

1. INTRODUCTION

Three gas samples from well 6407/6-3, DST 1, DST 2 and DST 3 were received March/April 1987.

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 and the δD value is also 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 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 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 Volume composition of gas samples from well 6407/6-3

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 1 2570-2577 m	6085	80.4	10.4	5.8	0.78	1.5	1.2	98.9	0.19	0.51
DST 2 2546-2555 m	6270	79.3	10.8	6.2	0.90	1.8	1.0	99.0	0.20	0.49
DST 3 2479-2489 m	6271	80.3	10.6	5.7	0.83	1.6	0.94	99.1	0.19	0.52

Table 2 Isotopic composition of gas samples from well 6407/6-3

Sample	IFE no.	C ₁		C ₂	C ₃	i-C ₄	n-C ₄	CO ₂	
		δ ¹³ C PDB	δD SMOW	δ ¹³ C PDB	δ ¹³ C PDB	δ ¹³ C PDB	δ ¹³ C PDB	δ ¹³ C PDB	δ ¹⁸ O PDB
DST 1 2570- 2577 m	6085	-44.0	-216	-30.9	-29.9	-29.4	-30.6	-16.5	-12.3
DST 2 2546- 2555 m	6270	-45.6	-211	-31.8	-30.0	-28.9	-30.1	-17.8	-15.1
DST 3 2479- 2489 m	6271	-45.3	-214	-31.5	-30.3	-28.7	-30.2	-18.0	-15.0

4. INTERPRETATION

As seen from Table 2 the δ¹³C values of the propane are higher than or at the same level as the δ¹³C values of the n-butanes for the 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).

The present relationship between the $\delta^{13}\text{C}$ values of ethane, propane and n-butane may, however, also be due to a high maturity situation.

If it is assumed that $\text{C}_1\text{-C}_3$ are dominantly derived from one source the $\delta^{13}\text{C}$ 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.

This is also in accordance with the combined use of the δD methane and the $\delta^{13}\text{C}$ methane values, Figure 2 (Schoell 1983**) which also suggests a relatively high maturity level in the oil window.

5. CONCLUSION

The isotope study of the natural gases from 6407/6-3 indicates a mixed gas. The mixed gas is most likely derived from two different sources with one source dominating from the $\text{C}_1\text{-C}_3$ range and the other source dominating the contribution to the butanes.

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.

* 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.

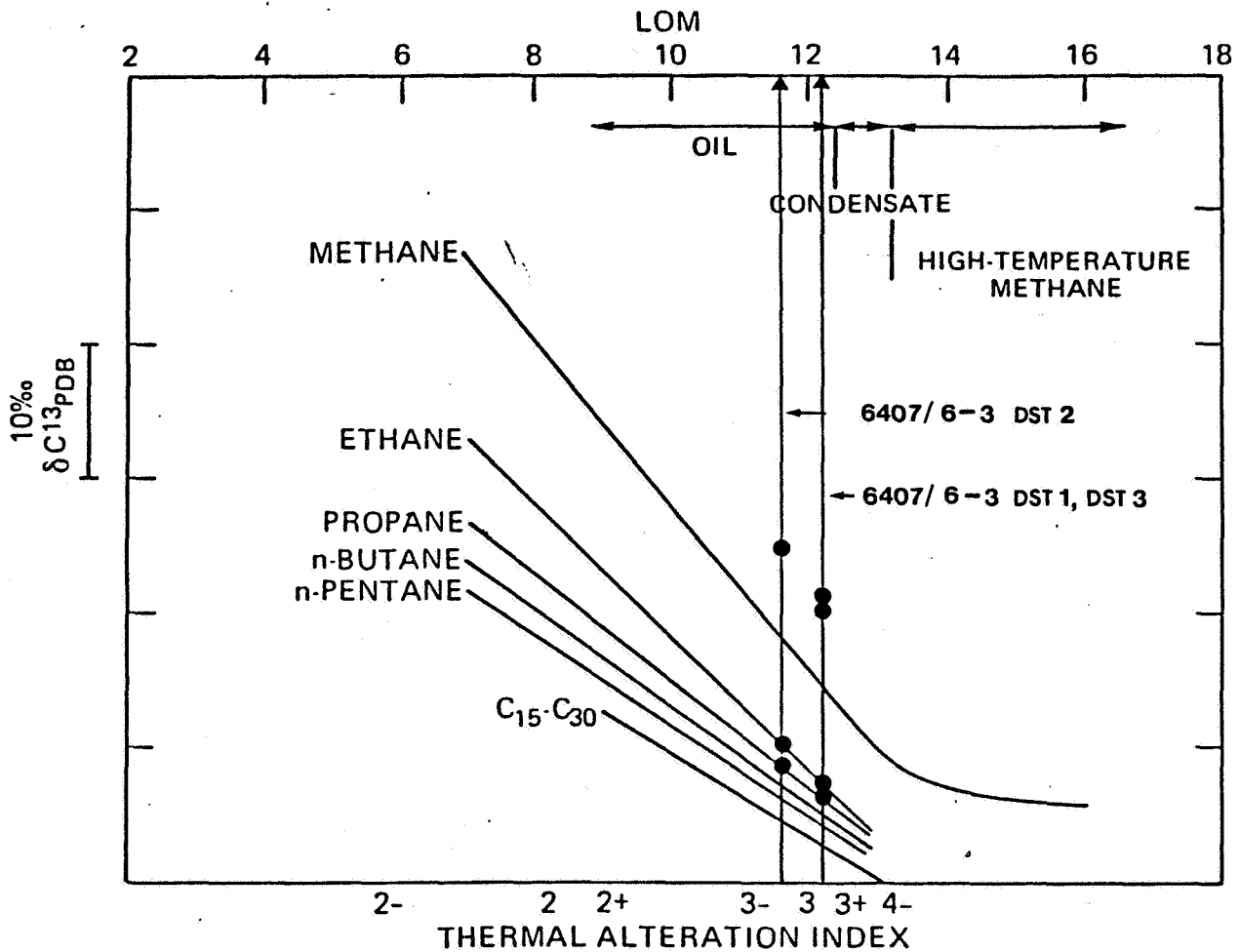
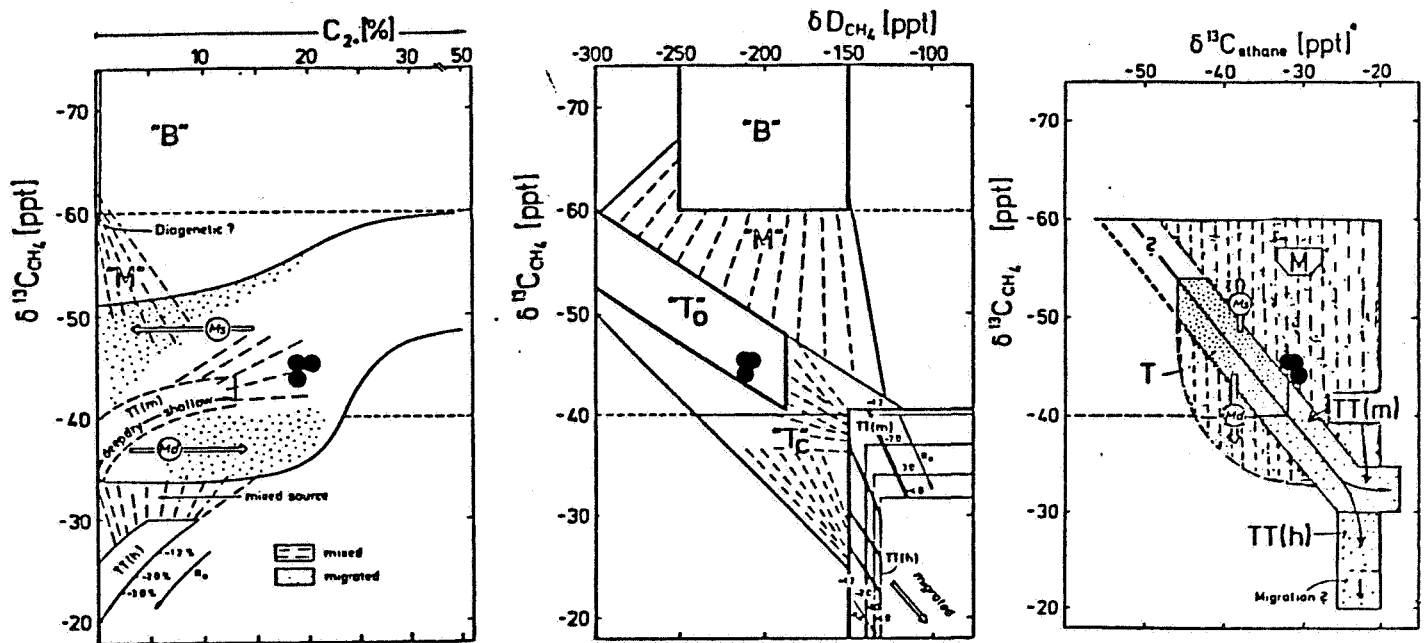


Figure 1. Carbon isotopic separations of gas samples from well 6407/6-3 are plotted on the maturity diagram (after James, 1983). A source LOM of about 12 is indicated for the gas.

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.



6407/6-3 DST1, DST2, DST3.

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