31/2-7

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A/S NORSKE SHELL

PRODUCTION LICENCE 054

BLOCK 31/2

APPRAISAL WELL PROPOSAL 31/2-J 7

A/S NORSKE SHELL
FORUS

FEBRUARY 1982

31/2-7

CONFIDENTIAL

NSEP-146

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APPRAISAL WELL PROPOSAL 31/2-J-7

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31/2-J APPRAISAL WELL PROPOSAL

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1. Introduction

Since 1979 six exploration wells have been drilled on the 31/2 structure (Figs. 1.a, b). Each of the wells was drilled in a separate fault block and found gas underlain by a thin oil rim in sandstones of Middle to Upper Jurassic age.

The GOC is believed to occur at a constant depth of around 1547 m s.s. throughout the field, although in the more micaceous sands it is less clearly defined. The OWC (taken at 50% Sw) is more difficult to interpret, however, and appears to vary, possibly from well to well, but certainly between well 31/2-5 and the remaining part of the field.

The occurrence of a thicker oil column in well 31/2-5 necessitates appraisal of the 31/2-5 sub-block and the area to the north (i.e. west of 31/2-4) into which the thicker oil column may extend. The primary aim of appraisal is to gain an understanding of the occurrence of the oil in order to accurately determine reserves and formulate a viable field development plan. For this purpose a minimum of two appraisal wells are scheduled for 1982. This document comprises the proposal for the appraisal well 31/2-J.

If reservoir conditions are favourable in this well, i.e. oil column thickness is around 21 m, it is intended to test the feasibility and effectiveness of a milled casing underreamed gravel pack completion in an attempt to improve inflow performance.

2. Geological Summary

Lithological subdivision

The Middle to Upper Jurassic reservoir interval has been sudivided into four zones, each with distinct lithostratagraphic characteristics.

Zone 1 is dominantly clean, medium to coarse grained sand, often poorly consolidated with high permeability.

Zone 2 is dominantly fine to very fine grained, strongly micaceous sandstone, often well consolidated and homogeneous, but with low permeability.

Zone 3 is a variable sequence of interbedded medium grained sand and fine micaceous sand with moderate to low permeability.

Zone 4 is composed of fairly coarse, clean sands in the more eastern wells (i.e. 31/2-1, -2, -3), passing laterally into fine sands and silts to the west (well 31/2-4, -5).

Thin (less than 1 m thick), strongly carbonate cemented bands occur in all four zones, probably as discontinous 'stringers' of nodules along certain horizons.

Hydrocarbon occurrence

Hydrocarbons are present in zones 1, 2 and 3 but have not been found in zone 4. Of these three zones it is estimated that zone 1 contains some 90% of the total hydrocarbons in place (Fig. 2).

The GOC is considered to be at a constant depth of 1547 m s.s. throughout the field.

The OWC (50% Sw) appears to be more variable, however, possibly from well to well, but certainly between well 31/2-5 and the rest. In well 31/2-5 the thicker (21 m) oil column was observed in the clean sands of zone 1.b. If capillarity plays a major role in determining the position of the OWC, then this thickness is unlikely to be constant throughout the area. If, however capillarity is not a significant effect and the difference in oil column can be accounted for by migration and sealing (fault(s), then the 21 m oil column could be representative of the 31/2-5 sub-block and may extend into the area to the north (i.e. west of well 31/2-4).

Log and core data from well 31/2-1 suggest a FWL at ± 1606 m s.s. Generally this lies in more or less micaceous sands and is therefore difficult to define with precision. Saturations in the transition zone below the observed OWC in all of the wells drilled

COST ESTIMATE FOR BUDGET PURPOSES

APPRAISAL WELL 31/2-J

Planned spud date : 01.04.82

COST CATEGORY	VALUE NOK thousands			% OF TOTAL
	DRILLING	TESTING	TOTAL	
Time dependent costs				
Rig rental	13 700	3 700	17 400	
Fuel and lubricants	1 800	500	2 300	
Drilling materials	200	100	300	
Tool maintainance	40	10	50	
Diving	400	100	500	
Mud logging	200	50	250	
Electric logging	550	200	750	
Other daily costs	750	200	950	
Air transport	1 000	300	1 300	
Water transport	2 700	700	3 400	
Support transport	500	100	600	
Materials overhead	200	100	300	
Rig supervision	3 500	1 000	4 500	
TOTAL	25 540	7 060	32 600	60%
Depth dependent costs				
Casing	2 800	--	2 800	
Mud	900	--	900	
Bits and coreheads	300	--	300	
Cement and cementing materials	1 300	--	1 300	
Other depth costs	2 000	--	2 000	
TOTAL	7 300	--	7 300	13%
Evalution costs				
Wireline logging surveys	2 500	--	2 500	
Production test	--	5 000	5 000	
Stimulation	--	600	600	
TOTAL	2 500	5 600	8 100	15%
Site costs				
Site preparation	300	--	300	
Rig move	1 500	--	1 500	
Wellhead equipment	1 500	--	1 500	
Miscellaneous costs	600	200	800	
Mobilization	--	--	--	
TOTAL	3 900	200	4 100	8%
Contingency (3 days)	2 100	--	2 100	4%
TOTAL WELL COST	41 340	12 860	54 200	

Fig. 5

to-date suggest that either capillarity (and hence lithology) controls the level of the OWC, or that a flushed zone containing residual oil exists.

Lateral continuity

Reservoir zones 1, 2 and 3 can be readily identified in all six wells. Variations in zone character do occur but are not of sufficient scale to effect well to well correlation.

Zone thicknesses are approximately constant from well to well. Zone 1 has a maximum thickness variation of 30 m between wells 31/2-5 and -6 (some 16 km apart). With closer spaced wells (e.g. 31/2-1 and -4) thickness variations are much smaller - only 10 m difference.

The upper part of zone 1 (zone 1.a) does show variations in both thickness and reservoir quality, however. The former largely as a result of erosion of the top of zone 1 and the latter due to lateral interfingering of sand sequences. In the area to the west of 31/2-4 zone 1.a does appear somewhat thicker than has been observed in the 31/2-5 area (45 m and 27 m respectively).

3. Appraisal Objectives

The primary objective in appraisal is to achieve an UNDERSTANDING OF THE OCCURRENCE OF THE OIL. This is essential in order to formulate a viable field development plan.

There are two parts to the problem of the oil distribution which require explanation:

i) the vertical variation in oil column thickness
ii) the lateral variation in the extent of the oil column.

One, or a combination, of the following may have contributed to this distribution:

- capillarity (related to lithological variability)
- migration (including loss of hydrocarbons from the present trap)
- sealing fault(s)

In addition to the primary objective of understanding the occurrence of the oil, it is necessary to acquire more detailed knowledge of its producibility. The following six objectives of the appraisal programme are aimed at fulfilling these requirements.

1. The maximum thickness of the oil column should be established and the areal extent of this $\geq$ 21 m oil column defined.

2. Top reservoir and intra-reservoir 'markers' should be defined downflank of the structure where there is no clear gas effect on the seismic, but where additional oil may be found.

3. To inhibit early gas-cut of oil wells at realistic production rates, conditions more favourable to production than those of 31/2-5 should be sought i.e. oil in good reservoir sands outside the area of the gas cap.

4. An additional set of data in the 31/2-5 area is required to increase the confidence level in development studies and to aid in production prediction.

5. The feasibility and effectiveness of a milled casing underreamed gravelpack completion should be evaluated at the earliest opportunity as a step toward improving inflow performance.

6. A deviated well should be drilled in a suitable area (preferably shallow structural dip) to test the feasibility of completion and to determine borehole stability criteria at a high angle of deviation ($>45^{o}$).

31/2-J location considerations

The location of the appraisal well 31/2-J some 3.25 km to the west of well 31/2-4 is intended to test the northward extension of the 21 m oil column found in well 31/2-5.

The possibility that the position of the OWC (and hence the thickness of the oil column) may be significantly affected by lithological variations makes the position of the oil column with respect to the reservoir zones important.

In 31/2-J it is intended that, providing the oil column is similar in thickness to that of well 31/2-5, the foot of the oil column should occur in the clean sands of zone 1.b Thus, any capillarity effects should be minimized.

The proposed location of 31/2-J on seismic line 8007 147 at shot point 998 would seem to meet this requirement (Encl. 1). A reasonable seismic correlation with the 31/2-5 location has been achieved for prognosis of 31/2-J (Fig. 3).

4. Appraisal Well 31/2-J

Drilling proposal

1. Well

31/2-J appraisal well
Statoil/Norske Shell (operator)/Conoco/Superior/Norsk Hydro
Production Licence 054

2. Location

Co-ordinates	:	Latitude 60^{o} 51' 25.9"
		Longitude 3^{o} 27' 9.3"
		UTM ZONE 31 EASTING 524589 METRES
		NORTHINGS 6747125 METRES
Seismic line	:	8007 147
Shot point	:	998
Water depth	:	338 $\pm$ 5 m

3. Reservoir

Upper Jurasssic sands

4. Objectives

i) Appraise the oil column to the west of well 31/2-4
ii) Encounter the oil column such that the OWC and sufficient thickness of oil column for testing is present in the good quality reservoir sands of zone 1

iii) if objective ii) is fulfilled:-
Test the feasibility and performance of a milled casing underreamed gravel pack completion for oil production

5. Total depth

1635 m s.s. (1660 m bdf) in Upper Jurassic sandstones.
(A minimum of 20 m into zone 2 micaceous sands to log the zone 1/zone 2 boundary and locate the FWL).

6. Pressures

Data gained from drilling, electric logging, RFT pressure measurements and production tests show that the first six wells drilled in block 31/2 are hydrostatically pressured.

The proposed location 31/2-J is some 3.25 km west of well 31/2-4 and is considered to be in the same hydrostatically pressured regime.

7. Well prognosis (Encl. 1)

(Depths are in metres subsea)

338 m (± 5)

seabed

338 m (± 5) - 735 m (± 5)

Nordland Group (Quaternary-Miocene)
- claystone, light to medium grey, occasionally sandy and calcareous

735 m (± 5) - 1290 m (± 10)

Hordaland Group (Oligocene-Eocene)
- claystone, light to dark grey/green, occasionally silty and calcareous

1290 m (± 10) - 1330 m (± 10)

Balder Formation, Rogaland Group (Eocene)

- claystone, light green/brown to grey, tuffaceous, occasionally calcareous

1330 m (± 10) - 1495 m (± 10)

Sele Formation and Lista Formation, Rogaland Group (Palaeocene)

- claystone, grey/green, occasionally silty and calcareous, locally marls

1495 m (± 10) - 1520 m (± 5)

Shetland Group (Cretaceous)

- calcareous mudstone, white to light green/grey, chalky and argillaceous, occasionally silty

1520 m (± 5) : top reservoir (top zone 1)

1520 m (± 5) - 1565 m (± 10)

Zone 1.a, Sogn Formation, Humber Group (Upper Jurassic)

- sand, unconsolidated to friable, fine to coarse grained, moderately well sorted, micaceous;
  with thin (up to 1 m thick) strongly carbonate cemented bands throughout

1547 m (± 1) : GOC

1565 m (± 10) - 1600 m (± 10)

Zone 1.b, Sogn Formation, Humber Group (Upper Jurassic)

- sand, unconsolidated, medium grained, well sorted, clean, occasional carbonate cemented bands

? : OWC

1600 m (± 10) - 1635 m T.D.

a pity !

Zone 2 (incomplete), Heather Formation, Humber Group (Upper Jurassic)

- sandstone, consolidated, fine to very fine grained, well sorted, occasionally silty, strongly micaceous, homogeneous

1606 m (± ?) : FWL

1635 m : T.D.

(A minimum of 20 m below top zone 2 micaceous sands)

8. Cuttings

Sample interval : every 10 m below 30" casing
: every 3 m below 1270 m

9. Coring

Objectives : to obtain detailed data of the reservoir in the area to the west of well 31/2-4
: to provide material for relative permeability measurements in the oil zone to aid in reservoir simulation studies
: to determine the lithological effect on the position of the OWC
: to provide material for capillary pressure measurements to position the FWL

Interval : from top reservoir through the complete hydrocarbon-bearing sequence until just below the assumed FWL
i.e. 1515 - 1610 m s.s. (1540 - 1635 m bdf)
95 m of core

Technique : fibre-glass sleeve coring over the complete interval

10. Casing

Casing size	Approximate casing shoe depth	
	m s.s.	m b.d.f.
30"	435	460
20"	785	810
13-3/8"	1480	1505
9-5/8"	1625	1650

11. Mud resumé

The 36" hole section will be drilled with a sea water and viscous pill combination.

The 17-1/2" pilot hole for the 26" hole section will be drilled with an unweighted gelled water mud combined with frequent spotting of viscous pills. The 17-1/2" pilot hole will be opened up to 26" using seawater and viscous pills, with the riser removed and returns to seabed.

Prior to pulling out of the 17-1/2" pilot hole and 26" hole for logging and running of the 20" casing respectively, mud of sufficient density will be spotted in the open hole section to ensure hole stability.

The 17-1/2" hole section will be drilled with a KCL/polymer mud system.

In the 12-1/4" hole section the KCL/polymer mud will be dispersed by the use of lignosulphonates.

If hydratable clays are encountered in the 12-1/4" hole section, the mud will be "broken over" to a gypsum/lignosulphonate mud system.

12. Logging programme

At 20" casing depth:	ISF/SONIC/SP/GR	N.B. GR to seabed
	LDT/CNL/CAL/GR	
	(LSS)	
At 13-3/8" casing depth:	ISF/SONIC/SP/GR	
	LDT/CNL/CAL/GR	
	SWS	
	(LSS)	
At 9-5/8" casing depth:	ISF/SONIC/SP/NGT	
	LDT/CNL/CAL/GR	
	MSFL/DLL/CAL/SP/GR	
	HDT	
	(LSS)	
	SWS	
	Velocity survey	
	RFT's as required	
	CBL (on 13-3/8" and 9-5/8" casing)	

13. Testing

Objective : A short production test in the oil zone will record performance and provide another calibration point for simulation studies.

In an attempt to improve inflow performance, a milled casing underreamed gravel pack completion (MCURGP) will be tested.

Requirement: Sufficient thickness of oil column in zone 1 reservoir sands is required to facilitate trial of the MCURGP completion technique. Should a thin oil column occur in 31/2-J, the MCURGP test will be deferred to the next appraisal well in the programme.

Programme : If the testing requirement (above) is met in 31/2-J, the following testing programme will be carried out:

After the 12-1/4" hole has been logged, a 9-5/8" casing will be cemented.

A bridge plug will be set for depth control and the production test interval milled and under-reamed. Thereafter, the gravel pack screens are to be run, and gravel-packing carried out.

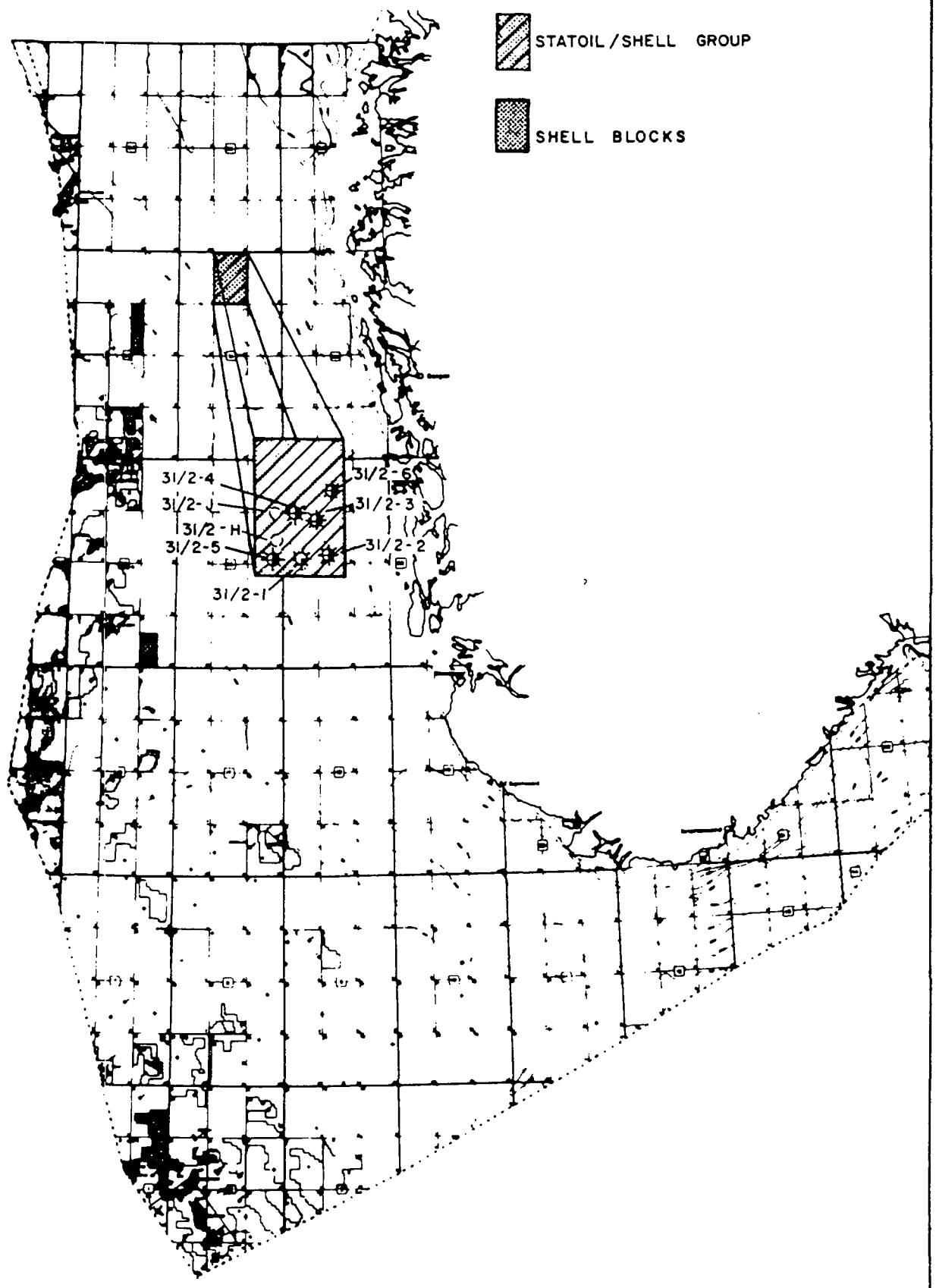
Following the pulling of the running string for the screens, a 5" production tubing will be installed prior to bringing the well in for production testing.

14. Drilling progress (Fig. 4)

		Days
1)	Rig move/anchoring	4
2)	26"/36" hole	1
3)	30" casing	3
4)	17-1/2"/26" hole	2
5)	20" casing/logging	4
6)	17-1/2" hole	5
7)	13-3/8" casing/logging	4
8)	12-1/4" hole/open core section	1
9)	8-1/2" coring (95 m)	5
10)	9-5/8" casing/logging	4
11)	Abandonment	4
	TOTAL	37
	Production testing	10
	TOTAL	47
	Contingency	3
	TOTAL	50

15. Cost estimate

(see figure 5).



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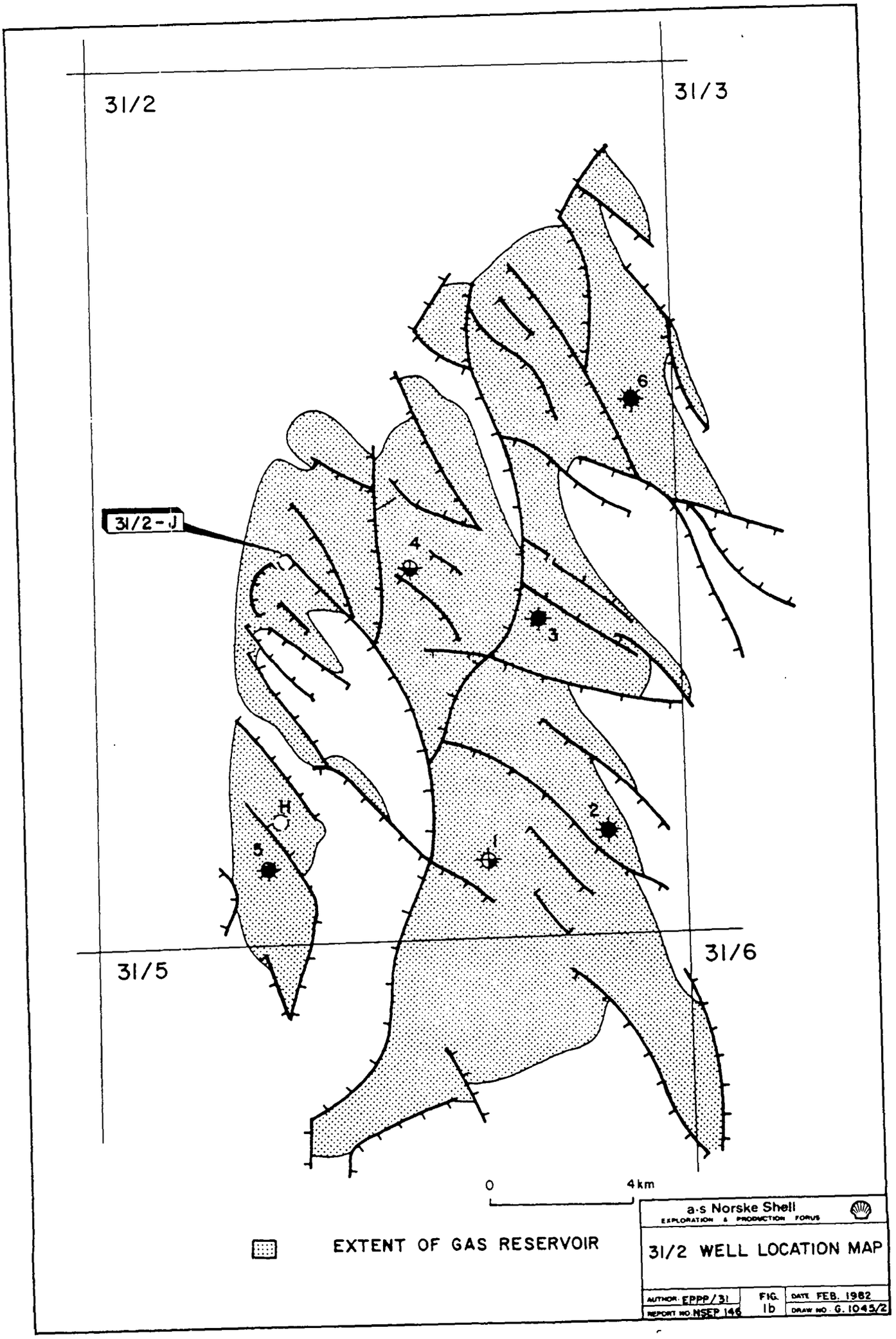
LOCATION MAP BLOCK 31/2

AUTHOR EPPP/31	FIG	DATE FEB. 1982
RPT No. NSEP 146	10	DRAW. No G 1045/1

DEC. 81/P.T



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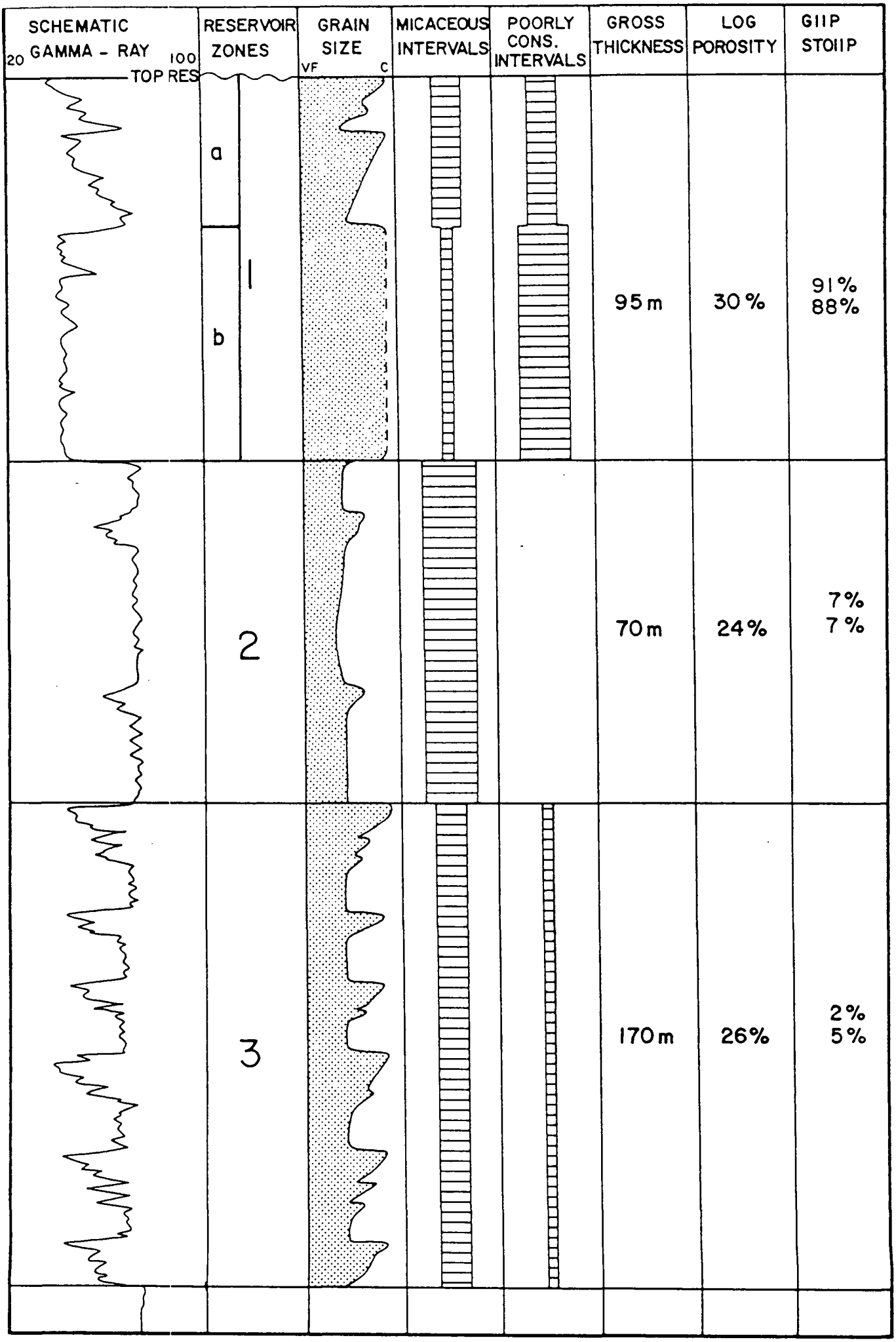
31/2 WELL LOCATION MAP

AUTHOR: EPPP/31	FIG. 1b	DATE FEB. 1982
REPORT NO. NSEP 146		DRAW NO. G. 1045/2

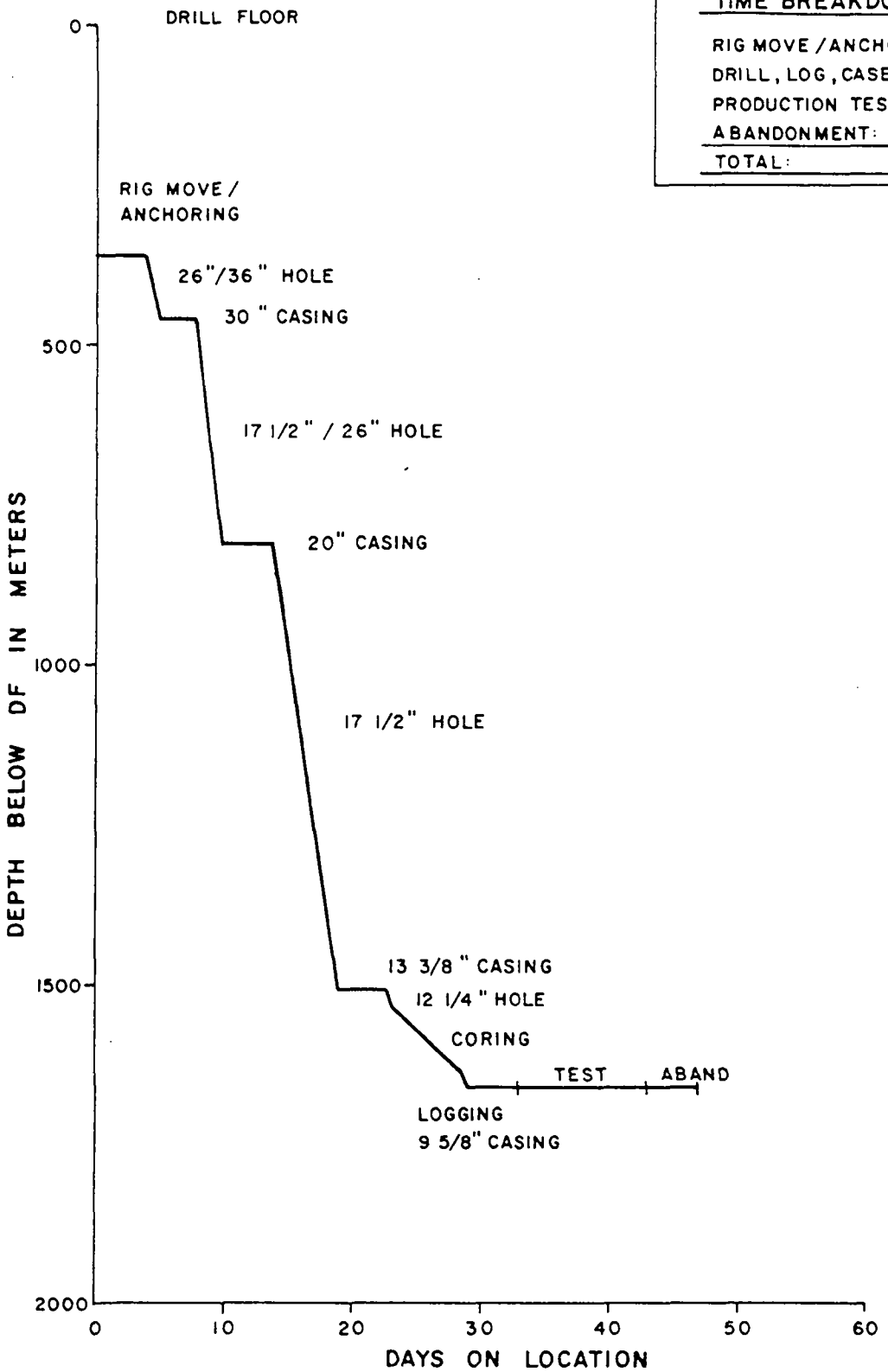


SCHEMATIC SUMMARY OF THE CHARACTERISTICS OF ZONES 1, 2 AND 3 AVERAGED FROM WELLS 31/2-1 TO -6 (NO SCALE)

FIG. 2 G.1045/3

DRILLING PROGRESS CURVE 31/2-J

TIME BREAKDOWN (DAYS)	
RIG MOVE/ANCHORING:	4
DRILL, LOG, CASE TO TD:	29
PRODUCTION TESTING:	10
ABANDONMENT:	4
TOTAL:	47



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31/2-J

DRILLING PROGRESS CURVE

AUTHOR EPPP/11	FIG. 4	DATE FEB. '82
REPORT NO NSEP146		DRAW NO. G. 1045/5

22/2'82 JM