	KJELLER	HALDEN
ADDRESS	N-2007 Kjeller, Norway	N-1751 Halden, Norway
TELEPHONE	+47 2 712560 - 713560	+47 31 83100
TELEX	74 573 energ n	76 335 energ n
TELEFAX	+47 2 715553	

AVAILABILITY

Private
Confidential

REPORT TYPE

REPORT NO.
IFE/KR/F-87/018

DATE
1987-02-10

REPORT TITLE

REPORT ON STABLE ISOTOPES ($\delta^{13}C$, δD, $\delta^{18}O$) ON A NATURAL GAS FROM WELL 6406/3-2

DATE OF LAST REV.

REV. NO.

CLIENT
Statoil

NUMBER OF PAGES
5

CLIENT REF.
T 6269 no. 91

NUMBER OF ISSUES
15

SUMMARY

The gas components C_1-C_4 and CO_2 have been separated from a natural gas from well 6406/3-2, and the $\delta^{13}C$ values of these components have been measured. The isotopic composition of hydrogen from CH_4 has also been measured.

The isotope study of a natural gas sample from well 6406/3-2 indicates a mixed gas.

The mixed gas is derived from two different sources or from one source at different maturity levels. The source rock (or rocks) is in this case characterized by isotopically light stable isotopes.

It is in the present case (because of the mixed gas) difficult to use the isotopes to indicate a fixed maturity level of the source rocks. A moderate maturity level in the oil window is, however, suggested.

DISTRIBUTION

Statoil (10)
Andresen, B.
Brevik, E.M.
Råheim, A.

KEYWORDS

	NAME	DATE	SIGNATURE
PREPARED BY	Bjørg Andresen Einar M. Brevik	1987-02-10 1987-02-10	Bjørg Andresen Einar M. Brevik
REVIEWED BY	Arne Råheim	1987-02-10	Arne Råheim
APPROVED BY			

1. INTRODUCTION

One gas sample from well 6406/3-2, DST 2; 3937 - 3995 m RKB, was received January 1987.

On the sample C_1-C_4 and CO_2 are quantified, and the $\delta^{13}C$ value is measured on methane, ethane, propane, the butanes and CO_2. The δD value is also measured on methane.

2. ANALYTICAL PROCEDURE

The natural gas has been quantified and separated into the different gas components by a Carlo-Erba 4200 instrument. This gas chromatograph is equipped with a special injection loop in order to concentrate the samples, in the case of low concentration of the gas components. The hydrocarbon gas components were oxidized in separate CuO-ovens in order to prevent cross contamination. The combustion products CO_2 and H_2O were frozen into collection vessels and separated.

The water was reduced with zinc metal in a sealed quartz tube to prepare hydrogen for isotopic analysis. The isotopic measurements were performed on a Finnigan Mat 251 and a Finnigan Mat delta mass spectrometer. Our $\delta^{13}C$ value on NBS-22 is -29.77 $\pm$ .06 o/oo PDB.

3. RESULTS

The volume composition of the sample is given in Table 1. The results have been normalized to 100%. The stable isotope results are given in Table 2.

Our uncertainty on the $\delta^{13}C$ value is estimated to be $\pm$ 0.3 o/oo and includes all the different analysis step. The uncertainty on the δD value is likewise estimated to be $\pm$ 5 o/oo.

Table 1 Volume composition of a gas sample from well 6406/3-2

Sample	IFE no.	C_1 %	C_2 %	C_3 %	i-C_4 %	n-C_4 %	CO_2 %	ΣC_1-C_4	$\frac{\Sigma C_2\text{-}C_4}{\Sigma C_1\text{-}C_4}$	$\frac{i\text{-}C_4}{n\text{-}C_4}$
6406/3-2 DST 2 3937-3995 m RKB	5868A	69.2	12.4	8.7	1.1	3.0	5.5	94.5	0.27	0.38

Table 2 Isotopic composition of a gas sample from well 6406/3-2

Sample	IFE no.	C_1 $\delta^{13}C$ PDB	C_1 δD SMOW	C_2 $\delta^{13}C$ PDB	C_3 $\delta^{13}C$ PDB	i-C_4 $\delta^{13}C$ PDB	n-C_4 $\delta^{13}C$ PDB	CO_2 $\delta^{13}C$ PDB	CO_2 $\delta^{18}O$ PDB
6406/3-2 DST 2 3937-3995 m RKB	5868A	-48.5	-228	-36.6	-32.7	-31.3	-32.3	-14.9	-9.6

4. INTERPRETATION

The isotopic results, Table 2, indicate a mixed gas derived from two or more different sources. Gases derived from the same source but at different maturity levels is also a possibility.

The combined use of the $\delta^{13}C$ methane and $\delta^{13}C$ ethane values, Figure 2 (Schoell 1983)** may indicate that the thermogenic methane is mixed with a small component of biogenic methane. The relative light $\delta^{13}C$ values of methane and ethane may, however, indicate that the organic matter of the source rock is isotopically light.

The relationship between the $\delta^{13}C$ values of propane and n-butane indicates as seen from Fig. 1 a high maturity situation. This is not in accordance with the combined use of the $\delta^{13}C$ and δD values of methane (Fig. 2, Schoell 1983)**, where the results suggest a maturity situation in the middle of the oil window. This conclusion is also in best agreement with the combined use of the $\delta^{13}C$ methane and the $\delta^{13}C$ ethane values (Fig. 2).

5. CONCLUSION

The isotope study of a natural gas sample from well 6406/3-2 indicates a mixed gas.

The mixed gas is derived from two (or more) different sources or from one source at different maturity levels. The source rock is in this case characterized by isotopically light stable isotopes.

It is in the present case (because of the mixed gas) difficult to use the isotopes to indicate a fixed maturity level of the source rocks. A moderate maturity level in the oil window is, however, suggested.

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

** Schoell, M. (1983): Genetic Characterization of Natural Gases, AAPG, December 1983.

Institute for energy technology

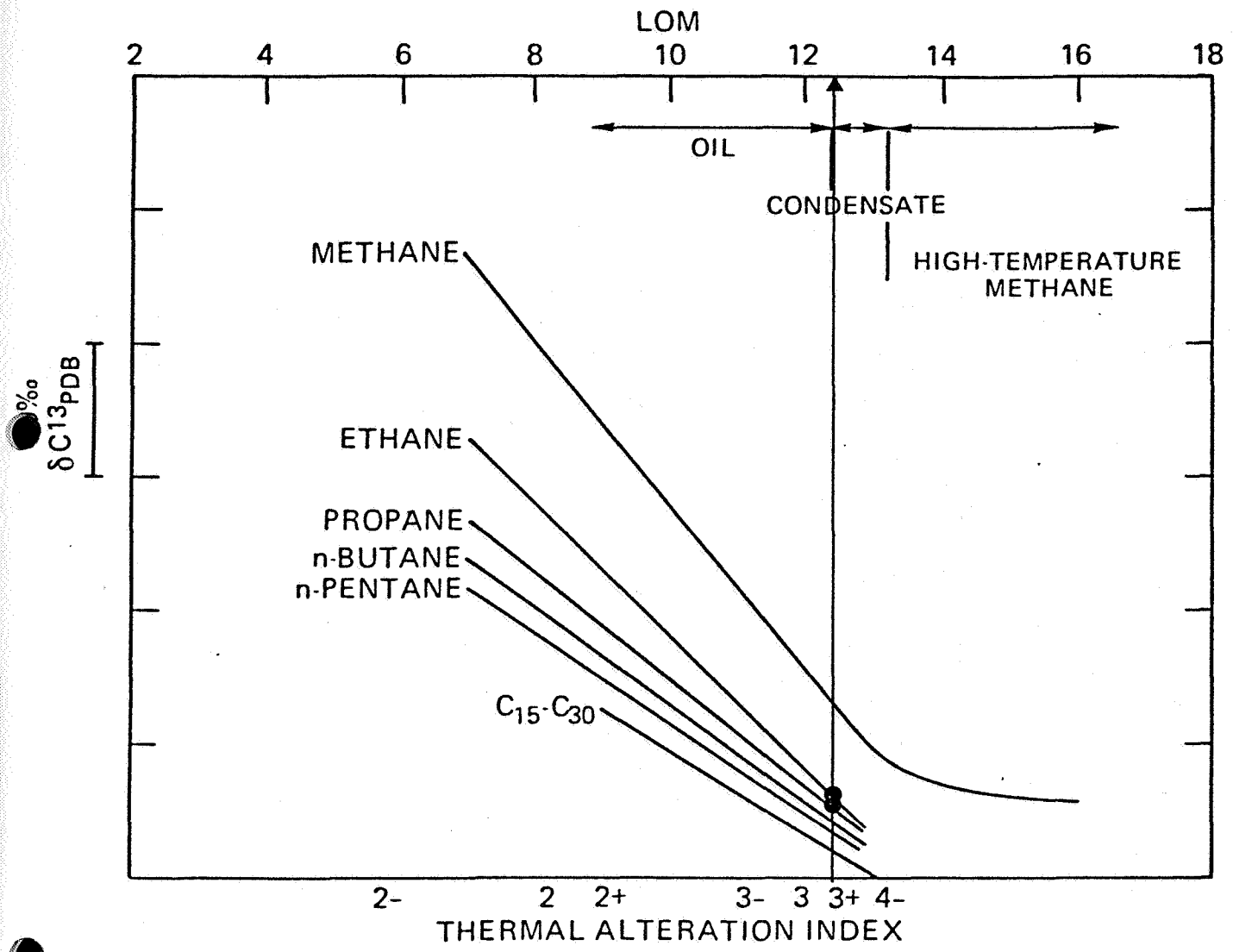
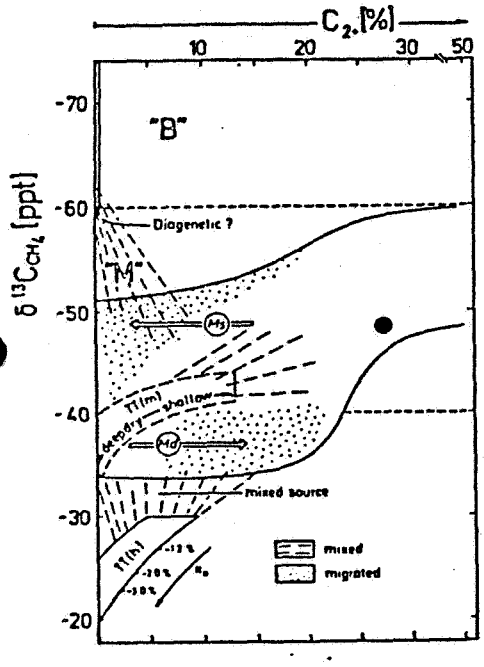
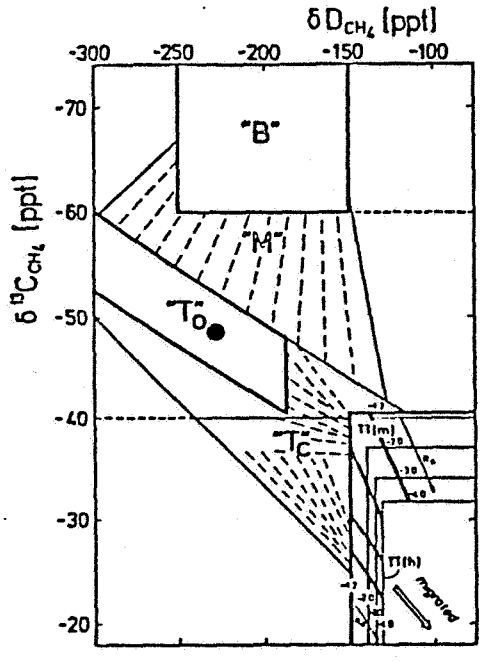


Figure 1. Carbon isotopic separations of a gas sample from well 6406/3-2 are plotted on the maturity diagram (after James, 1983).

The calculated carbon isotopic separations between gas components 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.

Institute for energy technology





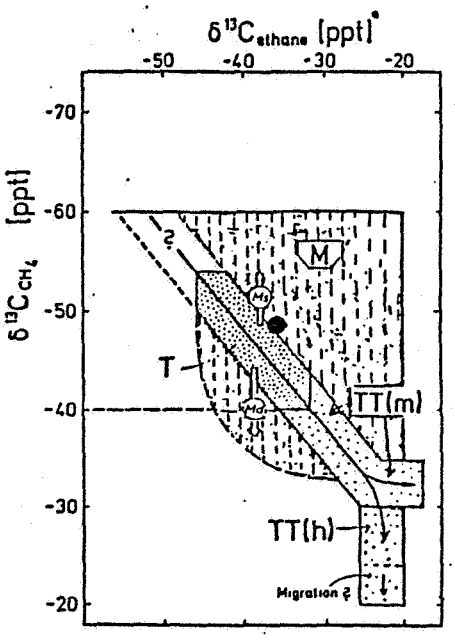


Figure 2a

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

Figure 2b

Carbon and hydrogen isotope variations in methanes.

Figure 2c

Carbon isotope variations in ethane related to carbon isotope variations in methane.

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_o" are gases associated with petroleum in an initial phase of formation. "T_c" are gases associated with condensates. (Schoell 1983).