TYPE CABLE | STREAMER |
| CABLE LENGTH | 2950 MTR. |
| CABLE DEPTH | 15 METERS |
| LEAD IN | 277 METERS |
| GROUP INTERVAL | 50 METERS |
| NUMBER OF GEOPHONES PER GROUP | 32 |
| NUMBER OF GROUPS RECORDED | 60 |

### PROCESSING SEQUENCE AND PARAMETERS

PROCESSING SAMPLING INTERVAL 4 MS

1. EDIT
2. DEBUBBLE
3. DECONVOLVED BEFORE STACK
   TYPE - MINIMUM PHASE INVERSE FILTER
   WINDOW LENGTH 2 EQUAL ZONES
   OVERLAP 20% OF ZONE
   LENGTH OPERATOR 148 MS
   PREDICTION DISTANCE 12MS
4. NMO STACK 3000 %
5. DECONVOLVED AFTER STACK
   TYPE - MINIMUM PHASE INVERSE FILTER
   WINDOW LENGTH 2 EQUAL ZONES
   OVERLAP 20% OF ZONE
   LENGTH OPERATOR 252 MS
   PREDICTION DISTANCE 4MS
6. TIME VARIANT FILTER AT SP 1

| TIME ZONE | L.C. (HZ) | H.C. |
|---|---|---|
| 0.00-0.45 SEC | 15 | 50 |
| 0.45-0.90 SEC | 12 | 45 |
| 0.90-1.45 SEC | 12 | 42 |
| 1.45-2.00 SEC | 10 | 40 |
| 2.00-8.50 SEC | 8 | 35 |




LEGEND

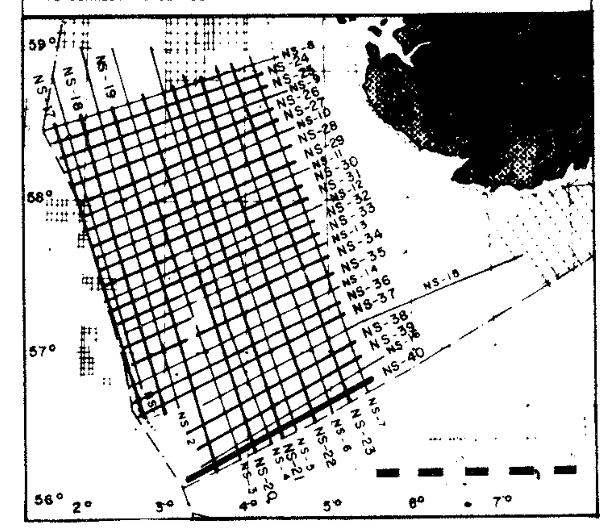
V VELOCITY ANALYSIS
INTERSECTIONS
W.D. WATER DEPTH

HORIZONTAL SCALE
1 CM/630 M

VERTICAL SCALE
5 CM/SEC

POLARITY CONVENTION
RECORDING : COMPRESSION PULSE NEGATIVE NUMBER
PROCESSING : COMPRESSION PULSE NEGATIVE NUMBER
DISPLAY : COMPRESSION PULSE TROUGH (DECREASING BLACK)

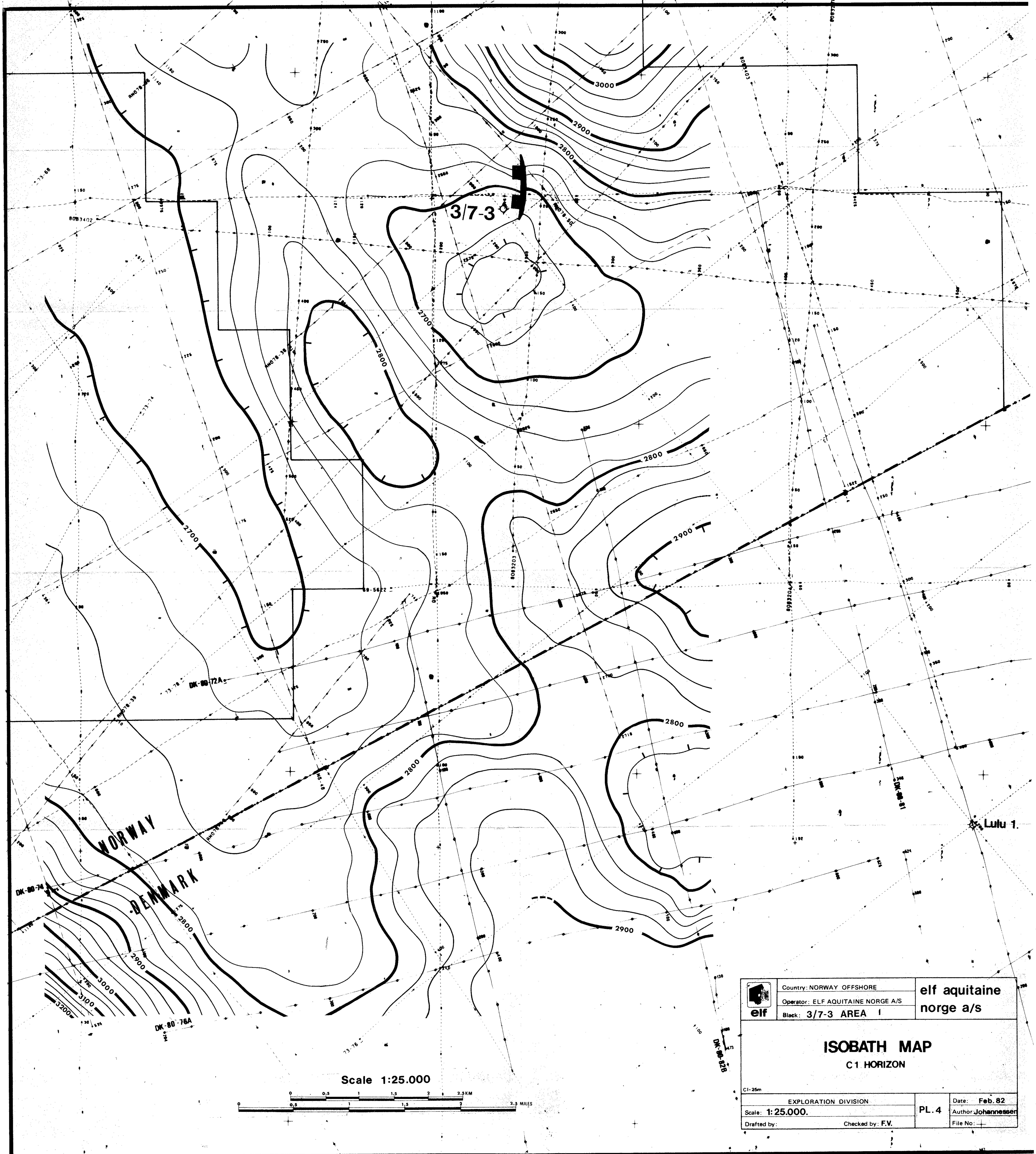
NOTATIONS
SHOTPOINT LOCATION AT ANTENNA
TO CORRECT TO SEA LEVEL ADD 17 MS



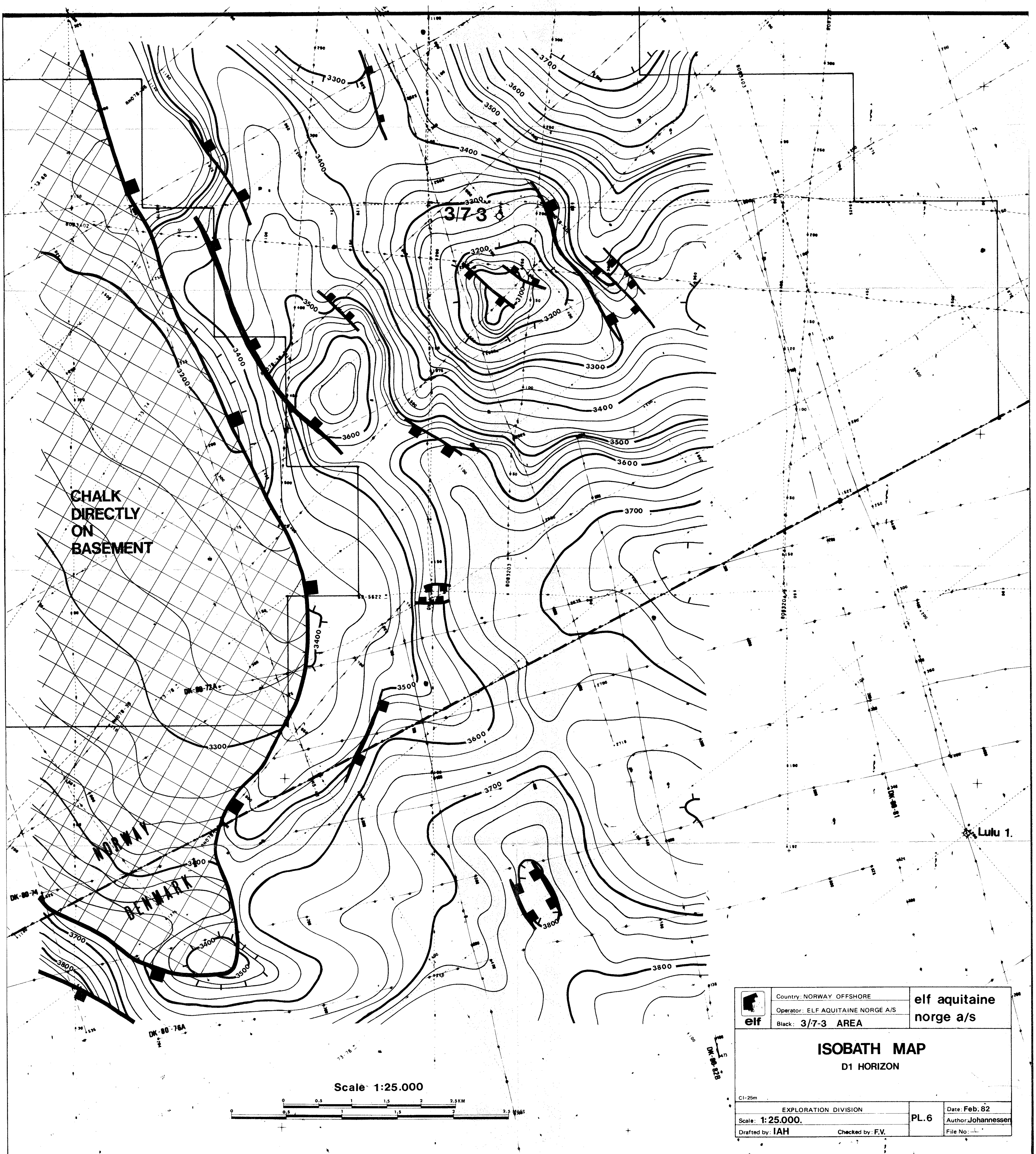

| | |
|---|---|
| Country: NORWAY OFFSHORE | elf aquitaine norge a/s |
| Operator: ELF AQUITAINE NORGE A/S | |
| Block: 3/7-3 | |

## INTERPRETATION OF SEISMIC LINE NS - 40

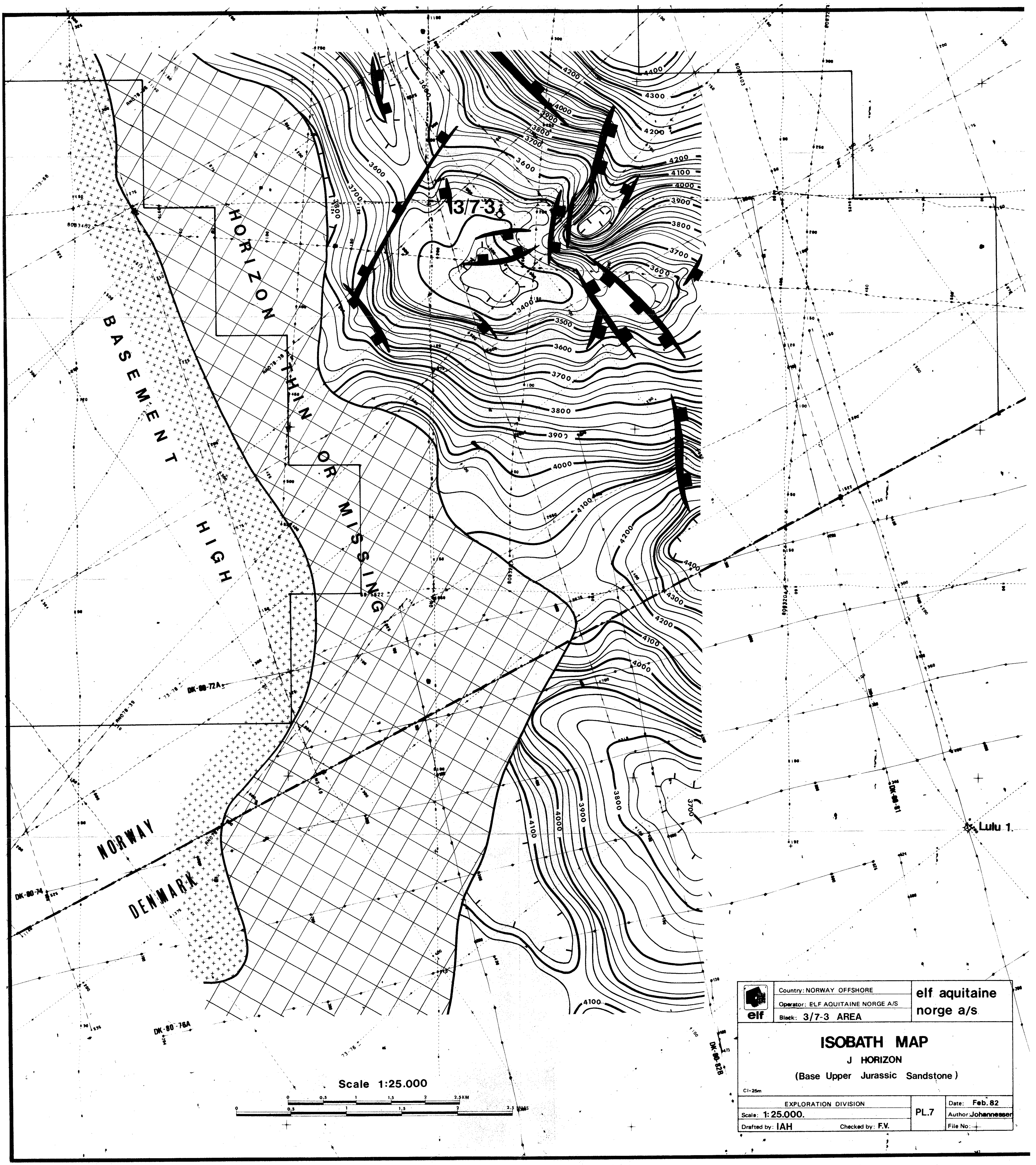
| | | |
|---|---|---|
| EXPLORATION DIVISION | PL.3 | Date: DEC 1981 |
| Scale: | | Author: P Perfetti |
| Drafted by: Checked by: | | File No: 82079 |


3/7-3
3000
2900
2800
2700
3100
3200
NORWAY
DENMARK
Lulu 1.
DK-80-72A
DK-80-74
DK-80-76A
DK-80-81
DK-80-82B
Scale 1:25.000
KM
MILES
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA I
elf
elf aquitaine
norge a/s
ISOBATH MAP
C1 HORIZON
CI-25m
EXPLORATION DIVISION
Scale: 1:25.000.
Drafted by:
Checked by: F.V.
PL. 4
Date: Feb. 82
Author: Johannessen
File No:


3/7-3
3200
3100
3000
2900
2800
2825
2775
2725
2950
2925
NORWAY
DENMARK
DK-80-72A
DK-80-74
DK-80-76A
8083402
8083203
RN078-39
Scale 1:25.000
0 0.5 1 1.5 2 2.5KM
0 0.5 1 1.5 2 2.5 MILES
elf
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA
elf aquitaine norge a/s
ISOBATH MAP
C2 HORIZON
CI=25m
EXPLORATION DIVISION
Scale: 1:25.000.
PL.5
Date: Feb 82
Author: R.Jo
Drafted by:
Checked by: F.V.
File No:



CHALK DIRECTLY ON BASEMENT
NORWAY
DENMARK
3/7-3
Lulu 1.
Scale 1:25.000
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA
elf aquitaine norge a/s
elf
ISOBATH MAP
D1 HORIZON
CI-25m
EXPLORATION DIVISION
Scale: 1:25.000.
Drafted by: IAH
Checked by: F.V.
PL.6
Date: Feb. 82
Author: Johannessen
File No:


3/7-3
HORIZON THIN OR MISSING
BASEMENT HIGH
NORWAY
DENMARK
Lulu 1.
DK-80-72A
DK-80-74
DK-80-76A
DK-80-82B
DK-80-81
3400
3500
3600
3700
3800
3900
4000
4100
4200
4300
4400
Scale 1:25.000
0 0.5 1 1.5 2 2.5 KM
0 0.5 1 1.5 2 2.5 MILES
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7-3 AREA
elf aquitaine norge a/s
elf
ISOBATH MAP
J HORIZON
(Base Upper Jurassic Sandstone)
CI=25m
EXPLORATION DIVISION
Scale: 1:25.000.
Drafted by: IAH
Checked by: F.V.
PL.7
Date: Feb. 82
Author: Johannessen
File No:

CALIBRATED SONIC AND IMPEDANCE LOG ON SEISMIC SECTION 73-80


| Country: NORWAY OFFSHORE | elf aquitaine norge a/s |
|---|---|
| Operator: ELF AQUITAINE NORGE A/S | |
| Black: 3/7 | |

**CALIBRATED SONIC AND IMPEDANCE LOG**
**ON**
**SEISMIC SECTION 73-80**

| EXPLORATION DIVISION | PL.8 | Date: 12/1981 |
|---|---|---|
| Scale: | | Author: P. Perfetti |
| Drafted by: R. Sand Checked by: | | File No: |

PL.9

# CHROMATOGRAPHIC LOG

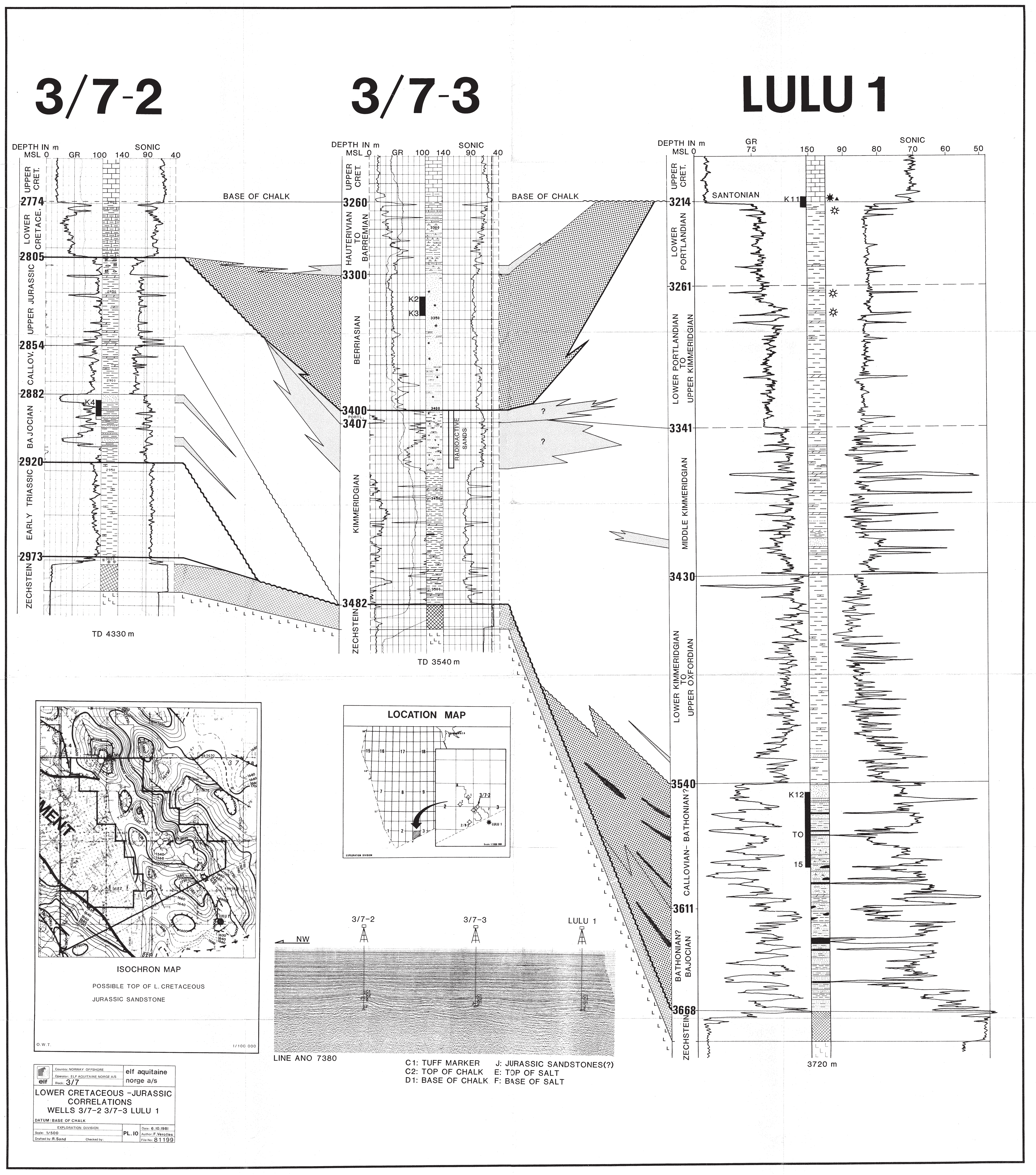
Well: 3/7-3

LEGEND:

$C_1 / C_2$ ———

$C_1 / C_3$ – – – –

| | |
|---|---|
| C1 | |
| C2 | 161 |
| C3 | 110 |
| Ic4 | 80 |
| Nc4 | 30 |
| C5 | 240 |


3/7-2
3/7-3
LULU 1
DEPTH IN m MSL
GR
SONIC
BASE OF CHALK
UPPER CRET.
LOWER CRETACE.
UPPER JURASSIC
CALLOV.
BAJOCIAN
EARLY TRIASSIC
ZECHSTEIN
2774
2805
2854
2882
2920
2973
K4
TD 4330 m
HAUTERIVIAN TO BARREMIAN
BERRIASIAN
PORTL.
KIMMERIDGIAN
3260
3300
3400
3407
3482
K2
K3
RADIOACTIVE SANDS
TD 3540 m
SANTONIAN
K11
LOWER PORTLANDIAN
LOWER PORTLANDIAN TO UPPER KIMMERIDGIAN
MIDDLE KIMMERIDGIAN
LOWER KIMMERIDGIAN TO UPPER OXFORDIAN
CALLOVIAN- BATHONIAN?
BATHONIAN? BAJOCIAN
3214
3261
3341
3430
3540
3611
3668
K12
TO
15
3720 m
ISOCHRON MAP
POSSIBLE TOP OF L. CRETACEOUS
JURASSIC SANDSTONE
O.W.T.
1/100 000
LOCATION MAP
EXPLORATION DIVISION
NW
LINE ANO 7380
C1: TUFF MARKER
C2: TOP OF CHALK
D1: BASE OF CHALK
J: JURASSIC SANDSTONES(?)
E: TOP OF SALT
F: BASE OF SALT
Country: NORWAY OFFSHORE
Operator: ELF AQUITAINE NORGE A/S
Block: 3/7
elf aquitaine norge a/s
LOWER CRETACEOUS -JURASSIC CORRELATIONS
WELLS 3/7-2 3/7-3 LULU 1
DATUM: BASE OF CHALK
EXPLORATION DIVISION
Scale: 1/500
Drafted by: R.Sand
Checked by:
PL. 10
Date: 6.10.1981
Author: F.Verolles
File No. 81199