



OLJEDIREKTORATET

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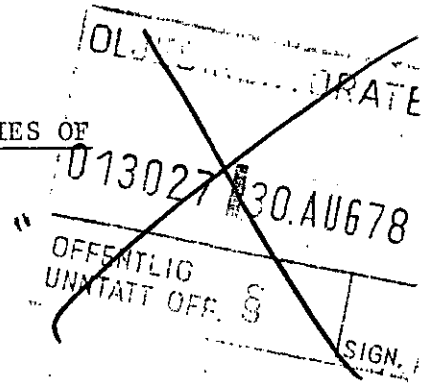
ROBERTSON RESEARCH INTERNATIONAL LIMITED

NORWEGIAN OFFSHORE AREA - PRELIMINARY REPORT NO. 5C

Project No. RRI/789/IIB/2676

PRELIMINARY RESULTS OF PETROLEUM GEOCHEMICAL STUDIES OF
OF THE ELF NORGE 16/6-1 WELL

18th August, 1978



8A 78-118-1

29 AUG 1978

REGISTRERT
OLJEDIREKTORATET

INTRODUCTION

Petroleum geochemical studies have been carried out on samples received from the Elf Norge 16/6-1 well. Samples were received at 5 metre intervals from 1370 to 2055 metres and were composited at 20 metre intervals dependent on lithological and log data. The composite samples were washed with cold water as necessary to remove drilling mud and air dried at 50°C. The 13 $\frac{3}{8}$ " casing was set at about 1351.5 metres in the Upper Cretaceous Chalk with no further casing points to T.D. However, casing has not proved to be a significant problem in geochemical evaluation of the section.

Samples have not been obtained from the Tertiary interval of this well and since reliable maturation data has been obtained in the Lower Cretaceous/Jurassic interval, it is not intended to analyse the Tertiary. A full analysis

is being carried out on the neighbouring 16/5-1 well.

Relevant information on drilling conditions and mud properties are included in N.P.D. Paper 9. No significant amounts of diesel were used during drilling to our knowledge.

The analytical procedures used include organic carbon analysis on all the bulk cuttings samples at 20 metre intervals and also on individual lithologies where bulk samples consisted of more than one lithotype. Extractive source rock analysis has been carried out on samples containing more than 0.5% organic carbon at varying intervals. Gas chromatographic analysis has not been carried out on alkane fractions in this section since no samples contained greater than 100 ppm of hydrocarbon. Pyrolysis source rock evaluation using the IFP/Rina ROCK-EVAL apparatus has been carried out on the same samples as used for extractive analysis, on samples where insufficient material was available for extractive analysis and on samples of picked lithologies where composite samples contained more than one significant lithotype. Kerogen composition has been assessed on a semiquantitative basis, by visual estimation of the kerogen components in unsieved, unoxidised, palynological preparations.

Maturity levels have been assessed in this study using principally spore colouration analysis on sieved, unoxidised, palynological preparations and vitrinite reflectivity on kerogen concentrates. In assessing maturity level, reference may also be made to the temperatures of maximum pyrolysis rate which give useful indications of maturity level when used in conjunction with the kerogen type.

II

RESULTS AND INTERPRETATION

The results of the various analyses carried out on the 16/6-1 well are presented in Tables 1 to 3 and are represented graphically in Figures 1 to 4.

Table 1 lists data on maturity level in the section along with the kerogen composition data for the same samples. The spore colouration and vitrinite reflectivity trends with depth are shown in Figures 1 and 2 respectively. Table 2 lists the organic carbon and extractive source rock evaluation data while pyrolysis data are presented in Table 3. Pyrolysis data are represented graphically against depth in Figures 3 and 4. A detailed graphic compilation of all the data will be presented later in the compilation report.

MATURITY DATA

Our assessment of the spore colouration data is that the Lower Cretaceous and Jurassic intervals of the well are at an early stage of maturity for generation of oil from oil-prone organic matter (see source rock evaluation). Oil-prone organic matter in the Jurassic interval would be anticipated to be capable of heavy (low ⁰API gravity) oil generation.

Vitrinite reflectivity data have been obtained only in the Lower Cretaceous interval of the well and values are between 0.4% and 0.45%. The Kimmeridgian interval was mostly rich in sapropelic material with subordinate amounts of humic macerals. Reflectivity values of this order in Lower Cretaceous sediments suggest a low level of thermal maturity.

HYDROCARBON SOURCE POTENTIAL DATA

On the basis of the geochemical data obtained, the following breakdown of the analysed interval of the 16/6-1 well is made:

Interval 1370 to 1715 metres - Upper Cretaceous Chalk tending to become argillaceous/marly at the base of the interval. The samples are organically lean and the interval has no hydrocarbon source potential. No significant amounts of solvent extractable migrated hydrocarbons were detected at the top of the interval.

Interval 1720 to 2015 metres - Lower Cretaceous variously coloured grey marls and shales with limestones/chalk. The organic carbon content is generally below average and is predominantly inertinitic. The section is considered to have no hydrocarbon generating potential. Solvent extractive source rock analysis has revealed no significant amounts of hydrocarbons and along with pyrolysis data confirm the lack of source potential.

Interval 2020 to 2055 metres - Jurassic. Samples consist of dark grey to grey-black micaceous shales with minor siltstone and in the case of the deeper sample, igneous fragments. The organic carbon content of the shales is well above average at around 6 to 7%. The shales presently are only in the early stages of maturity and contain insignificant amounts of hydrocarbons. However, the pyrolysis yield at optimum maturity is very good and the kerogen is predominantly sapropel so that if this shale is located offstructure in a more mature situation, then significant amounts of oil could be sourced.

TABLE 1 MATURITY EVALUATION DATA

WELL: 16/6-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH METRES	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%)		
					INERTINITE	VITRINITE	SAPROPEL
1670-690	Ctgs	Wht chk/marl	3	*	100	tr	*
1720-735	"	Ditto+mnr gy sh	3	0.40(9)	80	20	*
1775-795	"	Med-lt gy sh+wht chk/marl	3-3.5	0.32(5)	95	5	*
1825-845	"	Ditto+ditto	3.5	0.41(4)	95	5	*
1875-895	"	Ditto+ditto	3.5	0.44(1)	100	tr	*
1925-940	"	Pnk-gy marl+med gy calc sh	3.5	0.37(3)	95	5	*
1975-995	"	Lt ol-gy/gy-red marl+med gy calc sh	3.5-4	0.45(5)	90	10	*
2020-040	"	Dk gy/gy-blk mic sh+ditto+ditto	3.5	*	5	5	90
2045-055	"	Ditto+ditto+ditto	3.5-4	*	25	10	65

SOURCE ROCK EVALUATION DATA

WELL: 16/6-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH METRES OR NOTATION	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONS P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANES % HYDRO- CARBONS
1370-390	Ctgs	Wht chk + mnr ol-gy sh /mdst	0.48	755	17.9	30	4	74
1395-415	"	Ditto + ditto	0.20					
1420-440	"	Ditto + ditto	0.11					
1445-465	"	Ditto + ditto	0.08					
1470-490	"	Ditto + ditto	0.08					
1495-515	"	Ditto + ditto	0.08					
1520-540	"	Ditto + ditto	0.06					
1545-565	"	Ditto + ditto	0.12					
1570-590	"	Ditto + ditto	0.13					
1595-615	"	Ditto + ditto	<0.05					
1620-640	"	Wht-v lt gy chk + mnr sft marl	0.10					
1645-665	"	Ditto + ditto	0.17					
1670-690	"	Ditto + ditto	0.43					
1695-715	"	Ditto + ditto	0.76	1245	16.4	<20	*	*
1720-735	"	Ditto + 10% med gy calc sh	0.10					
1740-760	"	Ditto + ditto	0.49					
1765-770	"	Wht/v lt gy/pnk-gy arg chk/marl + mnr dk gy sh	0.52	170	3.2	<20	*	*
1775-795	"	Med-lt gy calc sh/marl	0.75					
1800-820	"	Ditto	0.65					
1825-845	"	Ditto	0.78					
1850-870	"	Med-lt gy/med gy calc sh + mnr chk + mnr lt brn-gy glauc sltst	0.77					
1875-895	"	Ditto + mnr chk + mnr ditto	0.76					
1900-920	"	Med gy mic sh + lt gy marl + mnr chk + mnr slt/snd	0.59	1020	17.3	<20	*	*
1925-940	"	Pnk gy/gy-red marl + 30% med-lt gy/lt ol- gy calc sh	0.37					
1950-970	"	Ditto + 30% ditto	0.40					
1975-995	"	Ditto + 15% ditto	0.71					
2000-015	"	Ditto + 10% ditto	0.48					

SOURCE ROCK EVALUATION DATA

WELL: 16/6-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (METRES OR NOTATION)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	TOTAL EXTRACT P.P.M.	EXTRACT % OF ORGANIC CARBON	HYDRO- CARBONS P.P.M. OF ROCK	HYDRO- CARBONS % OF EXTRACT	TOTAL ALKANES % HYDRO- CARBONS
2020-040	Ctgs	Dk gy/gy-blk mic sh + 10% lt gy carb sltst + mnr snd	4.30	1600	3.7	<20	*	*
2045-055	"	Ditto + ditto + igneous frags + mnr gy -red sh	2.73					
<u>PICKED LITHOLOGIES</u>								
1740-760	"	Lt-med gy sh	1.69					
1900-920	"	Ditto	0.85					
1900-920	"	Red sh	0.65					
1925-940	"	Lt-med gy sh	6.35					
1950-970	"	Ditto	0.31					
2000-015	"	Ditto	1.26					
2020-040	"	Dk gy/gy-blk sh	6.82					
2045-055	"	Dk gy sh	6.67					
2045-055	"	Gy-red sh	0.01					

TABLE 3

ROCK - EVAL. PYROLYSIS DATA

WELL: 16/6-1

LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (METRES) OR NOTATION	GENERALISED LITHOLOGY	ORGANIC CARBON (%)	TEMPERATURE (°C)	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (PPM)
1420-440	Chk + mnr lt ol- gy sh	0.16	*	*	587	*	*
1495-515	Ditto + mnr ditto	0.13	*	*	685	*	*
1570-590	Ditto + mnr ditto	0.23	*	*	479	*	*
1645-665	V lt gy chk/marl	1.34	*	*	102	*	*
1695-715	Ditto	0.76	*	*	535	*	*
1765-770	Ditto + mnr med- dk gy calc sh	0.52	*	*	724	*	*
1825-845	Med-lt gy calc sh/marl	0.64	*	*	282	*	*
1900-920	Ditto	0.59	*	*	671	*	*
1975-995	Lt ol-gy/gy-red marl	0.50	*	*	559	*	*
2020-040	Dk gy/gy-blk sh	2.60	428	210	18	*	5500
2045-055	Ditto + igneous frags	1.82	429	418	81	*	7700
<u>PICKED LITHOLOGIES</u>							
1740-760	Med gy sh	1.69	435	64	80	*	1100
2000-015	Ditto	1.26	432	39	127	*	500
2020-040	Dk gy sh	6.82	430	417	20	*	28500
2045-055	Ditto	6.57	414	403	27	*	26450

TEMPERATURE (°C) = TEMPERATURE AT MAXIMUM RATE OF PYROLYSIS
 PRODUCTION INDEX = AN ESTIMATE OF PRESENT HYDROCARBON GENERATING POTENTIAL
 COMPARED TO THAT AT OPTIMUM MATURITY
 POTENTIAL YIELD = AN ESTIMATE OF HYDROCARBON PRODUCTION AT OPTIMUM MATURITY

FIGURE 1

SPORE COLOURATION INDICES AGAINST DEPTH

WELL: 16/6-1

LOCATION: NORWEGIAN NORTH SEA

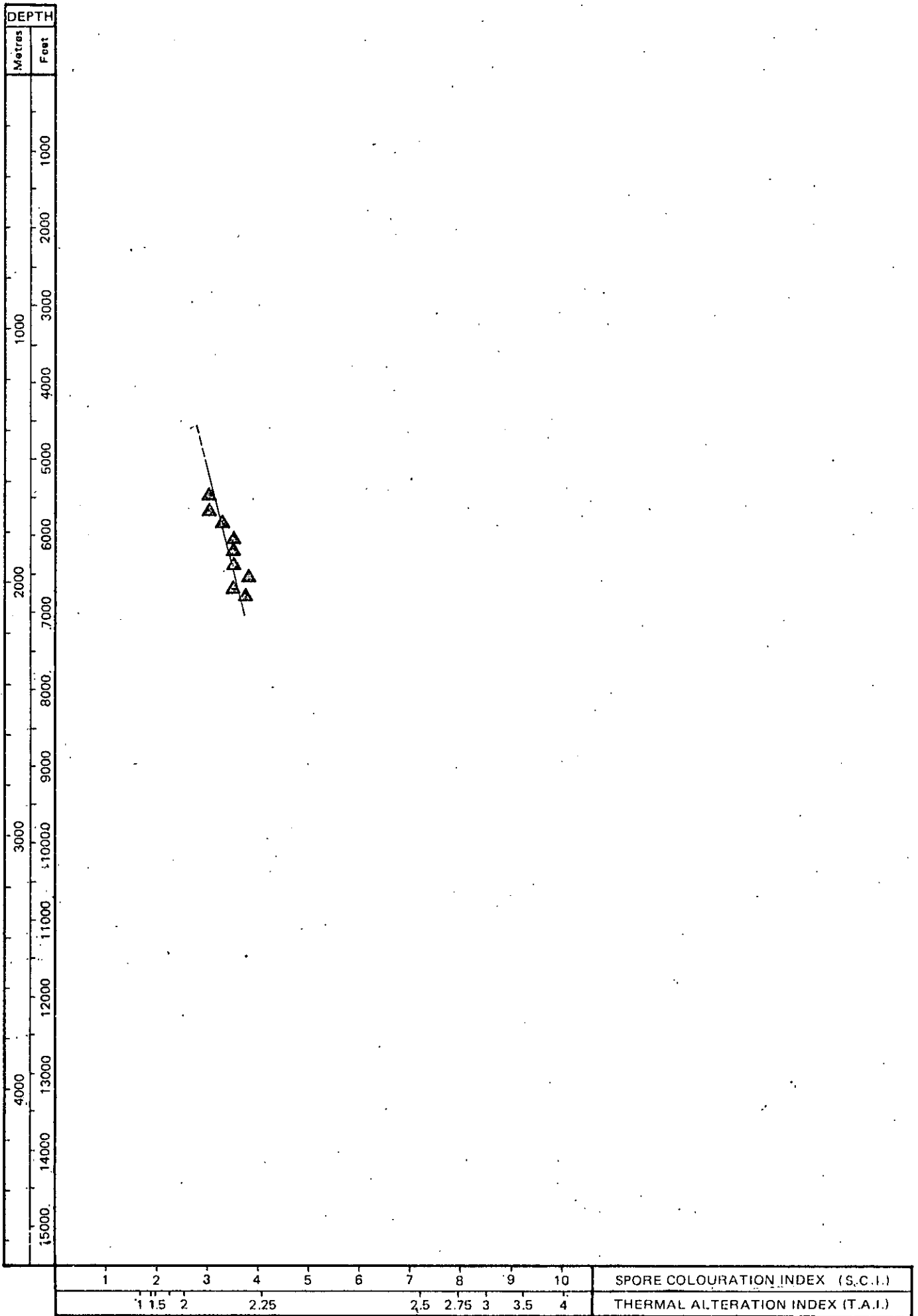


FIGURE 2 VITRINITE REFLECTIVITY AGAINST DEPTH

WELL: 16/6-1

LOCATION: NORWEGIAN NORTH SEA

