Institute for energy technology

	KJELLER	HALDEN	AVAILABILITY
ADDRESS	N-2007 Kjeller, Norway	N-1751 Halden, Norway	
TELEPHONE	+47 2 712560 - 713560	+47 31 83100	Private
TELEX	74 573 energ n	76 335 energ n	Confidential
TELEFAX	+47 2 715553		

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SUMMARY

The gas components C_1-C_4 from headspace cans are quantified and the $\delta^{13}C$ value is measured when possible on CH_4, C_2H_6, C_3H_8, i-C_4H_{10} and n-C_4H_{10}.

The $\delta^{13}C$ value of CH_4 shows a biogenic component down to about the 1900 m level, while thermogenic methane may be mixed with biogenic methane up to about the 1500 m level.

The samples from 2120-2330 m level have a reversal of the $\delta^{13}C$ values of propane and n-butane compared to normal natural gas samples. This reversal may be due to a mixture of gases derived from two or multiple sources, or gases from one source, but derived at different maturity levels.

The headspace gas from the 2532-2541 m level shows a normal isotopic composition. This isotopic composition indicates that the gas (gases) was formed at relatively high maturity in the oil window.

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Andresen, B.
Brevik, E.M.
Råheim, A.

KEYWORDS

	NAME	DATE	SIGNATURE
PREPARED BY	Bjørg Andresen	1986-01-22	Bjørg Andresen
	Einar M. Brevik	1986-01-22	Einar M. Brevik
	Arne Råheim	1986-01-22	Arne Råheim
REVIEWED BY			
APPROVED BY	Karen Garder	1986-01-22	Karen Garder

1. INTRODUCTION

Headspace cans from well 34/7-7 were received late November 1985 and were analyzed during December 1985.

C_1-C_4 are quantified and the $\delta^{13}C$ value is measured when possible on methane, ethane, propane and the butanes.

2. ANALYTICAL PROCEDURE

The headspace gas was quantified by a Carlo Erba HRGC 5300 gas chromatograph equipped with a FID detector. To be able to do the isotopic measurements the gases have been separated into the different gas components by a Carlo Erba 4200 instrument. This gas chromatograph is equipped with a special injection loop in order to concentrate the samples, in the case of low concentration of the gas components. 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 isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our $\delta^{13}C$ value on NBS 22 is -29.77 $\pm$ .06 o/oo.

3. RESULTS

The composition of the headspace gas are given in Table 1. The results have not been normalized, the rest is air.

The stable isotope results are given in Table 2.

The results are also shown graphically in Figure 1.

Table 1 Composition of headspace gas from well 34/7-7

	Sample depth (m)	Abundance C_1 x 10^4 ppm	C_2 ppm	C_3 ppm	i-C_4 ppm	n-C_4 ppm	ΣC_1-C_4 x 10^4 ppm	ΣC_2-C_4 x 10^4 ppm	Wetness	i-C_4/n-C_4
1	930-940	1.1000	4	2	1	0.6	1.1008	0.0008	<0.01	1.7
	1030-1040	0.1400	2	2	-	-	0.1404	0.0004	<0.01	-
2	1050-1060	0.2800	3	2	-	-	0.2805	0.0005	<0.01	-
3	1130-1140	1.6000	10	4	3	0.8	1.6018	0.0018	<0.01	3.8
4	1230-1240	3.5000	20	15	-	-	3.5035	0.0035	<0.01	-
5	1340-1350	0.5000	5	3	-	-	0.5008	0.0008	<0.01	-
6	1430-1440	0.6000	5	1	-	-	0.6006	0.0006	<0.01	-
7	1530-1540	0.4400	15	5	2	1	0.4423	0.0023	<0.01	2.0
8	1630-1640	0.6700	35	15	10	4	0.6764	0.0064	0.01	2.5
9	1730-1740	0.7500	50	10	5	2	0.7567	0.0067	0.01	2.5
10	1830-1840	0.4600	50	20	7	4	0.4681	0.0081	0.02	1.8
11	1930-1940	0.8100	230	100	20	15	0.8465	0.0365	0.04	1.3
	2030-2040	0.1350	-	-	-	-	-	-	-	-
12	2050-2060	0.6000	550	380	45	60	0.7035	0.1035	0.15	0.75
13	2120-2130	0.2300	150	180	50	85	0.2765	0.0465	0.17	0.59
	2130-2140	0.1200	40	60	15	30	0.1345	0.0145	0.11	0.50
14	2210-2220	0.2100	380	535	100	215	0.3330	0.1230	0.37	0.47
	2230-2240	0.2350	330	450	80	180	0.3390	0.1040	0.31	0.44
15	2320-2330	0.1900	185	435	85	275	0.2880	0.0980	0.34	0.31
	2330-2340	0.0125	50	155	40	115	0.0485	0.0360	0.74	0.35
16	2430-2440	0.3200	405	715	180	620	0.5120	0.1920	0.38	0.29
17	2532-2541	0.0480	355	1360	385	1355	0.3935	0.3455	0.88	0.28
	1595-2604	0.0190	110	415	110	315	0.1140	0.0950	0.83	0.35
	2622-2631	0.0080	40	170	75	270	0.0635	0.0555	0.87	0.28
	2631-2640	0.0050	30	150	55	190	0.0475	0.0425	0.89	0.29
	2748-2757	0.0350	20	15	-	-	0.0385	0.0035	0.09	
	2829-2838	0.0050	6	3	-	-	0.0059	0.0009	0.15	
	2928-2937	0.0020	2	2	-	-	0.0024	0.0004	0.17	
	3054	0.0090	3	3	-	-	0.0096	0.0006	0.06	

Table 2 Isotopic composition of headspace gas from well 34/7-7

Sample	C_1	C_2	C_3	i-C_4	n-C_4
	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$	$\delta^{13}C$
930-940	-71.4				
1050-1060	-72.3				
1130-1140	-73.9				
1230-1240	-75.7				
1340-1350	-72.6				
1430-1440	-65.9				
1530-1540	-57.1				
1630-1640	-56.0				
1730-1740	-56.1				
1830-1840	-56.5				
1930-1940	-50.7	-30.8			
2050-2060	-45.1	-29.9	-31.1	-24.5	
2120-2130	-46.7	-29.4	-30.3	-27.8	-32.4
2210-2220	-47.0	-30.8	-30.8	-26.4	-33.0
2320-2330	-46.3	-31.2	-29.9	-	-32.3
2430-2440	-47.9	-31.0	-31.9	-24.7	-29.7
2532-2541	-46.6	-34.0	-32.8	-23.0	-32.6
2595-2604			-32.4	-24.8	-32.0
2622-2631			-32.0	-27.1	-32.0

4. INTERPRETATION

As seen from Table 1 the composition of the headspace gas are characterized by a rather low abundance. Beneath the reservoir level no isotopic measurements have been possible at all.

As seen from Table 2 the isotopic composition is characterized by rather light isotopic values, indicating a source (or sources) with isotopically light kerogen(s).

The $\delta^{13}C$ values of methane show a biogenic component at least down to about the 1900 m level. Thermogenic methane may have migrated and mixed with biogenic methane to about the 1500 m level.

In some of the cans where isotopic measurements are performed on C_1-C_4 (from 2120 m - 2330 m) the headspace gas shows a rather strange isotopic composition with a reversal in the propane and n-butane composition. This reversal of the isotopic composition may result from a mixture of gases derived from two or multiple sources, or gases from one source but derived at different maturity levels.

The headspace gas from the 2532 - 2541 m level (from the reservoir) shows a normal isotopic composition. These $\delta^{13}C$ values are plotted in the maturity diagram by James (1983)*, Fig. 2. A source LOM of about 12 is indicated, e.g. that the gas was formed at a relatively high maturity in the oil window.

5. CONCLUSION

The $\delta^{13}C$ value of CH_4 shows a biogenic component down to about the 1900 m level, while thermogenic methane may be mixed with biogenic methane up to about the 1500 m level.

The samples from 2120 - 2330 m level have a reversal of the $\delta^{13}C$ values of propane and n-butane compared to normal natural gas samples. This reversal may be due to a mixture of gases derived from two or multiple sources, or gases from one source, but derived at different maturity levels.

* James, Alan T. (1983): Correlation of Natural Gas by Use of Carbon Isotopic Distribution between Hydrocarbon Components, AAPG, Vol. 67, No. 7, July 1983.

The headspace gas from the 2532 - 2541 m level shows a normal isotopic composition. This isotopic composition indicates that the gas (gases) was formed at relatively high maturity in the oil window.

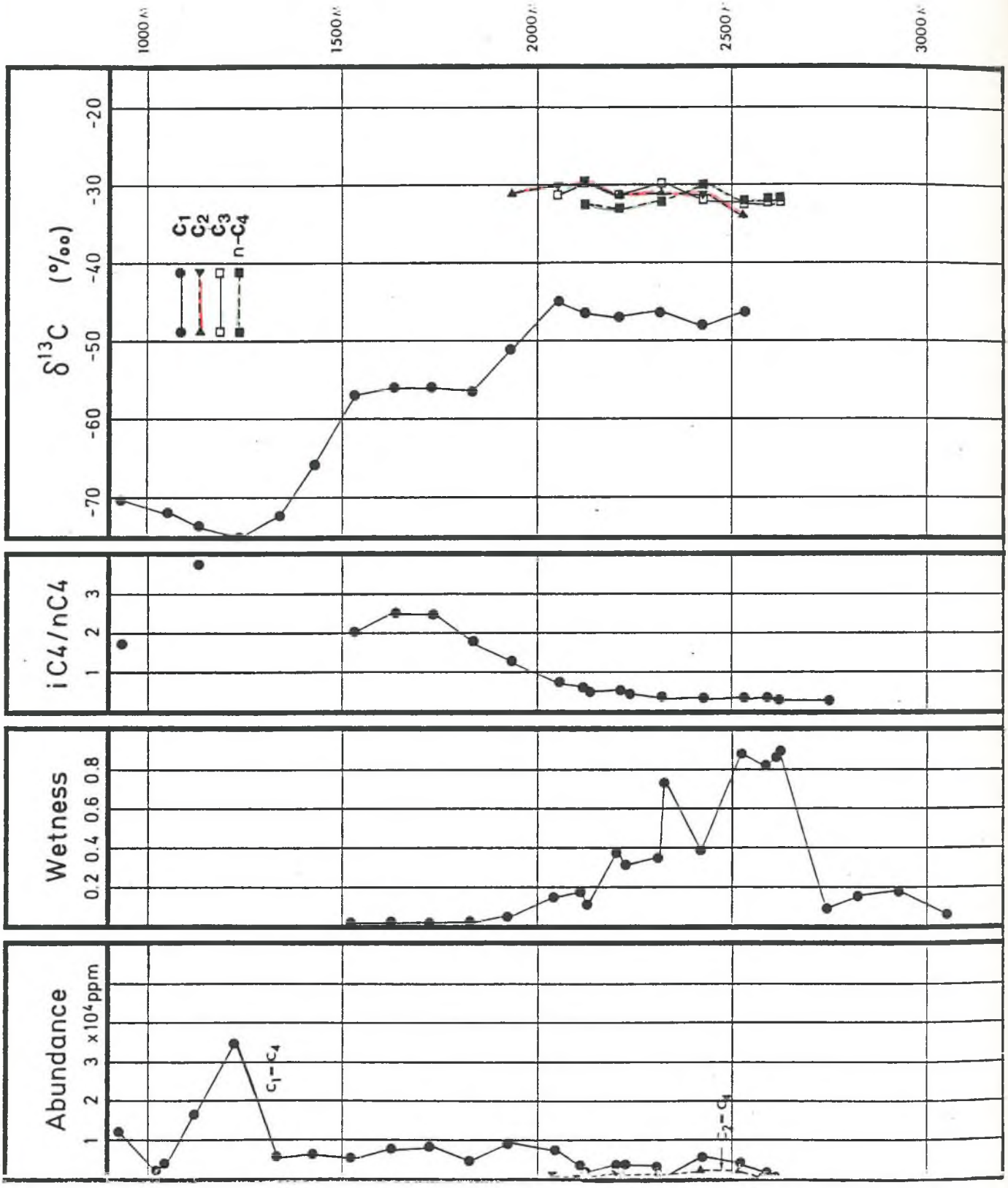

Figure 1 Composition of headspace gas from well 34/7-7

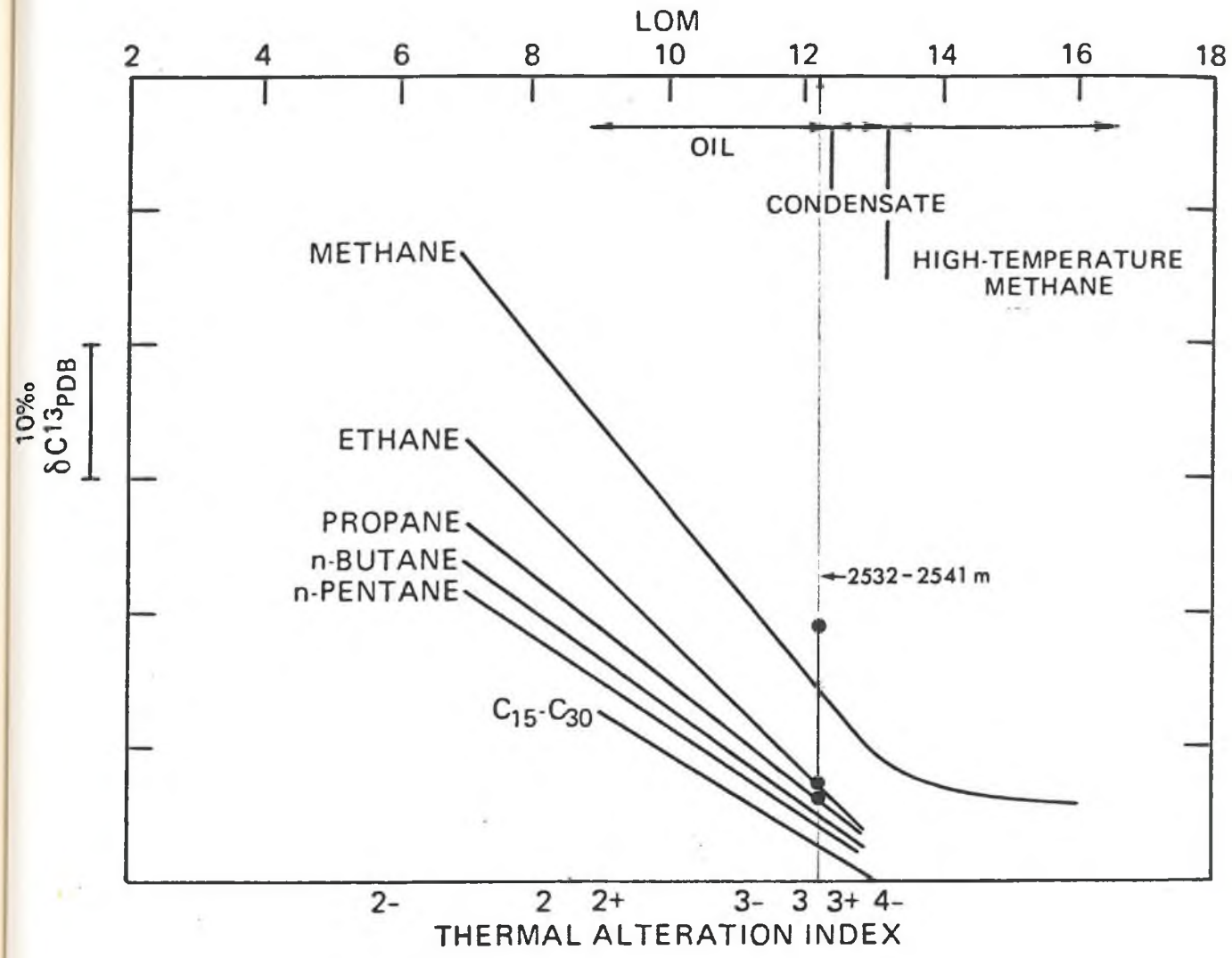

Figure 2. Carbon isotopic separations of gas samples from well 34/7-7 are plotted on the maturity diagram (after James, 1983). A source LOM of 12 is indicated for the gas.

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 $\delta^{13}C$ 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.