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Source Rock Analyses of Well 30/7-8 Part I

CLIENT/ OPPDRAGSGIVER

Norsk Hydro A/S

RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG

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SUMMARY/ SAMMENDRAG

Detailed analyses were only performed on the lower 600 metres of the well.

Zones A, B, C and D (1700-3350 m) were found to consist mostly of claystone, and are immature to moderate mature with a fair potential as source rocks for hydrocarbons.

Zones E and F (3350-3755 m) consist of a variety of shale/claystone types, and black shale found mostly in Zone E has a good potential as a source rock for gas and is mature. The sandstone in Zone G (3755-3790 m) has migrated hydrocarbons. The claystones in this zone are mature with a fair potential as a source rock for gas.

Zone H (3790-4200 m) has an oil window maturity, and consists mostly of dark grey claystones and some brown/yellow-brown limestones. The claystones in particular, have a rich potential as a source rock for gas and heavy oil - generally gas prone. Zone I is a mixed sandstone/claystone sequence with some coal, it is oil window mature with a good potential, in parts, as a source rock for gas and heavy oil.

KEY WORDS/ STIKKORD: Source Rock

EXPERIMENTAL AND DESCRIPTION OF INTERPRETATION LEVELS

Headspace gas analyses

One ml. of the headspace gas from each of the cans was analysed gas chromatographically for light hydrocarbons. The results are shown in Table la. 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.

Occluded gas

An aliquot of the 1-2 mm fraction of each sample before drying was crushed in water using an airtight ball mill, and one ml. of the headspace analysed chromatographically. The results are shown in Table lb.

Total Organic Carbon (TOC).

Picked cuttings of the various lithologies in each sample were 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 filings 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 fraction was 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 = NUMERICAL 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 ORANCE 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 (15 meshes).
O-slide contains palynodebris remaining after flotation ($ZnBr_2$) to remove disturbing heavy minerals.
X-slides contain oxidized residues, (oxidizing may be required due to sapropel which embeds palynomorphs, or to high coalification preventing 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 evaluations of kerogen have 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 wanted, to make a more refined classification of the screened residues (particles >15).

The colour evaluation is based on colour tones of spores and pollen (preferably) with support from other types of kerogen (woody material, cuticles and sapropel). These colours are dependant upon the maturity, but also are under influence of the paleo-environment (lithology of the rock, oxidation and decay processes). The colours and the estimated colour index of an individual sample may therefore deviate 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 3+ index	2-	2	2+	3-	3
Maturity intervals	Moderate mature	Mature (oil window)			Condensate window

Rock-Eval Pyrolyses

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

Headspace Gas Analyses

Based on the headspace gas analyses the analysed sequence of the well, 1700-4290 m was divided into nine zones.

A: 1700-2050 m
B: 2050-2420 m
C: 2420-2720 m
D: 2720-3350 m
E: 3350-3710 m
F: 3710-3755 m
G: 3755-3790 m
H: 3790-4200 m
I: 4200-4290 m

Zone A, 1700-2050 m: The abundances of both C_1 - C_4 and C_5+ hydrocarbons are low but constant throughout this zone. A very low value is also found for the wetness of the gas while the isobutane/normal butane ratio (iC_4/nC_4) is high. This indicates that the analysed samples have a low maturity, probably containing biogenic gas.

Zone B, 2050-2420 m: The abundances of C_1 - C_4 and C_5+ hydrocarbons show an increase compared to zone A. The wetness of the gas increases throughout this zone while the iC_4/nC_4 ratio shows a gentle decrease. This information indicates the zone to rapidly become more mature and increase the abundance of light hydrocarbons, (especially of C_5+ hydrocarbons), with increasing depth.

Zone C, 2420-2720 m: The abundances of both C_1 - C_4 and C_5+ hydrocarbons show a "bulge" for this zone while the wetness of the gas and the iC_4/nC_4 are uniform throughout the zone.

Zone D, 2720-3350 m: The abundances of both C_1 - C_4 and C_5+ hydrocarbons decreases in this zone and is found to be fair and poor respectively, increasing slightly towards the lower end of the zone. The wetness of the gas and the iC_4/nC_4 ratio are uniform throughout the zone.

Zone E, 3350-3710 m: The abundances of C_1 - C_4 and C_5+ hydrocarbons are erratic throughout the zone while the wetness of the gas shows a sudden increase at the top of the zone with a further gentle increase with increasing depth. The erratic values of the hydrocarbon abundances are probably due to the variation in lithology with claystone and limestone of various amounts.

Zone F, 3710-3755 m: The abundances of both C_1 - C_4 and C_5+ hydrocarbons show a sharp increase and then a sudden drop while the wetness of the gas and the iC_4/nC_4 ratio is constant throughout the zone.

Zone G, 3755-3790 m: The abundances of C_1 - C_4 and C_5+ hydrocarbons show similar changes in this zone as in zone F but to a far larger degree. The wetness of the gas is also higher than in the zones above. This zone contains a small sandstone lense and the results encountered indicate that the sandstone may contain migrated hydrocarbons.

Zone H, 3390-4200 m: Some variations are found for the various analyses throughout this zone, probably due to small variations in the lithology. On the whole, both the abundances of C_1 - C_4 and C_5+ hydrocarbons and the wetness of the gas show a "bulge", with a maximum at approximately 3900 m and decreasing gently with increasing depth.

Zone I, 4200-4290 m: The abundances of both C_1 - C_4 and C_5+ hydrocarbons show a marked increase with increasing depth, while the wetness of the gas and the iC_4/nC_4 ratio is constant.

Total Organic Carbon

Zone A: This zone, which consists mainly of claystone, is found to have a fair abundance of organic carbon, approximately 0.4-0.6%.

Zone B: The lithology of this zone is also mainly claystone with slightly higher TOC values than zone A but still with a fair abundance of organic carbon.

Zone C: The abundance of organic carbon of the claystone in this zone is similar to the zones above. The limestone at 2650 m is found to have an abundance of 0.4% organic carbon and has a fair potential as a source rock.

Zone D: Another zone comprised mainly of claystones with an abundance of organic carbon similar to those in the zones above.

Zone E: This zone has a very variable lithology, while the organic carbon values for the different claystone lithologies show only small variations and are mainly found to be approximately 0.8%.

Zone F: The dark grey brown shale in this zone is found to have a rich abundance of organic carbon.

Zone G: The claystone in this zone has organic carbon values of approximately 1% while the marl and the one sandstone sample measured have values between 0.8 and 1.5% organic carbon. This indicates that these lithologies might contain migrated hydrocarbons.

Zone H: Again a zone with variable lithologies. All the samples measured for organic carbon including the limestone have values above 1%. This indicates that the limestone, claystone and black shale lithologies in this zone have a good to rich potential as source rocks.

Zone I: The black shale in this zone has a good to rich abundance of organic carbon.

Extraction and Chromatographic Separation

Zones A, B, C and D: No samples from these zones were extracted.

Zone E: One sample (3680-95 m) was extracted and found to have a good abundance of extractable hydrocarbons. This is verified by the organic

carbon normalized results. The liquid chromatographic separation shows these hydrocarbons to be mainly saturated hydrocarbons. The gas chromatogram of the saturated hydrocarbon fraction shows a bimodal distribution with a small maximum at nC_{17} and a large one at nC_{29}. The n-alkanes from nC_{25} - nC_{33} are completely dominant in the chromatogram, indicating the hydrocarbons in the sample to mainly originate from terrestrial material.

Zone F: No samples from this zone was extracted.

Zone G: One sample (3790-3805 m) was extracted and found to have a rich abundance of extractable hydrocarbons. This is verified by the organic carbon normalized results. The percentage of saturated hydrocarbons is lower than for the sample from zone E. The gas chromatogram of the saturated hydrocarbon fraction shows a unimodal, front biased n-alkane distribution, typical for well mature hydrocarbons. The heavy end n-alkanes are almost none existant in the sample. This indicates either contamination by diesel or that the sample contains migrated condensate.

Zone H: Seventeen samples from various levels in this zone were extracted and all were found to have a rich abundance of extractable hydrocarbons. This is verified by the organic carbon normalized values. Some of the samples have a very high extractability when normalized to organic carbon, especially 3875 and 4000 m, indicating that these might contain free hydrocarbons. The separation of the hydrocarbons shows that these samples have a slightly higher ratio of saturated/aromatic hydrocarbons compared to the rest of the zone. The gas chromatograms of the saturated hydrocarbon fraction of the analysed samples from 3820-3905 m show only minor variation. They all show a unimodal, front-biased n-alkane distribution typical for well mature hydrocarbons. All of the samples have a relatively large abundance of heavy n-alkanes indicating an input of some terrestrial material. The main difference between the various samples is found for the isoprenoids, where the pristane/phytane ratio increases slightly with increasing depth. Similar results are also found for the pristane/nC_{17} ratio. The gas chromatogram of the saturated hydrocarbon fraction of the sample from 3920-3935 m is similar to the one from 3790-3805 m and could be either due to diesel contamination or condensate. The gas chromatograms of the rest of the analysed samples from this zone are similar to those from the upper part of the zone with a smooth, front biased n-alkane distribution, except the sample from 3935-3950 m which does not have such a distinct front-biased

distribution. All the chromatograms are typical for well mature hydrocarbons.

Zone I: Three samples from this zone were extracted and found to have a rich abundance of extractable hydrocarbons. The organic carbon normalized values are found to be different, however, with the sample from 4200-4230 m showing a rich extractability while the two lowermost samples have a good extractability. These two samples also have a lower saturated/aromatic ratio than the uppermost sample in the zone. The gas chromatograms of the saturated hydrocarbon fraction of the two uppermost samples, 4200-4230 m and 4230-4260 m have a distribution similar to those from the zone above with a smooth, front-biased n-alkane distribution typical for well mature hydrocarbons. The gas chromatogram of the saturated hydrocarbon fraction of the lowermost sample does not have the typical front biased distribution; this could indicate a larger input of terrestrial material.

Examination in Reflected Light

A total of thirtyseven samples were examined in reflected light. Below, each sample is described and the vitrinite reflectance results given together with other results from the examination.

Sample K 6792, 2120-50 m: Shale, Ro=0.33(21)

The sample contains bitumen wisps and blebs, a low content of inertinite and reworked particles, and subordinate vitrinite wisps and wispy particles. UV light shows a yellow and yellow to orange fluorescence from spores and a low to moderate exinite content.

Sample K 6798, 2300-30 m: Shale, Ro=0.43(13)

The sample contains bitumen wisps together with a low to moderate content of inertinite and reworked material. Only a trace of corroded vitrinite particles are recorded. UV light shows a yellow to orange fluorescence from spores and a low to moderate exinite content.

Sample K 6806, 2540-70 m: Shale, Ro=0.39(7)

The sample contains bitumen wisps, otherwise a low organic content. Particles of inertinite and reworked material are recorded. A handful only of poor vitrinite particles. All phytoclasts are corroded. UV light shows a yellow to orange fluorescence from spores and hydrocarbon specks, together with a trace of exinite.

Sample K 6813, 2720-50 m: Shale and Carbonate, Ro=0.61(1)

The sample has a very low organic content with small gnarled particles of inertinite and reworked material. Only one low reflectant vitrinite particle is recorded, this is also probably reworked. UV light shows a light orange fluorescence from spores together with a trace of exinite.

Sample K 6821, 2960-90 m: Shale, Ro=0.53(2)

About 70% of the sample is turbo-drilled material with no organics. The phytoclasts are restricted to only a few non-turbo-drilled cuttings. Within these cuttings a low to moderate content of small, gnarled inertinite and reworked particles are recorded. Only two scraps of possible vitrinite are located. UV light shows a light orange fluorescence from spores and a trace of exinite.

Sample K 6940, 3170-200 m: Shale, no determination possible

Almost the whole of the sample is turbo-drilled material. Only a handful of true sediment cuttings, containing low content of very gnarled inertinite and reworked particles, were recorded. No true vitrinite. UV light shows a yellow to orange fluorescence from spores and a trace of exinite.

Sample K 6946, 3350-80 m: Shale, no determination possible

Almost 60% of the material was turbo-drilled. True shale sediment contains a low to moderate content of very corroded reworked material and inertinite particles. No vitrinite particles were recorded. UV light shows a yellow to orange fluorescence from spores and a trace of exinite.

Sample K 6851, 3500-80 m: Shale, Ro=0.83(7)

About 50% of the material was turbo-drilled. The rest of the material contained a low content of particles and wispy particles of vitrinite. Inertinite is dominant. The vitrinite particles could be true but probably reworked. UV light does not show any fluorescence.

Sample K 7003, 3680-95 m: Shale and Carbonate, Ro=0.64(1) and Ro=1.16(8)

The sample has a very low organic content. Small corroded particles of high-reflectance inertinite and virtinite are recorded. These are probably reworked. The lowest reflectance values are measured. UV light shows a light orange fluorescence from spores and a trace of exinite.

Sample K 7006, 3725-40 m: Mixed Shale Lithologies, Ro=0.51(2) and Ro=0.82(2)

The sample has a variable but strong bitumen staining and a low content of very corroded specks of vitrinite and inertinite, probably mostly reworked material. The lowest reflectance particles are measured. UV light shows a mid orange fluorescence from spores and a low exinite content.

Sample K 7432, 3755-60 m: Shale, no determination possible

The sample contains only a handful of sediment cuttings. These show heavy bitumen staining and a few inertinite particles. UV light does not show any fluorescence.

Sample K 7434, 3775-90 m: Shale and Limestone, Ro=0.68(5)

The sample contains bitumen staining and wisps. Only a trace of small particles of inertinite and vitrinite are recorded. These are very corroded, but the lowest reflectance are measured and these could possibly be true. UV light shows a mid-to deep orange fluorescence from spores and a trace of exinite.

Sample K 7435 (Claystone), 3790-3805 m: Shale, Ro=0.36(1) and Ro=0.76(1)

The sample shows a heavy bitumen staining together with extremely corroded specks of high-reflectance particles of vitrinite and inertinite. A couple of low reflectance particles are measured; these could possibly be true. UV light does not show any fluorescence.

Sample K 7435 (Marl), 3790-3805 m: Calcareous Shale, Ro=0.62(1) and Ro=1.17(11)

The sample has a low organic content with a few high-reflectance vitrinite wispy particles which look to be o.k., but could be reworked. Inertinite particles are dominant. UV light shows a yellow to orange fluorescence from spores and a trace of exinite.

Sample K 7436, 3805-20 m: Pyritic Shale, Ro=0.44(2) and Ro=0.71(3)

The sample show an intense bitumen staining, otherwise a low content of inertinite particles with only a trace of vitrinite wispy particles. UV light shows fluorescence from hydrocarbons dissolving in immersion oil. No exinite is recorded.

Sample K 7437, 3820-35 m: Shale, Ro=0.86(3)

The sample shows a strong overall bitumen staining with only a trace of phytoclasts. A few small particles of inertinite and a couple of vitrinite specks are recorded. UV light shows a mid-to deep orange fluorescence from spores. Hydrocarbons are dissolving in immersion oil. A trace of exinite is recorded.

Sample K 7438, 3835-50 m: Pyritic Shale, Ro=0.68(2)

Bitumen staining is recorded in the sample together with a very low content of inertinite particles and a couple of vitrinite specks. UV light shows hydrocarbons dissolving in immersion oil. No liptinite is recorded.

Sample K 7439, 3850-65 m: Shale, Ro=0.69(6)

The sample shows an intense bitumen staining together with a very low content of inertinite particles and a couple of vitrinite particles. UV light shows a fluorescence from hydrocarbons dissolving in immersion oil.

Sample K 7440, 3865-80 m: Shale and Calcareous Shale, Ro=0.49(3) and Ro=0.76(4)

Bitumen staining is recorded in the sample, otherwise a low organic content. Inertinite and reworked particles, with only a handful of (doubtful) vitrinite particles are recorded. UV light does not show any fluorescence.

Sample K 7441, 3880-95 m: Shale, Ro=0.70(9)

The sample is saturated in bitumen, otherwise a low to moderate content of inertinite and reworked particles, with a trace of true vitrinite wispy particles. UV light shows a mid to deep orange fluorescence from spores and a trace of exinite.

Sample K 7442, 3985-3905 m: Shale, Ro=0.65(15)

A strong bitumen staining is recorded in the sample, otherwise a low content of inertinite and reworked particles. Only a trace of vitrinite wispy particles is recorded. UV light shows hydrocarbons dissolving in immersion oil, together with mid orange fluorescence from spores and a trace of exinite.

Sample K 7443 (Claystone), 3905-20 m: Shale, Ro=0.75(6)

The sample has an overall bitumen staining, otherwise a moderate content of inertinite and reworked particles. Only a trace of vitrinite particles are recorded. UV light shows a mid orange fluorescence from spores and a trace of exinite.

Sample K 7443 (Limestone), 3905-20 m: Carcareous Shale and Limestone, Ro=0.63(5)

The sample shows bitumen staining, otherwise a low to moderate content of

inertinite and reworked particles. Only of trace of poor vitrinite wispy particles are recorded. UV light shows a mid orange fluorescence from spores and a low exinite content.

Sample K 7444, 3920-35 m: Mixed Shale Lithologies and Carbonate, Ro=0.71(15)

A strong bitumen staining is recorded in some of the cuttings, otherwise a moderate organic content. Almost wholly inertinite and reworked particles. Only a trace of true vitrinite wispy particles are recorded. UV light shows a mid orange fluorescence from spores and a trace of exinite.

Sample K 7445 (Claystone), 3935-50 m: Shale, Ro=0.82(11)

The sample shows a heavy bitumen staining, otherwise a moderate content of inertinite and reworked particles with only a trace of poor vitrinite particles. UV light shows a mid to deep orange fluorescence from spores and hydrocarbon specks together with a trace of exinite.

Sample K 7445 (Limestone), 3935-50 m: Limestone, no determination possible

The sample shows an overall bitumen staining, otherwise a low content of inertinite particles and interstitial bitumen. No vitrinite, and bitumen too corroded for measurement. UV light shows a mid-orange fluorescence from spore specks and a trace of exinite.

Sample K 7446, 3950-65 m: Shale, Ro=0.71(21)

The sample shows a bitumen staining, otherwise a moderate content of inertinite and reworked particles with only a trace of vitrinite wispy particles. UV light shows a mid-orange fluorescence from spores and a trace of exinite.

Sample K 7463, 3965-80 m: Shale, Ro=0.61(15)

The sample has a strong bitumen staining, otherwise a moderate to rich content of inertinite and reworked particles, with only a trace of vitrinite wispy particles of variable reflectance. UV light shows a mid orange fluorescence from spore specks and a trace of exinite.

Sample K 7465, 3995-4005 m: Shale, Ro=0.62(7) and Ro=0.97(1)

The sample is saturated in bitumen but otherwise has a very low content of phytoclasts with only a trace of inertinite. UV light shows a mid-orange fluorescence from spores and hydrocarbon specks, together with a trace of exinite.

Sample K 7467, 4020-35 m: Silty Shale, Ro=0.57(5) and Ro=0.91(6)

The sample has an overall bitumen staining, otherwise a moderate content of inertinite and reworked particles. Only a trace of (doubtful) vitrinite particles is recorded. UV light shows a mid-orange fluorescence from spores and a trace of exinite.

Sample K 7469, 4050-65 m: Shale and Siltstone, Ro=0.77(12)

The sample has a heavy bitumen staining and is found to be moderate to rich in organic material: Mainly inertinite and reworked particles, with only a trace of poor vitrinite particles and wispy particles. UV light shows a deep orange fluorescence from spore specks and a trace of exinite.

Sample K 7473, 4110-25 m: Shale and Siltstone, Ro=0.71(9) and Ro=1.05(3)

The sample has a heavy overall bitumen staining, otherwise a moderate content of inertinite and reworked particles, with only a trace of vitrinte wispy particles of variable reflectance. UV light shows a mid-orange fluorescence from spores and a trace of exinite.

Sample K 7475, 4140-55 m: Shale and Carbonate traces, Ro=0.72(6)

The sample has a strong bitumen staining, otherwise a low to moderate content of inertinite and reworked particles. Only a trace of vitrinite wispy particles is recorded. UV light shows a mid-to deep orange fluorescence from spores and a trace of exinite.

Sample K 7477, 4170-85 m: Shale, Ro=0.77(9)

The sample has a heavy bitumen staining, otherwise a moderate content of

inertinite and reworked particles. Only of trace of true vitrinite is recorded. UV light shows a light to mid-orange fluorescence from spores and a trace of exinite.

Sample K 7549, 4200-15 m: Mixed Shale Lithologies, Ro=0.64(5) and Ro=1.00(15)

A heavy bitumen staining is recorded in some cuttings, otherwise a moderate organic content. Some good vitrinite wisps and wispy particles are recorded in a few cuttings but inertinite is dominant. UV light shows a deep orange fluorescence from hydrocarbon specks and no exinite.

Sample K 7551, 4230-45 m: Shale and Siltstone, Ro=0.84(20)

The sample has a heavy bitumen staining, otherwise a moderate content of inertinite and reworked particles, with subordinate vitrinite wisps and particles. Very variable reflectance values. UV light shows a deep orange fluorescence from spores and a trace of exinite.

Sample K 7553, 4260 m: Shale, Ro=0.94(11)

A variable bitumen staining is recorded in the sample which contains a moderate to rich content of inertinite particles, with only a trace of vitrinite as wispy particles. UV light shows a deep orange fluorescence from spore specks and a trace of exinite.

Analysis in Transmitted Light

Dispersed Organic Matter in the Sediments

The interval 3680 to 4275 m of this well has been represented by 24 samples, all of which were rock fragments selected from ditch cutting samples ("picked samples").

The organic residues investigated consisted mostly of particles/fragments stuck together as more-or-less dense lumps or aggregates. The material is derived from different sources but the very poorly preserved sapropelised and finely disseminated remains of land plant are difficult to distinguish from the true amorphous material.

We have evaluated the residues from the investigated interval as composed of a major terrestrial element, dominantly cuticles. True amorphous material is considered as 25-40% of the total organic residues.

Most residues are rich and apparently have good potential for gas and oil.

The paleoenvironment during deposition of the material seems to have been an inner deltaic or lateral deltaic, low or fairly low energy area with restricted circulation and some reworking of older woody material. The marine influence, judged by the observed cysts, was variable.

At 4200 m and below, the energy seems somewhat higher, with more circulation.

On the basis of the colour of the pollen grains, and with support from cuticles and spores, we may subdivide the interval into four main zones;

3680 to 3805 m	immature deposits
3805 to 4065 m	moderate mature to mature
4110 to 4185 m	mature
4200 to 4275 m	mature

The colour tones of the individual samples apparently are controlled by the lithology and as a result the evaluated colour indices may be somewhat too high as maturation parameters.

Rock-Eval Pyrolyses

Zone A, B, C and D: None of the samples from these four zones were pyrolysed.

Zone E: One sample from this zone (3680-95 m) was pyrolysed and found to have a low hydrogen index typical for type III kerogen. The T_{max} value of 435°C indicates the sample to be moderate mature to mature. The low petroleum index ($S_1 + S_2$) indicates the sample to have a poor potential as a source rock for gas.

Zone F and zone G: One sample from each of these zones was pyrolysed and found to be similar to the analysed sample from zone E, but with a higher T_{max} indicating a higher maturity.

Zone H: Eighteen samples from this zone were pyrolysed and all were found to have a low to moderate hydrogen index and a moderate oxygen index. The T_{max} values indicate most of the samples to be mature, in the upper part (the start) of the oil window. The petroleum index is moderate to high for most of the samples indicating a good to rich potential as source rocks. The production index is high for all the samples indicating these to contain a large proportion of free hydrocarbons, possibly contaminated by migrated hydrocarbons. Based on the different results all the samples are found to contain mainly kerogen type III with a variable proportion of kerogen type II.

Zone I: Three samples from this zone were analysed. The sample from 4230-60 m is probably of kerogen type II while the two others are typical kerogen type III. Otherwise results are similar to those from zone H.

CONCLUSION

Detailed analyses were only performed on the lower 600 m of the well. The maturity of the sequence 1700-3700 m is based on the vitrinite reflectance and spore fluorescence data. For the last 600 m of the well maturity is based on the vitrinite reflectance, spore fluorescence, kerogen colour in transmitted light and the T_{max} values from the Rock-Eval analyses. The richness of the samples is based on TOC for the upper 2000 m of the analysed sequence and on TOC and Rock-Eval pyrolyses, with additional evidence from light hydrocarbon concentrations and the abundance of extractable C_{15+} hydrocarbons, for the last 600 m. Source rock quality is based mainly on Rock-Eval pyrolyses with additional evidence coming from visual kerogen examination and from the saturated hydrocarbon gas chromatograms.

Zone A, B, C and D; 1700-3350 m: These zones consist mostly of claystone with a fair abundance of extractable hydrocarbons. All four zones are found to be immature increasing to moderate mature from approximately 2000 m with a fair potential as source rocks for hydrocarbons.

Zone E: 3350-710 m: The claystone in this zone is found to be moderate mature to mature with a fair potential as a source rock for hydrocarbons. The lowermost samples are analysed in detail and these are found to be source rocks for gas.

Zone F; 3710-55 m: This zone consists of a mixture of lithologies. The black shale encountered in this zone is found to be mature with a good potential as a source rock for gas, while the other claystone lithologies have a fair potential as source rocks for gas.

Zone G; 3755-90 m: The sandstone in this zone is found to contain migrated hydrocarbons while the claystone is found to be mature with a fair potential as a source rock for gas.

Zone H; 3790-4200 m: The whole of this zone is found to have an oil window maturity with a rich potential as a source rock for gas and heavy oil. Both the Rock-Eval pyrolyses and the visual kerogen examination show the samples to be mainly gasprone. The gas chromatograms of the saturated fraction show well mature hydrocarbons with a relatively large

proportion of heavy n-alkanes, indicating an input from terrestrial material.

Zone I; 4200-90 m: This zone is also found to have an oil window maturity with, in parts, a good potential as a source rock for gas and heavy oil.

IKU

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
K6778	1700	1760	5				71	1766	5	.29	1.00
K6780	1760	2115	6				180	2121	6	.30	1.00
K6782	1820	1595	10				194	1605	11	.65	1.00
K6784	1880	862	5				67	867	5	.59	1.00
K6786	1940	1991	11				162	2002	11	.56	1.00
K6788	2000	1897	31				211	1928	31	1.60	1.00
K6790	2060	798	28	8			113	834	36	4.29	1.00
K6792	2120	5542	556	282	78	117	427	6575	1033	15.71	.66
K6794	2180	1316	139	114	34	61	557	1664	348	20.93	.56
K6796	2240	2434	487	466	124	298	1431	3808	1374	36.08	.42
K6798	2300	4469	769	726	171	391	1518	6526	2057	31.52	.44
K6800	2360	891	355	1055	360	947	2391	3608	2717	75.31	.38
K6802	2420	639	292	511	123	318	1147	1881	1243	66.06	.39
K6804	2480	7900	1208	1808	404	997	1831	12316	4416	35.86	.41
K6806	2540	17605	2428	4049	1366	3489	7937	28936	11332	39.16	.39
K6808	2600	14258	1872	1729	312	775	1405	18946	4688	24.74	.40
K6811	2660	6528	987	1330	299	700	1645	9844	3316	33.69	.43
K6813	2720	1475	218	245	65	142	361	2146	671	31.25	.46
K6815	2780	911	159	147	27	58	162	1301	390	29.97	.46
K6817	2840	1011	166	178	43	88	203	1486	475	31.96	.49
K6819	2900	1040	172	156	35	76	209	1479	439	29.70	.47
K6821	2960	1544	363	408	115	276	677	2706	1162	42.95	.42
K6823	3020	1056	120	71	15	34	90	1296	239	18.48	.43
K6825	3080	689	80	63	16	30	109	877	188	21.45	.54

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
K6940	3170	1763	287	374	115	238	346	2777	1014	36.51	.48
K6942	3230	3938	606	514	121	258	512	5437	1499	27.57	.47
K6944	3290	5912	708	549	140	271	874	7580	1668	22.01	.52
K6946	3350	3944	1097	1255	326	523	1001	7145	3201	44.80	.62
K6948	3410	888	144	148	61	79	274	1320	432	32.73	.77
K6950	3470	3535	760	659	189	247	361	5390	1855	34.42	.77
K6951	3500	2152	351	394	138	221	620	3256	1104	33.91	.62
K6952	3530	4016	398	265	54	95	133	4828	812	16.82	.57
K6953	3560	409	165	320	99	160	248	1233	744	60.34	.62
K6954	3590	1113	276	343	109	172	326	2013	900	44.71	.63
K7001	3650	877	299	530	234	384	1092	2324	1447	62.26	.61
K7003	3680	1121	421	585	161	242	542	2530	1409	55.69	.67
K7005	3710	2431	1090	2325	712	1679	3548	8237	5806	70.49	.42
K7006	3725	8482	3593	7457	1928	4845	8470	26305	17823	67.76	.40
K7431	3740	3958	1707	2931	621	1646	2684	10863	6905	63.56	.38
K7432	3755	2795	1247	2115	402	1060	1607	7619	4824	63.32	.38
K7433	3760	3003	2061	4079	720	1966	2184	11829	8826	74.61	.37
K7434	3775	6667	7282	18358	3142	9866	14317	45315	38648	85.29	.32
K7435	3790	10455	9895	28942	4299	14857	18051	68448	57993	84.73	.29
K7436	3805	5962	5394	9501	1290	4300	5677	26447	20485	77.46	.30
K7437	3820	20578	20475	29839	3062	10557	9897	84511	63933	75.65	.29
K7438	3835	15963	19758	21174	3784	12278	10403	72957	56994	78.12	.31
K7439	3850	67076	54349	81554	9678	34152	33210	241809	179733	74.33	.28
K7440	3865	49156	55978	68774	11668	38132	39443	224008	174552	77.92	.31
K7441	3880	37501	20429	21502	3633	12043	11565	95308	57807	60.65	.30

IKU

TABLE I a.

CONCENTRATION (ml 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
K7442	3895	47052	27623	34805	5065	16337	22836	130882	88830	64.05	.31
K7443	3905	60368	46741	64020	10723	34848	30863	216700	156332	72.14	.31
K7444	3920	23896	20870	27275	6578	21445	23830	100064	76168	76.12	.31
K7445	3935	53739	54342	74990	15576	53129	45219	251776	198037	78.66	.29
K7446	3950	20517	16481	20469	2755	9314	12413	69536	49019	70.49	.30
K7463	3965	30383	28310	42097	5935	19574	29551	126299	95916	75.94	.30
K7465	3995	25238	25024	39578	6299	21112	37548	117251	92013	78.48	.30
K7467	4020	29110	24471	26991	3040	8326	7706	91938	62828	68.34	.37
K7469	4050	26719	20948	22946	3028	8241	11049	81882	55163	67.37	.37
K7471	4080	69157	18446	13352	1626	4086	4694	106667	37510	35.17	.40
K7473	4110	31739	36563	12170	1849	4358	5634	186679	154940	83.00	.42
K7475	4140	60934	12905	6131	1149	2106	2885	83225	22291	26.78	.55
K7477	4170	26311	4972	2757	351	858	1015	35249	8938	25.36	.41
K7549	4200	22624	6128	1208	157	259	344	30376	7752	25.52	.61
K7551	4230	52592	14605	2274	243	373	533	70087	17495	24.96	.65
K7553	4260	116400	27886	8801	1658	2396	3994	157141	40741	25.93	.69

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

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

Sample	Depth	TOC	Lithology
K 6778	1700-30	0.52	100% Claystone, grey/light grey to brown-grey and greenish Sm.am. Siderite
K 6780	1760-90	0.54	100% Claystone, as above Sm.am. Sand; Siderite
K 6782	1820-50	0.55	95% Claystone, greenish grey to green-grey, brownish to grey-brown, light green 5% Siderite Sm.am. Sand
K 6784	1880-1910	0.56	90% Claystone, as above 10% Sand, clear, coarse to fine sub-angular-rounded
K 6786	1940-70	0.42	75% Claystone, as above 20% Sand 5% Limestone, white
K 6788	2000-30	0.38	85% Claystone, grey/light grey (some bluish) and brownish to grey-brown, some greenish 15% Sand and Sandstone Sm.am. Limestone
K 6790	2060-90	0.41	80% Claystone, as above 15% Sand and Sandstone, fine to coarse 5% Limestone, white-light grey

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

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

Sample	Depth	TOC	Lithology	
K 6792	2120-50	0.96	95%	Claystone, brownish to greenish and bluish grey, brownish light grey grading to dark grey
			5%	Sand/Sandstone
K 6794	2180-2210	0.38	100%	Claystone, grey to light grey, greenish to grey-green, some brownish
K 6796	2240-70	0.53	85%	Claystone, grey to light grey, greenish to green
			15%	Sand
K 6798	2300-30	0.66	90%	Claystone, as above
			10%	Sand
K 6800	2360-90	0.50	75%	Claystone, partly silty/sandy, mottled, as above, occasionally red-brown
			15%	Sand
			10%	Limestone, white to yellow-white
K 6802	2420-50	0.52	90%	Claystone, grey
			10%	Limestone, as above
K 6804	2480-2510	0.61	100%	Claystone, grey, calcareous to non-calcareous Sm.am. Limestone, white to yellow-brown
K 6806	2540-70	0.62	100%	Claystone, as above Sm.am. Marl/Siderite, very silty, yellow

014/M/2/mk

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

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

Sample	Depth	TOC	Lithology	
K 6808	2600-30	0.53	100%	Claystone, as above Sm.am. Siderite/Marl, yellow-brown
K 6811	2660-90	0.45	50% 15% 25% 10%	Claystone, grey-light grey Claystone, red-brown Marl, silty, light grey to brownish-white Additives (Coal, steel, mud)
K 6813	2720-50	0.47	95% 5%	Claystone, grey, non-calcareous and some calcareous, partly greenish and slightly brownish Siderite, brown, hard Additives (Coal/Lignite)
K 6815	2780-2810	0.38	100%	Claystone, grey, greenish to green, some red-brown, non-calcareous and some calcareous
K 6817	2840-70	0.45	100%	Claystone, as above
K 6819	2900-30	0.52	100%	Claystone, as above, light grey/grey to black (50%) (influenced by turbo-drill)
K 6821	2960-90	0.65	100%	Claystone, light grey/grey to black, occasionally laminated (turbo-drill), grey to light grey and green (20%)
K 6823	3020-50	0.48	95% 5%	Claystone, grey to dark grey (occasionally black), partly laminated (influenced by turbo-drill) Claystone, grey to light grey and greenish/green (? caved)

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC	Lithology	
K 6825	3080-3110	0.44	95%	Claystone, as above
			5%	Claystone, as above
K 6940	3170-3200	0.69	100%	Claystone, grey to light grey and dark grey, occasionally laminated (influenced by turbo-drill)
K 6942	3230-60	0.76	98%	Claystone, as above
		0.41	2%	Claystone, grey to green
K 6944	3290-3320	0.57	100%	Claystone, light grey to grey, some dark grey, occasionally laminated, slightly calcareous-non-calcareous (influenced by turbo-drill)
K 6946	3350-80	0.46	80%	Claystone, as above
		0.54	20%	Claystone, grey to green, some red-brown, non-calcareous to some calcareous
K 6948	3410-40	0.66	85%	Claystone, as above
			5%	Claystone, grey to green
		0.74	10%	Claystone, very silty, very calcareous, light grey/grey (slightly brownish)
K 6950	3470-3500	0.55	70%	Claystone, as above
		0.63	20%	Claystone, very calcareous, as above
		0.45	15%	Claystone, grey to green, as above (? caved)
		0.31		Sm.am. Marl, light grey

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC	Lithology	
K 6951	3500-30		15%	Claystone, as above
		0.76	75%	Claystone, very calcareous, as above
			10%	Claystone, grey to green, slightly to some calcareous
K 6952	3530-60	0.72	100%	Claystone, silty, some grading to clayey Siltstone, grey grading to light grey (calcareous), greenish to green, some red-brown, non-calcareous to calcareous Cement
K 6953	3560-90	0.64	70%	Claystone, slightly calcareous to very calcareous, grey, light grey, green
			25%	Claystone, very calcareous, as above
			5%	Limestone, white to brownish white
K 6954	3590-3620	0.66	75%	Claystone, grey, light grey (calcareous), green, non-calcareous to calcareous
		0.62	15%	Claystone, light grey to brown-grey, very calcareous
			10%	Limestone, white to yellow, some grey
K 7001	3650-65	0.71	70%	Claystone, as above
			10%	Claystone, very calcareous, as above
			20%	Marl to Limestone, yellowish light grey to yellow-brown, partly sandy

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC	Lithology	
K 7003	3680-95	0.61	93%	Claystone, as above
		2.17	7%	Shale, dark grey to black
				Sm.am. Coal (?additive)
K 7005	3710-25	0.53	50%	Claystone, grey, greenish/green
		1.46	5%	Shale, black to dark grey
			20%	Claystone, light grey/grey, very calcareous, dark brown-grey
			10%	Limestone, light to light yellow-brown, sideritic
		0.56	15%	Marl, light grey (partly slightly brownish)
				Sm.am. Coal (? additive)
K 7006	3725-40	0.60	35%	Claystone, as above
		2.59		Sm.am. Shale, dark grey; Limestone, sideritic
		0.68	55%	Claystone, very calcareous, light grey/grey, brownish to dark brown-grey
			10%	Limestone, light yellow grey/brown, sideritic
K 7431	3740-55	0.78	10%	Claystone, grey to dark grey
			90%	Cement
K 7432	3755-60	1.02	10%	Claystone, grey, some grading to dark grey, non-calcareous to very calcareous
			90%	Cement
K 7433	3760-75	0.99	15%	Claystone, grey to light and dark grey, calcareous to very calcareous
			85%	Cement

014/M/6/mk

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC		Lithology
K 7434	3775-90	0.92	35%	Claystone, as above
		1.44	30%	Marl, silty brownish light grey to light grey, partly sandy
		0.91	35%	Sandstone, very fine, slightly glauconitic and micaceous and lignitic, very calcareous, light brown-grey
K 7435	3790-3805	1.05	40%	Claystone, grey grading to light and dark, calcareous-very calcareous
		1.10	55%	Marl, as above
			5%	Sandstone, as above
K 7436	3805-20	0.79	40%	Claystone, non-calcareous to calcareous, grey, brownish, greenish
		1.01	10%	Limestone, white/light grey, loose to hard
		5.47	8%	Claystone, dark grey to black (brownish), non-calcareous, finely disseminated Pyrite, earthy
			5%	Sandstone
			40%	Cement
				Sm.am. Coal
K 7437	3820-35	7.16	45%	Claystone, silty, dark grey to black (slightly brownish), non-calcareous, earthy
			5%	Claystone, light grey/grey to greenish (? caved)
			50%	Cement

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC	Lithology	
K 7438	3835-50	6.01	95%	Claystone, dark grey to black, as above
			5%	Claystone, grey
K 7439	3850-65	4.68	90%	Claystone, as above, pyritic
			10%	Claystone, light grey/grey (? caved) (the fine fraction contaminated)
K 7440	3865-80	5.50	95%	Claystone, dark grey
			5%	Claystone, light grey to grey
K 7441	3880-95	4.40	80%	Claystone, silty, dark grey, some shaly
			15%	Limestone, yellowish grey-brown, sideritic, dolomitic
			5%	Claystone, light grey/grey, green (the fine fraction some contaminated)
K 7442	3895-3905	5.97	40%	Claystone, dark grey occasionally coaly (plants)
		1.88	60%	Limestone, light brown-grey to dark grey-brown, sideritic, silty
K 7443	3905-20	1.20	50%	Claystone, as above, some shaly
		3.14	50%	Limestone, yellowish grey-brown, sideritic, dark grey-brown (the fine fraction contaminated)
K 7444	3920-35	8.38	15%	Claystone, as above
		1.07	80%	Limestone, sideritic
		1.10	5%	Claystone, light grey to grey, obs. greenish

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC	Lithology	
K 7445	3935-50	1.32	85%	Limestone, light yellow-grey, silty, brittle to dark hard grey-brown (the fine fraction contaminated)
		3.15	15%	Claystone
K 7446	3950-65	3.49	25%	Claystone, as above
		1.01	75%	Limestone, sideritic
K 7463	3965-80	3.86	50%	Claystone, very silty, dark grey
		1.22	50%	Limestone, silty, light yellow-grey to yellow-brown
K 7465	3995-4005	2.23	80%	Claystone, as above
		1.25	20%	Limestone, as above
K 7467	4020-35	2.59	100%	Silty Claystone to Silt/Clay-stone, brownish dark grey, some light grey and grey, obs. light green
K 7469	4050-65	2.57	95%	Silty Claystone, as above
			5%	Limestone, as above
K 7471	4080-95	2.61		The cuttings material consists of caved silty Claystone as above and some Sand, while Core samples only show Sandstone
K 7473	4110-25	2.75		As above
K 7475	4140-55	3.10	10%	Claystone, grey (slightly brownish), dark grey
			87%	Sandstone, very fine to fine, brownish light grey
			3%	Coal

IKU

LITHOLOGY AND TOTAL ORGANIC CARBON MEASUREMENTS

TABLE NO.: II

WELL NO.: 30/7-8

Sample	Depth	TOC	Lithology	
K 7477	4170-85	3.15	85%	Claystone to clayey Siltstone, brown-grey to dark grey, some micaceous
			10%	Sandstone, very fine to fine, white, calcareous
			5%	Coal
K 7549	4200-15	1.88	20%	Claystone, brown-grey/grey (waxy) to dark grey, silty and some micaceous, very slickensided
			50%	Sandstone, fine-medium, white/ clear with brown staining, slightly calcareous
			20%	Coal, some interlamination with Claystone (some mud contamination)
K 7551	4230-45	1.85	35%	Claystone, as above
			20%	Sandstone, as above, some coarse
			25%	Coal
			20%	Mud/Cement Sm.am. Siderite/Dolomite, dark grey-brown
K 7553	4260-75	2.99	80%	Claystone, silty, brownish dark grey, very slickensided (deformation)
			5%	Sand/Sandstone
			5%	Coal
			10%	Cement

IKU

TABLE : 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-7003	3680	3.8	4.6	.8	.2	1.1	3.5	1.2
K-7435	3790	15.8	21.1	8.5	4.1	12.6	8.5	1.0
K-7437	3820	31.0	335.1	122.4	79.2	201.6	133.5	6.9
K-7438	3835	36.1	272.0	124.7	53.5	178.2	93.8	5.1
K-7439	3850	24.7	203.5	76.0	43.8	119.8	83.7	5.3
K-7440	3865	10.0	59.6	22.2	10.8	33.0	26.6	4.8
K-7441	3880	19.9	159.5	67.2	34.2	101.4	58.1	5.0
K-7442	3895	12.7	91.8	41.9	15.7	57.6	34.2	4.2
K-7443	3905	5.7	35.2	15.1	8.3	23.4	11.8	3.1
K-7444	3920	2.9	12.7	4.6	1.4	6.0	6.7	2.9
K-7445	3935	1.3	7.1	2.5	1.2	3.7	3.4	3.2
K-7446	3950	23.4	118.6	57.1	17.7	74.8	43.9	2.8
K-7463	3965	11.5	72.7	35.3	11.2	46.4	26.3	3.2
K-7465	3995	16.5	79.7	40.3	12.2	52.6	27.1	2.4
K-7467	4020	31.0	119.3	57.2	19.0	76.2	43.1	2.5
K-7469	4050	29.1	109.9	55.7	18.7	74.4	35.5	2.7
K-7473	4110	28.0	126.6	60.2	22.4	82.6	44.1	3.0
K-7475	4140	7.2	33.1	16.7	6.5	23.2	9.9	2.6
K-7477	4170	26.3	138.7	55.9	24.8	80.6	58.1	3.3
K-7549	4200	20.7	56.0	24.1	10.7	34.8	21.2	2.4
K-7551	4230	19.7	74.4	24.0	13.1	37.1	37.3	3.7
K-7553	4260	17.6	28.0	9.1	4.3	13.4	14.6	2.5

IKU

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-7003	3680	1211	221	63	284	926
K-7435	3790	1335	539	258	797	538
K-7437	3820	10810	3948	2555	6504	4306
K-7438	3835	7535	3455	1481	4936	2598
K-7439	3850	8239	3077	1773	4850	3389
K-7440	3865	5960	2220	1080	3300	2660
K-7441	3880	8015	3377	1721	5097	2918
K-7442	3895	7228	3298	1238	4535	2693
K-7443	3905	6175	2653	1453	4105	2070
K-7444	3920	4379	1572	497	2069	2310
K-7445	3935	5462	1938	923	2862	2600
K-7446	3950	5068	2439	756	3194	1874
K-7463	3965	6322	3068	970	4038	2283
K-7465	3995.	4830	2444	742	3185	1645
K-7467	4020	3848	1845	612	2457	1391
K-7469	4050	3777	1913	643	2557	1220
K-7473	4110	4521	2150	799	2948	1573
K-7475	4140	4597	2317	900	3217	1381
K-7477	4170	5274	2124	942	3066	2208
K-7549	4200	2705	1165	516	1681	1024
K-7551	4230	3777	1218	664	1882	1894
K-7553	4260	1591	518	245	764	827

IKU

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-7003	3680	104.4	19.1	5.4	24.5	79.9
K-7435	3790	130.9	52.9	25.3	78.2	52.7
K-7437	3820	156.4	57.1	37.0	94.1	62.3
K-7438	3835	148.9	68.3	29.3	97.6	51.4
K-7439	3850	156.0	58.3	33.6	91.9	64.2
K-7440	3865	124.2	46.3	22.5	68.8	55.4
K-7441	3880	160.9	67.8	34.6	102.4	58.6
K-7442	3895	171.3	78.1	29.3	107.5	63.8
K-7443	3905	196.7	84.5	46.3	130.7	65.9
K-7444	3920	152.6	54.8	17.3	72.1	80.5
K-7445	3935	173.4	61.5	29.3	90.8	82.5
K-7446	3950	178.5	85.9	26.6	112.5	66.0
K-7463	3965	198.8	96.5	30.5	127.0	71.8
K-7465	3995	203.8	103.1	31.3	134.4	69.4
K-7467	4020	153.9	73.8	24.5	98.3	55.6
K-7469	4050	140.9	71.4	24.0	95.4	45.5
K-7473	4110	153.3	72.9	27.1	99.9	53.3
K-7475	4140	175.5	88.4	34.4	122.8	52.7
K-7477	4170	161.8	65.2	28.9	94.1	67.7
K-7549	4200	114.6	49.4	21.9	71.2	43.4
K-7551	4230	66.0	21.3	11.6	32.9	33.1
K-7553	4260	64.4	21.0	9.9	30.9	33.5

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-7003	3680	18.3	5.2	23.5	350.0	76.5	30.7
K-7435	3790	40.4	19.3	59.7	208.8	40.3	148.2
K-7437	3820	36.5	23.6	60.2	154.5	39.8	151.0
K-7438	3835	45.9	19.7	65.5	233.3	34.5	190.0
K-7439	3850	37.3	21.5	58.9	173.5	41.1	143.1
K-7440	3865	37.2	18.1	55.4	205.6	44.6	124.1
K-7441	3880	42.1	21.5	63.6	196.3	36.4	174.7
K-7442	3895	45.6	17.1	62.7	266.4	37.3	168.4
K-7443	3905	43.0	23.5	66.5	182.6	33.5	198.3
K-7444	3920	35.9	11.3	47.2	316.7	52.8	89.6
K-7445	3935	35.5	16.9	52.4	210.0	47.6	110.1
K-7446	3950	48.1	14.9	63.0	322.8	37.0	170.5
K-7463	3965	48.5	15.4	63.9	316.1	36.1	176.8
K-7465	3995	50.6	15.4	65.9	329.4	34.1	193.7
K-7467	4020	47.9	15.9	63.9	301.4	36.1	176.7
K-7469	4050	50.7	17.0	67.7	297.4	32.3	209.6
K-7473	4110	47.5	17.7	65.2	269.2	34.8	187.4
K-7475	4140	50.4	19.6	70.0	257.4	30.0	233.0
K-7477	4170	40.3	17.9	58.1	225.4	41.9	138.9
K-7549	4200	43.1	19.1	62.1	225.8	37.9	164.2
K-7551	4230	32.3	17.6	49.8	183.5	50.2	99.4
K-7553	4260	32.6	15.4	48.0	211.1	52.0	92.3

TABLE VII

TABULATION OF DATAS FROM THE GASCHROMATOGRAMS

IKU No.	DEPTH (m)	PRISTANE / n-C17	PRISTANE / PHYTANE	CPI
K7003	3680	.9	2.0	.9
K7435	3790	.4	1.6	1.0
K7437	3820	.3	1.1	.9
K7438	3835	.3	1.0	.9
K7439	3850	.3	1.0	.9
K7440	3865	.3	1.2	.9
K7441	3880	.4	1.4	1.0
K7442	3895	.4	1.5	1.0
K7443	3905	.4	1.5	.9
K7444	3920	.4	1.9	1.0
K7445	3935	.5	1.7	1.0
K7446	3950	.5	1.8	1.0
K7463	3965	.5	1.9	1.0
K7465	3995	.4	1.9	1.0
K7467	4020	.4	1.9	1.0
K7469	4050	.4	1.9	1.0
K7473	4110	.4	1.8	1.0
K7475	4140	.4	2.0	1.0
K7477	4170	.4	1.7	1.0
K7549	4200	.4	1.8	1.0
K7551	4230	.4	1.7	1.0
K7553	4260	.4	1.7	1.0

IKU

VITRINITE REFLECTANCE MEASUREMENTS

TABLE NO.: VIII

WELL NO.: 30/7-8

Sample	Depth	Vitrinite reflectance	Fluorescence in UV light	Exinite content
K 6792	2120-50	0.33(21)	Yellow + Yellow/Orange	Low-Moderate
K 6798	2300-30	0.43(13)	Yellow/Orange	Low-Moderate
K 6806	2540-70	0.39(7)	Yellow/Orange	Trace
K 6813	2720-50	0.61(1)	Light Orange	Trace
K 6821	2960-90	0.53(2)	Light Orange	Trace
K 6940	3170-200		Yellow/Orange	Trace
K 6946	3350-80		Yellow/Orange	Trace
K 6951	3500-80	0.83(7)		Nil
K 7003	3680-95	0.64(1) 1.16(8)	Light Orange	Trace
K 7006	3725-40	0.51(2) 0.82(2)	Mid Orange	Low
K 7432	3755-60			Nil
K 7434	3775-90	0.68(5)	Mid-deep Orange	Trace
K 7435 Claystone	3790-805	0.36(1) 0.76(1)		Nil
K 7435 Marl	3790-805	0.62(1) 1.17(11)	Yellow/Orange	Trace
K 7436	3805-20	0.44(2) 0.71(3)		Nil
K 7437	3820-35	0.86(3)	Mid-deep Orange	Trace
K 7438	3835-50	0.68(2)		Nil
K 7439	3850-65	0.69(6)		Nil
K 7440	3865-80	0.49(3) 0.76(4)		Nil
K 7441	3880-95	0.70(9)	Mid-deep Orange	Trace
K 7442	3895-905	0.65(15)	Mid-Orange	Trace
K 7443 Claystone	3905-20	0.75(6)	Mid-Orange	Trace
K 7443 Limestone	3905-20	0.63(5)	Mid-Orange	Low
K 7444	3920-35	0.71(15)	Mid-Orange	Trace
K 7445 Claystone	3935-50	0.82(11)	Mid-deep Orange	Trace
K 7445 Limestone	3935-50		Mid-Orange	Trace
K 7446	3950-65	0.71(21)	Mid-Orange	Trace

IKU

VITRINITE REFLECTANCE MEASUREMENTS

TABLE NO.: VIII

WELL NO.: 30/7-8

Sample	Depth	Vitrinite reflectance	Fluorescence in UV light	Exinite content
K 7463	3965-80	0.61(15)	Mid-Orange	Trace
K 7465	3995-4005	0.62(7) 0.97/1)	Mid-Orange	Trace
K 7467	4020-35	0.57(5) 0.91(6)	Mid-Orange	Trace
K 7469	4050-65	0.77(12)	Deep Orange	Trace
K 7473	4110-25	0.71(9) 1.05(3)	Mid-Orange	Trace
K 7475	4140-55	0.72(6)	Mid-deep Orange	Trace
K 7477	4170-85	0.77(9)	Light + Mid-Orange	Trace
K 7549	4200-15	0.64(5) 1(15)	Deep Orange	Nil
K 7551	4230-45	0.84(20)	Deep Orange	Trace
K 7553	4260	0.94(11)	Deep Orange	Trace

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX

WELL NO.: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
K 7003	3680-95	He,Cut,R!W,P,S/Am,Cy	F-M	poor	1	Abundant pyrite framboids and resistant minerals/min aggr. Differential decay. Am.aggregates.
K 7006	3725-40	Am,Cy/He,Cut,W,WR!P,S	F-M	poor	1	Dense amorphous aggregates. Differential decay. Pyrite framboids.
K 7435	3790-805	He,P,W,WR!/Am,Cy	F	poor	1	Arbitrary proportions Am/He as the amorphous aggregates are of organic/inorganic nature. Preservation controlled by carbonate lithology. Poor 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

01/I/1/jlh

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX

WELL NO.: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
K 7436	3805-20	Cut,He,P,WR!W/Am,Cy	F-M-L	poor	(1) 2	Amorphous dense dark aggregates of sapropelised material, mostly of herbaceous nature.
K 7437	3820-35	Am/Cut,He,W,P	F-M-L	poor	$^{2}/_{2+}$	Amorphous dense dark aggregates of true amorphous and sapropelised herbaceous material.
K 7438	3835-50	He,W,Cut,P/Am	F-M	poor	$^{2}/_{2+}$	Dense, very dark aggregates, supposed to be dominantly sapropelised terrestrial material.
K 7439	3850-65	Cut,He,W,P/Am	F-M	poor	$^{2}/_{2+}$	

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

01/I/2/jlh

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX

WELL NO.: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
K 7440	3865-80	Cut, He,W,P/Am	F-M	poor	$^{2}/_{2+}$	Less dense aggregates than in the interval above, with embedded crystals.
K 7441	3880-95	He,Cut,W,WR!,P/Am,Cy	F-M-L	poor to good	$^{2}/_{2+}$	Tasmanites and well preserved Early Cretaceous cysts.
K 7442	3895-905	He,Cut,W,WR!,P/Am	F-M-L	poor	$^{2}/_{2+}$	Pollen more abundant than in the above interval.
K 7443	3905-20	Cut,He,P,W/Am,Cy	F-M-L	poor	$^{2-}/_{2}$	As 3895-905 abundant pollen.
K 7444	3920-35	Cut,W,P,He/Am,Cy	F-M-L	poor	$2\ ^{2}/_{2+}$	More woody material (semifusinite and fusinite).

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

01/I/3/jlh

IKU

VISUAL KEROGEN ANALYSIS

TABLE NO.: IX

WELL NO.: 30/7-8

Sample	Depth	Composition of residue	Particle size	Preservation-palynomorphs	Thermal maturation index	Remarks
K 7467	4020-35	He,WR!,W,He,P/Am	F-M-L	poor	$^{2}/_{2+}$	Aggregates as above. Rich but extremely poorly preserved palynomorphs.
K 7569	4050-65	Cut,He,WR!,W,P/Am	F-M-L	poor	$^{2}/_{2+}$	Palynomorphs as above, destroyed by pyrite cavities. Fungi. Aggregates. Tasmanites.
K 7473	4110-25	Cut,He,WR!,W,P/Am	F-M-L	poor	$^{2+}/_{3}$	As above.
K 7475	4140-55	Cut,W,WR!,P,He/Am	F-M-L	poor	$^{2+}/_{3-}$	As above but increased woody material (fusinite/semifusinite).
K 7477	4170-85	Cut,W,WR!,P,He/Am	F-M-L	poor	$^{2+}/_{3-}$	As sample 4140-55. At least some of the material is from Late Jurassic beds.

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

01/I/5/jlh

TABLE X

ROCK EVAL PYROLYSES

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)
K7003	3680	.33	.80	.44	2.17	37	20	1.13	.29	435
K7006	3725	.64	1.08	1.06	2.59	42	41	1.72	.37	441
K7435	3790	.56	.48	.60	1.02	47	59	1.04	.54	448
K7436	3805	2.80	5.87	.58	5.47	107	11	8.67	.32	438
K7437	3820	6.71	10.25	1.04	7.16	143	15	16.96	.40	430
K7438	3835	4.23	5.05	.88	6.01	84	15	9.28	.46	431
K7439	3850	3.84	5.29	.61	4.68	113	13	9.13	.42	435
K7440	3865	3.05	5.78	.65	5.50	105	12	8.83	.35	441
K7441	3880	5.48	7.91	.51	4.41	179	12	13.39	.41	441
K7442	3895	3.24	4.79	.48	5.97	80	8	8.03	.40	443
K7443	3905	3.33	4.47	.45	3.14	142	14	7.80	.43	441
K7444	3920	4.01	5.94	.62	8.38	71	7	9.95	.40	440
K7445	3935	2.09	2.19	1.34	3.15	70	43	4.28	.49	443
K7446	3950	3.94	3.87	.70	3.49	111	20	7.81	.50	444
K7463	3965	3.75	4.05	.68	3.86	105	18	7.80	.48	445
K7465	3995	2.36	2.30	.56	2.23	103	25	4.66	.51	446
K7467	4020	3.21	5.03	1.20	2.59	194	46	8.24	.39	444
K7469	4050	1.81	2.14	.71	2.57	83	28	3.95	.46	449
K7473	4110	2.47	4.07	.52	2.75	148	19	6.54	.38	445
K7475	4140	2.49	3.38	.41	3.10	109	13	5.87	.42	443
K7477	4170	3.62	5.54	.40	3.15	176	13	9.16	.40	443
K7549	4200	.84	1.52	.60	1.88	81	32	2.36	.36	449
K7551	4230	1.92	4.33	.61	1.85	234	33	6.25	.31	448
K7553	4260	.65	1.43	.53	2.99	48	18	2.08	.31	455