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REPORT TYPE	REPORT NO. IFE/KR/F-85/022	DATE 1985-02-19	
	REPORT TITLE REPORT ON STABLE ISTOPES ( $\delta^{13}\text{C}$ and $\delta\text{D}$ ) ON A NATURAL GAS FROM WELL 7121/4-1	DATE OF LAST REV.	
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SUMMARY  The gas components $\text{CH}_4$ , $\text{C}_2\text{H}_6$ , $\text{C}_3\text{H}_8$ , $i\text{-C}_4\text{H}_{10}$ , $n\text{-C}_4\text{H}_{10}$ and $\text{CO}_2$ have been separated from the natural gas of well 7121/4-1, and the $\delta^{13}\text{C}$ values of these components have been measured. The isotopic composition of hydrogen which was made from the $\text{H}_2\text{O}$ during the combustion of $\text{CH}_4$ 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.  - 5 MAR 1985  <b>REGISTRERT</b> OLJEDIREKTORATET			DISTRIBUTION  Client, 10 Andresen, B. Brevik, E. Garder, K. Gaudernack, B. Råheim, A. Berg, J.O.
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## 1 ANALYTICAL PROCEDURE

The natural gas has been separated into the different gas components by a Carlo-Erba 4200 instrument. The hydrocarbon gas components were oxidized in separate CuO ovens, which enable us to collect several times when the concentration of a gas component is low. The combustion products CO<sub>2</sub> and H<sub>2</sub>O were frozen into collection vessels and separated. The isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our  $\delta^{13}\text{C}$ -value on NBS-22 is  $-29.77 \pm .06$  o/oo.

## 2 RESULTS

The results of the isotope determinations are given in the following table:

Table 1

C <sub>1</sub>		$\delta^{13}\text{C}_2$	$\delta^{13}\text{C}_3$	$\delta^{13}\text{C}_{i4}$	$\delta^{13}\text{C}_{n4}$	CO <sub>2</sub>	
$\delta^{13}\text{C}$	$\delta\text{D}$					$\delta^{13}\text{C}$	$\delta^{18}\text{O}$
-46.0	-130.0	-33.1	-31.3	-27.1	-30.9	-10.9	-12.2

Our uncertainty on the  $\delta^{13}\text{C}$  value is estimated to be  $\pm .3$  o/oo, and includes all the different analysis steps.

The uncertainty on the  $\delta\text{D}$  value is likewise estimated to be  $\pm 5$  o/oo.

The composition in % of the gas sample is given in Table 2. The results have not been normalized to 100%. The rest is air.

Table 2: Composition of the gas from well 7121/4-1

C <sub>1</sub>	57%
C <sub>2</sub>	4.4%
C <sub>3</sub>	2.3%
i C <sub>4</sub>	0.35%
n C <sub>4</sub>	0.69%
CO <sub>2</sub>	7.4%

### 3 INTERPRETATION

THE  $\delta^{13}\text{C}$  values of methane, ethane, propane and n-butane have been plotted on the maturation diagram by James (1983)<sup>\*</sup>, Figure 1. A source LOM between 11 and 12, e.g. to a vitrinite reflectance of about 1.1 is indicated.

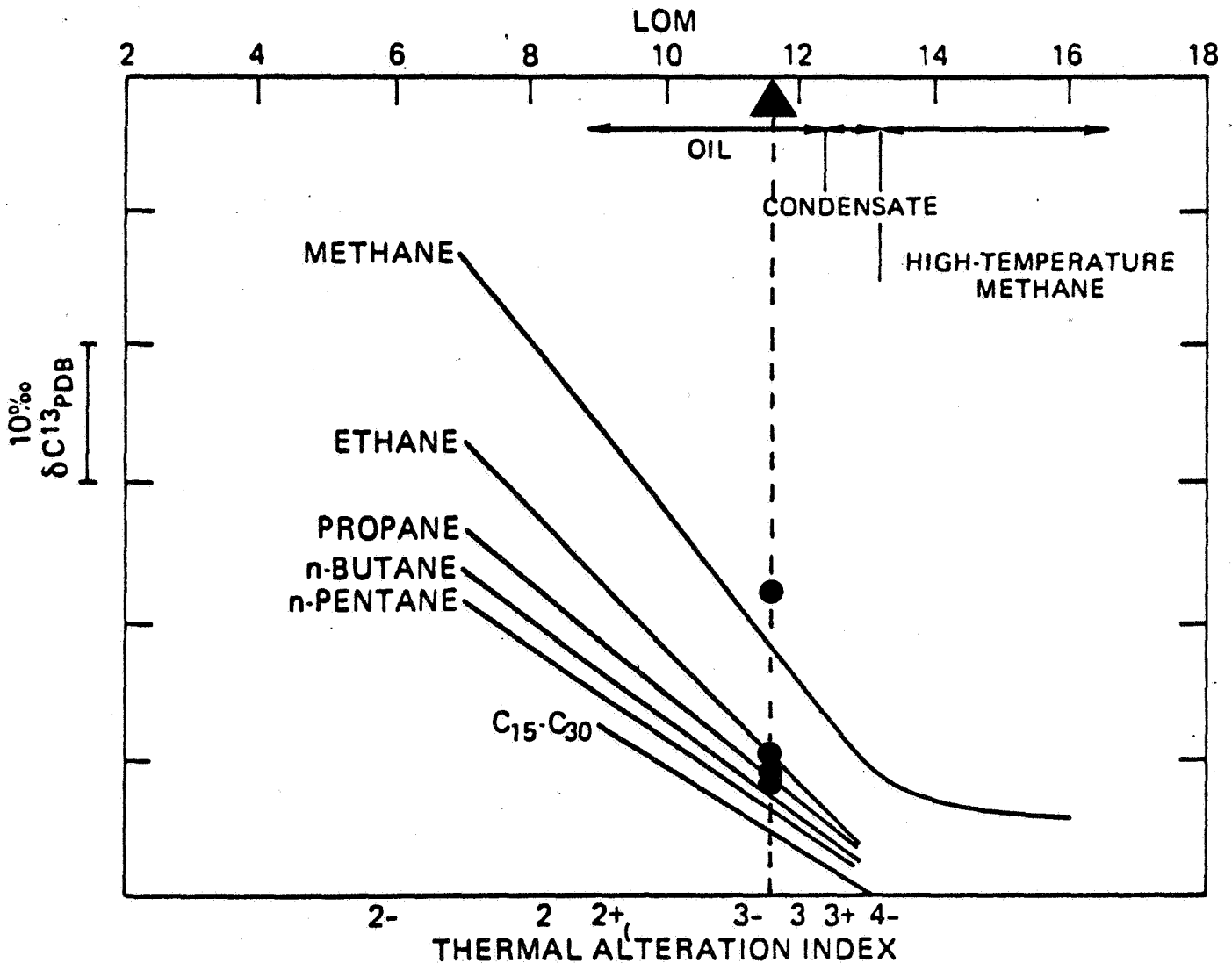
The carbon and hydrogen isotopic composition have been plotted in a  $\delta^{13}\text{C}$  methane vs.  $\delta\text{D}$  methane cross plot (Schoell 1983)<sup>\*\*</sup>, Figure 2. This indicates that the gas may have a small biogenic component. We do not, however, think that this is the case. Instead we think that the bulk of the methane may have formed at higher maturity (condensate - high temperature methane) than indicated by the use of  $\delta\text{C}_2 - \delta\text{nC}_4$  (see Fig. 1).

### 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.

\* 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.

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



**Figure 1.** Carbon isotopic separations of the gas from well 7121/4-1 are plotted on the maturity diagram (after James, 1983). A source LOM between 11 and 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  $\delta^{13}\text{C}$  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.

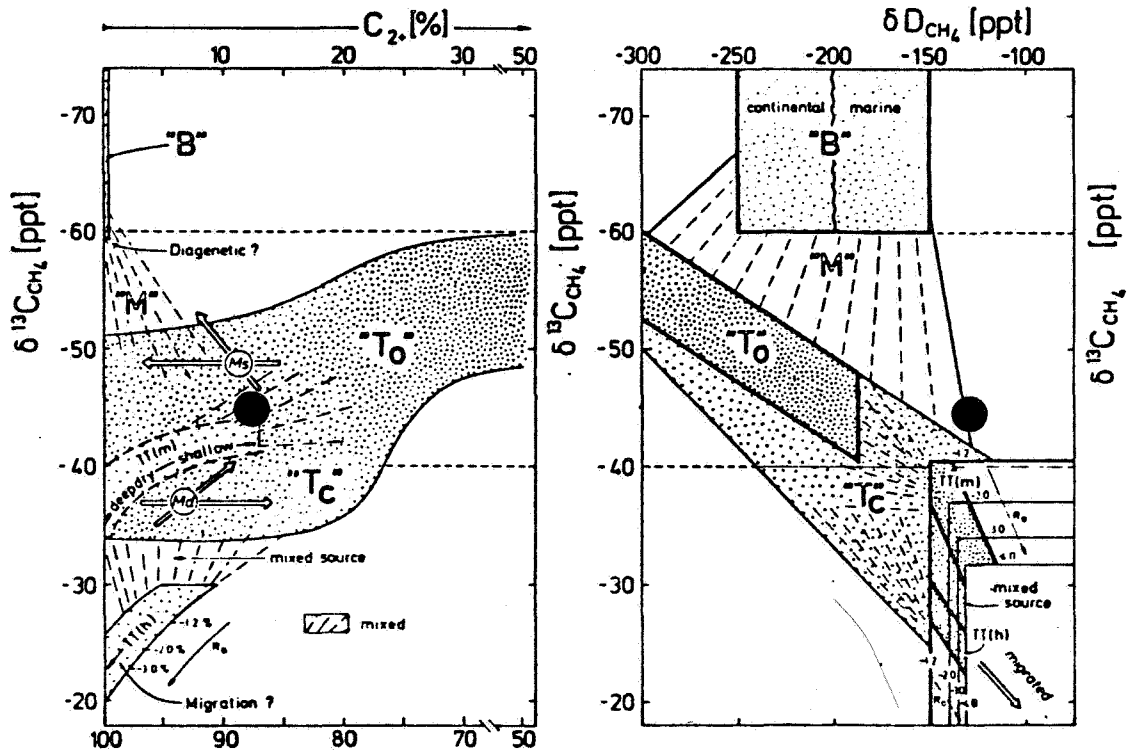


Figure 2 a. Variations of molecular composition in natural gases related to the isotope variations of methane.

Figure 2 b. 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 Md (deep migration) and Ms (shallow migration), respectively. "T" are gases associated with petroleum in an initial phase of formation. "T<sub>c</sub>" are gases associated with condensates. (Schoell, 1983).