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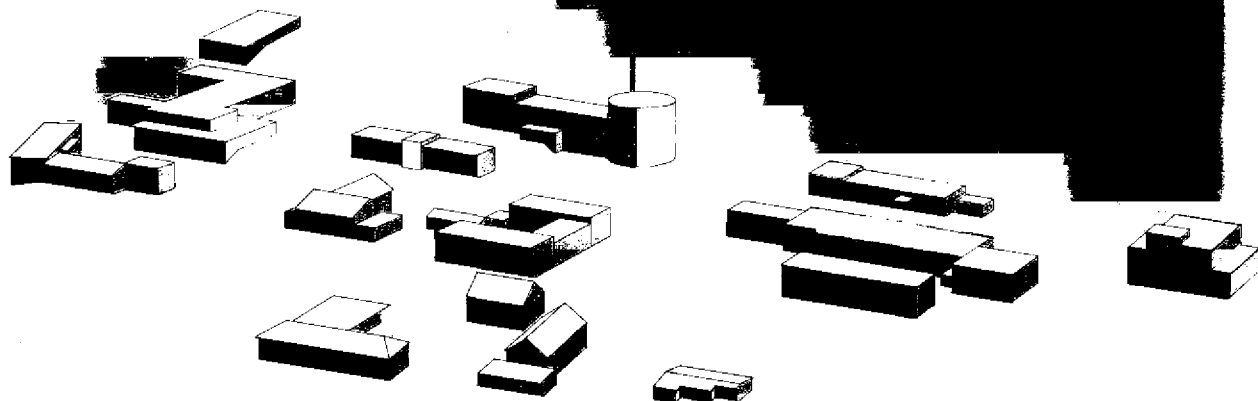
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REPORT TITLE

REPORT ON STABLE ISOTOPES ($\delta^{13}\text{C}$ AND δD) ON A NATURAL GAS FROM WELL 6407/1-2.

CLIENT

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Institute for energy technology

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SUMMARY			DISTRIBUTION
<p>The gas components CH_4, C_2H_6, C_3H_8, $i\text{-C}_4\text{H}_{10}$, $n\text{-C}_4\text{H}_{10}$ and CO_2 have been separated from the natural gas of well 6407/1-2, and the $\delta^{13}\text{C}$-values of these components have been measured. The isotopic composition of hydrogen which was made from the H_2O formed during the combustion of CH_4, have also been measured.</p> <p>The carbon isotopic distribution between the hydrocarbon gas components ; methane, ethane, propane and n-butane indicates together with the combined use of the carbon and hydrogen isotopic composition of methane that the gas was formed at a high maturity in the condensate field of the oil window.</p>			Oppdragsgiver, 10 Andresen, B. Brevik, E. Garder, K. Gaudernack, B. Råheim, A. Berg, J.O.
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REPORT ON STABLE ISOTOPES ($\delta^{13}\text{C}$, AND δD) ON A NATURAL GAS FROM WELL 6407/1-2.

ANALYTICAL PROCEDURE

The natural gas has been separated into the different gas components by a Carlo-Erba 4200 instrument. The hydrocarbon gas components were oxydized in separate CuO-ovens, which enables us to collect several times when the concentration of a gas component is low. The combustion products CO_2 and H_2O were frozen into collection vessles and separated. The isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our $\delta^{13}\text{C}$ -value on NBS-22 is $- 29.77 \pm .06 \text{ ‰}$.

RESULTS

The results are given in the following table :

Gas components	$\delta^{13}\text{C}$ -value in ‰ x)	δD -value in ‰ xx)
CH_4	- 45.8	- 151.-
C_2H_6	- 31.5	
C_3H_8	- 30.6	
n- C_4H_{10}	- 30.2	
i- C_4H_{10}	- 26.4	
CO_2	- 6.1	

x) Our uncertainty on the $\delta^{13}\text{C}$ -values is estimated to be $\pm 0.3 \text{ ‰}$, and includes all the different analyses steps.

xx) The uncertainty on the δD -value is about 5 ‰ , the isotopic measurement has been performed in Mook's laboratory, Groningen, Netherland.

INTERPRETATION

The $\delta^{13}\text{C}$ -values of methane, ethane, propane and n-butane have been plotted on the maturation diagram by James (1983)^{xxx} Figure 1. A source LOM between 12 and 13, eq. to a vitrinite reflectance of about 1.5 is indicated. The $\delta^{13}\text{C}$ -methane value falls above the methane line in the diagram. This is often the case for LOMs from 12 to 14, the range of maturities where condensates are common.

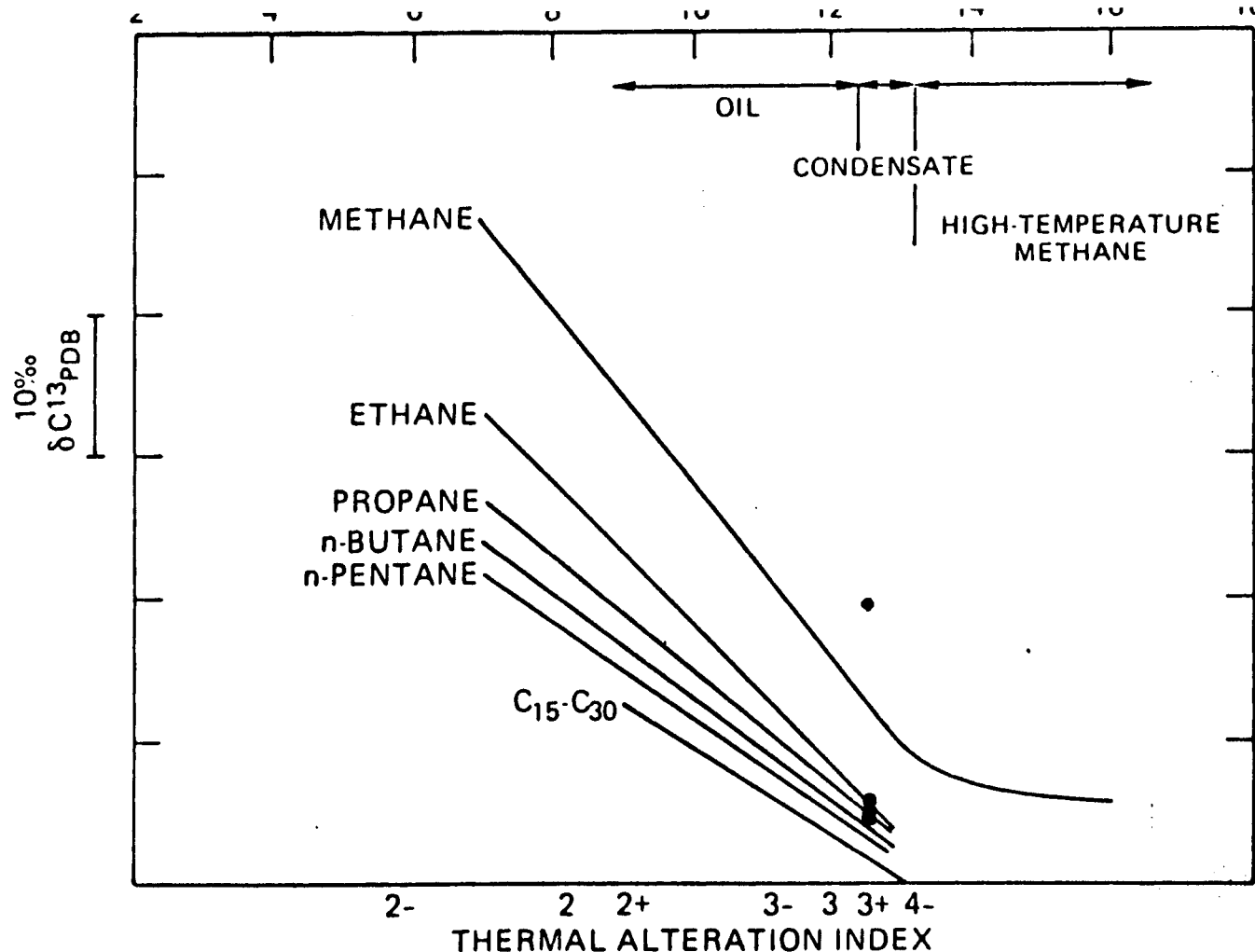
The carbon and hydrogen isotopic composition have been plotted in a $\delta^{13}\text{C}$ vs. $\delta\text{D}_{\text{CH}_4}$ cross plot (Schoell 1983)^{xxxx}, Figure 2. This also indicates that the gas was formed at a relatively high maturity in the condensate field of the oil window. The plot in the diagram also seems to indicate that the thermogenic methane is mixed with a small component of biogenic methane. This may be true, but the relatively light $\delta^{13}\text{C}$ methane value may also be indicative of methane formed by a cracking process

CONCLUSION

The carbon isotopic distribution between the hydrocarbon gas components ; methane ; ethane ; propane and n-butane indicates together with the combined use of the carbon and hydrogen isotopic composition of methane that the gas was formed at high maturity in the condensate field of the oil window.

xxx) James, Alan T. (1983) : *Correlation of Natural Gas by Use of Carbon Isotopic Distribution Between Hydrocarbon Components*, A.A.P.G. Vol. 67, No. 7, July, 1983.

xxxx) Schoell, M. 1983 : *Genetic Characterization of Natural Gases*. A.A.P.G. December, 1983.



	$\delta^{13}\text{C}$ ‰	Vol %
C ₁	- 45.8	47.5
C ₂	- 31.5	4.8
C ₃	- 30.6	3.1
n-C ₄	- 30.2	0.8
i-C ₄	- 26.4	0.4
CO ₂	- 6.1	2.6

Figure 1. Carbon isotopic separations of well 6407/1-2 gas plotted on the maturity diagram (after James, 1983). A source LOM between 12 and 13 is indicated for the gas.

The calculated carbon isotopic separations between gas component 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.

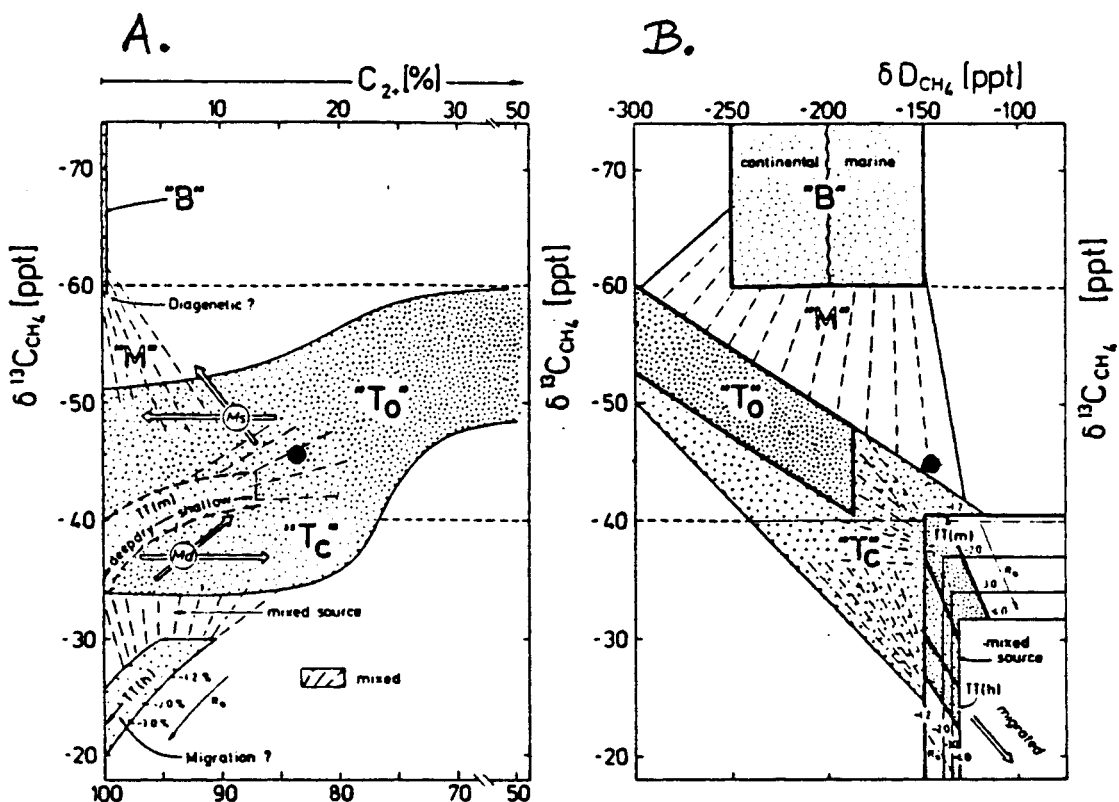


Figure 2 a. Variations of molecular composition in natural gases related to the isotope variations of methane.

Figure 2b. Carbon and hydrogen isotope variations in methanes.

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 M_d (deep migration) and M_s (shallow migration) respectively. "T" are gases associated with petroleum in an initial phase of formation. "T_c" are gases associated with condensates.

(Schoell, 1983).