5

Institute for energy technology

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

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HEADSPACE GAS GEOCHEMISTRY ON SAMPLES FROM WELL 31/3-3

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SUMMARY

The gas components CH_4, C_2H_6, C_3H_8, iC_4H_{10} and nC_4H_{10} from headspace cans are quantified and the $\delta^{13}C$ value is measured on CH_4 and when possible on C_2H_6, C_3H_8 and nC_4H_{10}.

The $\delta^{13}C$-values of methane shows a biogenic component throughout the whole well, indicating that drainage of thermogenic gases into the reservoir is restricted.

The present data does not suggest bacterial degradation in the possible reservoir formations.

The data are best explained by mixtures of gases of different origin and maturity.

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Berg, J.O.
Andresen, B.
Brevik, E.M.
Garder, K.
Gaudernack, B.
Råheim, A.
Throndsen, T.

Summary
Aamodt, N-G.
Project leaders
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Department heads
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	NAME	DATE	SIGNATURE
PREPARED BY	Bjørg Andresen Einar M. Brevik Arne Råheim Torbjørn Throndsen	1985-01-23	Bjørg Andresen Einar M. Brevik Arne Råheim Torbjørn Throndsen
APPROVED BY	Karen Garder	1985-01-23	Karen Garder

INTRODUCTION

Headspace cans from well 31/3-3 were received in December 1984, and were analyzed early January 1985. C_1-C_4 are quantified and the $\delta^{13}C$ value is measured on methane and when possible on ethane, propane and n-butane.

ANALYTICAL PROSEDURE

The headspace gas were quantified by a Perkin Elmer 3920 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 oxydized in separate CuO-ovens in order to prevent cross contamination. The combustion products CO_2 and H_2O were frozen into collection vessles 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 +/- $.06^0/oo$.

RESULTS

The composition of the headspace gas are given in table 1. The results have not been normalized to 100%. The rest is air.

The stable isotope results are given in table 2. The results are also shown graphically in figure 1.

INTERPRETATION

The isotopic compositions of the head space gases from well 31/3-3 are distinctly different from the other wells which have been analysed from the Troll area.

A comparison between the δ^{13}C-methane distribution of the present well and the wells 31/6-2 and 31/5-1,2 shows that biogenic methane is dominating to about the same stratigraphical level, fig. 2. The biogenic-thermogenic-methane mixture zone also appear to be roughly the same for the wells. The δ^{13}C values of the present well show however that the methanes have a component of biogenic or early diagenetic methane all the way to the 2426 m level (see fig. 1). This is different from the wells reported on earlier.

Contrary to the wells reported on earlier the present results does not indicate bacterial degradation of the gases. The propanes are all isotopically light.

The distribution of the δ^{13}C-values between ethane, propane and n-butane may indicate a high maturity of the gases. The often a bit more negative δ^{13}C-n-butane values compared to the corresponding δ^{13}C-propane values may also indicate some bacterial alteration.

We do, however, think that neither a high maturity for the gas or bacterial degradation are important factors when explaining the present results. Instead, we think that the present data are best explained by mixtures of gases of different origin (biogenic, thermogenic, early diagenetic) and maturity.

The δ^{13}C-values of methane and ethane from the 1949m can are distinctly different from the values of the cans above and below. This is most likely due to bacterial degradation in the can, we suspect that no bacterizide has been added.

CONCLUSION

The pattern of isotopic composition of the headspace gases from the present well is distinctly different from the wells reported on earlier.

The $\delta^{13}C$-values of methane shows a biogenic component throughout the whole well, indicating that drainage of thermogenic gases into the reservoir is restricted. The present data does not suggest bacterial degradation in the possible reservoir formations.

The data are best explained by mixtures of gases of different origin and maturity.

Table 1 Composition of headspace gas from well 31/3-3

Sample depth m	C_1 $\times 10^4$ ppm	C_2 ppm	C_3 ppm	iC_4 ppm	nC_4 ppm	Abundance ΣC_1-C_4 $\times 10^4$ ppm	Abundance ΣC_2-C_4 ppm	Wetness	$\frac{iC_4}{nC_4}$
490	4.0	4	7	0.8	0.7	4.001	13	3.1×10^{-4}	1.14
580	4.6	40	10	4.5	6.1	4.606	61	1.2×10^{-3}	0.74
650	2.9	75	40	0.3	0.8	2.912	116	4.0×10^{-3}	0.38
730	3.66	115	12	4.3	5.6	3.674	137	3.7×10^{-3}	0.75
810	2.2	28	3	1.2	1.5	2.203	34	1.5×10^{-3}	0.80
890	3.9	42	1	0.4	0.4	3.904	44	1.1×10^{-3}	1.00
970	2.8	67	13	5.3	4.6	2.809	90	3.2×10^{-3}	1.15
1050	0.44	10	2	1.1	0.9	0.441	14	3.2×10^{-3}	1.22
1130	0.43	19	7	6.3	4.2	0.434	37	0.01	1.50
1210	0.26	15	7	7.8	4.9	0.263	35	0.01	1.59
1274	0.45	32	15	14	11	0.457	72	0.02	1.27
1382	3.8	400	114	55	25	3.859	594	0.02	2.20
1454	0.14	23	13	-	-	0.144	36	0.03	-
1481	0.04	14	13	13	12	0.046	52	0.11	1.09
1490	0.03	8	5	4.5	3.5	0.035	21	0.06	1.29
1499	0.03	12	6	5.6	4.2	0.033	28	0.08	1.33
1544	0.07	20	15	-	-	0.075	35	0.05	-
1598	0.23	32	28	19	13	0.239	92	0.04	1.46
1706	0.96	873	624	206	200	1.150	1903	0.17	1.03
1769	1.75	1080	840	222	262	1.990	2404	0.12	0.85
1832	0.4	304	340	140	185	0.497	969	0.20	0.76
1886	0.7	669	608	206	196	0.868	1679	0.19	1.05
1940	1.22	867	425	107	112	1.371	1511	0.11	0.96
1949	2.5	1270	745	209	234	2.746	2458	0.09	0.89
1958	0.90	638	345	78	79	1.014	1140	0.11	0.99
2012	3.5	1550	695	154	171	3.757	2570	0.07	0.90
2066	0.8	625	405	124	132	0.929	1286	0.14	0.94
2129	1.9	1240	705	200	191	2.134	2336	0.11	1.05
2192	11.1	5600	1050	132	114	11.790	6896	0.06	1.16
2255	3.7	1390	590	167	177	3.932	2324	0.06	0.94
2309	0.26	185	220	92	141	0.324	638	0.20	0.65
2372	2.6	1060	470	137	159	2.783	1826	0.07	0.86
2426	0.6	340	204	79	93	0.672	716	0.11	0.85
2489	0.04	40	32	13	15	0.048	100	2.1×10^{-3}	0.87
2499	0.07	40	25	12	15	0.078	91	0.12	0.80
2561	0.01	19	20	8.3	9.5	0.018	57	0.31	0.87
2570	0.02	30	22	8.4	9.2	0.025	70	0.28	0.91
2573	0.01	8	8	3.9	4.4	0.010	24	0.23	0.89

Table 2 Isotopic composition of headspace gas from well 31/3-3

Sample depth	$\delta^{13}C_{PDB}$			
m	C_1	C_2	C_3	nC_4
490	-73.6			
580	-74.4			
650	-75.1			
730	-66.4			
810	-67.6			
890	-66.3			
970	-63.3			
1050	-62.6			
1130	-60.7			
1210	-60.5			
1274	-59.8			
1382	-51.7	-30.9		
1454	-58.9			
1544	-53.4			
1598	-54.0			
1706	-51.5	-32.3	-34.3	-34.9
1769	-52.1	-29.3	-31.7	-33.8
1832	-51.9	-31.1	-33.3	-31.8
1886	-50.0	-31.7	-32.5	-30.5
1940	-51.8	-32.0	-31.7	-30.5
1949	-39.5	-28.7	-32.0	-31.9
1958	-51.2	-32.0	-32.1	-31.9
2012	-53.2	-31.5	-32.0	-33.8
2066	-53.6	-32.8	-32.6	-32.9
2129	-49.4	-32.3	-32.0	-30.8
2192	-51.6	-30.2	-32.9	
2255	-49.4	-32.2	-31.5	
2309	-48.2			
2372	-49.1	-30.3	-28.6	-33.5
2426	-51.2	-29.5		

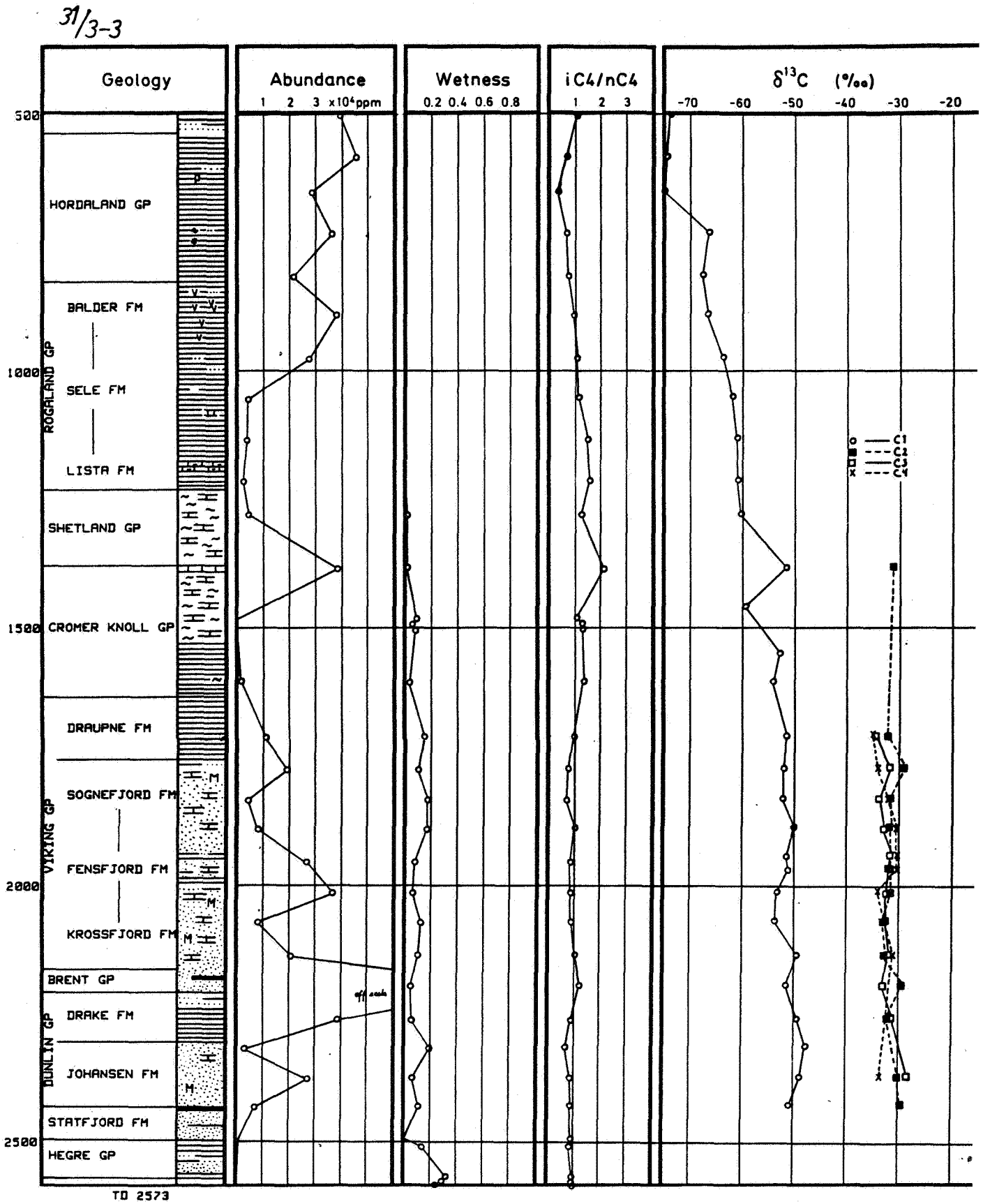

Figure 1. The composition of headspace gas from well 31/3-3.

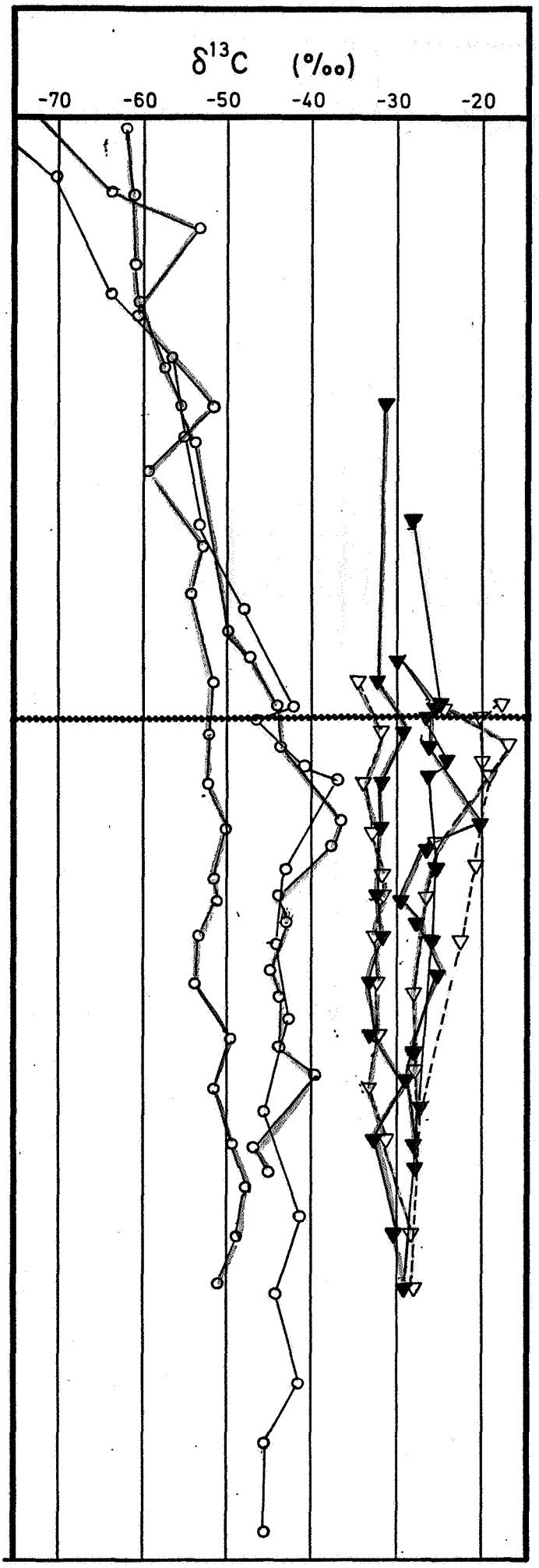

Figure 2: The isotopic composition of gas samples from well 31/3-31/6-2 and 31/5-1,2.