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Norway II study - preliminary reports 61 to 64.
Preliminary petroleum geochemistry results
of 17/9-1, 17/12-1, 17/12-2 and 18/11-1 wells

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NORWAY II STUDY - PRELIMINARY REPORTS G1 TO G4

AND PRELIMINARY REPORTS B6 AND B7

ROBERTSON RESEARCH INTERNATIONAL LIMITED

NORWAY II STUDY - PRELIMINARY REPORTS G1 TO G4

Project No. RRPS/801/B/2043

PRELIMINARY PETROLEUM GEOCHEMISTRY RESULTS OF

17/9-1, 17/12-1, 17/12-2 AND 18/11-1 WELLS

DECEMBER 1980

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ROBERTSON RESEARCH INTERNATIONAL LIMITED

Project No. RRPS/801/B/2043

NORWAY II STUDY - PRELIMINARY REPORT G1 (18/12/80)

PRELIMINARY PETROLEUM GEOCHEMISTRY RESULTS OF 17/9-1 WELL

SUMMARY

The Late Jurassic section between 6960' and 7250' (Kimmeridgian - late? Oxfordian to middle? Volgian) contains generally good quality oil source rocks, which have large potential yields between 7160' and 7250'. However, more advanced levels of maturity would be required for the waxy kerogens in these source rocks to generate significant quantities of oil; at present they are only early mature. None of the remaining analysed samples have significant oil generating potential, either due to insufficient organic carbon (Early to Middle? Jurassic between 8760' and 9970'; Early Cretaceous between 4830' and 5910') or unsuitable kerogen composition (Late Jurassic - Early Cretaceous between 5910' and 6930'). Traces of migrant oil staining are inferred between 6820' and 8730', and may be ascribed to more mature lateral equivalents of the interval between 6960' and 7250'. Minor quantities of heat-affected spores are noted between 9520' and 10010' (Middle? - Early Jurassic).

GENERAL COMMENTS

Well status: Plugged and abandoned, dry hole.

Drilling data: Casing points at 683' (30"), 1343' (20"), 3024' (13 $\frac{3}{8}$ "), 6931' (9 $\frac{3}{8}$ "). Drilled with water-based mud, spersene and XP-20.

Interval analysed: 2280'-10010' (T.D. 10370').

Age of analysed interval: Middle? - Early Jurassic to Early Eocene.

Sample type and quality: Composite samples of ditch cuttings. Sample quality was fair.

Maturation data quality: Good for Early Cretaceous and older sediments, poor in younger sediments due to lack of indigenous vitrinite and spores.

Source rock data quality: Fair to good.

Gas chromatography run at: 6820'-6870', 6960'-7010', 7040'-7090', 7130'-7160', 7200'-7250', 7280'-7370', 7800'-7890', 7920'-8010', 8400'-8490', 8520'-8610', 8640'-8730'.

MATURATION (Table 1; Figures 1 and 2)

The Jurassic to Early Cretaceous sediments (4110'-10010') have vitrinite reflectivity levels of 0.35% to 0.5%, and spore colour indices of 3-3.5 rising to 4.5 to 5, indicating an early stage of thermal maturity, verging on middle maturity in the lower part of the section. Oil-prone kerogen in this section

would thus be starting to generate hydrocarbons, but not in significant quantities. The data for the Late Cretaceous to Early Eocene sediments indicate either an immature or only transitionally mature state, insufficient for hydrocarbon generation. Heat-affected spores with spore colour indices of between 6 and 9 are noted in the interval 9520'-10010'. These spores may be ascribed to a minor localised heating event, which is not considered significant with respect to the overall maturity of the section.

OIL SOURCE ROCKS (Tables 1 and 2)

Oil-source rocks have been identified in the Kimmeridgian - late? Oxfordian to middle? Volgian part of the analysed section (6960'-7250'). They have a very high yield between 7160' (24000 ppm potential yield) and 7250' (25000 ppm potential yield). The hydrocarbons are generated from mainly waxy oil-prone kerogen (up to 45% of the total kerogen) with subordinate algal sapropel, representing up to 10% of the total kerogen. This section would yield oil in a more mature situation; at present it is insufficiently mature for significant oil generation.

Moderate to large quantities of free hydrocarbons are present in some of the samples analysed between 6820' and 8730'. Gas chromatographic analysis of the alkanes has shown that they are all very similar in composition, with a mature, oil-like distribution, not obviously in accord with the known early level of thermal maturity of the interval. The pristane/phytane ratio and general pattern of these alkane distributions are similar to those of the DST oils of the 17/12-1 and 17/12-2 wells, but the $n\text{-C}_{17}/\text{Pr}$ and $n\text{-C}_{18}/\text{Ph}$ ratios are slightly different. A more mature equivalent of the interval between 6960' and 7250' should generate oil with a similar type of alkane distribution to the 17/12-1 and 17/17-2 DST oils.

GEOCHEMICAL CHARACTERISTICS OF THE REMAINING SEDIMENTS

The organic carbon content of the analysed Middle? - Early Jurassic sediments, which are dominated by volcanics and which occur between 8760' and 9970', is insufficient to have any source potential regardless of their thermal maturity. Although the early Ryazanian - late Volgian to Hauterivian - Valanginian section between 5910' and 6930' contains above average organic carbon, the kerogen is predominantly inertinitic, so that the interval can have no source potential. The Early Cretaceous section between 4830' and 5910', is organically lean and inertinitic and has no significant hydrocarbon source potential.

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
2280-310	Ctgs.	CLYST, med gy+ SH gy-blk	2-2.5	0.22(8)	20	80	*				
3000-030	"	CHK	2.5-3	0.25(3)	20	80	*				
3510-540	"	CHK	2.5-3(c)	*	20	80	*				
4110-140	"	SH, med-dk gy	3.5	0.31(11); 0.42(1)	70	30	*				
4410-440	"	A/a	3.5	0.37(3)	80	20	*				
4980-5010	"	A/a	3.5-4	0.40(9); 0.31(1); 0.51(3); 0.84(6)	70	30	*				
5460-580	"	SH, a/a, slty+ LST, dk gy+PYR+ SST						100	*	*	*
5520-550	"	A/a	3.5	0.42(11); 0.52(2); 0.66(2)	70	30	*				
5910-940	"	A/a						100	*	*	*
5940-970	"	A/a						100	*	*	*
6000-030	"	A/a	3.5	0.38(20)	70	30	*				
6120-150	"	A/a						100	*	*	*
6180-210	"	A/a	3.5	0.41(11) 0.30(11) Bit/LRV	H	U	M	I	C		
6270-300	"	A/a						100	*	*	*
6360-370	"	A/a						100	*	*	*
6400-410	"	A/a						100	*	*	*
6480-490	"	A/a						85	15	*	*
6520-530	"	A/a	3.5	0.52(3)	HUMIC + SAPROPEL			80	20	*	tr
6580-590	"	A/a						70	30	*	*
6630-640	"	A/a						60	40	*	*
6680-690	"	A/a						85	15	*	*
6760	"	A/a	3.5	0.44(5); 0.30(3); 0.50(4)	*	*	~100	65	25	*	10
6760-770	"	SH, ol-gy, mic+ 10% SH, dk gy, mic+mnr SND						40	50	*	10
6820-870	"	SH, dk gy						45	50	*	5
6860-870	"	SH, a/a, mic						30	70	*	*
6920-930	"	A/a						45	45	*	10
6960-7010	"	A/a						10	70	*	20
7000-010	"	A/a	3.5-4	*	*	*	~100	50	5	*	45
7040-090	"	A/a						10	65	*	25
7080-090	"	A/a						25	45	*	30
7120-130	"	A/a						45	20	5	30
7130-160	"	A/a						60	*	5	35

TABLE 1A Maturity and Kerogen Data

WELL: 17/9-1

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALCAL SAPROPEL	WAXY SAPROPEL
7160-170	Ctgs.	SH, dk gy, mic						35	25	10	30
7200-250	"	A/a						65	*	5	30
7240-250	"	SH, dk gy	4	0.38(1); 0.49(3)	*	*	~100	45	*	10	45
7280-370	"	A/a						75	15	*	10
7530-600	"	SH, a/a+20% SH, gn-gy	4	*	*	*	~100	*	100	*	*
7680-770	"	SH, a/a+20% SH, a/a+tr COAL	4	0.27(15) Bit/LRV	*	*	~100				
7800-890	"	SH, brn-blk, carb+40% SH, gy- blk, carb+mnr SH, lt ol-gy+10% SND						45	55	*	*
7920-8010	"	SH, a/a+30% SH, a/a+mnr SH a/a+ 20% SND						70	10	*	20
8000-010	"	A/a	?4	*	*	*	~100				
8140-230	"	SH, dk gy+SND+ volcanics						*	100	*	*
8260-350	"	A/a						*	100	*	*
8400-490	"	A/a						55	30	5	10
8520-530	"	A/a	4-4.5	*	SAPROPELIC+HUMIC						
8520-610	"	A/a						55	40	*	5
8640-730	"	A/a						50	50	*	*
9000-010	"	A/a	*	0.26(9) Bit/LRV	SAPROPELIC+HUMIC						
9520-530	"	A/a	4.5	0.49(3); 0.25(3) Bit/LRV	*	*	*				
10,000-010	"	A/a	25	0.50(13); 0.32(8) LRV/Bit	*	*	*				

TABLE 1 B Maturity and Kerogen Data

GENERAL DATA			CHEMICAL ANALYSIS DATA															
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS				SOLVENT EXTRACTION										
				TEMPERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	MB/100 OF ORGANIC CARBON	% OF EXTRACT	ALKANES % OF HYDRO-CARBONS				
4830-950	Ctgs.	SH, med gy+PYR	0.44															
4950-5070	"	SH, a/a+LST, med-dk gy+PYR	0.51															
5070-190	"	SH, a/a+LST, a/a+PYR+FOSS	0.45															
5220-310	"	SH, a/a, slty+FOSS	0.72															
5340-430	"	SH, a/a+LST, a/a+PYR+FOSS	0.75															
5460-580	"	SH, a/a+LST, dk gy+PYR+SST	0.56	*	<1	18	0.64	<100										
5580-700	"	A/a	0.79															
5700-850	"	A/a	0.60															
5880-910	"	A/a	0.75															
5910-940	"	A/a	5.49	*	<1	13	0.72	<100										
5940-970	"	A/a	3.47	*	2	29	0.71	<100										
6000-030	"	SH, med gy, mic+PYR	3.67	427	2	15	0.64	<100										
6030-060	"	A/a	1.92															
6120-150	"	A/a	3.90	427	3	12	0.63	100										
6180-210	"	A/a	2.74	426	4	30	0.64	100										
6270-300	"	A/a	3.74	427	11	10	0.36	400										
6360-370	"	A/a	2.82	439	17	25	0.32	500										
6400-410	"	A/a	5.79	431	20	9	0.16	1200										
6440-450	"	A/a	0.90															
6480-490	"	A/a	1.93	432	27	31	0.38	500										
6520-530	"	A/a	2.48	436	40	27	0.31	1000										
6580-590	"	A/a	1.60	435	64	39	0.31	1000										
6630-640	"	A/a	1.98	435	77	32	0.22	1500										
6680-690	"	A/a	3.76	437	28	17	0.24	1100										
6760	"	A/a	2.22	438	95	19	0.18	2100										
6760-770	"	SH, ol-gy, mic+10% SH, dk gy, mic+mnr SND	1.76	436	143	31	0.03	2500										
6820-830	"	SH, dk gy	1.64	437	110	29	0.08	1800										
6820-870	"	SH, a/a, mic	2.13						420	150	2.0	7.0	35	78				
		After Extraction	2.15	447	107	12	0.01	2300										
6860-870	"	SH, a/a, mic	1.77	*	104	36	0.07	1900										
6920-930	"	A/a	1.70	437	136	29	0.06	2300										
6960-970	"	A/a	2.98	438	218	43	0.03	6500										
6960-7010	"	A/a	4.47						1340	465	3.0	10.4	35	73				
		After Extraction	3.65	434	263	15	0.01	9600										
7000-010	"	A/a	3.38	436	273	25	0.05	9200										
7040-050	"	A/a	2.83	435	266	45	0.05	7500										

TABLE 2 A Chemical Analysis Data

GENERAL DATA			CHEMICAL ANALYSIS DATA													
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS					SOLVENT EXTRACTION							
				TEMP - ERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDRO-CARBONS		
											mg/gf OF ORGANIC CARBON	% OF EXTRACT				
7040-090	Ctgs.	SH, dk gy	2.49								645	245	2.6	9.8	38	67
		After Extraction	2.60	435	129	20	0.01	3300								
7080-090	"	A/a	2.79	434	273	38	0.03	7600								
7120-130	"	A/a	3.65	429	264	25	0.03	9700								
7130-160	"	SH, med-dk gy, mic+40% SH, gy-blk, mic+mnr SH, lt ol-gy mic	7.69							2190	880	2.8	11.4	40	55	
		After Extraction	7.63	428	297	17	0.01	22700								
7160-170	"	A/a	7.42	425	323	28	0.03	24000								
7200-210	"	A/a	9.40	429	486	13	0.03	45700								
7200-250	"	A/a	6.91							1755	750	2.5	10.9	43	57	
		After Extraction	7.38	424	306	12	0.01	22600								
7240-250	"	A/a	6.45	426	387	23	0.03	25000								
7280-370	"	A/a	2.11	429	99	25	0.07	2100								
7280-370	"	A/a	2.92							1170	305	4.0	10.4	26	73	
		After Extraction	2.92	432	90	12	0.01	2600								
7400-490	"	A/a	0.58													
7530-600	"	SH, dk gy+20% SH, gn-gy, calc	1.47	*	125	59	0.07	1800								
7680-770	"	SH, a/a+20% SH, a/a+tr COAL	0.59													
7800-890	"	SH, a/a+COAL+QTZ, multi-col +GLAUC	0.90	434	124	41	0.07	1100								
7800-890	"	A/a	0.97							305	115	3.1	11.9	38	65	
		After Extraction	0.82	434	112	29	0.01	900								
7920-8010	"	SH, brn-blk, carb+30% SH, gy-blk, carb+mnr SH, lt ol-gy, carb+20% SND	1.37	435	194	39	0.04	2700								
7920-8010	"	A/a	1.44							335	160	2.3	11.1	48	64	
		After Extraction	1.47	430	166	15	0.02	2400								
8140-230	"	SH, dk-gy+QTZ, a/a+SND+ volcanics	1.00	437	193	160	0.03	1900								
8260-350	"	A/a	1.40	439	74	46	0.03	1000								
8400-490	"	A/a	1.57	438	199	34	0.03	3100								
8400-490	"	A/a	1.67							565	285	3.4	17.1	51	63	
		After Extraction	1.57	428	158	20	0.01	2500								
8520-610	"	A/a	2.30	*	122	201	0.54	2800								
8520-610	"	A/a	1.58							505	220	3.2	13.9	43	62	
		After Extraction	1.50	430	119	21	0.02	1800								
8640-730	"	A/a	1.85	438	114	206	0.03	2100								
8640-730	"	A/a	1.69							595	265	3.6	15.7	45	74	
		After Extraction	1.67	434	106	25	0.02	1800								

TABLE 2 B Chemical Analysis Data

GENERAL DATA			CHEMICAL ANALYSIS DATA											
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS				SOLVENT EXTRACTION						
				TEMPERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDRO-CARBONS
												mg/g OF ORGANIC CARBON	% OF EXTRACT	
8760-850	Ctgs.	SH, dk-gy+QTZ, multi-col+SND +volcanics	0.34	*	*	205	*	*						
8880-970	"	A/a	0.38											
9000-090	"	A/a	0.60											
9120-210	"	A/a	0.62											
9240-330	"	A/a	0.47											
9360-450	"	A/a	0.96											
9480-570	"	A/a	0.86											
9600-690	"	A/a	0.74											
9720-850	"	A/a	0.47											
9880-970	"	A/a	0.77											

TABLE 2 c Chemical Analysis Data

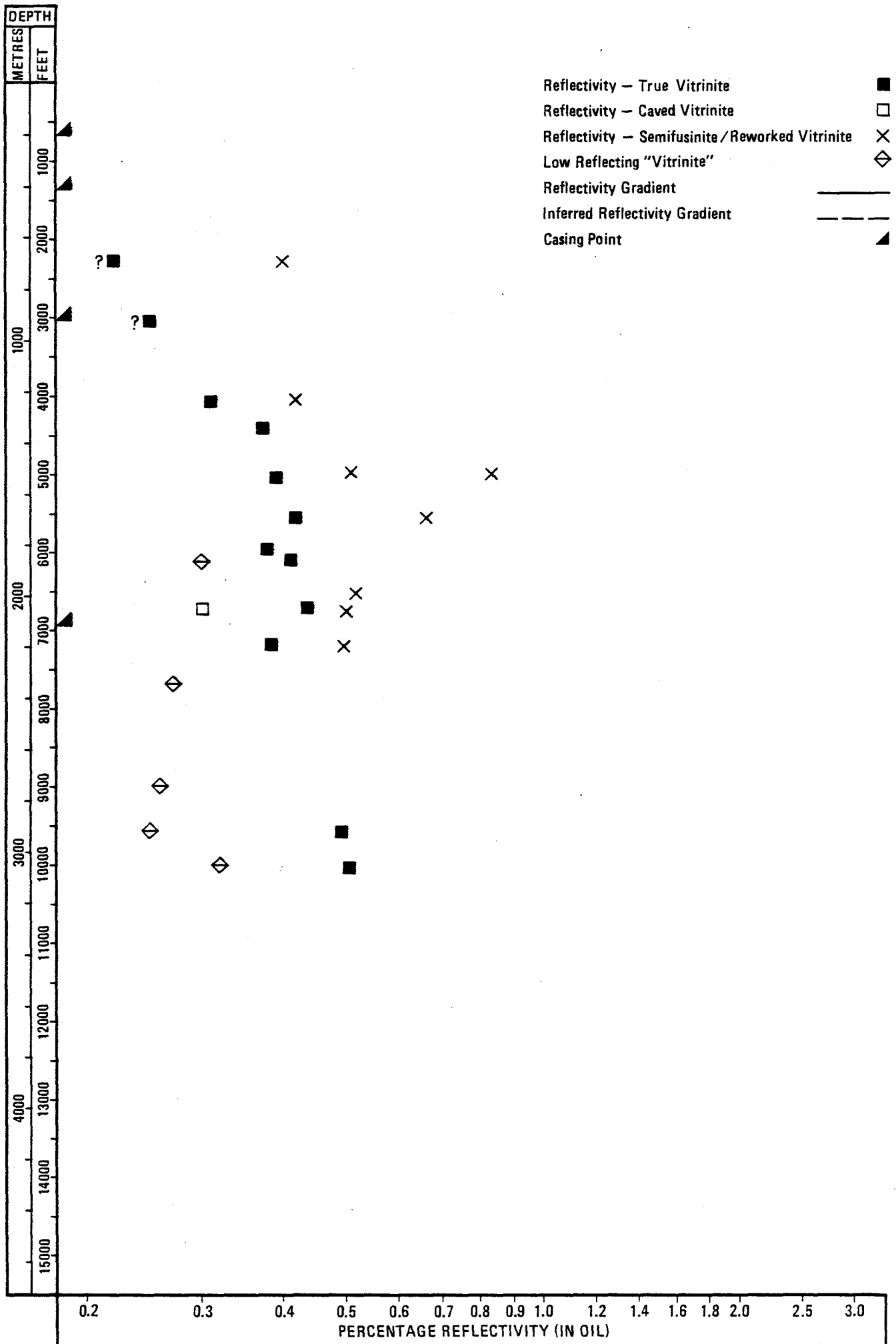


FIGURE 2 Vitrinite Reflectivity against Depth

ROBERTSON RESEARCH INTERNATIONAL LIMITED

Project No. RRPS/801/B/2043

NORWAY II STUDY - PRELIMINARY REPORT G2 (18/12/80)

PRELIMINARY PETROLEUM GEOCHEMISTRY RESULTS OF 17/12-1 WELL

SUMMARY

The analysed section is early mature between 5250' and 8020'. Very good oil source rocks are present between 7150' and 7275' (Kimmeridgian to early Volgian), and if situated in a more mature location could account for the migrated hydrocarbons, including DST oils, noted in the well section. Other oil-prone horizons, but with only generally fair generating potential are present throughout the analysed interval between 7075' and 7960'. Organically lean horizons with no source potential occur in the Early Cretaceous section between 5550' and 6300'. The Triassic - Indeterminate section from 7970'-8040' and the Late Jurassic - Early Cretaceous section between 6250' and 7075' have no source potential, irrespective of maturity, because of the presence of inertinitic kerogen.

GENERAL COMMENTS

Well status: Plugged and abandoned, oil discovery (Bream Field).

Drilling data: Casing points at 538' (30"), 1460' (20"), 3556' (13 $\frac{3}{8}$ "), 7901' (9 $\frac{5}{8}$ "). Drilled with bentonite and sea water/lignosulphonate muds over the analysed interval.

Interval analysed: 3900' to 8040' (T.D. 14100').

Age of analysed interval: Triassic to Late Cretaceous (Coniacian).

Sample type and quality: 64 composite ditch cuttings samples. Sample quality was fair.

Maturation data quality: Adequate.

Source rock data quality: Adequate.

Gas chromatography run at: 6450'-6525', 6975'-7050', 7075'-7150', 7300'-7400', 7510'-7600', 7625'-7700'.

MATURATION (Table 1; Figures 1 and 2)

The interpreted vitrinite reflectivity values increase from 0.35% at 4800' up to 0.52% at 8020', and the spore colour indices increase from 2-2.5 at 3900' to 4-4.5 at 8020'. These data are in close accord, and show that the analysed section from 5250' to 8040' (Triassic to Early Cretaceous) is early mature, such that oil-prone kerogen may generate only minor quantities of hydrocarbons. No indigenous hydrocarbon generating potential may be expected from the Early to Late Cretaceous section above 5250' which is immature.

OIL SOURCE ROCKS (Tables 1 and 2)

The Middle to Late Jurassic analysed section between 7075' and 7960' contains fair to very good oil source rocks. The organic carbon content is above average, (up to 16.98% organic carbon at 7700') and subordinate quantities of algal and waxy sapropel are also present (up to 50% at 7175'-7275'). The best oil source rocks of the section are found between 7150' and 7275' (Kimmeridgian to early Volgian) and yield large quantities of hydrocarbons on pyrolysis (e.g. 33,200 ppm at 7250'-7275' and 23,400 ppm at 7150'). This section could yield abundant oil in a more mature location, and such a situation may account for the DST oils recovered from Middle Jurassic sandstones at 7628'-7600' (DST 2) and 7668'-7682' (DST 1), and the hydrocarbons analysed by gas chromatography.

The high potential yield (28,700 ppm) oil-prone (20% waxy sapropel) sample at 7625'-7700', is considered to be caved from the Middle to Late Jurassic section which contains an interval between 7100' to 7205' with a high gamma ray log response (Börglum Member of the Bream Formation).

All the hydrocarbons from the analysed samples are similar and have a mature, crude-oil type distribution, unrelated to the early mature state of the analysed section. The high percentages of alkanes in the hydrocarbon mixtures from 6450'-6525', 6975'-7050' and 7075'-7150' further indicate a middle mature source. Thus the free hydrocarbons analysed between 6450' and 7700' are all considered to have migrated, and are possibly related to the DST oils.

GEOCHEMICAL CHARACTERISTICS OF THE REMAINING SEDIMENTS

The sample from 7970'-8040' (Triassic to Indeterminate) contains inertinitic kerogen, and has no source potential irrespective of thermal maturity. The Late Jurassic to Early Cretaceous analysed section between 6250' and 7050' contains average to above average quantities of organic carbon but of a predominantly inertinitic nature, and hence has no significant source potential irrespective of thermal maturity. The Early Cretaceous interval between 5550' and 6250' similarly has no source potential, but this is due to a lack of organic carbon.

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R av%	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
3900	Ctgs.	CHK	2-2.5(c)	*	20	80	*				
4210	"	CLYST, ol-gy, sandy	2.5(c)	*	90	10	*				
4505	"	CLYST, ol-gy, silty/ol-blk, waxy, sandy, silty	*	0.94(16)	80	20	*				
4800	"	A/a	2.5	0.36(9) 0.47(7)	40	60	*				
5200	"	A/a	3.5-4	*	70	30	*				
5475	"	A/a	3.5-4		90	10	*				
5525	"	A/a		0.36(1); 0.94(7)							
5675	"	A/a	?4		70	30	*				
5770	"	A/a		0.35(1); 0.27(4)							
5800	"	A/a	?4	*	70	30	*				
6075	"	A/a	?4		70	30	*				
6125	"	A/a		0.44(9) 0.66(23)							
6180	"	A/a		*							
6250-325	"	CLYST, ol-gy+40% SLTST, gy-red						90	10	*	*
6280	"	A/a		*							
6300	"	A/a	4		70	30	*				
6350-425	"	CLYST, a/a+mnr SLTST, a/a						85	15	*	*
6425	"	CLYST, a/a		0.60(18)							
6450-525	"	CLYST, med-dk gy+ 30% CLYST, med-lt gy+mnr SLTST						75	25	*	*
6500-550	"	CLYST, med gy, mic						80	20	*	*
6550	"	A/a	3-3.5		60	30	10	75	25	*	*
6560	"	A/a		0.43(2); 0.30(3) Rew.							
6625-650	"	SH, med gy, mic						70	30	*	*
6650-725	"	SH, med-dk gy+30% SH, med-lt gy+mnr SLTST						65	35	*	*
6700-750	"	SH, med-gy, mic						60	40	*	*
6750-825	"	SH, med-dk gy+30% SH, med-lt gy						50	50	*	*
6775	"	A/a	4		50	40	10				
6850-950	"	A/a						45	50	*	5
6883	"	A/a		0.60(20) Rew.							
6900	"	A/a		0.77(22)							
6975-7050	"	A/a						45	50	*	5

TABLE 1 A Maturity and Kerogen Data

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
7025	Ctgs.	SH, med gy, mic	3.5		30	20	50	50	50	*	*
7050	"	A/a						10	90	*	*
7075-150	"	SH, med-dk gy+ 30% SH, med lt gy						40	50	*	10
7100	"	SH, med gy mic						40	50	5	5
7120	"	A/a		0.44(16); 0.58 Rew.							
7150	"	A/a						60	5	15	20
7175-225	"	A/a						45	15	20	20
7175-275	"	SH, med-dk gy+ 30% SH, med-lt gy						50	*	5	45
7220	"	A/a		0.58(4) Rew.							
7225	"	A/a		0.49(14)							
7250-275	"	SH, med gy, mic						30	20	20	30
7300-400	"	SH, med-dk gy+ 30% SH, med-lt gy						5	95	*	*
7325	"	SH, med gy	4		30	20	50	65	15	5	15
7425-450	"	SH, med-dk gy+ 30% SH, med-lt gy						35	65	*	*
7510-600	"	SH, dk gy, mic+ tr SND/SST						55	45	*	*
7525	"	SH, med gy		0.45(20)							
7583	"	A/a		*							
7625-700	"	SH, dk gy+COAL+ mnr SND/SST		0.57(15); 0.64(11)				75	5	*	20
7640	"	A/a	4		20	10	70				
7720-780	"	SH, a/a+10% COAL +mnr SND/SST		0.56(25)				50	45	5	*
7800-860	"	SH, a/a+30% SH, lt ol-gy+10% SND /SST+COAL						15	85	*	*
7880-960	"	SH, med-dk gy+40% SH, dk gy+10% SND +tr COAL						50	50	*	*
7960	"	A/a	4		20	10	70				
7970-8040	"	SH, gy-blk+40% SH, med-dk gy+ 20% LST, wht/v lt gy+mnr SH, lt ol-gy/gn-gy, calc +tr SST, glauc.						60	40	*	*
8020	"	A/a	4-4.5		20	10	70				

TABLE 1B Maturity and Kerogen Data

GENERAL DATA			CHEMICAL ANALYSIS DATA											
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS				SOLVENT EXTRACTION						
				TEMP - ERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDRO-CARBONS
												MG/G OF ORGANIC CARBON	% OF EXTRACT	
5550-600	Ctgs.	SND, crs+SH, med-dk gy	0.70											
5650-725	"	A/a	0.42											
5750-800	"	A/a	1.20											
5850-925	"	CLYST, ol-gy, mic	0.58											
5950-6000	"	A/a	0.68											
6150-200	"	A/a	0.49											
6250-300	"	A/a	0.78											
6250-325	"	CLYST, ol-gy+40% SLTST, gy-red+mnr PYR	2.55	*	23	57	0.1	600						
6350-425	"	CLYST, a/a+ mnr SLTST, a/a	2.93	426	31	23	0.4	900						
6425-450	"	CLYST, a/a	1.10											
6450-525	"	CLYST, med-dk gy+30% CLYST, med lt gy+mnr SLTST+mnr PYR	2.86	423	46	28	0.1	1300	1180	400	4.1	14.0	34	87
		After Extraction	2.32	442	26	31	0.1	600						
6500-550	"	CLYST, med gy, mic	2.42	407	40	35	0.53	1000						
6550-625	"	SH, med-dk gy+30% SH, med-lt gy+mnr SLTST+tr PYR	2.16	424	49	38	0.1	1000						
6625-650	"	SH, med gy, mic	1.23	431	56	82	0.53	700						
6650-725	"	SH, med-dk gy+30% SH, med-lt gy+mnr SLTST+mnr PYR	2.05	428	72	33	0.04	1500						
6700-750	"	A/a	1.67	429	85	32	0.36	1400						
6750-825	"	A/a	1.83	430	93	48	0.04	1700						
6850-950	"	A/a	2.05	433	116	27	0.04	2400						
6975-7050	"	A/a	1.80	431	117	25	0.04	2100	770	270	4.3	15.0	35	81
		After Extraction	1.91	445	83	19	0.02	1600						
7025	"	A/a	1.72	431	112	25	0.28	1900						
7050	"	A/a	1.61	*	128	40	0.38	2100						
7075-150	"	A/a	2.27	433	155	29	0.02	3500	1125	395	5.0	17.4	35	81
		After Extraction	2.29	436	129	31	0.02	3000						
7100	"	SH, med gy, mic	2.18	429	155	28	0.22	3400						
7150	"	A/a	8.15	418	287	17	0.04	23400						
7175-225	"	A/a	8.17	418	338	22	0.05	27600						
7175-275	"	A/a	7.33	425	379	18	0.03	27800						
7250-275	"	A/a	8.15	*	408	29	0.04	33200						
7300-400	"	SH, med-dk gy+30% med-lt gy+ mnr PYR	2.95	431	139	43	0.03	4100	1700	220	5.8	7.5	13	55
		After Extraction	3.11	430	54	47	0.02	1700						
7325	"	SH, med gy, mic	4.49	424	199	17	0.11	8900						
7425-450	"	SH, med-dk gy+30% SH, med-lt gy+ mnr PYR	3.93	432	111	31	0.1	4400						

TABLE 2 A Chemical Analysis Data

GENERAL DATA			CHEMICAL ANALYSIS DATA												
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS					SOLVENT EXTRACTION						
				TEMPERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS			
												mg/g of ORGANIC CARBON	% OF EXTRACT	ALKANES % OF HYDRO-CARBONS	
7510-600	Ctgs.	SH, dk gy, mic+tr SND+tr SST	5.72	431	95	20	0.1	5400	1530	800	2.7	14.0	52	51	
		After Extraction	5.56	433	80	25	0.03	4400							
7625-700	"	SH, a/a+10% COAL+mnr SND+mnr SST	16.98	430	169	13	0.1	28700	6120	3930	3.6	23.1	64	52	
		After Extraction	16.48	435	90	11	0.01	14900							
7720-780	"	SH, a/a+10% COAL+10% LST, wht+mnr SND+mnr SST	6.98	429	107	21	0.2	7500							
7800-860	"	SH, dk-gy+30% SH lt ol-gy+10% SND+mnr SST+mnr COAL	3.73	437	129	37	0.1	4800							
7880-960	"	SH, med-dk gy+40% SH, dk gy+tr SH, lt ol-gy+10% SND+tr COAL	2.42	436	89	63	0.2	2200							
7970-8040	"	SH, gy-blk+40% SH, med-dk gy+20% LST, wht/v lt gy+mnr SH, lt ol-gy/gn-gy, calc+tr SST, glauc.	1.04	*	68	126	0.2	700							

TABLE 2 B Chemical Analysis Data

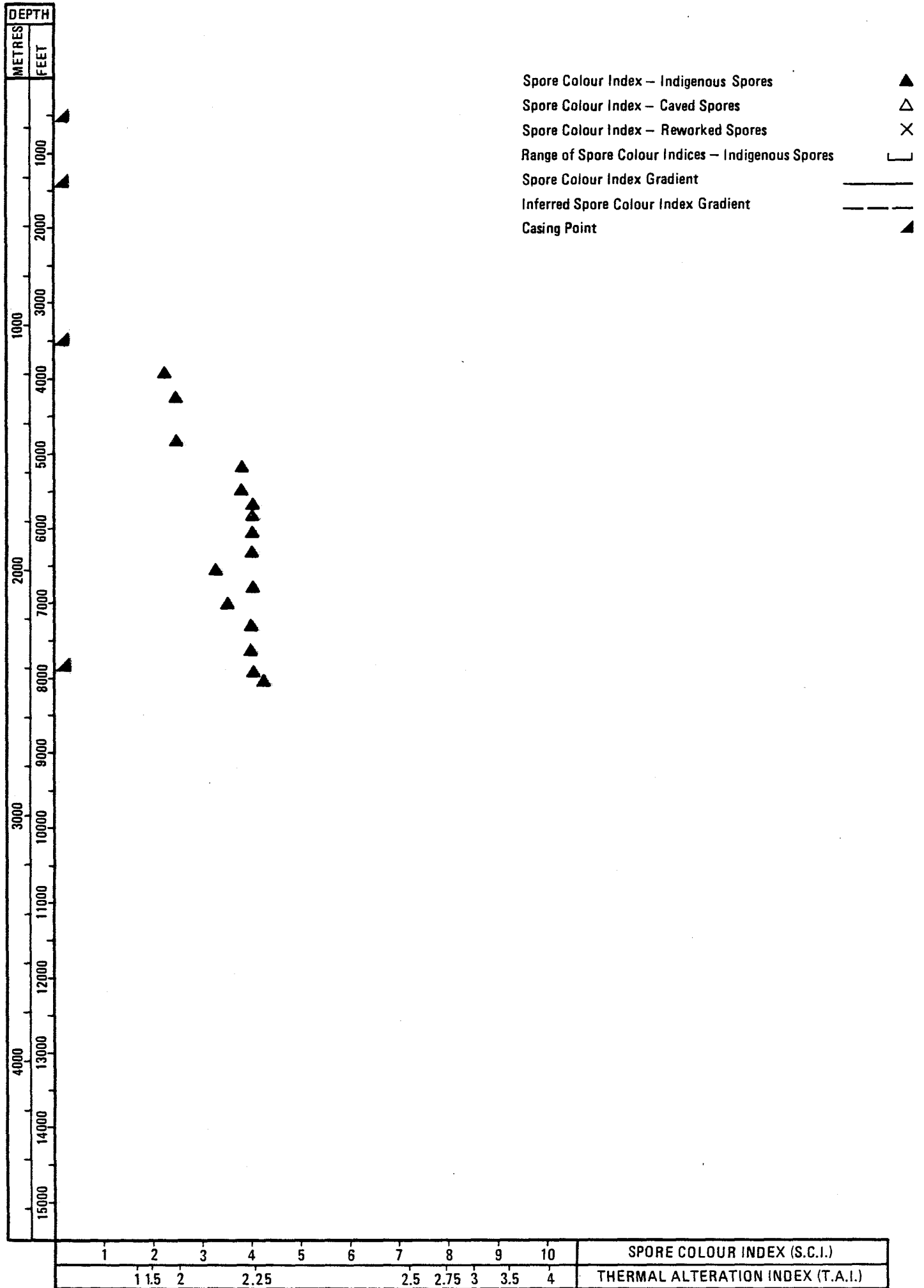


FIGURE 1 Spore Colour Indices against Depth

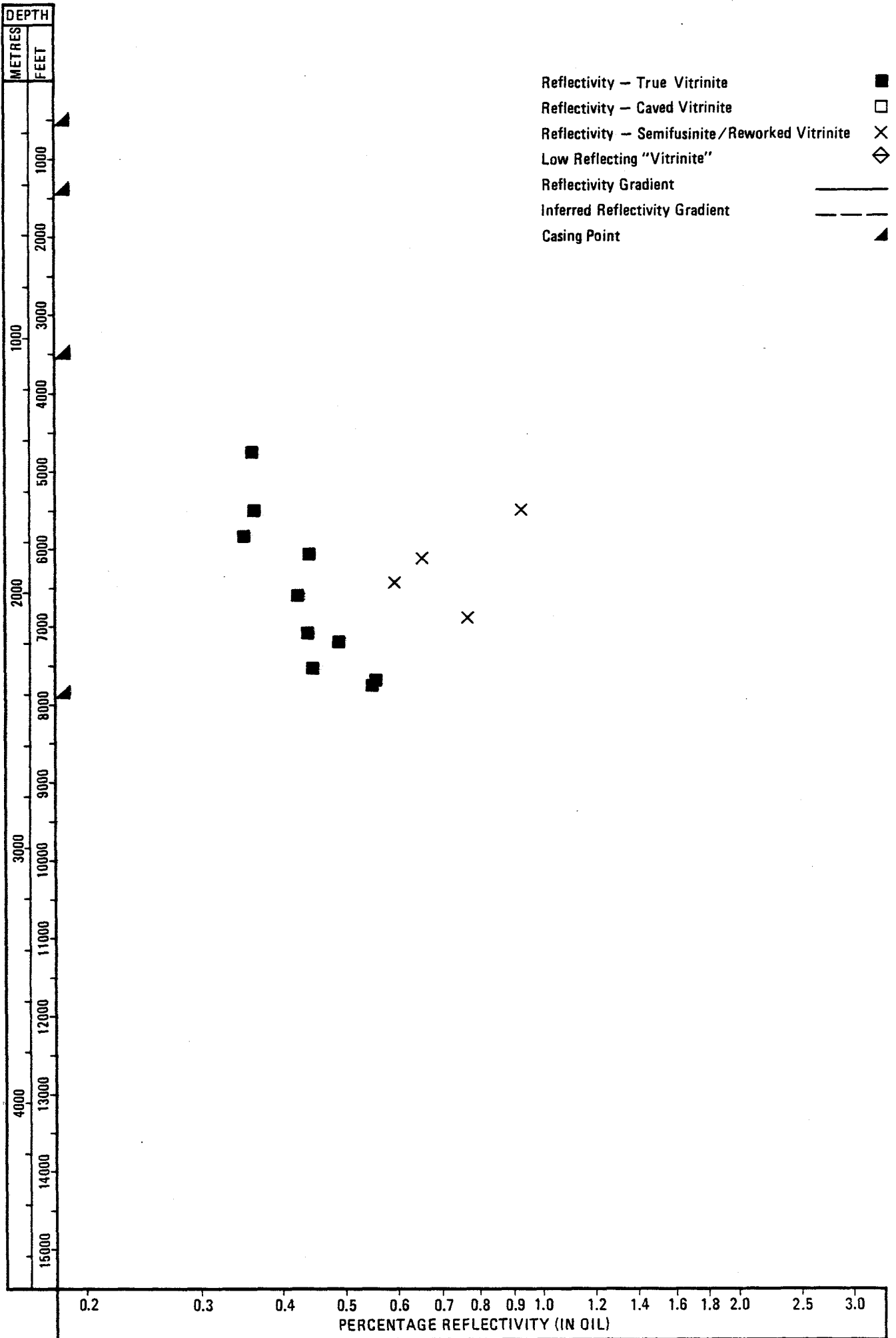


FIGURE 2 Vitrinite Reflectivity against Depth

ROBERTSON RESEARCH INTERNATIONAL LIMITED

Project No. RRPS/801/B/2043

NORWAY II STUDY - PRELIMINARY REPORT G3 (18/12/80)

PRELIMINARY PETROLEUM GEOCHEMISTRY RESULTS OF 17/12-2 WELL

SUMMARY

Fair to good quality oil source rocks are present in the Late Jurassic to Early Cretaceous section between 6640' and 7320' and most particularly between 7200' and 7280'. Although at present only early mature, these sediments would be capable of yielding oil from their contained waxy sapropel component in a more mature location. Such a situation may account for the migrated oil found in the section. The remaining analysed Late Jurassic to Early Cretaceous sediments (5590' to 6640') have no source potential irrespective of thermal maturity and contain inertinitic kerogens. The analysed section is thermally immature above 4800'.

GENERAL COMMENTS

Well status: Plugged and abandoned, oil discovery (Brisling Field).

Drilling data: Casing points at 508' (30"), 1568' (20"), 3551' (13 $\frac{3}{8}$ "), 7265' (9 $\frac{1}{8}$ "). Drilled with shaletrol to 3600', then sea water/lignosulphonate mud to 7657' (T.D.).

Interval analysed: 2000' to 7320' (T.D. 7657').

Age of analysed interval: Late - Middle Jurassic to Early Miocene.

Sample type and quality: 63 composite samples of ditch cuttings.
Sample quality was generally fair.

Maturation data quality: Fair to good throughout the analysed section.

Source rock data quality: Adequate.

Gas chromatography run at: 6700'-6760', 6960'-7020', 7040'-7100', 7120'-7180'.

MATURATION (Table 1; Figures 1 and 2)

The Late - Middle Jurassic to Early Cretaceous analysed section between 5110' and 7320' is early mature, with spore colour indices increasing from 3 to 4.5, and vitrinite reflectivity values increasing from 0.37% to 0.42%. Oil-prone kerogen at this level of thermal maturity will be capable of generating only very minor quantities of hydrocarbons. Between 2000' and 4800', the Late Cretaceous to Tertiary analysed section is immature.

OIL SOURCE ROCKS (Tables 1 and 2)

Shales with generally fair to good hydrocarbon generating potential are present throughout the interval 6640' to 7320' (Late - Middle Jurassic to Early

Cretaceous). This interval has above average organic carbon content (up to 6.6% at 7120'-7160'), contains subordinate quantities of waxy sapropel (up to 30% at 6940'-7020') and yields fair (above 2000 ppm potential yield) to good (from 6500 ppm at 7120'-7180' to 13,200 ppm at 7240'-7280') quantities of hydrocarbons on pyrolysis.

The gamma ray log response is high between 6955' and 7050', (Børglum Member of the Bream Formation). Analysed shale samples from this interval give good potential yields, but these are not as organically rich as those found in the interval 7120' to 7280'. However, the cuttings sample 6960'-7020' is the richest of the analysed samples in solvent extractable organic matter and free hydrocarbons.

Mature, crude oil-like alkane hydrocarbon distributions are found in the samples analysed by gas chromatography; the quantities of hydrocarbons (up to 1115 ppm at 6960'-7020') and alkane richness of the mixtures (up to 83%) also indicate an oil-prone source rock. The maturity of these hydrocarbons is not in accord with the early thermal maturity of the analysed source rocks, and they are thus considered to be contaminants and may represent migrated hydrocarbons. It is noted that the $n\text{-C}_{17}/\text{Pr}$, $n\text{-C}_{18}/\text{Ph}$ and pristane/phytane ratios of these hydrocarbons are not in close accord with those of the reservoired 17/12-2 (Brisling Field) oil, (Norway Phase I report). More mature equivalents of the oil source rocks noted in the analysed section between 6620' and 7320' should be capable of generating abundant oil, and are possible sources of the reservoired oils tested at 7078'-7094' (DST 2) and 7106'-7116' (DST 1).

GEOCHEMICAL CHARACTERISTICS OF THE REMAINING SEDIMENTS

The Late Jurassic to Early Cretaceous sediments between 6520' and 6640' and the Early Cretaceous sediments between 5590' and 6520' contain above average quantities of organic carbon. However, this organic carbon is mainly inertinitic, and hence the samples analysed have no significant hydrocarbon generating potential, irrespective of levels of thermal maturity.

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R av%	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
2000	Ctgs.	CLYST, ol-gy, silty, calc	?2	0.27(6)	30	70	*				
2400	"	A/a	*	0.25(11)	30	70	*				
2700	"	A/a	2.5	*	30	70	*				
3100	"	A/a	?3	*	30	70	*				
3380	"	A/a	2	0.30(20)	20	70	10				
3600	"	A/a	2.5	0.32(10)	20	70	10				
3900	"	A/a	*	0.36(3)	Mnr	>90	*				
4200	"	A/a	*	0.30(3)	*	*	*				
4500	"	A/a	*	*	*	*	*				
4800	"	A/a	*	0.83(9)	20	80	*				
5110	"	A/a	?3	0.37(9); 0.44(9)	20	80	*				
5470	"	A/a		0.40(7); 0.48(11)							
5590-60	"	A/a	3.5-4	0.38(1)	50	50	*	90	10	*	*
5650-680	"	A/a						95	5	*	*
5710-740	"	A/a		* 0.54(3)				95	5	*	*
5770-800	"	A/a						100	*	*	*
5820-860	"	A/a						95	5	*	*
5880-920	"	A/a	*		40	60	*	95	5	*	*
5940-980	"	A/a						95	5	*	*
5960	"	A/a		0.32(3)							
6000-040	"	A/a						75	25	*	*
6060-100	"	A/a						95	5	*	*
6120-160	"	A/a						95	5	*	*
6140	"	A/a	?3-4		40	60	*				
6180-220	"	A/a						95	5	*	*
6220	"	A/a		0.36(7); 0.56(4)							
6240-280	"	A/a						95	5	*	*
6300-340	"	A/a						95	5	*	*
6360-400	"	A/a						95	5	*	*
6400	"	A/a	?3-4		40	60	*				
6440-480	"	A/a						95	5	*	*
6460	"	A/a		0.35(16)							
6500-540	"	CLYST/SH, ol-gy/ ol-blk+mnr DOL, lt brn						95	5	*	*
6560-600	"	A/a						95	5	*	*
6620-640	"	A/a						45	55	*	*

TABLE 1 A Maturity and Kerogen Data

SAMPLE DEPTH (FEET)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
6620-680	Ctgs.	CLYST/SH, ol-gy/ ol-blk+mnr DOL, lt brn						*	100	*	*
6680-720	"	A/a						60	40	*	*
6700	"	A/a	3.5	*	20	70	10	75	*	*	25
6740-780	"	A/a						55	35	*	10
6780-840	"	A/a						70	10	*	20
6800-840	"	A/a						50	40	*	10
6820	"	A/a		*							
6860	"	A/a	3-3.5		20	mnr	80				
6880-920	"	A/a						55	25	*	20
6880-940	"	A/a						75	*	*	25
6940-980	"	A/a						50	20	*	30
6960-7020	"	A/a						70	*	*	30
6980	"	A/a	?3-4		20	mnr	80				
7000	"	A/a		0.26(6)							
7000-040	"	A/a						70	*	*	30
7040-100	"	A/a						80	*	*	20
7060-100	"	A/a	?3-4		50	30	20				
7060-100	"	SST, fn/med, mic, calc						55	35	*	10
7100	"	SH, med-dk gy, mic +10% SH, brn-gy, mic		*							
7120-160	"	SST, fn, mic+SH, lt ol-gy/ol-blk/ lt brn+COAL						50	35	*	15
7120-180	"	SH, brn-blk+30% SH, dk gy+tr COAL		0.42(14)				80	10	*	10
7180-220	"	SST, a/a+SH, lt ol-gy/ol-blk/lt- brn+COAL						55	45	*	*
7200-260	"	SH, brn-blk+40% SH, dk gy		0.52(25)				80	*	*	20
7240	"	A/a	?3-4		40	20	40				
7240-280	"	SST, fn, mic+SH, lt ol-gy/ol-blk/ lt-brn+COAL						70	5	*	25
7280-300	"	SH, brn-blk+40% SH, ol-gy+10% SH, ol-gy+10% COAL						70	15	*	15
7300-320	"	SST, a/a+SH, lt ol-gy/ol-blk/lt- brn+COAL						*	95	5	*
7320	"	SST, a/a+SH, a/a +COAL	4-4.5		30	10	60				

TABLE 1 B Maturity and Kerogen Data

GENERAL DATA			CHEMICAL ANALYSIS DATA												
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS					SOLVENT EXTRACTION						
				TEMP - ERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDRO-CARBONS	
												mg/g OF ORGANIC CARBON	% OF EXTRACT		
5590-620	Ctgs.	CLYST/SH, ol-gy, slty, mod calc+mnr GLAUC	1.66	*	23	66	0.7	1100							
5650-680	"	A/a	1.02	*	12	136	0.6	1400							
5710-740	"	A/a	1.02	*	8	75	0.8	800							
5770-800	"	A/a	1.54	*	5	52	0.9	800							
5820-860	"	A/a	2.25	426	9	23	0.9	200							
5880-920	"	A/a	3.33	425	7	27	0.7	300							
5940-980	"	A/a	2.29	425	10	35	0.6	200							
6000-040	"	A/a	2.32	*	12	51	0.5	300							
6060-100	"	A/a	3.65	*	6	24	0.5	200							
6120-160	"	A/a	5.13	*	5	20	0.7	200							
6180-220	"	A/a	2.95	426	8	25	0.7	200							
6240-280	"	A/a	4.05	*	8	23	0.7	300							
6300-340	"	A/a	2.78	427	6	28	0.8	200							
6360-400	"	A/a	2.91	427	7	30	0.8	200							
6440-480	"	A/a	3.30	426	9	19	0.8	300							
6500-540	"	CLYST/SH, 1t ol-gy/ol-blk+PYR+mnr DOL, 1t brn+LST	3.09	433	14	22	0.5	400							
6560-600	"	A/a	3.43	434	13	18	0.6	800							
6620-640	"	A/a	2.48	436	71	27	0.3	1800							
6620-680	"	A/a	2.27	434	110	55	0.1	2500							
6680-720	"	A/a	2.51	437	69	21	0.3	1700							
6700-760	"	A/a	2.05						2300	720	11.2	35.1	31	77	
		After Extraction	1.83	440	142	12	0.03	2600							
6740-780	"	A/a	2.90	437	122	24	0.2	3500							
		After Extraction	1.70	436	150	34	*	2600							
6780-840	"	A/a After Extraction	2.28	439	141	17	0.02	3200							
6800-840	"	A/a	2.92	436	141	28	0.3	4100							
		After Extraction	1.72	440	169	41	*	2900							
6880-920	"	A/a	2.83	*	147	25	0.2	4800							
		After Extraction	1.83	435	172	25	*	3200							
6880-940	"	A/a After Extraction	2.10	436	178	12	0.02	3800							
6940-980	"	A/a	2.81	437	189	17	0.2	7600							
		After Extraction	2.19	440	209	29	*	4600							
6960-7020	"	A/a	2.95						3000	1115	10.1	37.8	37	83	
		After Extraction	2.92	440	177	8	0.01	5200							
7000-040	"	A/a	3.89	434	194	16	0.1	5300							
		After Extraction	2.70	438	208	22	*	5600							

TABLE 2 A Chemical Analysis Data

GENERAL DATA			CHEMICAL ANALYSIS DATA												
SAMPLE DEPTH (FEET)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS					SOLVENT EXTRACTION						
				TEMPERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS mg/g OF ORGANIC CARBON	% OF EXTRACT	ALKANES % OF HYDRO-CARBONS	
7040-100	Ctgs.	CLYST/SH, lt ol-gy/ol-blk+ PYR+mnr DOL, lt brn+LST	3.83							1865	445	4.9	11.6	24	78
		After Extraction	3.68	430	156	9	0.02	5700							
7060-100	"	SST, fn/med, mic, calc	3.89	435	124	17	0.05	4200							
		After Extraction	2.79	439	125	24	*	3500							
7120-160	"	SST, fn, mic+SH, lt ol-gy/ ol-blk/lt-brn, carb, slty, sndy, mic+COAL	5.07	438	65	21	0.2	3300							
		After Extraction	3.02	438	160	27	*	4900							
7120-180	"	SH, brn-blk+30% SH, dk gy+ tr COAL	7.11						2020	700	2.8	9.8	35	80	
		After Extraction	6.60	430	99	10	0.03	6500							
7180-220	"	SST, a/a+SH, lt ol-gy/ol-blk/ lt brn, carb, slty, sndy, mic+COAL	5.54	438	129	18	0.2	7100							
		After Extraction	4.63	439	52	21	*	2400							
7200-260	"	SH, brn-blk+40% SH, dk gy+tr COAL After Extraction	7.42	433	152	5	0.02	11200							
7240-280	"	SST, a/a+SH, lt ol-gy/ol-blk/ lt-brn, carb, slty, sndy, mic+COAL	7.46	434	177	12	0.2	13200							
		After Extraction	5.90	*	165	14	*	9800							
7280-300	"	SH, brn-blk+40% SH, dk gy+ 10% SH, lt ol-gy+10% COAL After Extraction	2.43	*	129	16	0.04	3100							
7300-320	"	SST, fn, mic+SH, lt ol-gy/ lt-blk/lt brn, carb, slty, sndy, mic+COAL	2.43	*	229	97	0.2	5600							
		After Extraction	1.88	447	154	53	*	2900							

TABLE 2 B Chemical Analysis Data

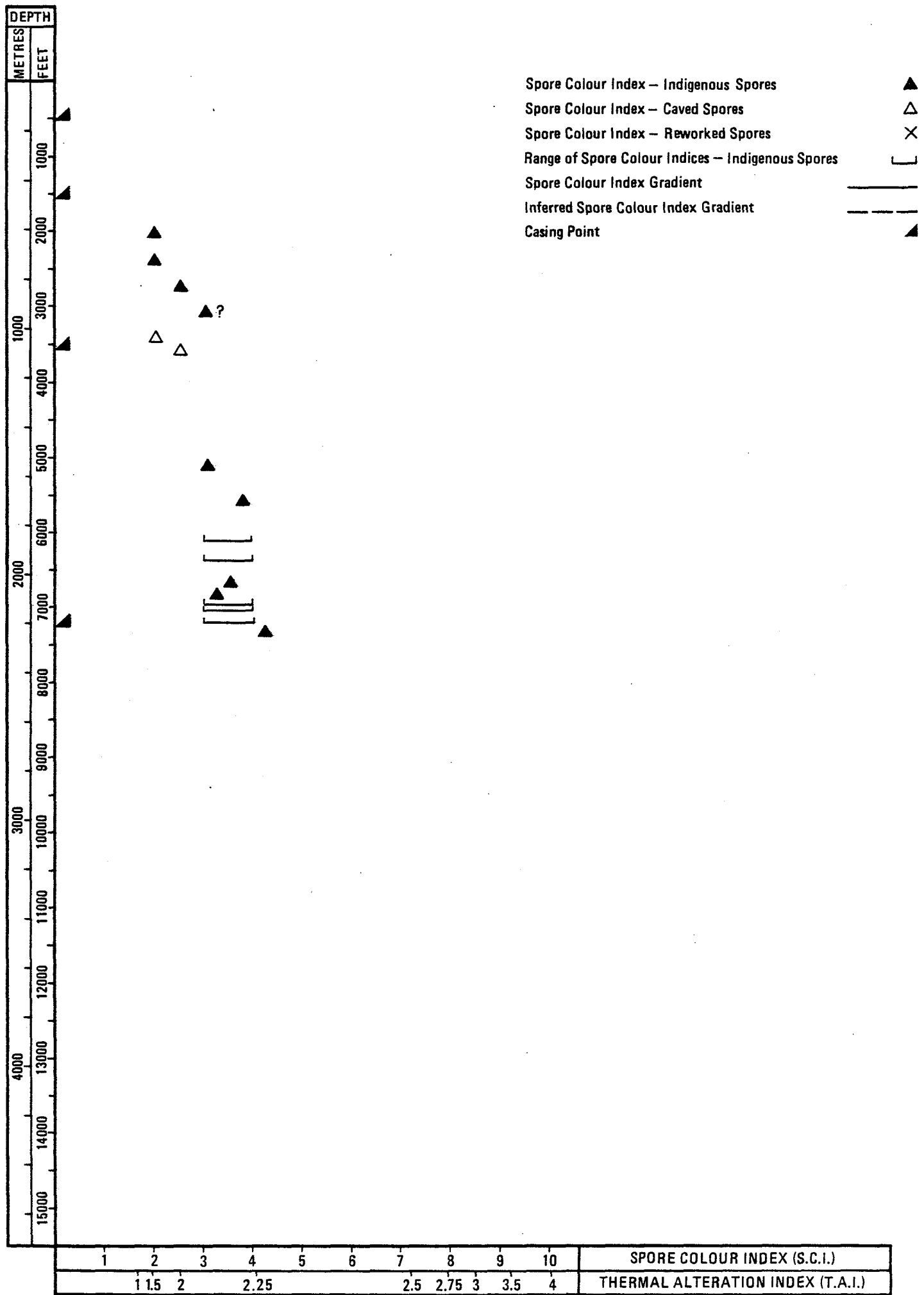


FIGURE 1 Spore Colour Indices against Depth

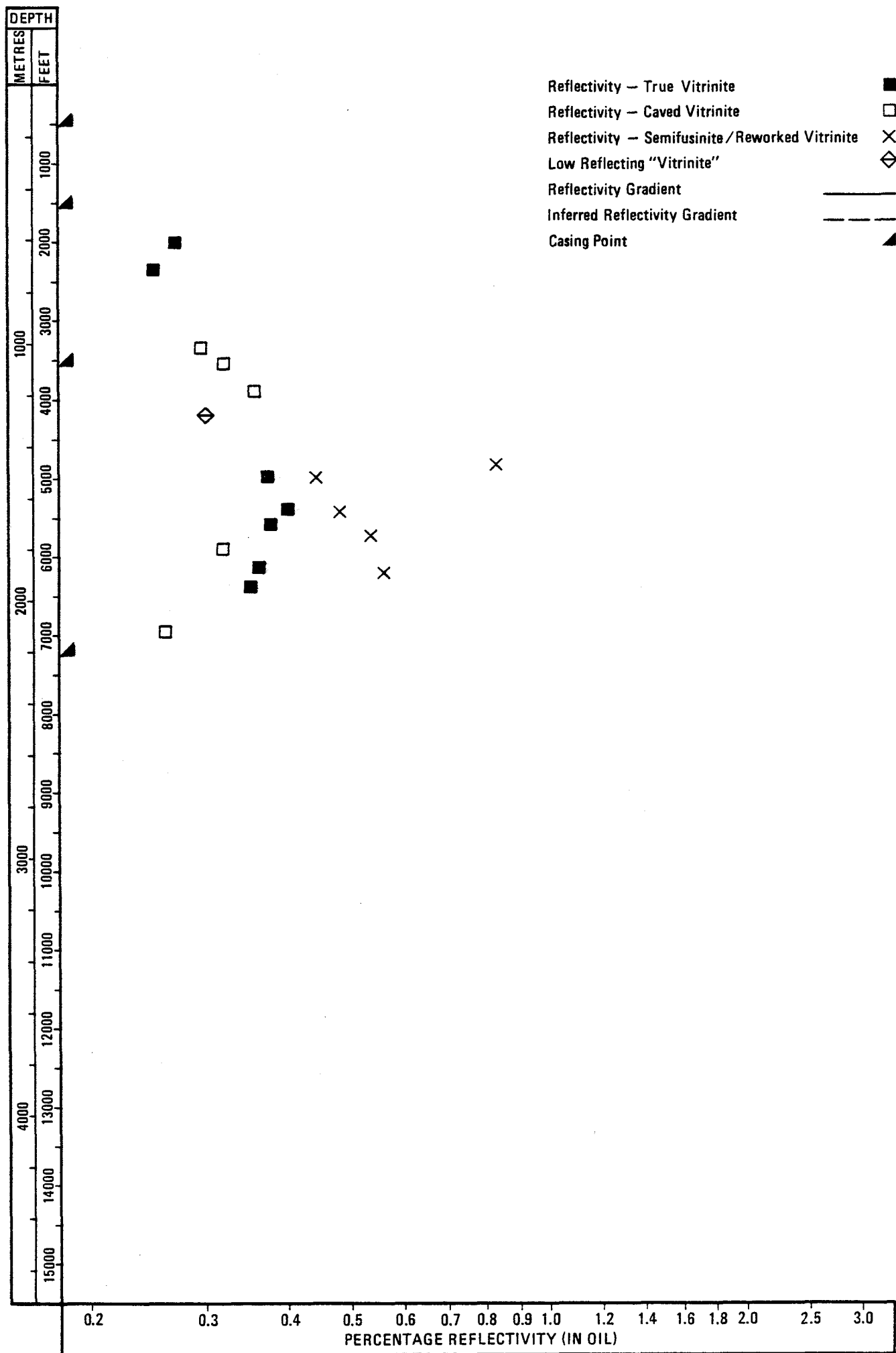


FIGURE 2 Vitrinite Reflectivity against Depth

ROBERTSON RESEARCH INTERNATIONAL LIMITED

Project No. RRPS/801/B/2043

NORWAY II STUDY - PRELIMINARY REPORT G4 (18/12/80)

PRELIMINARY PETROLEUM GEOCHEMISTRY RESULTS OF 18/11-1 WELL

SUMMARY

The analysed section, 1370m to 2055m, (Late - Middle Jurassic to Early Cretaceous) is early mature throughout, such that oil-prone kerogen may only generate very minor quantities of hydrocarbons. Possible oil source rocks have been identified in the early Volgian - Kimmeridgian interval between 1760m and 1805m, and have minor oil generating potential, being principally gas-prone. This interval probably includes the Børglum Member of the Bream Formation between 1742m and 1782m. There are no significant indications of migrated hydrocarbons within the analysed interval.

GENERAL COMMENTS

Well status: Plugged and abandoned, dry hole.

Drilling data: Casing points at 177m (30"), 373m (20"), 805m (13 $\frac{3}{8}$ "), 1805m (9 $\frac{5}{8}$ "). Drilled with FCL-LC drilling mud.

Interval analysed: 1370m to 2055m (T.D. 2082m).

Age of analysed interval: Middle Jurassic to Early Cretaceous (middle/early Barremian-Hauterivian).

Sample type and quality: 47 cuttings samples at between 10m and 20m intervals. Sample quality was fair but sample quantity was sometimes rather small.

Maturation data quality: Generally fair over the analysed interval.

Source rock data quality: Fair except where limited by sample size.

Gas chromatography run at: 1760m-1770m, 1790m-1805m, 1820m-1835m, 1970m.

MATURATION (Table 1; Figures 1 and 2)

Spore colour data indicate that the entire interval is early mature, indices increasing from a spore colour index of 4 at 1390m, to an interpreted spore colour index of 5 at 2045m. The vitrinite reflectivity data increase from 0.33% at 1390m, to 0.44% at 2045m, and thus show reasonable accord, although they are relatively low in the upper part of the analysed section. The spore colour index data indicate that approximately 600 metres of section may be missing (by erosion).

OIL SOURCE ROCKS (Tables 1 and 2)

The Late Jurassic section between 1760m and 1805m contains possible oil

source rocks. This section partly corresponds to the lower half of the shales with high gamma ray log response attributed to the Børglum Member of the Bream Formation (1742m to 1782m). The potential hydrocarbon yields of this section range from 2300 ppm (1790m-1805m, extracted sample) up to 6300 ppm (1760m-1770m unextracted sample), reflecting a fair source potential. However, kerogen composition analysis by both optical and chemical methods indicates a lack of sapropel, and a preponderance of humic kerogens throughout the whole of the analysed section, including the 1760m-1805m interval. The alkane gas chromatograms of the samples analysed from 1760m-1770m and 1790m-1805m show indigenous hydrocarbon distributions, with minor traces of contamination. Both hydrocarbon distributions show a significant long chain and polycyclic hydrocarbon component attributable to humic kerogens at an early stage of maturity.

GEOCHEMICAL CHARACTERISTICS OF THE REMAINING SEDIMENTS

The Late-Middle Jurassic sediments analysed between 1805m and 2055m have average to above average organic carbon content, but yield generally low quantities of hydrocarbons. This overall lack of oil or gas generating potential may be ascribed to the dominance of inertinitic kerogen within this interval.

The Late Jurassic to Early Cretaceous analysed section between 1370m and 1740m has poor potential yields, despite an average organic carbon content. Here again, the kerogen composition is dominated by inertinite.

SAMPLE DEPTH (METRES)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1 - 10)	VITRINITE REFLECTIVITY IN OIL, R _{av} %	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
1370	Ctgs.	CLYST, med-dk gy, silty						95	5	*	*
1390	"	A/a	4	0.33(9)	60	35	5	90	10	*	*
1400	"	A/a						90	10	*	*
1430	"	A/a						85	15	*	*
1440	"	A/a	4		60	40	mnr	90	10	*	*
1450	"	A/a						85	15	*	*
1470	"	A/a		0.34(6)				85	15	*	*
1480	"	A/a						80	20	*	*
1500	"	A/a						85	15	*	*
1510	"	A/a	4-4.5		20	60	20	85	15	*	*
1530	"	A/a						90	10	*	*
1545	"	A/a	4-4.5	0.33(4)	20	80	*	90	10	*	*
1560	"	A/a						95	5	*	*
1575	"	A/a						90	10	*	*
1590	"	A/a						90	10	*	*
1605	"	A/a	4-4.5		20	80	*	85	15	*	*
1620	"	A/a		0.31(12)				90	10	*	*
1635	"	A/a						80	20	*	*
1640	"	A/a						85	15	*	*
1660	"	A/a						70	30	*	*
1670	"	A/a						90	10	*	*
1675	"	A/a	4.5		20	80	*				
1685	"	A/a						90	10	*	*
1700	"	A/a	4.5	0.32(20)	60	35	5	90	10	*	*
1715	"	A/a						90	10	*	*
1730	"	A/a						85	15	*	*
1740	"	A/a						85	15	*	*
1760-770	"	CLYST, ol-blk+ 30% CLYST, brn- blk, mic						40	50	*	10
1770	"	A/a						35	60	*	5
1790	"	A/a	4.5	0.39(3)	40	60	*	50	50	*	*
1790-805	"	CLYST, a/a+30% CLYST, a/a+10% SND						80	20	*	*
1805	"	A/a						75	25	*	*
1820-835	"	SH, ol-blk, mic +30% SH, gn-blk, mic+mnr CMT						90	10	*	*
1835	"	SH, med-dk gy+ mnr SST, 1t gy	0.40(3)					80	20	*	*
1850	"	SH, a/a+10% SST, a/a	5-26		40	60	*	85	15	*	*

TABLE 1 A Maturity and Kerogen Data

SAMPLE DEPTH (METRES)	SAMPLE TYPE	GENERALISED LITHOLOGY	SPORE COLOUR INDEX (1-10)	VITRINITE REFLECTIVITY IN OIL, R av%	KEROGEN COMPOSITION (%) (by microscopic examination)			KEROGEN COMPOSITION (%) (by calculation from pyrolysis data)			
					INERTINITE	VITRINITE	SAPROPEL	INERTINITE	VITRINITE	ALGAL SAPROPEL	WAXY SAPROPEL
1865	Ctgs.	SH, med-dk gy+ mnr SST, lt gy						85	15	*	*
1880	"	SH, a/a+10% SST, a/a						60	40	*	*
1895	"	SH, a/a+30% SND, crs						70	30	*	*
1910	"	SH, a/a+40% SND, a/a	?5		70	30	*	70	30	*	*
1925	"	SH, a/a						70	30	*	*
1940-950	"	SH, a/a, mic+30% SH, dk gy, mic						65	35	*	*
1950	"	SH, med-dk gy						60	40	*	*
1970	"	SH, med-dk gy, mic+10% COAL+mnr SST	4-4.5	0.37(23)	60	40	*	85	15	*	*
1985	"	SND, a/a+mnr SH, dk gy						50	50	*	*
2000	"	SH, a/a+mnr SND, a/a						50	50	*	*
2015	"	SND, a/a+mnr SH, a/a	4-4.5	0.36(16)	30	70	*	60	40	*	*
2030	"	SND, a/a+30% SH, a/a						85	15	*	*
2045	"	SND, a/a+20% SH, a/a	4-4.5	0.44(4)	60	30	*	90	10	*	*
2055	"	SND, a/a+10% SH, a/a						60	40	*	*

TABLE 1 B Maturity and Kerogen Data

GENERAL DATA			CHEMICAL ANALYSIS DATA											
SAMPLE DEPTH (METRES)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS					SOLVENT EXTRACTION					
				TEMP. °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDRO-CARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDRO-CARBONS
				ERATURE °C								mg/g OF ORGANIC CARBON	% OF EXTRACT	
1370	Ctgs.	CLYST, med-dk gy, slty	1.61	425	10	105	0.12	200						
1390	"	A/a	2.06	428	26	74	0.09	500						
1400	"	A/a	1.69	425	23	78	0.15	400						
1430	"	A/a	1.39	429	37	128	0.12	500						
1440	"	A/a	1.16	*	26	127	0.11	300						
1450	"	A/a	0.92	428	30	167	0.22	300						
1470	"	A/a	1.38	428	34	124	0.06	500						
1480	"	A/a	1.37	429	45	107	0.1	600						
1500	"	A/a	1.17	433	28	113	0.13	300						
1510	"	A/a	1.19	*	28	115	0.13	300						
1530	"	A/a	1.17	432	20	113	0.15	200						
1545	"	A/a	1.17	430	26	100	0.12	300						
1560	"	A/a	2.14	431	15	51	0.07	300						
1575	"	A/a	1.43	431	20	103	*	300						
1590	"	A/a	1.82	*	16	81	0.06	300						
1605	"	A/a	1.36	433	40	102	*	500						
1602	"	A/a	1.90	433	24	73	*	500						
1635	"	A/a	1.72	434	45	93	0.05	800						
1640	"	A/a	1.74	431	41	86	0.04	700						
1660	"	A/a	1.65	429	63	132	0.05	1000						
1670	"	A/a	1.37	429	23	81	0.09	300						
1685	"	A/a	1.01	429	25	104	*	300						
1700	"	A/a	1.88	430	18	53	0.06	300						
1715	"	A/a	1.69	427	21	59	0.06	400						
1730	"	A/a	1.49	430	29	53	0.06	400						
1740	"	A/a	2.08	*	27	47	0.05	600						
1760	"	CLYST, ol-blk+CLYST, slty	3.58	431	172	33	0.02	6200						
1760-770	"	CLYST, ol-blk+30% CLYST, brn-blk, mic	4.35	431	144	27	0.03	6300	1000	240	2.3	5.5	24	72
		After Extraction	2.29	434	154	33	0.04	3500						
1770	"	A/a	3.59	433	147	36	0.01	5300						
1790	"	A/a	2.67	433	97	39	0.01	2600						
1790-805	"	A/a+10% SND	6.65	430	37	20	0.1	2500	1365	320	2.1	4.8	24	55
		After Extraction	5.34	432	43	23	0.1	2300						
1805	"	A/a	2.29	433	53	33	0.04	1200						
1820	"	SH, med-dk gy+mnr SST, lt gy	1.25	432	54	111	0.03	1400						

TABLE 2 A Chemical Analysis Data

GENERAL DATA			CHEMICAL ANALYSIS DATA											
SAMPLE DEPTH (METRES)	SAMPLE TYPE	ANALYSED LITHOLOGY	ORGANIC CARBON % OF ROCK	PYROLYSIS				SOLVENT EXTRACTION						
				TEMPERATURE °C	HYDROGEN INDEX	OXYGEN INDEX	PRODUCTION INDEX	POTENTIAL YIELD (ppm)	TOTAL EXTRACT (ppm)	HYDROCARBONS (ppm)	EXTRACT % OF ORGANIC CARBON	HYDROCARBONS		ALKANES % OF HYDROCARBONS
												mg/g OF ORGANIC CARBON	% OF EXTRACT	
1820-835	Ctgs.	SH, ol-blk, mic+30% SH, gn-blk, mic+mnr CMT	1.64	*	14	107	0.1	200	635	300	3.9	18.3	47	91
		After Extraction	0.92	433	23	221	0.2	200						
1835	"	SH, med-dk gy+mnr SST, a/a	1.31	*	44	101	0.04	1300						
1850	"	SH, a/a+10% SST, a/a	2.21	430	28	39	0.05	900						
1865	"	SH, a/a+mnr SST, a/a	2.05	434	29	70	0.06	1400						
1880	"	SH, a/a+10% SST, a/a	1.62	436	75	70	0.03	1200						
1895	"	SH, a/a+30% SND, crs	0.98	434	50	92	0.05	500						
1910	"	SH, a/a+40% SND, a/a	1.29	433	52	34	0.05	700						
1925	"	SH, a/a	3.53	*	52	52	0.05	1800						
1940	"	SH, a/a	3.47	429	61	39	0.05	2100						
1940-950	"	SH, a/a, mic+30% SH, dk gy, mic	3.00	432	9	90	0.1	300	545	60	1.8	2.0	11	87
		After Extraction	2.50	434	17	90	0.1	400						
1950	"	SH, med-dk gy	2.49	433	66	53	0.04	1600						
1970	"	SH, a/a+10% COAL+mnr SST	4.66	430	26	49	0.04	1200	2200	100	4.7	2.2	4	54
		After Extraction	3.53	432	33	67	0.04	1200						
1985	"	SND/SST+mnr SH, dk gy	1.31	434	87	35	0.04	1100						
2000	"	SH, med-dk gy, mic+mnr SND/SST	1.97	432	85	84	0.04	1700						
2015	"	SND/SST+mnr SH, med-dk gy	1.51	434	74	44	0.07	1100						
2030	"	SND/SST+30%SH, a/a	0.81	*	30	28	0.08	200						
2045	"	SND/SST+20% SH, a/a	0.82	429	22	30	0.10	200						
2055	"	SND/SST+10% SH, a/a	2.71	428	71	59	*	1900						

TABLE 2 B Chemical Analysis Data

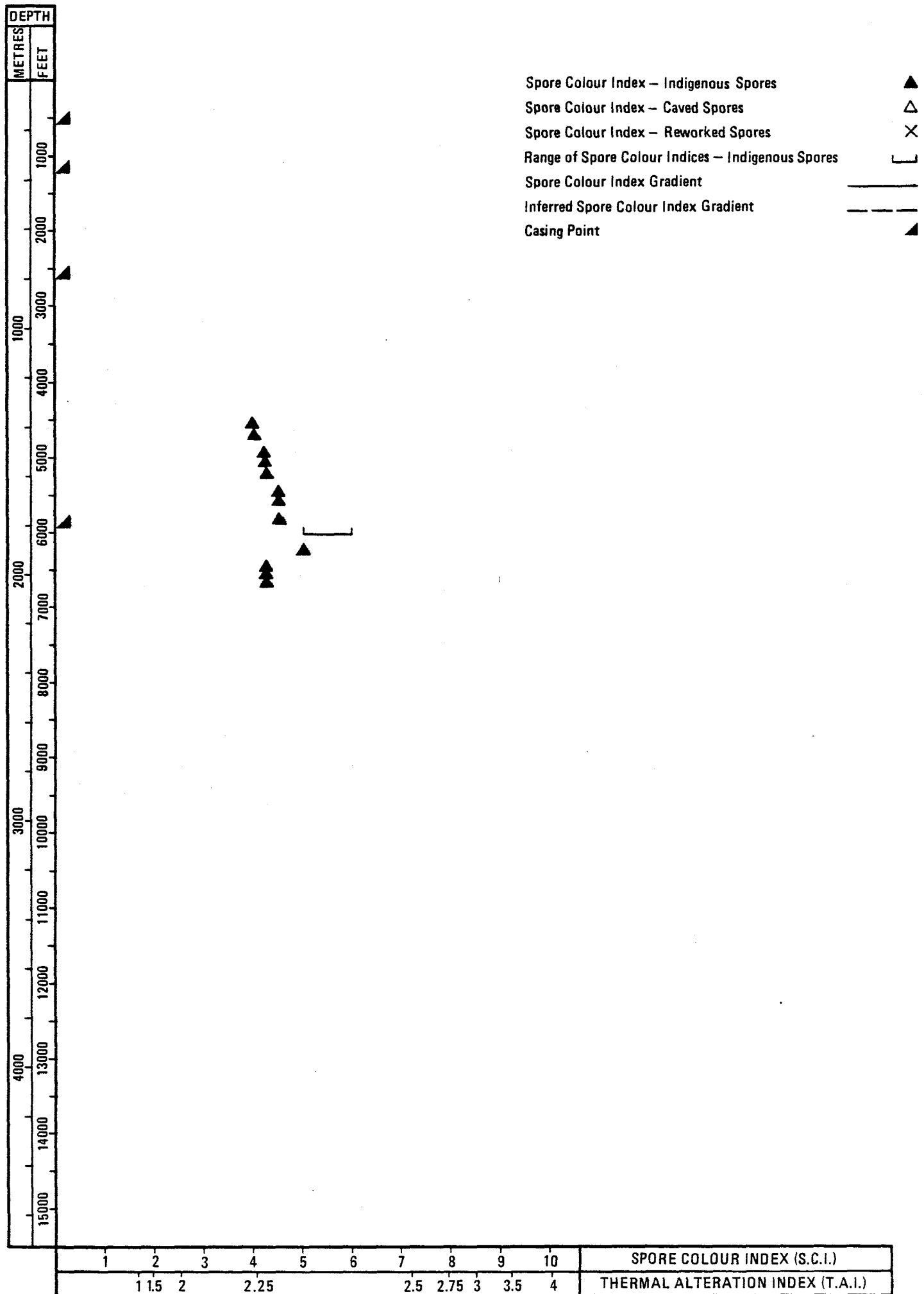


FIGURE 1 Spore Colour Indices against Depth

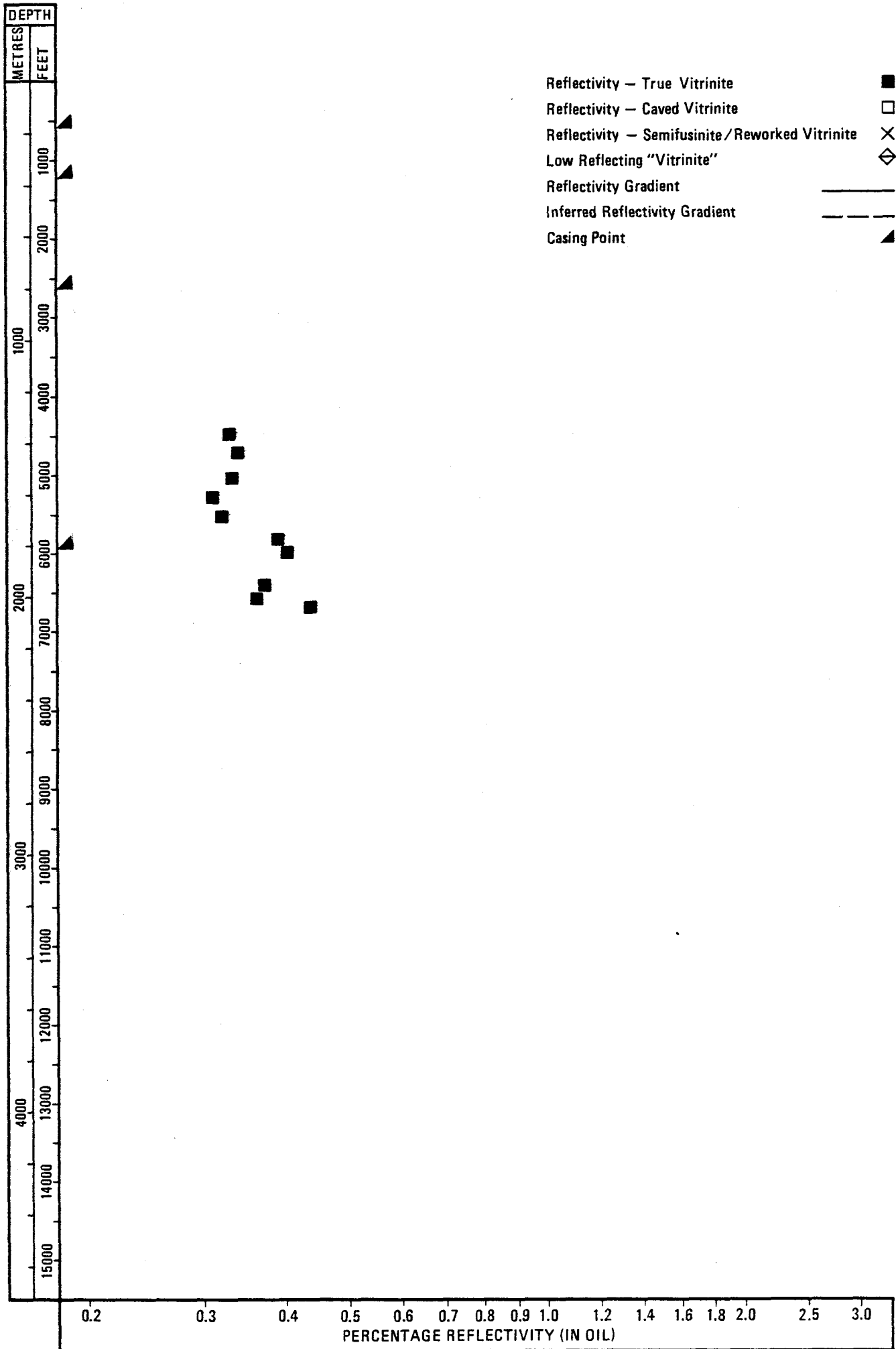


FIGURE 2 Vitrinite Reflectivity against Depth

ROBERTSON RESEARCH INTERNATIONAL LIMITED

NORWAY II STUDY - PRELIMINARY REPORTS B6 AND B7

Project No. RRPS/801/B/2043

PRELIMINARY BIOSTRATIGRAPHIC BREAKDOWNS

OF 25/12-1 AND UK 30/24-4 WELLS

DECEMBER 1980

ROBERTSON RESEARCH INTERNATIONAL LIMITED

Project No. RRPS/801/B/2043

NORWAY II STUDY - PRELIMINARY REPORT B6 (18/12/80)

PRELIMINARY BIOSTRATIGRAPHIC BREAKDOWN OF 25/12-1 WELL

		<u>Tops (in feet)</u>
Late Cretaceous	(Coniacian - Turonian	6140 (top not seen)
	(Turonian - Cenomanian	6158 (log)
	(Albian	6225 (log)
	(early Albian - Aptian	6790
	(early Aptian	6910
	(-----Unconformity-----	
Early Cretaceous -	(early Barremian	7040
Late Jurassic	(Hauterivian	7080
	(Valanginian - late Ryazanian c.	7140 (lith)
	(late Ryazanian	7175 (log)
	(early Ryazanian - late Volgian	7240
	(middle Volgian	7280
	-----Unconformity-----	
Late Jurassic	? Kimmeridgian - Oxfordian - Callovian	7363 (log)
? Middle Jurassic		7630 (log)
	-----Unconformity-----	
?Devonian		7957 (log) to 9400 T.D.

ROBERTSON RESEARCH INTERNATIONAL LIMITED

Project No. RRPS/801/B/2043

NORWAY II STUDY - PRELIMINARY REPORT B7 (18/12/80)

PRELIMINARY BIOSTRATIGRAPHIC BREAKDOWN OF UK 30/24-4 WELL

		<u>Tops (in feet)</u>
Late Cretaceous		9300 (top not seen)
-----Unconformity-----		
Early Cretaceous	Barremian - Neocomian	9415 (log)
-----Unconformity-----		
Late Jurassic	early Kimmeridgian - Oxfordian	9458 (log)
-----Unconformity-----		
? Triassic		9582 (log)
Late Permian	(Zechstein	9709 (log)
	(Kupferschiefer	9779 (log)
Permian	Rotliegendes	9783 (log) to 10084 T.D.