ROBERTSON RESEARCH INTERNATIONAL LIMITED

REPORT NO. 4121P

REPORT ON A GEOCHEMICAL EVALUATION OF THE 8/4 - 1 WELL NORWEGIAN NORTH SEA

by

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September, 1977

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SUMMARY

Maturation and source rock studies have been undertaken on ditch cuttings from the interval 450 to 2,640 metres in the Unionoil (Norway) 8/4-1 well, Norwegian North Sea.

Maturation evaluation has indicated that the zone of transitional maturity occurs between 1,410 and 2,280 metres in the Cretaceous section. Lower Cretaceous and Jurassic shales in the interval 2,280 to 2,430 metres are in the zone of early thermal maturity, and at present Jurassic shales between 2,340 and 2,430 metres are fair to good source rocks for heavy oil and gas. With increased depth of burial off-structure optimum maturity levels should be reached and the Jurassic shales would become good or very good oil sources.

I

INTRODUCTION

A geochemical study has been undertaken on the section between 300 and 2,640 metres on the Norwegian North Sea 8/4-1 well, on behalf of Unionoil, Norway. Maturation levels have been established using light hydrocarbon analysis spore colouration determinations and vitrinite reflectivity. Source rock potential has been evaluated by organic carbon determinations, followed by solvent extraction and chromatographic fractionation of the most promising samples.

Fresh unwashed ditch cuttings in sealed cans were available at 30 metre intervals between 300 and 2,130 metres, at 15 metre intervals between 2,130 and 2,460 metres, and at 30 metre intervals between 2,460 and 2,640 metres. All 89 samples were analysed for head space gases in the sample cans. Gaseous and gasoline range hydrocarbons were analysed for 20 samples. Organic carbon determinations were carried out on picked shales from all 89 samples and 28 source rock analyses were conducted on homogeneous samples at points of interest. Samples for vitrinite reflectivity analyses were selected at intervals of between 60 and 90 metres, a total of 39 samples being studied. Spore colouration data were established on 21 samples out of 32 taken through the well section.

The analysed section penetrates sediments of Tertiary, Cretaceous, Jurassic, Triassic and Upper Permian age as described in our biostratigraphic report currently being prepared.

II

RESULTS AND INTERPRETATION

A. MATURATION EVALUATION

1. Spore Colouration

The level of maturity in oil-prone organic matter in the analysed sediments has been assessed by a visual examination of the indigenous sporomorphs. The colouration of spores, with increasing thermal maturity, changes from pale yellow, through orange and brown, to black; spore colour indices used in this report are based on a scale of 1 to 10, with values of 3.0 to 3.5 representing the narrow zone of transition between immature and mature sediments.

Organic matter consists of two main elements, kerogens of a humic nature and those of a sapropelic nature. Humic organic matter comprises both the gas-prone 'vitrinite' and partly gas-prone 'inertinite' derived mostly from woody material. Sapropelic organic matter comprises the 'exinites' (spores, pollen and land-plant cuticle) and the 'liptinites' (algae, resins, amorphous sapropel), both of which are oil-prone; amorphous sapropel is by far the most important source of oil.

The spore colouration indices of the section are generally low, rising from 2 at the top of the analysed section, to 4 at 2,430 metres. These values fall within the expected range of values for the North Sea. Down to a depth of 2,100 metres the spore colouration indices increase gradually to 3, and then slightly more rapidly to T.D. This change in gradient occurs in the lower Cretaceous at approximately the base of the chalk and may indicate the onset of over pressuring, and thus increase in geothermal gradient, although the overall values are low.

The kerogen components of the shales are predominantly inertinitic down to 2,280 metres, but amorphous sapropel predominates in the shale interval between 2,380 and 2,430 metres. As only low levels of thermal maturity have

been reached towards the base of the well, the only present likely source rock is the sapropelic shale around 2,380 to 2,430 metres.

2. Vitrinite Reflectivity (Table 1, Figures 2 and 6)

The examination of vitrinite particles in shales is now a frequently used extension of coal rank studies. Vitrinite is not an important oil source and its maturation, unlike oil-prone organic matter, is strongly dependent on length of time of heating; however, it is the only reliable maturation indicator in the organically metamorphosed zone. Humic, gas-prone organic matter is considered to be transitionally mature over the reflectivity range 0.4% to 0.5%, but would not be expected to yield prolific gas until levels in excess of 0.8% to 1.0% have been reached. In an early Tertiary sequence, oil-prone organic matter would be expected to generate hydrocarbons at vitrinite reflectivities of 0.4% and above.

The vitrinite reflectivity values of the section are generally low, rising from 0.27% at 990 metres to 0.36% at the base of the well. These values fall within the expected range of values found in the North Sea. Over the first 2,000 metres of the well, the rise in vitrinite reflectivity is very gradual, but the rate of change increases slightly from 2,000 metres to T.D.

3. Light Hydrocarbons (Table 2, Figure 3)

The amount of head space gases in anomalously high (0.1%) in the upper part of the well section down to 1,470 metres. This may be due to either insufficient bacteriocide in the sealed cans or gas migration from an adjacent fault plane. The lack of wet gases in the head space gas over this interval makes the former more likely. However, the decrease in gas quantity around 1,620 metres correlates to the lithological change from mudstone to chalk. The proportion of wet gases in the head space gas increases from 1% at 1,140 metres to 20% at 2,310 metres with two maxima at 1,560 metres and 2,040 metres. The latter high point (30%) correlates to a band of dark brown shale within olive grey shales. Between 2,340 and 2,430 metres, a sharp increase and broad maximum is seen in gas content and proportion of wet gases, corresponding to the sapropelic shales in this

interval. The gas content decreases as sandstones and red beds are encountered while the proportion of wet gases continues to follow an upward trend with increasing depth.

Gaseous and gasoline range hydrocarbons in the cuttings samples are only present in trace amounts throughout all of the samples analysed. This probably relates to the generally low levels of thermal maturity throughout the section.

B. SOURCE ROCK EVALUATION

The results of source rock evaluation analysis are presented in Tables 3 and 4, and Figures 4, 5 and 6; they can be discussed as eight groups based on organic carbon, source rock and maturation data.

1. Interval 450 to 900 metres

This interval comprises mainly light olive grey mudstone with minor quantities of overlying superficial deposits. The organic carbon content of the rock varies between 0.5% and 2.37%,but is generally less than 1% and thus below average for argillaceous lithologies. Quantities of extractable hydrocarbon are also low, being less than 20 ppm in all but one of the samples examined. Although the organic carbon contents of some of these mudstones are fairly high, there is no source potential because of low levels of thermal maturity.

2. Interval 900 to 1,620 metres

This interval comprises a mixed lithology of light olive-grey mudstone with medium dark grey shales and mudstones. It is possible that some of the light olive-grey mudstone is caved. The organic contents vary between 0.45% and 3.77%, with a mean value of 1.6% which compares well with values for a worldwide average shale. The concentration of hydrocarbons in the rock is generally 20 ppm, but rises to 55 ppm between 1,320 and 1,380 metres, which correlates to a layer of brownish grey shale. At present this interval is immature and has no hydrocarbon generating potential; at optimum levels of thermal maturity these mudstones may represent good hydrocarbon source rocks.

3. Interval 1,620 to 2,130 metres

This interval comprises chalk with intercalations of light grey shale.

The organic carbon content of the chalk is between 0.15% and 0.25%, and of the light grey shale 0.4% to 0.8%. The shale contains low amounts (130 ppm at 2,130 metres) of organic extract, and very low concentrations of hydrocarbons. There is considered to be no significant hydrocarbon generating potential in the shales even at higher levels of thermal maturity.

4. Interval 2,130 to 2,280 metres

This interval comprises light olive grey shale with minor quantities of greyish red shale and caved chalk. The organic carbon content averages 0.45%. Although the extract contents of the shale reaches 690 ppm in places (2,220 metres) the hydrocarbon concentrations are low, being 20 ppm in all of the samples examined. The section is considered to have no significant hydrocarbon generating potential.

5. Interval 2,280 to 2,340 metres

This interval comprises dark greenish grey shale with varying amounts of greyish red shale. The organic carbon content of the dark greenish shale is 0.4%, and of red shale (picked from 2,325 metre sample) 0.15%. The organic extract concentration in the dark greenish grey shale is 725 ppm, and the concentration of hydrocarbons 45 ppm. Thus, although the organic carbon content is low, the proportion of extractable organic matter is fairly high, at 17%. At present these sediments are marginally mature and have little source potential; this would not be expected to increase significantly with increased thermal maturity.

6. Interval 2,340 to 2,430 metres

This interval comprises mainly dark grey shale, with organic carbon contents varying between 4% and 11%. The extractability of the shale is between 4,330 ppm and 4,585 ppm and the hydrocarbon concentrations between 768 ppm and 860 ppm. Presently the interval is a fair to good source rock for heavy oil, but it is only in the early stages of maturity and oil generation. It is probable that with greater depth of burial off-structure this would become a good or very good source rock.

7. Interval 2,430 to 2,580 metres

This interval comprises coarse sandstones with occasional coaly fragments. Also present in the cuttings are fragments of light olive-grey, grey and grey-red shale, but is possible that some of these shales are caved. The organic carbon content of the mixed lithology is less than 0.5%, but separated shale samples contained up to 5.4% organic carbon (2,490 metres). The organic material in the sandstones is mainly humic, but overall is present only in minor quantities, therefore it is unlikely to be a good gas source, especially at its present low level of thermal maturity.

8. Interval 2,580 to 2,640 metres (T.D.)

The lithology of this interval comprises Permo-Triassic reddish grey shales and anhydrite; organic carbon contents in the shales are low and do not suggest any significant source rock potential.

III

CONCLUSIONS

Maturation analysis has indicated that the zone of transitional maturity is reached at around 1,410 metres depth and a stage of early thermal maturity is reached from 2,280 metres to T.D. Overall the level of thermal maturity in this well is low such that oil prone organic matter is capable of generating oil of low API gravity.

Source rock, organic carbon and maturation data have been used to divide the well into eight groups, which correspond to lithological divisions. Mostly gas prone, but very immature sediments occur down to 1,400 metres. Early maturity is reached below 2,280 metres, but the only likely source rocks for oil are the sapropelic shales between 2,340 and 2,430 metres. These shales have a fair oil potential, which could improve to good oil potential off-structure at greater depths. Below these shales, there is some gas prone kerogen in sandstone, but this is not present in any significant amounts. The Permo-Triassic beds at the base of the well are barren.

TABLE 1

MATURATION EVALUATION DATA

COMPANY: UNIONOIL NORWAY WELL: 8/4-1 LOCATION: NORWEGIAN NORTH SEA

SAMPLE DEPTH (METRES) OR NOTATION	SAMPLE TYPE	GENERALISED LITHOLOGY	MAXIMUM PALAEOTEMP-ERATURE °F	VITRINITE REFLECTIVITY %	SPORE COLOURATION (1-10)	LIGHT HYDROCARBONS
6. 450	Ctgs	SST	-	-	2	
9. 540	"	MDST	-	-	2-2.5	
11. 600	"	"	-	-	2.5	
13. 660	"	"	-	-	3.5 (?)	
15. 720	"	"	-	-	2.5	
22. 930	"	SH	-	-	-	
24. 990	"	"	-	0.27 (5)	2.5	
27. 1080	"	MDST	-	-	3	
30. 1170	"	"	-	0.27(10)	-	Immature
32. 1230	"	"	-	0.27(8)	2.5	
34. 1290	"	"	-	0.27(18)	-	
36. 1350	"	"	-	0.29(10)	-	
39. 1440	"	"	-	0.29(13)	2.5	----------
42. 1530	"	"	-	0.27(5)	-	
45. 1620	"	"	-	0.26(12)	3	
48. 1710	"	CHK	-	0.30(6)	3	
52. 1830	"	"	-	0.30(7)	3	
57. 1980	"	"	-	0.29(5)	3	Transitional
61. 2100	"	"	-	0.31(6)	3-3.5	Maturity
65. 2175	"	SH	-	-	3.5	
67. 2220	"	"	-	0.32(3)	3.5	
71. 2280	"	"	-	0.28(3)	3.5	----------
73. 2310	"	"	-	-	3.5-4	
74. 2325	"	"	-	0.32(21)	-	
76. 2355	"	"	-	0.31(7)	3.5	
77. 2370	"	"	-	-	-	Early maturity
79. 2400	"	"	-	0.35(5)	4	
81. 2430	"	"	-	0.37(37)	4	
83. 2460	"	SST	-	0.34(2)	-	
88. 2610	"	SH, Anhydrite	-	0.36(2)	-	

Figures in brackets (reflectivity column) indicate no. of measurements

TABLE 2

HEADSPACE GAS ANALYSIS DATA

COMPANY: UNIONOIL NORWAY WELL: 8/4-1 LOCATION: NORTH SEA

SAMPLED DEPTH (METRES)	TOTAL C_1-C_4 GAS (% v/v)	PERCENT C_1	PERCENT C_2	PERCENT C_3	PERCENT iso C_4	PERCENT n-C_4
300	0.1964	99.57	tr	0.05	0.02	0.36
330	0.4747	99.77	0.19	0.11	0.01	0.02
360	1.6388	99.99	tr	tr	tr	tr
390	2.6477	99.59	0.40	0.05	tr	0.05
420	0.9217	99.99	tr	0.01	tr	tr
450	0.3344	99.58	0.45	0.02	tr	tr
480	0.6059	99.72	0.25	0.02	tr	0.01
510	0.7517	99.44	0.52	0.03	tr	0.01
540	0.6210	99.77	0.19	0.03	tr	tr
570	0.3797	99.80	0.13	0.05	0.01	0.01
600	1.5395	99.77	0.19	0.03	tr	0.01
630	0.5482	99.00	0.89	0.08	0.01	0.02
660	0.9574	99.47	0.46	0.05	0.01	0.01
690	0.7045	99.56	0.34	0.07	0.01	0.01
720	0.5386	99.82	0.07	0.07	0.01	0.02
750	1.2042	99.92	0.02	0.02	0.02	0.03
780	1.6445	99.63	0.18	0.13	0.04	0.02
810	2.0054	99.57	0.19	0.17	0.05	0.02
840	2.2632	99.54	0.20	0.18	0.05	0.03
870	2.8837	99.43	0.25	0.22	0.06	0.03
900	1.4405	99.52	0.22	0.18	0.05	0.03
930	0.6801	99.37	0.25	0.25	0.09	0.04
960	0.5571	99.26	0.27	0.31	0.11	0.05
990	0.4120	99.42	0.17	0.27	0.09	0.05
1020		CAN NOT SEALED GAS LOST IN TRANSIT				
1050	0.2995	99.16	0.30	0.33	0.14	0.07
1080	0.2529	99.20	0.24	0.32	0.16	0.08
1110	0.2735	99.23	0.29	0.29	0.12	0.07
1140	0.5277	98.96	0.36	0.45	0.15	0.08
1170	0.3677	98.86	0.38	0.49	0.19	0.08
1200	0.3474	98.73	0.35	0.83	0.06	0.03
1230	0.8982	99.19	0.29	0.35	0.11	0.06
1260	0.8875	99.22	0.27	0.35	0.09	0.07
1290	0.7297	98.93	0.47	0.38	0.16	0.05
1320	0.5760	98.66	0.43	0.73	0.08	0.10
1350	1.4735	98.68	0.53	0.60	0.12	0.07
1380	1.0195	98.43	0.71	0.67	0.13	0.07
1410	0.6160	98.08	0.88	0.78	0.16	0.10
1440		NO GAS SAMPLED - ALL MUD EXPELLED				
1470	0.1872	98.45	0.80	0.48	0.16	0.11
1500	0.0843	97.15	1.42	0.83	0.36	0.24
1530	0.1070	98.13	0.93	0.56	0.19	0.19
1560	0.0109	82.57	8.26	5.50	1.83	1.83
1590	0.1103	97.46	1.36	0.73	0.27	0.18

TABLE 2 (Cont'd.)

HEADSPACE GAS ANALYSIS DATA

COMPANY: UNIONOIL NORWAY WELL: 8/4-1 LOCATION: NORTH SEA

SAMPLED DEPTH (METRES)	TOTAL C_1-C_4 GAS (% v/v)	PERCENT C_1	PERCENT C_2	PERCENT C_3	PERCENT iso C_4	PERCENT n-C_4	
1620	0.0839	97.62	1.43	0.59	0.24	0.12	
1650	0.0267	95.88	1.87	1.50	0.37	0.37	
1680	0.0345	97.10	1.45	0.87	0.29	0.29	
1710	0.0429	96.50	1.40	1.17	0.47	0.47	
1740	0.0147	97.15	1.36	0.68	0.41	0.41	
1770	0.0070	95.85	1.43	1.43	0.57	0.72	
1800	0.0105	96.77	0.95	0.95	0.57	0.76	
1830	0.0038	92.11	2.63	2.63	1.32	1.32	
1860	0.0055	94.89	1.82	1.82	0.73	0.73	
1890	0.0057	95.58	1.77	1.06	0.53	1.06	
1920	0.0041	96.62	1.21	0.72	0.48	0.97	
1950	0.0030	93.65	2.01	1.67	1.00	1.67	
1980	0.0038	93.99	2.61	1.57	0.78	1.04	
2010	0.0013	93.02	3.88	3.10	tr	tr	
2040	0.0018	68.57	17.14	2.28	0.57	11.43	
2070	0.0025	89.43	4.07	2.85	1.22	2.44	
2100	0.0011	85.72	4.76	4.76	1.90	2.86	
2130	0.0071	90.40	2.82	4.24	1.13	1.41	9.6
2145	0.0056	92.53	3.56	0.89	1.25	1.78	
2160	0.0040	88.38	2.53	5.05	1.52	2.53	
2175	0.0040	88.38	2.53	5.05	1.52	2.53	11.6
2190	0.0038	91.86	2.62	2.62	1.06	1.84	
2220	0.0036	66.67	8.33	13.89	5.56	5.56	
2235	0.0078	89.74	2.56	5.13	1.28	1.28	
2250	0.0043	79.07	4.65	9.30	2.33	4.65	21.
2265	0.0077	64.94	5.19	15.58	5.19	9.09	
2280	0.0064	70.31	4.69	12.50	4.69	7.81	30
2295	0.0044	75.00	4.55	11.36	2.27	6.82	
2310	0.0033	79.27	3.05	9.15	2.44	6.10	
2325	0.0017	72.29	6.02	12.05	3.61	6.02	27.7
2340	0.0078	89.74	2.56	3.85	1.28	2.56	
2355	0.0569	20.91	10.72	38.66	10.72	18.98	79
2370	0.1614	14.50	10.03	38.72	11.34	25.40	
2385	0.2016	17.26	10.96	39.58	9.23	22.96	87.7
2400	0.1546	26.52	12.74	36.68	8.02	16.04	
2415	0.0983	24.02	11.60	31.74	15.16	17.48	
2430	0.4343	36.31	12.87	22.98	8.98	18.86	64
2445	0.3271	42.25	15.26	26.75	5.35	10.39	
2460	0.1062	32.30	14.69	31.64	6.87	14.50	68
2490	0.0575	24.70	14.43	35.48	8.00	17.39	
2520	0.0397	24.18	13.85	35.77	7.81	18.39	
2550	0.0401	13.47	14.96	40.40	9.48	21.70	86.5
2580	0.0352	15.91	14.20	40.34	8.81	20.74	
2610	0.0151	8.61	7.28	40.40	12.58	31.13	
2640	0.0058	15.52	6.90	37.93	12.07	27.59	

TABLE 3

ORGANIC CARBON DATA

COMPANY: UNIONOIL NORWAY WELL: 8/4-1 LOCATION: NORTH SEA

SAMPLE DEPTH (METRES)	ORGANIC CARBON % OF ROCK	SAMPLE DEPTH (METRES)	ORGANIC CARBON % OF ROCK
6. 450	0.36	48. 1710	0.53
7. 480	0.48	49. 1740	0.19
8. 510	0.64	50. 1770	0.39
9. 540	0.64	51. 1800	0.44
10. 570	0.72	52. 1830	1.18
11. 600	0.71	53. 1860	0.72
12. 630	0.85	54. 1890	0.72
13. 660	0.92	55. 1920	0.82
14. 690	1.82	56. 1950	0.72
15. 720	0.99	57. 1980	0.13
16. 750	0.50	58. 2010	0.25
17. 780	1.04	59. 2040	0.15
18. 810	1.88	60. 2070	2.10
19. 840	0	61. 2100	0.19
20. 870	2.37	62. 2130	0.24
21. 900	0.71	63. 2145	0.54
22. 930	1.25	64. 2160	0.46
23. 960	2.25	65. 2175	0.26
24. 990	1.03	66. 2190	0.53
25. 1020	1.13	67. 2220	0.38
26. 1050	2.59	68. 2235	0.54
27. 1080	1.24	69. 2250	0.51
28. 1110	1.62	70. 2265	0.33
29. 1140	2.10	71. 2280	0.43
30. 1170	1.13	72. 2295	0.40
31. 1200	1.22	73. 2310	0.33
32. 1230	1.88	74. 2325	0.15
33. 1260	2.12	75. 2340	0.40
34. 1290	2.74	76. 2355	0.44
35. 1320	3.77	77. 2370	3.88
36. 1350	2.40	78. 2385	3.51
37. 1380	2.85	79. 2400	3.36
38. 1410	1.82	80. 2415	7.50
39. 1440	1.61	81. 2430	11.70
40. 1470	0.74	82. 2445	1.44
41. 1500	0.95	83. 2460	0.46
42. 1530	0.62	84. 2490	5.42
43. 1560	0.45	85. 2520	0.38
44. 1590	0.73	86. 2550	5.74
45. 1620	0.62	87. 2580	3.97
46. 1650	0.65	88. 2610	0.42
47. 1680	0.69	89. 2640	1.18

TABLE 4

SOURCE ROCK EVALUATION DATA

COMPANY: UNIONOIL NORWAY WELL: 8/4-1 LOCATION: 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
6. 450-480	Ctgs	Sandy SLTST	0.36	185	5.1	<20	*	*
8. 510-540	"	Lt ol-gy SH and MDST	0.64	290	4.5	<20	*	*
10. 570-600	"	"	0.72	535	7.4	<20	*	*
12. 630-660	"	"	0.85	435	5.1	<20	*	*
14. 690-720	"	"	1.82	500	2.7	35	7	46
16. 750-780	"	"	0.50	300	6.0	<20	*	*
18. 810-840	"	"	1.88	560	3.0	<20	*	*
20. 870-900	"	"	2.37	820	3.4	<20	*	*
23. 960-990	"	Med-dk gy MDST/SH & lt ol-gy MDST	2.25	360	1.6	25	7	>95
26.1050-1080	"	"	2.59	220	0.8	<20	*	*
29.1140-1170	"	"	2.10	480	2.3	30	6	>95
31.1200-1230	"	"	1.22	700	5.7	35	5	57
33.1260-1290	"	"	2.12	720	3.4	<20	2	68
35.1320-1350	"	Br-gy SH and lt ol MDST	3.77	1005	2.7	55	5	61
37.1380-1410	"	Med dk gy MDST/SH and lt ol gy MDST	2.85	1045	3.7	55	5	71
40.1470-1500	"	Lt ol gy SH and MDST	0.74	275	3.7	<20	*	*
41.1500-1530	"	"	0.95	220	2.3	<20	*	*
43.1560-1590	"	"	0.45	105	2.3	<20	*	*
45.1620-1650	"	"	0.62	155	2.5	<20	*	*
59.2040-2070	"	CHK	0.15	75	5.0	<20	*	*
62.2130-2145	"	CHK and sandy SLTST	0.24	130	5.4	<20	*	*

TABLE 4 (Cont'd.)

SOURCE ROCK EVALUATION DATA

COMPANY: UNIONOIL NORWAY WELL: 8/4-1 LOCATION: 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
64. 2160-2175	Ctgs	Gy-gn and gy-red SH	0.46	90	2.1	<20	*	*
67. 2220-2235	"	"	0.38	690	18.1	<20	*	*
70. 2265-2280	"	"	0.33	260	7.9	<20	*	*
72. 2295-2310	"	Dk gy-gn and gy-red	0.40	720	18.0	35	5	31
76. 2355-2370	"	"	0.44	730	16.6	35	5	58
78. 2385-2400	"	Dk gy SH	3.51	4330	12.3	768	17	46
79. 2400-2415	"	"	3.36	4585	13.6	860	19	55

FIGURE 1

SPORE COLOURATION INDICES AGAINST DEPTH

COMPANY : UNIONOIL NORWAY WELL : 8/4-1 LOCATION : NORWEGIAN NORTH SEA

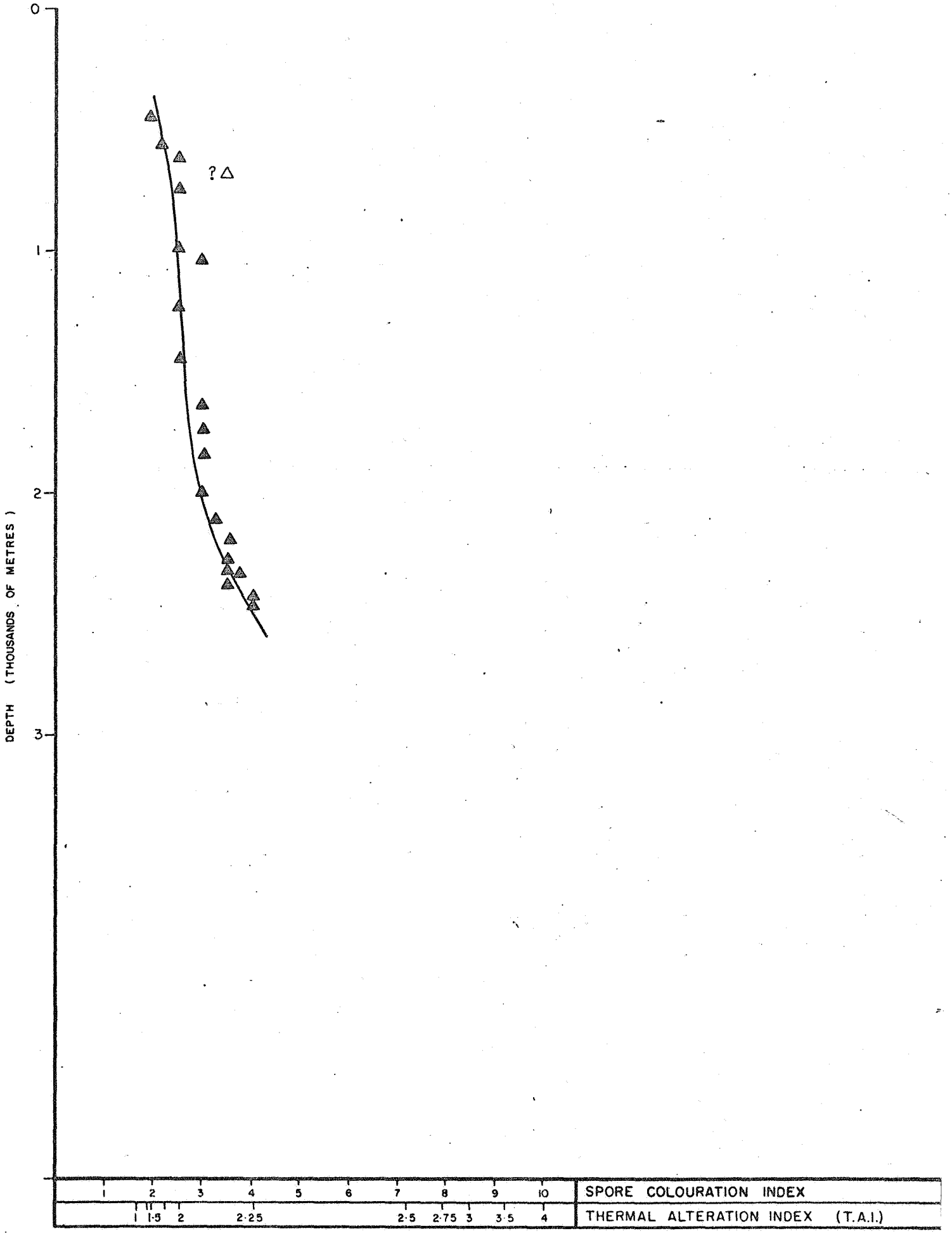


FIGURE 2

VITRINITE REFLECTIVITY AGAINST DEPTH

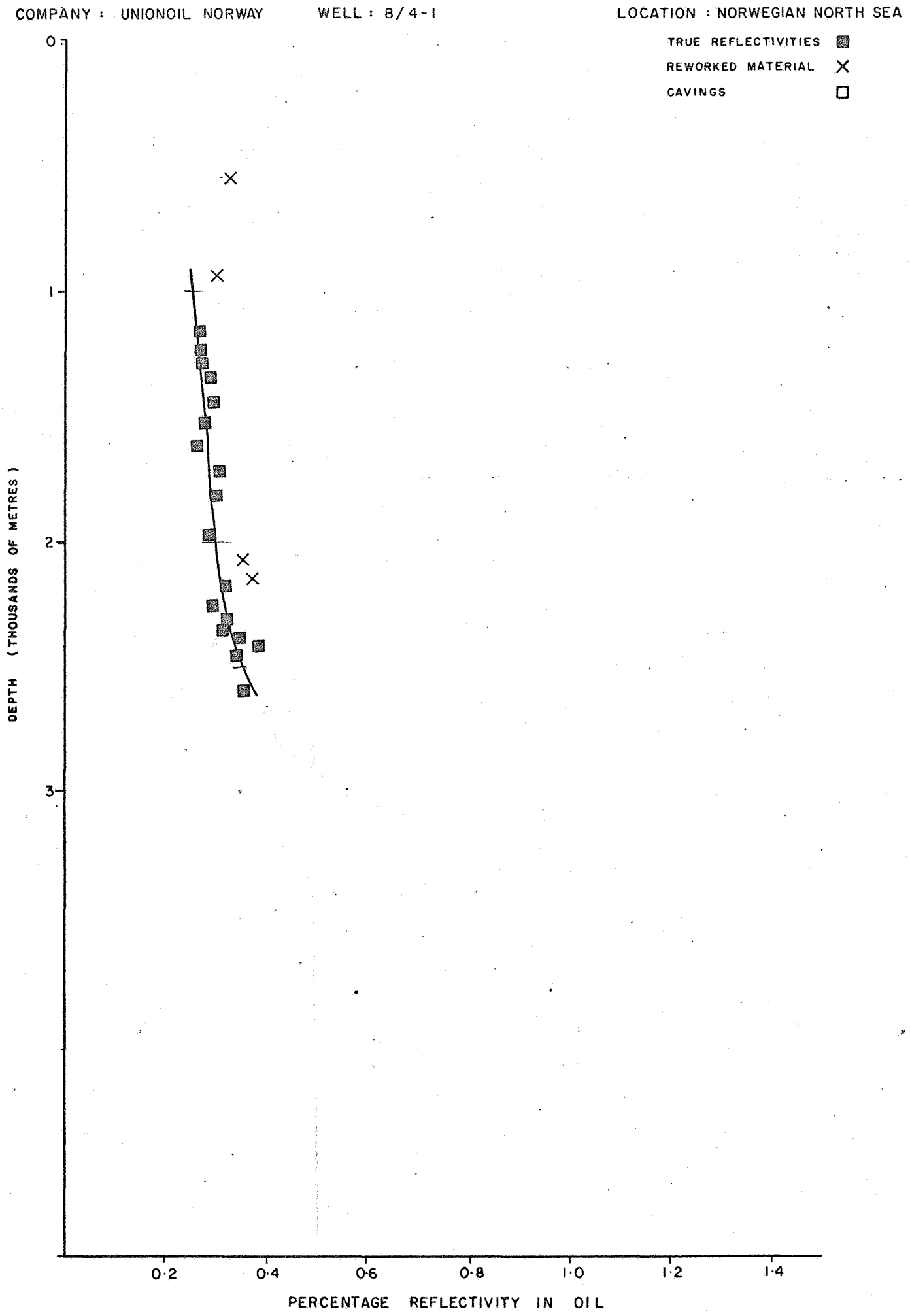


FIGURE 3

AIRSPACE GASEOUS ($C_1 - C_4$) HYDROCARBONS

COMPANY : UNIONOIL NORWAY WELL : 8/4-1 LOCATION : NORWEGIAN NORTH SEA

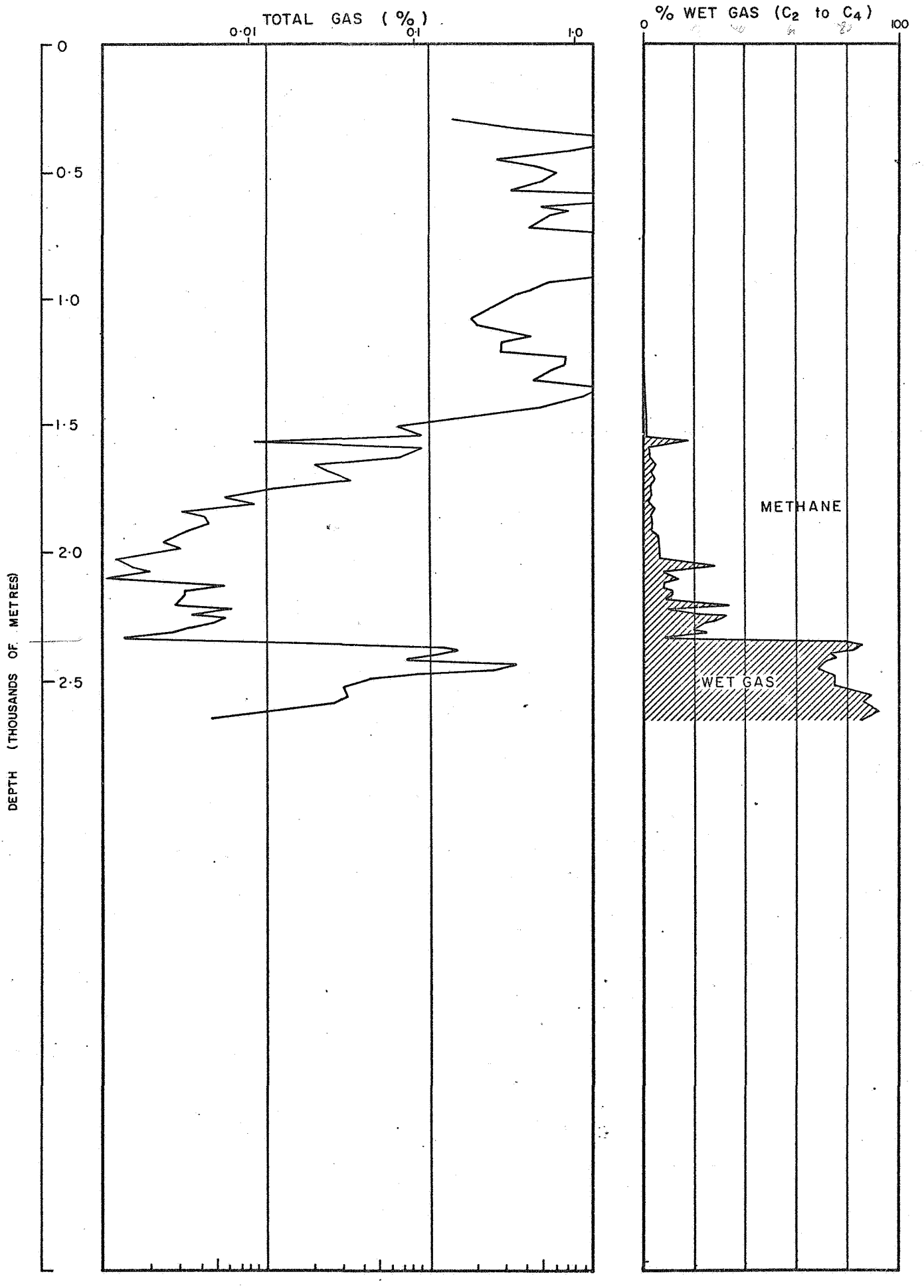


FIGURE 4

MATURE SOURCE ROCK RICHNESS

COMPANY : UNIONOIL NORWAY WELL : 8/4-1 LOCATION : NORWEGIAN NORTH SEA

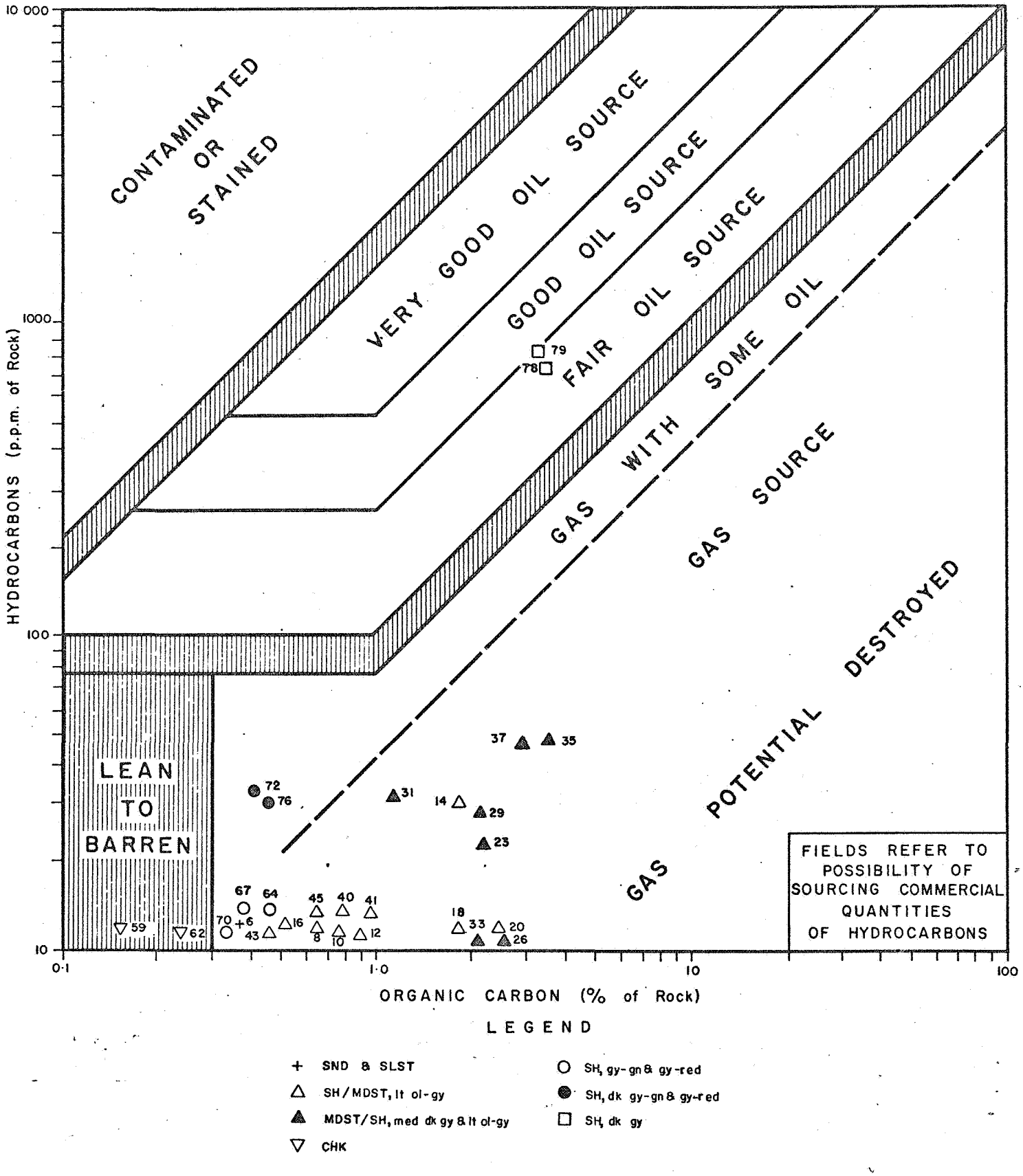
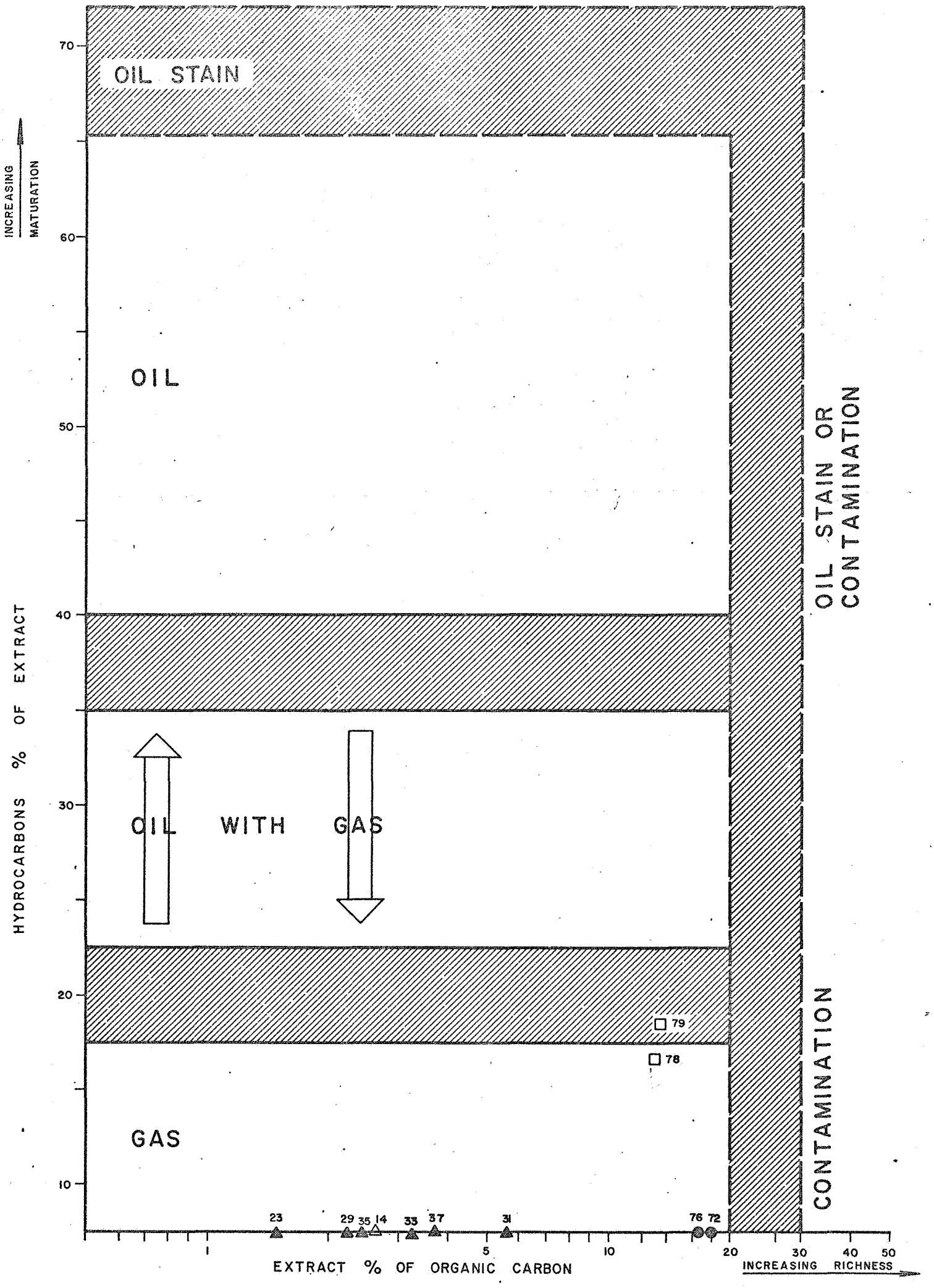


FIGURE 5

TYPE OF HYDROCARBON PRODUCT FROM SOURCE ROCKS

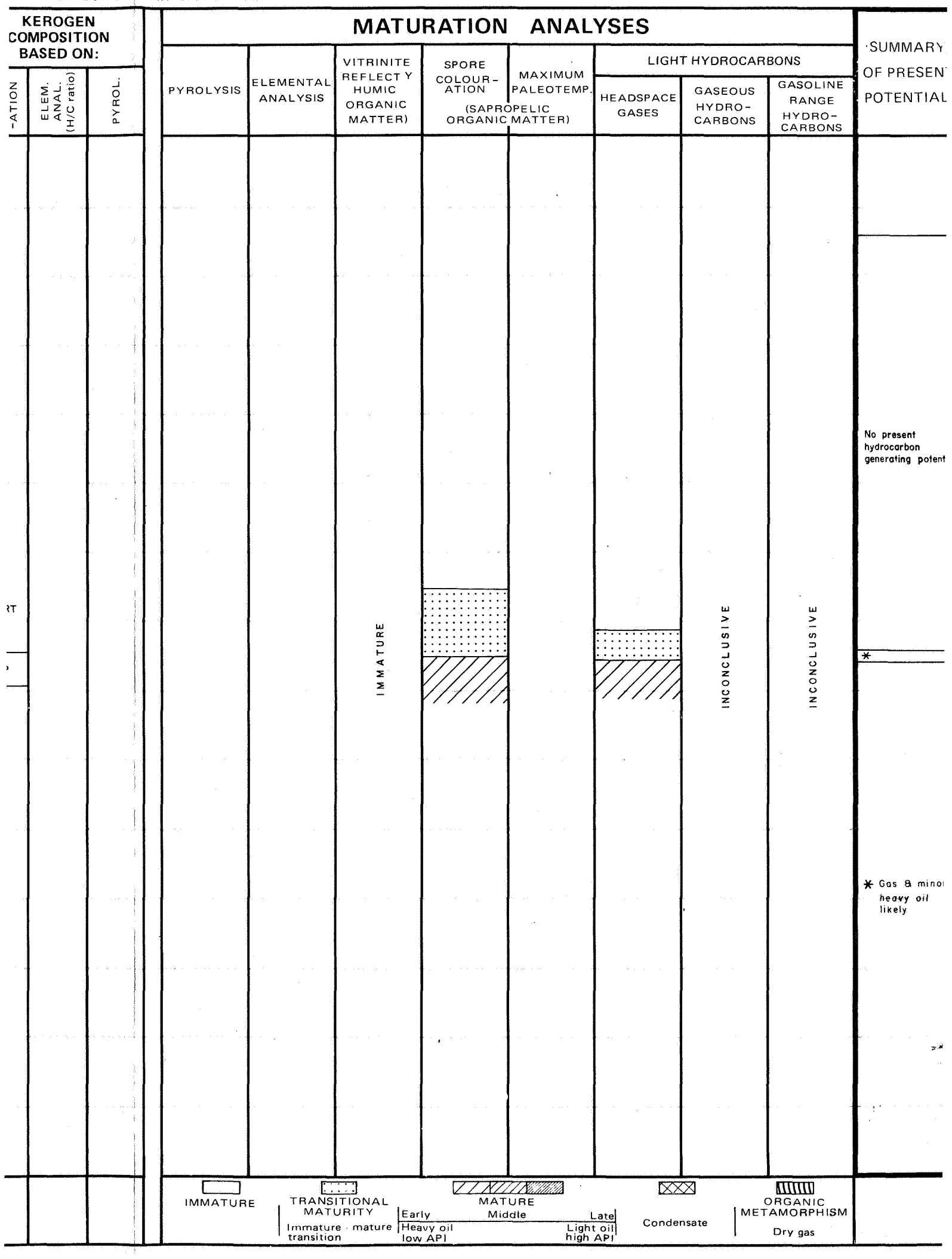
COMPANY : UNIONOIL NORWAY WELL : 8/4-1 LOCATION : NORWEGIAN NORTH SEA



RT

FIGURE 6

CATION: NORWEGIAN NORTH SEA



GEOCHEMICAL DATA SUMMARY CHART

RGE WELL: 8/4 – 1 LOCATION: NORWEGIAN

ANALYSES

EXTRACT % OF ORGANIC CARBON

1 2.5 5 10 20 30 50

HYDRO-CARBONS % OF EXTRACT

LIKELY PRODUCT

20 40 70

SYMBOL

RATIO OF HC to OC

OIL RICHNESS

Poor Fair Good V. Good Stain

PROSPECTIVE SECTIONS

No present potential; minor hydro-carbons possible at optimum maturity.

No present potential; may become good hydrocarbon source at optimum maturity.

No source rock potential in chalk or shales.

No source rock potential.

*

No hydro-carbon gener-ating potential at any level of maturity

* Fair source for gas & heavy oil at present; good to very good at optimum maturity

SAMPLE DEPTH (TOPS) AND NUMBERS

450	6
510	8
570	10
630	12
690	14
750	16
810	18
870	20
960	23
1050	26
1140	29
1200	31
1260	33
1320	35
1380	37
1470	40
1500	41
1560	43
1620	45
2040	59
2130	62
2160	64
2220	67
2265	70
2295	72
2355	76
2385	78
2400	79

KEROGEN COMPOSITION BASED ON:

VISUAL EXAMIN-ATION

ELEM. ANAL. (H/C ratio)

PYROL.

INERT

SAP

Gas - prone ⟷ Oil - prone

Contamin.

Gas

Oil & Gas

Oil

Stain

Good gas source *

Conv. Core

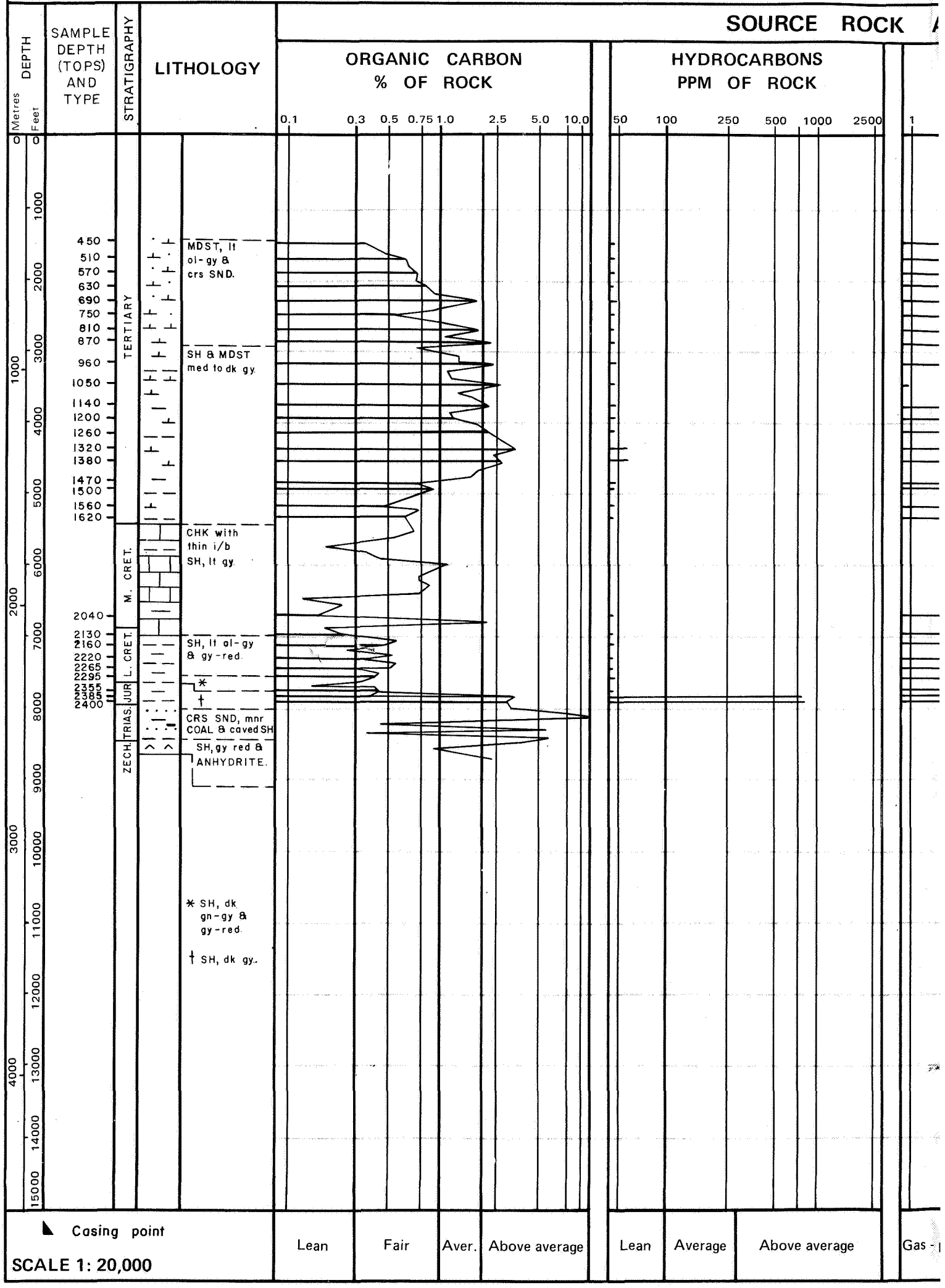
S W C

Ditch ctgs

Drawing No. 121P/2546/3933

COMPANY: UNIONOIL NORGE

SOURCE ROCK



SCALE 1: 20,000

APPENDIX I

ABBREVIATIONS USED IN ANALYTICAL DATA SHEETS

Alg	-	Algae	Mtl	-	Mottled
Aren	-	Arenaceous	Musc	-	Muscovite
Arg	-	Argillaceous	NS	-	No sample
Bit	-	Bitumen/bituminous	Occ	-	Occasional
Bl	-	Blue	Ol	-	Olive
Blk	-	Black	Ool	-	Oolite/oolitic
Brn	-	Brown	Orng	-	Orange
Calc	-	Calcareous	Pnk	-	Pink
Carb	-	Carbonaceous	Pop	-	Population
Chk	-	Chalk	Pp	-	Purple
Cht	-	Chert	Pyr	-	Pyrite/pyritic
Cgl	-	Conglomerate	Qtz	-	Quartz
Cly	-	Clay	Ref	-	Reflectivity
CMT	-	Cement	Sap	-	Sapropel
Crs	-	Coarse	Sft	-	Soft
Ctgs	-	Ditch cuttings	Sh	-	Shale
Dk	-	Dark	Shly	-	Shaly
Dol	-	Dolomite	Sil	-	Siliceous
F	-	Fine	Slt	-	Silt
Fer	-	Ferruginous	Sltst	-	Siltstone
Flu	-	Fluorescence	Slty	-	Silty
Fm	-	Formation	Snd	-	Sand
Foram	-	Foraminifera	Sndy	-	Sandy
Fr	-	Friable	Sst	-	Sandstone
Frags	-	Fragments	SWC	-	Sidewall core
Glc	-	Glauconite	Tr	-	Trace
Gn	-	Green	V	-	Very
Gy	-	Grey	Vgt	-	Variegated
Gyp	-	Gypsum	Vit	-	Vitrinite
Hd	-	Hard	Wht	-	White
Inert	-	Inertinite	Yel	-	Yellow
Lam	-	Laminae/laminated	-	-	Sample not analysed
LCM	-	Lost circulation material	*	-	No results obtained
Lig	-	Lignite/lignitic	Gy-gn	-	Greyish green
Lst	-	Limestone	Gn/gy	-	Green to/and grey
Lt	-	Light	Gn-gy	-	Greenish grey
Mdst	-	Mudstone			
Med	-	Medium			
Mic	-	Micaceous			
Mnl	-	Mineral			
Mnr	-	Minor			