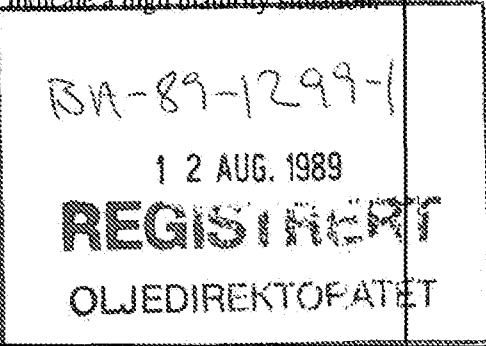


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	REPORT TITLE REPORT ON STABLE ISOTOPES ( $\delta^{13}\text{C}$ , $\delta\text{D}$ , $\delta^{18}\text{O}$ ) ON NATURAL GAS SAMPLES FROM WELL 34/10-33.		DATE OF LAST REV. REV. NO.
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SUMMARY		DISTRIBUTION	
<p>The gas components <math>\text{C}_1</math>-<math>\text{C}_3</math> and <math>\text{CO}_2</math> have been separated from natural gas samples from well 34/10-33, DST 2.1, Main Flow, 3279-3307/3311.5-3329 m RKB and DST 1.2, Main Flow, 3378-3394/3359-3374 m RKB, and the <math>\delta^{13}\text{C}</math> values of methane, ethane, propane, the butanes and <math>\text{CO}_2</math> have been measured. The isotopic composition of hydrogen from <math>\text{CH}_4</math> has also been measured.</p> <p>The isotopic composition of the gas samples indicate a high maturity situation.</p>		<p>Statoil (10) Andresen, B. Råheim, A. Thronsen, T. File (2)</p>	
			
KEYWORDS			
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## 1 INTRODUCTION

Two gas samples from well 34/10-33, DST 2.1, Main Flow, 3279-3307/3311.5-3329 m RKB and DST 1.2, Main Flow, 3378-3394/3359-3374 m RKB was received and analysed June/July 1989.

On the samples  $C_1 - C_5$  and  $CO_2$  are quantified, and the  $\delta^{13}C$  value is measured on methane, ethane, propane, the butanes and  $CO_2$ . The  $\delta D$  value is also measured on methane.

## 2 ANALYTICAL PROCEDURE

The natural gas have been quantified and separated into the different gas components by a Carlo Erba 4200 instrument.

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 and Finnigan Delta mass spectrometer. IFE's value on NBS 22 is  $-29.77 \pm .06$  ‰ PDB.

## 3 RESULTS

The volume composition of the gas samples is given in table 1. The results have been normalized to 100%. The stable isotope results are given in table 2.

The uncertainty on the  $\delta^{13}C$  value is estimated to be  $\pm 0.3$  ‰ PDB and includes all the different analytical steps. The uncertainty on the  $\delta D$  value is likewise estimated to be  $\pm 5$  ‰.

**Table 1** Volume composition of a gas samples from well 34/10-33.

SAMPLE	IFE no.	C <sub>1</sub> %	C <sub>2</sub> %	C <sub>3</sub> %	iC <sub>4</sub> %	nC <sub>4</sub> %	iC <sub>5</sub> %	nC <sub>5</sub> %	CO <sub>2</sub> %	Σ C <sub>1</sub> - C <sub>5</sub>	WET-NESS	iC <sub>4</sub> /nC <sub>4</sub>
DST 2.1, Main Flow, 3279-3307/3311.5-3329 m	8304	87.6	7.0	2.3	0.26	0.48	0.07	0.07	2.24	97.8	0.10	0.55
DST 1.2, Main Flow, 3378-3394/3359-3374 m	8305	82.5	9.3	3.5	0.42	0.84	0.14	0.14	3.13	96.9	0.15	0.50

**Table 2** Isotopic composition of a gas samples from well 34/10-33.

SAMPLE	IFE no.	C <sub>1</sub> δ <sup>13</sup> C PDB	C <sub>1</sub> δD SMOW	C <sub>2</sub> δ <sup>13</sup> C PDB	C <sub>3</sub> δ <sup>13</sup> C PDB	iC <sub>4</sub> δ <sup>13</sup> C PDB	nC <sub>4</sub> δ <sup>13</sup> C PDB	CO <sub>2</sub> δ <sup>13</sup> C PDB	CO <sub>2</sub> δ <sup>18</sup> O PDB
DST 2.1, Main Flow, 3279-3307/3311.5-3329 m	8304	-37.3	-193	-28.4	-26.8	-26.4	-26.4	-5.7	-12.3
DST 1.2, Main Flow, 3378-3394/3359-3374 m	8305	-38.3	-195	-29.0	-27.0	-26.2	-26.6	-9.1	-12.1

## 4 INTERPRETATION

As seen from table 2 this gas sample is characterized by rather low δ<sup>13</sup>C values in all of the different hydrocarbon groups, which are in the range of -26 to -38‰. This is not a typical value for natural gas, but rather a value for gas from a low-grade reservoir.

The isotopic composition of the gas from an older well had a δ<sup>13</sup>C value of -26.4‰. This may be due to a mixed gas situation with gas of both low and high grade. Gases derived from the same source but of different maturity may have a δ<sup>13</sup>C value in the range of -26 to -38‰.

The present relationship between the  $\delta^{13}\text{C}$  value of propane and n-butane may also be due to a high maturity situation. A source LOM of about 12 is indicated when the  $\delta^{13}\text{C}$  values of methane, ethane, propane and n-butane are plotted in James maturity diagram, fig.1 (James, 1983), e.g. a relatively high maturity level in the oil window. A high maturity level in the condensate field of the oil window is also indicated by the combined use of the carbon and hydrogen isotopes of methane, fig.2 (Schoell, 1983).

## 5 CONCLUSION

The present gas samples from well 34/10-33, DST 2.1, Main Flow, 3279-3307/3311.5-3329 m RKB and DST 1.2, Main Flow, 3378-3394/3359-3374 m RKB are characterized by carbon isotopic values depleted in the light isotope, which may indicate a biodegraded environment or an isotopically heavy source rock.

The isotopic composition of the gas samples indicate a high maturity situation.

## 6 LITERATURE

James, A.T. (1983). Correlation of natural gas by use of carbon isotopic distribution between hydrocarbon components. *American Association of Petroleum Geologists Bulletin*, 67, 1176-1191A.

Robert, P. (1985) Methods and means of paleothermal analysis. *Organic Methamorphism and Geothermal History*, Elf-Aquitaine and D. Reidel Publishing Company.

Schoell, M. (1983). Genetic characterization of natural gases. *American Association of Petroleum Geologists Bulletin*, 67, 2225-2238.

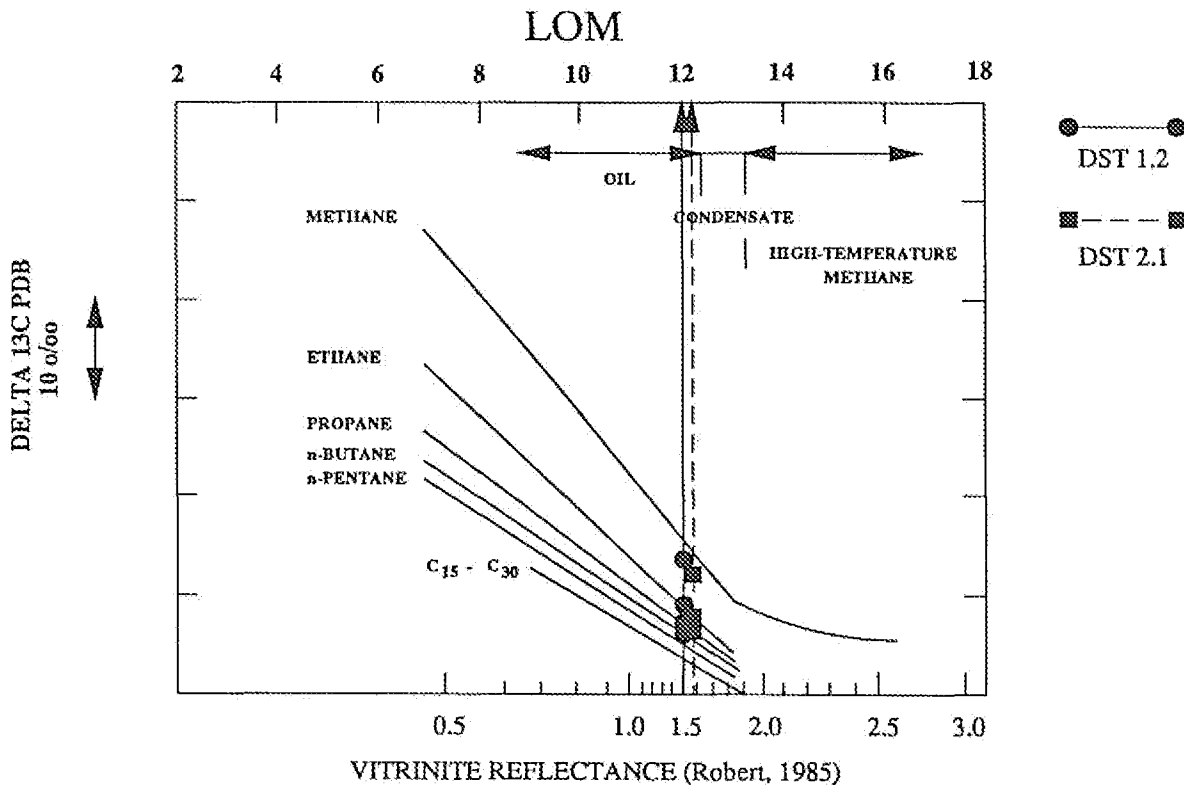


Figure 1

Carbon isotopic separation of gas samples from well 34/10-33, DST 2.1, Main Flow, 3279-3307/3311.5-3329 m RKB and DST 1.2, Main Flow, 3378-3394/3359-3374 m RKB are plotted on the maturity diagram (after James, 1983). A source LOM of about 12 is indicated for the gas samples.

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 composition 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.

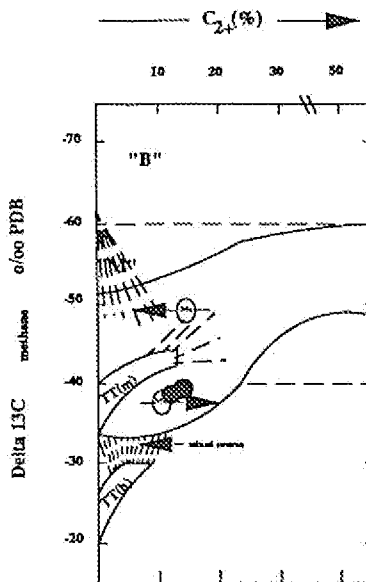


Figure 2A

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

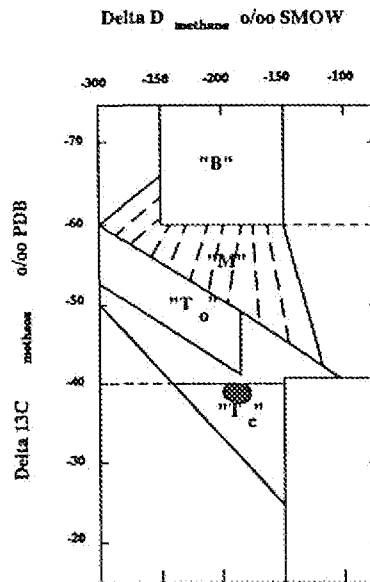


Figure 2B

Carbon and hydrogen isotope variations in methane.

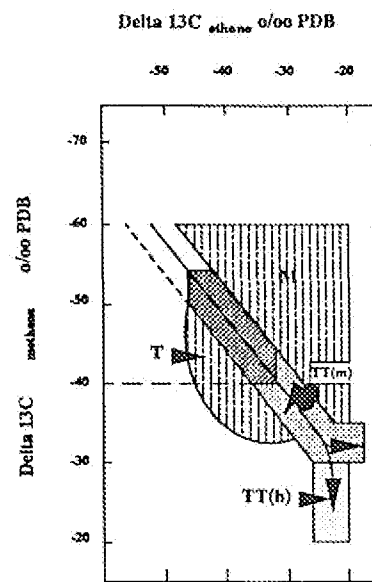


Figure 2C

Carbon isotope variations in ethane related to carbon isotope variations in methane.

The principle for the genetic characterization of natural gases is that 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<sub>0</sub>" are gases associated with petroleum in an initial phase of formation. "T<sub>c</sub>" are gases associated with condensates (Schoell, 1983).