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REPORT TYPE	REPORT NO. IFE/KR/F-86/079	DATE 1986-06-27
	REPORT TITLE REPORT ON STABLE ISOTOPES ($\delta^{13}C$, δD , $\delta^{18}O$) ON NATURAL GASES FROM WELL 6407/7-1	DATE OF LAST REV.
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SUMMARY The gas components C_1 , C_4 and CO_2 have been separated from natural gases of well 6407/7-1, 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 the natural gases from well 6407/7-1 indicates a mixed gas. The mixed gas is at least derived from two different sources with one source dominating from the C_1 - C_3 range and the other source dominating the contribution to the butanes. A gas prone source for C_1 - C_3 and a more oil prone source for the butanes is suggested. It is in the present case (because of the mixed gas) difficult to use the isotopes to indicate the maturity level of the source rocks. The data, however, suggest high maturity. A high maturity in the oil window is also in accordance with the isotopic composition of the test 5 sample which shows a "normal" isotopic trend.		DISTRIBUTION Norsk Hydro (10) Andresen, B. Brevik, E.M. Råheim, A.
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1. INTRODUCTION

Three gas samples from well 6407/7-1, test 2, test 3 and test 5 were received late April 1986.

The test 5 sample was empty at the arrival in the laboratory. A new test 5 sample was received late June 1986.

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

2. ANALYTICAL PROCEDURE

The natural gases have 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 tube to prepare hydrogen for isotopic analysis. The isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our $\delta^{13}C$ value on NBS-22 is $-29.77 \pm .06$ o/oo.

3. RESULTS

The composition of the samples are 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 ± 0.3 o/oo and includes all the different analysis step. The uncertainty on the δD value is likewise estimated to be ± 5 o/oo.

Table 1 Composition of natural gases from well 6407/7-1

Sample	IFE no.	C ₁ %	C ₂ %	C ₃ %	i-C ₄ %	n-C ₄ %	CO ₂ %	ΣC ₁ -C ₄	$\frac{\Sigma C_2-C_4}{\Sigma C_1-C_4}$	$\frac{i-C_4}{n-C_4}$
Test 2	4983	79.4	10.5	5.6	0.9	2.0	1.7	98.3	0.19	0.45
Test 3	4984	82.8	9.6	4.2	0.5	1.1	1.8	98.2	0.16	0.45
Test 5	5159	79.9	10.6	5.4	0.7	1.5	1.9	98.1	0.19	0.47

Table 2 Isotopic composition of natural gases from well 6407/7-1

Sample	IFE no.	C ₁		C ₂	C ₃	i-C ₄	n-C ₄	CO ₂	
		δ ¹³ C	δD SMOW	δ ¹³ C	δ ¹³ C	δ ¹³ C	δ ¹³ C	δ ¹³ C	δ ¹⁸ O PDB
Test 2	4983	-39.6	-200	-29.1	-27.9	-28.8	-28.6	-10.9	-7.8
Test 3	4984	-40.3	-205	-29.7	-27.9	-27.8	-28.1	-9.5	-15.6
Test 5	5159	-42.4	-190	-30.4	-29.6	-28.3	-28.4	-13.4	-15.3

4. INTERPRETATION

As seen from Table 2 the δ¹³C values of the propanes are higher than the δ¹³C values of the n-butananes for the test 2 and test 3 samples. This indicates a mixed gas, at least derived from two different sources with one source dominating from the C₁-C₃ range and the other source dominating from C₄ (and higher). This suggests a gas prone source rock for C₁-C₃ and a more oil prone source rock for the butanes.

If it is assumed that C₁-C₃ are dominately derived from one source the δ¹³C values of methane, ethane and propane can be used to indicate the maturity level of the gas, by using James' maturation diagram (James, 1983^{*}), Figure 1. A source LOM of about 12 may thus be indicated, e.g.

that the gases were formed at a relatively high maturity level in the oil window.

The test 5 sample shows however a "normal" trend in the isotopic composition of methane, ethane, propane and n-butane. By using James maturation diagram (James 1983*), fig. 1 a source LOM of about 12 is indicated also for the test 5 sample, which indicate that the gas was formed at a relatively high maturity level in the oil window.

The combined use of the δD methane and the $\delta^{13}C$ methane values ** suggest on the other hand that the gases may have formed at even higher maturity, in the condensate field of the oil window.

5. CONCLUSION

The isotope study of the natural gases from 6407/7-1 indicates a mixed gas. The mixed gas is at least derived from two different sources with one source dominating from the C_1-C_3 range and the other source dominating the contribution to the butanes. A gas prone source for C_1-C_3 and a more oil prone source for the butanes is suggested.

It is in the present case (because of the mixed gas) difficult to use the isotopes to indicate the maturity level of the source rocks, the data, however, suggest high maturity.

A high maturity in the oil window is also in accordance with the isotopic composition of the test 5 sample which shows a "normal" isotopic trend.

* 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.

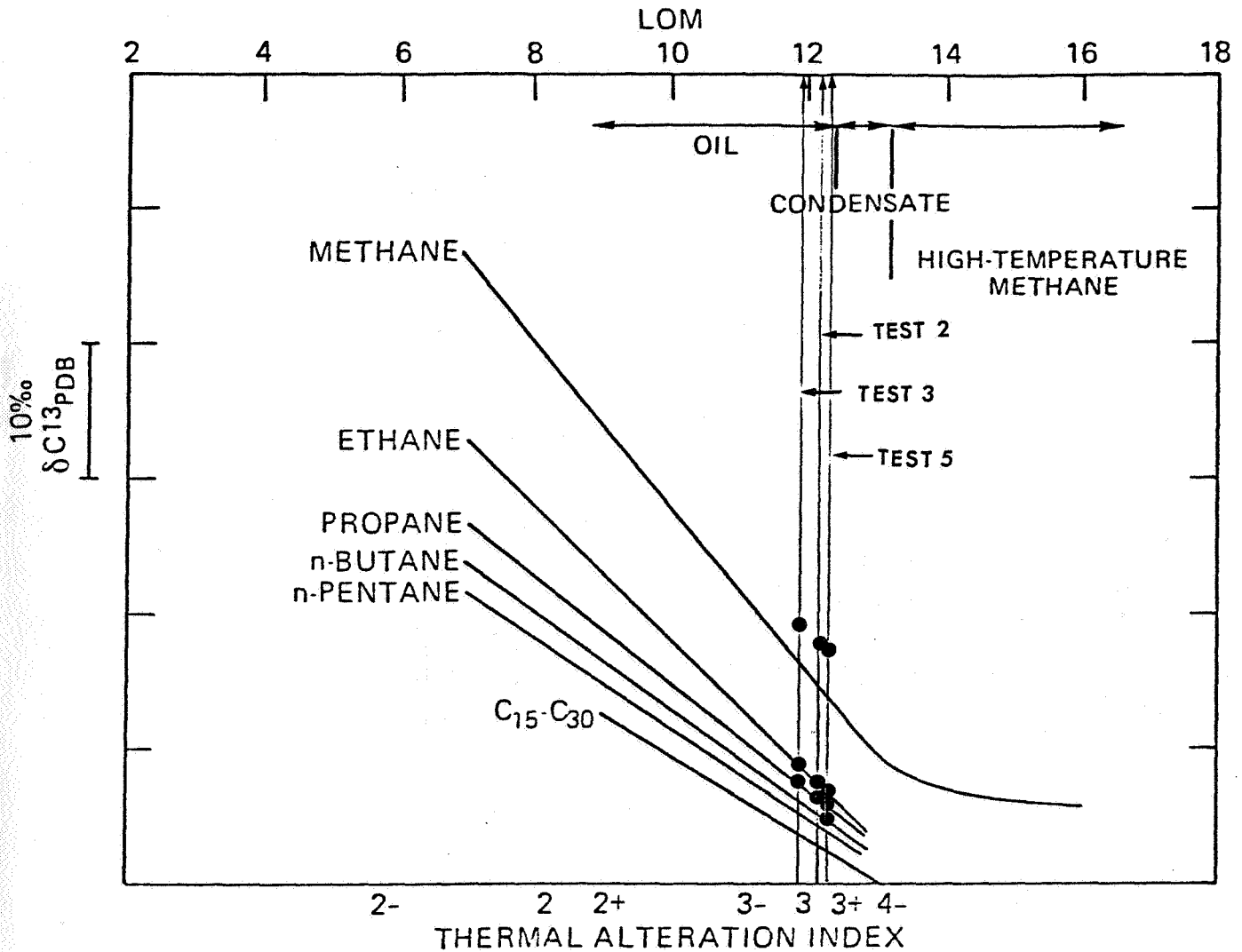


Figure 1. Carbon isotopic separations of gases from well 6407/7-1 are plotted on the maturity diagram (after James, 1983). A source LOM of about 12 is indicated for the gases.

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 $\delta^{13}\text{C}$ 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.

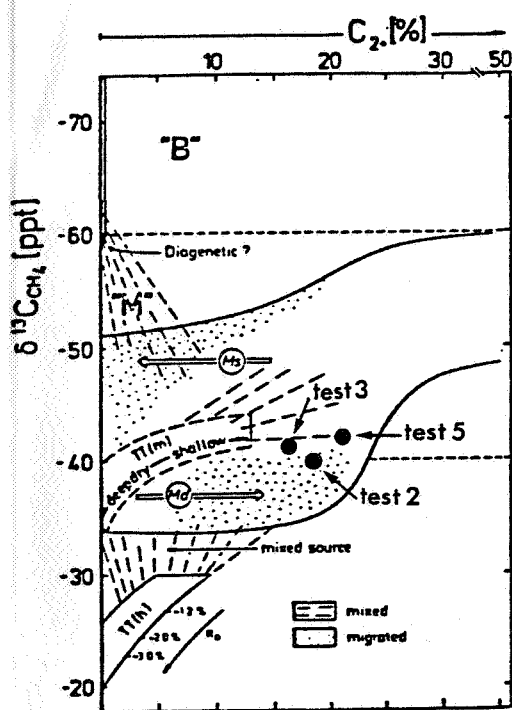


Figure 2a

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

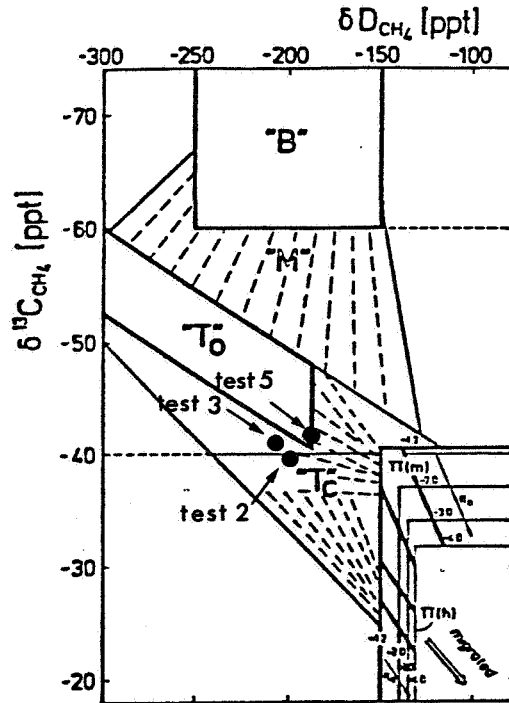


Figure 2b

Carbon and hydrogen isotope variations in methanes.

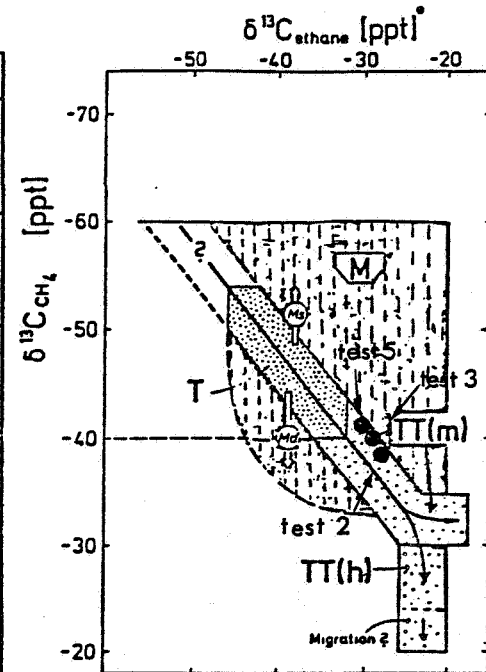


Figure 2c

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. "T₀" are gases associated with petroleum in an initial phase of formation. "T_c" are gases associated with condensates. (Schoell 1983).