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REPORT ON STABLE ISOTOPES ($\delta^{13}C$, δD, $\delta^{18}O$) ON NATURAL GASES FROM WELL 2/12-1

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SUMMARY

The gas components C_1-C_4 and CO_2 have been separated from natural gases from well 2/12-1, 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 natural gas samples from well 2/12-1 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 (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 to high maturity level in the oil window is, however, suggested.

DISTRIBUTION

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1. INTRODUCTION

Two gas samples from well 2/12-1, DST 1 and DST 2 was received March 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. 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 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 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 $\pm$ 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 gas samples from well 2/12-1

Sample	IFE no.	C_1 %	C_2 %	C_3 %	i-C_4 %	n-C_4 %	CO_2 %	ΣC_1-C_4	$\frac{\Sigma C_2\text{-}C_4}{\Sigma C_1\text{-}C_4}$	$\frac{i\text{-}C_4}{n\text{-}C_4}$
DST 1	6088	74.1	14.0	7.2	0.62	1.8	2.3	97.7	0.24	0.35
DST 2	6089	75.7	13.1	6.7	0.59	1.8	2.2	97.8	0.23	0.33

Table 2 Isotopic composition of gas samples from well 2/12-1

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
DST 1	6088	-51.7	-255	-34.8	-30.2	-29.8	-29.8	- 5.5	-11.5
DST 2	6089	-50.9	-250	-34.3	-30.3	-31.5	-30.2	- 6.1	-12.5

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 1 (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.

If the gas components C_3 and C_4 are from the same source, the isotopic separation between $\delta^{13}C_3$ and $\delta^{13}nC_4$ indicate a high maturity situation. This may also be in agreement with the $\delta^{18}O$-values of the reservoar CO_2-gas. If this CO_2 is mainly derived from the source rock and

the CO_2 equilibrated with $CaCO_3$ in the source rock, a high temperature (probably in excess of 120^0C) or a high maturity is indicated, at least for parts of the reservoir gas. A high maturity situation is, however, not in accordance with the combined use of the $\delta^{13}C$ and the δD values of methane (Fig. 1, Schoell 1983)*, where the results suggest a maturity situation in the middle of the oil window.

5. CONCLUSION

The isotope study of natural gas samples from well 2/12-1 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 (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 to high maturity level in the oil window is, however, suggested.

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

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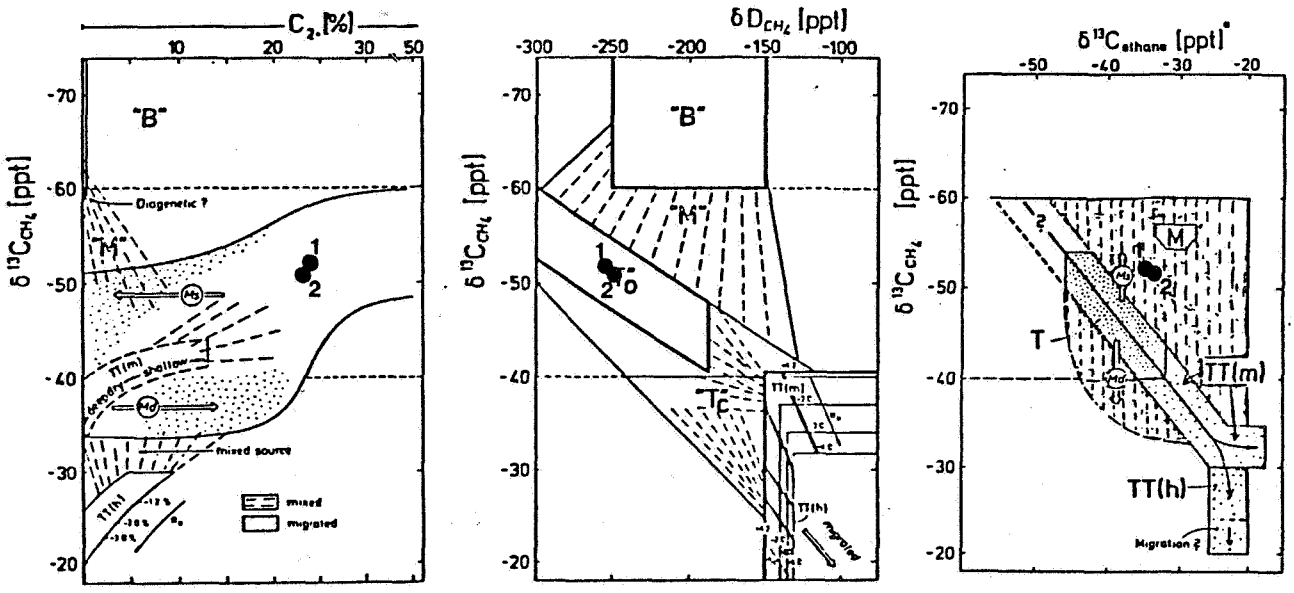

1; 2/12-1 DST 1
2; 2/12-1 DST 2

Figure 1a

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

Figure 1b

Carbon and hydrogen isotope variations in methanes.

Figure 1c

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).