34/7-6

Institute for energy technology

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REPORT ON STABLE ISOTOPES ($\delta^{13}C$, δD, $\delta^{18}O$) ON NATURAL GASES FROM WELL 34/7-6

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SUMMARY

The gas components C_1-C_4 and CO_2 have been separated from the natural gas of well 34/7-6, and the $\delta^{13}C$ values of these components have been measured. The isotopic composition of hydrogen which was made from the H_2O during the combustion of CH_4 have also been measured.

The carbon isotopic distribution between the hydrocarbon gas components methane, ethane, propane and n-butane indicates that the gas was formed at a relatively high maturity in the oil window. The carbon isotope measurements indicate a source with isotopically light kerogens.

The carbon and hydrocarbon isotopic composition of methane suggest that methane has a biogenic component.

DISTRIBUTION

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KEYWORDS

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1. ANALYTICAL PROCEDURE

The natural gases have been 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.

2. RESULTS

The composition of the samples are given in Table 1. The results have not been normalized to 100%. The rest is air. 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 Composition of Gas Samples from Well 34/7-6

Sample	C_1	C_2	C_3	$i\text{-}C_4$	$n\text{-}C_4$	CO_2
			%			
34/7-6 DST 1 Item 1 of 3	~~87~~ 94.0	~~3.3~~ 3.6	~~1.0~~ 1.1	~~0.05~~ 0.05	~~0.17~~ 0.18	~~0.9~~ 0.97
34/7-6 DST 1 Item 2 of 3	~~83~~ 93.0	~~3.2~~ 3.6	~~1.0~~ 1.1	~~0.05~~ 0.05	~~0.16~~ 0.17	~~1.8~~ 2.0
34/7-6 DST 2 Item 3 of 3	~~70~~ 70.2	~~14~~ 14	11	1.1	3.1	0.6

Table 2 Isotopic Composition of Gas Samples from Well 34/7-6

DMET DET DPP DIBT DNBT DCO2

Sample	C_1		C_2	C_3	$i\text{-}C_4$	$n\text{-}C_4$	CO_2	
	$\delta^{13}C$	δD	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{18}O$
34/7-6 DST 1 Item 1 of 3	-52.2	-205	-32.6	-31.0	-29.2	-30.0	-14.9	- 9.5
34/7-6 DST 1 Item 2 of 3	-52.8	-205	-33.4	-32.4	-32.5	-30.0	-17.0	-10.0
34/7-6 DST 2 Item 3 of 3	-52.9	-210	-35.9	-33.7	-31.6	-31.7	-17.2	-18.0

3. INTERPRETATION

The $\delta^{13}C$ values of methane, ethane, propane and n-butane have been plotted on the maturation diagram by James (1983)*, Figure 1. The three samples indicate a source LOM of about 11 - 12. This suggests that the gas was formed at a relatively high maturity in the oil window. The carbon isotopic distribution may indicate that the DST 1 samples are slightly more mature than the DST 2 sample. The isotopic signature of the gas components indicate a source rock with isotopically light kerogens.

The carbon and hydrogen isotopic composition have been plotted in a $\delta^{13}C$ methane vs. δD methane cross plot (Schoell 1983)**, Figure 2. This indicates that the gases may have a biogenic component.

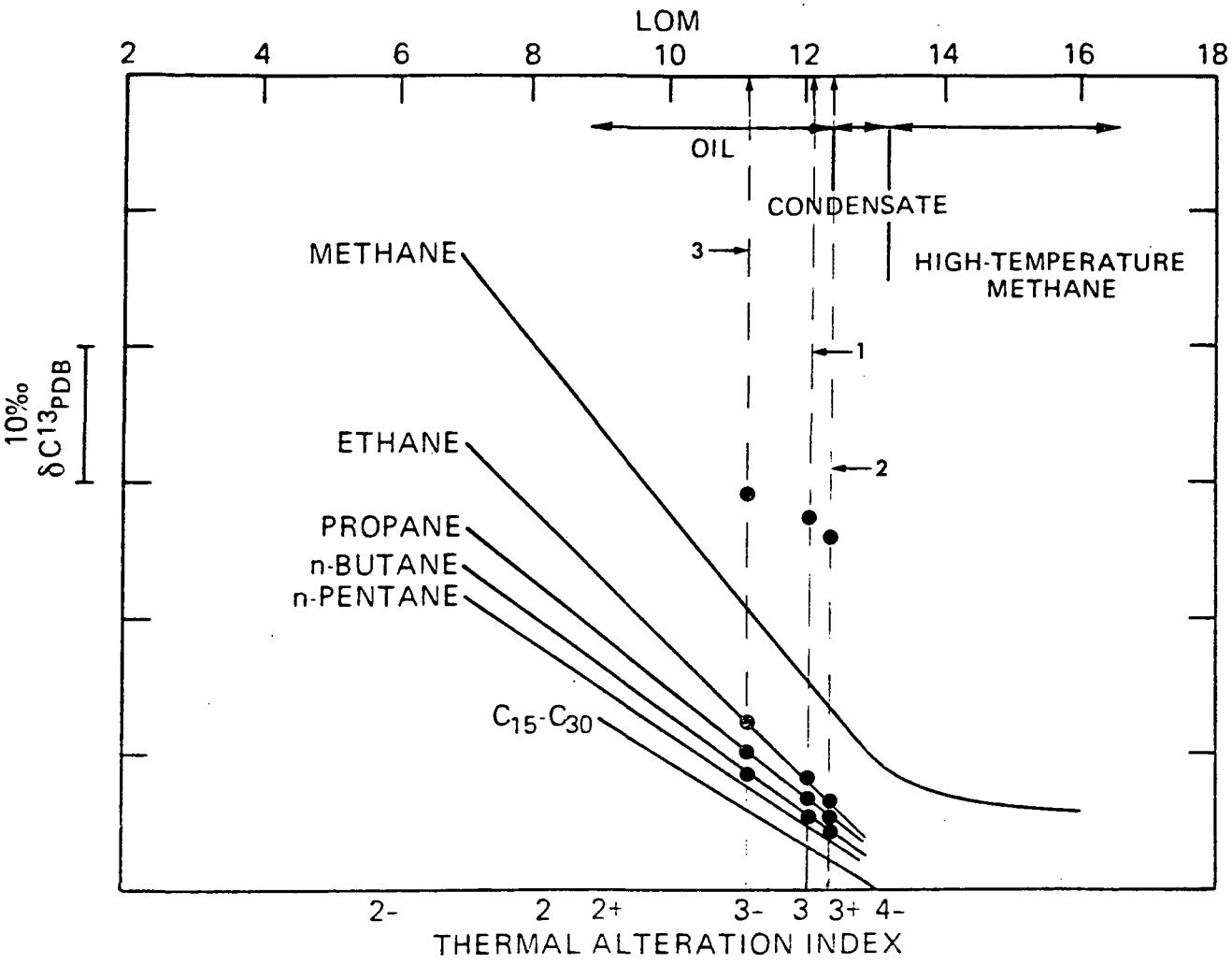
4. CONCLUSION

The carbon isotopic distribution between the hydrocarbon gas components methane, ethane, propane and n-butane indicates that the gas was formed at a relatively high maturity in the oil window. The carbon isotope measurements indicate a source rock with isotopically light kerogens.

The carbon and hydrogen isotopic composition of methane suggest that methane has a biogenic component.

* 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.



1 DST 1 Item 1 of 3
2 DST 1 Item 2 of 3
3 DST 2 Item 3 of 3

Figure 1. Carbon isotopic separations of the gas from well 34/7-6 are plotted on the maturity diagram (after James, 1983). A source LOM of about 11 - 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 $\delta^{13}C$ 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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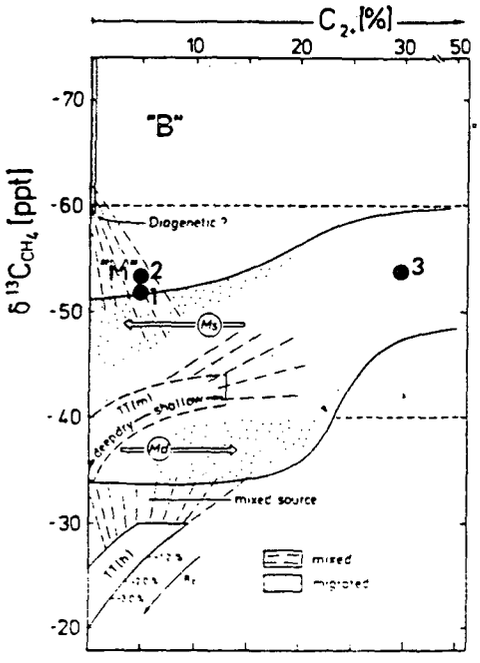

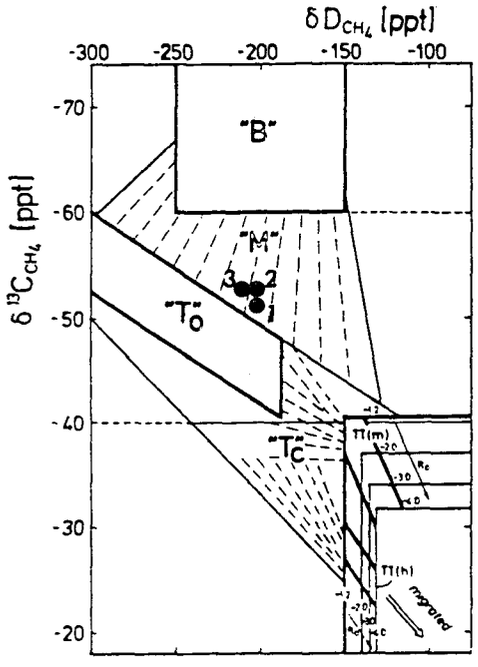

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Figure 2a

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

Figure 2b

Carbon and hydrogen isotope variations in 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).