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REPORT ON THE PETROLEUM GEOCHEMICAL APPRAISAL OF SAMPLES FROM THE CONOCO NORWAY 24/9 - 2 WELL USING THE ROCK-EVAL PYROLYSIS METHOD

by

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CONTENTS

TABLES

I

INTRODUCTION

A geochemical study has been carried out on part of the 24/9-2 Norwegian North Sea Well, on behalf of the Continental Oil Company of Norway Incorporated. Nine sidewall core samples and five of wet ditch cuttings in sealed cans were received from the interval 1,980 to 2,703.5 metres. These samples were analysed by the IFP/Fina pyrolysis method using the Rock-eval apparatus to establish parameters of kerogen type, maturity and source rock potential. The five wet ditch cuttings samples were, in addition, analysed to determine the proportions of hydrocarbon gases in the can airspace, and to identify the abundance and nature of both gaseous and gasoline range hydrocarbons in the washed cuttings.

II

RESULTS AND INTERPRETATION

The results of the geochemical study of the 24/9-2 Well are presented in Tables 1, 2 and 3.

A. LIGHT HYDROCARBON ANALYSIS (Tables 1, 2)

Hydrocarbons present in the five can headspaces were analysed, followed by analysis of the gaseous and gasoline range hydrocarbons.

1. Headspace Gas Analysis

Prior to unsealing the canned samples an aliquot of the head or air-space gas was removed and analysed for the gaseous C_1 to C_4 hydrocarbons. The results of these analyses are presented in Table 1.

The most useful parameter to be obtained from the headspace gas analyses is the proportion of wet gases (C_2 to C_4) in the gaseous hydrocarbon fraction (C_1 to C_4); only methane is found in immature sediments, with the wet gases being generated as maturity is reached. Wet gases in the five samples make up between 50% and 80% of the gaseous hydrocarbon fraction, indicating that some of the contained organic matter has reached an early level of thermal maturity. Hydrocarbon abundance in these samples is, however, very low, suggesting that hydrocarbon generating organic matter is in low concentrations.

2. Gaseous and Gasoline Range Hydrocarbons

As with headspace gas analysis the proportion of wet gases in the gaseous hydrocarbons liberated from the ditch cuttings samples can be used to estimate the maturity of the analysed material. Table 2 shows that wet gases contribute more than 90% of the gaseous hydrocarbon content, but rarely exceed 200 ppb. abundance. These data concur with those obtained from the headspace gas analyses and similar conclusions are drawn.

Gasoline hydrocarbon abundance is extremely low, only traces of the C_5 to C_7 hydrocarbon components being observed. This could tentatively be interpreted to indicate a predominantly humic type of organic matter at a low level of thermal maturity.

B. ORGANIC CARBON CONTENT

The lithologies of the samples are dominantly medium grey calcareous shales. Organic carbon contents are between 0.20% and 1.20% with twelve of the fourteen samples containing less than 1% so that the majority contain below average organic contents and cannot be significant source rocks.

C. PYROLYSIS (Table 3)

The pyrolysis technique involves oven heating of samples from 250° to 550°C over a period of approximately 15 minutes. During this time, three pulses of gases are released and recorded as peaks on the appropriate detectors. The first of these pulses relates to hydrocarbons present in the sediment which could normally be extracted in organic solvents (present source rock potential, including reservoired hydrocarbons). The second pulse relates to hydrocarbons released by thermal breakdown of kerogen (optimum source potential of sediments) whilst the temperature at which these are liberated can be used to identify the present maturation level. The third pulse, relating to liberated CO_2, can be used in conjunction with the other parameters to make an assessment of the kerogen type, in a similar manner to that used by Van Krevelan with elemental analysis data.

The parameters used are the hydrogen index, oxygen index, temperature of maximum rate of pyrolysis and the production index.

The hydrogen index is a measure of the hydrocarbon generating potential of the kerogen. Oil source rocks would have values above 200, and immature oil source rocks values above 550.

The oxygen index indicates the presence of vitrinite. Index values of 50 show that the vitrinite is immature, with values between 35 and 50, is transitionally mature and for values below 35, vitrinite reflectivities above 0.5% could be anticipated for particulate vitrinite.

The temperature of maximum rate of pyrolysis depends on the nature and maturity of the organic matter, but the transition to maturity occurs between 435^{o} and 445^{o} C for both vitrinite and sapropelic kerogens. The transition from oil generation to dry gas generation is indicated by temperatures between 445^{o} and 460^{o}C.

The production index is the ratio of the amounts of hydrocarbons released in the first phase of heating to the total released. The index increases with maturity. Anomalously high values indicate staining.

The results of pyrolysis of the samples from the 24/9-2 (N) Well show generally low hydrogen indices and high oxygen indices and indicate without doubt that the organic matter is immature and vitrinitic in composition. It is anticipated that particles of vitrinite in these samples would give reflectivities not above 0.4%. The level of maturity is confirmed by the temperatures of maximum pyrolysis which are never higher than 420^{o} C.

One exception to the general composition of the samples is shown by the sidewall core at 2,125.5 which appears to contain an appreciable amount of sapropel indicated by a hydrogen index of 354. However, the low organic carbon content, 0.46%, of this sample precludes it from being a significant oil source.

Of the parameters, only the production index shows a trend with increasing depth, but the high value of this parameter given by the sample at 2,521.5 metres suggests that oil stain is present and the samples at 2,510 metres and 2,574 metres must be viewed with suspicion also.

III

CONCLUSIONS

Light hydrocarbon analysis shows that the proportion of hydrocarbon generating organic matter in the samples is low but is transitionally mature. Pyrolysis analysis shows that in general the composition of the organic matter is vitrinitic and quite immature. Only one sample showed potential for oil generation,but it has an overall low organic content. Minor staining is believed to be present in samples at 2,510 metres, 2,521.5 metres and 2,574 metres.

TABLE 1

HEADSPACE GAS ANALYSIS DATA

COMPANY: CONOCO NORWAY WELL: 24/9-2 LOCATION: NORWEGIAN N. SEA

SAMPLE DEPTH (METRES)	TOTAL C_1-C_4 GAS (%)	% C_1	% C_2	% C_3	% iso C_4	% n-C_4
1980	0.2987	49.28	10.38	21.12	9.78	9.04
2010	0.4003	31.65	14.14	30.90	10.92	12.39
2070	0.7227	30.10	15.65	31.22	10.56	12.47
2130	0.5846	19.26	17.89	43.79	10.30	8.76
2160	0.8519	36.67	12.99	20.54	17.11	12.98

TABLE 2

GASEOUS AND GASOLINE HYDROCARBON DATA

COMPANY: CONOCO NORWAY WELL: 24/9-2 LOCATION: NORWEGIAN N. SEA

% C_1 to C_4 (GASEOUS HYDROCARBONS)								
DEPTH (METRES)	1980	2010	2070	2130	2160			
C_1	9	2	3	3	2			
C_2	4	4	2	6	8			
C_3	31	47	31	32	49			
iso-C_4	*	*	*	*	*			
n-C_4	56	47	64	59	41			
TOTAL ABUNDANCE P.P.B	41	127	57	162	195			

% C_5 to C_7 (GASOLINE RANGE HYDROCARBONS)								
ISO-PENTANE								
N-PENTANE								
CYCLOPENTANE								
2-ME.PENTANE								
3-ME.PENTANE								
N-HEXANE								
ME-CYCLOPENTANE								
CYCLOHEXANE								
2-ME.HEXANE								
3-ME.HEXANE								
3-ETHYLPENTANE								
N-HEPTANE								
BENZENE								
DIME.PENTANE								
ME.CYCLOHEXANE								
TOTAL ABUNDANCE P.P.B	tr	tr	tr	tr	tr			

TABLE 3

PYROLYSIS DATA

COMPANY: CONOCO NORWAY WELL: 24/9-2 LOCATION: NORWEGIAN N. SEA

SAMPLE DEPTH (METRES)	ORGANIC CARBON % OF ROCK	MAX. RATE OF PYROLYSIS T^oc	PRODUCTION INDEX	OIL & GAS	H.I.	O.I.
1. 1980	0.44	411	0.30	0.38	61	309
2. 2010	0.66	413	0.27	0.92	103	253
3. 2070	0.58	418	0.23	0.62	83	241
4.+ 2125.5	0.46	409	0.07	1.77	354	272
5. 2130	1.20	410	0.15	1.47	103	116
6. 2160	1.06	419	0.12	1.38	117	116
7.+ 2280	0.42	415	0.26	0.14	24	102
8.+ 2440	0.70	419	0.22	0.93	104	66
9.+ 2468	0.55	420	0.25	0.32	44	96
10.+2510	0.66	415	0.40	0.98	88	142
11.+2521.5	0.20	*	0.80	0.07	5	200
12.+2533	0.62	417	0.25	0.97	116	115
13.+2574	0.42	408	0.41	0.25	36	324
14.+2703.5	0.20	*	*	*	*	815

H.I. : Hydrogen Index

O.I. : Oxygen Index

Oil & Gas : Hydrocarbon content in Kg per metric ton of rock.

+ : Sidewall Core

* : No data