

Denne rapport  
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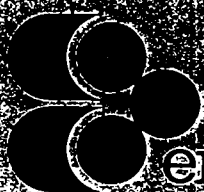
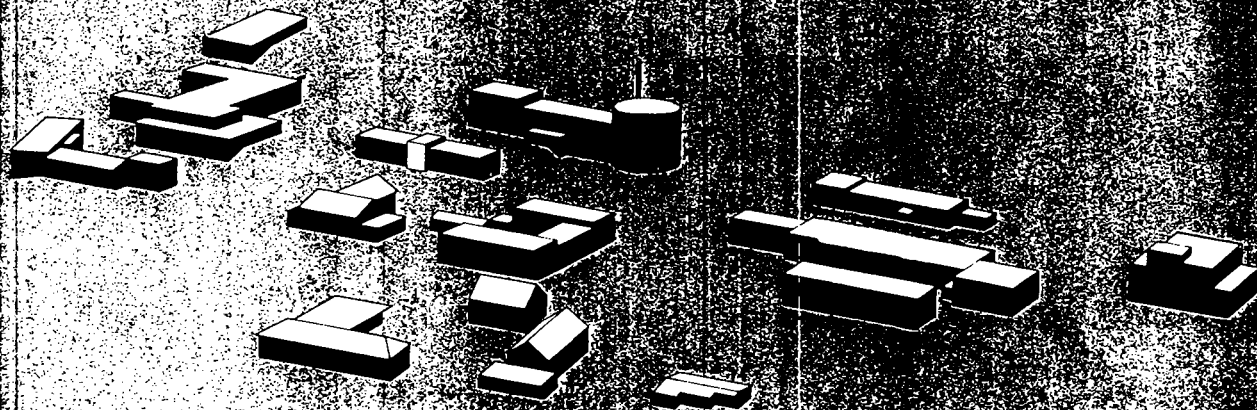
KODE Well 15/9-11 nr 26

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REPORT NO. :  
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REPORT TITLE  
REPORT ON STABLE ISOTOPES ( $\delta^{13}\text{C}$  AND  $\delta\text{D}$ ) ON A  
NATURAL GAS FROM WELL 15/9-11

CLIENT  
STATOIL  
Den norske stats oljeselskap a.s.



Institute for  
energy technology



REPORT ON STABLE ISOTOPES ( $\delta^{13}\text{C}$  AND  $\delta\text{D}$ ) ON A NATURAL GAS FROM WELL 15/9-11

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  $\text{CO}_2$  and  $\text{H}_2\text{O}$  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 +/- .06 ‰.

RESULTS

The results are given in the following table :

$\text{CH}_4$		$\text{C}_2\text{H}_6$	$\text{C}_3\text{H}_8$	$i\text{-C}_4\text{H}_{10}$	$n\text{-C}_4\text{H}_{10}$	$\text{CO}_2$
$\delta^{13}\text{C}$	$\delta\text{D}$	$\delta^{13}\text{C}$	$\delta^{13}\text{C}$	$\delta^{13}\text{C}$	$\delta^{13}\text{C}$	$\delta^{13}\text{C}$
-42.9	-167	-26.7	-25.7	-24.3	-24.1	12.3

Our uncertainty on the  $\delta^{13}\text{C}$ -value is estimated to be +/- .3 ‰, and includes all the different analyses steps.

The uncertainty on the  $\delta\text{D}$ -value is about +/- 5 ‰. The isotopic measurement has been performed in Mook's laboratory, Groningen, Netherland.

INTERPRETATION

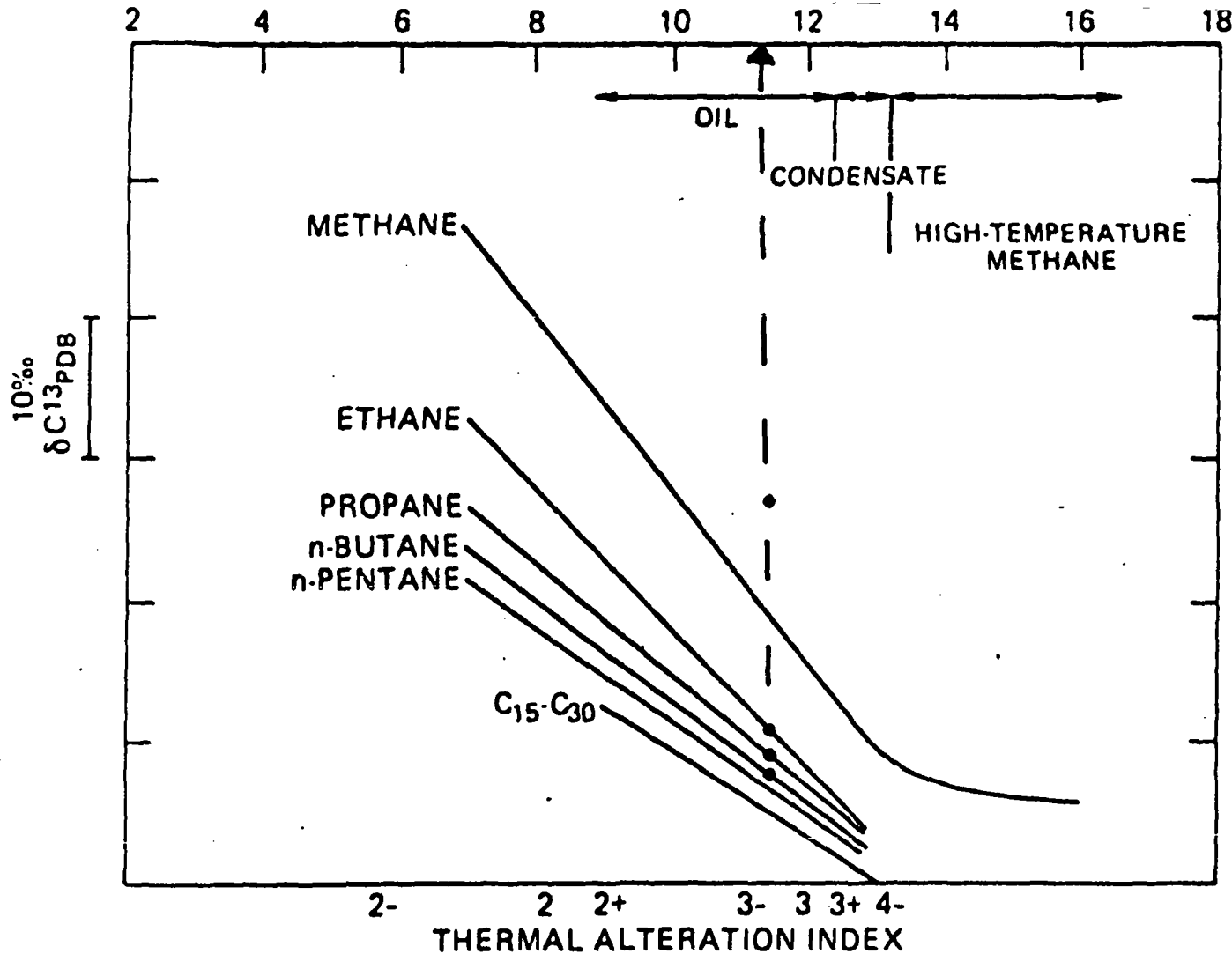
The  $\delta^{13}\text{C}$ -values of methane, ethane, propane and n-butane have been plotted on the maturation diagram by James (1983) \* Figure 1. A source LOM between 11 and 12, eq. to a vitrinite reflectance of about 1.1 is indicated.

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)\*\*, Figure 2. This also indicates that the gas was formed at a relatively high maturity of the oil window.

## 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 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 Characertization of Natural Gases. A.A.P.G. December, 1983.



	δ <sup>13</sup> C ‰ / 100	Vol %
C <sub>1</sub>	- 42.9	58
C <sub>2</sub>	- 26.7	7.3
C <sub>3</sub>	- 25.9	5.8
n-C <sub>4</sub>	- 24.3	1.7
i-C <sub>4</sub>	- 24.1	1.1
CO <sub>2</sub>	- 12.3	.4

Figure 1. Carbon isotopic separations of the gas from well 15/9-11 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 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 δ<sup>13</sup>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.

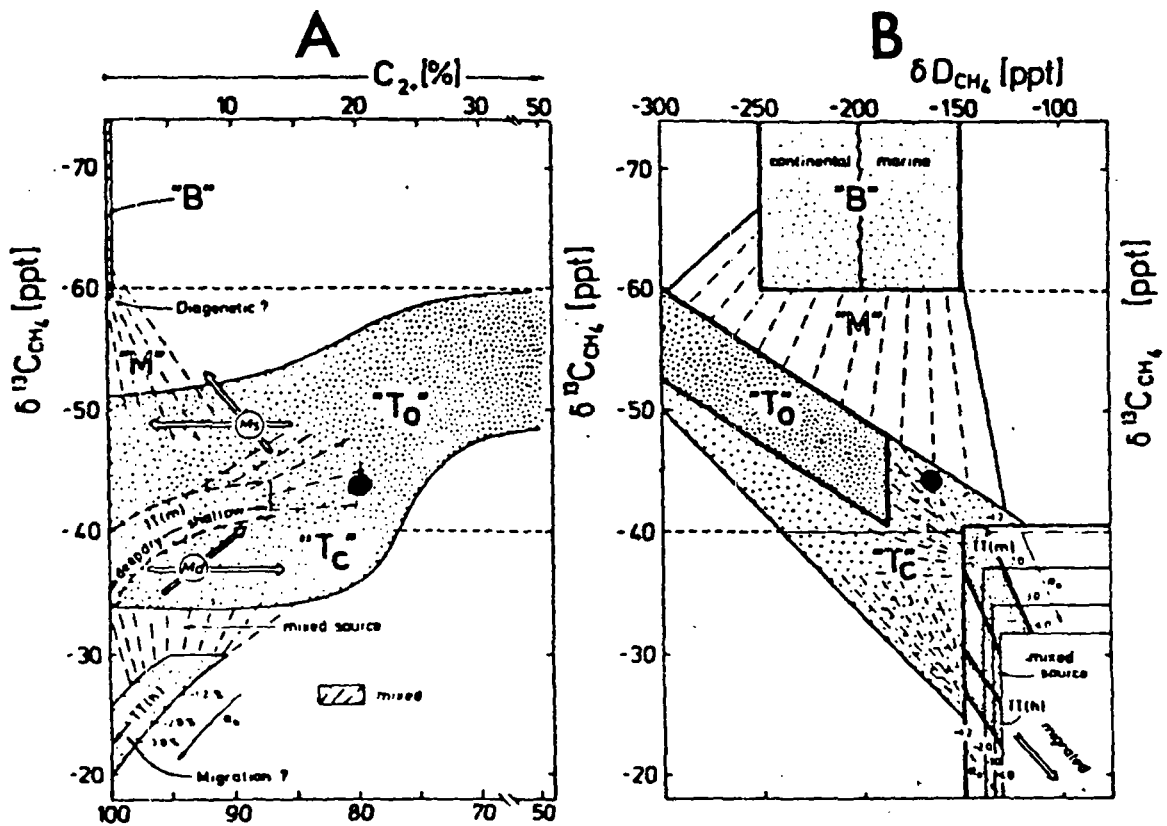


Figure 2 a. Variations of molecular composition in natural gases related to the isotope variations of methane.

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).