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REPORT TITLE/ TITTEL

Source Rock Evaluation of well 30/7-8 Part II

CLIENT/ OPPDRAGSGIVER

Norsk Hydro A/S

RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG

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SUMMARY/ SAMMENDRAG

The analysed sequence in this well (4280-4815m) was divided into three zones:

A: 4280-4395m is composed of some sand and coal and abundant claystones (brown grey, light grey and dark grey). Kerogens in dark claystones (rich TOC) are mature oil window and are mixed type II/III. They have already generated hydrocarbons and still have a good potential (rich in coals) as source rocks for gas.

B & C: 4395-4815m. Composed mostly of sandstones and grey claystones with poor to fair TOC and of condensate window maturity. Generally poor source rock potential, except for brown-grey claystone between 4530-4595m and coal between 4420-4485m with a fair to good potential as source rocks for gas.

KEY WORDS/ STIKKORD: Source Rock

EXPERIMENTAL AND DESCRIPTION OF INTERPRETATION LEVELS

Headspace Gas Analysis

One ml. of the headspace gas from each of the cans was analysed gas chromatographically for light hydrocarbons. The results are shown in Table 1a. The canned samples were washed with temperated water on 4, 2, 1 and 0.125 mm sieves to remove drilling mud and thereafter dried at 35°C.

Total Organic Carbon (TOC)

Picked cuttings of the various lithologies in each sample was crushed in a centrifugal mill. Aliquots of the samples were then weighed into Leco crucibles and treated with hot 2N HCl to remove carbonate and washed twice with distilled water to remove traces of HCl. The crucibles were then placed in a vacuum oven at 50°C and evacuated to 20 mm Hg for 12 hrs. The samples were then analysed on a Leco E C 12 carbon analyser, to determine the total organic carbon (TOC).

Extractable Organic Matter (EOM)

From the TOC results samples were selected for extraction. Of the selected samples, approximately 100 gm of each was extracted in a flow through system (Radke et al,, 1978, Anal. Chem. 49, 663-665) for 10 min. using dichloromethane (DCM) as solvent. The DCM used as solvent was distilled in an all glass apparatus to remove contaminants.

Activated copper fillings were used to remove any free sulphur from the samples.

After extraction, the solvent was removed on a Buchi Rotavapor and transferred to a 50 ml flask. The rest of the solvent was then removed and the amount of extractable organic matter (EOM) determined.

Chromatographic Separation

The extractable organic matter (EOM) was separated into saturated fraction, aromatic fraction and non hydrocarbon fraction using a MPLC system with hexane as eluant (Radke et al., Anal. Chem., 1980). The various fractions were evaporated on a Buchi Rotavapor and transferred to glassvials and dried in a stream of nitrogen. The various results are given in Table III-VI.

Gas Chromatographic Analyses

The saturated and aromatic hydrocarbon fractions were each diluted with n-hexane and analysed on a HP 5730 A gas chromatograph, fitted with a 25 m OV101 glass capillary column and an automatic injection system. Hydrogen (0.7 ml/min.) was used as carrier gas and the injection was performed in the split mode (1:20).

Vitrinite Reflectance

Samples, taken at various intervals, were sent for vitrinite reflectance measurements to Geoconsultants, Newcastle-upon-Tyne. The samples were mounted in Bakelite resin blocks; care being taken during the setting of the plastic to avoid temperatures in excess of 100^{o}C. The samples were then ground, initially on a diamond lap followed by two grades of corundum paper. All grinding and subsequent polishing stages in the preparation were carried out using isopropyl alcohol as lubricant, since water leads to the swelling and disintegration of the clay fraction of the samples.

Polishing of the samples was performed on Selvyt cloths using three grades of alumina, 5/20, 3/50 and Gamma, followed by careful cleaning of the surface.

Reflectance determinations were carried out on a Leitz M.P.V. microphotometer under oil immersion, R.I. 1.516 at a wavelength of 546 nm. The field measured was varied to suit the size of the organic particle, but was usually of the order of 2 micron diameter.

The surface of the polished block was searched by the operator for suitable areas of vitrinitic material in the sediment. The reflectance of the organic particle was determined relative to optical glass standards of known reflectance. Where possible, a minimum of twenty individual particles of vitrinite was measured, although in many cases this number could not be achieved.

The samples were also analysed in UV light, and the colour of the fluorescing material determined. Below, a scale comparing the vitrinite reflectance measurements and the fluorescence measurements are given.

VITRINITE REFLECTANCE R.AVER. 546 nm 1516	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10
% CARBON CONTENT DAF.	57	62	70	73	76	79	80.5	82.5	84	85.5
LIPTINITE FLUOR nm	725 750	790	820	840		860	890		940	
EXC. 400 nm BAR. 530 nm colour	G	$G/_Y$	Y	$Y/_O$	L.O	M.O.		D.O.	$O/_R$	R
zone	1	2	3	4	5	6		7	8	9

NOTE: Liptinite NM = Numberical measurements of overall spore colour and not peak fluorescence wavelength.

Relationship between liptinite fluorescence colour, vitrinite reflectance and carbon content is variable with depositional environment and catagenic history. The above is only a guide. Liptinite will often appear to process to deep orange colour and then fade rather than develop O/R red shade. Termination of fluorescence is also variable.

Processing of Samples and Evaluation of Visual Kerogen

Crushed rock samples were treated with hydrochloric and hydrofluoric acids to remove the minerals. A series of microscopic slides contain strew mounts of the residue:

T-slide represents the total acid insoluble residue.
N-slide represents a screened residue (15μ mesh).
O-slide contains palynodebris remaining after flotation ($ZnBr_2$) to remove heavy minerals.
X-slides contain oxidized residues, (oxidizing may be required to remove sapropel which embeds palynomorphs, or where high coalification prevents the identification of the various groups).

T and/or O slides are necessary to evaluate kerogen composition/-palynofacies which is closely related to sample lithology.

Screened or oxidized residues are normally required to concentrate the larger fragments, and to study palynomorphs (pollen, spores and dinoflagellates) and cuticles for paleodating and colour evaluation.

So far visual evaluation of kerogen has been undertaken from residues mounted in glycerine jelly, and studied by Leitz Dialux in normal light (halogene) using x10 and x63 objectives. By x63 magnification it is possible to distinguish single particles of diameters about 2 and, if required, to make a more refined classification of the screened residues (particles >15μ).

The colour evaluation is based on colour tones of spores and pollen (preferably) with supporting evidence from colour tones of other types of kerogen (woody material, cuticles and sapropel). These colours are dependant upon the maturity, but are also influenced by the paleoenvironment (lithology of the rock, oxidation and decay processes). The colours and the estimated colour index of an individual sample may therefore differ from those of the neighbouring samples. The techniques in visual kerogen studies are adopted from Staplin (1969) and Burgess (1974).

In interpretation of the maturity from the estimated colour indices we follow a general scheme that is calibrated against vitrinite reflectance values (R_o).

Ro	0.45	0.6	0.9	1.0	1.3
colour index	2-	2	2+	3-	3
Maturity intervals	Moderate mature	Mature (oil window)			Condensate window

Rock-Eval Pyrolysis

100 mg crushed sample was put into a platinum crucible whose bottom and cover are made of sintered steel and analysed on a Rock-Eval pyrolyser.

RESULTS AND DISCUSSION

Light Hydrocarbons

The headspace gas in canned samples, over the interval 4280-4815 m of the well, was analysed. Based on results from these analyses, the sequence was divided into three zones:

A: 4280-4395 m
B: 4395-4485 m
C: 4485-4815 m

Zone A; 4280-4395 m: This zone is found to consist mainly of claystone and sandstone. The whole of the zone is found to have a good abundance of C_1-C_4 hydrocarbons with a low wetness of the gas. The abundance of C_5+ hydrocarbons is fair for most of the zone increasing to good towards the base.

Zone B; 4395-4485 m: The abundance of both C_1-C_4 and C_5+ hydrocarbons decreases considerably in this zone compared to the zone above, and the wetness of the gas increases. The lithology changes, almost entirely, to sandstone in this zone.

Zone C; 4485-4815 m: The lithology of the samples from this zone alternates from sample to sample, but is mainly grey claystones and some sandstones. The wetness of the gas decreases sharply at the top of the zone while the abundances of both C_1-C_4 and C_5+ hydrocarbons show a steady decrease with increasing depth.

Total Organic Carbon

With the exception of most of the sandstone samples, organic carbon measurements were undertaken on all lithologies which constituted 10% or more of the samples.

Zone A: The brownish-grey to light grey and the grey-brown to dark grey-brown claystone found in the samples from this zone were found to have rich abundances of organic carbon.

Zone B: This zone consists mainly of sandstone with a low percentage of siltstone in some samples. The siltstone has good and rich abundances of organic carbon. The sandstone from a couple of the samples was measured for organic carbon and found to have a fair abundance. The high TOC values for both the siltstone and the sandstone are probably due to coal particles and stringers in the samples.

Zone C: The grey claystone at the top of this zone has a fair abundance of organic carbon while the brown and red-brown claystone from approximately 4630 m downwards have a poor abundance. A few core samples from 4534-4540 m were analysed and the TOC values of these vary from 0.6-3.36% with the brownish grey, waxy claystone at 4540.16m showing the highest TOC value.

Extraction and Chromatographic Separation

A total of five samples, all from zone A were extracted and all have a rich abundance of extractable hydrocarbons. The organic carbon normalised results are, however, somewhat low. This could indicate a low C_{15}^{+} hydrocarbon production efficiency, per unit of organic carbon. The composition of the hydrocarbons vary somewhat, but they all have a much higher concentration of saturated than of aromatic hydrocarbons.

The gas chromatograms of the saturated hydrocarbon fractions all have a front-end biased smooth n-alkane distribution with a maximum at nC_{17} or lower. There are only minor differences in the pristane/nC_{17} and pristane/phytane ratios for the analysed samples. All the gas chromatograms are typical for well mature hydrocarbons. The relatively high concentration of higher n-alkanes (>nC_{20}) indicate that they have probabaly originated from terrestrial material.

Examination in Reflected Light

K 9020, 4265-4280m: Shale and Coal, Ro=1,14(23)

The sample shows bitumen staining. It has plentiful coal fragments and vitrinite wisps and inertinite particles in shale. UV light shows dull red fluorescence from spores and a low exinite content.

K 9024, 4325-4340m: Shale and Coal, Ro=1,16(22)

The sample has plentiful coal cuttings and normal lithologies with a low content of phytoclasts in shale. UV light shows orange/red fluorescence from spores and a trace only of exinite.

K 9026, 4355-4370m: Shale and Coal, Ro=1,29(23)

The sample has a moderate organic content with bitumen staining in the shale. It consists of inertinite particles and vitrinite wisps and a few loose coal cuttings. UV light shows red fluorescence from spores and a few hydrocarbon specks and only a trace of exinite.

K 9028, 4385-4395m: Shale, Carbonate and Lignite, Ro=1,20(21)

The sample has a moderate bitumen staining with a low content of inertinite particles and vitrinite wisps. It has a few loose coal fragments of similar Ro values. UV light shows no fluorescence and the exinite content is nil.

M 288, 4470-4485m: Shale, Carbonate and Lignite, Ro=0,31(23)

The sample has light bitumen staining and wips with plentiful lignite cuttings - normal lithology. UV light shows yellow fluorescence from spores in shale and lignite and a low exinite content.

M 393, 4530-4545m: Sandstone, Ro=0,33(12) 1,36(8)

The sample has a few lignite cuttings. There are traces of material with high Ro values and interstitial bitumen with high Ro values. UV light shows a trace of yellow fluorescence from spores in lignite and a trace only of exinite.

M 397, 4590-4605m: Sandstone and shale traces, Ro=0,33(13) 1,35(10)

The sample consists of barren sandstone. It has a few lignite cuttings with low Ro values. The shale contains only very high Ro values, wispy particles and particles which are possibly reworked. UV light shows a couple of loose yellow/orange spores and a trace only of exinite.

M 401, 4650-4665m: Sandstone and Shale, Ro=0,41(20) 1,80(3)

The sample has moderate bitumen staining in shale. It has plentiful lignite cuttings. The shale contains high Ro values reworked and inertinite particles. UV light shows yellow fluorescence from spores in lignite and a trace only of exinite.

M 566, 4740-4755m: Shale and Sandstone, Ro=0,32(22)

The sample consists of barren shale. The organic material is restricted to plentiful loose lignite cuttings. UV light shows yellow fluorescence from spores and resin in lignite and a trace only of exinite.

M 570, 4800-4815m: Red Shale and Carbonate, Ro=0,35(21)

The sample is barren apart from a few loose lignite cuttings. UV light shows no definite organic fluorescence and the exinite content is nil.

Investigation in Transmitted Light (Visual Kerogen Analyses)

Twelve samples in the interval from 4265 m to 4815 m were investigated.

The organic residues of this interval apparently belong to two intervals, an upper one 4265-4395 m with potential mainly for gas, and a lower interval that was very poor in organic matter. From the colours of pollen, spores, and cuticles the upper part seems mature, and in the lower part of the oil window.

Samples 4265m, 4295m, 4325m, 4355m and 4385-95m: The residues contain organic material as aggregates mainly of sapropelised terrestrial material and dominated by woody particles (vitrinite together with inertinite). Cuticles, pollen, and spores were regularly observed. True amorphous material was evaluated as present, about 20%, but the distinction from sapropelised material is arbitrary. Pyrite is present and fungi seems to have been active in most of the samples especially in the lower part of the interval.

The content of inertinite is variable 10-25%.

The colour index: 3-/3 or 3.

Samples 4530m, 4561m, 4631m, 4680m, 4740m, 4773m, 4800-15m: The residues of this interval were all small and were rich in or dominated by acid and resistant minerals.

The organic remains were partly observed as aggregates of combined organic/inorganic composition and evaluated as derived from carbonatic lithologies. Apart from the 4680 m level the organic material was dominantly derived from woody matter. Inertinite was dominant in the lower part of the interval.

Colour index: Palynomorphs or cuticles of value for a colour estimate were not recorded in this interval.

Rock-Eval Pyrolysis

Zone A: A total of six samples from this zone were pyrolysed on a Rock-Eval instrument. They are all found to have high T_{max} values indicating a maturity in the lower part of the oil window. All the samples except the grey claystone from 4395 m have low oxygen indices and low to moderate hydrogen indices. The samples with hydrogen indices of 120-150 and T_{max} values from 447-462 probably consist of a mixture of kerogen type II and III while the rest of the samples contain kerogen type III. The moderate production index values indicate that the samples do not contain any migrated hydrocarbons. The analysed samples have a fair to good petroleum potential.

Zone B: None of the samples from this zone were pyrolysed.

Zone C: A total of six samples, three cutting samples and three core samples were pyrolysed. The S_2 peaks are small and broad on some of the samples and T_{max} is therefore difficult to determine. The whole zone has, however, some T_{max} values which indicates that the whole of the zone has a condensate window maturity. The hydrogen indices are low for all the analysed samples which indicates that only kerogen type III is present. The hydrocarbon potential is poor for the whole of the zone.

CONSLUSIONS

Zone A (4280-4395m): Brownish-grey to light grey, and dark-grey claystones in this section have an oil window maturity approaching condensate window maturity (%Ro>1% <1.3%). The kerogens in these claystones are predominantly mixed type II/III from Rock-Eval analysis. Visual kerogen analysis indicates that the organic material in the claystones is mostly sapropelised terrestrial matter and mainly of woody origin (vitrinite and inertinite) although there is some cuticle and spore material. It is evident from Rock-Eval anlysis that significant hydrocarbons have already been generated (high S1) from these coaly claystones, and that they have a fair to good potential as source rocks for gas (including coals).

Zones B and C (4395-4815m): These two zones are composed mostly of sandstones and TOC-poor claystones (grey, grey-green and red-brown) with type III or IV kerogens. The zones which are condensate window mature (mainly deduced from extrapolation of the vitrinite reflectance curve) have a poor source potential, except for a coal from 4420-4485m with a rich? potential as a source rock for gas and a brown-grey waxy claystones between 4530-4545m with a fair to good potential as a source rock for gas.

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TABLE I a.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN HEADSPACE.

IKU No.	DEPTH (m)	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
K9020	4280	162824	14069	3384	458	560	1194	181295	18471	10.19	.82
K9021	4295	173914	13393	2547	296	388	949	190538	16624	8.72	.76
K9022	4310	118424	11708	3898	610	899	1456	135539	17115	12.63	.68
K9023	4325	149291	15291	4943	940	1272	2918	171737	22446	13.07	.74
K9024	4340	5650	529	172	48	56	361	6455	805	12.47	.86
K9025	4355	49910	6509	3041	454	995	2196	60909	10999	18.06	.46
K9026	4370	71373	8898	4112	669	1196	2226	86248	14875	17.25	.56
K9027	4385	125028	19159	10639	1602	3527	6888	159955	34927	21.84	.45
K9028	4395	12723	5012	2889	476	1209	13603	22309	9586	42.97	.39
M284	4425	1405	555	613	156	256	885	2985	1580	52.93	.61
M286	4455	870	549	501	107	167	601	2194	1324	60.35	.64
M288	4485	892	403	351	131	875	557	2652	1760	66.37	.15
M391	4515	2231	309	208	68	110	852	2926	695	23.75	.62
M393	4545	4360	478	71	10	16	99	4935	575	11.65	.63
M395	4575	7821	1259	153	18	19	172	9270	1449	15.63	.95
M397	4605	4649	520	74	11	12	129	5266	617	11.72	.92
M399	4635	964	120	21	4	63	28	1172	208	17.75	.06
M401	4665	448	84	9	3	3	267	547	99	18.10	1.00
M403	4695	1107	45	5			232	1157	50	4.32	---
M405	4725	250	11				200	261	11	4.21	---
M566	4755	2555	50				159	2605	50	1.92	
M568	4785	431	7				162	438	7	1.60	
M570	4815	69	116	2			129	187	118	63.10	

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LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II
WELL NO.: 30/7-8 II

Sample	Depth	TOC	Lithology	
K 9020	4265-4280	2,57	60%	Claystone, brownish grey to light grey, some dark, occasionally coaly, some deformed/waxy
		0,19	25%	Sandstone, fine-medium, some coarse, white
			15%	Coal, black
K 9021	4280-4295	1,56	40%	Claystone, as above
			20%	Coal to carbonaceous Claystone, black to dark grey
			40%	Sandstone, as above
K 9022	4295-4310	3,03	50%	Claystone, brownish grey to light grey, some dark
			35%	Sand/Sandstone, fine to coarse, white
			15%	Coal to carbonaceous Claystone, black to dark grey
K 9023	4310-4325	2,23	65%	Claystone, brownish grey, grading to light and dark, waxy/deformed, occasionally coaly, grading to very silty, laminated
			10%	Claystone, dark brown-grey
			20%	Coal to carbonaceous Claystone, black to dark grey
			5%	Sand/Sandstone
K 9024	4325-4340	3,66	60%	Claystone, as above, some Siltstone-laminae
			20%	Coal to carbonaceous Claystone, black
			20%	Sandstone, fine

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LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II
WELL NO.: 30/7-8 II

Sample	Depth	TOC	Lithology	
K 9025	4340-4355	1,39	70%	Claystone, silty, grey-brown to dark and light grey, occasionally some calcareous, largely deformed/waxy
			20%	Coal/carbonaceous Claystone, mainly black
			10%	Sandstone
K 9026	4355-4370	5,76	80%	Claystone, grey-brown to dark grey-brown, some light grey, waxy/deformed, coaly, some very silty
			10%	Sandstone, fine, white, some medium Sand
			10%	Coal to carbonaceous Claystone, black
K 9027	4370-4385	2,29	63%	Claystone/Siltstone, dark grey to black, partly coaly or carbonaceous (stringers)
		0,50	20%	Claystone/Siltstone, grey to light grey (brownish)
			10%	Sand/Sandstone
			7%	Coal, shiny, black
K 9028	4385-4395	5,86	43%	Siltstone/Claystone, (brownish) dark grey, grading to black, as above
		1,07	10%	Siltstone/Claystone, grey to light grey partly brownish
			7%	Coal, black, shiny
		0,51	20%	Sandstone, light grey/white, silty, very fine-fine, partly micaceous, some medium-coarse Sand
			20%	Mud, yellowish light grey, loose

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LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II
WELL NO.: 30/7-8 II

Sample	Depth	TOC	Lithology	
M 284	4410-4425	0,54	100%	Sandstone, fine, occasionally micaceous, white to light grey, scattered Coal-grains and Pyrite, obs. Chlorite, partly some calcareous
			Sm.am.	Siltstone/Claystone, brownish dark grey; Sand, medium/coarse; Pyrite; additives and cement
M 286	4440-4445	0,56	100%	Sandstone, as above, some dark brownish micaceous Silt-laminae, Coal-particles abundant
			Sm.am.	Coal grains; additives
M 288	4470-4485	0,90	10%	Siltstone, sandy, grey, slightly glauconitic, laminated, obs. Chlorite
			40%	Mud cake, slightly brownish light grey/white, loose
			40%	Coal
			10%	Sandstone, very fine-fine, white to light brownish grey, micaceous, laminated, slightly glauconitic
			Sm.am.	Calcite, white
M 391	4500-4515		100%	Sand, medium to coarse, angular, white
M 393	4530-4545	1,38	85%	Sand/Sandstone, as above
			15%	Claystone, brown-grey to dark brown-grey (grading to black, carbonaceous), grey
			Sm.am.	Coal; Mud cake, light yellow-grey

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LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II
WELL NO.: 30/7-8 II

Sample	Depth	TOC	Lithology	
M 395	4560-4575	0,78	55%	Sand/Sandstone, medium-very coarse, white
			45%	Claystone, dark brownish grey to brownish grey
M 397	4590-4605	0,75	85%	Sand, medium to coarse
			15%	Claystone, light brown-grey to dark brown-grey, occasionally coaly
			Sm.am.	Coal; Pyrite
M 399	4620-4635	0,38	90%	Claystone, silty, grey to light grey, partly brownish, deformed internal surfaces
			10%	Sand/Sandstone
M 401	4650-4665	0,29	75%	Claystone, as above, green and dark observed
			20%	Sand/Sandstone, medium to very coarse
			5%	Coal
M 403	4680-4695	0,30	80%	Claystone, grey to light grey, partly brownish, deformed internal surfaces, some dark
			20%	Sand/Sandstone, white - light grey, obs. green, fine to very coarse
M 405	4710-4725	0,32	50%	Claystone, grey-green, grey, red-brown
			50%	Sand/Sandstone, medium-coarse

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LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II
WELL NO.: 30/7-8 II

Sample	Depth	TOC	Lithology	
M 566	4740-4755	0,29	60%	Claystone, grey/light grey, grading to green and red-brown
			40%	Sand/Sandstone, fine to coarse, partly calcareous
			Sm.am.	Pyrite
M 568	4770-4785	0,14	20%	Claystone, red-brown, occasionally calcareous
		0,26	15%	Claystone, grey to grey-green
		0,11	65%	Sandstone, white and red-brown, chloritic, largely calcareous, fine-medium
			Sm.am.	Calcite, white; Limestone, light grey
M 570	4800-4815	0,23	80%	Claystone/Siltstone, red-brown
		0,19	15%	Claystone, grey-green
			5%	Sandstone
			Sm.am.	Coal

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T A B L E : III

WEIGHT OF EOM AND CHROMATOGRAPHIC FRACTIONS

IKU-No	DEPTH (m)	Rock Extr. (g)	EOM (mg)	Sat. (mg)	Aro. (mg)	HC (mg)	Non HC (mg)	TOC (%)
K-9020	4280	29.1	70.5	28.3	7.1	35.4	35.1	3.9
K-9022	4310	22.6	144.3	19.6	7.0	26.6	117.7	4.0
K-9024	4340	13.2	46.7	9.6	2.1	11.7	35.0	2.9
K-9026	4370	23.7	40.5	15.1	4.9	20.0	20.5	2.8
K-9028	4395	2.9	35.7	4.7	1.1	5.8	29.9	5.1

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T A B L E : IV

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

(Weight ppm of rock)

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
K-9020	4280	2423	973	244	1216	1206
K-9022	4310	6388	868	310	1178	5210
K-9024	4340	3525	725	158	883	2642
K-9026	4370	1706	636	206	842	864
K-9028	4395	12439	1638	383	2021	10418

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T A B L E : V

CONCENTRATION OF EOM AND CHROMATOGRAPHIC FRACTIONS

(mg/g TOC)

IKU-No	DEPTH (m)	EOM	Sat.	Aro.	HC	Non HC
K-9020	4280	61.5	24.7	6.2	30.9	30.6
K-9022	4310	161.7	22.0	7.8	29.8	131.9
K-9024	4340	122.4	25.2	5.5	30.7	91.7
K-9026	4370	61.4	22.9	7.4	30.3	31.1
K-9028	4395	243.9	32.1	7.5	39.6	204.3

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T A B L E : VI

COMPOSITION IN % OF THE MATERIAL EXTRACTED FROM THE ROCK

IKU-No	DEPTH (m)	Sat --- EOM	Aro --- EOM	HC --- EOM	Sat --- Aro	Non HC ------ EOM	HC ------ Non HC
K-9020	4280	40.1	10.1	50.2	398.6	49.8	100.9
K-9022	4310	13.6	4.9	18.4	280.0	81.6	22.6
K-9024	4340	20.6	4.5	25.1	457.1	74.9	33.4
K-9026	4370	37.3	12.1	49.4	308.2	50.6	97.6
K-9028	4395	13.2	3.1	16.2	427.3	83.8	19.4

TABLE VII

TABULATION OF DATAS FROM THE GASCHROMATOGRAMS

IKU No.	DEPTH (m)	PRISTANE / n-C17	PRISTANE / PHYTANE	CPI
K9020	4280	.5	1.7	1.0
K9022	4310	.5	1.5	1.0
K9024	4340	.4	1.7	1.0
K9026	4370	.4	1.7	1.0
K9028	4395	.4	1.3	1.0

IKU

VITRINITE REFLECTANCE MEASUREMENTS

TABLE NO.: VIII

WELL NO. 30/7-8

Sample	Depth	Vitrinite reflectance	Fluorescence in UV light	Exinite content
K9020	4265-4280	1,14(23)	Dull red	Low
K9024	4325-4340	1,16(22)	Orange/Red	Trace
K9026	4355-4370	1,29(23)	Red	Trace
K9028	4385-4395	1,20(21)	No fluorescence	-
M 288	4470-4485	0,31(23)	Yellow	Low
M393	4530-4545	0,33(12) 1,36(8)	Yellow	Trace
M397	4590-4605	0,33(13) 1,35(10)	Yellow/Orange	Trace
M401	4650-4665	0,41(20) 1,80(3)	Yellow	Trace
M566	4740-4755	0,32(22)	Yellow	Trace
M570	4800-4815	0,35(21)	No fluorescence	-

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX
WELL: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
K 9020	4265-4280	W,Cut,P,S,WR!/Am	F-M-L	fair to poor	3-/3	Sapropelised material. Small spherical bodies, fungal hyphae. Aggregates with flaky granulate structure. Some pyrite.
K 9022	4295-4310	W,Cut,P,S,WR!/Am	F-M-L	fair to poor	3/3-	As above. Increase in inertinite.
K 9024	4325-4340	W,WR!,Cut,P,S,Am	F-M-L	fair to poor	3-/3	Increase in inertinite.
K 9026	4355-4370	W,P,S,Cut,WR!/Am	F-M-L	fair	3-/3	As above, but decrease in inertinite. Aggregates of a more homogenous granulate structure.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

038/A/jlh/1

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX
WELL: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
K 9028	4385-4395	Cut,W,WR!,P,S/Am	F-M-L	fair	3/3-	Larger fragments, more pyrite framboids. Very rich in hyphae of fungi.
M 393	4530-4545	W,Cut,WR!,P,S/Am	F-M-L	fair to poor	3/3-	Partly as above, partly influenced by carbonate, rich in pyrite.
	4561swc	W,Cut,WR!/Am	F-M	-	-	Disperse residue but small aggregates present. Rich in semifusinite. (Tertiary/-Cretaceous cont.).
	4631swc	*Am/WR!	F	-	-	*Acid resistant minerals dominate in an extremely small residue.

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

038/A/jlh/2

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX
WELL: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
	4680swc	*Am/W,WR!	F-M	-	-	*Acid reistant minerals dominate in a small residue. Aggregates propose presence of carbonate.
M 566	4740-4755	WR!,W/	F-M-?L	poor	-	Very small residue. Inertinite and vitrinite/coaly fragments dominate.
	4773swc	*				*Extremely small residue, almost barren.
M 570	4800-4815	*WR!,W/	F-M	-	-	*Small residue. Minerals dominate. Inertinite and traces of adhering mud additives. Etched material (carbonate?).

ABBREVATIONS

Am	Amorphous	Cy	Cysts, algae	W	Woody material	F	Fine
He	Herbaceous	P	Pollen grains	C	Coal	M	Medium
Cut	Cuticles	S	Spores	R!	Reworked	L	Large

038/A/jlh/3

IKU

TABLE Xa

ROCK EVAL PYROLYSES (Cuttings)

IKU No.	DEPTH (m)	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	OIL OF GAS CONTENT S1+S2	PROD. INDEX S1/(S1+S2)	TEMP. max (C)
K9020	4280	1.37	2.89	.45	2.57	112	18	4.26	.32	452
K9022	4310	2.07	4.53	.38	3.05	149	12	6.60	.31	451
K9024	4340 Clst	1.84	3.78	.33	3.66	103	9	5.62	.33	447
K9026	4370 Clst bn-gy	1.35	3.98	.36	5.76	69	6	5.33	.25	462
K9028	4395 Clst gy	.46	.64	.62	1.07	60	58	1.10	.42	452
K9028	4395 Clst dk gy	2.62	7.14	.31	5.86	122	5	9.76	.27	448
M393	4545	.17	.36	.37	1.38	26	27	.53	.32	485
M395	4575	.05	.06	.27	.72	8	38	.11	.45	402
M397	4605	.16	.12	.37	.75	16	49	.28	.57	482

IKU

TABLE X b

ROCK EVAL PYROLYSES (Cores)

IKU No.	DEPTH (m)	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	OIL OF GAS CONTENT S1+S2	PROD. INDEX S1/(S1+S2)	TEMP. max (C)
M299	4534.06	.24	.67	.07	1.03	65	7	.91	.26	474
M302	4539.6	.17	.56	.21	1.75	32	12	.73	.23	498
M303	4540.46	.38	1.65	.22	3.36	49	7	2.03	.19	473