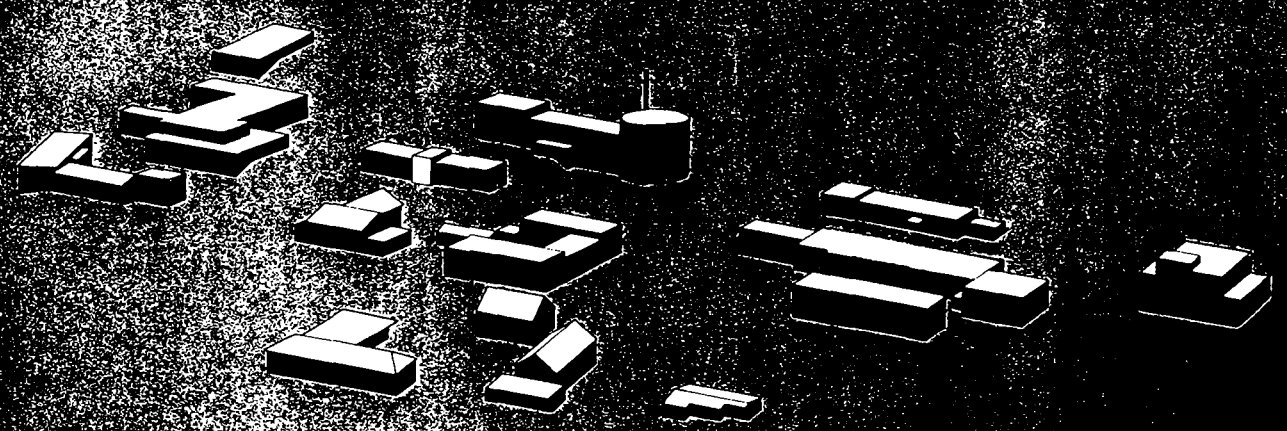
statoil DENNE RAPPORT TILHØRER
UND-ARKIVET
L.NR. 12384060027
KODE Well 30/2-1 nr 46
Returneres etter bruk

REPORT NO.
IFE/KR/F-84/018

REPORT TITLE
REPORT ON STABLE ISOTOPES ($\delta^{13}C$ AND δD) ON NATURAL GASES FROM WELL 30/2-1

CLIENT
STATOIL
Den norske stats oljeselskap a.s.



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REPORT TYPE		
	REPORT NO. IFE/KR/F-84/018	DATE 1984-01-27
	REPORT TITLE REPORT ON STABLE ISOTOPES ($\delta^{13}C$ AND δD) ON NATURAL GASES FROM WELL 30/2-1	DATE OF LAST REV. REV. NO.
	CLIENT STATOIL Den norske stats oljeselskap a.s.	NUMBER OF PAGES 4
	CLIENT REF.	NUMBER OF ISSUES 20

SUMMARY

The gas components CH_4, C_2H_6, C_3H_8, i-C_4H_{10}, n-C_4H_{10} and CO_2 have been separated from the natural gas of well 30/2-1, and the $\delta^{13}C$-values of these components have been measured. The isotopic composition of hydrogen which was made from the H_2O during the combustion of CH_4 have also been measured.

When plotted in the maturity diagram by James, a source LOM between 10-11 eq. to a vitrinite reflectance of about .9 is indicated. This suggest that oil should have been generated if the source rock is suitable. The combined use of $\delta^{13}C$ methane value and the δD methane value indicate, however, a maturity more in the condensate field of the oil window.

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REPORT ON STABLE ISOTOPES ($\delta^{13}C$ AND δD) ON A NATURAL GASES FROM WELL 30/2-1

ANALYTICAL PROCEDURE

The natural gas has been separated into the different gas components by a Carlo-Erba 4200 instrument. The hydrocarbon gas components were oxydized in separate CuO-ovens, which enables us to collect several times when the concentration of a gas component is low. The combustion products CO_2 and H_2O were frozen into collection vessles and separated. The isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our $\delta^{13}C$-value on NBS-22 is -29.77 +/- .06 $^0/oo$.

RESULTS

The results are given in the following table :

Sample No.	CH_4		C_2H_6	C_3H_8	$i\text{-}C_4H_{10}$	$n\text{-}C_4H_{10}$	CO_2
	$\delta^{13}C$	δD	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$
DST 3, 3720-3728 m	-40.0	-108	-28.2	-25.6		-24.2	- 4.5
RFT, 3791 m	-40.2	-169	-27.5				

Our uncertainty on the $\delta^{13}C$-value is estimated to be +/- .3 $^0/oo$, and includes all the different analyses steps.

The uncertainty on the δD-value is about $\pm$ 5$^0/oo$. The isotopic measurement has been performed in Mook's laboratory, Groningen, Netherland.

INTERPRETATION

The $\delta^{13}C$-values of methane, ethane, propane and n-butane for the DST3, 3720-3728 m sample have been plotted on the maturity diagram by James (1983)* Figure 1. A source LOM between 10 and 11, eq. to a vitrinite reflectance of about .9 is indicated. The $\delta^{13}C$-methane value plot above the methane line in the diagram. This may be due to biogenic methane trapped in the reservoir at an earlier stage.

The carbon and hydrogen isotopic composition of sample DST3, 3720-3728 m have been plotted in a $\delta^{13}C$ methane vs. δD methane cross plot. (Schoell, 1983)** figure 2.

We suspect that H_2O from sample DST 3, 3720-3728 m is contaminated and that a δD-value of -169, as in the RTF sample, is closer to the real value. This value is therefore used in the interpretation.

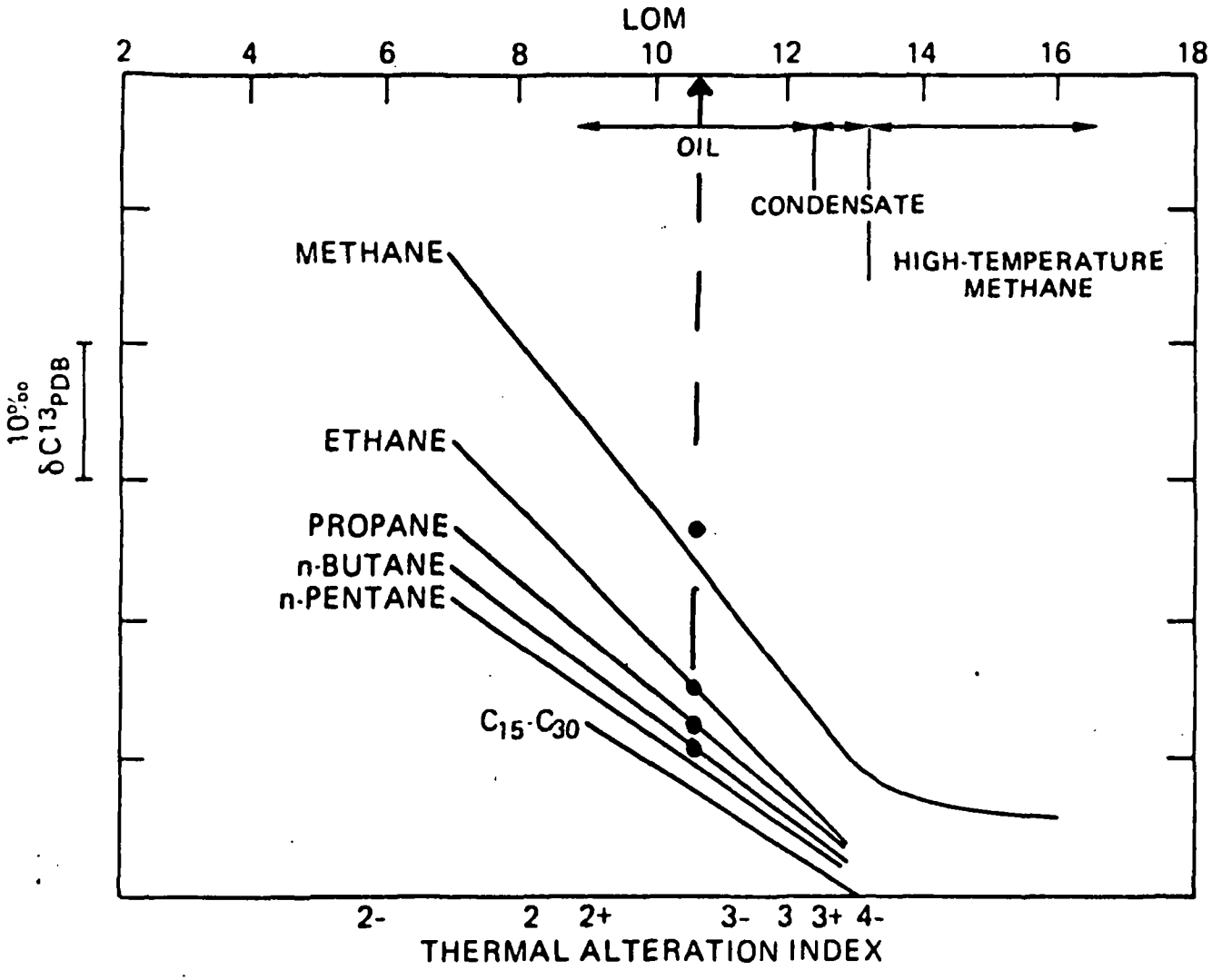
As seen from Figure 2, the combined use of $\delta^{13}C$ methane and the δD methane value indicate a somewhat higher maturity (in the condensate field) than indicated by Alan James' method above.

CONCLUSION

When plotted in the maturity diagram by James, a source LOM between 10-11 eq. to a vitrinite reflectance of about .9 is indicated. This suggest that oil should have been generated if the source rock (or rocks) is suitable. The combined use of $\delta^{13}C$ methane value and the δD methane value indicate, however, a maturity more in the condensate field of the oil window.

* James, Alan T. (1983) : Correlation of Natural Gas by Use of Carbon Isotopic Distribution Between Hydrocarbon Components, A.A.P.G. Vol. 67, No. 7, July, 1983.

** Schoell, M. 1983 : Genetic Characertization of Natural Gases. A.A.P.G. December, 1983.



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	DST 3 3720-3728 m		RFT 3791 m	
	$\delta^{13}C$ ‰	Vol %	$\delta^{13}C$ ‰	Vol %
C_1	- 40.0	63.0	-40.2	47.0
C_2	- 28.2	5.0	-27.5	.6
C_3	- 25.6	2.4		-
$n\text{-}C_4$	- 24.2	.7		-
$i\text{-}C_4$		.4		-
CO_2	- 4.5	4.3		

Figure 1. Carbon isotopic separations of the gas from well 30/2-11 is plotted on the maturity diagram (after James, 1983). A source LOM between 10 and 11 is indicated for the gas.

The calculated carbon isotopic separations between gas component are plotted on the vertical axis using a sliding scale that is simply the algebraic difference, in parts per mil, between the isotopic compositions of the natural gas components. The scale does not possess a fixed origin, but is oriented with the more depleted $\delta^{13}C$ values at the upper end. Use of this sliding scale allows the maturity of a gas to be assessed without prior knowledge of the isotopic composition of the gas' source.

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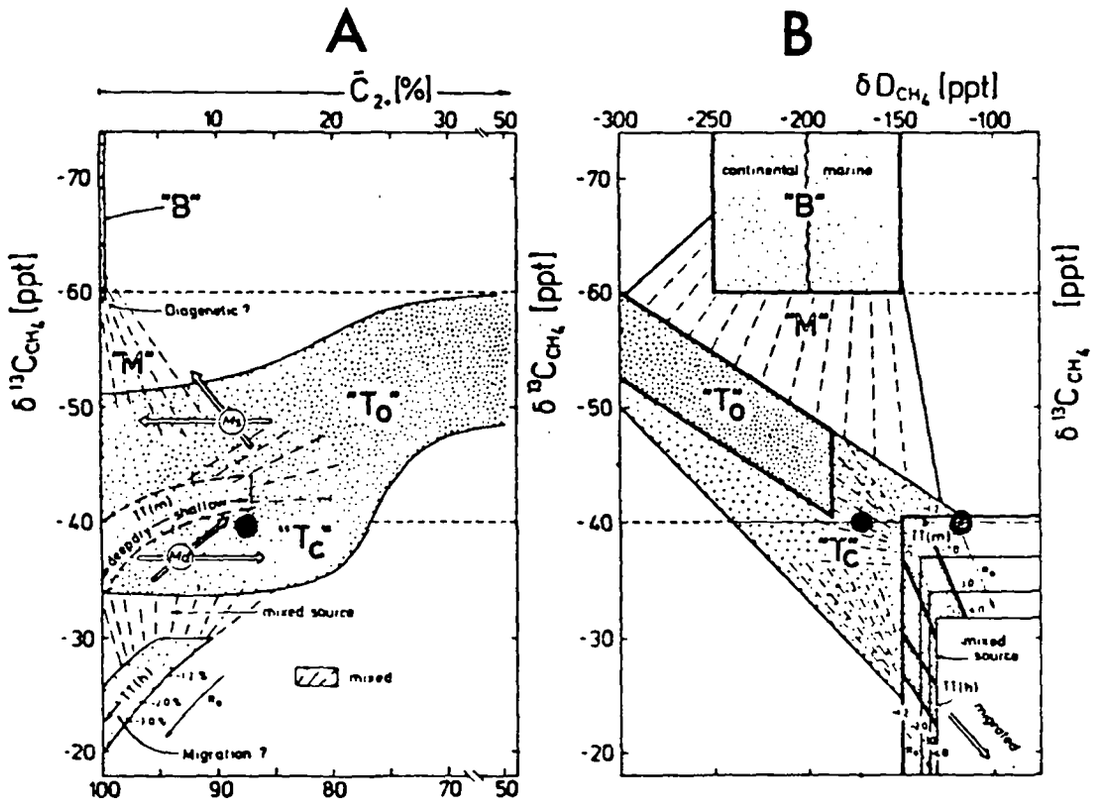

Figure 2 a. Variations of molecular composition in natural gases related to the isotope variations of methane.

Figure 2 b. Carbon and hydrogen isotope variations in methanes. Both δD values have been used. The lowest δD value (-169) is preferred.

The principle for the genetic characterization of natural gases is that the primary gases (B-biogenic gas, T-associated gas, TT-non-associated gas) are defined by fields of compositional variations. These primary gases may become mixed and form various mixtures "M" of intermediate composition. "TT(m)" and "TT(h)" are non associated gases from marine source rocks and coal gases from N.W. Germany respectively, compositional shifts due to migration are indicated by arrows Md (deep migration) and Ms (shallow migration) respectively. "T" are gases associated with petroleum in an initial phase of formation. "T_C" are gases associated with condensates. (Schoell, 1983).