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REPORT ON A PETROLEUM GEOCHEMICAL EVALUATION OF THREE SIDEWALL CORE SAMPLES FROM THE CONOCO NORWAY 24/9 - 2 WELL

by

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I

INTRODUCTION

This report finalises the geochemical study carried out on the Conoco Norway 24/9-2 well, the initial work being discussed and presented in our Report No. 4132P.

In the first part of this study the parameters of kerogen type, maturity and source rock potential were established for nine sidewall cores and five wet ditch cuttings samples; this involved the use of both light hydrocarbon analysis and the IFP/Fina pyrolysis method using the Rock-Eval apparatus.

The second part of this study as detailed in this report, involved the examination of non-indigenous hydrocarbon material in reservoir-type lithologies as represented by three extra sidewall core samples. Examination of these samples included analysis for light hydrocarbon content, by the pyrolysis method and by extraction of C_{15+} hydrocarbons for gas chromatography analysis of the saturate fraction.

It was requested that, if any source rocks had been located, an assessment of their potential to generate any of the hydrocarbons found in the reservoir lithologies be made.

II

RESULTS AND INTERPRETATION

The results of the study of the three sidewall core samples are presented in Table 1.

A. ORGANIC CARBON CONTENT AND LITHOLOGY

The two samples, from 2,102.5 and 2,103.5 metres comprise a light grey-brown, fine to medium grained loose sand with a slight oil or diesel smell. The sample at 2,105 metres comprises a relatively clean yellow-grey silty sand alternating with grey-brown argillaceous material.

Organic carbon contents are all below 1%, ranging from 0.65% up to 0.99% in the sample at 2,102.5 metres.

B. LIGHT HYDROCARBON ANALYSIS

Analysis of the samples for the presence of both gaseous (C_1 to C_4) and gasoline range (C_5 to C_7) hydrocarbons was carried out. Very little hydrocarbon material was encountered in either the gaseous or gasoline ranges with only the sample at 2,105 metres containing more than a few ppb. gasoline hydrocarbons. This suggests that hydrocarbons in these samples are either of a heavy, residual type and do not contain any of the lighter, more volatile hydrocarbons, or that only traces of hydrocarbons have been generated from very low rank indigenous organic matter.

C. GAS CHROMATOGRAPHY OF EXTRACTS

Organic material was removed from the three samples by extraction in dichloromethane. In view of the very minor quantities of material recovered it was not possible, by fractionation of the extract, to obtain a saturate hydrocarbon fraction sufficient for gas chromatographic analysis. It was, however, possible to analyse the whole extract.

The three samples, though yielding data of poor quality, show a high range of n-alkanes (up to $n\text{-}C_{30}$), and a carbon preference index approaching unity.

This suggests a heavy oil residue derived from a just mature source rock. The two loose sand samples also show a lower proportion of the lighter alkanes up to n-C_{22} but with high proportions of pristane and phytane relative to n-C_{17} and n-C_{18}. The analyses are unlike those of normal North Sea oils, but appear to show that the oil has undergone some biodegradation which has resulted in the selective removal of the n-alkanes.

D. PYROLYSIS

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.

A significant oxygen index indicates the presence of vitrinite. Index values of more than 50 show that the vitrinite is immature; values between 35 and 50, transitionally mature; 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° and 445°C for both vitrinite and sapropelic kerogens. The transition from oil generation to dry gas generation is indicated by temperatures between 445° and 460°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 the pyrolysis of the three samples show low hydrogen indices (not obtained in one sample) of 46 to 192, and high oxygen indices of between 70 and 187; these indicate organic matter which is immature and vitrinitic in type. It is anticipated that reflectivities would not exceed 0.4%, this being confirmed by the temperatures of maximum rate of pyrolysis which do not exceed 430°C.

It was possible to obtain production indices for two samples and these values are anomalously high both as absolute values and when compared to adjacent values as described in our previous report. Such high values at the estimated level of maturity are indicative of an oil stain.

III

CONCLUSIONS

From our studies of the 24/9-2 well it is possible to make the following conclusions:

The two reservoir lithologies at 2,102.5 and 2,103.5 metres, and to a lesser extent that at 2,105 metres, contain very limited quantities of an oil residue, in addition to some indigenous, low rank, humic organic matter. The oils are not associated with gas and gasolines and have unusual compositions. It is concluded that they have been water flushed and biodegraded.

The source rocks analysed over the interval 1,980 to 2,703.5 metres are considered insufficiently rich in organic matter or in maturity to generate any significant quantities of hydrocarbons. It is suggested that at their present levels of thermal maturity, the source rock samples have not generated the reservoired hydrocarbons, although those samples where the organic carbon contents reach 1% might yield minor oil and gas at much higher levels of thermal maturity offstructure. A deeper source rock could also have been responsible for the reservoired hydrocarbons.

TABLE 1

PYROLYSIS DATA

SAMPLE DEPTH (FEET)	ORGANIC CARBON % OF ROCK	MAX. RATE OF PYROLYSIS T°C	PRODUCTION INDEX	OIL & GAS	H.I.	O.I.
2102.5	0.99	*	1.00	14.26	*	70
2103.5	0.65	430	0.71	4.11	192	187
2105.0	0.65	425	*	0.30	46	106

H.I. : Hydrogen Index
O.I. : Oxygen Index
Oil and Gas : Hydrocarbon content in Kg per metric ton of rock