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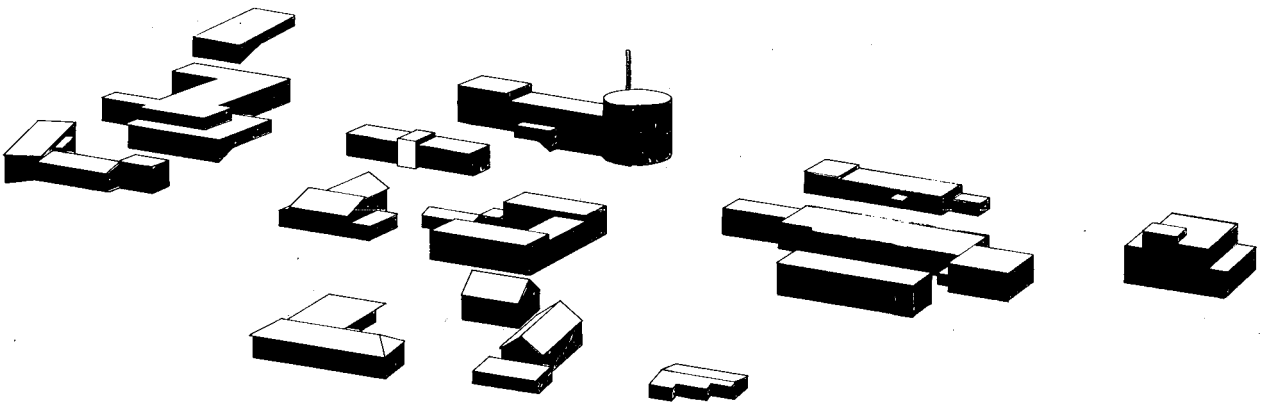
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REPORT TITLE

RESERVOIR GAS GEOCHEMISTRY ON SAMPLE FROM  
WELL 31/6-6

CLIENT

STATOIL, NORSK HYDRO A/S, SAGA A/S



ADDRESS	KJELLER N-2007 Kjeller, Norway	HALDEN N-1751 Halden, Norway	AVAILABILITY Private confidential
TELEPHONE	(02)712560 - 713560	(031)83100	
TELEX	76361 energ n	76335 energ n	
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SUMMARY		DISTRIBUTION	
<p>A rather heavy <math>\delta^{13}\text{C}</math> propane value together with the uncommon relationships between the <math>\delta^{13}\text{C}</math> values of propane and the butanes can in our view only be explained by effects from bacterial degradation in the reservoir.</p> <p>This in accordance with the conclusion given in the reports on well 31/3-1, 31/5-1/31/5-2, 31/6-2, 31/6-5, 31/5-2 (reservoir gas) and 31/6-1.</p> <p>This biodegradation was probably followed by a period of renewed supply of predominantly dry gas possibly of mixed thermogenic and biogenic origin. The <math>\delta\text{D}</math> values are similar to that reported from well 31/5-2 but different from the other wells reported earlier. This may indicate migration from different source rocks or a source rock with different kerogene types. The isotopic composition on some of the gas components are distinctly different between the two samples from different depths. This may indicate a migration barrier between the sampling sites.</p>		<p>Oppdragsgivere, 10 Andresen, B. Berg, J.O. Brevik, E.M. Gaudernack, B. Garder, K. Råheim, A.</p> <p>SUMMARY Aamodt, N-G. Project leaders Halden Sectionheads Kjeller Library</p>	
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PREPARED BY	Einar M. Brevik Bjørn Andresen Arne Råheim	1984-11-12	<i>Einar Brevik Bjørn Andresen Arne Råheim</i>
REVIEWED BY			
APPROVED BY	Karen Garder	1984-11-12	<i>Karen Garder</i>

## ANALYTICAL PROCEDURE

The samples were received in two Al bags. 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<sub>2</sub> and H<sub>2</sub>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  $-29.77 \pm 0.06$  ‰.

## RESULTS

The stable isotope results of the natural gases from well 31/6-6 are given in the following table :

Table 1. Isotopic composition of gas samples from well 31/6-6.

31/6-6	$\delta^{13}\text{C}_1$ $\delta\text{D}$	$\text{C}_2$	$\text{C}_3$	$\text{iC}_4$	$\text{nC}_4$	$\delta^{13}\text{C}_2$ $\delta^{18}\text{O}$
DST I A 1470/ 40784	-47.7 -237	- 25.5	- 15.2	- 27.0	- 28.0	+4.3 - 15
DST #2 1520-33M A 14832	-49.5 -200	- 26.5	- 23.0	- 24.2	- 27.9	- 10 - 13.8

The composition in % of the gas sample is given in table 2. The result has not been normalized to 100%, the rest is air.

Table 2. Composition of gas from well 31/6-6 % of C<sub>1</sub>-C<sub>4</sub>

	DST 1A	DST #2
C <sub>1</sub>	70.0	63.0
C <sub>2</sub>	3.3	3.1
C <sub>3</sub>	0.4	1.4
iC <sub>4</sub>	0.4	0.5
nC <sub>4</sub>	0.06	0.3
CO <sub>2</sub>	0.3	0.2

#### INTERPRETATION

The rather heavy  $\delta^{13}\text{C}$  propane values together with the uncommon relationships between the  $\delta^{13}\text{C}$  values of propane and the butanes can in our view only be explained by effects from bacterial degradation in the reservoir.

A new, relatively dry gas has migrated into the reservoir after the bacterial degradation had stopped. The new gas mixed with the gas left after the bacterial degradation.

This makes it impossible to use Alan T. James' method \* to indicate the maturity of the source.

It is, however, likely that the methane component of the natural gas is representative for the new, relatively dry gas. This assumption is based on our experience on bacterial degradation from laboratory experiments.

The carbon and hydrogen isotopic composition of the gases indicate, however, when plotted in a  $\delta^{13}\text{C}$  methane v.s.  $\delta\text{D}$  methane plot (Schoell, 1983) that the methane is oil associated. This contradicts the conclusion given in earlier Troll reports. It should be pointed out that Schoell's diagram is based on empirical data and is not necessarily correct. It is also possible that the methane is of mixed origin. The reservoir is

probably shallow enough that biogenic methane could have migrated into the reservoir and mixed with high maturity thermogenic methane. The comparatively light isotopic composition of the methane hydrogen is similar to that reported from well 31/5-2. It is possible that this reflects different isotopic compositions of the kerogens in the source rocks. It is interesting to note that the two gas samples from 31/6-6 are distinctly different. This is easily seen from a comparison between the  $\delta D$ ,  $\delta^{13}C_3$  and the  $\delta^{13}C_{CO_2}$  values of the two samples. This may indicate a migration barrier between the sampling sites.

\* 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.

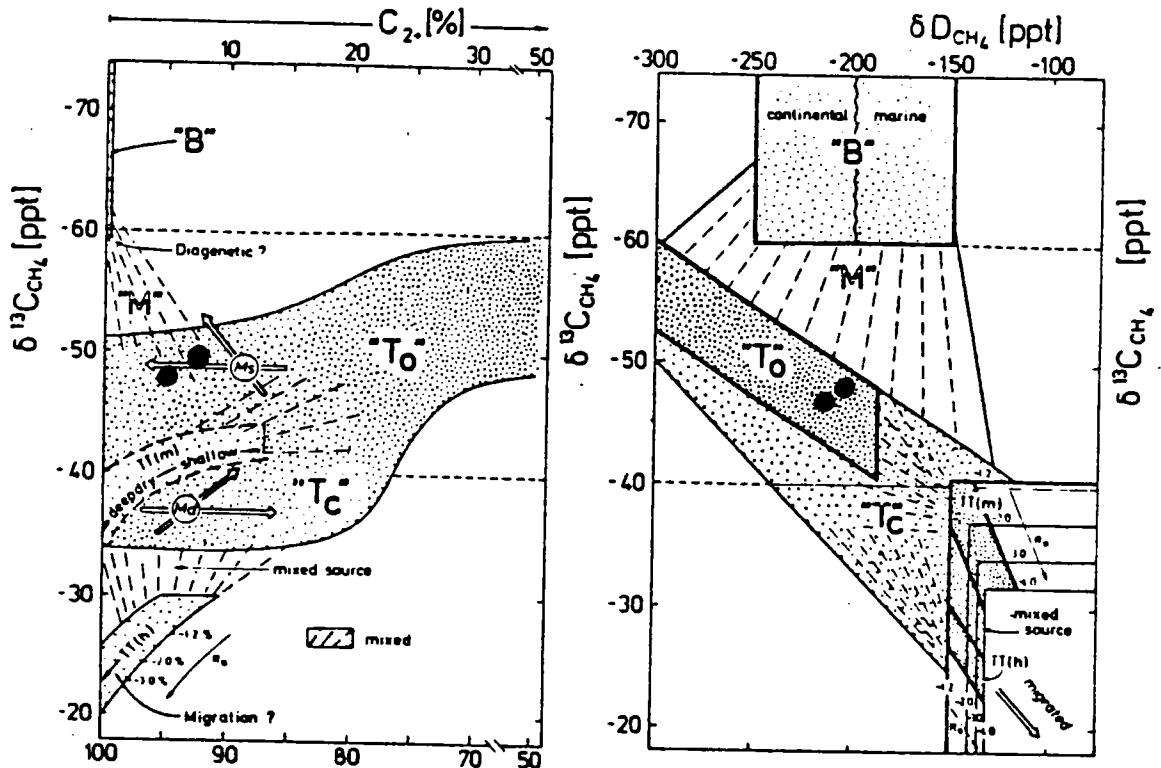


Figure 1 a. Variations of molecular composition in natural gases related to the isotope variations of methane.

Figure 1 b. 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" are gases associated with petroleum in an initial phase of formation. "T<sub>c</sub>" are gases associated with condensates. (Schoell, 1983).