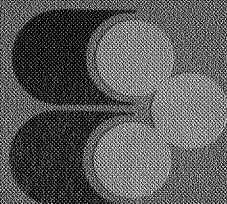


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REPORT ON STABLE ISOTOPES
($\delta^{13}\text{C}$, δD , $\delta^{18}\text{O}$) ON NATURAL
GASES FROM WELL 6407/7-3;
DST 2A 3014-2990 m RKB;
DST 3 2866-2851 m RKB



IFE



Norsk Hydro a.s

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Rapport/Report

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Resymé/konklusjon/anbefaling
Summary/Conclusion/Recommendation

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1. INTRODUCTION

Two gas samples from well 6407/7-3, DST 2A; 3014-2990 m RKB and DST 3; 2866-2851 m RKB were received and analysed June/July 1988.

On the samples 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 samples 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 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 samples 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 ± 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 Volume composition of gas samples from well 6407/7-3

Sample	IFE no.	C ₁ %	C ₂ %	C ₃ %	i-C ₄ %	n-C ₄ %	CO ₂ %	ΣC ₁ -C ₄	$\frac{\Sigma C_2-C_4}{\Sigma C_1-C_4}$	$\frac{i-C_4}{n-C_4}$
DST 2A 3014- 2990 m RKB	7471	78.4	12.0	5.8	0.68	1.5	1.6	98.4	0.20	0.45
DST 3 2866- 2851 m RKB	7472	77.0	12.3	6.1	0.74	1.75	2.1	97.9	0.21	0.42

Table 2 Isotopic composition of gas samples from well 6407/7-3

Sample	IFE no.	C ₁	C ₁	C ₂	C ₃	i-C ₄	n-C ₄	CO ₂	
		$\delta^{13}C_{PDB}$	δD_{SMOW}	$\delta^{13}C_{PDB}$	$\delta^{13}C_{PDB}$	$\delta^{13}C_{PDB}$	$\delta^{13}C_{PDB}$	$\delta^{13}C_{PDB}$	$\delta^{18}O_{PDB}$
DST 2A 3014- 2990 m RKB	7471	-47.0	-208	-32.1	-28.5	-29.0	-28.1	- 8.1	-11.1
DST 3 2866- 2851 m RKB	7472	-45.2	-215	-31.0	-28.8	-29.5	-28.5	-10.3	-13.2

4. INTERPRETATION

As seen from Table 2 the $\delta^{13}C$ values of the propanes are at the same level as the $\delta^{13}C$ values of the n-butanenes for the gas 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). Gases derived from the same source but at different maturity levels is also a possibility. On the other hand, the present relationship between the $\delta^{13}C$ value of the propane and the n-butane may also be due to a high maturity situation.

If it is assumed that C_1-C_3 are dominantly derived from one source the $\delta^{13}C$ values of methane, ethane and propane can be used to indicate the maturity level of the gases, by using James maturity diagram (James, 1983)*, Figure 1. A source LOM of about 11 may thus be indicated, e.g. that the gases were formed at a relatively high maturity level in the oil window.

The DST 3 sample may seem slightly more mature than the DST 2A sample.

A relatively high maturity level in the oil window is in accordance with the combined use of the hydrogen and carbon isotopes on methane as plotted in Figure 2 (Schoell 1983**).

5. CONCLUSION

The isotope study of natural gases from well 6407/7-3, DST 2A 3014-2990 m RKB and DST 3 2866-2851 m RKB, indicates a relatively high maturity situation in the oil window. The gases may possibly be of mixed origin, derived from two (or more) sources or derived at different maturity levels from the same source.

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

** Schoell, M. (1983): Genetic Characterization of Natural Gases, AAPG, Vol. 67, No. 12, December 1983.

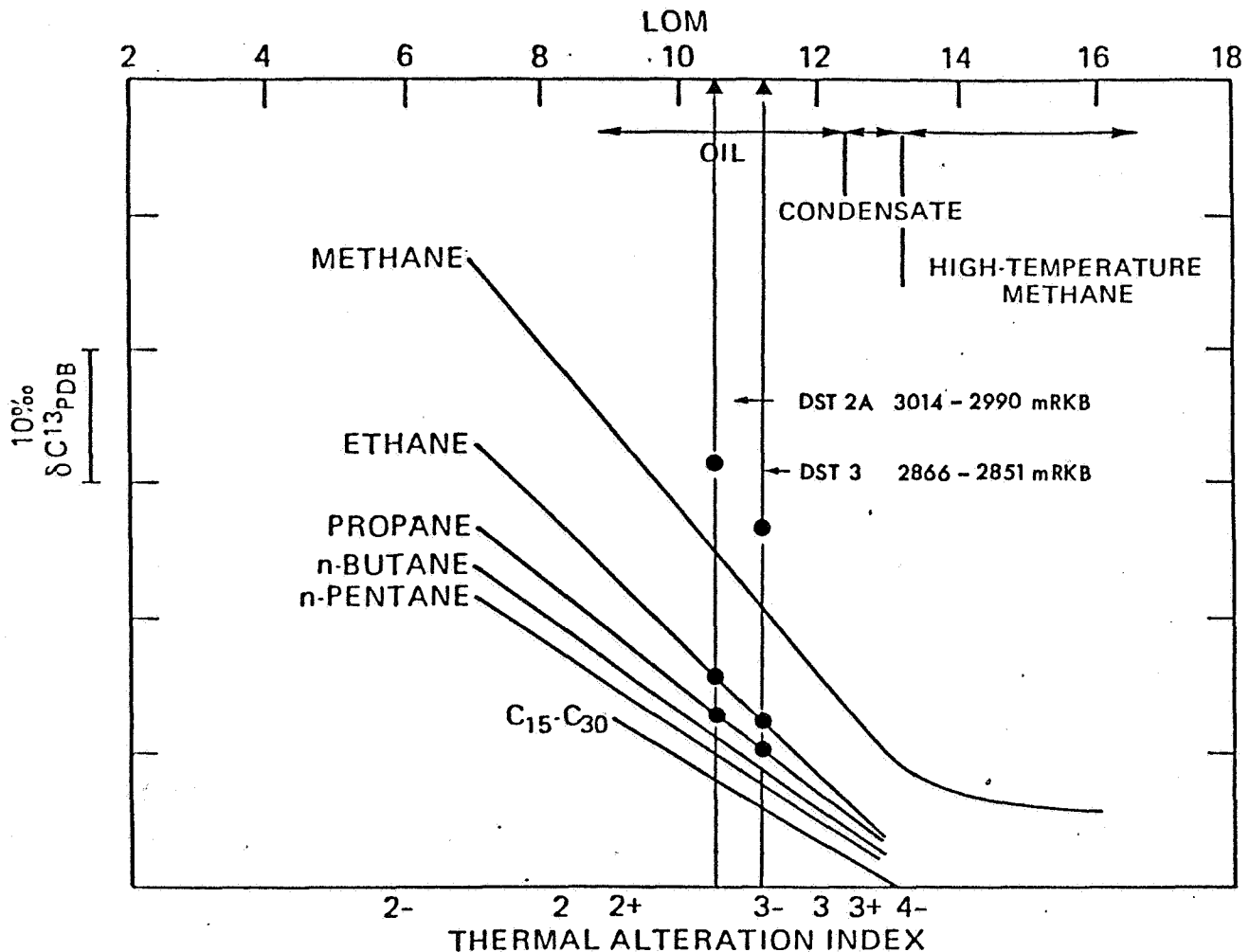
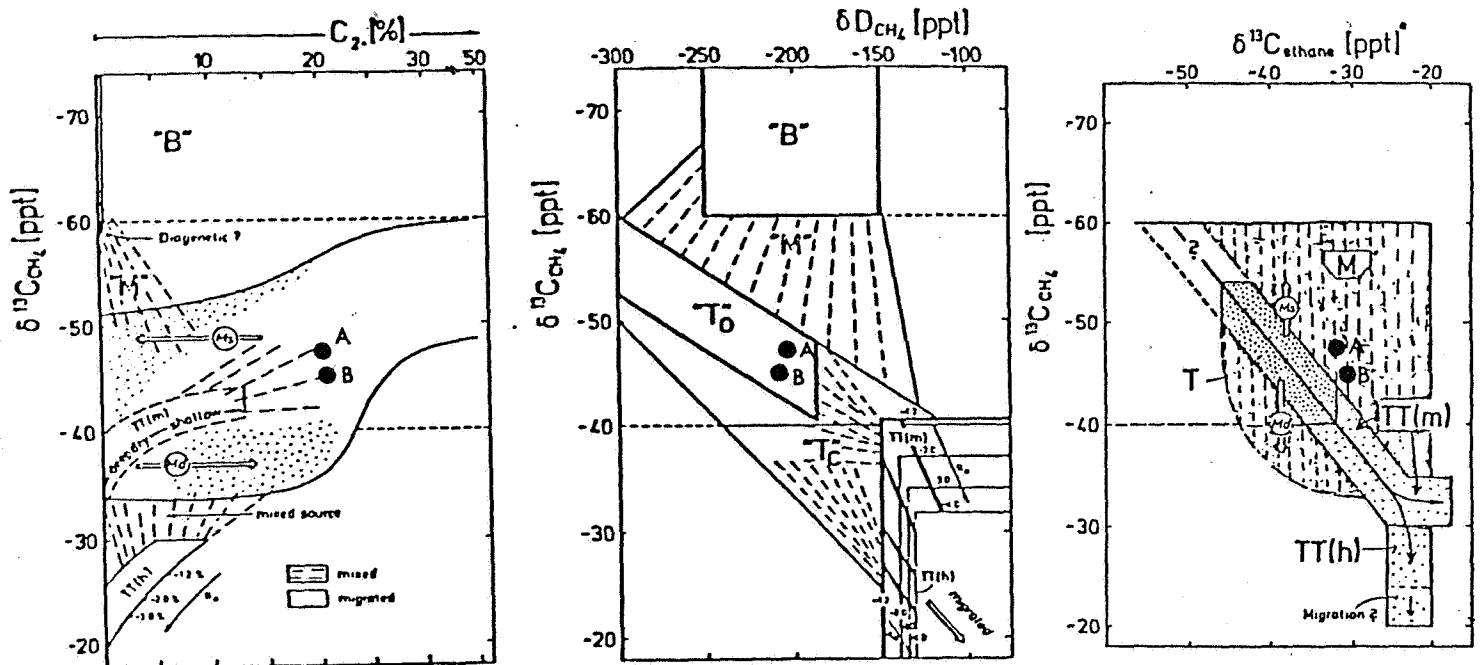


Figure 1. Carbon isotopic separations of gas samples from well 6407/7-3 are plotted on the maturity diagram (after James, 1983). A source LOM of about 11 is indicated for the gas samples.

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.



A: 6407/7-3 DST 2A 3014-2990 m RKB
 B: 6407/7-3 DST 3 2866-2851 m RKB

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).