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REPORT ON STABLE ISOTOPES ($\delta^{13}C$, δD, $\delta^{18}O$) ON A NATURAL GAS FROM WELL 15/12-5

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SUMMARY

The gas components C_1-C_4 and CO_2 have been separated from a natural gas of well 15/12-5, 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 gas sample from well 15/12-5 indicates a high maturity source rock situation. The gas may possibly be of mixed origin, derived from two (or more) sources or derived at different maturity levels from the same source.

DISTRIBUTION

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1. INTRODUCTION

One gas sample from well 15/12-5, DST1, was received early September 1986.

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 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 NBS22 is -29.77 $\pm$ .06 o/oo PDB.

3. RESULTS

The volume composition of the sample 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 $\pm$ 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 natural gas from well 15/12-5

Sample	IFE no.	C_1 %	C_2 %	C_3 %	i-C_4 %	n-C_4 %	CO_2 %	ΣC_1-C_4	$\frac{\Sigma C_2\text{-}C_4}{\Sigma C_1\text{-}C_4}$	$\frac{i\text{-}C_4}{n\text{-}C_4}$
15/12-5 DST 1 2926-2936 m RBK 84B00384	5283A	76.2	11.7	7.2	0.9	1.6	2.4	97.6	0.22	0.56

Table 2 Isotopic composition of a natural gas from well 15/12-5

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
15/12-5 DST 1 2926-2936 m RKB 84B00384	5283A	-38.5	-161	-28.6	-27.6	-26.6	-27.8	-11.8	-6.4

4. INTERPRETATION

As seen from Table 2 the $\delta^{13}C$ value of the propane is at the same level as the $\delta^{13}C$ value of the n-butane. This may indicate a mixed gas derived from two different sources. 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, which is in accordance with the combined use of the hydrogen and carbon

isotopes on CH_4. A maturity level equivalent to the condensate field of the oil window is indicated when the results are plotted in figs. 2b and 2c (Schoell, 1983).

If it is assumed that C_1-C_3 are dominately derived from one source the $\delta^{13}C$ 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 gas were formed at a relatively high maturity level in the oil window.

5. CONCLUSION

The isotope study of a natural gas sample from well 15/12-5 indicates a high maturity source rock situation. The gas 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 Distribution between Hydrocarbon Components, AAPG, Vol. 67, No. 7, July 1983.

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

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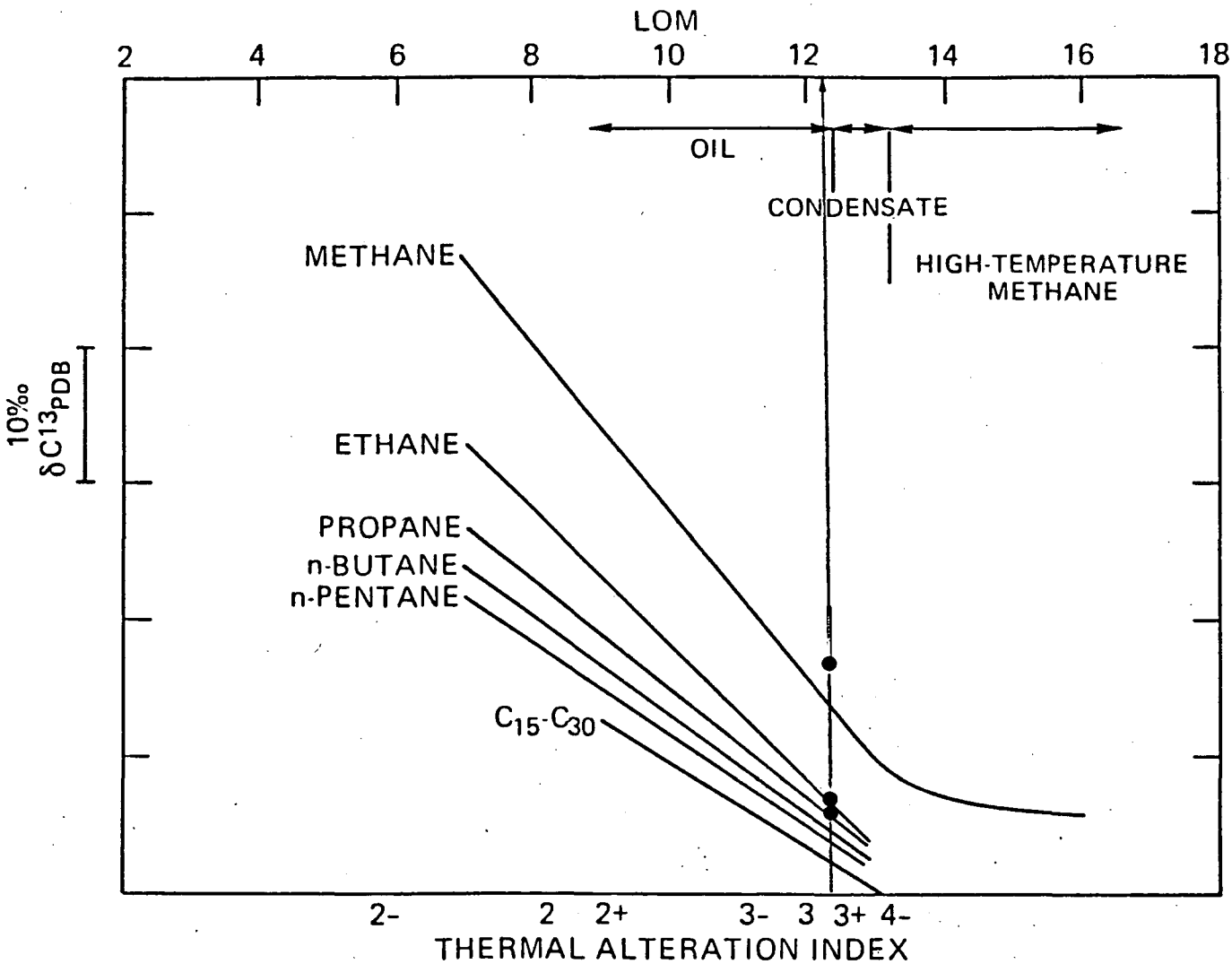

Figure 1. Carbon isotopic separations of a gas from well 15/12-5 are plotted on the maturity diagram (after James, 1983). A source LOM of about 12 is indicated for the gas.

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.

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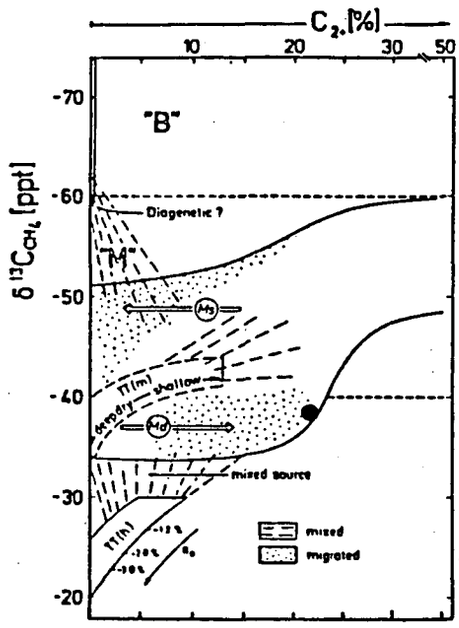

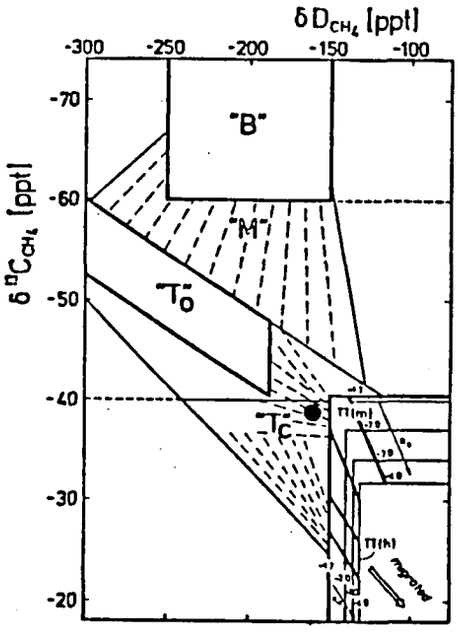

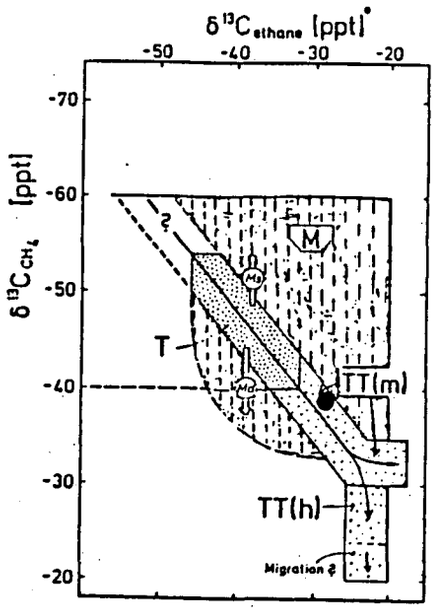

Figure 2a

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).