ELF AQUITAINE NORGE A/S

18/10-1

GEOLOGICAL WELL PROGNOSIS

and

DRILLING PROGRAM

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GEOLOGICAL WELL PROGNOSIS
18/10-1

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1 LOCATION

Area:	Block 18/10 (licence 008)
Well identification:	18/10-1
Owner:	Petronord - Phillips Group
Operator:	Elf Aquitaine Norge A/S
Well classification:	Wildcat
Preliminary coordinates:	X = 04° 07' 02.13" E
	Y = 58° 04' 37.29" N
Seismic location:	Seismic line 685 402
	shot point 160
Drilling rig:	Dyvi Alpha
Water depth:	97 m
RKB - Sea bottom:	122 m
Projected total depth:	2750 m

2 MAIN POINTS

2.1 Purpose of Test

The 18/10-1 is a wildcat designed to test possible hydrocarbon accumulation in Jurassic sandstones on a seismic structure of block 18/10. This structure is located, on the same trend, south-east of Phillips/Petronord's Bream discovery.

The well will be bottomed about 150 to 200 m below Jurassic sandstone in a shaly-sandy sequence of Early Jurassic or top of Triassic.

2.2 Objectives

The target of well 18/10-1 is sandstones of Middle Jurassic age, oil bearing at well 17/12-1 (Bream). These sandstones are below a thick shaly formation of Cretaceous and the Upper Jurassic age. They are expected at 2365 m RKB.

2.3 Drilling Hazards

Based on data from site survey and regional knowledge, no particular drilling hazards are anticipated in this well. No undercompacted shale is expected and therefore only hydrostatic pressure formation will be encountered.

3 GENERAL OUTLINE

See Location Map - figure 1.

Block 18/10 is located east of the two discoveries Bream and Briesling made in 1972 by Phillips on block 17/12. Jurassic sandstones are the objective.

The 18/10-1 prospect is close to the Bream discovery, on the same trend toward south-east. They both are on the border of a large syncline where there is good probability of organic matter maturation, the 18/10 prospect being between the syncline and Bream.

The Bream discovery (17/12-1) (see plate 2) was completed in June 1972. The well was tested at 162 m^3/day from two sands reservoirs with a net thickness of 15 m. The pay is in the Middle Jurassic at a depth of -2289 m (MSL). The Bream structure is a deep seated salt feature with a hydrocarbon bearing area of 19 km^2. The area is delimited by the contact of the water level with the caprocks. The total closure area is 81 km^2.

The tests showed that the oil bearing sandstones could be divided into two parts with a level of shale between them. It is impossible for the time being to say whether the two levels communicate, and whether they have the same oil/water contact.

In this area the Upper Jurassic shales are the potential source rock. Studies of data, vitrinite reflectance, thermic alteration index and well temperature, have shown that they can produce oil at a burial depth of 2500 - 3000 m (2200 to 2400 milliseconds two way time). These shales have been buried deeper in the syncline.

After the well 17/12-1 was drilled Phillips shot a seismic survey on this area. In 1976 - 1977 Elf shot another survey on

block 18/10. Both these surveys are of very good quality. Therefore seismic data have been calibrated with the 17/12-1 results and the various horizons are well established.

On seismic line 685 402 passing through well 17/12-1 and the proposed location for well 18/10-1, it is very easy to follow the different seismic markers: C2 (top of Maastrichtian), D1 (top of Lower Cretaceous), top of Jurassic sands, E (top of salt) and F (bottom of salt).

The top of Jurassic does not give any seismic horizon in this area as the radioactive shales are not located at the top of it. The first Jurassic reflector corresponds to Middle Jurassic sandstones, which is the target of the proposed well.

4 DESCRIPTION OF THE 18/10-1 PROSPECT

Seismic line 685 402 cuts across the two structures, Bream and 18/10. Well 17/12-1 is located at the NW end (shot point 487) and 18/10-1 prospect at the SE end (shot point 160). Both features show broad arches of fairly similar relief (60 to 70 milliseconds one way time) on each side of their common saddle.

However, the two structures are different in many aspects.

A. A geological section (see plate 4) made from seismic line 685 402 shows Lower Triassic formation with a 60 m thick conglomeratic sandstone layer above the salt which has a constant thickness.

   Therefore, at the Lower Triassic, the two structures were probably at the same level. Then a "tilt" happened which is shown by a relative sinking of the 17/12-1 compared to 18/10 and during Middle Triassic the basin was filled up.

   From upper Triassic to bottom of chalk the thicknesses are similar on the two structures. A thinning of Upper Cretaceous chalk on 17/12-1 shows the movement of the salt at this age. The 17/12-1 structure is therefore much younger than the 18/10 one.

B. The 17/12 structure is younger than 18/10 due to a halokinetic salt movement while the 18/10 is due to a high point of the basement.

C. Whereas 17/12-1 is at Jurassic level, a very smooth dome, 18/10, is broken up by minor faulting which defines a kind of slump close to the top of the structure.

The position of 18/10 feature between the syncline and 17/12-1 is much favourable. Maturation study of organic matter con-

tained in the Upper Jurassic shale and the oil analysis indicates that the main part of the hydrocarbons found in 17/12-1 have migrated from the syncline. It is therefore expected that coming from the syncline, the oil has first filled up the 18/10-1 prospect to the spill point then the excess has moved to 17/12-1.

The seismic character of the Jurassic sandstone does not vary from 17/12-1 to 18/10-1.

5 ANTICIPATED FORMATION TOPS - STRATIGRAPHY

5.1 Geophysical Prognosis

See plate and figure 3.

Line 685 402 - shot point 160 (water depth: 97 m):

Horizon	Section ms o.w.t.	C corr.	T corr.	ΔT	Vi*	ΔP	Depth MSL
				400	1792	720	
C2 (top of chalk)	440	40	400				- 720
				195	3073	599	
D1 (top of L.Cret.)	635	"	595				-1315
				65	2608	169	
(fault)	700	"	660				-1485
				292	2608	761	
Radioactive shales	992	"	952				-2245
				36	2625	94	
Jurassic sst	1028	"	988				-2340
				110	3675	370	
Trias ?	1128	"	1088				-2710
				217	4315⁂	940	
Salt	1345	"	1305				-3650

* - 17/12-1 velocity

⁂ - Estimated velocity till top of salt

Calibration of horizon

Well 17/12-1 gave a reliable calibration as far as the top of Zechstein salt. The usual complete mesozoic section is encountered, but it should be noted that the Lower Cretaceous/Jurassic limit does not correspond to a seismic interface. The strong Jurassic reflector occuring around 2 seconds (two way time) corresponds to Middle Jurassic sandstones (.975 seconds on the sonic).

The thick Triassic sequence (.430 ms on sonic) yields no continuous reflector and an attempt to follow the Liassic/Triassic interface failed.

The top of Zechstein is a fair reflector, and so is the presumed base of the salt (around 3,4 seconds two way time).

5.2 Geological Prognosis

The series of the 18/10-1 well could be summarized as follows (all depths are RKB):

122 (sea bottom) - 165 m: Quaternary, mainly sands.

175 - 725 m: Oligocene to Eocene
Silty clays with stringers of limestone and siltstone.

725 - 745 m: Paleocene
Tuff and grey shales.

745 - 1340 m: Upper Cretaceous
Limestone chalky and soft at the top, tight and hard towards the base. Some marly or shaly interbeds.

1340 - 1900 m: Lower Cretaceous
Clays with stringers of dolomitic limestones and sandstones.

1900 - 2365 m: Upper Jurassic
Clays with limestone stringers, levels of black organic shales between 2270 and 2300 m.

2365 - 2625 m: Callovo-Oxfordian?/Middle Jurassic
Sandstones interbedded with siltstone and shale. Traces of coal.

2625 - 2735 m: Lower to Middle Jurassic
Shale and sandstone.

2735 - 2750 m: (TD) Possible top of Triassic
Shale and sandstone as above.

6 DRILLING PROGRAM

For details, see Drilling Program made by Drilling Department.

6.1 Casing and Cementing Program

Hole	Casing	Weight	Grade	Setting depth RKB	Cemented
26" x 36"	30"	310	X52	175	up to seabed
17 1/2" x 26"	20"	106	K55	350	up to seabed
17 1/2"	13 3/8"	68	K55	850	up to 175 m
12 1/4"	9 5/8"	47	N80	2300	2300 - 600 m
8 1/2"	7"	If required			

6.2 Mud Program

36" Phase - 175 m

No returns - spud mud with gelly plugs

- Mud weight: 1.04 - 1.06
- Funnel viscosity: 120 - 150
- Waterloss API: 15 - 20

26" Phase - 350 m

Bentonitic mud with sea water

- Mud weight: 1.10 - 1.15
- Funnel viscosity: 60 - 80
- Waterloss API: 6 - 10

17 1/2" Phase - 850 m

Bentonitic mud with ferroligno sulfonate

- Mud weight: 1.10 - 1.15
- Funnel viscosity: 60 - 70
- Waterloss API: 6 - 8

12 1/4" Phase - 2300 m

Ferroligno sulfonate mud

- Mud weight: 1.15 - 1.25
- Funnel viscosity: 50 - 60
- Plastic vicosity: 25 - 30
- Waterloss API: 3 - 4

8 1/2" Phase - 2750 m (TD)

Ferroligno sulfonate mud

- Mud weight: 1.25
- Funnel viscosity: 50 - 55
- Plastic viscosity: 25 - 30
- Waterloss API: 2 - 4

Mud weight will be adjusted according to on-site pore pressure computation and well behaviour. FIT/RFT could be performed when reaching the target to obtain an accurate formation pressure and eventually adjust mud weight.

6.3 Geological Justification of Casing Points

36" and 20" casings are set to cover the very soft sediments of the upper part of the well.

13 3/8" casing could be set at 850 m. The first alternative is to set the 13 3/8" casing when reaching the Upper Cretaceous chalk at 745 m. This depth is acceptable because no over-pressure is expected in the Jurassic.

9 5/8" casing is to be set above the target to cover the black radioactive shales which may cave if left uncovered for too long.

6.4 Anticipated Problems

No particular problems, like shallow gas or undercompacted shales are expected and only normal hydrostatic formation pressure is to be encountered.

In any case, high pressure survey will as usual be performed while drilling.

7 MUD LOGGING

For the time being the contractor for mud logging is not chosen. We will, however, have onboard the conventional mud logging equipment (with gas detector, chromatograph, drilling rate recorder, densimud in/out etc.).

An on-line data acquisition is also scheduled for computation of "D" exponent, pore pressure etc. Further details will be given later.

At least one logger and one engineer (to compute on-line data acquisition) will be furnished by the mud logging company for each 24 hours shift. The geological supervision will be assumed by an Elf well site geologist.

8 SAMPLING

8.1 Cuttings/Sampling

Sampling of ditch cuttings will be performed every 10, 5 or 2 meters according to drilling rate. The sampling interval can be reduced at well site geologist's request.

Cuttings will continuously be observed under the microscope and fluoroscope.

A set of dried and wet samples (according to enclosed Dispatch List) will be made at the rig site. In addition, samples for source rock analysis and special show studies will be collected every 50 or 100 meters under special protecting conditions.

Shale density, calcimetry will be performed with a spacing defined by the well site geologist. A carbide test will be done at least once a day under normal drilling conditions to test the degasser and to check lag time computation.

Drilling parameters and choice of rock bits will have to be discussed between the drilling supervisor and the well site geologist to be able to get representative cuttings and very good shows, chiefly when reaching the target. This means that use of diamond bit and turbo drilling will have to get the approval of the well site geologist.

8.2 Coring Program

In case of hydrocarbon shows cores should be cut on request from Geological and/or Reservoir Departments. Anyhow, one core will be cut in the Jurassic sandstone, which is the well's target. In the reservoir coring will be carried out down to the water table.

Additional cores requested by the well site geologist will depend on the presence of hydrocarbons, or whenever lithological information is required.

Pictures of the cores will be taken at the rig site.

Sidewall cores could be shot prior to run the 13 3/8" casing. They will be shot before setting the 9 5/8" casing and below. They can be taken at any time if needed to check and accurate information: micropaleontology, palynology, sedimentology, log quality etc.

Program will be made by the well site geologist in collaboration with the Exploration Division and the Laboratory or Reservoir Department if necessary.

8.3 Fluid Sampling

Wire line tests (FIT and/or RFT) will be run in front of reservoirs as soon as possible in order to get a representative value of the formation pressures whatever the nature of formation fluids is.

At least one wire line test will be performed at the top of the Jurassic sandstones.

A more comprehensive survey of pore pressure measurements may be studied, according to encountered fluids and reservoirs, by the Geological and Reservoir Departments.

Conventional DST through casing might be performed if warranted by log analysis. Appropriate test procedure will be dispatched in due time upon NPD's approval.

9 LOGGING PROGRAM

Basic Runs

ISF - SL - GR and FDC caliper will be run prior to set any casing even in the 26" hole. GR will be recorded up to the mud line.

FDC log is run in order to introduce density parameter in synthetic seismograph computation.

ISF - SL - GR, FDC caliper and CST gun will have to be available at any time and to be permanently onboard.

Intermediate logs can be run if needed on request from Geological and/or Geophysical Departments.

HDT will be run in open hole below 13 3/8" casing shoe and only deviation above up to 20" casing shoe. On request from Drilling Department a deviation survey (with HDT) could be run with a spacing of about 500 meters.

Additional logs can be run on specific request:

- Spectral Gamma Ray if requested by Exploration Division in cooperation with laboratories and central services.

- Velocity survey at TD (or at an intermediate depth on request from Geophysical Department).

- Temperature and/or CBL recorded behind casing if requested by Drilling Department.

Reservoir Zones

If requested by Reservoir and/or Geological Departments the following logs will be run on specific intervals:

- DLL
- ML - MLL and/or PL
- FDC - CNL - GR
- Dual laterolog (shallow/deep) - MSFL

All logs will be recorded at 1/500 and 1/200 scale while the ML - MLL and HDT will be run at 1/200 and 1/40 scale.

Sidewall cores (see chapter 8.2): The logging engineer will, with the well site geologist, discuss the choice of charges, kind of bullets etc. to be used. In any case, all necessary material will have to be available onboard in order to obtain the best results considering recovery of the cores.

Note: In the reservoir zones, decisions on logging will be taken by the reservoir engineer and the geologist.

10 STUDIES REQUESTED ON WELL 18/10-1

- Micropaleontological datation and ecological study over the whole section.

- Palynological datation, thermal alteration index (TAI) below 1800 m (Jurassic top expected around 1850 m) or as requested by the Geological Department.

- Composite logs 1/1000 and 1/2000 over the whole section.

- Vitrinite reflectance and geochemistry of the organic matter of the Jurassic section.

- Sedimentological study of the Jurassic.

- Hydrocarbon analysis on FIT/RFT and/or DST samples.

- Pictures of cores.

In reservoirs:

- Petrophysical measurements on cores.

- Percentage of shale and major minerals.

- Sequential study.

Further studies can be requested by the Geological Department if necessary, such as diagenesis study etc.

Some studies on cores cut in reservoir zones (porosity, permeability, extraction) can be performed by local laboratories if reservoir data are requested urgently.

BEHANDLINGSRUTINE FOR BOREPROGRAM

Saksbehandler | 1A | ST |

Brønn 18/10-1 Selskap Elf Presentasjon av boreprogram

Brønntype undersøkelsesbrønn Boreprogr. godkjent

Boreprogram mottatt 23/9-79 Tillatelse nr

Mottatt materiale

- Mudprogram — - Casingprogram o.k
- Logge-program o.k
- Prøvetakingsprogram o.k
- Geol./geof. prognoser Bra
- Antall seismiske kart 1
- Tolket seismisk profil 1 - Sparkerundersøkelse o.k

Bemerkninger:

Kontroll av selskapets prognoser

Sammenlignbare brønner 17/12-1

Kvalitativ kontroll

Reg. geol. plassering

Vurdering av overtrykk

Geologisk vurdering isopachtrend

Kvalitet av seism. tolkning Lova

Seismisk korr. fra brønn(er) 17/12-1

Seismisk referanse

Linje: 685 402 - SP: 160

Kvantitaviv kontroll

Reflektorer	Top Chalk (C2)	Lower Cret. (D1)	Hot Shale	Callovian Sd.
Enveis gangtid	0.400 s	0.595 s	0.952 s	0.988 s
Selskapets dybdeprognose	720 m	1315 m	2245 m	2340 m
Selskapete gj.hastighet	1800 m/s	2210 m/s	2358 m/s	2368 m/s
Gj.sn. hast. basert på nabo-brønn	1789 m/s	2102 m/s	2301 m/s	2319 m/s
OD dybdeprognose	716 m	1250 m	2191 m	2292 m
Selskapets interval hastighet	3073 m/s	2608 m/s	2625 m/s	
Int.val. hast. fra nabo-brønn	3061 m/s	2608 m/s	2672 m/s	

Vurdering av oppgitte dyp Synes lova.

Antatt geologi ved foringssko

Bemerkninger:

Ev.: Kontroll testprogram

11 GEOLOGICAL REPORT AND MISCELLANEOUS

Geological report is given daily at 08.00 to the Stavanger office and dispatched as soon as possible to all the partners and NPD.

If requested, below 1800 m, all radio reported depths, formation logs, sample descriptions, shows etc. could be given in code from the rig to the office. In this case, telexes should also be coded.

Detailed well site geologist instructions will be issued separately if necessary.

Holiday or night numbers are:

- S. Guyonnet, tel. (045) 40 009
- F. Verroles, tel. (045) 89 195
- Exploration stand-by mobil tel. 097 - 64 089

POSITION MAP

BLOCK : 18/10

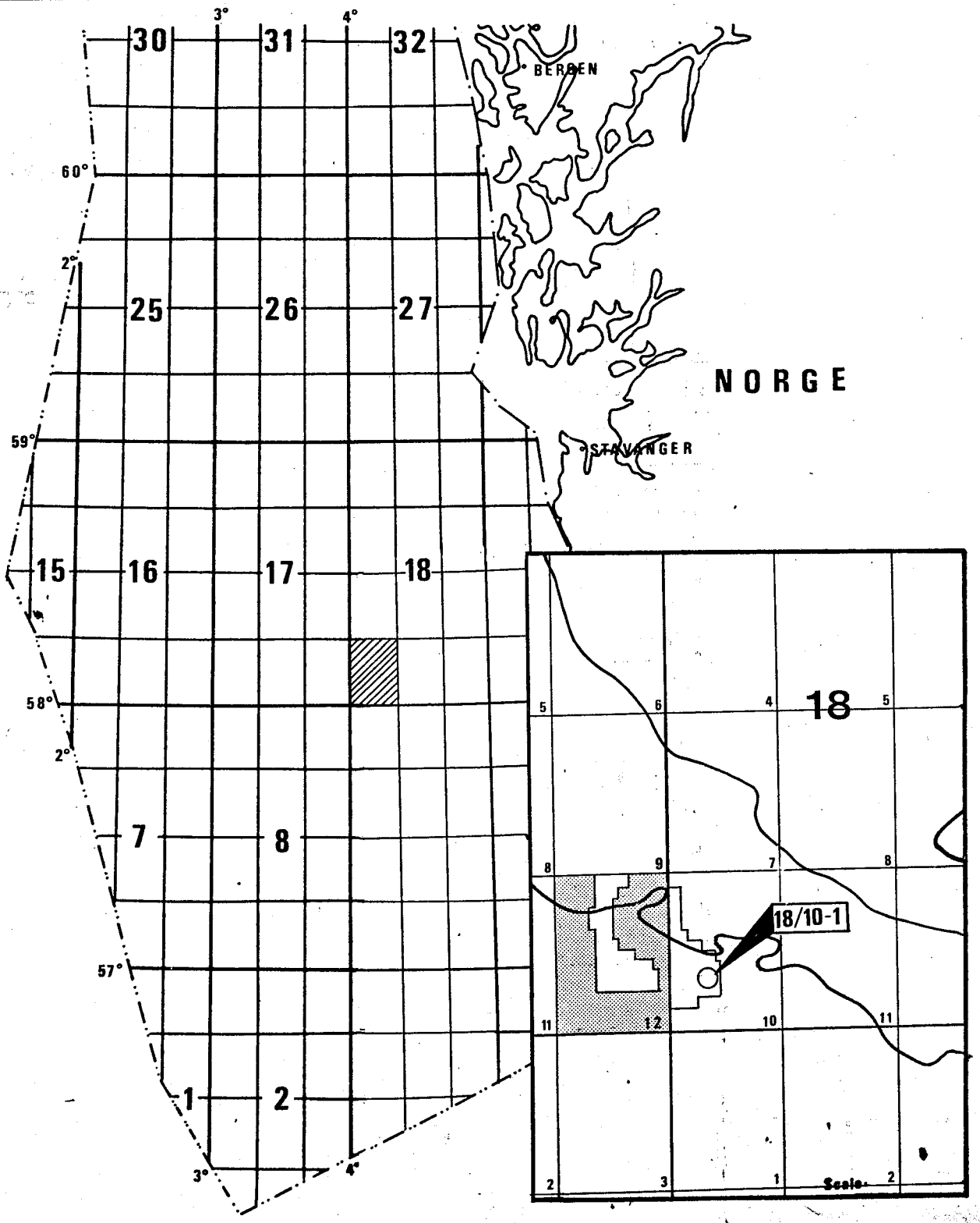
WELL : 18/10-1

OWNER : PETRONORD

x: 04° 07' 02.13" E
y: 58° 04' 37.29" N

Scale: 1/2500 000

Date:



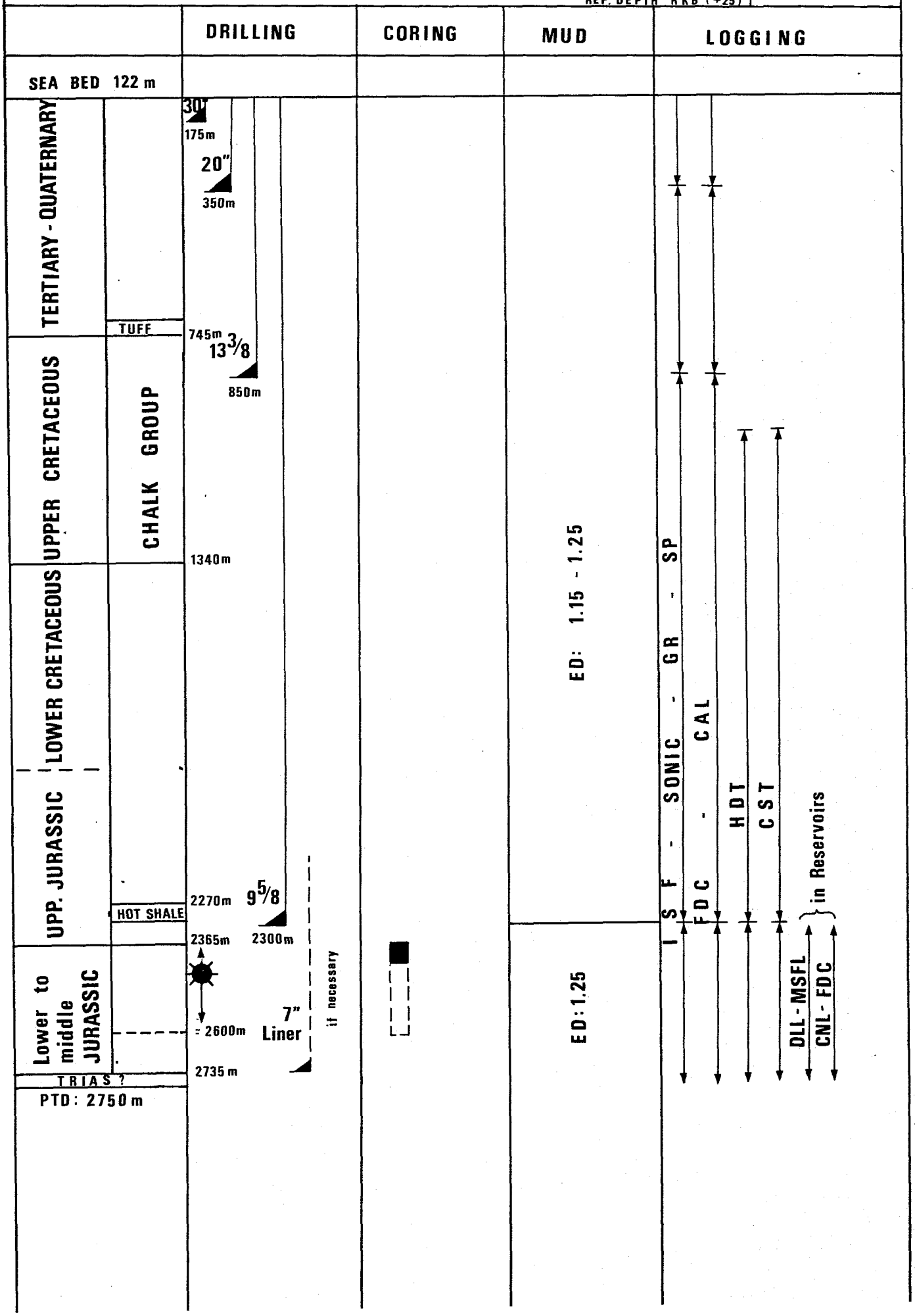
GEOLOGICAL WELL PROGNOSIS Fig.1

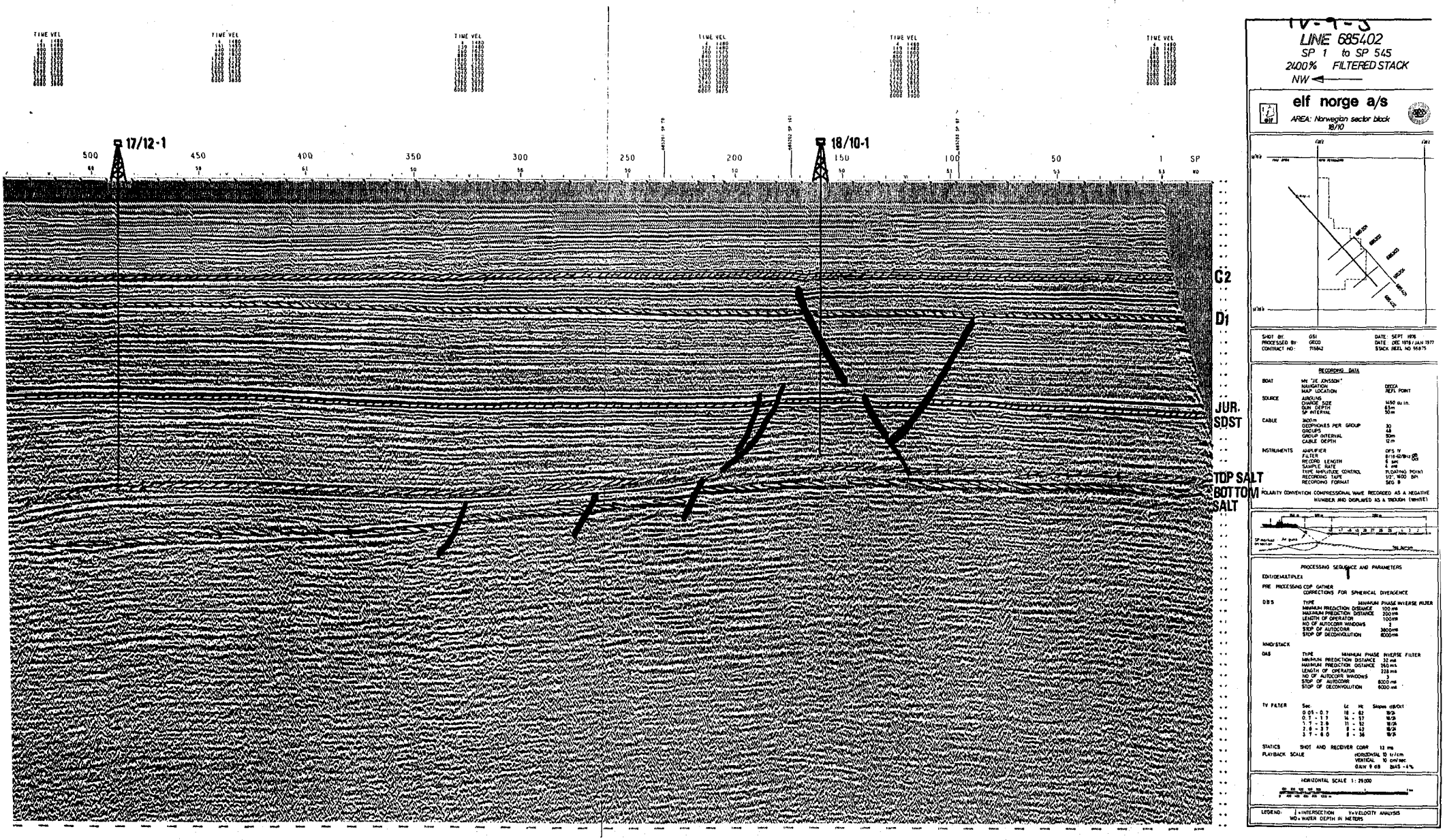
EXPLORATION DIVISION

PROPOSED DRILLING PROGRAM

18/10-1

REF. DEPTH RKB (+25)





IV-9-3

LINE 685402

SP 1 to SP 545

2400% FILTERED STACK

NW

elf norge a/s

AREA: Norwegian sector block 18/10

SHOT BY: GSI DATE: SEPT 1978
PROCESSED BY: GECO DATE: DEC 1978 / JAN 1977
CONTRACT NO: 715842 STACK REEL NO 55875

RECORDING DATA

BOAT	MV "JE JONSSON"	
	NAVIGATION	DECCA
	MAP LOCATION	REFL POINT
SOURCE	AIRGUNS	
	CHARGE SIZE	1450 cu in.
	GUN DEPTH	6.5m
	SP INTERVAL	50m
CABLE	LENGTH	3600m
	GEOPHONES PER GROUP	30
	GROUPS	48
	GROUP INTERVAL	50m
	CABLE DEPTH	12m
INSTRUMENTS	AMPLIFIER	DFS IV
	FILTER	8-16-62-81Hz
	RECORD LENGTH	6 sec
	SAMPLE RATE	4 ms
	TYPE AMPLITUDE CONTROL	FLOATING POINT
	RECORDING TAPE	1/2", 1600 BPI
	RECORDING FORMAT	SEG B

POLARITY CONVENTION COMPRESSIONAL WAVE RECORDED AS A NEGATIVE NUMBER AND DISPLAYED AS A TROUGH (WHITE)

PROCESSING SEQUENCE AND PARAMETERS

EDIT/DEMULTIPLEX

PRE PROCESSING CDP GATHER
CORRECTIONS FOR SPHERICAL DIVERGENCE

OBS
TYPE MINIMUM PHASE INVERSE FILTER
MINIMUM PREDICTION DISTANCE 100 ms
MAXIMUM PREDICTION DISTANCE 200 ms
LENGTH OF OPERATOR 1000 ms
NO OF AUTOCORR WINDOWS 3
STOP OF AUTOCORR 3600 ms
STOP OF DECONVOLUTION 6000 ms

NMO/STACK

DAS
TYPE MINIMUM PHASE INVERSE FILTER
MINIMUM PREDICTION DISTANCE 32 ms
MAXIMUM PREDICTION DISTANCE 240 ms
LENGTH OF OPERATOR 228 ms
NO OF AUTOCORR WINDOWS 3
STOP OF AUTOCORR 6000 ms
STOP OF DECONVOLUTION 6000 ms

TV FILTER

Sec	Lc	Hc	Slopes dB/Oct
0.05 - 0.7	18 - 62		18/24
0.7 - 1.7	14 - 57		18/24
1.7 - 2.8	11 - 52		18/24
2.8 - 3.7	8 - 45		18/24
3.7 - 6.0	6 - 36		18/24

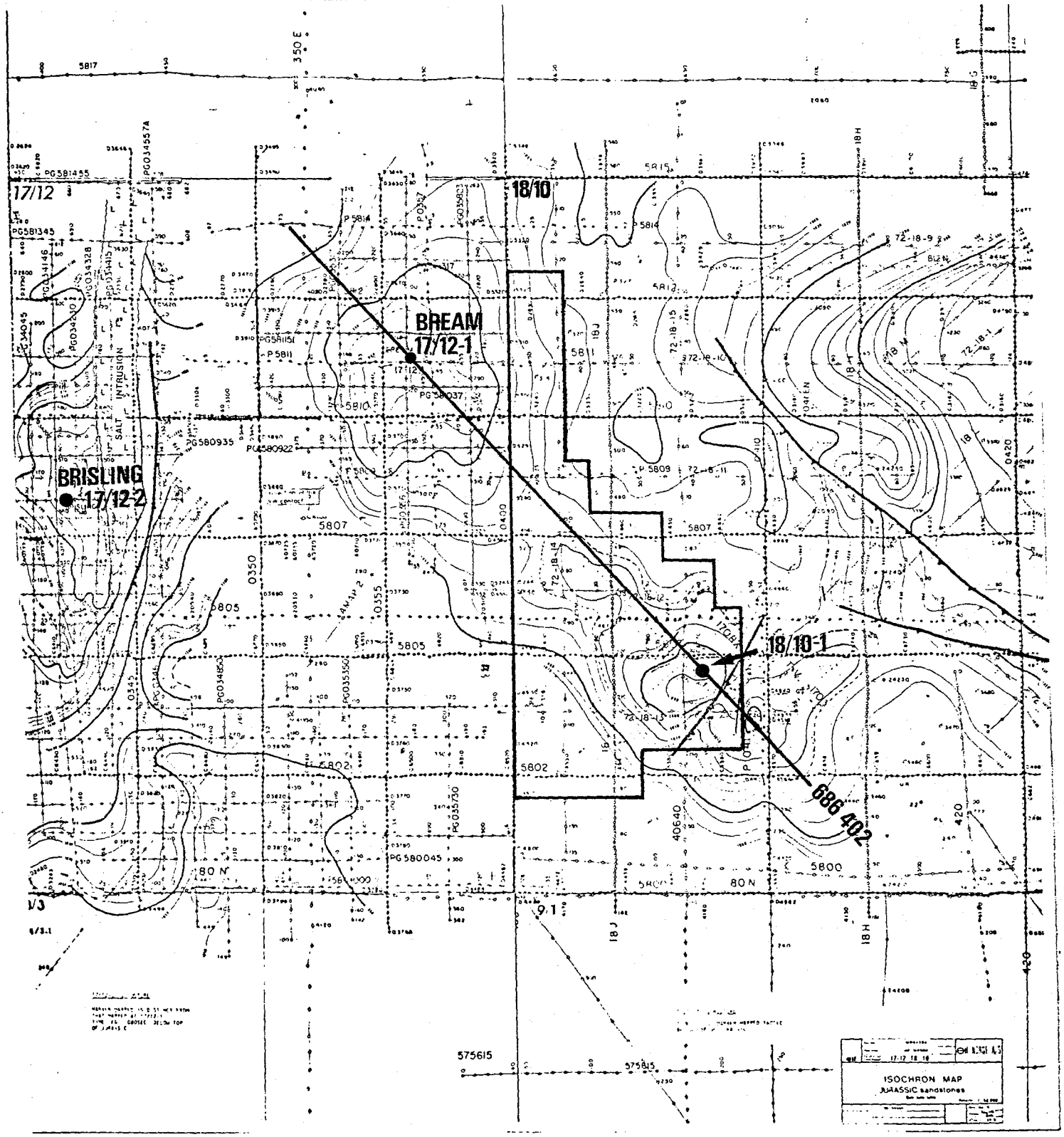
STATICS SHOT AND RECEIVER CORR 11 ms
PLAYBACK SCALE HORIZONTAL 10 1/2 cm
VERTICAL 10 cm/sec
GAIN 9 dB BIAS -4%

HORIZONTAL SCALE 1 : 25000

LEGEND: | = INTERSECTION V = VELOCITY ANALYSES
WD = WATER DEPTH IN METERS

Fig. 3

Fig.4


BREAM
17/12-1
BRISLING
17/12-2
18/10-1
18/10
17/12
686 402
ISOCHRON MAP
JURASSIC sandstones